Areva EPRDCPEm Resource

From:	WELLS Russell (AREVA) [Russell.Wells@areva.com]
Sent:	Thursday, March 31, 2011 8:01 PM
To:	Tesfaye, Getachew
Cc:	GUCWA Len (EXTERNAL AREVA); BENNETT Kathy (AREVA); DELANO Karen (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 434, FSAR Ch. 6, Supplement 4
Attachments:	RAI 434 Supplement 4 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 434 on November 15, 2010. AREVA NP submitted Supplement 1, Supplement 2 and Supplement 3 to the response on January 26, 2011, February 24, 2011, and March 16, 2011 to provide revised response schedules.

The attached file, "RAI 434 Supplement 4 Response US EPR DC.pdf" provides technically correct and complete responses to the remaining 11 questions, as committed.

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 434 Questions 06.02.02-71, 06.02.02-72, 06.02.02-74, and 06.02.02-75.

The following table indicates the respective pages in the response document, "RAI 434 Supplement 4 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 434 — 06.02.02-69	2	2
RAI 434 — 06.02.02-70	3	4
RAI 434 — 06.02.02-71	5	8
RAI 434 — 06.02.02-72	9	34
RAI 434 — 06.02.02-73	35	36
RAI 434 — 06.02.02-74	37	37
RAI 434 — 06.02.02-75	38	38
RAI 434 — 06.02.02-76	39	39
RAI 434 — 06.02.02-77	40	41
RAI 434 — 06.02.02-78	42	43
RAI 434 — 06.02.02-79	44	44

This concludes the formal AREVA NP response to RAI 434 and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

From: WELLS Russell (RS/NB)
Sent: Wednesday, March 16, 2011 4:31 PM
To: Tesfaye, Getachew
Cc: GUCWA Len (External RS/NB); BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 434, FSAR Ch. 6, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 434 on November 15, 2010. AREVA NP submitted Supplement 1 to the response on January 26, 2011 to provide a revised response schedule. Supplement 2 response to RAI 434 was provided on February 24, 2011 to provide a revised schedule for responding to Questions 06.02.02-70, 06.02.02-75 and 06.02.02-77.

To provide an opportunity for additional interaction with the NRC staff, AREVA NP is providing a revised schedule for responding to Questions 06.02.02-69, 06.02.02-71, 06.02.02-72, 06.02.02-73, 06.02.02-74, 06.02.02-76, 06.02.02-78, and 06.02.02-79. The schedule for the remaining questions is unchanged.

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

Question #	Response Date
RAI 434 — 06.02.02-69	**March 31, 2011**
RAI 434 — 06.02.02-70	March 31, 2011
RAI 434 — 06.02.02-71	**March 31, 2011**
RAI 434 — 06.02.02-72	**March 31, 2011**
RAI 434 — 06.02.02-73	**March 31, 2011**
RAI 434 — 06.02.02-74	**March 31, 2011**
RAI 434 — 06.02.02-75	March 31, 2011
RAI 434 — 06.02.02-76	**March 31, 2011**
RAI 434 — 06.02.02-77	March 31, 2011
RAI 434 — 06.02.02-78	**March 31, 2011**
RAI 434 — 06.02.02-79	**March 31, 2011**

Sincerely,

Russ Wells
U.S. EPR Design Certification Licensing Manager
AREVA NP, Inc.
3315 Old Forest Road, P.O. Box 10935
Mail Stop OF-57
Lynchburg, VA 24506-0935
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Russell.Wells@Areva.com

From: WELLS Russell (RS/NB)
Sent: Thursday, February 24, 2011 5:11 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); BENNETT Kathy (RS/NB); ROMINE Judy (RS/NB); BRYAN Martin (External RS/NB); GUCWA Len (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 434, FSAR Ch. 6, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 434 on November 15, 2010. AREVA NP submitted Supplement 1 to the response on January 26, 2011 to provide a revised response schedule. To provide an opportunity for additional interaction with the NRC staff, AREVA

NP is providing a revised schedule for responding to Questions 06.02.02-70, 06.02.02-75 and 06.02.02-77. The schedule for the remaining questions is unchanged.

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

Question #	**Response Date**
RAI 434 — 06.02.02-69	March 16, 2011
RAI 434 — 06.02.02-70	**March 31, 2011**
RAI 434 — 06.02.02-71	March 25, 2011
RAI 434 — 06.02.02-72	March 25, 2011
RAI 434 — 06.02.02-73	March 16, 2011
RAI 434 — 06.02.02-74	March 16, 2011
RAI 434 — 06.02.02-75	**March 31, 2011**
RAI 434 — 06.02.02-76	March 16, 2011
RAI 434 — 06.02.02-77	**March 31, 2011**
RAI 434 — 06.02.02-78	March 16, 2011
RAI 434 — 06.02.02-79	March 16, 2011

Sincerely,

Russ Wells
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From: BRYAN Martin (External RS/NB)
Sent: Wednesday, January 26, 2011 12:16 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); GUCWA Len (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 434, FSAR Ch. 6, Supplement 1

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the 11 questions in RAI No. 434 on November 15, 2010. To allow additional time to finalize the responses and interact with the NRC, a revised schedule is provided.

The schedule for providing a complete response to the remaining questions has been revised as indicated below.

Question #	**Response Date**
RAI 434 — 06.02.02-69	March 16, 2011
RAI 434 — 06.02.02-70	March 16, 2011
RAI 434 — 06.02.02-71	March 25, 2011

RAI 434 — 06.02.02-72	March 25, 2011
RAI 434 — 06.02.02-73	March 16, 2011
RAI 434 — 06.02.02-74	March 16, 2011
RAI 434 — 06.02.02-75	March 16, 2011
RAI 434 — 06.02.02-76	March 16, 2011
RAI 434 — 06.02.02-77	March 25, 2011
RAI 434 — 06.02.02-78	March 16, 2011
RAI 434 — 06.02.02-79	March 16, 2011

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Monday, November 15, 2010 4:58 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); GUCWA Len (External RS/NB); 'Miernicki, Michael'
Subject: Response to U.S. EPR Design Certification Application RAI No. 434, FSAR Ch. 6

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 434 Response US EPR DC.pdf," provides a schedule since a technically correct and complete response to the 11 questions is not provided.

The following table indicates the respective pages in the response document, "RAI 434 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 434 — 06.02.02-69	2	2
RAI 434 — 06.02.02-70	3	3
RAI 434 — 06.02.02-71	4	5
RAI 434 — 06.02.02-72	6	6
RAI 434 — 06.02.02-73	7	7
RAI 434 — 06.02.02-74	8	8
RAI 434 — 06.02.02-75	9	9
RAI 434 — 06.02.02-76	10	10
RAI 434 — 06.02.02-77	11	11
RAI 434 — 06.02.02-78	12	12
RAI 434 — 06.02.02-79	13	13

A complete answer is not provided for 11 of the 11 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 434 — 06.02.02-69	January 26, 2011
RAI 434 — 06.02.02-70	January 26, 2011
RAI 434 — 06.02.02-71	January 26, 2011
RAI 434 — 06.02.02-72	January 26, 2011
RAI 434 — 06.02.02-73	January 26, 2011
RAI 434 — 06.02.02-74	January 26, 2011
RAI 434 — 06.02.02-75	January 26, 2011
RAI 434 — 06.02.02-76	January 26, 2011
RAI 434 — 06.02.02-77	January 26, 2011
RAI 434 — 06.02.02-78	January 26, 2011
RAI 434 — 06.02.02-79	January 26, 2011

Sincerely,

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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, October 15, 2010 11:11 AM
To: ZZ-DL-A-USEPR-DL
Cc: Ashley, Clinton; Jackson, Christopher; McKirgan, John; Carneal, Jason; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 434 (4897), FSAR Ch. 6

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on August 6, 2010, and discussed with your staff on September 24, 2010. No changes were made to the draft RAI as a result of that discussion. 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: 2795

Mail Envelope Properties (1F1CC1BBDC66B842A46CAC03D6B1CD41042B9CDB)

Subject: Response to U.S. EPR Design Certification Application RAI No. 434, FSAR Ch. 6, Supplement 4
Sent Date: 3/31/2011 8:00:44 PM
Received Date: 3/31/2011 8:00:52 PM
From: WELLS Russell (AREVA)

Created By: Russell.Wells@areva.com

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Files	**Size**	**Date & Time**
MESSAGE	10229	3/31/2011 8:00:52 PM
RAI 434 Supplement 4 Response US EPR DC.pdf		259384

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

Response to

Request for Additional Information No. 434, Supplement 4

10/15/2010

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 06.02.02 - Containment Heat Removal Systems
Application Section: 6.3

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects)
(SPCV)

Question 06.02.02-69:

Follow-Up to RAI 310, Question 06.03-14 and RAI 363, Question 06.02.02-43:

US EPR FSAR Tier 2, Section 6.3.3.3 “NPSH Evaluation” states the SIS pump NPSH evaluation for LBLOCA events is performed using the maximum pump flow head-capacity curves. The response to RAI 310, Question 06.03-14, indicates the design basis maximum flow through one sump is 3447 gpm (MHSI and LHSI combined flow). In the response to RAI 363, Question 06.02.02-43, the flow through the sump used for strainer qualification is 3284 gpm. It appears that strainer qualification flow does not bound the design basis maximum flow. Therefore, provide a detailed discussion of AREVA's approach to selecting the plant ECCS flow rate used for strainer qualification and justify the described approach.

Response to Question 06.02.02-69:

The U.S. EPR safety injection system (SIS) design basis maximum flow rate of 3447 gpm (combined medium head safety injection (MHSI) and low head safety injection (LHSI) flow through one sump) is based on the following conservative assumptions:

- Increased pump performance.
- Reduced pipe friction (i.e., decreased pressure drops).
- No debris loss across strainers.

The strainer qualification test procedure was revised to reflect the higher flow rate of 3447 gpm.

FSAR Impact:

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

Question 06.02.02-70:

Follow-up to RAI 111, Question 06.02.02-8E4:

The NRC safety evaluation report on NEI 04-07 guidance report discusses “miscellaneous debris” and provides a method the staff finds acceptable for evaluating this debris source. AREVA debris generation analysis assumes 100 ft^2 and 50 lbm of “miscellaneous debris”. For the 100 ft^2 assumption, it is not clear how AREVA applied this assumption to the screen area as part of their analysis and qualification testing. For the 50 lbm, AREVA deviates from guidance (i.e. fiber assumption) and did not justify the approach. Both of these “miscellaneous debris” issues impact qualification testing. The staff requests that AREVA justify their method and approach to “miscellaneous debris” in comparison to guidance and explain how qualification testing incorporates debris generation analysis “miscellaneous debris” assumptions.

Response to Question 06.02.02-70:

The amount of miscellaneous debris was assumed because a walkdown of the plant, to determine miscellaneous debris sources, was not possible. An area of 100 ft^2 was assumed as miscellaneous debris. Volume 2 of the NEI 04-07 guidance recommends that the wetted flow area of the sump screen should be reduced by 75 percent of the total single-sided area of the miscellaneous debris items. The qualification testing thereby must account for a sacrificial screen area of 75 ft^2.

The U.S. EPR employs a unique retaining basket and strainer design. Because miscellaneous debris will be confined in the retaining basket and not transport to the strainer, a sacrificial area was applied to the retaining basket. There are two different types of retaining basket designs within the in-containment refueling water storage tank (IRWST): a single compartment retaining basket and a double compartment retaining basket.

The single compartment retaining basket provides more surface area (approximately 784 ft^2) for capturing loss of coolant accident (LOCA)-generated debris from the heavy floor than the double compartment retaining basket, which is divided into two sections. The double compartment retaining basket has a screened divider separating the two compartments (front and back) within the basket. The screened divider contains the same mesh that surrounds the basket. The double compartment retaining basket is designed to capture debris laden water from the heavy floor in only the front compartment. The front portion of the double basket, excluding the screened divider, has a total surface area of approximately 642 ft^2. This area was scaled by 9.37 percent to 60.2 ft^2 and used for strainer qualification testing.

To account for miscellaneous debris and the sacrificial screen criterion of 75 ft^2, the screened area of the double compartment retaining basket divider is not credited in strainer qualification testing. The screened area of the basket divider is greater than 75 ft^2 and is considered the sacrificial screen area assumed in the U.S. EPR debris generation analysis.

The U.S. EPR debris generation calculation has been revised to remove 50 lbs of miscellaneous debris. The 50 pounds of miscellaneous debris was included for conservatism, but has since been removed from the debris source term.

FSAR Impact:

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

Question 06.02.02-71:

Follow-up to RAI 363, Question 06.02.02-43 item 11:

Analysis of the most challenging postulated accident with regard to sump performance during long-term core cooling involves selection of the most limiting pipe break size, location, and debris combination within containment. RG 1.82 position C.1.3.2.3 states that a sufficient number of breaks in each high pressure system that relies on recirculation should be considered. The NEI 04-07 GR states that the objective of the break selection process is to identify the break size and location which results in debris generation that produces the maximum head loss across the sump screen.

For the US EPR, ANP-10293 indicates there are two main paths for debris to enter the IRWST and potentially transport to the sump strainer. The two main paths for debris to enter the IRWST are from the heavy floor and the annular floor. The flow from these floors is filtered by debris interceptors called retaining baskets. Flow from the heavy floor to the IRWST is filtered by a large basket. Flow from the annular floor to the IRWST is filtered by a small basket.

The retaining basket performance is critical for analyzing and measuring strainer performance because the basket is designed to capture debris and keep it from reaching the strainer. However, the basket can overflow and as a result, debris can bypass the retaining basket and transport to the strainer. Therefore, in order to assess what causes the maximum head loss across the sump screen, a complete understanding of basket performance is necessary. Since the maximum head loss for US EPR is determined by testing, it is important to evaluate the performance of each debris flow path to the IRWST and their associated debris interceptors (retaining baskets).

AREVA's analysis and testing approach to date has focused on the large retaining basket. In RAI 363, Question 06.02.02-43 item 11, AREVA was asked how the small compartment retaining basket was bounded by testing for the large compartment retaining basket. In a June 17, 2010, phone call discussing this question and AREVAs response, AREVA indicated that the small compartment retaining basket no longer receives water from the annular floor due to a design change that redirected pressurizer room break flow from the annular floor to the heavy floor. It was also mentioned that the annular floor will only receive water from condensation and it will not fill up and spill into the small compartment basket located in the IRWST. Because this information is not be docketed and has not been fully explained , the staff requests AREVA to document the assessment of whether pipe breaks (consistent with RG 1.82 and NEI 04-07 guidance) can deliver water and/or debris to the annular floor. Provide a listing of potential systems that were considered and why they can or cannot deliver water to the annular region. If they can, then assess the impact on small basket performance and strainer head loss (debris generation, debris transport, and debris accumulation). As part of the discussion clearly define the purpose of the small retaining basket and document this discussion in ANP-10293.

In addition, the staff request that AREVA provide a complete assessment of the annular floor region and its water hold-up capacity in response to a design basis accident that requires recirculation. Include in the discussion the annular region water sources (pipe break, condensation), how high the water level can rise in the annular region, what limits the height of the water level in the annular region, identify any compartment(s) into which the water from the annular region spills, and describe any components (dampers, valves) that need to actuate/function/operate in order to allow the annular region to spill into another compartment (e.g. IRWST). If condensation is the sole source of water collecting in the annular region, describe the method and approach used to assess the amount of condensate that could collect in the annular region.

Response to Question 06.02.02-71:

For a large break loss of coolant accident (LBLOCA), the annular space will receive water from condensation that spills into the small compartment of the double compartment retaining basket and into the single compartment retaining basket. The U.S. EPR design has two double compartment retaining baskets and two single compartment retaining baskets located in the IRWST. All four retaining baskets collect and filter flow from the annular space. U.S. EPR FSAR Tier 2, Section 6.3.2 will be clarified in this regard. The small compartment is no longer used for fibrous material collection, except from latent debris.

Water entering the annular region will spill into the IRWST via seven openings. The openings are not controlled by any components and will begin spilling water into the IRWST when the level in the annular region rises above the four inch high weirs of the openings. The height of retained water in the annular region will be four inches plus a dynamic head height, which will vary depending on the flow of condensation into the annular region. Another factor which increases the dynamic head height is the width of the weir; a smaller width yields a larger dynamic head height. The total width of the openings is approximately 25 ft 7in; however, in the water retention analysis a conservative value of 20 ft is used.

In the long term, the primary water source in the annular region is condensation. However, during the blowdown phase of the LBLOCA there may be sufficient pressure difference between the equipment space and the service space to force water from the IRWST to the annular area. The exact amount of water displaced from the IRWST is dependent on a number of interrelated factors for each break scenario. Therefore, a bounding scenario that would allow the annular area to be filled up to the weir height by liquid from the IRWST in the first 18 seconds is applied.

The amount of condensation spilling into the annular region is determined by calculating a ratio of the surface areas for all compartments that spill condensate into the annular region and comparing the total internal surface area of the Reactor Building. This ratio is then applied to the total condensation rate of the Reactor Building. The total condensation rate is determined by using the total amount of energy absorbed by all of the heat structures in the GOTHIC multi-node model and the latent heat of vaporization at containment pressure saturated conditions. This method conservatively assumes that all energy absorbed by a heat structure relates to the condensing of steam and that the condensation rate is proportionally distributed in the Reactor Building based on the amount of surface area. A list of rooms that are assumed to spill condensate into the annular region is provided in Table 06.02.02-71-1.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 6.3.2 will be revised as described in the response and indicated on the enclosed markup.

Table 06.02.02-71-1—Rooms that Drain Condensate into Annular Region

Room	Description	Surface Area (ft²)	% of Total SA
UJA07013	Access Area	4214.29	1.00
UJA07014	Area for JND, JNG & JMQ (MHSI, LHSI, SAHRS) Pipe Penetrations	6858.78	1.62
UJA07015	Area for JND, JNG & JMQ (MHSI, LHSI, SAHRS) Pipe Penetrations	6986.92	1.65
UJA07016	Area for Hot Pipe Penetrations from UFA	7520.54	1.78
UJA07018	LCQ (SGBS) HX Room	3648.70	0.86
UJA11013	Loop 1 Annular Area 180-270 Deg	5601.81	1.33
UJA11014	Loop 2 Annular Area 270-0 Deg	3928.62	0.93
UJA11015	Loop 3 Annular Area 0-90 Deg	4287.86	1.02
UJA11016	Loop 4 Annular Area 90-180 Deg	5702.91	1.35
UJA11020	Access to Personnel Airlock	3778.52	0.89
UJA11021	FAL (FPPS) Valve Room	839.27	0.2
UJA11025	JND & JNG (MHSI & LHSI) Valve 1 Room	1210.21	0.29
UJA11026	JND & JNG (MHSI & LHSI) Valve 2 Room	1060.47	0.25
UJA11027	JND & JNG (MHSI & LHSI) Valve 3 Room	1060.47	0.25
UJA11028	JND & JNG (MHSI & LHSI) Valve 4 Room	1210.21	0.29
UJA11031	Access to Loop 1 & 2 Area	654.45	0.15
UJA11032	Access to Loop 3 & 4 Area	654.45	0.15
UJA15013	JNG13 (LHSI) Tank & Loop 1 Annular Area	3782.21	0.9
UJA15014	JNG23 (LHSI) Tank & Loop 2 Annular Area	4482.89	1.06
UJA15015	JNG33 (LHSI) Tank & Loop 3 Annular Area	4759.5	1.13
UJA15016	JNG43 (LHSI) Tank & Loop 4 Annular Area	4420.76	1.05
UJA15020	Access to Transfer Tube Compartment	1232.47	0.29
UJA15021	Transfer Tube Compartment	1087.95	0.26
UJA15023	Instrumentation Lances Storage Room	654.73	0.15
UJA15025	FAL (FPPS) Room	881.07	0.21
UJA18013	JNG13 (LHSI) Tank & Loop 1 Annular Area	3762.42	0.89
UJA18014	JNG23 (LHSI) Tank & Loop 2 Annular Area	4493.34	1.06
UJA18015	JNG33 (LHSI) Tank & Loop 3 Annular Area	4202.81	0.99
UJA18016	JNG43 (LHSI) Tank & Loop 4 Annular Area	3829.62	0.91
UJA23013	JNG13 (LHSI) Tank & Loop 1 Annular Area	5286.01	1.25
UJA23014	JNG23 (LHSI) Tank & Loop 2 Annular Area	5670.3	1.34
UJA23015	JNG33 (LHSI) Tank & Loop 3 Annular Area	5495.17	1.3
UJA23016	JNG43 (LHSI) Tank & Loop 4 Annular Area	5461.96	1.29
UJA23042	Instrumentation Measuring Cabinets Room	1786.31	0.42
UJA29013	Setdown Area, Operating floor	8444.62	2
UJA29014	Annular Area, 240-0 Deg	7751.37	1.83
UJA29015	Annular Area, 0-120 Deg	5728.13	1.36
UJA29016	Access to Equipment Hatch	6205.06	1.47
UJA29018	Access to Operating Floor	2476.75	0.59
UJA29022	KLA51/52 Compressor & KLA50 Filter (CBVS) Room	2822.09	0.67
UJA29023	Access to Emergency Airlock	2618.05	0.62

UJA34014	Annular Area, 240-0 Deg	6170.05	1.46
UJA34015	Annular Area, 0-120 Deg	8078.52	1.91
UJA34018	RPV Closure Head Storage Area	2136.58	0.51
UJA34022	JEG (RPS) Valve Room	1418.31	0.34
UJA40001	Dome	41306.5	9.78
	Total	**215664.01**	**51.05**

Note: “Percent of total surface area (SA)” considers the total surface area for those structures inside reactor containment.

Question 06.02.02-72:

Follow-up to RAI 111, Question 06.02.02-8, and RAI 233, Question 06.02.02-29 Regarding Upstream Effects and water hold-up:

Upstream effects and water holdup is an important aspect of Generic Safety Issue (GSI) 191 and NEI 04-07, especially where curbs or weirs or flooding berms are used to hold up debris and water. In RAI 111, Question 06.02.02-8 responses, AREVA provides a discussion of the US EPR upstream effects and provides water hold-up information in the Supplement 4 response to RAI 233, Question 06.02.02-29. This information is an important design detail to support resolution of GSI-191 upstream effects and water hold-up. However, minimal upstream effects and water hold information is provided in the FSAR. In addition, ANP 10293 Rev 1, “US EPR Design Features to Address GSI-191”, assesses the US EPR design with respect to NEI 04-07 and RG 1.82 but provides a limited discussion on upstream effects and water holdup. The staff requests that AREVA document their upstream effects and water hold-up evaluation in ANP-10293 or the FSAR and include a summary of design information such as a table listing hold-up volumes and their location (floors, steam, condensate, trapped in compartments etc.).

Response to Question 06.02.02-72:

The mass of water holdup in the Reactor Building is examined during various phases of the transient: blowdown, refill/reflood, post reflood, peak containment pressure, peak IRWST temperature, and half peak containment pressure. There are several different categories analyzed for water holdup: condensate on walls and ceilings, water retained in steam and droplet phase within the containment atmosphere, and water retained on floors.
The tables below are based on condensation being the only source of water in the annular area. During blowdown there may be sufficient pressure difference between the equipment space and the service space to force water from the IRWST into the annular area. The exact amount of IRWST water that could be displaced is dependent on a number of interrelated factors for each break scenario. Therefore in the water retention analysis a worst case evaluation was made assuming that the annular area would instantly fill to the height of the weir with IRWST liquid. The total retained mass values only changed during the first three analyzed times as the annular area is already filled to the weirs in the remaining times. The results showed that the water hold up was still within the margin of allowable IRWST inventory for NPSH. The most limiting case in terms of NPSH was still at one hour.

Table 06.02.02-72-1 lists the wall condensation film thickness during each phase. The mass of condensation on walls in each compartment is listed in Table 06.02.02-72-2.

Table 06.02.02-72-3 lists the volume of condensation drops on ceilings per square foot. The mass of condensation on the ceiling of each compartment during each phase is listed in Table 06.02.02-72-4.

Table 06.02.02-72-5 lists the mass of water retained during the steam and droplet phase in the containment atmosphere.

Table 06.02.02-72-6 lists the depths of flooding level within the lower annular region during the different phases. Table 06.02.02-72-7 lists the depths of flooding level on the heavy floor at the different phases. Table 06.02.02-72-8 lists the flooding depths of the compartments which will flood due to curbs/doors. The rooms listed in Table 06.02.02-72-8 do not include the core spreading area and the reactor cavity. Table 06.02.02-72-9 lists the mass of water retained on floors in the annular region, heavy floor, and behind doors/curbs in other compartments.

The mass of retained water re-injected into the reactor coolant system (RCS) is calculated using the maximum flow of safety injection pumps in the beginning of the transient. After the end of reflood, the mass of retained water re-injected into the RCS is calculated based on the RCS volumes. The values of the mass of retained water re-injected into the RCS for each phase are listed in Table 06.02.02-79-10.

In the water retention analysis, it is assumed that one of the double compartment retaining baskets becomes clogged and is completely filled with water. Based on the volume of the retention compartments above the IRWST level, the retained mass for the clogged basket is 68,064 lbm. This mass is conservatively applied during each phase.

Table 06.02.02-79-10 lists the total mass of retained water in the Reactor Building for each analysis during a transient.

A summary of the water holdup evaluation is included in Section 3.2.5 of Technical Report ANP-10293P, Revision 3, “U.S. EPR™ Design Features to Address GSI-191.” U.S. EPR FSAR Tier 2, Section 6.3.6 will be revised to include this revision of the technical report.

The peak, post-LOCA IRWST temperature (246.2˚F) will also be revised in U.S. EPR FSAR Tier 2, Section 6.3.3.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 1.6-1, Section 6.3.3 and Section 6.3.6 will be revised as described in the response and indicated on the enclosed markup.

Table 06.02.02-72-1—Film Thickness of Wall Condensate

Parameter	During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Time (s)	29.18	60.09	600.10	3600.11	12304.73	40122.71
Containment Pressure (psia)	66.37	63.44	65.15	69.27	61.63	41.97
Liquid Conductivity (Btu/°F·ft·h)	0.397	0.398	0.397	0.397	0.398	0.398
Liquid Viscosity (lbm/ft·h)	0.443	0.447	0.445	0.439	0.452	0.504
Liquid Density (lbm/ft^3)	57.33	57.42	57.37	57.24	57.49	58.24
Vapor Density (lbm/ft^3)	0.1532	0.1468	0.1505	0.1595	0.1429	0.0996
Latent Heat of Vaporization (Btu/lbm)	910.60	912.69	911.48	908.52	914.19	932.9
Tsat – Ts (°F)	195.38	180.97	52.93	17.41	11.39	9.64
Height, L (ft)	134.2	134.2	134.2	134.2	134.2	134.2
Average Film Thickness (ft)	**0.00157**	**0.00154**	**0.00113**	**0.00086**	**0.00077**	**0.00075**

Table 06.02.02-72-2—Mass of Condensation on Walls

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA04002	Spreading Area	2390.9	215.15	211.71	155.41	117.27	106.35	104.95
UJA04003	IRWST	53.8	4.84	4.76	3.50	2.64	2.39	2.36
UJA04004	KT (NI DVS) Sump Room	561.9	50.56	49.76	36.52	27.56	24.99	24.67
UJA04005	Flooding Device Compartment	1907.6	171.66	168.92	124.00	93.56	84.85	83.74
UJA04006	Flooding Device Compartment	1907.6	171.66	168.92	124.00	93.56	84.85	83.74
UJA04012	Elevator	533.9	48.04	47.28	34.70	26.19	23.75	23.44
UJA04013	Access Area	418.8	37.69	37.08	27.22	20.54	18.63	18.38
UJA07001	Reactor Cavity	1709.5	153.83	151.38	111.12	83.85	76.04	75.04
UJA07003	IRWST Area	2709.5	243.82	239.93	176.12	132.89	120.52	118.94
UJA07004	KT (NI DVS) Sump Room	592.1	53.28	52.43	38.49	29.04	26.34	25.99
UJA07012	Elevator	437.1	39.33	38.71	28.41	21.44	19.44	19.19
UJA07013	Access Area	1986.1	178.72	175.87	129.10	97.41	88.34	87.18
UJA07014	Pipe Penetrations	2751.5	247.60	243.64	178.85	134.95	122.39	120.78
UJA07015	Pipe Penetrations	2807.5	252.64	248.60	182.49	137.70	124.88	123.24
UJA07016	Pipe Penetrations	3340.4	300.59	295.79	217.13	163.84	148.58	146.63
UJA07017	Venting Area for Spreading Compartment	547.9	49.30	48.52	35.61	26.87	24.37	24.05
UJA07018	LCQ (SGBS) HX Room	1532.9	137.94	135.74	99.64	75.19	68.18	67.29
UJA07020	KT (NI DVS) Floor Drain and Tank Room	784.8	70.62	69.49	51.01	38.49	34.91	34.45
UJA07021	KTA10 (NI DVS) HX Room	574.8	51.72	50.90	37.36	28.19	25.57	25.23
UJA07022	KTA10 (NI DVS) Pumps Room	900.0	80.99	79.69	58.50	44.14	40.03	39.51
UJA07023	KTA10 (NI DVS) Floor Drain and Tank Room	803.1	72.27	71.11	52.20	39.39	35.72	35.25
UJA07024	KT (RCDT) Tank Room	771.8	69.45	68.34	50.17	37.85	34.33	33.88
UJA07026	KBA12 (CVCS) HX Room	713.7	64.22	63.20	46.39	35.01	31.75	31.33
UJA07027	KBA11 (CVCS) HX Room	734.2	66.07	65.01	47.72	36.01	32.66	32.23
UJA07028	KBA (CVCS) Valve Room	740.6	66.64	65.58	48.14	36.32	32.94	32.51
UJA07029	KBA (CVCS) Valve Room	582.4	52.41	51.57	37.86	28.57	25.91	25.56
UJA11001	JAA10 (RPV) Room	1095.9	98.62	97.04	71.24	53.75	48.75	48.11

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA11002	JEB10 (RCP) Oil Collection Tank Area	932.2	83.89	82.55	60.59	45.72	41.47	40.92
UJA11003	JEA10 (SG) Supports Area	504.9	45.43	44.71	32.82	24.76	22.46	22.16
UJA11004	JEA20 (SG) Supports Area	504.9	45.43	44.71	32.82	24.76	22.46	22.16
UJA11005	JEB20 (RCP) Oil Collection Tank Area	936.6	84.28	82.94	60.88	45.94	41.66	41.11
UJA11006	JEB30 (RCP) Oil Collection Tank Area	936.6	84.28	82.94	60.88	45.94	41.66	41.11
UJA11007	JEA30 (SG) Supports Area	504.9	45.43	44.71	32.82	24.76	22.46	22.16
UJA11008	JEA40 (SG) Supports Area	504.9	45.43	44.71	32.82	24.76	22.46	22.16
UJA11009	JEB40 (RCP) Oil Collection Tank Area	932.2	83.89	82.55	60.59	45.72	41.47	40.92
UJA11010	South Staircase	574.8	51.72	50.90	37.36	28.19	25.57	25.23
UJA11012	Elevator	419.8	37.78	37.17	27.29	20.59	18.67	18.43
UJA11013	Loop 1 Annular Area 180-270 Deg	2488.9	223.97	220.39	161.78	122.07	110.71	109.25
UJA11014	Loop 2 Annular Area 270-0 Deg	1820.4	163.81	161.20	118.33	89.29	80.97	79.91
UJA11015	Loop 3 Annular Area 0-90 Deg	1906.5	171.56	168.82	123.93	93.51	84.80	83.69
UJA11016	Loop 4 Annular Area 90-180 Deg	2505.0	225.42	221.82	162.83	122.86	111.43	109.96
UJA11017	Venting Area for Spreading Compartment	724.5	65.20	64.15	47.09	35.53	32.23	31.80
UJA11018	LCQ50 (SGBS) Tank Room	2146.5	193.16	190.07	139.53	105.28	95.48	94.22
UJA11019	JEG (PRT) Tank Room	1537.2	138.33	136.12	99.92	75.40	68.38	67.48
UJA11020	Access to Personnel Airlock	1711.6	154.02	151.56	111.26	83.95	76.13	75.13
UJA11021	FAL (FPPS) Valve Room	591.0	53.18	52.33	38.42	28.99	26.29	25.94
UJA11022	KBA (CVCS) Valve Room	856.9	77.11	75.88	55.70	42.03	38.12	37.61
UJA11023	KBA (CVCS) Valve Room	1398.4	125.84	123.83	90.90	68.59	62.20	61.38
UJA11024	KBA10 (CVCS) HX Room	812.8	73.14	71.97	52.83	39.87	36.15	35.68
UJA11025	JND & JNG (MHSI & LHSI) Valve 1 Room	818.1	73.62	72.44	53.18	40.13	36.39	35.91
UJA11026	JND & JNG (MHSI & LHSI) Valve 2 Room	747.1	67.23	66.16	48.56	36.64	33.23	32.79
UJA11027	JND & JNG (MHSI & LHSI) Valve 3	747.1	67.23	66.16	48.56	36.64	33.23	32.79

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
	Room							
UJA11028	JND & JNG (MHSI & LHSI) Valve 4 Room	818.1	73.62	72.44	53.18	40.13	36.39	35.91
UJA11031	Access to Loop 1 & 2 Area	478.0	43.01	42.33	31.07	23.44	21.26	20.98
UJA11032	Access to Loop 3 & 4 Area	478.0	43.01	42.33	31.07	23.44	21.26	20.98
UJA15001	Reactor Cavity	1446.8	130.19	128.11	94.04	70.96	64.36	63.51
UJA15002	JEB10 Pump (RCP) Room	1242.3	111.79	110.01	80.75	60.93	55.26	54.53
UJA15003	JEA10 (SG) Support Area	1382.2	124.38	122.39	89.84	67.79	61.48	60.67
UJA15004	JEA20 (SG) Support Area	1409.1	126.80	124.78	91.59	69.11	62.68	61.85
UJA15005	JEB20 Pump (RCP) Room	1303.6	117.31	115.43	84.74	63.94	57.99	57.22
UJA15006	JEB30 Pump (RCP) Room	1303.6	117.31	115.43	84.74	63.94	57.99	57.22
UJA15007	JEA30 (SG) Support Area	1409.1	126.80	124.78	91.59	69.11	62.68	61.85
UJA15008	JEA40 (SG) Support Area	1382.2	124.38	122.39	89.84	67.79	61.48	60.67
UJA15009	JEB40 Pump (RCP) Room	1242.3	111.79	110.01	80.75	60.93	55.26	54.53
UJA15010	South Staircase	647.0	58.22	57.29	42.06	31.73	28.78	28.40
UJA15011	North Staircase	806.3	72.56	71.40	52.41	39.55	35.87	35.39
UJA15012	Elevator	313.3	28.19	27.74	20.36	15.37	13.94	13.75
UJA15013	JNG13 (LHSI) Tank & Loop 1 Annular Area	2296.2	206.63	203.33	149.26	112.62	102.14	100.79
UJA15014	JNG23 (LHSI) Tank & Loop 2 Annular Area	2932.4	263.88	259.66	190.61	143.83	130.44	128.72
UJA15015	JNG33 (LHSI) Tank & Loop 3 Annular Area	3110.0	279.86	275.39	202.15	152.54	138.34	136.52
UJA15016	JNG43 (LHSI) Tank & Loop 4 Annular Area	2526.5	227.35	223.72	164.23	123.92	112.38	110.90
UJA15017	Core Internals Storage Room	426.3	38.36	37.75	27.71	20.91	18.96	18.71
UJA15018	Spray Lines Area	937.6	84.37	83.02	60.95	45.99	41.71	41.16
UJA15019	Surge Line Area	1124.9	101.23	99.61	73.12	55.17	50.04	49.38
UJA15020	Access to Transfer Tube Compartment	793.4	71.40	70.26	51.57	38.91	35.29	34.83
UJA15021	Transfer Tube Compartment	797.7	71.78	70.64	51.85	39.13	35.48	35.02
UJA15023	Instrumentation Lances Storage	503.8	45.34	44.61	32.75	24.71	22.41	22.11

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
	Room							
UJA15024	Access to Reactor Cavity	396.2	35.65	35.08	25.75	19.43	17.62	17.39
UJA15025	FAL (FPPS) Room	564.1	50.76	49.95	36.67	27.67	25.09	24.76
UJA15026	HVAC	648.1	58.32	57.39	42.13	31.79	28.83	28.45
UJA15027	HVAC	648.1	58.32	57.39	42.13	31.79	28.83	28.45
UJA18001	Reactor Cavity	2099.2	188.90	185.88	136.45	102.96	93.37	92.15
UJA18002	JEB10 Pump (RCP) Room	1784.8	160.61	158.04	116.01	87.54	79.39	78.35
UJA18003	JEA10 (SG) Room	1356.4	122.06	120.11	88.17	66.53	60.33	59.54
UJA18004	JEA20 (SG) Room	1395.1	125.54	123.54	90.68	68.43	62.06	61.24
UJA18005	JEB20 Pump (RCP) Room	1872.0	168.46	165.76	121.68	91.82	83.27	82.17
UJA18006	JEB30 Pump (RCP) Room	1872.0	168.46	165.76	121.68	91.82	83.27	82.17
UJA18007	JEA30 (SG) Room	1395.1	125.54	123.54	90.68	68.43	62.06	61.24
UJA18008	JEA40 (SG) Room	1356.4	122.06	120.11	88.17	66.53	60.33	59.54
UJA18009	JEB40 Pump (RCP) Room	1784.8	160.61	158.04	116.01	87.54	79.39	78.35
UJA18010	South Staircase	929.0	83.60	82.26	60.39	45.57	41.32	40.78
UJA18011	North Staircase	1158.3	104.23	102.57	75.29	56.81	51.52	50.84
UJA18012	Elevator	586.7	52.80	51.95	38.14	28.78	26.10	25.75
UJA18013	JNG13 (LHSI) Tank & Loop 1 Annular Area	3763.4	338.66	333.25	244.63	184.59	167.40	165.20
UJA18014	JNG23 (LHSI) Tank & Loop 2 Annular Area	4494.4	404.44	397.98	292.14	220.44	199.92	197.29
UJA18015	JNG33 (LHSI) Tank & Loop 3 Annular Area	4203.7	378.28	372.24	273.25	206.18	186.98	184.52
UJA18016	JNG43 (LHSI) Tank & Loop 4 Annular Area	3830.2	344.67	339.16	248.97	187.86	170.37	168.13
UJA18017	Core Internals Storage Room	1707.3	153.63	151.18	110.98	83.74	75.94	74.94
UJA18018	Spray Lines Area	1723.5	155.09	152.62	112.03	84.53	76.66	75.65
UJA18019	Surge Line Area	1723.5	155.09	152.62	112.03	84.53	76.66	75.65
UJA18020	Corridor	1002.2	90.18	88.74	65.14	49.16	44.58	43.99
UJA18021	Transfer Tube Compartment	1088.3	97.93	96.37	70.74	53.38	48.41	47.77
UJA18023	Instrumentation Lances Storage Room	1189.5	107.04	105.33	77.32	58.34	52.91	52.21

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA18026	HVAC	931.2	83.80	82.46	60.53	45.67	41.42	40.88
UJA18027	HVAC	931.2	83.80	82.46	60.53	45.67	41.42	40.88
UJA23001	Reactor Cavity	1914.0	172.23	169.48	124.41	93.88	85.14	84.02
UJA23002	JEB10 Pump (RCP) Room	1644.9	148.02	145.66	106.92	80.68	73.17	72.20
UJA23003	JEA10 (SG) Room	1516.8	136.49	134.31	98.59	74.40	67.47	66.58
UJA23004	JEA20 (SG) Room	1559.8	140.36	138.12	101.39	76.50	69.38	68.47
UJA23005	JEB20 Pump (RCP) Room	2092.7	188.32	185.31	136.03	102.64	93.09	91.86
UJA23006	JEB30 Pump (RCP) Room	2092.7	188.32	185.31	136.03	102.64	93.09	91.86
UJA23007	JEA30 (SG) Room	1559.8	140.36	138.12	101.39	76.50	69.38	68.47
UJA23008	JEA40 (SG) Room	1516.8	136.49	134.31	98.59	74.40	67.47	66.58
UJA23009	JEB40 Pump (RCP) Room	1644.9	148.02	145.66	106.92	80.68	73.17	72.20
UJA23010	South Staircase	1038.8	93.48	91.99	67.52	50.95	46.21	45.60
UJA23011	North Staircase	1295.0	116.53	114.67	84.18	63.52	57.60	56.85
UJA23012	Elevator	655.6	59.00	58.05	42.61	32.16	29.16	28.78
UJA23013	JNG13 (LHSI) Tank & Loop 1 Annular Area	3781.7	340.30	334.87	245.82	185.48	168.21	166.00
UJA23014	JNG23 (LHSI) Tank & Loop 2 Annular Area	4111.1	369.94	364.04	267.23	201.64	182.87	180.46
UJA23015	JNG33 (LHSI) Tank & Loop 3 Annular Area	3843.1	345.83	340.30	249.81	188.49	170.95	168.70
UJA23016	JNG43 (LHSI) Tank & Loop 4 Annular Area	3829.1	344.57	339.07	248.90	187.81	170.32	168.08
UJA23017	HVAC	2993.7	269.39	265.09	194.59	146.83	133.16	131.41
UJA23018	HVAC	1437.1	129.32	127.25	93.41	70.49	63.92	63.08
UJA23019	JEF10 (RCS) Pressurizer Room	1966.8	176.99	174.16	127.84	96.47	87.49	86.33
UJA23020	FAL (FPPS) Valve Room	920.4	82.82	81.50	59.83	45.14	40.94	40.40
UJA23021	Transfer Tube Compartment	1216.4	109.46	107.71	79.07	59.66	54.11	53.39
UJA23023	Instrumentation Lances Storage Room	1316.6	118.48	116.58	85.58	64.58	58.56	57.79
UJA23026	HVAC Duct	648.1	58.32	57.39	42.13	31.79	28.83	28.45
UJA23027	HVAC Duct	648.1	58.32	57.39	42.13	31.79	28.83	28.45
UJA23031	FAL (FPPS) Pump Room	924.7	83.21	81.88	60.11	45.35	41.13	40.59

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA23041	Instrumentation Measuring Table Room	917.2	82.54	81.22	59.62	44.99	40.80	40.26
UJA23042	Instrumentation Measuring Cabinets Room	1240.1	111.59	109.81	80.61	60.82	55.16	54.44
UJA29003	JEA10 (SG) Room	1174.5	105.69	104.00	76.34	57.61	52.24	51.56
UJA29004	JEA20 (SG) Room	11669.2	1050.07	1033.30	758.51	572.35	519.06	512.23
UJA29005	JEB20 Pump (RCP) Room	1121.7	100.94	99.33	72.91	55.02	49.89	49.24
UJA29006	JEB30 Pump (RCP) Room	1179.8	106.17	104.47	76.69	57.87	52.48	51.79
UJA29007	JEA30 (SG) Room	1166.9	105.01	103.33	75.85	57.23	51.90	51.22
UJA29008	JEA40 (SG) Room	1174.5	105.69	104.00	76.34	57.61	52.24	51.56
UJA29011	North Staircase	1031.3	92.80	91.32	67.04	50.58	45.87	45.27
UJA29012	Elevator	405.8	36.52	35.93	26.38	19.90	18.05	17.81
UJA29013	Setdown Area, Operating floor	4021.8	361.91	356.13	261.42	197.26	178.89	176.54
UJA29014	Annular Area, 240-0 Deg	3699.9	332.94	327.62	240.50	181.47	164.58	162.41
UJA29015	Annular Area, 0-120 Deg	3423.3	308.05	303.13	222.52	167.90	152.27	150.27
UJA29016	Access to Equipment Hatch	2988.4	268.92	264.62	194.25	146.57	132.93	131.18
UJA29018	Access to Operating Floor	1156.2	104.04	102.38	75.15	56.71	51.43	50.75
UJA29019	JEF10 (RCS) Pressurizer Room	1385.5	124.68	122.69	90.06	67.96	61.63	60.82
UJA29022	KLA51/52 Compressor & KLA50 Filter (CBVS) Room	1567.4	141.05	138.79	101.88	76.88	69.72	68.80
UJA29023	Access to Emergency Airlock	1441.4	129.71	127.64	93.69	70.70	64.11	63.27
UJA29025	HVAC Shaft	483.3	43.49	42.80	31.42	23.70	21.50	21.21
UJA29026	HVAC Shaft	483.3	43.49	42.80	31.42	23.70	21.50	21.21
UJA34003	JEA10 (SG) Room	1863.4	167.68	165.00	121.12	91.40	82.89	81.80
UJA34004	JEA20 (SG) Room	1851.6	166.62	163.96	120.36	90.82	82.36	81.28
UJA34005	JEB20 Pump (RCP) Room	1072.2	96.48	94.94	69.69	52.59	47.69	47.07
UJA34006	JEB30 Pump (RCP) Room	1128.2	101.52	99.90	73.33	55.34	50.18	49.52
UJA34007	JEA30 (SG) Room	1851.6	166.62	163.96	120.36	90.82	82.36	81.28
UJA34008	JEA40 (SG) Room	1863.4	167.68	165.00	121.12	91.40	82.89	81.80
UJA34011	North Staircase	862.3	77.60	76.36	56.05	42.29	38.36	37.85
UJA34012	Elevator	344.5	31.00	30.51	22.39	16.90	15.32	15.12
UJA34013	Setdown Area, Operating floor	4969.1	447.15	440.01	323.00	243.72	221.03	218.12

Room	Description	Area of Walls (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA34014	Annular Area, 240-0 Deg	5205.9	468.46	460.98	338.39	255.34	231.56	228.52
UJA34015	Annular Area, 0-120 Deg	4189.7	377.02	371.00	272.34	205.49	186.36	183.91
UJA34018	RPV Closure Head Storage Area	1431.7	128.83	126.78	93.06	70.22	63.68	62.85
UJA34019	Pressurizer Head & Safety Relief Valves Room	879.5	79.14	77.88	57.17	43.14	39.12	38.61
UJA34022	JEG (RPS) Valve Room	971.0	87.38	85.98	63.12	47.63	43.19	42.62
UJA34025	HVAC Shaft	348.8	31.39	30.89	22.67	17.11	15.51	15.31
UJA34026	HVAC Shaft	348.8	31.39	30.89	22.67	17.11	15.51	15.31
UJA41003	JEA10 (SG) Room	842.9	75.85	74.64	54.79	41.34	37.49	37.00
UJA41004	JEA20 (SG) Room	837.5	75.36	74.16	54.44	41.08	37.25	36.76
UJA41007	JEA30 (SG) Room	837.5	75.36	74.16	54.44	41.08	37.25	36.76
UJA41008	JEA40 (SG) Room	842.9	75.85	74.64	54.79	41.34	37.49	37.00
UJA41013	Setdown Area, Operating floor	7000.5	629.95	619.89	455.04	343.36	311.39	307.29
UJA41014	Annular Area, 240-0 Deg	5597.8	503.73	495.68	363.86	274.56	249.00	245.72
UJA41015	Annular Area, 0-120 Deg	5202.7	468.17	460.70	338.18	255.18	231.42	228.38
UJA40001	Dome	25214.8	2269.00	2232.76	1639.00	1236.73	1121.58	1106.82
Sum			27217.19	26782.52	19660.19	14834.84	13453.65	13276.64
10% Uncertainty Factor			2721.72	2678.25	1966.02	1483.48	1345.36	1327.66
Total			29938.91	29460.78	21626.21	16318.33	14799.01	14604.30

Table 06.02.02-72-3—Ceiling Condensate Mass per Square Foot

Parameter	During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Time (s)	29.18	60.09	600.10	3600.11	12304.73	40122.71
Containment Pressure, (psia)	66.37	63.44	65.15	69.27	61.63	41.97
Surface Tension (lbm/hr^2)	1.403e6	1.412e6	1.407e6	1.393e6	1.419e6	1.502e6
Liquid Density (lbm/ft^3)	57.33	57.42	57.37	57.24	57.49	58.24
Vapor Density (lbm/ft^3)	0.1532	0.1468	0.1505	0.1595	0.1429	0.0996
Maximum Drop Radius (ft)	1.329e-2	1.332e-2	1.330e-2	1.325e-2	1.334e-2	1.363e-2
Volume of One Drop (ft^3)	4.912e-6	4.947e-6	4.928e-6	4.872e-6	4.974e-6	5.307e-6
Number of Drops per Square Foot (1/ft^2)	1416.175	1409.521	1413.204	1423.939	1404.378	1345.126
Volume of Drops per Square Foot (ft^3/ft^2)	6.957e-3	6.973e-3	6.964e-3	6.938e-3	6.986e-3	7.138e-3

Table 06.02.02-72-4—Mass of Condensate on Ceiling

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA04002	Spreading Area	2229.42	889.17	892.66	890.72	885.35	895.39	926.83
UJA04003	IRWST	1767.61	704.98	707.75	706.22	701.95	709.91	734.84
UJA04004	KT (NI DVS) Sump Room							
UJA04005	Flooding Device Compartment							
UJA04006	Flooding Device Compartment							
UJA04012	Elevator							
UJA04013	Access Area							
UJA07001	Reactor Cavity							
UJA07003	IRWST Area	4102.53	1636.23	1642.66	1639.09	1629.20	1647.67	1705.53
UJA07004	KT (NI DVS) Sump Room	78.58	31.34	31.46	31.40	31.21	31.56	32.67
UJA07012	Elevator							
UJA07013	Access Area	1114.17	444.37	446.12	445.15	442.46	447.48	463.19
UJA07014	Pipe Penetrations	2053.95	819.18	822.40	820.62	815.67	824.91	853.88
UJA07015	Pipe Penetrations	2090.56	833.79	837.06	835.24	830.20	839.62	869.10
UJA07016	Pipe Penetrations	2090.56	833.79	837.06	835.24	830.20	839.62	869.10
UJA07017	Venting Area for Spreading Compartment							
UJA07018	LCQ (SGBS) HX Room	1058.20	422.05	423.70	422.78	420.23	425.00	439.92
UJA07020	KT (NI DVS) Floor Drain and Tank Room	342.33	136.53	137.07	136.77	135.95	137.49	142.32
UJA07021	KTA10 (NI DVS) HX Room	117.34	46.80	46.98	46.88	46.60	47.13	48.78
UJA07022	KTA10 (NI DVS) Pumps Room	361.70	144.26	144.83	144.51	143.64	145.27	150.37
UJA07023	KTA10 (NI DVS) Floor Drain and Tank Room	291.73	116.35	116.81	116.56	115.85	117.17	121.28
UJA07024	KT (RCDT) Tank Room	329.41	131.38	131.90	131.61	130.82	132.30	136.94
UJA07026	KBA12 (CVCS) HX Room	184.08	73.42	73.71	73.55	73.10	73.93	76.53
UJA07027	KBA11 (CVCS) HX Room	176.55	70.41	70.69	70.54	70.11	70.91	73.40
UJA07028	KBA (CVCS) Valve Room	153.94	61.40	61.64	61.50	61.13	61.83	64.00
UJA07029	KBA (CVCS) Valve Room	122.72	48.94	49.14	49.03	48.73	49.29	51.02
UJA11001	JAA10 (RPV) Room							

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA11002	JEB10 (RCP) Oil Collection Tank Area							
UJA11003	JEA10 (SG) Supports Area							
UJA11004	JEA20 (SG) Supports Area							
UJA11005	JEB20 (RCP) Oil Collection Tank Area							
UJA11006	JEB30 (RCP) Oil Collection Tank Area							
UJA11007	JEA30 (SG) Supports Area							
UJA11008	JEA40 (SG) Supports Area							
UJA11009	JEB40 (RCP) Oil Collection Tank Area							
UJA11010	South Staircase							
UJA11012	Elevator							
UJA11013	Loop 1 Annular Area 180-270 Deg	1556.61	620.83	623.27	621.91	618.16	625.17	647.12
UJA11014	Loop 2 Annular Area 270-0 Deg	1053.89	420.33	421.98	421.06	418.52	423.27	438.13
UJA11015	Loop 3 Annular Area 0-90 Deg	1191.68	475.28	477.15	476.11	473.24	478.61	495.41
UJA11016	Loop 4 Annular Area 90-180 Deg	1599.67	638.00	640.51	639.12	635.26	642.46	665.03
UJA11018	LCQ50 (SGBS) Tank Room	641.59	255.89	256.89	256.34	254.79	257.68	266.73
UJA11019	JEG (PRT) Tank Room	472.58	188.48	189.22	188.81	187.67	189.80	196.46
UJA11020	Access to Personnel Airlock	1033.44	412.17	413.79	412.89	410.40	415.05	429.63
UJA11021	FAL (FPPS) Valve Room	123.80	49.38	49.57	49.46	49.16	49.72	51.47
UJA11022	KBA (CVCS) Valve Room	134.56	53.67	53.88	53.76	53.44	54.04	55.94
UJA11023	KBA (CVCS) Valve Room	312.18	124.51	125.00	124.73	123.97	125.38	129.78
UJA11024	KBA10 (CVCS) HX Room	215.30	85.87	86.21	86.02	85.50	86.47	89.51
UJA11025	JND & JNG (MHSI & LHSI) Valve 1 Room	195.92	78.14	78.45	78.28	77.80	78.69	81.45
UJA11026	JND & JNG (MHSI & LHSI) Valve 2 Room	195.92	78.14	78.45	78.28	77.80	78.69	81.45
UJA11027	JND & JNG (MHSI & LHSI)	157.17						

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
	Valve 3 Room		62.68	62.93	62.79	62.42	63.12	65.34
	JND & JNG (MHSI & LHSI)		78.14	78.45	78.28	77.80	78.69	81.45
UJA11028	Valve 4 Room	195.92						
UJA11031	Access to Loop 1 & 2 Area	88.27	35.21	35.34	35.27	35.05	35.45	36.70
UJA11032	Access to Loop 3 & 4 Area	88.27	35.21	35.34	35.27	35.05	35.45	36.70
UJA11017	Venting Area for Spreading Compartment	79.66	31.77	31.90	31.83	31.63	31.99	33.12
UJA15001	Reactor Cavity							
UJA15002	JEB10 Pump (RCP) Room							
UJA15003	JEA10 (SG) Support Area							
UJA15004	JEA20 (SG) Support Area							
UJA15005	JEB20 Pump (RCP) Room							
UJA15006	JEB30 Pump (RCP) Room							
UJA15007	JEA30 (SG) Support Area							
UJA15008	JEA40 (SG) Support Area							
UJA15009	JEB40 Pump (RCP) Room							
UJA15010	South Staircase							
UJA15011	North Staircase							
UJA15012	Elevator							
UJA15013	JNG13 (LHSI) Tank & Loop 1 Annular Area							
UJA15014	JNG23 (LHSI) Tank & Loop 2 Annular Area							
UJA15015	JNG33 (LHSI) Tank & Loop 3 Annular Area							
UJA15016	JNG43 (LHSI) Tank & Loop 4 Annular Area							
UJA15017	Core Internals Storage Room							
UJA15018	Spray Lines Area	469.35	187.19	187.93	187.52	186.39	188.50	195.12
UJA15019	Surge Line Area	544.71	217.25	218.10	217.63	216.32	218.77	226.45
UJA15020	Access to Transfer Tube Compartment	219.61	87.59	87.93	87.74	87.21	88.20	91.30

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA15021	Transfer Tube Compartment							
UJA15023	Instrumentation Lances Storage Room							
UJA15024	Access to Reactor Cavity	55.98	22.33	22.41	22.37	22.23	22.48	23.27
UJA15025	FAL (FPPS) Room	158.24	63.11	63.36	63.22	62.84	63.55	65.78
UJA15026	HVAC							
UJA15027	HVAC							
UJA18001	Reactor Cavity							
UJA18002	JEB10 Pump (RCP) Room							
UJA18003	JEA10 (SG) Room							
UJA18004	JEA20 (SG) Room							
UJA18005	JEB20 Pump (RCP) Room							
UJA18006	JEB30 Pump (RCP) Room							
UJA18007	JEA30 (SG) Room							
UJA18008	JEA40 (SG) Room							
UJA18009	JEB40 Pump (RCP) Room							
UJA18010	South Staircase							
UJA18011	North Staircase							
UJA18012	Elevator							
UJA18013	JNG13 (LHSI) Tank & Loop 1 Annular Area							
UJA18014	JNG23 (LHSI) Tank & Loop 2 Annular Area							
UJA18015	JNG33 (LHSI) Tank & Loop 3 Annular Area							
UJA18016	JNG43 (LHSI) Tank & Loop 4 Annular Area							
UJA18017	Core Internals Storage Room							
UJA18018	Spray Lines Area	544.71	217.25	218.10	217.63	216.32	218.77	226.45
UJA18019	Surge Line Area	544.71	217.25	218.10	217.63	216.32	218.77	226.45
UJA18020	Corridor	117.34	46.80	46.98	46.88	46.60	47.13	48.78
UJA18021	Transfer Tube Compartment							

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA18023	Instrumentation Lances Storage Room							
UJA18026	HVAC							
UJA18027	HVAC							
UJA23001	Reactor Cavity	767.54	306.12	307.32	306.66	304.81	308.26	319.09
UJA23002	JEB10 Pump (RCP) Room	442.44	176.46	177.15	176.77	175.70	177.69	183.93
UJA23003	JEA10 (SG) Room							
UJA23004	JEA20 (SG) Room							
UJA23005	JEB20 Pump (RCP) Room							
UJA23006	JEB30 Pump (RCP) Room							
UJA23007	JEA30 (SG) Room							
UJA23008	JEA40 (SG) Room							
UJA23009	JEB40 Pump (RCP) Room	442.44	176.46	177.15	176.77	175.70	177.69	183.93
UJA23010	South Staircase							
UJA23011	North Staircase							
UJA23012	Elevator							
UJA23013	JNG13 (LHSI) Tank & Loop 1 Annular Area	1504.94	600.22	602.58	601.27	597.64	604.42	625.64
UJA23014	JNG23 (LHSI) Tank & Loop 2 Annular Area	1559.84	622.12	624.56	623.20	619.44	626.47	648.47
UJA23015	JNG33 (LHSI) Tank & Loop 3 Annular Area	1652.42	659.04	661.63	660.19	656.21	663.65	686.96
UJA23016	JNG43 (LHSI) Tank & Loop 4 Annular Area	1634.12	651.74	654.30	652.88	648.94	656.30	679.35
UJA23017	HVAC	831.05	331.45	332.75	332.03	330.03	333.77	345.49
UJA23018	HVAC	348.78	139.11	139.65	139.35	138.51	140.08	145.00
UJA23019	JEF10 (RCS) Pressurizer Room	540.40	215.53	216.38	215.91	214.60	217.04	224.66
UJA23020	FAL (FPPS) Valve Room	103.34	41.22	41.38	41.29	41.04	41.50	42.96
UJA23021	Transfer Tube Compartment							
UJA23023	Instrumentation Lances Storage Room							
UJA23026	HVAC Duct	49.52	19.75	19.83	19.78	19.67	19.89	20.59

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA23027	HVAC Duct	49.52	19.75	19.83	19.78	19.67	19.89	20.59
UJA23031	FAL (FPPS) Pump Room	93.66	37.35	37.50	37.42	37.19	37.62	38.94
UJA23041	Instrumentation Measuring Table Room	171.16	68.26	68.53	68.38	67.97	68.74	71.16
UJA23042	Instrumentation Measuring Cabinets Room	273.43	109.05	109.48	109.24	108.58	109.82	113.67
UJA29003	JEA10 (SG) Room							
UJA29004	JEA20 (SG) Room							
UJA29005	JEB20 Pump (RCP) Room							
UJA29006	JEB30 Pump (RCP) Room							
UJA29007	JEA30 (SG) Room							
UJA29008	JEA40 (SG) Room							
UJA29011	North Staircase							
UJA29012	Elevator							
UJA29013	Setdown Area, Operating floor							
UJA29014	Annular Area, 240-0 Deg	2025.97	808.02	811.20	809.44	804.55	813.68	842.25
UJA29015	Annular Area, 0-120 Deg	1152.93	459.83	461.63	460.63	457.85	463.04	479.30
UJA29016	Access to Equipment Hatch							
UJA29018	Access to Operating Floor	659.89	263.19	264.22	263.65	262.06	265.03	274.33
UJA29019	JEF10 (RCS) Pressurizer Room	540.40	215.53	216.38	215.91	214.60	217.04	224.66
UJA29022	KLA51/52 Compressor & KLA50 Filter (CBVS) Room	627.60	250.31	251.29	250.75	249.23	252.06	260.91
UJA29023	Access to Emergency Airlock	587.77	234.42	235.34	234.83	233.42	236.06	244.35
UJA29025	HVAC Shaft							
UJA29026	HVAC Shaft							
UJA34003	JEA10 (SG) Room							
UJA34004	JEA20 (SG) Room							
UJA34005	JEB20 Pump (RCP) Room							
UJA34006	JEB30 Pump (RCP) Room							
UJA34007	JEA30 (SG) Room							
UJA34008	JEA40 (SG) Room							
UJA34011	North Staircase	194.85	77.71	78.02	77.85	77.38	78.26	81.00

Room	Description	Ceiling Area (ft^2)	Mass at 29 sec (lb)	Mass at 60 sec (lb)	Mass at 600 sec (lb)	Mass at 3600 sec (lb)	Mass at 12304 sec (lb)	Mass at 40122 sec (lb)
UJA34012	Elevator	60.28	24.04	24.14	24.08	23.94	24.21	25.06
UJA34013	Setdown Area, Operating floor							
UJA34014	Annular Area, 240-0 Deg							
UJA34015	Annular Area, 0-120 Deg	1596.44	636.71	639.22	637.83	633.98	641.17	663.68
UJA34018	RPV Closure Head Storage Area							
UJA34019	Pressurizer Head & Safety Relief Valves Room	540.40	215.53	216.38	215.91	214.60	217.04	224.66
UJA34022	JEG (RPS) Valve Room	223.91	89.30	89.65	89.46	88.92	89.93	93.09
UJA34025	HVAC Shaft							
UJA34026	HVAC Shaft							
UJA41003	JEA10 (SG) Room							
UJA41004	JEA20 (SG) Room							
UJA41007	JEA30 (SG) Room							
UJA41008	JEA40 (SG) Room							
UJA41013	Setdown Area, Operating floor							
UJA41014	Annular Area, 240-0 Deg							
UJA41015	Annular Area, 0-120 Deg							
UJA40001	Dome	16095.77	6419.53	6444.77	6430.76	6391.96	6464.43	6691.45
		Total	26094.59	26197.18	26140.24	25982.50	26277.10	27199.88

Note: Table cells containing no information represent rooms with no ceilings.

Table 06.02.02-72-5—Water Retained in Steam and Droplet Phase

Parameter	During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Initial Pressure (psia)	15.96	15.96	15.96	15.96	15.96	15.96
Initial Temperature °F (°R)	86 (546)	86 (546)	86 (546)	86 (546)	86 (546)	86 (546)
Time (s)	29.18	60.09	600.10	3,600.11	12304.73	40122.71
Containment Pressure, (psia)	66.37	63.44	65.15	69.27	61.63	41.97
Containment Saturation Temp, °F (°R)	257 (716)	259 (719)	275 (735)	279 (739)	269 (729)	232 (692)
Containment Free Volume (ft^3)	2,827,498	2,827,498	2,827,498	2,827,498	2,827,498	2,827,498
Vapor Partial Pressure (psia)	45.44	42.42	43.68	47.67	40.32	21.74
Vapor Density (lbm/ft^3)	0.1073	0.1006	0.1034	0.1122	0.0959	0.0538
Total Steam Mass (lbm)	303,391	284,446	292,363	317,245	271,157	152,119
Total Droplet Mass (lbm)	39,208	2,827	248	81	33	6
Total Steam and Droplet Mass (lbm)	342,599	287,273	292,611	317,326	271,190	152,125

Table 06.02.02-72-6—Depth of Retained Water in Annular Region

Parameter	During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Time (s)	29.18212	60.09352	600.1035	3600.11	12304.73	40122.71
Total Condensate Mass (lbm)	13243.24	24433.63	89316.40	216150.85	392431.21	606627.63
Condensation Rate (lbm/s)	446.79	308.17	70.15	33.17	15.74	4.65
Total Condensate Volume (ft^3)	231.00	425.52	1556.85	3776.22	6826.08	10416.00
Condensate Volumetric Flow (ft^3/s)	7.79	5.37	1.22	0.58	0.27	0.08
Weir Height (ft)	0.333	0.333	0.333	0.333	0.333	0.333
Weir Width (ft)	20.00	20.00	20.00	20.00	20.00	20.00
Calculated Dynamic Head (ft)	0.229	0.181	0.069	0.042	0.025	0.011
Area of Lower Annular Rooms (ft^2)	8407.36	8407.36	8407.36	8407.36	8407.36	8407.36
Depth of Water (ft)	0.027	0.051	0.185	0.376	0.358	0.345

Table 06.02.02-72-7—Retained Water Depth on Heavy Floor

Parameter	During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Time (s)	29.18212	60.09352	600.1035	3600.11	12304.73	40122.71
Pressure in Control Volume 10, PR10 (psia)	66.45	63.49	65.22	69.33	61.68	42.02
Liquid Density (lbm/ft³)	57.33	57.42	57.37	57.24	57.49	58.23
Total Condensate (lbm)	6076.42	11210.93	40981.21	99176.89	180059.94	278340.07
Condensation Rate (lbm/s)	205.00	141.40	32.19	15.22	7.22	2.13
Average Break Effluent Enthalpy, h_{ave} (Btu/lbm)	339.03	256.73	613.27	0.00	0.00	0.00
Evaporation Enthalpy, h_{fg} (Btu/lbm)	910.81	913.04	911.73	908.71	914.44	931.75
Saturated Liquid Enthalpy, h_f (Btu/lbm)	269.25	266.13	267.96	272.18	264.17	239.26
Break Effluent Quality, $X = (h_{ave} - h_f)/ h_{fg}$	0.08	-0.01	0.38	0.00	0.00	0.00
Break Mass Flow, M_b (lbm/s)	9312.67	5565.30	254.58	0.00	0.00	0.00
Liquid Break Mass Flow (lbm/s) $= M_b \cdot (1-X)$	8599.17	5565.30	158.16	0.00	0.00	0.00
Safety Injection Mass Flow (lbm/s)	0.00	0.00	0.00	223.95	624.73	627.23
Total Flow onto Heavy Floor (lbm/s)	8804.17	5706.70	190.35	239.17	631.95	629.37
Total Volumetric Flow (ft³/s)	153.57	99.39	3.32	4.18	10.99	10.81
Weir Height (ft)	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667
Weir Width (ft)	66.3	66.3	66.3	66.3	66.3	66.3
Dynamic Head Height (ft)	0.6188	0.4851	0.0599	0.0696	0.1290	0.1276
Retained Water Depth (ft)	0.7855	0.6518	0.2266	0.2363	0.2957	0.2943

Table 06.02.02-72-8—Depth of Water behind Doors and Curbs

Room	Floor Area (ft^2)	Depth of Retained Water (ft) at Time					
		29 s	60 s	600 s	3600 s	12304 s	40122 s
UJA04005	103.33	0.05250	0.09671	0.35383	0.85823	1.55138	2.36728
UJA04006	103.33	0.05046	0.09294	0.34005	0.82480	1.49096	2.27507
UJA04012	40.90	0.09946	0.18322	0.67034	1.62595	2.93915	4.48488
UJA11010	82.88	0.04229	0.07789	0.01610	0.00361	0.00081	0.00007
UJA15011	188.37	0.03147	0.05797	0.04605	0.01034	0.00231	0.00020
UJA15020	219.58	0.01132	0.02085	0.00810	0.00182	0.00041	0.00003
UJA29025	38.75	0.02406	0.04432	0.16213	0.39326	0.71088	1.08475
UJA29026	38.75	0.02406	0.04432	0.16213	0.39326	0.71088	1.08475
UJA34018	705.04	0.00325	0.00598	0.02188	0.05306	0.09592	0.14636

Note: Rooms do not include the core spreading area and the reactor cavity.

Table 06.02.02-72-9—Total Mass of Water Retained on Floors

Retained Water on Heavy Floor							
		During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Pressure, (psia)		66.45	63.49	65.22	69.33	61.68	42.02
Liquid Density (lbm/ft³)		57.33	57.42	57.37	57.24	57.49	58.23
Room Name	**Floor Area (ft²)**	**Mass @ 29s**	**Mass @ 60s**	**Mass @ 600s**	**Mass @ 3,600s**	**Mass @ 12,307s**	**Mass @ 40,122s**
UJA11002	710.5	31,995	26,592	9,238	9,609	12,077	12,177
UJA11003	737.4	33,207	27,599	9,588	9,972	12,534	12,638
UJA11004	737.4	33,207	27,599	9,588	9,972	12,534	12,638
UJA11005	628.7	28,312	23,530	8,174	8,502	10,686	10,775
UJA11006	617.9	27,825	23,126	8,034	8,356	10,503	10,590
UJA11007	737.4	33,207	27,599	9,588	9,972	12,534	12,638
UJA11008	737.4	33,207	27,599	9,588	9,972	12,534	12,638
UJA11009	772.9	34,805	28,927	10,049	10,452	13,137	13,246
UJA11018	641.6	28,893	24,013	8,342	8,677	10,906	10,996
UJA11019	472.6	21,282	17,688	6,145	6,391	8,033	8,100
	Subtotal (lbm)	305,940	254,272	88,332	91,877	115,478	116,436
Retained Water in the Annular Area							
		During Blowdown	During Refill/Reflood	During Post Reflood	Time of Peak Cont. Pressure	Time of Peak IRWST Temp	Time of Half Peak Pressure
Liquid Density (lbm/ft³)		57.33	57.42	57.37	57.24	57.49	58.24
Depth of Water (ft)		0.027	0.051	0.185	0.376	0.358	0.345
Room Name	**Floor Area (ft²)**	**Mass @ 29s**	**Mass @ 60s**	**Mass @ 600s**	**Mass @ 3,600s**	**Mass @ 12,307s**	**Mass @ 40,122s**
Lower Annular Rooms with Weir							
UJA07013	1114.1	1,755	3,238	11,836	23,960	22,946	22,366
UJA07014	2054	3,235	5,969	21,821	44,173	42,304	41,236
UJA07015	2090.6	3,293	6,076	22,210	44,960	43,057	41,971
UJA07016	2090.6	3,293	6,076	22,210	44,960	43,057	41,971
UJA07018	1058.1	1,667	3,075	11,241	22,755	21,792	21,242
Other Annular Rooms with a Constant Uniform Depth of ½ inch							
UJA11020	1033.4	2,488	2,492	2,490	2,484	2,495	2,528

UJA15013	1486.6	3,580	3,585	3,582	3,574	3,590	3,636
UJA15014	1550.2	3,733	3,739	3,735	3,727	3,743	3,792
UJA15015	1650.3	3,974	3,980	3,976	3,967	3,985	4,037
UJA15016	1894.6	4,562	4,569	4,565	4,555	4,575	4,634
UJA29013	4424.3	10,653	10,670	10,661	10,636	10,683	10,822
UJA29014	2026	4,878	4,886	4,882	4,871	4,892	4,956
UJA29015	1152.9	2,776	2,780	2,778	2,772	2,784	2,820
UJA29016	3217.7	7,748	7,760	7,753	7,736	7,769	7,871
UJA29018	659.9	1,589	1,591	1,590	1,586	1,593	1,614
UJA29022	627.6	1,511	1,514	1,512	1,509	1,515	1,535
UJA29023	587.8	1,415	1,418	1,416	1,413	1,419	1,438
UJA34014	964.5	2,322	2,326	2,324	2,319	2,329	2,359
UJA34015	2292.9	5,521	5,530	5,525	5,512	5,536	5,609
UJA11013	1556.6	3,748	3,754	3,751	3,742	3,759	3,808
UJA11014	1053.9	2,538	2,542	2,539	2,534	2,545	2,578
UJA11015	1191.7	2,869	2,874	2,871	2,865	2,877	2,915
UJA11016	1599.7	3,852	3,858	3,855	3,846	3,863	3,913
	Subtotal (lbm)	83,000	94,300	159,123	250,456	243,108	239,650
Retained Water Behind Doors							
		During Blowdown	**During Refill/Reflood**	**During Post Reflood**	**Time of Peak Cont. Pressure**	**Time of Peak IRWST Temp**	**Time of Half Peak Pressure**
Liquid Density (lbm/ft³)		57.33	57.42	57.37	57.24	57.49	58.24
Room Name	**Floor Area (ft²)**	**Mass @ 29s**	**Mass @ 60s**	**Mass @ 600s**	**Mass @ 3,600s**	**Mass @ 12,307s**	**Mass @ 40,122s**
UJA04005	103.33	311	574	2,098	5,076	9,216	14,247
UJA04006	103.33	299	551	2,016	4,879	8,857	13,692
UJA04012	40.90	233	430	1,573	3,807	6,911	10,684
UJA11010	82.88	201	371	77	17	4	0
UJA15011	188.37	340	627	498	111	25	2
UJA15020	219.58	142	263	102	23	5	0
UJA29025	38.75	53	99	360	872	1,584	2,448
UJA29026	38.75	53	99	360	872	1,584	2,448
UJA34018	705.04	131	242	885	2,141	3,888	6,010
	Subtotal (lbm)	1,765	3,256	7,968	17,799	32,074	49,531

Total Mass (lbm) on Floors Including 10% Uncertainty	429,775	387,011	280,965	396,146	429,726	446,178

Table 06.02.02-72-10—Total Mass of Retained Water in Reactor Building

	During Blowdown	**During Refill/Reflood**	**During Post Reflood**	**Time of Peak Cont. Pressure**	**Time of Peak IRWST Temp**	**Time of Half Peak Pressure**
Time (s)	29	60	600	3,600	12,305	40,123
Steam Phase (lbm)	303,391	284,446	292,363	317,245	271,157	152,119
Droplets (lbm)	39,208	2,827	248	81	33	6
Wall Condensate (lbm)	29,939	29,461	21,626	16,318	14,799	14,604
Ceiling Condensate (lbm)	26,095	26,197	26,140	25,983	26,277	27,200
Retention on RB Floors (lbm)	429,775	387,011	280,965	396,146	429,726	446,178
Retention in Clogged Basket (lbm)	68,064	68,064	68,064	68,064	68,064	68,064
Re-injected into RCS (lbm)	65,270	134,409	363,825	363,825	363,825	363,825
Total Mass of Retained (lbm)	**961,742**	**932,415**	**1,053,231**	**1,187,662**	**1,173,881**	**1,071,996**

Question 06.02.02-73:

ANP-10293 Rev. 1 Figures E.6-2, E.6-4 includes a note indicating basket head change due to flume water evaporation. Given that testing employed water level management controls (make-up and letdown); it is not clear why evaporation was a factor. Explain the reasons behind AREVAs conclusion that the head loss change was related to evaporation and not other causes. In the response, include any other test impacts or test observations associated with evaporation.

Response to Question 06.02.02-73:

The note indicating basket head change due to flume water evaporation was intended to explain the increase in measured retaining basket head loss between hours 33.9 and 37.4 during the Design Basis Debris Loaded Strainer Head Loss Test (Test 2) and hours 14.1 and 23.7 during the Thin Bed Test (Test 4). ANP-10293, Revision 1 shows the measured increases graphed in Figures E.6-2 and E.6-4 for Test 2 and Test 4, respectively.

The water management system consisted of two parts; water removal and water addition. As wetted debris was added to the flume, the volume of water within the flume increased. To maintain the prototypical strainer submergence, an overflow weir removed excess water from the flume.

The water addition system used a makeup water tank to add water to the test flume as required. As debris was inserted into the retaining basket, a debris bed formed on the retaining basket screen. This debris bed caused the water level in the retaining basket to increase above the water level downstream of the basket (surrounding the strainer). The water volume increase within the retaining basket reduced the water volume downstream of the retaining basket. As the volume of water downstream of the retaining basket decreased below prototypical levels, power was applied to the makeup water pump to add water to the flume downstream of the retaining basket.

Debris plugged the entire retaining basket screen during Test 2 and Test 4 creating an overflow condition within the retaining basket. The water addition system performed adequately during the debris addition portions of the test. After overflow, debris addition (and associated water volume) continued until all required debris constituents were applied to the flume and water addition was no longer necessary. The additional volume of debris laden water increased the water level to the prototypical strainer submergence level (at the overflow weir). The measured differential pressure (elevation head) across the retaining basket after the last debris addition to the test flume was approximately 7.3 feet during Test 2 and Test 4.

After all debris was added to the flume, the flume water was recirculated to observe changes in the measured strainer head loss created by debris addition until test termination criterion was met. During this period of approximately 3.5 hours, the 120°F water began to evaporate to the environment outside of the test flume. Because the water recirculates into the plugged retaining basket, the volume of water in the retaining basket remained unchanged. However, the volume of water downstream of the retaining basket began to slowly decrease. The measured head loss of the retaining basket 3.5 hours after all debris was inserted into the flume was approximately 7.4 feet for both Test 2 and Test 4. The increase in measured differential pressure across the retaining basket from approximately 7.3 feet to approximately 7.4 feet was not created by water increase within the retaining basket because the basket was already in an overflow condition. The increase in measured differential pressure across the retaining basket was created by the change in measured elevation head as the water in the vicinity of the strainer decreased by approximately 0.1 feet within the 3.5 hour period. Test 4 was continued 9.6 hours (overnight) after all debris was added to the test flume and the water addition system disabled after the basket overflow condition was reached. The final measured retaining basket head loss was approximately 7.7 feet due to evaporation; this was visually confirmed by the water level decrease in the vicinity of the test strainer. The decrease in strainer submergence was conservative and evaporation was not a factor to the test conclusions, merely an observation of the data.

FSAR Impact

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

Question 06.02.02-74:

The U.S. EPR debris generation analysis uses a 2.4D zone-of-influence (ZOI) for assessing the amount of fiber insulation generated during the accident. This ZOI is for steel jacketed Nukon (fiber insulation) with Sure-Hold bands based on NEI 04-07 GR and NRC SE Table 3-2. The 2.4D ZOI was derived from testing for a specific insulation system. Therefore, in order to apply the 2.4D ZOI, the U.S. EPR fiber insulation system, fasteners, and associated components should be of a design that is equivalent or more robust than the tested Sure-Hold system (the BWROGs air jet impact testing is described in Volume 3 of the BWROGs Utility Resolution Guidance). Important design features of the testing include band spacing, pipe diameter, band fasteners, band width, jacket overlap (axial and circumferential), jacket material and thickness, etc. The staff requests that AREVA evaluate if their design specific application of the 2.4D ZOI is bounded by existing testing, with specific consideration given to differences in pipe diameters between the test and U.S. EPR design and minimum radius requirements for the fasteners. For those piping applications that are not bounded, the staff request that AREVA provide additional analysis or ITAAC to support the debris generation analysis (fiber insulation source term derived by application of a 2.4D ZOI). In addition, to assess the sensitivity of the U.S. EPR source term to the ZOI size, assuming that the 2.4D ZOI was increased to 17D (as listed in the NRC SE value corresponding to unjacketed Nukon or jacketed Nukon with standard bands), estimate how much additional fibrous insulation debris would be generated using break locations listed in ANP-10293 Rev. 1 Appendix C.

Response to Question 06.02.02-74:

The U.S. EPR debris generation calculation was revised to modify the debris source term. The revision changed the insulation of piping less than four inches in diameter from NUKON® jacketed with Sure-Hold® bands to Reflective Metal Insulation (RMI). The U.S. EPR design no longer incorporates NUKON® insulation on piping subject to loss of coolant accident (LOCA) jet blast effects. This change will be incorporated into Revision 3 of Technical Report ANP-10293P, “U.S. EPR™ Design Features to Address GSI-191.” The debris source term will also be revised in U.S. EPR FSAR Tier 2, Section 6.3.2 and Table 6.3-5.

FSAR Impact

U.S. EPR FSAR Tier 2, Section 6.3.2 and Table 6.3-5 will be revised as described in the response and indicated on the enclosed markup.

Question 06.02.02-75:

Follow-up to RAI 111, Question 06.02.02-8:

FSAR Tier 2, Section 1.8 and 6.3.2.2.2 describe COL item 6.3-1 “A COL applicant that references the U.S. EPR design certification will describe the containment cleanliness program which limits debris within containment”. Revision 1 to FSAR Tier 2, Section 6.3.2.2.2 provides additional information on what is included in the U.S. EPR containment cleanliness program such as permanent and temporary modifications, foreign material, conduct of maintenance, and coatings but does not discuss latent (resident) and miscellaneous debris. Explain how and where latent and miscellaneous debris are included in the cleanliness program as described in the FSAR. What specific latent debris limits or controls does the U.S. EPR design establish to enable the COL applicant to remain within the containment cleanliness program design basis limits? What specific miscellaneous debris limits or controls does the U.S. EPR design establish to enable the COL applicant to remain within the containment cleanliness program design basis limits? Explain why these design basis limits or performance criteria (i.e. lbm of latent debris and area assumed for miscellaneous debris) are not contained within the COL cleanliness program description in FSAR section 6.3.2.2.2?

Response to Question 06.02.02-75:

Latent and miscellaneous debris limits, intended or unintended, are 150 lbm and 100 ft^2. These limits will be specified in U.S. EPR FSAR Tier 2, Section 6.3.2.

Latent debris is controlled through the containment cleanliness program by limiting the amount of potential debris sources. This program includes control of intended debris sources and unintended debris sources. General surveys, consisting of a visual examination of the containment, can be performed at each refueling outage. Surveys with detailed calculations of latent debris can be performed. Additional surveys can be conducted after extended maintenance activities. The containment cleanliness program surveys, in conjunction with containment close-out procedures, provide controls for maintaining design basis latent debris values.

Visual inspection of the containment for loose debris is performed to reduce intended and unintended debris sources. Visual inspection includes all levels of the containment; including the trash racks, weirs, and retaining baskets located below each heavy floor opening. The inspection will include the safety injection system (SIS) strainers located above each respective sump. The containment cleanliness program will limit latent debris within containment.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 6.3.2 will be revised as described in the response and indicated on the enclosed markup.

Question 06.02.02-76:

Follow-up to RAI 111, Question 06.02.02-8:

In the Supplement 10 response to RAI 111, Question -6.02.02-8K6, AREVA indicated that fluid from a pressurizer surge line break reaches the pressurizer relief tank (PRT) room and is released through a door separating the PRT room and steam generator blowdown (SGBD) room. Flooding berms, associated with SGBD room doors and doorways, are mentioned as design features that prevent flooding of the annular space and serve to contain the fluids within the SGBD and PRT rooms. Also, wall openings are provided at four locations to route fluid out of the SGBD room and into the loop areas of the heavy floor.

Given that four openings are now provided to connect the SGBD room to the loop area heavy floor, describe the impact during a large break LOCA where fluid spills onto the loop area heavy floor. Will fluid from a break in the loop area flood the SGBD and PRT rooms? How is this volume considered in the water hold-up analysis? Describe the design of the four SGBD room wall openings and any devices installed at the opening that are required to actuate to permit/block fluid flow to/fm the loop area of the heavy floor through these openings. Also, describe how floor openings, wall openings, berms and doors permit fluid and debris, generated during a break near the pressurizer, to flow into and out of the PRT room and SGBD room (include assessment of break selection, debris generation, debris transport and upstream effects (water hold up or choke points) and provide details of debris types and quantities evaluated). In addition, provide a simple figure or discussion about where and how water is held up and how high a level is reached in the PRT and SGBD rooms in response to a pressurizer surge line break and a break in the loop area. Discuss height of curbs, openings, and flooding berms, and how doors are used to either release or contain water. A discussion of these important design features to address GSI-191 is expected to be included in technical report ANP-10293 or an appropriate FSAR Section.

Response to Question 06.02.02-76:

The information requested is provided in Section 3.2.5 of Technical Report ANP-10293P, Revision 3, “U.S. EPR™ Design Features to Address GSI-191.”

FSAR Impact:

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

Question 06.02.02-77:

Follow-up to RAI 111, Question 06.02.02-8 K10:

In the Supplement 10 response to RAI 111, Question 06.02.02-8 K10, AREVA made several qualitative statements and staff requests additional information to support or justify these statements.

The first statement is the amount of LOCA water reaching the annular space is minimal because the water reaching the annular space is essentially condensation from released steam. Explain how this conclusion was reached. What model is used to estimate the amount of water collected due to condensation that supported reaching a conclusion that the amounts were minimal? How much water is collected? Also, define what is meant by minimal and assess if the inventory of condensate in the annular region is sufficient to cause an overflow into the IRWST.

The second qualitative statement is a "limited" amount of latent debris can be transported to the annular space from condensation effects. What is the basis that supports this conclusion and what is the amount considered. The third qualitative statement is the effects of a small amount of latent debris reaching the retaining basket from the annular area are bounded by favorable test results. Define what is meant by small amounts reaching the basket in GSI-191 terms such as debris source term assumptions and debris transport assumptions. Also, explain how the tested basket (large basket) bounds the basket serving the annular region (small basket) given that they have different source terms, areas, heights etc.

Response to Question 06.02.02-77:

Over the long term, water reaching the annular space following a loss of coolant accident (LOCA) is the result of condensation on the outer containment walls and liner plate. During blowdown there may be sufficient pressure difference between the equipment space and the service space to force some water from the in-containment refueling water storage tank (IRWST) to the annular area. The amount of IRWST water that could be displaced from the IRWST depends on a number of interrelated factors for each break scenario. A significant reactor coolant system (RCS) break is not postulated in the annular region. In the Response to RAI 111, Question 06.02.02-8, the amount of water in the annular space was described as being minimal . However, the calculation of the condensation rate in the annular space is explained in the Response to RAI 434, Question 06.02.02-71.

In the event that the pressure difference between the equipment space and the service space is not sufficient to force water from the IRWST to the annular area, the annular region will begin to overflow into the IRWST at 34 minutes into the design basis transient. This conclusion is based on condensation rates only. The depth of retained water in the lower annular space, at six different times is provided in the Response to RAI 434, Question 06.02.02-72, Table 06.02.02-72-6.

The limited amount of latent debris is the fractional amount of the total inside containment. The heavy floor area and the annular floor area debris sources are the same and comprise the total area for the latent debris that is assumed to enter the IRWST. There are no other sources of fibrous material within the zone of influence (ZOI) that will enter the IRWST.

The large compartment testing bounds the small compartment testing. The only source of fiber within the ZOI is from latent fiber. Latent fiber is uniformly distributed within containment. Based on a uniform distribution, 66 percent of the available containment surface area feeds the service area annular space. The remainder of the surface area feeds the heavy floor and the retention volumes. Therefore, the annular space will receive 15 pounds of latent fiber (i.e., 66 percent of 22.5 pounds total latent fiber).

In order to address compartment loading and fiber retention performance, we need to identify the available screen surface area. The small compartment has 269 sq ft of total surface area. The wetted surface area at the minimum level for safety injection pump net positive suction head (NPSH) is approximately 135 sq ft. The large compartment has a total surface area of 721 sq ft and approximately 450 sq ft of wetted surface area at the same IRWST level. The wetted surface areas above do not include the common screen between the two compartments.

Fiber in the annular space transports to each of the four baskets via holes in the IRWST wall. The debris is routed into the basket through the use of gutters that discharge below the IRWST water level. Latent fiber in the annular space migrates uniformly to each basket. Therefore, each basket sees 3.75 pounds of latent fiber. This yields a loading of 0.028 pounds/sq ft for the small compartment. By comparison, the large compartment (as tested) is loaded with 22.5 pounds of latent fiber for a loading of 0.050 pounds/sq ft.

Testing the large compartment introduced fiber in small batches. No basket level increase was observed after complete loading with the design basis latent fiber. The level increased only after adding paint chips. The small compartment received fiber in small increments, similar to the large compartment. The small compartment would not receive paint chips as they are introduced via the heavy floor. The overall fiber loading is less than that of the large compartment. Therefore, the level in the small compartment is not expected to rise and result in any overflow condition. Testing performed on other basket and strainer configurations showed that the fiber bypass rate was fairly insensitive to basket/screen modifications to the size of the hole and material type. Fiber bypass ratios observed were between 65 and 70 percent. The small compartment is expected to perform similarly to the large basket with a consistent bypass fraction. This would yield a situation where the strainer would receive the same loading, assuming all four baskets feed one strainer, or less than the large compartment as tested.

FSAR Impact:

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

Question 06.02.02-78:

Provide the density of latent particulate material and justify its selection in comparison with guidance.

Response to Question 06.02.02-78:

The U.S. EPR strainer testing used latent particulate debris prepared by Performance Contracting Incorporated (PCI). PCI formulated their surrogate based on guidance provided by NEI 04-07, Volume 2 and NUREG/CR-6877. Section 3.5.2.3 in Volume 1 of NEI 04-07 recommends the use of 10 µm diameter grains as the debris characteristic for latent particulate debris. Volume 2 of NEI 04-07 considers the 10 µm diameter assumption as conservative and provides additional guidance in Appendix V to determine appropriate parameters for a mix of multiple fiber and particulate components. Section V.2.2 in Volume 2 of NEI 04-07 states that "plant debris characteristics pertinent to the specification of a recipe to create a suitable latent particulate surrogate include specific gravity and particulate-size distribution." Section V.2.2 also states that debris characteristics were determined by the Los Alamos National Laboratory (LANL) report LA-UR-04-3970 2004a, which was published in July 2005 as NUREG/CR-6877.

NUREG/CR-6877 analyzed latent samples of five volunteer pressurized water reactor (PWR) plants and included the properties of material composition and hydraulic flow properties. These characteristic properties were analyzed by LANL and provided a surrogate latent particulate debris recipe for use in head-loss testing performed at the University of New Mexico (UNM). NUREG/CR-6877 guidance for surrogate latent particulate mass distribution was: 27.7 percent of debris between 500 µm and 2 mm, 35.2 percent of debris between 75 µm and 500 µm, and 37.1 percent less than 75 µm. Though some of the volunteer plant debris included materials larger than 2 mm, NUREG/CR-6877 removed this constituent and renormalized the distribution amongst the smaller particulates because visual inspection showed that material larger than 2 mm had very limited transport potential. The surrogate latent particulate distribution is again captured in Table V-2 in Volume 2 of NEI 04-07. The PCI latent particulate debris distribution used for testing was: approximately 27.3 percent of debris between 500 µm and 2 mm, approximately 35.3 percent of debris between 75 µm and 500 µm, and approximately 37.4 percent less than 75 µm as specified in PCI's proprietary technical document, "Sure Flow Suction Strainer - Testing Debris Preparation and Surrogates" (ADAMS Accession No. ML090900476).

Page 3-37 in Volume 1 of NEI 04-07 recommends 100 lbm/ft^3 as the particle density for latent particulate debris. This density was derived by the densities of "Earth," dry and packed and "Sand." Page 51 in Volume 2 of NEI 04-07 provides guidance to "assume that latent particulates are primarily geophysical in origin being composed of soil, sand, and dust." Volume 2 of NEI 04-07 provides additional guidance to assume that latent particulate material has a nominal density of 2.7 g/cm^3 (169 lbm/ft^3). Page V-8 references the debris characteristic data provided by LANL as "well represented" with the specific gravity of 2.7 g/cm^3 (an equivalent density of 169 lbm/ft^3). Finally, bullet 8 on page V-11 in Volume 2 of NEI 04-07 summarizes particulate density by recommending 100 lb/ ft^3 for the material density of latent particulate debris because this is conservative relative to the heavier densities (169 lbm/ft^3) referenced in the LA-UR-04-3970 document. Actual plant analysis of particulate density was performed by LANL and documented in NUREG/CR-6877. The results of the LANL analyses showed that the particulate ranged in densities from 1.5 to 4.0 g/cm^3 (93.6 to 249.7 lbm/ft^3) with the median density of 2.7 g/cm^3 (169 lbm/ft^3). It is noted that the LANL data showed that the average densities varied depending on debris size with the smaller debris being the densest and the largest debris being the least dense. NUREG/CR-6877 also determined that bulk densities of the latent particulate debris varied depending on the size distribution from 39 to 104 lbm/ft^3 specifying that the particulate recipe provided an approximate density between 63 to 75 lbm/ft^3.

PCI provided the U.S. EPR test with a dirt and dust mix based on a size distribution that is similar to that provided by the guidance within NUREG/CR-6877. The density of the dirt and dust is related to the packing factor. Dirt and dust densities will vary; therefore, the size distribution and mass of tested surrogate dirt and dust are more justifiable for use during strainer qualification testing.

FSAR Impact:

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

Question 06.02.02-79:

The retaining basket and strainer head loss testing for US EPR was designed to assess debris accumulation on the basket and strainer screens. During the July 2010 strainer test, after all the non-chemical particulate and fiber was added, the staff noted a potentially significant floating layer of fibrous debris, covering a large portion of the test tanks water surface. The staff was surprised by the amount of floating fibrous debris in the test. Based on observation, it appears that air bubbles generated by the impingement of the recirculation system jet and entrained in the water flow were interacting directly with debris to create floating masses.

The staff also noted that the test protocol and scaling were intended to conservatively or prototypically represent the fluid dynamic conditions at the screen and basket faces. The phenomena that are pertinent to debris floating do not appear to have been scaled conservatively or prototypically. For example, the test temperature was lower than in the plant, the debris concentrations were higher than in the plant, and the distances between the screens and the impingement of the recirculation jet were generally much shorter.

Therefore, the staff requests AREVA to evaluate the impact on strainer head loss if the floating fibrous debris had transported/accumulated on the strainer and address the following questions:

What are the principal phenomena that would contribute to debris floating? Were these phenomena modeled conservatively or prototypically in the test? Explain why it is acceptable for the test to permit floating as a debris removal mechanism given how the principal phenomena were scaled.

Response to Question 06.02.02-79:

The U.S. EPR test apparatus used several conservatisms to challenge the strainer design with regards to head loss. Throughout testing it has been observed that air bubbles generated by the impingement of the recirculation system jet entrain air into the flow of water. As the flow moves towards the strainer, tiny bubbles work their way to the surface, sometimes collecting fiber along the way. This is visually confirmed by the fact that fiber preparation removes air, yet there is air entrained within the fiber downstream of the retaining basket.

Air bubbles generated by the impingement of break flow from the heavy floor to the in-containment refueling water storage tank (IRWST) are prototypical; however, the flow towards the strainer was scaled slightly greater than plant conditions to enhance debris transport and prevent settling. To remedy any non-prototypical floating debris, floating debris will be documented with photographs, carefully removed with a filtering skimmer from the surface, and re-introduced into the test apparatus at an area downstream of the retaining basket. This process will be followed during future head-loss testing, and will be performed with extreme care to prevent any disturbances to strainer debris beds.

FSAR Impact:

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

U.S. EPR Final Safety Analysis Report Markups

Table 1.6-1—Reports Referenced
Sheet 2 of 4

Report No. (See Notes 1, 2, and 3)	Title	Date Submitted to NRC	FSAR Section Number(s)
ANP-10286P ANP-10286NP	U.S. EPR Rod Ejection Accident Methodology Topical Report	11/20/07	4.3 and 15
ANP-10287P ANP-10287NP	Incore Trip Setpoint and Transient Methodology for U.S. EPR Topical Report	11/27/07	4, 6, 7, and 15
ANP-10288P ANP-10288NP Revision 1	U.S. EPR Post-LOCA Boron Precipitation and Boron Dilution Technical Report	01/10	15
ANP-10290 Revision 1	AREVA NP Environmental Report Standard Design Certification	9/11/09	19.2
ANP-10291P ANP-10291NP	Small Break LOCA and Non-LOCA Sensitivity Studies and Methodology Technical Report	5/09	15
ANP-10292 Revision 1	U.S. EPR Conformance with Standard Review Plan (NUREG-0800) Technical Report	5/09	1.9
ANP-10293, Revision 3	U.S. EPR Design Features to Address GSI-191 Technical Report	~~2/08~~3/11	6.3 and 15.6.5.4.3
ANP-10294 Revision 1	U.S. EPR Reactor Coolant Pump Motor Flywheel Structural Analysis Technical Report	3/09	5.4.1.6.6
ANP-10295 Revision 1	U.S. EPR Security Design Features	10/09	13.6
ANP-10296	U.S. EPR Design Features that Enhance Security	12/08	13.6
ANP-10299P Revision 2	Applicability of AREVA NP Containment Response Evaluation Methodology to the U.S. EPR for Large Break LOCA Analysis	12/09	6.2.1 and 6.2.2
ANP-10304 Revision ~~1~~2	U.S. EPR Diversity and Defense in Depth Assessment Technical Report	~~12/09~~3/11	1.9, 7.1, 7.2, 7.3, 7.7, 7.8, 18.7, 19.1
ANP-10306P	Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report	12/09	3.9.2.1.1, 3.9.2.3, 3.9.2.4, and 3.9.2.7
ANP-10310P	Methodology for 100% Combinatorial Testing of the U.S. EPR™ Priority Module Technical Report	10/09	7.1

06.02.02-72

In-Containment Refueling Water Storage Tank

The IRWST is an open pool within a partly immersed building structure. It is located at the bottom of the containment between the reactor pit and the secondary shield wall, below the level of the heavy floor which supports the primary components. It is connected to various safety and non-safety systems and serves as a water source, heat sink, and return reservoir. Select design data for the IRWST are shown in Table 6.3-4.

The IRWST supplies borated water to the SIS, the severe accident heat removal system (SAHRS), and the chemical and volume control system (CVCS). It also supplies the fuel pool cooling system (FPCS) via the CVCS suction line. The IRWST provides the necessary inventory of borated water for design basis events. It contains a minimum 66,886 ft^3 of borated water which is monitored for its level, temperature, and homogeneous boron concentration. The water is used for both refueling and SIS operations and provides:

- Sufficient water during plant shutdown to fill the reactor cavity, the internal storage pool, the RB transfer pool, and the RCS.
- Sufficient water depth (static pressure head) to the suction of the SIS, SAHRS, and CVCS pumps during normal and accident conditions (per RG 1.1).
- A heat sink and water inventory for flooding the core melt in the spreading area during a beyond design basis event (severe accident).

The walls of the IRWST are lined with an austenitic stainless steel liner covering the immersed region of the building structure. The liner prevents leaks and the interaction of the boric acid with the concrete structure. Leaks that occur are collected, monitored, and quantified by the nuclear island drain and vent system (NIDVS).

The IRWST is provided with the following three filtering stages for the borated water return path to its integral sumps as shown in Figure 6.3-4—SIS Sump Debris Entrainment Prevention Features:

- The trash racks and the weirs above the heavy floor openings to the IRWST are considered components of the IRWST. After a LOCA, the flow of coolant out of the RCS back to the IRWST passes through four openings in the heavy floor. The trash racks prevent large debris from entering the IRWST, while the weirs provide a barrier that retains sediment and debris on the heavy floor.

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- Retaining baskets in the IRWST below each heavy floor opening trap debris transported by the flow past the trash racks and weirs. T~~wo of t~~he retaining baskets also filter flow from the annular space in containment to the IRWST. The openings in the retaining baskets provide efficient retention of fiber and particulate debris. A gap between the top of the baskets and the heavy floor provides a flow path if the retaining basket is full or clogged.

- The SIS and SAHRS strainers are arranged above each respective SIS and SAHRS sump. These strainers are designed as large cages with inclined sieves to facilitate debris detachment during backflushing. The opening size of the sieves limits the passage of debris during SIS and SAHRS recirculation flow to avoid pump malfunction and clogging of the smallest restriction in the core. The CVCS sump is also provided with a suction strainer.

The large dispersion area within the IRWST results in low flow velocity and promotes settling of fine debris that passes through the retaining baskets. The orientation of the various IRWST sumps is shown on the sump level plan view on Figure 6.3-5—IRWST Sump Level Plan View. The orientation of the trash racks and weirs is shown on the heavy floor plan view on Figure 6.3-6—IRWST Heavy Floor Level Plan View.

The IRWST sump screen flow performance was evaluated to verify that adequate long-term core cooling remains available in spite of impairment by accident-generated debris as well as debris in containment prior to the accident. The conservative estimate of total debris used for the evaluation, and an estimate of total debris in the containment of the U. S. EPR, is presented in Table 6.3-5. The increased use of reflective metal insulation (RMI), which is not subject to transport to the SIS sumps, in the U. S. EPR design in place of most or all of the fibrous or micro-porous insulation assumed in the evaluation further reduces the potential for post-accident blockage of the sumps.

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The features of the IRWST screen design ~~conform to RG 1.82 and~~ address the issues of GSI-191, as further described in Section 6.3.2.5. Technical Report ANP-10293, "U.S. EPR Design Features to Address GSI-191" (Reference 19) provides additional description of the U.S. EPR design features that limit the impact of post-accident debris accumulation on SIS performance, summarizes the performance evaluations and component test program, and compares the design to the regulatory positions of RG 1.82 and the information requested in GL 2004-02.

Performance of the strainers is enhanced by cleanliness programs that limit debris in the containment. A COL applicant that references the U.S. EPR design certification will describe the containment cleanliness program which limits debris within containment. This program consists of the following elements:

- Controls of permanent and temporary modifications so that changes to analytical inputs and assumptions confirm that the ECCS remains in compliance with 10 CFR 50.46, related regulatory requirements, and is consistent with guidance in RG 1.82 and GL 2004-02.
- Controls for foreign material exclusion to limit the introduction of foreign material and debris sources into containment.
- Controls to assess and manage maintenance activities, including associated temporary changes, to confirm that ECCS function is not reduced by associated

changes in analytical inputs or assumptions, or other activities that could introduce debris or potential debris sources into containment.

- Controls on the introduction of coating materials into containment and to address deficiencies of coating materials used in containment.

- Latent debris will be limited to 150 pounds and 100 ft^2.

06.02.02-75

Coolant pH adjustment baskets containing granulated trisodium phosphate dodecahydrate (TSP-C) are strategically placed in the inlet flow path to the IRWST within the boundary perimeter of the weirs at the four heavy floor openings of the RB. Flow through the baskets dissolves the TSP-C into the coolant that returns to the IRWST to passively neutralize entrained acids and maintain the alkalinity of the coolant. The pH of the recirculated coolant is maintained above 7.0. The control of pH in the recirculated coolant reduces the potential for stress-corrosion cracking of the austenitic stainless steel components, limits the generation of hydrogen attributable to corrosion of containment metals, and minimizes the re-evolution of iodine in post-LOCA containment solution, maintaining the radioiodine in solution to reduce radioactive releases to the environment. The minimum amount of granulated TSP-C for this pH control is 12,200 lb_m. Section 15.0.3.12 provides an evaluation of post-accident water chemistry control.

The IRWST is connected to the molten core spreading area by pipes that are closed during normal operation and accident conditions. If a severe accident occurs and molten material reaches the spreading area, an actuation device melts, flooding valves open, and IRWST water flows into the spreading area to support the operation of the SAHRS. The IRWST is located at a higher elevation than the core spreading area to provide gravity flooding of the spreading area with the IRWST water inventory. The core spreading area and the SAHRS are described in Section 19.2.3.3.

The debris interceptor components, including trash racks, retention baskets and ECCS strainers, are designed and analyzed per the provisions of ANSI/AISC N690-1994, “Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities,” including Supplement 2 (S2). The structural qualification of the debris interceptors includes an evaluation of the structural integrity of the supports and anchorages as it relates to the abilities of the trash rack, retention baskets and ECCS strainers to perform their intended function.

The structural design details and structural evaluation of the debris interceptor components, including the anchorages of the components to the walls or the floor and the attachments of the screens, will be provided in a structural evaluation and stress margin report.

The following industry codes and standards are used for the structural qualification of the debris interceptor components.

vented to maintain it full of coolant whenever the system is required to be operable to prevent loss of pump suction pressure that could result from accumulation of gases in the piping. Components of the SIS, including those for its support and auxiliary equipment, are designed, procured, installed, and maintained to the appropriate quality and reliability standards. These quality standards, coupled with the system redundancy and physical and electrical separation, allow the SIS to fulfill the design objectives presented in Section 6.3.1.

The RB floor drains direct leakage within the containment, up to an accumulation of two inches depth, to the RB sump where it is monitored, quantified, and processed as liquid waste. The RB floor drains are part of the NIDVS described in Section 5.2.5. Accumulation of leakage in containment greater than two inches depth, which is indicative of a LOCA, flows into the IRWST where it is available for accident response. The relatively low volume of the RB drains, in comparison to that of the IRWST, allows mixing of coolant during injection and recirculation so that no areas accumulate very high to low pH solutions.

06.02.02-74

The IRWSTS design responds to the post-LOCA ECCS sump performance issues of GSI-191 in accordance with~~by conforming to~~ the guidance of RG 1.82. The IRWSTS deters post-accident debris accumulation and SIS sump strainer blockage, in accordance with the expectations of RG 1.82, by:

- Minimizing the post-accident debris source term. The RCS piping and components, and other potentially insulated systems or components within a zone of influence~~containment~~, are insulated with RMI, and ~~negligible~~ or no fibrous or micro~~-~~porous insulation. Due to its high density, RMI is not susceptible to transport and therefore does not contribute to strainer head loss.

- Providing a three-tiered debris retention design. The combination of weirs/trash racks and retaining baskets are effective in retaining most post-accident debris. Furthermore, the sump strainers (the third stage of the three-tiered debris retention design) have a large screen surface area to accommodate the small amount of debris that reaches it. The full coverage screens and retention baskets, which are rigidly mounted to the IRWST floor, limit~~preven~~t bypass of debris into the suction lines.

The design features addressing GSI-191 and the performance evaluations are further described in Section 6.3.2.2.2 and Reference 19. Reference 19 also describes the component test program and compares the design to the regulatory positions of RG 1.82 and the information requested in GL 2004-02.

6.3.2.6 Protection Provisions

The four independent SIS trains are individually housed in four separate, Seismic Category I, reinforced concrete structures as described in Section 3.8.4. Since the SIS itself is Seismic Category I, the system is protected from potential earthquake damage.

When the lower plenum is refilled to the bottom of the fuel rod heated length, the refill phase ends and the reflood phase begins. The ECCS fluid flowing into the downcomer provides the driving head to move coolant through the core. As the mixture level moves up the core, steam is generated and liquid is entrained. As this entrained liquid is carried into the SGs, it vaporizes because of the higher temperature in the SGs. This causes steam binding, which reduces the core reflooding rate. The fuel rods are cooled and quenched by radiation and convective heat transfer as the quench front moves up the core. Long term recirculation cooling is maintained by the LHSI function of the SIS.

6.3.3.3 NPSH Evaluation

An evaluation of the MHSI and LHSI pumps demonstrates sufficient NPSH is available during postulated DBAs. This evaluation includes the effects of IRWST temperature, sump screen resistance with debris, pump performance, and uncertainties in hydraulic resistances.

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IRWST temperatures are calculated using RELAP5/B&W (Reference 16) to determine the mass and energy release, and GOTHIC (Reference 17) to determine the containment and IRWST responses. The IRWST temperatures are calculated conservatively by mixing the condensed liquid in the containment with the IRWST water. The limiting case is the double-ended guillotine (DEG) hot-leg break, Figure 6.3-7—IRWST LOCA Temperature Response. The peak IRWST temperature is calculated to be 246.2~~230~~°F.

The SIS pump NPSH evaluation for LBLOCA events is performed using the maximum pump flow head-capacity curves, maximum system resistances, debris laden sump screen resistance, and a reduced IRWST level to account for liquid hold up in the containment. The limiting evaluation of NPSH does not credit containment overpressure. It conservatively assumes the IRWST liquid is at the saturation pressure corresponding to the peak calculated IRWST temperature of 246.2~~230~~°F. Simultaneous operation of both the MHSI and LHSI pumps is considered. The increase in IRWST temperature is taken into account for the LBLOCA analysis in Section 15.6.5. The LBLOCA analysis inherently bounds the SBLOCA analysis.

6.3.4 Tests and Inspections

Refer to Section 14.2 (Test abstract #014, #015, #016, #022, #175, and #177) for initial plant testing. Applicable guidance from RG 1.79 is incorporated in the initial plant testing described in Section 14.2.

Surveillance Requirements 3.5.1, 3.5.2, 3.5.3, and 3.5.4 in Chapter 16 describe the SIS surveillance requirements.

18. GL 2004-02, “Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors,” U.S. Nuclear Regulatory Commission, September 2004.

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19. ANP-10293, Revision ~~0~~3, “U.S. EPR Design Features to Address GSI-191,” AREVA NP Inc., ~~February, 2008~~March, 2011.

Table 6.3-5—Total Debris Source Term

Material	~~Assumed for Evaluation~~	Estimated U.S. EPR Maximum
~~Mineral wool in cassettes~~	~~880 ft3~~	~~Negligible or none~~
~~Mineral wool in fiber glass cloth and protected by stainless steel sheet~~	~~140 ft3~~	~~Negligible or none~~
~~Mineral wool in mattress around auxiliary pipes protected by stainless steel sheet~~	~~210 ft3~~	~~Negligible or none~~
RMI ~~(primary reactor coolant pump)~~	~~105 ft3~~	2119~~1345~~ ft^{2}~~^{3}~~
~~Paint chips~~	~~110 lb~~	~~110 lb~~
Latent debris	~~110 lb~~	150~~110~~ lb
Microporous insulating material	~~220 lb~~	~~220 lb~~1 ft^{3}
Inorganic zinc		959 lb
Qualified epoxy coatings		126 lb
Unqualified epoxy coatings		250 lb

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