RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**410-8357**
SRP Section:	**SRP 19**
Application Section:	**19.1**
Date of RAI Issue:	**02/22/2016**

Question No. 19-29

Item 11 of Section II, “Acceptance Criteria,” of the (Draft) Revision 3 SRP, states, “The PRAs that meet the applicable supporting requirements for Capability Category I and meet the high-level requirements as defined in the ASME PRA Standard (ASME/ANS RA-S-2008 and addenda ASME/ANS RA-Sa–2009) should generally be acceptable for DC and COL applications. Alternatively, the applicant may identify, and justify the acceptability of, alternative measures for addressing PRA quality and technical adequacy. The staff should specifically review the acceptability of these alternative measures in the context of the specific uses and applications of the PRA.”

The staff reviewed the APR1400 design control document (DCD) Section 19.1.4.1.1, “Description of Level 1 Internal Events PRA for Operations at Power,” and found insufficient information describing the initiating event analysis performed. Specifically, the applicant did not identify and/or evaluate a very small loss of coolant accident (LOCA) initiating event for which generic data is available, common cause failure of 4.16kV AC buses and loss of direct current (LODC) power for the ‘C’ and ‘D’ trains. Therefore, in order for the staff to reach an assurance finding on the conformance to Standard Review Plan (SRP) Chapter 19.0 regarding PRA technical adequacy, please evaluate the very small LOCA initiating event or provide a justification for not evaluating it and revise the DCD accordingly.

Response

Concerning very small LOCA, in the response to Action Item 19-206 (PRA-184), 19-214 (PRA-192) and 19-216 (PRA-194), CSLOCA is currently included in SLOCA. These three (3) action items included markups to all of the applicable documents as well as an assessment of the impact of adding VSLOCA. Note that since the VSLOCA break size is smaller than the SLOCA break size, operator action times would be greater; hence, treatment of VSLOCA within SLOCA is conservative with respect to operator action times. Also, since continued normal charging could, by definition, successfully mitigate a VSLOCA, and since the SLOCA event tree ((ET) does not credit normal charging, incorporation of the VSLOCA within the SLOCA ET is

conservative with respect to accident sequence analysis.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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Docket No. 52-046

RAI No.:	**410-8357**
SRP Section:	**SRP 19**
Application Section:	**19.1**
Date of RAI Issue:	**02/22/2016**

Question No. 19-30

Item 11 of Section II, “Acceptance Criteria,” of the (Draft) Revision 3 SRP, states, “The PRAs that meet the applicable supporting requirements for Capability Category I and meet the high-level requirements as defined in the ASME PRA Standard (ASME/ANS RA-S-2008 and addenda ASME/ANS RA-Sa–2009) should generally be acceptable for DC and COL applications. Alternatively, the applicant may identify, and justify the acceptability of, alternative measures for addressing PRA quality and technical adequacy. The staff should specifically review the acceptability of these alternative measures in the context of the specific uses and applications of the PRA.”

The staff reviewed the APR1400 design control document (DCD) Section 19.1.4.1.1, “Description of Level 1 Internal Events PRA for Operations at Power,” and found insufficient information describing the initiating event analysis performed. Specifically, the applicant did not describe the structured and systematic approach used to group initiating events (ASME/ANS PRA Standard supporting requirements – IE-B2). Therefore, in order for the staff to reach an assurance finding on the conformance to Standard Review Plan (SRP) Chapter 19.0 regarding PRA technical adequacy, please revise the DCD with a description of the approach used to group initiating events.

Response

The grouping of initiating events is one of the tasks for initiating events analysis, and the details are documented in the Initiating Event Analysis Notebook (APR1400-K-P-NR-013101-P, Rev. 0A).

The impact of initiating events on the core protection functions is a major consideration in the grouping process. The grouping task primarily focuses on the impact of initiating events and subsequent system failures upon the core protection functions, and the impact of initiating events upon plant system performance. Thus, this yields groups of initiators expected to have a

common core damage accident sequence progression and, accordingly, a common set of success criteria.

Table 2 in the Initiating Event Analysis Notebook (APR1400-K-P-NR-013101-P, Rev. 0A) presents an initial categorization of initiating event types with respect to the impacts on the core protection functions. Consistent with the initial identification of initiators, the initiating events are organized into either a LOCA, secondary piping break, or transient (including special initiators) category. In addition, there is an ATWS category for transients that are followed by a subsequent failure of the reactor protection system (RPS). ATWS is not caused by any single initiator; it is the combination of initiator occurrence and RPS failure that leads to ATWS sequences. Therefore, all failures of reactivity control, whether the initiating event was a transient or a special initiator, are placed into the ATWS category.

Grouping of events into such higher-level classifications is performed when the events can be considered similar in terms of plant response, success criteria, or timing, or are bounded by the impacts of the higher-level event.

Table 3 in the Initiating Event Analysis Notebook (APR1400-K-P-NR-013101-P, Rev. 0A), which shows the results of grouping the specific initiating events with respect to the impacts noted in Table 2, provides the summary dispositions of the initiating events.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: **410-8357**

SRP Section: **SRP 19**

Application Section: **19.1**

Date of RAI Issue: **02/23/2016**

Question No. 19-32

Item 11 of Section II, “Acceptance Criteria,” of the (Draft) Revision 3 SRP, states, “The PRAs that meet the applicable supporting requirements for Capability Category I and meet the high-level requirements as defined in the ASME PRA Standard (ASME/ANS RA-S-2008 and addenda ASME/ANS RA-Sa–2009) should generally be acceptable for DC and COL applications. Alternatively, the applicant may identify, and justify the acceptability of, alternative measures for addressing PRA quality and technical adequacy. The staff should specifically review the acceptability of these alternative measures in the context of the specific uses and applications of the PRA.”

The staff reviewed the APR1400 design control document (DCD) Section 19.1.4.1.1, “Description of Level 1 Internal Events PRA for Operations at Power,” and found insufficient information describing the initiating event analysis performed. Specifically, the applicant did not describe its process for selecting industry initiating event frequencies instead of the frequencies estimated from calculation in PRA supporting documents and how the decision correlates with the statement in the DCD that all initiating event frequencies come from generic data. Therefore, in order for the staff to reach an assurance finding on the conformance to Standard Review Plan (SRP) Chapter 19.0 regarding PRA technical adequacy, please revise the DCD with a description of the process used to select initiating event frequencies.

Response

There are four general approaches for the quantification of Initiating Event (IE) frequencies.

1) For very rare events such as LOCAs, the IE frequencies are typically based on generic industry data;

2) For events that have occurred frequently in a plant’s operating history, the IE frequencies are typically based on recent applicable plant data, combined with generic industry data using a Bayesian update process as appropriate;

3) For events that have never occurred or occurred infrequently, the IE frequencies are typically based on recent applicable plant data and insights combined with generic industry data using a Bayesian update process; and

4) Special initiating events, such as those due to plant system failures, the IE frequencies are often obtained from fault tree models developed and quantified to obtain initiator frequencies.

Since plant-specific data is not available during design certification, the frequencies for all initiating events in groups 1), 2) and 3) above are evaluated based on generic industry data. The primary source of generic industry data for these initiators is NUREG/CR-6928 (Initiating Event Data Sheets - Update 2010). In addition, NUREG-1829 was used for reactor vessel rupture frequency, and a vendor report was used to estimate POSRV failure resulting in a SLOCA. Details of this information is included in DCD Table 19.1-6.

Group 4 initiators are evaluated based on generic data, fault tree modeling, or calculation considering APR1400 design. Support system failure initiating events (SSIE) were initially evaluated based on fault tree analysis, and then compared to industry generic data from NUREG/CR-6928. These IEs include LOIA, PLOCCW, PLOESW, TLOCCW and TLOESW. For three of the five SSIE FTs (LOIA, PLOCCW and PLOESW), the IEF was greater than the generic source by about a factor of 2-3. These results were considered comparable to the industry generic data, and hence the IEFs for these events was based off of the SSIE FTs.

For the remaining two SSIEs (TLOCCW and TLOESW), the industry generic frequency was about 4 to 18 times greater of the SSIE IEFs. The basis for this larger difference is likely the redundancy in these two APR1400 systems, but given the lack of knowledge of the systems used to develop the industry generic source, it was decided that at the design certification stage, a conservative assessment was deemed more appropriate, and the industry generic values were used.

The last Group 4 initiator evaluated was ISLOCA. The APR1400 ISLOCA initiating event frequency was calculated based on plant specific APR1400 design. The resulting initiating event frequency was about 6 orders of magnitude less than the industry generic initiating event frequency from NUREG/CR-6928. However, the generic industry data is simply based on 0 events in 1362.787 rcry without any input regarding plant design, and the APR1400 analysis was a NUREG/CR-5744 and NUREG/CR-5102 ISLOCA analysis using input from the APR1400 design. Hence, the plant specific ISLOCA analysis was deemed to be appropriate.

The DCD will be revised to include this information (see Attachment). In addition, further details regarding this issue will be included in DCD Table 19.1-6. However, note that Table 19.1-6 is already being edited in response to RAI 410-8357, Question 19-34. Therefore, in order to avoid confusion, this information will be added to the notes section of the revised DCD Table 19.1-6 provided as Attachment of the response to RAI 410-8357, Question 19-34.

Impact on DCD

The DCD is being revised as part of 3 related RAIs: RAI 410-8357 Question 19-32, RAI 417-8359 Question 19-39, and this RAI. Section 19.1.4.1.1.1 of the DCD was revised to include a comparison and assessment of the differences between the initiating event frequencies from

industry generic sources and those calculated specifically for the APR1400 DC PRA (see Attachment of the response to RAI 410-8357 Question 19-32).

The Attachment to this RAI revises DCD Table 19.1-6 to include additional clarifying notes for the calculation of APR1400 IEFs including the identification of the generic sources, and which IEF was ultimately used (generic or plant specific). In addition, references and other clarifying text are added to several Table 19.1-6 notes.

Finally, Note 7 was added to DCD Table 19.1-6 as prescribed in RAI 417-8359 Question 19-39.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

~~As these initiating events are similar to those of existing nuclear power plants, the frequency for each initiating event is calculated based on generic estimates for current power plants from references such as NUREG/CR-6928 (Reference 11).~~

New text is added as shown in A

Initiating events identified by this process, along with the frequencies and uncertainties of the events, are shown in Table 19.1-6. Initiating event development for the internal flooding model is described in Subsection 19.1.5.3, and initiating event development during low power and shutdown (LPSD) states is identified and evaluated in Subsection 19.1.6.

19.1.4.1.1.2 Accident Sequence Analysis

The accident sequences that result from the initiating events are modeled in the form of event trees. The event trees are time sequences that show the response of the plant to a postulated disturbance. The response is depicted as nodes that represent the non-safety and safety systems potential response or use. The model includes support systems and operator actions that either respond to the initiating events or mitigate failure of other systems (note that this detail may also be reflected in the system or functional fault trees).

Accident sequence development involves, for each functional initiating event category, defining the safety functions and the systems and operator actions that potentially are available to support each safety function included in the event trees. Event trees are developed that trace the event sequences from initiating event to end states. The event trees are defined in a manner that captures the diversity of plant responses and severity. Table 19.1-7 provides the list of event trees used.

The success criteria for each event tree top event are defined in order to support the development of fault trees for the system functions and human reliability evaluations (for those top events that include operator actions); see Table 19.1-8.

An event sequence model structure is developed that facilitates identification of functional, physical, and human dependencies between the causes of initiating events and the causes of system and operator action failures that violate any of the event tree top event success criteria.

A

Finally, the initiating event frequencies are calculated. There are four general approaches for the quantification of initiating event frequencies:

1) For very rare events such as LOCAs, the initiating event frequencies are typically based on generic industry data;
2) For events that have occurred frequently in a plant's operating history, the initiating event frequencies are typically based on recent applicable plant data, combined with generic industry data using a Bayesian update process as appropriate;
3) For events that have never occurred or occurred infrequently, the initiating event frequencies are typically based on recent applicable plant data and insights combined with generic industry data using a Bayesian update process; and
4) Special initiating events, such as those due to plant system failures, the initiating event frequencies are often obtained from fault tree models developed and quantified to obtain initiator frequencies.

Since plant-specific data is not available during design certification, the frequencies for all initiating events in groups 1), 2) and 3) above are evaluated based on generic industry data. The primary source of generic industry data for these initiators is NUREG/CR-6928 (Reference 11). In addition, NUREG-1829 (Reference 54) was used for reactor vessel rupture frequency, and a vendor report was used to estimate POSRV failure resulting in a SLOCA. Details is included in DCD Table 19.1-6. Group 4 initiators are evaluated based on generic data, fault tree modeling, or calculation considering APR1400 design. Support system failure initiating events (SSIE) were initially evaluated based on fault tree analysis, and then compared to industry generic data from NUREG/CR-6928. These initiating events include LOIA, PLOCCW, PLOESW, TLOCCW and TLOESW. For three of the five SSIE FTs (LOIA, PLOCCW and PLOESW), the initiating event frequency was greater than the generic source by about a factor of 2-3. These results were considered comparable to the industry generic data, and hence the initiating event frequencies for these events were based off of the SSIE fault trees.

For the remaining two SSIEs (TLOCCW and TLOESW), the industry generic frequency was about 4 to 18 times greater of the SSIE initiating event frequencies. The basis for this larger difference is likely the redundancy in these two APR1400 systems, but given the lack of knowledge of the systems used to develop the industry generic source, it was decided that at the design certification stage, a conservative assessment was deemed more appropriate, and the industry generic values were used.

The last Group 4 initiator evaluated was ISLOCA. The APR1400 ISLOCA initiating event frequency was calculated based on plant specific APR1400 design. The resulting initiating event frequency was about 6 orders of magnitude less than the industry generic initiating event frequency from NUREG/CR-6928. However, the generic industry data is simply based on 0 events in 1362.787 rcry without any input regarding plant design, and the APR1400 analysis was a NUREG/CR-5744 and NUREG/CR-5102 ISLOCA analysis using input from the APR1400 design. Hence, the plant specific ISLOCA analysis was deemed to be appropriate.

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Docket No. 52-046

RAI No.:	**410-8357**
SRP Section:	**SRP 19**
Application Section:	**19.1**
Date of RAI Issue:	**02/23/2016**

Question No. 19-34

Item 11 of Section II, “Acceptance Criteria,” of the (Draft) Revision 3 SRP, states, “The PRAs that meet the applicable supporting requirements for Capability Category I and meet the high-level requirements as defined in the ASME PRA Standard (ASME/ANS RA-S-2008 and addenda ASME/ANS RA-Sa–2009) should generally be acceptable for DC and COL applications. Alternatively, the applicant may identify, and justify the acceptability of, alternative measures for addressing PRA quality and technical adequacy. The staff should specifically review the acceptability of these alternative measures in the context of the specific uses and applications of the PRA.”

The staff reviewed the APR1400 design control document (DCD) Section 19.1.4.1.1, “Description of Level 1 Internal Events PRA for Operations at Power,” and found insufficient information describing the initiating event analysis performed. Specifically, the applicant stated in the DCD that the PRA meets the PRA standard, however the applicant did not compare the initiating event analysis results to available generic data and explain the differences to provide a reasonable check of the results as prescribed by PRA standard supporting requirement IE-C12. Therefore, in order for the staff to reach an assurance finding on the conformance to SRP Chapter 19.0 regarding PRA technical adequacy, please describe a comparison between the data sources and explain any differences in the DCD.

Response

The APR1400 is currently in the design stage, thus generic data is used for all initiating events with a few noted exceptions, specifically:

- fault tree analysis is used for initiating events due to plant system failures (e.g., loss of instrument air),
- a direct calculation is used to estimate an APR1400 design specific ISLOCA IEF, and

- a combination of generic and vendor data is used was used to estimate the SLOCA IEF.

As part of the response to RAI 410-8357 Question 19-32, Section 19.1.4.1.1.1 of the DCD was revised to include a comparison and assessment of the differences between the initiating event frequencies from industry generic sources and those calculated specifically for the APR1400 DC PRA (see Attachment of the response to RAI 410-8357 Question 19-32).

In addition, the DCD will be revised to replace existing Table 19.1-6 with additional information and notes to clarify this issue. In addition, the DCD will be revised to clarify the issues discussed in both RAI 410-8357 Question 19-32, and to include Note 7 as prescribed in RAI 417-8359 Question 19-39.

Impact on DCD

The DCD is being revised as part of 3 related RAIs: RAI 410-8357 Question 19-32, RAI 417-8359 Question 19-39, and this RAI. Section 19.1.4.1.1.1 of the DCD was revised to include a comparison and assessment of the differences between the initiating event frequencies from industry generic sources and those calculated specifically for the APR1400 DC PRA (see Attachment of the response to RAI 410-8357 Question 19-32).

The attachment to this RAI revises DCD Table 19.1-6 to include additional clarifying notes for the calculation of APR1400 IEFs including the identification of the generic sources, and which IEF was ultimately used (generic or plant specific). In addition, references and other clarifying text are added to many Table 19.1-6 notes.

Finally, Note 7 was added to DCD Table 19.1-6 as prescribed in RAI 417-8359 Question 19-39.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environment Report.

APR1400 DCD TIER 2

Table 19.1-6 (1 of 2)

Internal Events PRA Initiating Event Frequencies

Designator	Initiating Event Description	Mean Frequency (Per Rx Critical Year)(1)	Mean Frequency (Per Rx Calendar Year)(2)	Error Factor
LLOCA(3)	Large LOCA (Rupture greater than 15.24 cm dia.)	1.33E-06	1.26E-06	10.7
MLOCA(3)	Medium LOCA (Rupture of 5.08 cm to 15.24 cm dia.)	5.10E-04	4.85E-04	10.0
SLOCA(3)	Small LOCA (Rupture of 5.08 cm dia. or less) (Total of SLOCA + RCP Seal LOCA + IOSRV Frequencies)	2.09E-03	1.99E-03	8.4
SGTR	Steam Generator Leakage/Tube Rupture	2.07E-03	1.97E-03	2.5
LSSB-U	Large Secondary Side Breaks Upstream of MSIV	3.67E-04	3.49E-04	8.4
LSSB-D	Large Secondary Side Breaks downstream of MSIV	7.70E-03	7.32E-03	1.6
LODCA	Loss of Class 1E 125V DC A	7.37E-04	7.00E-04	3.3
LODCB	Loss of Class 1E 125V DC B	7.37E-04	7.00E-04	3.3
GTRN	General Transient	6.90E-01	6.56E-01	1.7
LOFW	Loss of Main Feedwater	6.89E-02	6.55E-02	2.7
FWLB	Main Feedwater Line Break	1.83E-03	1.74E-03	2.5
LOCV	Loss of Condenser Vacuum	5.86E-02	5.57E-02	2.2
ATWS	Anticipated Transient without SCRAM	Transferred from each Event Tree (including RT)		N/A
LOOP	Loss of Offsite Power:	-		-
LOOP-PL	Plant-centered	1.93E-03	1.83E-03	2.5
LOOP-SW	Switchyard-centered	1.04E-02	9.88E-03	1.5
LOOP-GR	Grid-related	1.22E-02	1.16E-02	11.6

APR1400 DCD TIER 2

Table 19.1-6 (2 of 2)

Designator	Initiating Event Description	Mean Frequency (Per Rx Critical Year)(1)	Mean Frequency (Per Rx Calendar Year)(2)	Error Factor
LOOP-WE	Weather related	3.91E-03	3.71E-03	1.7
SBO	Station Blackout	Transferred from LOOP Event Tree		1.7
LOIA(3)	Loss of Instrument Air System	2.48E-02	2.69E-02	2.1
TLOCCW(3)	Total Loss of Component Cooling Water System	2.46E-04	2.34E-04	8.4
PLOCCW(3)	Partial Loss of Component Cooling Water System	4.59E-03	4.36E-03	2.0
TLOESW(3)	Total Loss of Essential Service Water System	2.46E-04	2.34E-04	8.4
PLOESW(3)	Partial Loss of Essential Service Water System	1.72E-3	2.52E-03	2.6
RVR(4)	Reactor Vessel Rupture	3.22E-08	3.06E-08	67.5
ISLOCA(5)	Interfacing System Loss of Coolant Accident	1.24E-10	1.18E-10	10.0

(1) The mean frequencies for these initiating events are values presented in Reference 11 in units of per reactor critical year (rcry). (Excludes frequencies for ISLOCA, and reactor vessel rupture, which a separately calculated.)

(2) The mean frequencies for these initiating events were adjusted to an APR1400 specific per reactor calendar year (rcy). Converting to APR1400 specific reactor calendar year (rcy), it was assumed the reactor is critical 95% of the year.
Converting to rcy, the result is:
(Mean Initiating Event Frequency/rcry) × (0.95 rcry/rcy) = Mean Initiating Event Frequency/rcy

(3) APR1400 LOCA break size from generic industry data. These LOCA initiating event frequencies are used as an estimate for APR1400 LOCA frequencies.
Support system initiating event frequencies (/rcry) for LOIA, TLOCCW, PLOCCW, TLOESW, and PLOESW are calculated using fault trees in the initiating event analysis for information purposes. However, industry values for these parameters are utilized in the quantified PRA model.

(4) Reactor Vessel Rupture frequency (2.90E-08/rcy) was taken from NUREG-1829, Volume 1, Table 7.19, for break sizes > 31 inches (Reference 52). This value was treated similarly to other LOCA frequencies, converting to per reactor critical year by multiplying by 1 rcy/0.9 rcry.

(5) The ISLOCA initiating event frequency (/rcy) is taken from calculation. No Error Factor (EF) is calculated for this initiating event frequency and thus an EF of 10 is assumed.

Revised Table 19.1-6 is as shown in below tables

Designator	Initiating Event Description	Generic Data		APR1400 PRA			
		Mean Frequency (/rcry)[1]	Data Source	Mean Frequency (/rcry)	Mean Frequency (rcy) [2]	Error Factor	Final APR1400 PRA IEF Source
LLOCA	Large LOCA	1.33E-06	NUREG/CR-6928	1.33E-06	1.26E-06	10.7	Generic
MLOCA	Medium LOCA	5.10E-04	NUREG/CR-6928	5.10E-04	4.85E-04	10.0	Generic
SLOCA	Small LOCA	3.67E-04	NUREG/CR-6928	2.09E-03[3]	1.99E-03	8.4	Generic
SGTR	Steam Generator Leakage/Tube Rupture	2.07E-03	NUREG/CR-6928	2.07E-03	1.97E-03	2.5	Generic
LSSB-U	Large Secondary Side Breaks Upstream of MSIV	3.67E-04	NUREG/CR-6928	3.67E-04	3.49E-04	8.4	Generic
LSSB-D	Large Secondary Side Breaks downstream of MSIV	7.70E-03	NUREG/CR-6928	7.70E-03	7.32E-03	1.6	Generic
LODCA	Loss of Class 1E 125V DC A	7.37E-04	NUREG/CR-6928	7.37E-04	7.00E-04	3.3	Generic
LODCB	Loss of Class 1E 125V DC B	7.37E-04	NUREG/CR-6928	7.37E-04	7.00E-04	3.3	Generic
GTRN	General Transient	6.90E-01	NUREG/CR-6928	6.90E-01	6.56E-01	1.2	Generic
LOFW	Loss of Main Feedwater System	6.89E-02	NUREG/CR-6928	6.89E-02	6.55E-02	2.7	Generic
FWLB	Main Feedwater Line Break	1.83E-03	NUREG/CR-6928	1.83E-03	1.74E-03	2.5	Generic
LOCV	Loss of Condenser Vacuum	5.86E-02	NUREG/CR-6928	5.86E-02	5.57E-02	2.2	Generic

Designator	Initiating Event Description	Generic Data		APR1400 PRA			
		Mean Frequency (/rcry)[1]	Data Source	Mean Frequency (/rcry)	Mean Frequency (rcy) [2]	Error Factor	Final APR1400 PRA IEF Source
LOOP-PL	LOOP (Plant-centered)	1.93E-03	NUREG/CR-6928	1.93E-03	1.83E-03	2.5	Generic
LOOP-SW	LOOP (Switchyard-centered)	1.04E-02	NUREG/CR-6928	1.04E-02	9.88E-03	1.5	Generic
LOOP-GR	LOOP (Grid-related)	1.22E-02	NUREG/CR-6928	1.22E-02	1.16E-02	11.6	Generic
LOOP-WE	LOOP (Weather-related)	3.91E-03	NUREG/CR-6928	3.91E-03	3.71E-03	1.7	Generic
LOIA	Loss of Instrument Air System	8.22E-03	NUREG/CR-6928	2.83E-02[4]	2.69E-02	12.2	SSIE FT – Note 4
TLOCCW	Total Loss of Component Cooling Water System	2.46E-04	NUREG/CR-6928	2.46E-04[4]	2.34E-04	8.4	Generic – Note 4
PLOCCW	Partial Loss of Component Cooling Water System	2.21E-03	NUREG/CR-6928	4.59E-03[4]	4.36E-03	2.0	SSIE FT – Note 4
TLOESW	Total Loss of Essential Service Water System	2.46E-04	NUREG/CR-6928	2.46E-04[4]	2.34E-04	8.4	Generic – Note 4
PLOESW	Partial Loss of Essential Service Water System	1.72E-03	NUREG/CR-6928	2.65E-03[4]	2.52E-03	2.2	SSIE FT – Note 4
RVR	Reactor Vessel Rupture	3.22E-08[4)]	NUREG-1829	3.22E-08[5]	3.06E-08	67.5	Generic – Note 5
ISLOCA	Interfacing System Loss of Coolant Accident	3.67E-4	NUREG/CR-6928	1.24E-10[6]	1.18E-10	207.3	Plant Specific Calculation – Note 6
ATWS	Anticipated Transient without SCRAM	N/A – ATWS is transferred to from transient sequences with failure of Rx trip.					
SBO	Station Blackout	N/A – SBO is transferred to from LOOP sequence with failure of all DGs					

Designator	Initiating Event Description	Generic Data		APR1400 PRA			
		Mean Frequency (/rcry)[1]	Data Source	Mean Frequency (/rcry)	Mean Frequency (rcy) [2]	Error Factor	Final APR1400 PRA IEF Source
GRID-LOOP	Consequential LOOP	N/A – GRID-LOOP is transferred to from other initiators with consequential LOOP					
GRID-SBO	Consequential SBO	N/A – GRID-SBO is transferred to from GRID-LOOP sequence with failure of all DGs					

Note:

1. The mean frequencies for these initiating events are values presented in NUREG/CR-6928 (Initiating Event Data Sheets - Update 2010) in units of per reactor critical year (rcry's). Excludes frequencies for fault tree calculated IEs LOIA, TLOCCW, PLOCCW, TLOESW, PLOESW, separately calculated ISLOCA, and reactor vessel rupture.

2. The mean frequencies for these initiating events were adjusted to an APR1400 specific reactor calendar year (rcy). It was assumed the reactor is critical 95% of the year. Converting to rcy, the result is: (Mean IE Frequency/rcry) * (0.95rcry/rcy) = Mean IE Frequency/rcy

3. Small LOCA Frequency = 1) SLOCA + 2) RCP Seal LOCA + 3) POSRV Inadvertent Opening

    1) SLOCA frequency : 3.67E-04/rcry from NUREG/CR-6928 (Initiating Event Data Sheets - Update 2010)
    2) RCP Seal LOCA frequency : 3.67E-04/rcry from NUREG/CR-6928 (Initiating Event Data Sheets - Update 2010)
    3) POSRVs Inadvertent Opening : 3.88E-08/hr from vendor data (Sempell) X 8760hr/rcry X 4 POSRVs = 1.36E-03/rcry

    Therefore, 1) + 2) + 3) = 3.67E-04/rcry + 3.67E-04/rcry + 1.36E-03/rcry = 2.09E-03/rcry

4. Support system IE FT (/rcry) for LOIA, TLOCCW, PLOCCW, TLOESW, and PLOESW are developed to calculate supporting system IE frequencies. After review of both supporting system IE FT quantification results and NUREG/CR-6928 (Initiating Event Data Sheets - Update 2010), the larger value is used for each supporting system IE of APR1400.

SSIE	SSIE FT Quantification (/rcry)	NUREG/CR-6928 (/rcry)	Final SSIE Freq. (/rcy)	Remarks for Calculation of Final SSIE Freq. (/rcy)
PLOCCW	4.59E-03	2.21E-03	4.36E-03	[SSIE FT Quantification] * 0.95
TLOCCW	1.33E-05	2.46E-04	2.34E-04	[NUREG/CR-6928 Data] * 0.95
PLOESW	2.65E-03	1.72E-03	2.52E-03	[SSIE FT Quantification] * 0.95
TLOESW	6.63E-05	2.46E-04	2.34E-04	[NUREG/CR-6928 Data] * 0.95

SSIE	SSIE FT Quantification (/rcry)	NUREG/CR-6928 (/rcry)	Final SSIE Freq. (/rcy)	Remarks for Calculation of Final SSIE Freq. (/rcy)
LOIA	2.83E-02	8.22E-03	2.69E-02	[SSIE FT Quantification] * 0.95

5. Reactor Vessel Rupture frequency (2.90E-08/rcy) was taken from NUREG-1829 (Reference 54), Volume 1, Table 7.19 for break sizes > 31 inches. This value was treated similarly to other LOCA frequencies, converting to per reactor critical year by multiplying by 1 rcy/0.9 rcry. The 25 year fleet average mean value was deemed appropriate as this is the same as was used in NUREG/CR-6928 (Reference) to calculate the LOCA frequencies.

6. The ISLOCA initiating event frequency is taken from the ISLOCA calculation in APR1400-K-P-NR-013101-P, Attachment A (Reference 7).

7. APR1400 LOCA break size from NUREG/CR-6928 (Reference 11).

Designator	Initiating Event Description	Generic Data		APR1400 PRA			
		Mean Frequency (/rcry)[1]	Data Source	Mean Frequency (/rcry)	Mean Frequency (rcy) [2]	Error Factor	Final APR1400 PRA IEF Source
LLOCA	Large LOCA	1.33E-06	NUREG/CR-6928	1.33E-06	1.26E-06	10.7	Generic
MLOCA	Medium LOCA	5.10E-04	NUREG/CR-6928	5.10E-04	4.85E-04	10.0	Generic
SLOCA	Small LOCA	3.67E-04	NUREG/CR-6928	2.09E-03[3]	1.99E-03	8.4	Generic
SGTR	Steam Generator Leakage/Tube Rupture	2.07E-03	NUREG/CR-6928	2.07E-03	1.97E-03	2.5	Generic
LSSB-U	Large Secondary Side Breaks Upstream of MSIV	3.67E-04	NUREG/CR-6928	3.67E-04	3.49E-04	8.4	Generic
LSSB-D	Large Secondary Side Breaks downstream of MSIV	7.70E-03	NUREG/CR-6928	7.70E-03	7.32E-03	1.6	Generic
LODCA	Loss of Class 1E 125V DC A	7.37E-04	NUREG/CR-6928	7.37E-04	7.00E-04	3.3	Generic
LODCB	Loss of Class 1E 125V DC B	7.37E-04	NUREG/CR-6928	7.37E-04	7.00E-04	3.3	Generic
GTRN	General Transient	6.90E-01	NUREG/CR-6928	6.90E-01	6.56E-01	1.2	Generic
LOFW	Loss of Main Feedwater System	6.89E-02	NUREG/CR-6928	6.89E-02	6.55E-02	2.7	Generic
FWLB	Main Feedwater Line Break	1.83E-03	NUREG/CR-6928	1.83E-03	1.74E-03	2.5	Generic
LOCV	Loss of Condenser Vacuum	5.86E-02	NUREG/CR-6928	5.86E-02	5.57E-02	2.2	Generic

Designator	Initiating Event Description	Generic Data		APR1400 PRA			
		Mean Frequency (/rcry)[1]	Data Source	Mean Frequency (/rcry)	Mean Frequency (rcy) [2]	Error Factor	Final APR1400 PRA IEF Source
LOOP-PL	LOOP (Plant-centered)	1.93E-03	NUREG/CR-6928	1.93E-03	1.83E-03	2.5	Generic
LOOP-SW	LOOP (Switchyard-centered)	1.04E-02	NUREG/CR-6928	1.04E-02	9.88E-03	1.5	Generic
LOOP-GR	LOOP (Grid-related)	1.22E-02	NUREG/CR-6928	1.22E-02	1.16E-02	11.6	Generic
LOOP-WE	LOOP (Weather-related)	3.91E-03	NUREG/CR-6928	3.91E-03	3.71E-03	1.7	Generic
LOIA	Loss of Instrument Air System	8.22E-03	NUREG/CR-6928	2.83E-02[4]	2.69E-02	12.2	SSIE FT – Note 4
TLOCCW	Total Loss of Component Cooling Water System	2.46E-04	NUREG/CR-6928	2.46E-04[4]	2.34E-04	8.4	Generic – Note 4
PLOCCW	Partial Loss of Component Cooling Water System	2.21E-03	NUREG/CR-6928	4.59E-03[4]	4.36E-03	2.0	SSIE FT – Note 4
TLOESW	Total Loss of Essential Service Water System	2.46E-04	NUREG/CR-6928	2.46E-04[4]	2.34E-04	8.4	Generic – Note 4
PLOESW	Partial Loss of Essential Service Water System	1.72E-03	NUREG/CR-6928	2.65E-03[4]	2.52E-03	2.2	SSIE FT – Note 4
RVR	Reactor Vessel Rupture	3.22E-08[4)]	NUREG-1829	3.22E-08[5]	3.06E-08	67.5	Generic – Note 5
ISLOCA	Interfacing System Loss of Coolant Accident	3.67E-4	NUREG/CR-6928	1.24E-10[6]	1.18E-10	207.3	Plant Specific Calculation – Note 6
ATWS	Anticipated Transient without SCRAM	N/A – ATWS is transferred to from transient sequences with failure of Rx trip.					
SBO	Station Blackout	N/A – SBO is transferred to from LOOP sequence with failure of all DGs					

Designator	Initiating Event Description	Generic Data		APR1400 PRA			
		Mean Frequency (/rcry)[1]	Data Source	Mean Frequency (/rcry)	Mean Frequency (rcy) [2]	Error Factor	Final APR1400 PRA IEF Source
GRID-LOOP	Consequential LOOP	N/A – GRID-LOOP is transferred to from other initiators with consequential LOOP					
GRID-SBO	Consequential SBO	N/A – GRID-SBO is transferred to from GRID-LOOP sequence with failure of all DGs					

Note:

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