ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Friday, July 24, 2009 4:54 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); NOXON David B (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 227, FSAR Ch 19, Supplement 2
Attachments: RAI 227 Supplement 2 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. provided responses to 12 of the 20 questions of RAI No. 227 on July 6, 2009. On July 16, 2009, AREVA NP submitted Supplement 1 to the response to address 1of the remaining questions. Several pages were unintentionally omitted in the appended U.S. EPR Final Safety Analysis Report (FSAR) markups provided in Supplement 1.

The attached file, "RAI 227 Supplement 2 Response U.S. EPR DC" provides the affected pages of the U.S. EPR FSAR in redline-strikeout format which support the response to RAI 227 Question 19-285, provided in Supplement 1. These FSAR markups replace, in their entirety, the FSAR markups provided in Supplement 1.

The schedule for a technically correct and complete response to the remaining questions was provided previously and remains as indicated below.

Question #	Response Date
RAI 227 — 19-284	September 18, 2009
RAI 227 — 19-287	September 18, 2009
RAI 227 — 19-292	September 18, 2009
RAI 227 — 19-293	September 18, 2009
RAI 227 — 19-294	September 18, 2009
RAI 227 — 19-295	September 18, 2009
RAI 227 — 19-298	August 28, 2009

Sincerely,

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From: Pederson Ronda M (AREVA NP INC)
Sent: Thursday, July 16, 2009 1:57 PM
To: 'Tesfaye, Getachew'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); NOXON David B (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 227, FSAR Ch 19, Supplement 1

Getachew,

AREVA NP Inc. provided responses to 12 of the 20 questions of RAI No. 227 on July 6, 2009. The attached file, "RAI 227 Supplement 1 Response U.S. EPR DC" provides a technically correct and complete response to one of the remaining 8 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 227 Question 19-285.

The following table indicates the respective pages in the response document, "RAI 227 Supplement 1 Response U.S. EPR DC," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 227 — 19-285	2 A-1 B-1	3 A-90 B-130

A complete answer is not provided for 7 of the 20 questions. The schedule for a technically correct and complete response to these questions was provided previously and remains as indicated below.

Question #	Response Date
RAI 227 — 19-284	September 18, 2009
RAI 227 — 19-287	September 18, 2009
RAI 227 — 19-292	September 18, 2009
RAI 227 — 19-293	September 18, 2009
RAI 227 — 19-294	September 18, 2009
RAI 227 — 19-295	September 18, 2009
RAI 227 — 19-298	August 28, 2009

Sincerely,

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From: WELLS Russell D (AREVA NP INC)
Sent: Monday, July 06, 2009 6:08 PM
To: 'Getachew Tesfaye'
Cc: Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 227, FSAR Ch 19

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 227 Response US EPR DC.pdf" provides technically correct and complete responses to 12 of the 20 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 227 Questions 19-299 and 19-300.

The following table indicates the respective pages in the response document, "RAI 227 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 227 — 19-284	2	3
RAI 227 — 19-285	4	4
RAI 227 — 19-286	5	5
RAI 227 — 19-287	6	6
RAI 227 — 19-288	7	10
RAI 227 — 19-289	11	11
RAI 227 — 19-290	12	12
RAI 227 — 19-291	13	13
RAI 227 — 19-292	14	14
RAI 227 — 19-293	15	15
RAI 227 — 19-294	16	16
RAI 227 — 19-295	17	17
RAI 227 — 19-296	18	19
RAI 227 — 19-297	20	22
RAI 227 — 19-298	23	23
RAI 227 — 19-299	24	26
RAI 227 — 19-300	27	32
RAI 227 — 19-301	33	33
RAI 227 — 19-302	34	35
RAI 227 — 19-303	36	37

A complete answer is not provided for 8 of the 20 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 227 — 19-284	September 18, 2009
RAI 227 — 19-285	July 20, 2009
RAI 227 — 19-287	September 18, 2009
RAI 227 — 19-292	September 18, 2009
RAI 227 — 19-293	September 18, 2009
RAI 227 — 19-294	September 18, 2009
RAI 227 — 19-295	September 18, 2009
RAI 227 — 19-298	August 28, 2009

(Russ Wells on behalf of)
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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, June 05, 2009 3:29 PM
To: ZZ-DL-A-USEPR-DL
Cc: Theresa Clark; Hanh Phan; Edward Fuller; Lynn Mrowca; Prosanta Chowdhury; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 227 (2564, 2598),FSAR Ch. 19

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 15, 2009, and discussed with your staff on May 29, 2009. Draft RAI Questions 19-296, 19-300, and 19-302 were modified 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,
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Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 689

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Subject: Response to U.S. EPR Design Certification Application RAI No. 227, FSAR Ch 19, Supplement 2
Sent Date: 7/24/2009 4:54:02 PM
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Response to

Request for Additional Information No. 227 (2564, 2598), Supplement 2
6/05/2009

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

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

U.S. EPR Final Safety Analysis Report Markups

- Group 23 represents cutsets resulting from an SLBO, followed by a CCF to close MSIVs resulting in all four SGs uncontrolled blowdown, and with operator failure to initiate EBS and control reactivity.

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- The important CDF sequences for internal events are presented in Table 19.1-127—U.S. EPR Important Sequences – Level 1 Internal Events. The "important" CDF sequences are defined as those sequences with a sequence frequency greater than one percent of total at-power CDF, as presented in Section 19.1.8.1. For each sequence, Table 19.1-127 gives corresponding event tree, sequence number, event tree sequence identifier, the sequence frequency, and a brief description. It also connects the sequence to the corresponding cutset group in Table 19.1-7, which gives a more detailed description of the sequences.

19.1.4.1.2.4 Significant SSC, Operator Actions and Common Cause Events

Table 19.1-8—U.S. EPR Risk-Significant Equipment based on FV Importance - Level 1 Internal Events through Table 19.1-11—U.S. EPR Risk-Significant Human Actions based on RAW Importance - Level 1 Internal Events shows the important contributors to the internal CDF. Importance is based on the Fussell-Vesely (FV) importance measure (FV ≥0.005), or the risk achievement worth (RAW) importance measure (RAW ≥2).

- Table 19.1-8 shows the risk-significant structures, systems and components (SSC) based on the FV importance measure. The components with the highest FV are the EDG trains and air chiller unit trains. The most important SSC can be explained by a high LOOP contribution to the total CDF and by an importance of the HVAC system in the SB 1 and SB 4 (the location of the running CCW pumps).

- Table 19.1-9—U.S. EPR Risk-Significant Equipment based on RAW Importance - Level 1 Internal Events shows the risk-significant SSC based on the RAW importance measure. The two most important events are the EFW storage tanks and 250V DC buses. Their high RAW rank can be explained by their high reliability and by a high consequence of their failures. A failure (a leak) of an EFW tank, if not isolated, would disable all EFW; failure of the Division 4 DC Bus would disable all Division 4 after a LOOP, and would also disable fault isolations in this division (all breaks are assumed to occur in Division 4)

- Table 19.1-10—U.S. EPR Risk-Significant Human Actions based on FV Importance - Level 1 Internal Events shows the risk-significant human actions based on FV importance. The most important operator action based on the FV is the operator failure to recover room cooling locally given the loss of ventilation. This importance illustrates the importance of the HVAC system. This action, that follows any failure of ventilation to the SBs, shows in cutsets that contribute 43 percent to the total CDF.

- Table 19.1-11—U.S. EPR Risk-Significant Human Actions based on RAW Importance - Level 1 Internal Events shows the risk-significant human actions based on RAW importance. The most important human action based on RAW is, again, the operator failure to recover room cooling locally given the loss of

specific failure pattern 1 above, a loss of Divisions 1 and 4, associated with the running CCW trains, could, if not recovered in time, lead to a loss of two additional safety divisions. All EFW and the possibility to perform feed-and-bleed will be lost, leading to core damage.

Group 5 represents a sequence with a loss of all feedwater and an operator failure to initiate feed and bleed. A flood in the TB disables the MFW and the SSS, followed by an independent CCF of the EFW pumps to start.

Groups 6, 8, 9 and 10 represent the RCP seal LOCA sequences following a flood in the SB 1 or SB 4 including the FB. As explained in flood-specific failure pattern 1 above, a flood in SB 1 or SB 4 results directly in a loss of CCW CH2 and consequently in a loss of seal cooling to two RCPs (the seal injection is disabled because of the flood propagation to the FB, which hosts the CVCS). A failure to isolate seals for one of those two RCPs leads to a seal LOCA with an assumed probability of 0.2. The mechanism by which mitigation of the seal LOCA is failed differs slightly between these groups. It involves either a failure of long-term cooling of the IRWST by the LHSI heat exchanger (the SAHRS is unavailable due to the flood), or failure of MHSI to inject. In Table 19.1-41, which accounts for the top 100 cutsets, seal LOCA sequences contribute to 6.4 percent of the flooding CDF. Overall, a consequential seal LOCA accounts for about 30 percent of the flooding CDF.

Groups 7 and 12 represent sequences when floods caused by pipe breaks in the EFWS result in a complete loss of feedwater. Since the four EFW tanks are connected and are required for a successful core cooling during a 24-hour mission time, a break in any of the trains has the potential to drain the full inventory unless the operator isolates the break and initiates makeup with the demineralized water system (DWS). The DWS is a non-safety system that relies on offsite power. Therefore, a consequential LOOP following the flooding event will fail the makeup. Since it also fails the MFWS and the SSS, all feedwater is lost. Failure of feed-and-bleed, either due to an operator failure to initiate the action (Group 7) or due to a failure of required systems (Group 12, a CCF of all EDGs to run), results in core damage.

Group 11 represents a single cutset that combines a flood in SB 4, with independent failures of HVAC to Division 2, MHSI pump Division 1, and PAS (disables MFW and SSS). This leads to a failure of three divisions (2, 3 and 4), a failure of MSRTs because of electrical dependencies (see Section 19.1.4.1.1.3), and only one EFW train being available when two are needed to remove decay heat through MSSVs. Feed and bleed fails because the only available MHSI pump fails independently.

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The important CDF sequences for internal floods are presented in Table 19.1-128—U.S. EPR Important Sequences – Level 1 Flooding Events. The "important" CDF sequences are defined as those sequences with a sequence frequency greater than one percent of total at-power CDF, as presented in Section 19.1.8.1. For each sequence,

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Table 19.1-128 gives corresponding event tree, sequence number, event tree sequence identifier, the sequence frequency, and a brief description. It also connects the sequence to the corresponding cutset group in Table 19.1-41, which gives a more detailed description of the sequences.

19.1.5.2.2.4 Significant SSC, Operator Actions and Common Cause Events

Table 19.1-42 through Table 19.1-48 show the important contributors to the internal flooding CDF. Importance is based on the FV importance measure (FV ≥0.005), or the RAW importance measure (RAW ≥2).

Table 19.1-42—U.S. EPR Risk-Significant Equipment based on FV Importance - Level 1 Flooding shows the top risk-significant SSC based on the FV importance measure. The MHSI pump trains have the highest FV. This could be explained by an overall high contribution of the consequential RCP seal LOCA sequences that follow a flood in a SB (Groups 6, 8, 9, 10 in Table 19.1-41), and require safety injection.

Table 19.1-43—U.S. EPR Risk-Significant Equipment based on RAW Importance - Level 1 Flooding shows the top risk-significant SSC based on the RAW importance measure. The two most important components are the RCP seal isolation MOVs (i.e., nitrogen and leakoff valves) and the SSSS. This can be explained by the importance of those components in preventing an RCP seal LOCA following a flood in SB 1 or SB 4. Since these floods are assumed to propagate to the FB, they could simultaneously fail one CCW common header (CH) and the CVCS, thereby disabling thermal barrier cooling and the seal injection to two RCPs. A single failure of an RCP seal isolation MOV or the SSSS could result in a seal LOCA.

Table 19.1-44—U.S. EPR Risk-Significant Human Actions based on FV Importance - Level 1 Flooding shows the risk-significant human actions based on the FV importance measure. The most important operator action based on the FV is the failure to recover room cooling locally following a loss of ventilation. The high importance of that action reflects the importance of ventilation dependencies in the plant risk in general.

Table 19.1-45—U.S. EPR Risk-Significant Human Actions based on RAW Importance - Level 1 Flooding shows the risk-significant human actions based on the RAW importance measure. The most important operator action based on the RAW value is the operator failure to initiate a feed and bleed for transient events. Its importance could be explained by multiple flooding sequences leading to a total loss of feedwater. It is also important to note that the operator failure to isolate a FWDS break in the annulus is modeled as part of the initiating event frequency, therefore it is not shown in these tables. If it was included in the model, this action would be expected to have a significant contribution to the internal flooding CDF.

Table 19.1-46—U.S. EPR Risk-Significant Common Cause Events based on RAW - Level 1 Flooding shows the risk-significant common-cause events based on the RAW

associated with the running CCW trains, could, if not recovered in time, lead to losses of two additional safety divisions. All EFW and possibility to perform feed-and-bleed will be lost, leading to core damage.

Groups 4, 5, 7 and 11 represent the RCP seal LOCA sequences resulting from a fire in the switchgear room of SB 1 or SB 4. As explained in the first fire-specific failure pattern 1 above, a fire in the switchgear room of SB 1 or SB 4 results directly in a loss of CCW CH 2, and consequently in a loss of thermal barrier cooling to the seals of two RCPs. When the CVCS suction switchover to the IRWST is required, the CVCS would fail because Division 4 power is required to perform the switchover. This results in a loss of CVCS seal injection, and total loss of the cooling to two affected RCPs. A failure to isolate seals for one of these two RCPs, leads to a seal LOCA with an assumed probability of 0.2. The PCD function fails because the MSRTs are not available, and the primary bleed fails because of the loss of Division 4. In Table 19.1-66, which summarizes the top 100 cutsets, the seal LOCA sequences represent 30 percent of the fire CDF. Overall, a consequential seal LOCA accounts for about 43 percent of the fire CDF.

Group 8 represents a single cutset resulting from a fire in the pressurizer compartment. Spurious operation of any pressurizer valve leads to a small LOCA. A CCF to open the MSRTs prevents secondary cooldown to succeed. Feed-and-bleed is disabled by the fire.

Group 10 represents a single cutset describing a fire in the Switchgear Building followed by a consequential LOOP and an independent CCF of all EDGs to run. Since the SBO DGs are disabled by the fire, this sequence leads to a total SBO. The consequential LOOP sequences represent 11 percent of the overall fire risk.

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The important CDF sequences for internal fires are presented in Table 19.1-129—U.S. EPR Important Sequences – Level 1 Fire Events. The "important" CDF sequences are defined as those sequences with a sequence frequency greater than one percent of total at power CDF, as presented in Section 19.1.8.11. For each sequence, Table 19.1-129 gives corresponding event tree, sequence number, event tree sequence identifier, the sequence frequency, and a brief description. It also connects the sequence to the corresponding cutset group in Table 19.1-66, which gives a more detailed description of the sequences.

19.1.5.3.2.4 Significant, SSC, Operator Actions and Common Cause Events

Table 19.1-67 through Table 19.1-73 show the important contributors to the internal fire CDF. Importance is based on the FV importance measure (FV ≥0.005), or the RAW importance measure (RAW ≥2).

Table 19.1-67—U.S. EPR Risk-Significant Equipment based on FV Importance - Level 1 Fire Events shows the top risk-significant SSC based on the FV importance measure.

reducing station MOVs to close on demand, in this case followed by a CCF of cold leg injection check valves, common to all injection trains.

Groups 5, 6, 7, 9 and 10 all represent a loss of RHR cooling due to a LOOP event during POS CAU, CAD, CBD, and CBU, followed by a CCF of all EDGs to run. Since CCW trains are not supplied from SBO DGs, the only way to cool the plant is by the EFW pump in Division 1 (only SGs 1 and 2 are assumed to be available) or the SAHR dedicated ESW/CCW. In the summarized cutsets, various combinations disable these two systems, for example a loss of SBO DG in Division 1 would disable both of these systems.

Groups 8 and 11 represent a loss of RHR cooling due to a LOOP event during POS CAU, CAD, CBD, CBU, and DU, followed by a CCF of all safety-related batteries on demand. This results in a total loss of instrumentation, and, because no instrumentation is available to operators, these sequences are conservatively assumed to lead to core damage, without crediting a LOOP recovery or non safety batteries.

Group 12 represents a loss of RHR system in POS CBD, due to a total loss of the HVAC system which occurred after the SAC air supply fans failed to run and no compensatory operator action was implemented. The result is a loss of all safety divisions.

Group 13 and 14 represent a LOCA in POS CBD and DU, due to an inadvertent opening of a LHSI overpressure protection safety valve and an operator failure to isolate. Core damage occurred because of a CCF of cold leg injection check valves, common to all injection systems.

Group 15 represents a LOCA outside containment in POS E and CBD, caused by a pipe break in an operating RHR train, followed by a failure of both manual and auto isolation.

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All "important" CDF sequences, with a sequence frequency greater than one percent of shutdown core damage frequency (as presented in Section 19.1.6.2.1), are shown in Table 19.1-130—U.S. EPR Important Sequences – Level 1 Shutdown. For each sequence, Table 19.1-130 gives event tree, sequence number, corresponding initiating event, event tree sequence identifier, the sequence frequency, and a brief description. It also connects the sequence to the corresponding cutset group in Table 19.1-92, which gives a more detailed description of the sequence.

19.1.6.2.4 Significant SSC, Operator Actions, and Common Cause Events

Table 19.1-93 through Table 19.1-98 show the important contributors to shutdown CDF. Importance is based on FV importance measure (FV ≥0.005), or RAW importance measure (RAW ≥2). Note that the SSC and CCFs that could directly cause an IE were not ranked based on RAW importance measure.

Table 19.1-127—U.S. EPR Important Sequences – Level 1 Internal Events
Sheet 1 of 3

Event Tree	Seq. Num	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
					Table Number	Group Number
LOOP	14	LOOP-REC LOOP-EFW-PBL	8.58E-08	A LOOP event, no recovery of OSP in 2 hours; followed by failures of EFW system and pressure relief for feed and bleed function (dominated by HVAC related failures).	19.1-7	1, 2
GT	15	GT-MFW-SSS-EFW-PBL	2.02E-08	A plant trip with a consequential LOOP (no recovery) and subsequent MFW and SSS failures, followed by failures of EFW system and pressure relief for feed and bleed function (dominated by HVAC related failures).	19.1-7	18, 19
SLOCA	17	SLOCA-SSS-EFW-OP FB	1.95E-08	An SLOCA event with failures of SSS and EFW systems (dominated by a failure of PCD function); followed by an operator failure to initiate F&B.	19.1-7	9, 10
SLOCA	34	SLOCA-MHSI-OP FCD	1.73E-08	An SLOCA event with a failure of all MHSI system, followed by an operator failure to initiate FCD.	19.1-7	8
LOOP	45	LOOP-EDG-REC LOOP-SBO	1.66E-08	A LOOP event, no recovery of OSP in 2 hours; with a failure of all EDGs and both SBO DGs leading to a total blackout.	19.1-7	4
LOOP	44	LOOP-EDG-REC LOOP-EFW	1.12E-08	A LOOP event, no recovery of OSP in 2 hours; with a failure of all EDGs (SBO conditions), followed by a EFW system failure (F&B is not possible in SBO conditions).	19.1-7	5, 6
SLBI	40	SLBI-MSIV ISO(3)-FW ISO	1.04E-08	An SLBI event, followed by a failure of all MS/FW isolation (dominated by common cause software failure of protection system group B).	19.1-7	15

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Table 19.1-127—U.S. EPR Important Sequences – Level 1 Internal Events Sheet 2 of 3

Event Tree	Seq. Num	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
					Table Number	Group Number
SGTR	18	SGTR-SG ISO-OP RHR	9.72E-09	An SGTR event with a failure to isolate the faulted SG and operator failure to depressurize RCS and initiate RHR.	19.1-7	16
ATWS	12	ATWS-PSR	9.36E-09	An ATWS event, pressure relief was not credited for ATWS events w/o MFW	19.1-7	17
LOOP	53	LOOP-EDG-RCP LOCA-REC LOOP-OP FCD	7.24E-09	A LOOP event, no recovery of OSP in 2 hours, with a failure of all EDGs (SBO conditions), followed by a seal LOCA and operator failure to initiate a FCD (MHSI not available in SBO conditions).	19.1-7	7
GT	14	GT-MFW-SSS-EFW-MHSI 01	6.78E-09	A plant trip with a consequential LOOP (no recovery) and subsequent MFW and SSS failures, followed by failures of EFW and MHSI system (MHSI is failing a feed and bleed function).	19.1-7	20, 21
SLBI	17	SLBI-FW ISO-EFW	6.78E-09	An SLBI event, followed by a failure of FW isolation and EFW (F&B not credited)		
SLBI	30	SLBI-MSIV ISO-FW ISO-EFW	6.49E-09	An SLBI event, followed by a failure of one MS line and FW isolation (2 SG blowing down) and EFW failure (F&B not credited)		
LOOP	11	LOOP-REC LOOP-EFW-LHSI-SAHR	6.39E-09	A LOOP event, no recovery of OSP in 2 hours, with failure of EFW, feed and bleed fails by lack of long term heat removal (no LHSI or SAHRS)		

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Table 19.1-127—U.S. EPR Important Sequences – Level 1 Internal Events Sheet 3 of 3

Event Tree	Seq. Num	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
					Table Number	Group Number
SLOCA	20	SLOCA-MHSI-ACC	6.24E-09	An SLOCA event, with a failure of MHSI system and accumulators (dominated by a failure to open MHSI/ACC/LHSI common discharge check valves).	19.1-7	11
LOOP	56	LOOP-EDG-I&C	5.63E-09	A LOOP event where a loss of all 1E 2hr batteries prevents starting of EDGs and results in loss of all instrumentation. Given that no instrumentation is available, OSP recoveries or SBO DGs (controlled from 12-hour batteries) are not credited.	19.1-7	3
LOOP	30	LOOP-RCP LOCA-REC LOOP-EFW-OP FB	5.48E-09	A LOOP event, no recovery of OSP in 2 hours, followed by an RCP LOCA, a failure of EFW and an operator failure to initiate feed and bleed.		
LOOP	29	LOOP-RCP LOCA-REC LOOP-EFW-PBL	5.38E-09	A LOOP event, no recovery of OSP in 2 hours, followed by an RCP LOCA, and failures of EFW system and pressure relief for feed and bleed function.		
LOOP	52	LOOP-EDG-RCP LOCA-REC LOOP-EFW	5.31E-09	A LOOP event, no recovery of OSP in 2 hours, with a failure of all EDGs (SBO conditions), followed by an RCP LOCA, and a failure of EFW		

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Table 19.1-128—U.S. EPR Important Sequences – Level 1 Flooding Events

Event Tree	Seq. Num	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
					Table Number	Group Number
FLD-ANN ALL	2	FLD-ANN ALL-PROB ANNULUS	9.72E-09	A flood caused by a pipe break in the annulus reaches the level of the electrical penetrations and damages connection boxes (assumed to lead to core damage).	19.1-41	1
LOCCW (IE FLD-SAB14 FB)	31	IE FLD-SAB14 FB-RCP LOCA-MHSI-SAHR	8.98E-09	A flood in the pump room of SB 4 (or SB1) extending to the FB, resulting in a seal LOCA, with a failure of MHSI system and long term cooling of IRWST with the SAHR (SAHR is unavailable because of the flood).	19.1-41	6
LOCCW (IE FLD-SAB14 FB)	17	IE FLD-SAB14 FB-RCP LOCA-LHSI-SAHR	8.66E-09	A flood in the pump room of SB 4 (or SB1) extending to the FB, resulting in a seal LOCA, with failures of LHSI and SAHR causing a failure of IRWST long term cooling.	19.1-41	8

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Table 19.1-129—U.S. EPR Important Sequences – Level 1 Fire Events

Event Tree	Seq. Num	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
					Table Number	Group Number
31BDA (IE FIRE-SAB14)	32	IE FIRE-SAB14-AC-RCP LOCA-SSS-EFW-PBL	5.78E-08	A fire in the switchgear room of SB 4 (or SB1), resulting in a seal LOCA, followed by failures of SSS and EFW (dominated by a failure of PCD function), and a failure of pressure relief for feed and bleed function.	19.1-66	4, 5, 11
MSSV (IE FIRE-MS-VR)	24	IE FIRE-MS-VR-MSIV ISO(3)-OP RHR	2.73E-08	A fire in the MFW/MS valve room causing a spurious opening of an MSRIV, and a failure to isolate with MSIV, leading to two steam generators blowing down; followed by an operator failure to depressurize RCS and initiate RHR.	19.1-66	1
LBOP (IE FIRE-SWGR)	13	IE FIRE-SWGR-EFW-PBL	2.16E-08	A fire in the switchgear building fails all non-safety power, disabling MFW and SSS, failures of EFW and pressure relief for feed and bleed function.	19.1-66	6
31BDA (IE FIRE-SAB14)	19	IE FIRE-SAB14-AC-RCP LOCA-LHSI-SAHR	1.72E-08	A fire in the switchgear room of SB 4 (or SB1), resulting in a seal LOCA, with failures of LHSI and SAHR causing a failure of IRWST long term cooling.	19.1-66	7
31BDA (IE FIRE-SAB)	15	IE FIRE-SAB-MECH-MFW-SSS-EFW-PBL	1.25E-08	A fire in the pump room of SBs, followed by failures of MFW, SSS, EFW and pressure relief for feed and bleed function	19.1-66	3
31BDA (IE FIRE-SAB14)	33	IE FIRE-SAB14-AC-RCP LOCA-SSS-EFW-OP FB	7.53E-09	A fire in SB 4 (or SB1), resulting in a seal LOCA, followed by failures of SSS, EFW and operator action to initiate feed and bleed.		

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Table 19.1-130—U.S. EPR Important Sequences – Level 1 Shutdown
Sheet 1 of 4

Event Tree	Seq. Num	Initiating Event	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
						Table Number	Group No.
SD ULD CB	3	IE ULD CBD D	ISOLSD-OP ISOLSD	7.18E-09	CBD: An uncontrolled level drop IE, followed by an auto failure and a long term operator failure to isolate, leading to a slow RCS drain outside containment.	19.1-92	2
SD ULD D	3	IE ULD DU D	ISOLSD-OP ISOLSD	7.18E-09	DU: An uncontrolled level drop IE, followed by an auto failure and a long term operator failure to isolate, leading to a slow RCS drain outside containment.	19.1-92	1
SD LOCA C	30	IE LOCA CBD	MHSISD-LHSISD	6.07E-09	CBD: A LOCA IE followed by failures of MHSI/LHSI injection (dominated by a CC failure of common cold leg injection check valves).	19.1-92	13
SD RHR C	15	IE RHR CBD	EFWSD-MHSISD-LHSISD-(SAHRSD)	6.04E-09	CBD: A loss of RHR IE, followed by a failure of EFW and all injection (MHSI and LHSI).	19.1-92	5,6,7,8
SD RHR C	15	IE RHR CAD	EFWSD-MHSISD-LHSISD-(SAHRSD)	4.51E-09	CAD: A loss of RHR IE, followed by a failure of EFW and all injection (MHSI and LHSI).	19.1-92	5,6,7,8

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Table 19.1-130—U.S. EPR Important Sequences – Level 1 Shutdown Sheet 2 of 4

Event Tree	Seq. Num	Initiating Event	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
						Table Number	Group No.
SD RHR C	15	IE RHR CBU	EFWSD-MHSISD-LHSISD-(SAHRSD)	4.51E-09	CBU: A loss of RHR IE, followed by a failure of EFW and all injection (MHSI and LHSI).	19.1-92	5,6,7,8
SD LOCA D E	3	IE LOCA DU	MHSISD-LHSISD	3.08E-09	DU: A LOCA IE followed by failures of MHSI/LHSI injection (dominated by a CC failure of common cold leg injection check valves).	19.1-92	14
SD LOCA C	30	IE LOCA CBU	MHSISD-LHSISD	3.04E-09	CBU: A LOCA IE followed by failures of MHSI/LHSI injection (dominated by a CC failure of common cold leg injection check valves).	19.1-92	13
SD RHR C	15	IE RHR CAU	EFWSD-MHSISD-LHSISD-(SAHRSD)	2.99E-09	CAU: A loss of RHR IE, followed by a failure of EFW and all injection (MHSI and LHSI).	19.1-92	5,6,7,8
SD LOCA D E	3	IE LOCA DD	MHSISD-LHSISD	1.35E-09	DD: A LOCA IE followed by failures of MHSI/LHSI injection (dominated by a CC failure of common cold leg injection check valves	19.1-92	14

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Table 19.1-130—U.S. EPR Important Sequences – Level 1 Shutdown
Sheet 3 of 4

Event Tree	Seq. Num	Initiating Event	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
						Table Number	Group No.
SD LOCA C	29	IE LOCA CBD	MHSISD-SAHRSD	1.31E-09	CBD: A LOCA IE, followed by a failure of MHSI and long term cooling with SAHR (long term cooling with LHSI not credited if MHSI failed).		
SD RHR D	3	IE RHR DU	MHSISD-LHSISD	1.19E-09	DU: A loss of RHR IE, followed by a failure of all injection (MHSI and LHSI).	19.1-92	10,11
SD RHR C	12	IE RHR CBD	EFWSD-LHSISD-SAHRSD	9.23E-10	CBD: A loss of RHR IE, followed by a failure of EFW, F&B fails due to a failure of long term cooling (LHSI & SAHR).	19.1-92	9
SD RHR ISLOCA E	2	IE RHR ISLOCA E	RHR ISLOCA SD	7.92E-10	E: An ISLOCA IE is caused by a pipe break in one RHR train, followed by an isolation failure (automatic & manual) leading to an unisolated LOCA outside containment.	19.1-92	15
SD RHR C	12	IE RHR CBU	EFWSD-LHSISD-SAHRSD	6.85E-10	CBU: A loss of RHR IE, followed by a failure of EFW, F&B fails due to a failure of long term cooling (LHSI & SAHR).	19.1-92	9
SD RHR C	12	IE RHR CAD	EFWSD-LHSISD-SAHRSD	6.84E-10	CAD: A loss of RHR IE, followed by a failure of EFW, F&B fails due to a failure of long term cooling (LHSI & SAHR).	19.1-92	9

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Table 19.1-130—U.S. EPR Important Sequences – Level 1 Shutdown Sheet 4 of 4

Event Tree	Seq. Num	Initiating Event	RS Sequence ID	Seq. Freq (1/yr)	Description	Corresponding Cutsets	
						Table Number	Group No.
SD ULD D	6	IE ULD DU D	ISOLSD-MHSISD-LHSISD	6.74E-10	DU: An uncontrolled level drop IE, followed by a failure to isolate, and failures of all injection (MHSI and LHSI).	19.1-92	3
SD ULD CB	39	IE ULD CBD D	ISOLSD-MHSISD-LHSISD	6.72E-10	CBD: An uncontrolled level drop IE, followed by a failure to isolate, and failures of all injection (MHSI and LHSI).	19.1-92	4
SD LOCA C	29	IE LOCA CBU	MHSISD-SAHRSD	6.49E-10	CBU: A LOCA IE, followed by a failure of MHSI and long term cooling with SAHR (long term cooling with LHSI not credited if MHSI failed).		
SD RHR C	16	IE RHR CBD	EFWSD-PBLSD	6.40E-10	Shutdown State CBD: A loss of RHR IE, followed by failures of EFW and pressure relief for feed and bleed function.	19.1-92	12

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