RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/12/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 750-5675 REVISION 2**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19**
DATE OF RAI ISSUE:	**04/28/2011**

QUESTION NO. : 19-513

The staff requested additional information (RAI Questions 19-97, 19-98 and 19-364) regarding the implementation of the approach that was followed to determine PRA success criteria. In some cases, credit is taken in the T-H analysis of "bounding" sequences involving multiple failures for more than the minimum set of equipment that could be available based on the success criteria. In other cases, it is not clear whether some "success" sequences are bounded by an analyzed "success" sequence. In addition, there are no T-H analyses performed to support the assumed success criteria of some mitigating systems and functions, such as the alternate containment cooling function. Please perform a systematic investigation to demonstrate the robustness of the assumed PRA success criteria for all "success" sequences of significant frequency.

ANSWER:

Alternate Containment Cooling

The success criterion used in the US-APWR PRA for alternate containment cooling using containment fan cooler units is one component cooling water (CCW) pump and two containment fan cooler units. To demonstrate that this success criterion maintains long-term containment integrity, MHI performed two MAAP analyses using the analysis conditions listed in Table 19.513-1. As shown in Figure 19.513-1 for Case 1 (two containment fan cooler units), containment pressure rises for 13 hours following the initiating event until reaching the containment design pressure. When the containment design pressure is reached, the alternate containment cooling is established, and the pressure subsides as long as heat removal via the containment fan cooler units remains available. In Case 2 (one containment fan cooler unit), containment pressure will continue to rise following the establishment of alternate decay heat removal using only one containment fan cooler. When the containment spray system using containment spray/residual heat removal (CS/RHR) pumps is available, the decay heat from the containment can be removed via the CS/RHR heat exchangers. However,

to operate alternate containment cooling with containment fan cooler units, the CS/RHR heat exchanger must be isolated from the CCW so that the alternate containment cooling does not degrade CCWS cooling to other CCWS loads. The US-APWR PRA assumes that failure to isolate the CS/RHR heat exchangers from the CCW system results in loss of the containment cooling function with the containment fan cooler units. Each containment fan cooler unit requires a CCW flow rate of approximately 100m^3/hr (400 gpm). Each CCW pump is capable of supplying CCW with approximately 1,000m^3/hr (4,000 gpm), thus one CCW pump has the capacity to supply sufficient cooling water to all four containment fan cooler units if the CS/RHR heat exchangers are isolated. Therefore, the success criterion of one CCW pump and two containment fan cooler units is appropriate for alternate containment cooling using containment fan cooler units. DCD Table 19.1-15 incorporating the MAAP analysis results was provided in the original response to this RAI (Ref: UAP-HF-11201, dated June 30, 2011). (The US-APWR PRA model does not need to be revised to reflect the discussion.)

Systematic Search

DCD Tables 19.1-15 and 19.1-16 summarize the typical results of T-H analyses and success criteria for each initiating event. MHI performed a systematic search to identify success sequences not supported by T-H analyses. As a result of the systematic search, the following system sequences were identified as having mitigation functions without support by T-H analysis:

(1) RCS depressurization by secondary side cooling for alternate core cooling using CS/RHR pumps and heat exchangers, which is used for initiating events MLOCA, SLOCA, VSLOCA, PLOCW and LOOP. (Core cooling)

(2) RCS depressurization by secondary side cooling for alternate containment cooling using CS/RHR pumps and heat exchangers, which is used for initiating events MLOCA, SLOCA, VSLOCA, PLOCW and LOOP. (Containment integrity)

(3) RHR operation following an isolation failure of a ruptured SG in SGTR event (Sequence #3 in DCD Figure 19.1-1 sheet 5 of 19)

(4) SGTR sequence with no safety injection following the isolation of the ruptured SG (Sequence #20 in DCD Figure 19.1-1 sheet 5 of 19)

(5) RCS depressurization following a SGTR event with success of ruptured SG isolation (Event Heading “DEP” in DCD Figure 19.1-1 sheet 5 of 19).

(6) SGTR sequences following failure of RHR operation with isolation failure of a ruptured SG in SGTR event (Sequences #4, #5, and #7 in DCD Figure 19.1-1 sheet 5 of 19)

The T-H analyses results for the above six scenarios are provided as follows:

(1) RCS depressurization by secondary side cooling for alternate core cooling using CS/RHR pumps and heat exchangers (Core cooling)

Originally, MHI performed T-H analyses assuming that four emergency feedwater (EFW) pumps and four main steam depressurization valves (MSDVs) were available for RCS depressurization via secondary side cooling to support alternate core cooling with CS/RHR pumps and heat exchangers (See DCD Rev. 4 Table 19.1-15 No. 1.5). Based on engineering judgment, the success criterion used in the PRA was three EFW pumps and three MSDVs. MHI has now performed MAAP analyses that support the PRA success criteria.

Three T-H analyses were performed to investigate the capacity of alternate core cooling using CS/RHR pumps and heat exchangers. Table 19.513-2 provides the system conditions and the peak cladding temperature (PCT); Figure 19.513-2 shows the maximum fuel cladding temperature as a function of time. The cases depict two break sizes. Cases 1 and 2 differ only in the assumed time for the start of core cooling. For all cases, it was determined that PCT is much less than 1400°F, which is the MAAP criterion for core damage, and that three EFW pumps and three MSDVs are sufficient to prevent core damage, thus affirming the DCD Table 19.1-16 success criteria of three EFW pumps and three MSDVs for alternate core cooling using CS/RHR pumps.

The T-H analysis results do not affect the current PRA model. DCD Table 19.1-15 Item No. 1.5 will be revised, as shown in the attached markups.

(2) RCS depressurization by secondary side cooling for alternate containment cooling using CS/RHR pumps and heat exchangers (Containment integrity)

MHI performed T-H analyses assuming four EFW pumps and four MSDVs were available for RCS depressurization via secondary side cooling to support alternate containment cooling with CS/RHR pumps and heat exchangers (See Table 19.1-15, Item No 2.3). Based on engineering judgment, the success criterion used in the PRA was three EFW pumps and three MSDVs. MHI has now performed MAAP analyses to demonstrate that the success criterion used in the PRA does not result in exceeding the containment ultimate pressure.

Two additional T-H analyses were conducted to investigate the alternate containment cooling function using CS/RHR pumps. Table 19.513-3 provides the system conditions and the maximum containment pressure; Figure 19.513-3 illustrates containment pressure versus time. For both cases, containment pressure within 24 hours after the initiating event did not exceed the containment design pressure (216 psia). Therefore, MHI concludes that containment integrity could be maintained using one CS/RHR pump and heat exchanger with three EFW pumps and three MSDVs.

The T-H analysis results do not impact the PRA model. DCD Table 19.1-15 Item No. 2.3 will be revised, as shown in attached markups.

(3) RHR operation following an isolation failure of a ruptured SG in SGTR event (Sequence #3 in DCD Figure 19.1-1 sheet 5 of 19)

This RAI response provides the MARVEL-M thermal-hydraulic analysis results to demonstrate that Sequence #3 in DCD Figure 19.1-1 sheet 5 does not result in core damage. Table 19.513-4 lists the PRA results presented in DCD Rev. 4 and MARVEL-M analysis conditions; mitigating systems are essentially the same as those modeled in the PRA, aside from the number of SGs and MSDVs assumed in the PRA. These differences do not affect the PRA results because the heat removal capability in this case is not dependent on the number of steam generators. The PRA success criteria will be updated for consistency with the MARVEL-M analyses, as discussed below.

Table 19.513-5 and Figure 19.513-4 show the time sequence and time variation of typical system behavior for these sequences, respectively. Approximately 75 minutes after the initiating event, the RCS is depressurized sufficiently to permit RHR operation. But, the RCS temperature still exceeds the RHR operation condition (i.e., greater than 350°F). Operators manually open at least one SDV to reduce the RCS temperature, establishing RHR operation at approximately 173 minutes. After that, long-term decay heat removal

can be achieved by one CS/RHR pump and heat exchanger. As depicted in Figures 19.513-4 (2) and (3), the RCS temperature of each loop is below the saturation temperature indicating that no boiling will occur in the RCS. Also note that, as shown in Figure 19.513-4 (4), there is no SG overfill. After that, the RCS is depressurized to atmospheric conditions by RHR operation in order to terminate the leakage via the ruptured tube, maintaining RCS makeup using charging injection.

From the above, it is reasonable to assume that the aforementioned configuration is sufficient to prevent core damage. The success criteria in the PRA will be updated to be consistent with the MARVEL-M analysis conditions listed in Table 19.513-4. DCD Table 19.1-15 Item No. 3.5 will be added, as shown in attached markups. The model change does not affect PRA results and PRA insights such as the dominant core damage scenarios, importance measures, or uncertainty analyses results. This is because the dominant cutset consists of a combination of human errors, considering their dependency, rather than a combination of component failures.

(4) SGTR sequence with no safety injection following the isolation of the ruptured SG (Sequence #20 in DCD Figure 19.1-1 sheet 5 of 19)

This RAI response provides the MARVEL-M thermal-hydraulic analysis results for Sequence #20 in DCD Figure 19.1-1 sheet 5, based on analysis conditions in Table 19.513-6. Table 19.513-7 and Figure 19.513-5 show the time progression for this scenario and time variation of typical parameters, respectively. In this scenario, the RCS was depressurized using decay heat removal with two SGs available with flow from one EFW pump, and no SI pumps. As depressurization proceeds, the pressure difference between the RCS and secondary side system gradually becomes less, resulting in a decreasing leak rate through the ruptured SG tube to within the capability of the charging system.

The result has no impact on success criteria used in the PRA. The result will be incorporated into DCD Table 19.1-15, as Item No. 3.6, as shown in attached markups.

(5) RCS depressurization following a SGTR event with success of ruptured SG isolation (Event Heading “DEP” in DCD Figure 19.1-1 sheet 5 of 19)

There are several methods to depressurize the RCS. The basis, including the T-H analysis results, is provided in Tables 19.514-2 and 19.514-3 and Figure 19.514-3 of the amended response to RAI 750-5675 Question 19-514.

(6) SGTR sequence followed by failure of RHR operation with isolation failure of a ruptured SG (Sequences #4, #5, and #7 in DCD Figure 19.1-1 sheet 5 of 19)

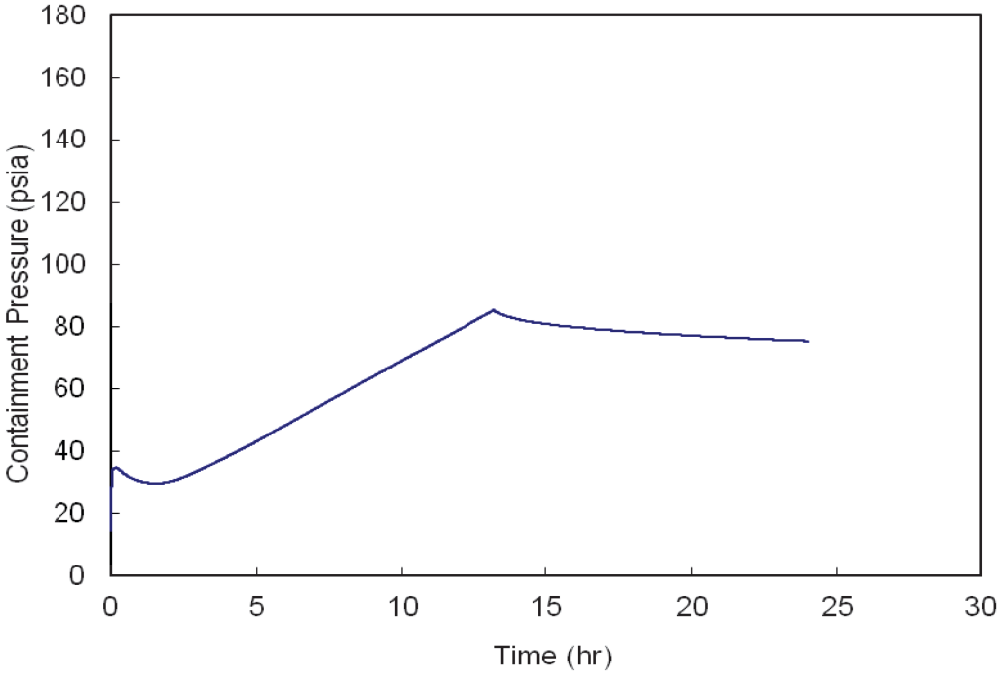
Cooling and recirculation scenarios (Sequences #4, #5, and #7) will be eliminated because failure of RHR operation (top event “CRA”) following a failure to isolate the ruptured SG (top event “SGI”) would directly lead to core damage. The model change does not have a significant effect on the PRA results and PRA insights such as the dominant core damage scenarios, importance measures, or uncertainty analyses results. This is because the frequency of core damage scenarios with failure of RHR operation following an isolation failure of a ruptured SG is on the order of 10^{-9}/RY, which is three orders of magnitude lower than the total CDF. Figure 19.513-6 illustrates the elimination of the cooling and recirculation scenarios.

Table 19.513-8 summarizes the basis of the success criteria and the relevant sequence number of event trees in DCD Figure 19.1-1 for events other than SGTR and Figure 19.513-6 for SGTR event. All of the success sequences (i.e., those not resulting in core damage) are supported by T-H analysis provided in DCD Table 19.1-15 (after inclusion of the DCD markups shown in this response).

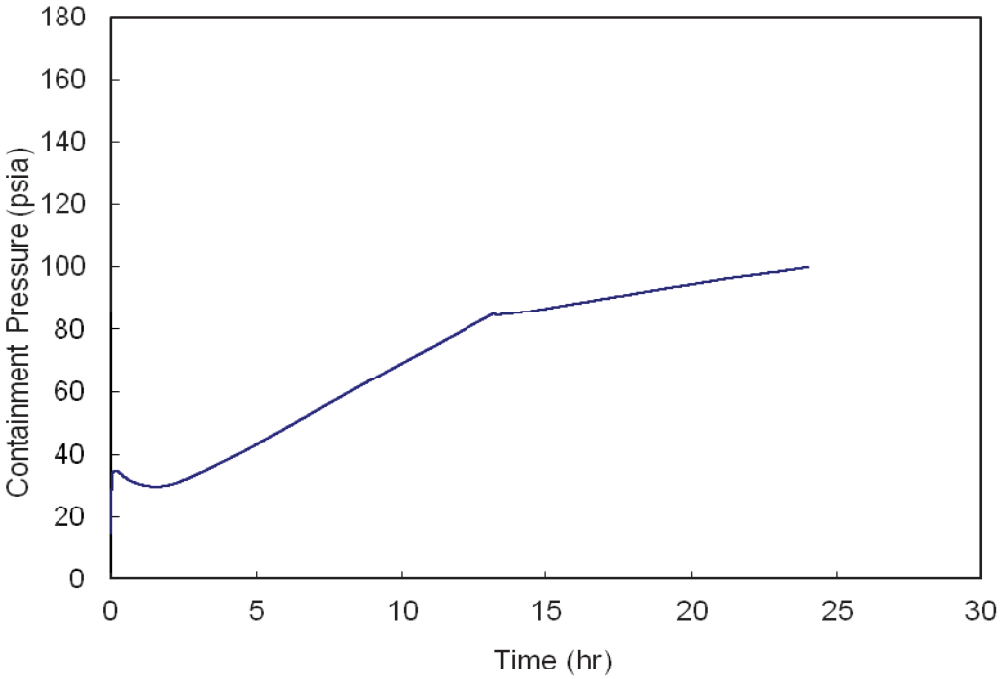
In addition to the operator actions mentioned above, there are some typographical errors in the loss of offsite power (LOOP) event tree (DCD Rev. 4 Figure 19.1-1 Sheets 13, 14 and 16) and the tree will be revised as depicted in Figure 19.513-7. However, these changes do not affect the calculated CDF because the PRA assumes a probability of 1.0 for RCP seal LOCA. Also, Table 19.1-15 will be corrected to replace “MSRV” used in DCD Rev. 4 with “MSDV”, where appropriate.

Table 19.513-1 MAAP Analysis Conditions for Alternate Containment Cooling

Case	1	2
Initiating Event	LOCA with 8 inch break size	
High Head Injection	4/4	
Alternate Core Injection	0/4	
Accumulators	4/4	
Containment Spray	0/4	
Heat Exchanger	4/4	
Emergency Feedwater	4/4	
SG Secondary Side Cooling	0/4	
RCS Depressurization	Disabled	
Containment Fan Cooler Units	2/4	1/4



(1) Case 1 (Two Containment Fan Cooler Units)

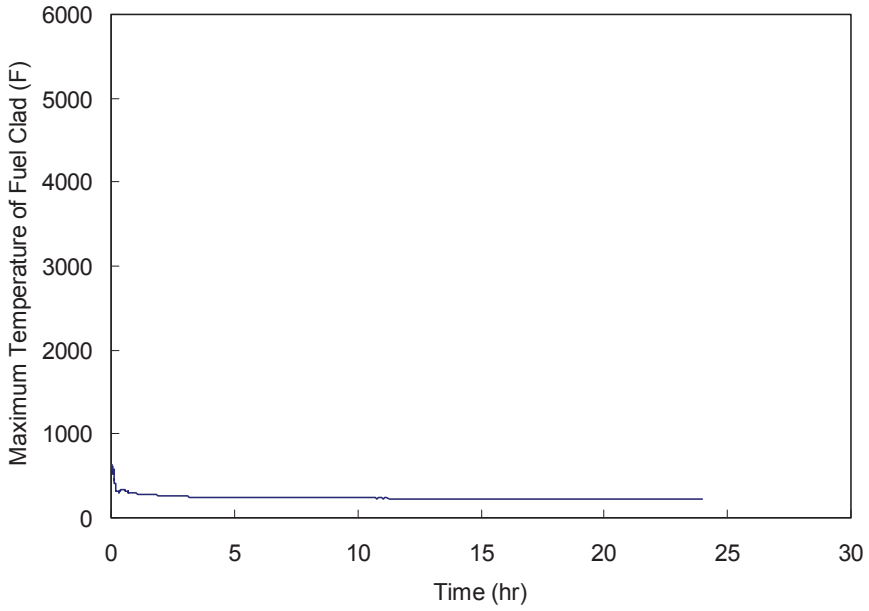


(2) Case 2 (One Containment Fan Cooler Unit)

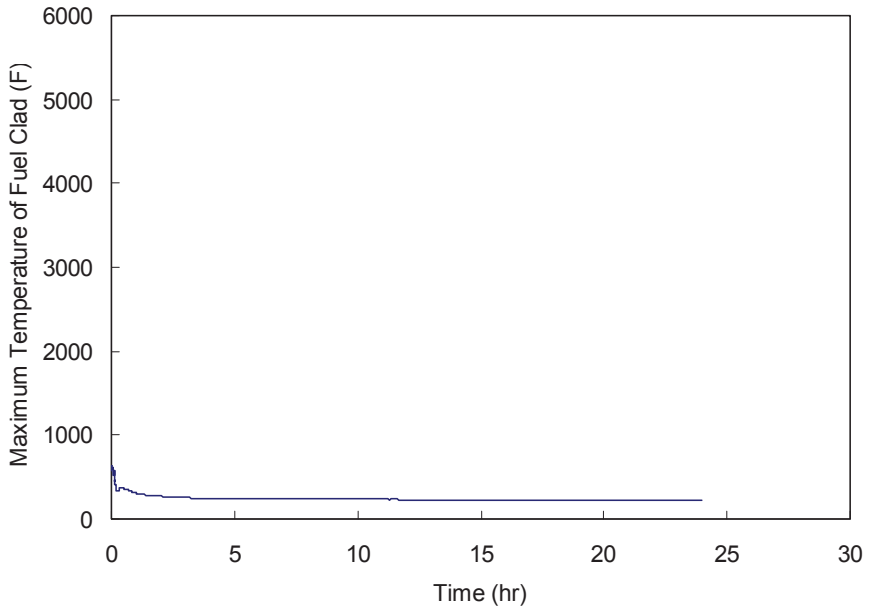
Figure 19.513-1 Variation of Containment Pressure

Table 19.513-2 Analysis Conditions and Typical Results for RCS Depressurization by Secondary Side Cooling (Alternate Core Cooling)

	Case 1	Case 2	Case 3
Initiating Event	Hot leg 8 inch break	Hot leg 8 inch break	Hot leg 2 inch break
Number of SI Pumps	0	0	0
Number of Accumulators	4	4	4
Number of EFW Pumps	3	3	3
Number of CS/RHR Pumps (for containment spray)	0	0	0
Other Measures	Alternate core cooling by 1 CS/RHR pump and 3 MSDVs at 10min	Alternate core cooling by 1 CS/RHR pump and 3 MSDVs at 30min	Alternate core cooling by 1 CS/RHR pump and 3 MSDVs at 30min
Computer Code and Results	MAAP 4.0.6 PCT = 643°F <1400°F	MAAP 4.0.6 PCT = 643°F <1400°F	MAAP 4.0.6 PCT = 639°F <1400°F

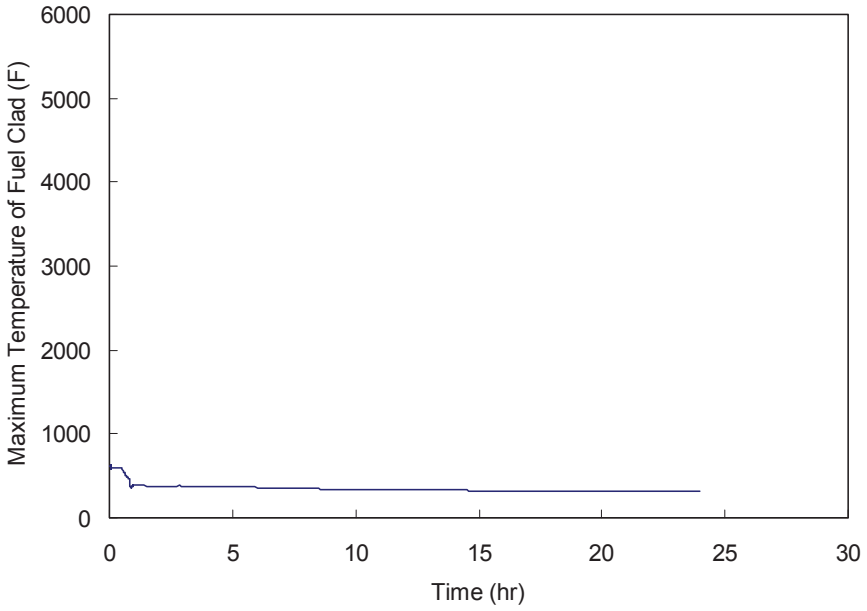


(1) Case 1 (8 inch break with alternate core cooling at 10 minutes)



(2) Case 2 (8 inch break with alternate core cooling at 30 minutes)

Figure 19.513-2 Maximum Temperature of Fuel Clad (Sheet 1 of 2)



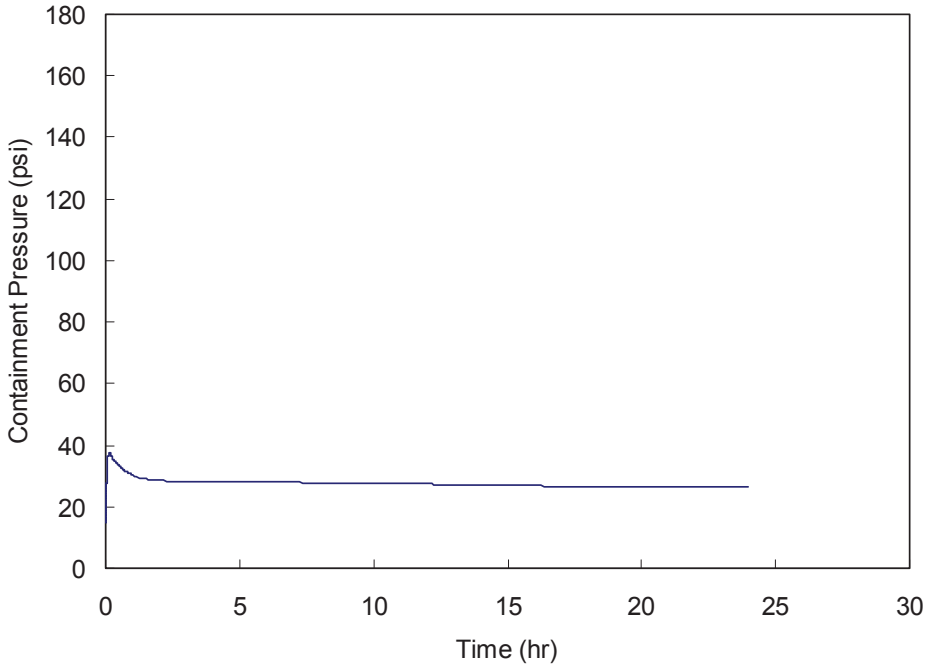
(3) Case 3 (2 inch break with alternate core cooling at 30 minutes)

Figure 19.513-2 Maximum Temperature of Fuel Clad (Sheet 2 of 2)

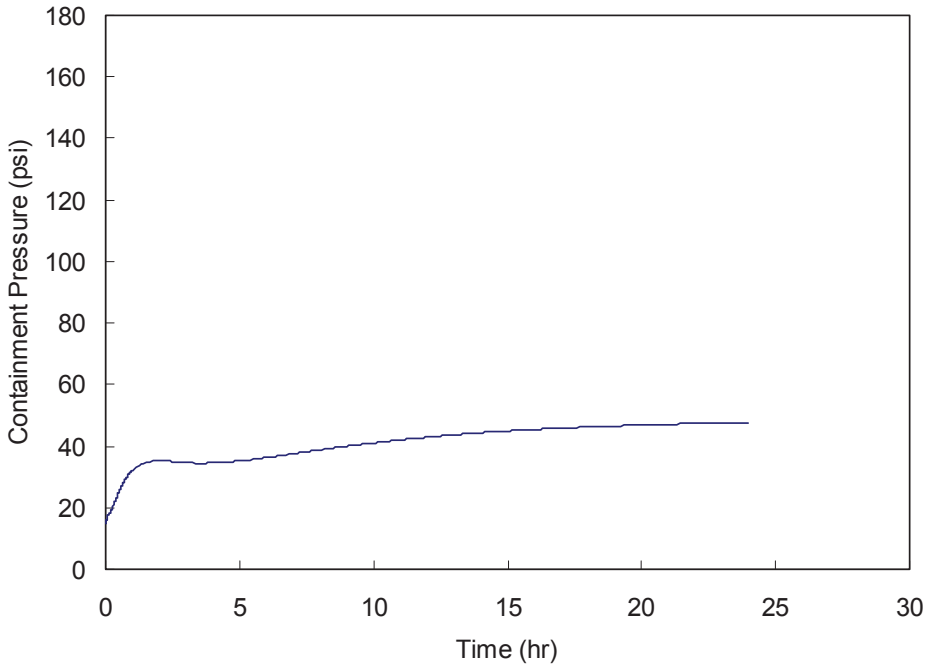
Table 19.513-3 Analysis Conditions and Typical Results for RCS Depressurization by Secondary Side Cooling (Alternate Containment Heat Removal)

	Case 1	Case 2
Initiating Event	Hot leg 8 inch break	Hot leg 2 inch break
Number of SI Pumps	4	4
Number of Accumulators	4	4
Number of EFW Pumps	3	3
Number of CS/RHR Pumps (for containment spray)	0	0
Other Measures	Alternate containment heat removal by 1 CS/RHR pump and 3 MSDVs at 30min	Alternate containment heat removal by 1 CS/RHR pump and 3 MSDVs at 30min
Computer Code and Results	MAAP 4.0.6 Maximum containment pressure is approximately 40 psia <216 psia [Note]	MAAP 4.0.6 Maximum containment pressure is approximately 50 psia < 216 psia [Note]

Note: Containment ultimate pressure = 216 psia



(1) Case 1 (8 inch break with alternate containment decay heat at 30 minutes)



(2) Case 2 (2 inch break with alternate containment decay heat at 30 minutes)

Figure 19.513-3 Containment Pressure

Table 19.513-4 Analysis Conditions for SGTR Event
(DCD Figure 19.1-1, Sheet 5, Sequence #3)

Condition	PRA [Note1]	MARVEL-M Analysis
Ruptured Loop	A-Loop with 0.66 inch diameter break	
ECCS	1 SI Pump	
Heat Removal via SGs	2 EFW Pumps to 2 SGs or 1 EFW Pump to 2 SGs with tie-line valves open	1 EFW Pump to 3 SGs with tie-line valves open [Note 2]
RCS Depressurization by Secondary Side Cooling	1 EFW Pump to 1 SG with 1 MSDV	1 EFW Pump to 3SGs with 3 MSDVs [Note 2]
RCS Depressurization by SDV	1 SDV	
Injection Control	Stop Running SI Pump and Start 1 Charging pump	
RHR Operation	1 CS/RHR Pump and 1 CS/RHR Hx	
Faulted Loop	A-Loop with stuck open of MSRV	

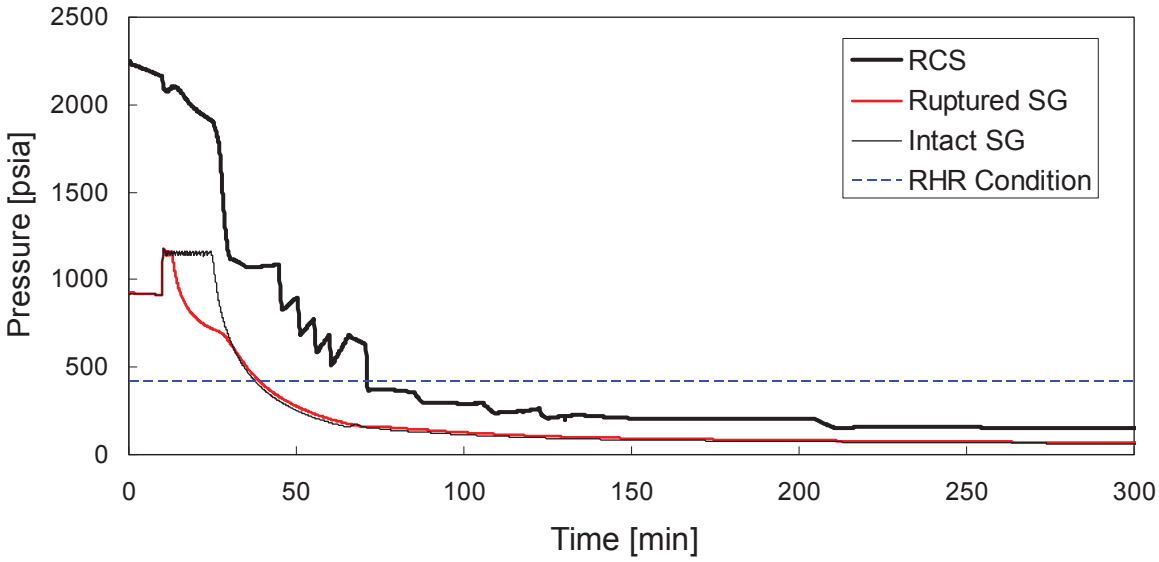
Note
1: This is the success criteria used in the PRA results presented in DCD Rev.4. The success criteria in the PRA, MUAP-07030, will be updated to be consistent with the condition used in MARVEL-M analysis when MUAP-07030 is updated.
2: A-SG is unavailable due to initiating event.

Table 19.513-5 Time Following SGTR Event (with Isolation Failure of "A" Ruptured SG)

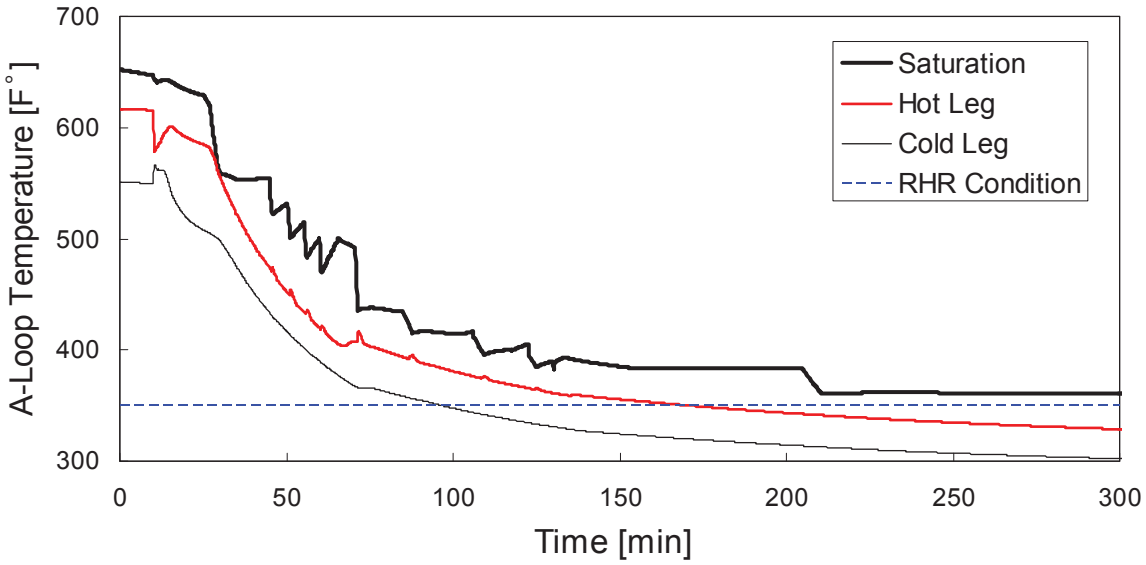
Event	Time (min.)
SG tube rupture	0
Reactor Trip	10.0
Main Feedwater Isolation	10.0
EFW Actuation (3 EFW pumps)	12.3
Ruptured Loop-A SG Isolation [Note 1]	20.0
EFW Isolation of Ruptured Loop-A SG [Note 2]	N/A
3 MSDVs Open (RCS Depressurization)	25.0
ECCS Actuation (1 SI pump) [Note 3]	26.8
RCS Depressurization by SDV (to restore Pressurizer Water Level)	44.9
ECCS Termination and Charging Flow Restore	65.7
RCS Depressurization by SDV (to reach RHR Condition)	70.7
RHR Operation [Note 4]	172.5

Note

1. MSIV on a ruptured loop is closed. Then, MSRV remains stuck open.
2. EFW pump is assumed not to supply EFW to a ruptured SG.
3. SI pump is automatically actuated by low pressurizer pressure.
4. RHR operation is implemented when RCS pressure and temperature is below 400 psig and 350 °F, respectively.

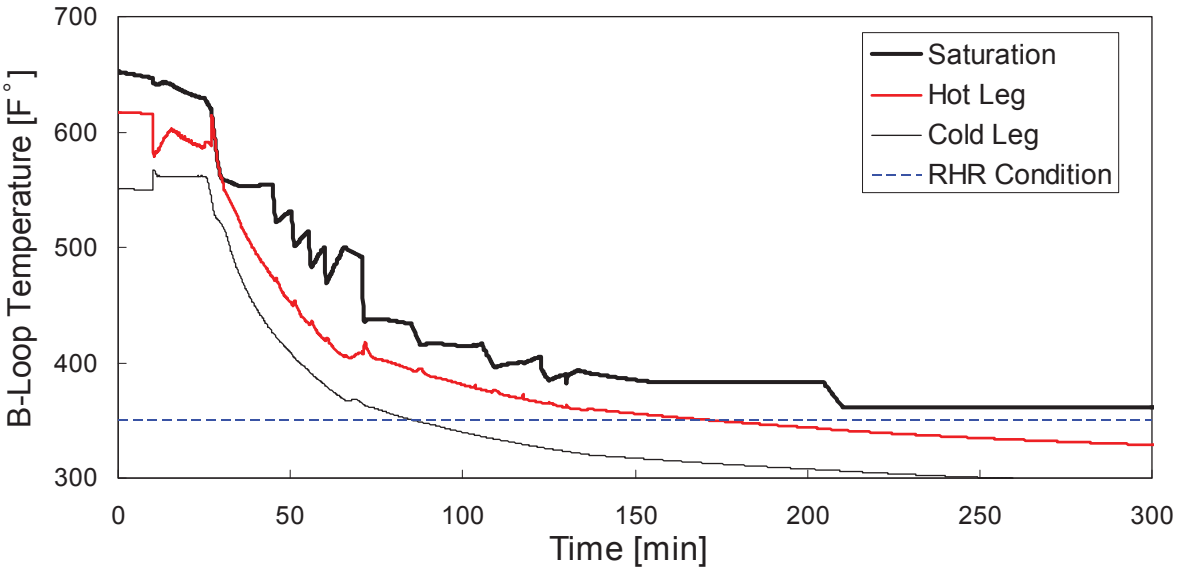


(1) Pressure of RCS, Ruptured (A-Loop) and Intact (B-Loop) Loops

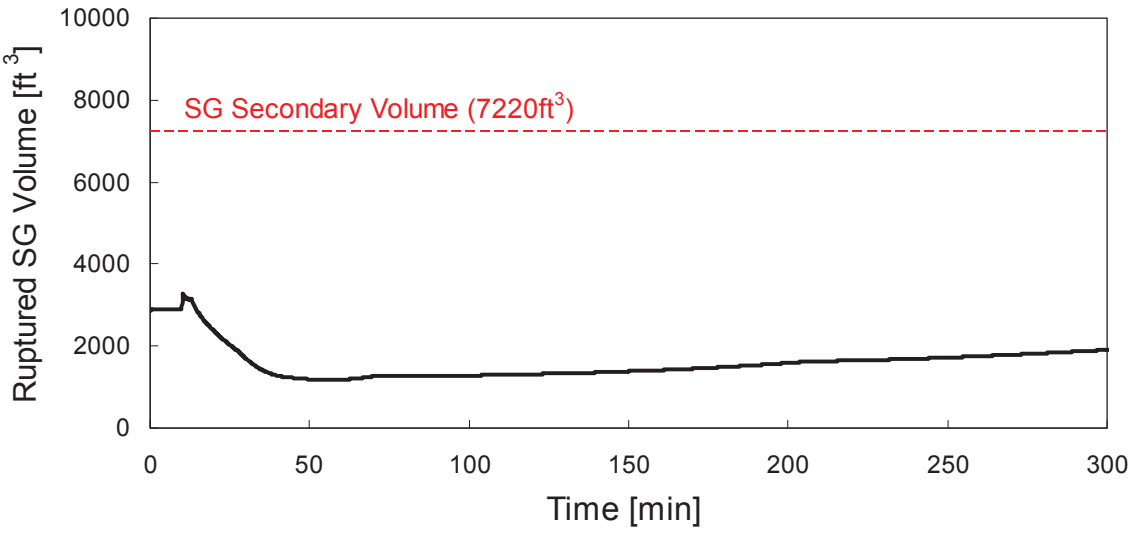


(2) Saturation Temperature, Hot Leg and Cold Leg Temperature on Ruptured Loop

Figure 19.513-4 Analysis Results of Sequence followed by Isolation Failure of Ruptured SG (Sheet 1 of 2)



(3) Saturation Temperature, Hot Leg and Cold Leg Temperature on Intact Loop



(4) Ruptured SG Water Volume

Figure 19.513-4 Analysis Results of Sequence followed by Isolation Failure of Ruptured SG (Sheet 2 of 2)

Table 19.513-6 Analysis Conditions
(No Core Injection, DCD Figure 19.1-1, Sheet 5, Sequence 20)

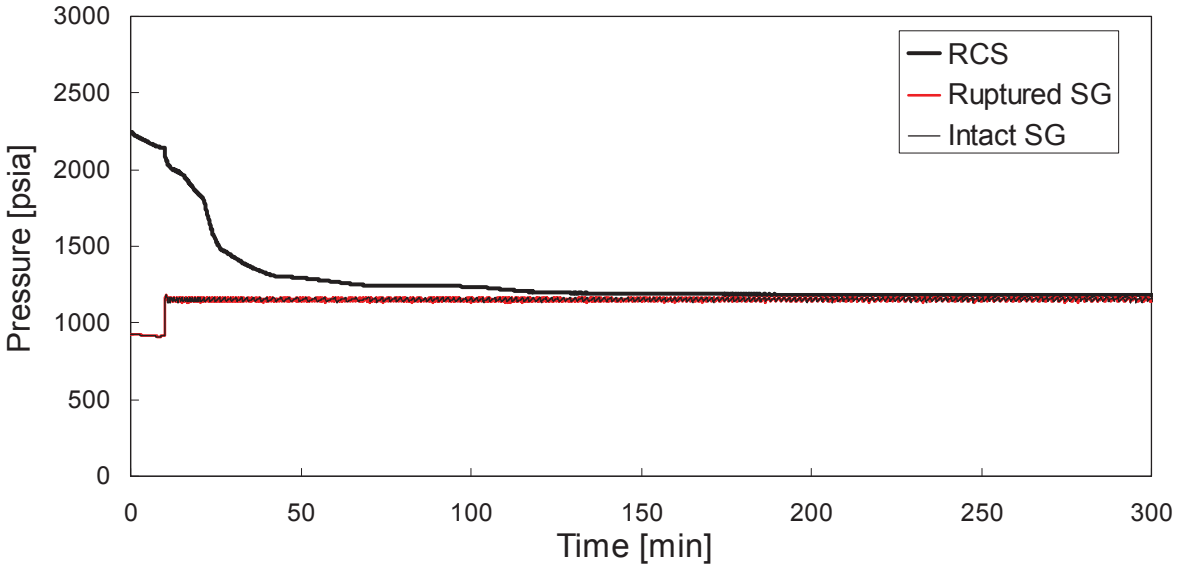
Condition	MARVEL-M Analysis
Ruptured Loop	A-Loop with 0.66 inch diameter break
ECCS	No SI Pump
Heat Removal via SGs [Note 1]	1 EFW Pump to 2 SGs [Note 2] with tie-line open and no MSDVs

Note
1: This condition is based on success criteria for this sequence
2: This evaluation assumes that only C-EFW pump supplies EFW to C and D-SGs.

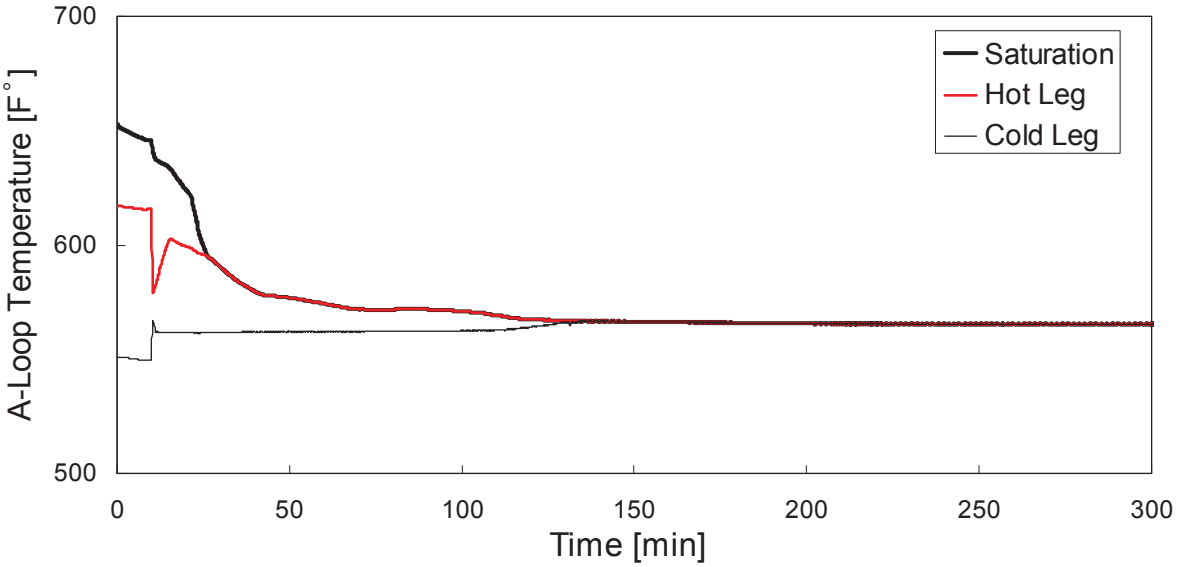
Table 19.513-7 Time Sequences Followed by SGTR Event (No Core Injection)

Event	Time (min.)
SG tube rupture	0
Reactor Trip	10.0
Main Feedwater Isolation	10.0
EFW Actuation (1 EFW pump to 2 SGs) [Note 1]	12.3
Ruptured Loop-A SG Isolation [Note 2]	20.0
ECCS Actuation [Note 3]	N/A

Note
1. A-loop is the ruptured loop. B SG is assumed to be unavailable. C and D SGs are supplied EFW by one available EFW pump.
2. Operators manually close MSIV of the ruptured loop.
3. ECCS actuation signal is initiated at 21.7 min, but no SI pump is running.

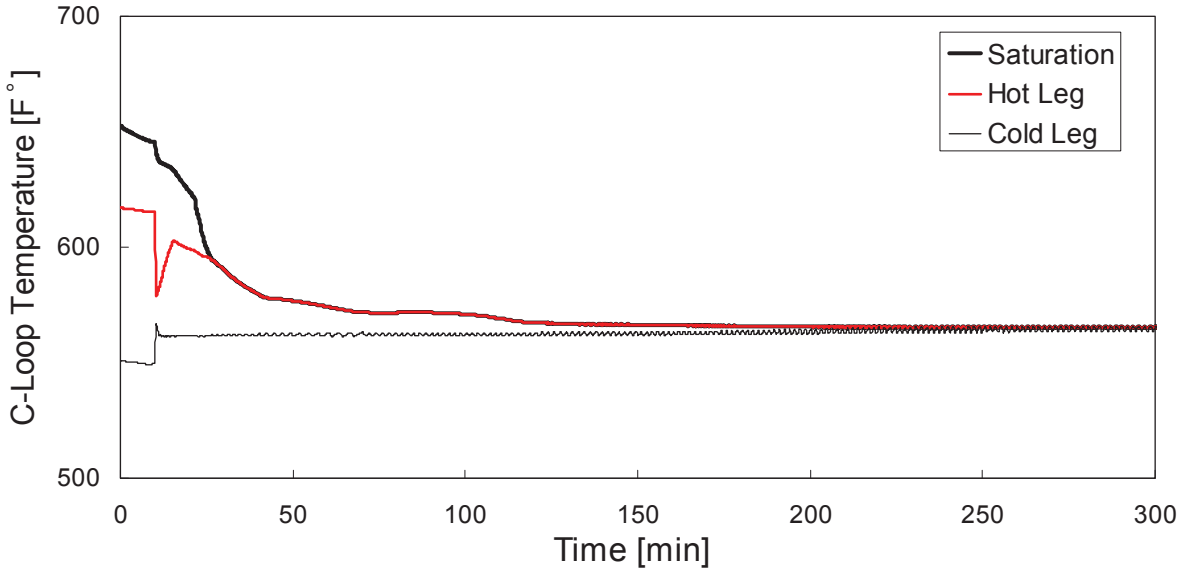


(1) Pressure of RCS, Ruptured (A-Loop) and Intact (C-Loop) Loops

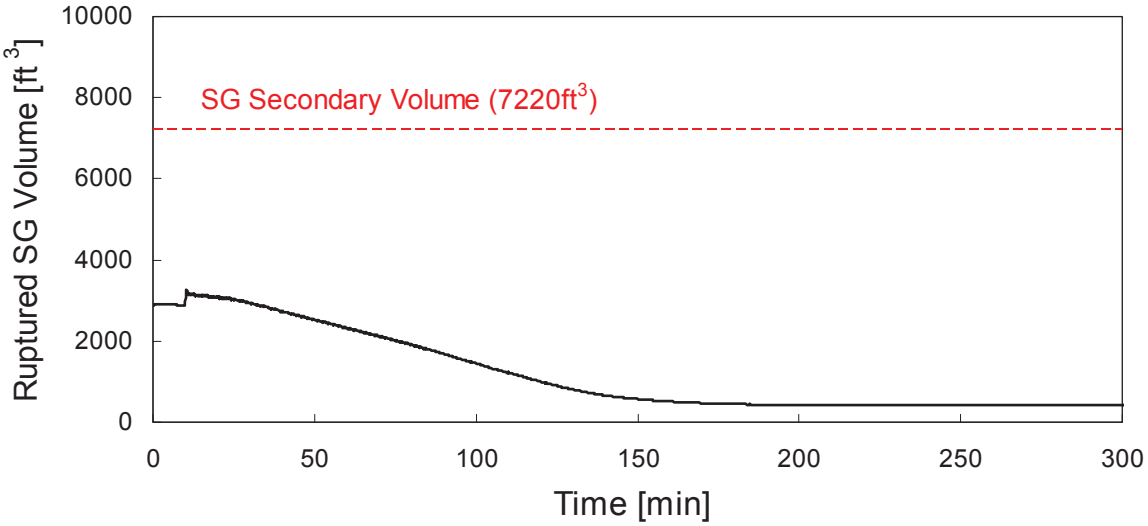


(2) Saturation Temperature, Hot Leg and Cold Leg Temperature on Ruptured Loop

Figure 19.513-5 Analysis Results of Sequence with No Core Injection Function (Sheet 1 of 2)



(3) Saturation Temperature, Hot Leg and Cold Leg Temperature on Intact Loop



(4) A Ruptured SG Water Volume

Figure 19.513-5 Analysis Results of Sequence with No Core Injection Function (Sheet 2 of 2)

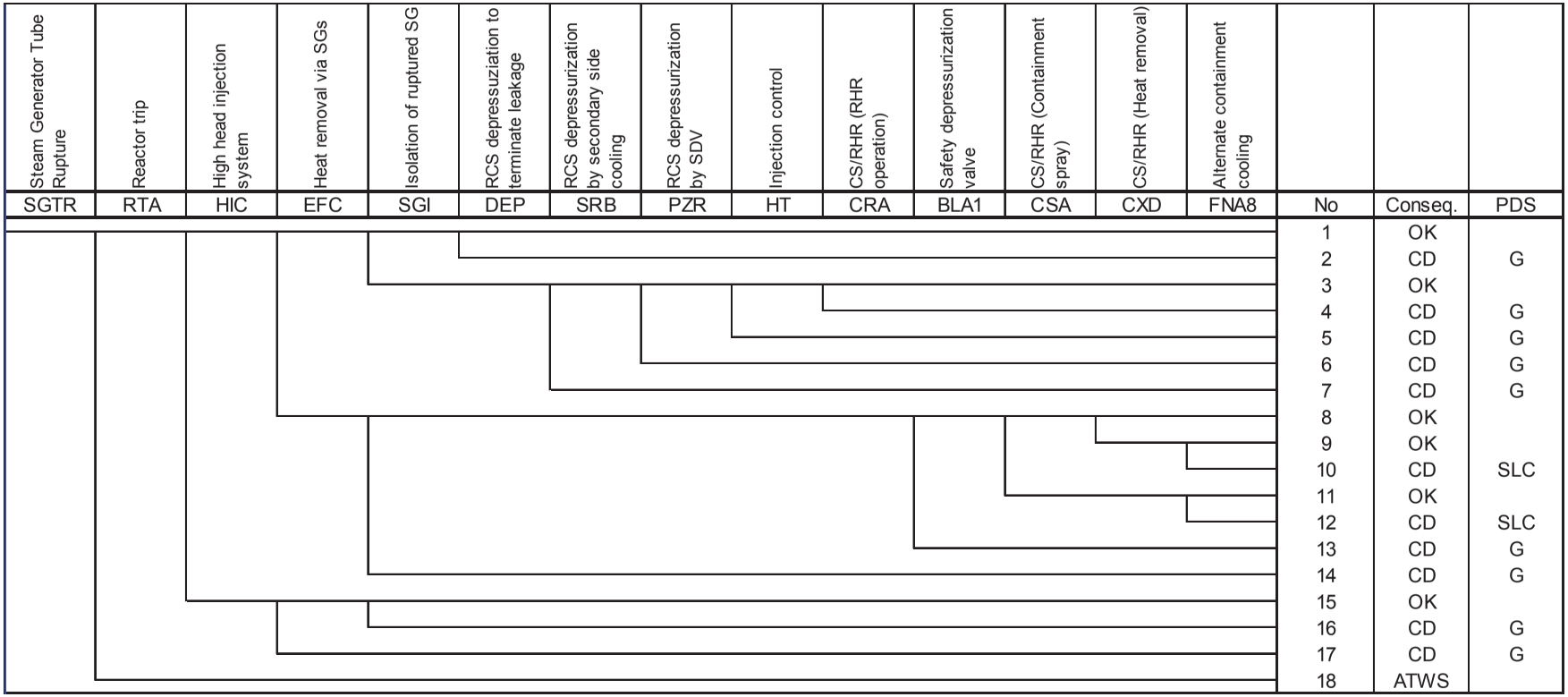


Figure 19.513-6 Revised SGTR Event Tree

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 1 of 25)
Large Pipe Break LOCA (> 8 inches) Event Success Criteria

		Core injection function			Decay heat removal & containment heat removal function			Sequence number in event tree of DCD Figure 19.1-1
		Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [2]	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [2] and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	2/3 ACCs [1]	2/4 SIPs [1]	-	1/4 CS/RHR pump and Hx	-	-	#1
	Basis in Table 19.1-15	No. 1.1	No. 1.1	-	No. 2.1	-	-	
2	Success Criteria	2/3 ACCs	2/4 SIPs	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#2, #5, #7
	Basis in Table 19.1-15	No. 1.1	No. 1.1	-	-	-	No. 2.4	
3	Success Criteria	2/3 ACCs	2/4 SIPs	-	-	1/4 CS/RHR pump and Hx	-	#4
	This success scenario is addressed in the event tree of large break LOCA and the frequency is zero. This is because CS/RHR (Alternate core cooling) is not credited due to insufficient time to perform operator action for CS/RHR (Alternate core cooling) and CS/RHR (Heat removal).							
4	Success Criteria	2/3 ACCs	-	1/4 CS/RHR pump	1/4 CS/RHR pump and Hx	-	-	#18
	This success scenario is addressed in the event tree of large break LOCA and the frequency is zero. This is because CS/RHR (Alternate core cooling) is not credited due to insufficient time to perform operator action for CS/RHR (Alternate core cooling) and CS/RHR (Heat removal).							
5	Success Criteria	2/3 ACCs	-	1/4 CS/RHR pump	-	-	1/2 CCWP and 2/4 containment fan cooler units	#19, #25
	This success scenario is addressed in the event tree of large break LOCA and the frequency is zero. This is because CS/RHR (Alternate core cooling) is not credited due to insufficient time to perform operator action for CS/RHR (Alternate core cooling) and CS/RHR (Heat removal).							
6	SuccessCriteria	2/3 ACCs	-	1/4 CS/RHR pump	-	1/4 CS/RHR pump and Hx	-	#24
	This success scenario is addressed in the event tree of large break LOCA and the frequency is zero. This is because CS/RHR (Alternate core cooling) is not credited due to insufficient time to perform operator action for CS/RHR (Alternate core cooling) and CS/RHR (Heat removal).							

Note (1): RCS cold leg pipe break is assumed for large pipe break LOCA. Accumulator injection via the broken line is unavailable, and high head injection via DVI lines is available.
Note (2): Required operator action to change line-up to CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode. For large pipe break LOCA, this mitigation system is assumed to be unavailable because there is not enough time to operate before core damage.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 2 of 25)
Medium Pipe Break LOCA (2 - 8 inches) Event Success Criteria

		Core injection function			Decay heat removal & containment heat removal function				Sequence number in event tree of DCD Figure 19.1-1
		Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [2]	RCS depressurization by secondary side cooling	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [2] and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	2/3 ACCs [3]	1/3 SIP [1]	-	-	1/4 CS/RHR pump and Hx	-	-	#1
	Basis in Table 19.1-15	No. 1.1, No. 1.2	No. 1.1, No. 1.2	-		No. 2.1	-	-	
2	Success Criteria	2/3 ACCs [3]	1/3 SIP [1]	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#2, #5, #7, #9
	Basis in Table 19.1-15	No. 1.1, No. 1.2	No. 1.1, No. 1.2	-		-	-	No. 2.4	
3	Success Criteria	2/3 ACCs [3]	1/3 SIP [1]	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	1/3 CS/RHR pump and Hx [3]	-	#4
	Basis in Table 19.1-15	No. 1.1, No. 1.2	No. 1.1, No. 1.2	-	No. 2.3	-	No. 2.2, No. 2.3	-	
4	Success Criteria	2/3 ACCs [3]	-	1/3 CS/RHR pump [3]	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	1/4 CS/RHR pump and Hx [3]	-	-	#20
	Basis in Table 19.1-15	No. 1.1, No. 1.2	-	No. 1.4, No. 1.5	No. 1.5	No. 2.1	-	-	
5	Success Criteria	2/3 ACCs [3]	-	1/3 CS/RHR pump [3]	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/2 CCWP and 2/4 containment fan cooler units	#22, #32
	Basis in Table 19.1-15	No. 1.1, No. 1.2	-	No. 1.4, No. 1.5	No. 1.5	-	-	No. 2.4	
6	SuccessCriteria	2/3 ACCs [3]	-	1/3 CS/RHR pump [3]	3/4 SGs and 3/4 EFW pumps and3/4 MSDVs opened	-	1/3 CS/RHR pump and Hx [3]	-	#29
	Basis in Table 19.1-15	No. 1.1, No. 1.2	-	No. 1.4, No. 1.5	No. 1.5, No. 2.3	-	No. 2.2, No. 2.3	-	

Note (1): DVI pipe break is assumed for high head injection system. High head injection via the broken line is unavailable.
Note (2): Required operator action to change line-up to CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode.
Note (3): RCS cold leg pipe break is assumed for alternate core cooling and accumulator injection. Alternate core cooling and accumulator injection via the broken line is unavailable.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 3 of 25)
Small Pipe Break LOCA (1/2 - 2 inches) Event Success Criteria

		Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip [4]	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [2]	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [2] and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP [1]	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	-	1/4 CS/RHR pump and Hx	-	-	#1
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 1.3	-	No. 3.1	-	-	No. 2.1	-	-	
2	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP [1]	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#2, #5, #7, #9
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 1.3	-	No. 3.1	-	-	-	-	No. 2.4	
3	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP [1]	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/4 CS/RHR pump and Hx [3]	-	#4
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 1.3	-	No. 3.1	No. 2.3	-	-	No. 2.2, No. 2.3	-	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 4 of 25)
Small Pipe Break LOCA (1/2 - 2 inches) Event Success Criteria

		Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip [4]	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [2]	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [2] and CS/RHR (Heat removal)	Alternate containment cooling	
4	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC [3]	-	1/4 CS/RHR pump [3]	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	1/4 CS/RHR pump and Hx	-		#11
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 1.1, No. 1.2, No. 1.5	-	No. 1.5	No. 3.1	No. 1.5	-	No. 2.1	-		
5	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC [3]	-	1/4 CS/RHR pump [3]	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#13, #23
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 1.1, No. 1.2, No. 1.5	-	No. 1.5	No. 3.1	No. 1.5	-	-	-	No. 2.4	
6	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC [3]	-	1/4 CS/RHR pump [3]	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/4 CS/RHR pump and Hx	-	#20
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 1.1, No. 1.2, No. 1.5	-	No. 1.5	No. 3.1	No. 1.5, No. 2.3	-	-	No. 2.2, No. 2.3	-	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 5 of 25)
Small Pipe Break LOCA (1/2 - 2 inches) Event Success Criteria

		Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip [4]	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [2]	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [2] and CS/RHR (Heat removal)	Alternate containment cooling	
7	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP [1]	-	-	-	1/2 SDV	1/4 CS/RHR pump and Hx	-	-	#38
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.3, No. 3.4	-	-	-	No. 3.3, No. 3.4	No. 2.1	-	-	
8	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP [1]	-	-	-	1/2 SDV	-	-	1/2 CCWP and 2/4 containment fan cooler units	#39, #41
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.3, No. 3.4	-	-	-	No. 3.3, No. 3.4		-	No. 2.4	

Note (1): DVI pipe break is assumed for high head injection. High head injection via the broken line is unavailable.
Note (2): Required operator action to change line-up to CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode.
Note (3): Even if RCS cold leg pipe break is assumed for alternate core cooling and accumulator injection, alternate core cooling and accumulator injection via RCS cold leg pipe is available because of a little spilled water.
Note (4): Refer to PRA Technical Report Chapter 5 (Reference 19.1-47)

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 6 of 25)
Very Small Pipe Break LOCA (< 1/2 inches) Event Success Criteria

		Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip [2]	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [1]	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [1] and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP OR 1/2 CHP	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	-	-	-	-	-	#1, #2
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 1.3 or DCD Sec. 9.3.4.2.7.4	-	No. 3.1	-	-	-	-	-	
2	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	-	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	1/4 CS/RHR pump and Hx	-	-	#3
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 1.1, No. 1.2, No. 1.5	-	No. 1.5	No. 3.1	No. 1.5	-	No. 2.1	-	-	
3	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	-	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#5, #15
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 1.1, No. 1.2, No. 1.5	-	No. 1.5	No. 3.1	No. 1.5	-	-	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 7 of 25)
Very Small Pipe Break LOCA (< 1/2 inches) Event Success Criteria

		Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip [2]	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) [1]	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) [1] and CS/RHR (Heat removal)	Alternate containment cooling	
4	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	-	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valve opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/4 CS/RHR pump and Hx	-	#12
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 1.1, No. 1.2, No. 1.5	-	No. 1.5	No. 3.1	No. 1.5, No. 2.3	-	-	No. 2.2, No. 2.3	-	
5	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	-	-	-	1/2 SDV	1/4 CS/RHR pump and Hx	-	-	#30
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.3, No. 3.4	-	-	-	No. 3.3, No. 3.4	No. 2.1	-	-	
6	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	-	-	-	1/2 SDV	-	-	1/2 CCWP and 2/4 containment fan cooler units	#31, #33
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.3, No. 3.4	-	-	-	No. 3.3, No. 3.4	-	-	No. 2.4	

Note (1): Require operator action to change line-up to CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode.
Note (2): Refer to PRA Technical Report Chapter 5 (Reference 19.1-47)

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 8 of 25)
Steam Generator Tube Rupture Event Success Criteria

		Condition		Reactor shutdown function	Core injection function			Condition	Decay heat removal & containment heat removal function				Sequence number in event tree of Figure 19.513-6 of this RAI response
		Isolation of ruptured SG [1]	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling and RCS depressurization by SDV and injection control	Equalization of pressure between RCS and secondary system [3]	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) [2] and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	Succeeded	Succeeded	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/4 required actions AND Termination of SI	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	#1
	Basis in Table 19.1-15			DCD Ch.4 and 15	No. 1.3	-	-	No. 3.7, No. 3.8 [4]	No. 3.1	-	-	-	
2	Success Criteria	Failed	Succeeded	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	1/3 SG and 1/3 MSDV AND 1/2 SDV AND 1/2 charging pump and injection control	-	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	1/4 CS/RHR pump and Hx	-	#3
	Basis in Table 19.1-15			DCD Ch.4 and 15	No. 3.5 (See Table 19.513-5 and Figure 19.513-4)								
3	Success Criteria	Succeeded	Failed	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	-	-	-	1/4 CS/RHR pump and Hx	-	-	#8
	Basis in Table 19.1-15			DCD Ch.4 and 15	No. 3.3, No. 3.4	No. 3.3, No. 3.4	-	-	-	No. 2.1	-	-	
4	Success Criteria	Succeeded	Failed	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	-	-	-	-	-	1/2 CCWPs and 2/4 containment fan cooler units	#9, #11
	Basis in Table 19.1-15			DCD Ch.4 and 15	No. 3.3, No. 3.4	No. 3.3, No. 3.4	-	-	-	-	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 9 of 25)
Steam Generator Tube Rupture Event Success Criteria

		Condition		Reactor shutdown function	Core injection function			Condition	Decay heat removal & containment heat removal function				Sequence number in event tree of Figure 19.513-6 of this RAI response
		Isolation of ruptured SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling and RCS depressurization by SDV and injection control	Equalization of pressure between RCS and secondary system (3)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (2) and CS/RHR (Heat removal)	Alternate containment cooling	
5	Success Criteria	Succeeded	Succeeded	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	#15
	Basis in Table 19.1-15			DCD Ch.4 and 15	No. 3.6 (See Table 19.513-7 and Figure 19.513-5)								

Note (1): Closing the following valves for ruptured SG isolation, EFW isolation valve and {(main steam relief valve or main steam relief valve block valve) and (MSIV or turbine bypass valve) and main steam safety valve)}.
Note (2): Requires operator action to change line-up to RHR operation mode
Note (3): Requires at least one of following four actions.
- Open 1/2 SDV
- Actuate pressurizer auxiliary spray
- Open 2/2 depressurization valves for severe accident
- Actuate pressurizer spray by re-starting reactor coolant pumps

Note (4): See Tables 19.514-2 and 19.514-3 and Figure 19.514-3 in the amended response to RAI 750-5675 Question 19-514.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 10 of 25)
Steam Line Break Downstream MSIV Event Success Criteria

		Condition	Reactor shutdown function	Decay heat removal function			Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Main steam line isolation	Reactor trip	Heat removal via SGs	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	Succeeded (3/4 MSIVs closed)	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	-	#1, #22
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.1	-	-	No. 2.1		
2	Success Criteria	Faulted	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and Hx	-	#2, #12
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 3.4	No. 3.4	No. 2.1	-	
3	Success Criteria	Faulted	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#3, #5, #13, #15
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 3.4	No. 3.4	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 11 of 25)
Steam Line Break Upstream MSIV Event Success Criteria

		Condition	Reactor shutdown function	Decay heat removal function			Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Main steam line isolation	Reactor trip	Heat removal via SGs	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	Succeeded (3/3 intact loop MSIVs closed OR 1/1 ruptured loop main steam check valve closed OR 1/1 ruptured loop MSIV closed)	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	-	#1, #22
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.1	-	-	No. 2.1		
2	Success Criteria	Faulted	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and Hx	-	#2, #12
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 3.4	No. 3.4	No. 2.1	-	
3	Success Criteria	Faulted	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#3, #5, #13, #15
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 3.4	No. 3.4	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 12 of 25)
Feedwater Line Break Event Success Criteria

		Condition	Reactor shutdown function	Decay heat removal function			Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Main steam line isolation	Reactor trip	Heat removal via SGs	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	Succeeded (3/3 intact loop MSIVs closed OR 1/1 ruptured loop main steam check valve closed OR 1/1 ruptured loop MSIV closed)	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	-	#1, #22
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.1	-	-	No. 2.1		
2	Success Criteria	Faulted	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and Hx	-	#2, #12
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 3.4	No. 3.4	No. 2.1	-	
3	Success Criteria	Faulted	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#3, #5, #13, #15
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 3.4	No. 3.4	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 13 of 25)
General Transient Event Success Criteria

		Reactor shutdown function	Decay heat removal function			Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip	Heat removal via SGs	Main feedwater system	Feed and bleed	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-	-	#1
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 3.1	-	-	-	-	
2	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	2/4 SGs and 2/4 main feedwater pumps	-	-	-	#2
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.1	-	-	-	
3	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP and 1/2 SDV	1/4 CS/RHR pump and Hx	-	#3
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	-	No. 3.4	No. 2.1	-	
4	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP and 1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#4, #6
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	-	No. 3.4	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 14 of 25)
Loss of Feedwater Flow Event Success Criteria

		Reactor shutdown function	Decay heat removal function		Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip	Heat removal via SGs	Feed and bleed	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-	#1
	Basis in Table 19.1-15	DCD Ch.4 and 15	No. 3.1	-	-	-	
2	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP and 1/2 SDV	1/4 CS/RHR pump and Hx	-	#2
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.4	No. 2.1	-	
3	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP and 1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#3, #5
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	No. 3.4	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 15 of 25)
Loss of Component Cooling Water Event Success Criteria

		Condition	Reactor shutdown function	RCP seal injection	Decay heat removal function	Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	Alternate component cooling (Seal injection) (2)	Heat removal via SGs (3)	
1	Success Criteria	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 CHP and 1/2 fire protection water pump OR 1/1 non-essential chilled water pump	2/2 SGs and 2/2 T/D EFW pumps OR 2/4 SGs and 1/2 T/D EFW pump and isolation valves of pump discharge tie-line opened	#1
	Basis in Table 19.1-15		DCD Ch.4 and 15	DCD Table 9.3.4-2	No. 3.2	

Note (1): Occurrence of stuck open safety valve LOCA during this initiating event is assumed to result in core damage.
Note (2): RCP seal LOCA is assumed to occur, when alternate component cooling fails.
Note (3): Two motor-driven EFW pumps are unavailable in a loss of CCW event.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 16 of 25)
Partial Loss of Component Cooling Water Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA [3]	Reactor trip	High head injection system [1]	Accumulator	CS/RHR (Alternate core cooling) [1]	Safety depressurization valve	RCS depressurization by secondary side cooling [2]	Heat removal via SGs [2]	CS/RHR (Containment spray) and CS/RHR (Heat removal) [1]	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) [1]	Alternate containment cooling	
1	Success Criteria	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-	#1, #2
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	-	-	-	-	No. 3.2	-	-	-	
2	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie-line opened	1/2 CS/RHR pump and Hx	-	-	#3, #40
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.4	-	-	-	-	No. 3.2	No. 2.1	-	-	
3	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie-line opened	-	-	1/2 CCWP and 2/4 containment fan cooler units	#4, #7, #9, #11, #41, #44, #46, #48
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.4	-	-	-	-	No. 3.2	-	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 17 of 25)
Partial Loss of Component Cooling Water Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA [3]	Reactor trip	High head injection system [1]	Accumulator	CS/RHR (Alternate core cooling) [1]	Safety depressurization valve	RCS depressurization by secondary side cooling [2]	Heat removal via SGs [2]	CS/RHR (Containment spray) and CS/RHR (Heat removal) [1]	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) [1]	Alternate containment cooling	
4	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie-line opened		1/2 CS/RHR pump and Hx		#6, #43
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.4	-	-	-	No. 2.3	No. 3.2		No. 2.2, No. 2.3		
5	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/2 CS/RHR pump	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	-	1/2 CS/RHR pump and Hx	-	-	#13, #50
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 1.5	No. 1.5	-	No. 1.5	-	No. 2.1	-	-	
6	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/2 CS/RHR pump	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#15, #25, #52, #62
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 1.5	No. 1.5	-	No. 1.5	-	-	-	No. 2.4	
7	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/2 CS/RHR pump	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	-	-	1/2 CS/RHR pump and Hx	-	#22, #59
	Basis in Table 19.1-15		DCD Ch.4 and 15	-	No. 1.5	No. 1.5	-	No. 1.5, No. 2.3	-	-	No. 2.2, No. 2.3	-	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 18 of 25)
Partial Loss of Component Cooling Water Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA [3]	Reactor trip	High head injection system [1]	Accumulator	CS/RHR (Alternate core cooling) [1]	Safety depressurization valve	RCS depressurization by secondary side cooling [2]	Heat removal via SGs [2]	CS/RHR (Containment spray) and CS/RHR (Heat removal) [1]	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) [1]	Alternate containment cooling	
8	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	1/2 SDV	-	-	1/2 CS/RHR pump and Hx	-	-	#77
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.4	-	-	No. 3.4	-	-	No. 2.1	-	-	
9	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#78, #80
	Basis in Table 19.1-15		DCD Ch.4 and 15	No. 3.4	-	-	No. 3.4	-	-	-	-	No. 2.4	

Note (1): A and B trains are unavailable due to initiating event
Note (2): B M/D EFW pump is unavailable due to loss of HVAC caused by initiating event.
Note (3): Failure of RCP seal cooling by standby charging pump is assumed to lead to RCP seal LOCA.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 19 of 25)
Loss of Offsite Power Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA [1]	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling	
1	Success Criteria	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	-	#A-1, #A-2, #A-3, #B-2, #B-3, #B-4, #C-3, #C-4, #C-5, #C-7, #C-45, #C-47
	Basis in Table 19.1-15		DCD Ch.15	-	-	-	-	-	No. 3.2	-	-	-	
2	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and Hx	-	-	#A-5, #B-6, #C-8, #C-49
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	-	-	No. 3.2	No. 2.1	-	-	
3	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	1/2 CCWP and 2/4 containment fan cooler units	#A-6, #A-9, #A-11, #A-13, #B-7, #B-10, #B-12, #B-14, #C-9, #C-12, #C-14, #C-16, #C-50, #C-53, #C-55, #C-57
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	-	-	No. 3.2	-	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 20 of 25)
Loss of Offsite Power Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA [1]	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling	
4	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	1/4 CS/RHR pump and Hx	-	#A-8, #B-9, #C-11, #C-52
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	-	No. 2.3	No. 3.2	-	No. 2.2, No. 2.3	-	
5	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/4 CS/RHR pump	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and Hx	-	-	#A-15, #B-16, #C-18, #C-59
	Basis in Table 19.1-15		DCD Ch.15	-	No. 1.5	No. 1.5	-	No. 1.5	No. 3.2	No. 2.1	-	-	
6	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/4 CS/RHR pump	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	1/2 CCWP and 2/4 containment fan cooler units	#A-17, #A-27, #B-18, #B-28, #C-20, #C-30, #C-61, #C-71
	Basis in Table 19.1-15		DCD Ch.15	-	No. 1.5	No. 1.5	-	No. 1.5	No. 3.2	-	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 21 of 25)
Loss of Offsite Power Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling	
7	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/4 CS/RHR pump	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	1/4 CS/RHR pump and Hx	-	#A-24, #B-25, #C-27, #C-68
	Basis in Table 19.1-15		DCD Ch.15	-	No. 1.5	No. 1.5	-	No. 1.5, No. 2.3	No. 3.2	-	No. 2.2, No. 2.3	-	
8	Success Criteria	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	1/4 CS/RHR pump and Hx	-	-	#A-43, #B-44, #D-4
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	No. 3.4	-	-	No. 2.1	-	-	
9	Success Criteria	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#A-44, #A-46, #B-45, #B-47, #D-5, #D-7
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	No. 3.4	-	-	-	-	No. 2.4	

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 22 of 25)
Loss of Offsite Power Event Success Criteria

		Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						Sequence number in event tree of DCD Figure 19.1-1
		Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling	
10	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	1/4 CS/RHR pump and Hx	-	-	#A-55, #B-56
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	No. 3.4	-	-	No. 2.1	-	-	
11	Success Criteria	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units	#A-56, #A-58, #B-57, #B-59
	Basis in Table 19.1-15		DCD Ch.15	No. 3.4	-	-	No. 3.4	-	-	-	-	No. 2.4	

Note (1): Failure of RCP seal injection by standby charging pump results in RCP seal LOCA.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 23 of 25)
Loss of Vital ac Bus Event Success Criteria

		Decay heat removal function			Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Heat removal via SGs (1)	Main feedwater system	Feed and bleed (1)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	Alternate containment cooling	
1	Success Criteria	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and tie-line valves opened	-	-	-	-	#1
	Basis in Table 19.1-15	No. 3.2	-	-	-	-	
2	Success Criteria	-	2/4 SGs and 2/4 main feedwater pumps	-	-	-	#2
	Basis in Table 19.1-15	-	No. 3.2	-	-	-	
3	Success Criteria	-	-	1/3 SIP and 1/2 SDV	1/3 CS/RHR pump and Hx	-	#3
	Basis in Table 19.1-15	-	-	No. 3.4	No. 2.1	-	
4	Success Criteria	-	-	1/3 SIP and 1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#4, #6
	Basis in Table 19.1-15	-	-	No. 3.4	-	No. 2.4	

Note (1): B-Class 1E 6.9kV ac bus is unavailable due to initiating event.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 24 of 25)
Loss of Vital dc Bus Event Success Criteria

		Decay heat removal function			Containment heat removal function		Sequence number in event tree of DCD Figure 19.1-1
		Heat removal via SGs (1)	Main feedwater system	Feed and bleed (1)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	Alternate containment cooling	
1	Success Criteria	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and tie-line valves opened	-	-	-	-	#1
	Basis in Table 19.1-15	No. 3.2	-	-	-	-	
2	Success Criteria	-	2/4 SGs and 2/4 main feedwater pumps	-	-	-	#2
	Basis in Table 19.1-15	-	No. 3.2	-	-	-	
3	Success Criteria	-	-	1/3 SIP and 1/2 SDV	1/3 CS/RHR pump and Hx	-	#3
	Basis in Table 19.1-15	-	-	No. 3.4	No. 2.1	-	
4	Success Criteria	-	-	1/3 SIP and 1/2 SDV	-	1/2 CCWP and 2/4 containment fan cooler units	#4, #6
	Basis in Table 19.1-15	-	-	No. 3.4	-	No. 2.4	

Note (1): A-Class 1E 125V dc switchboard is unavailable due to initiating event.

Table 19.513-8 Results of Systematic Search for Success Criteria (Sheet 25 of 25)
Anticipated Transient without Scram Event Success Criteria

		Reactivity control				RCS pressure control		Sequence number in event tree of DCD Figure 19.1-1
		Reactor trip	Turbine trip	Moderator temperature coefficient (1)	Boric acid injection	Pressurizer safety valve	Heat removal via SGs	
1	Success Criteria	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	-	#1
	Basis in Table 19.1-15	DCD Ch.4 and 15	-	-	-	-	-	
2	Success Criteria	-	2/4 RPSs and 4/4 turbine stop valves OR DAS and 4/4 turbine stop valves	MTC within allowable range (95% of fuel cycle)	1/2 Boric acid transfer pump and 1/2 CHP	4/4 pressurizer safety valves open	4/4 SGs with 4/4 EFW pumps	#2
	Basis in Table 19.1-15	-	These success criteria are the conservative condition because single failure leads to core damage.					

Note (1): The basis is summarized in the US-APWR PRA Report (MUAP-07030 Rev.3) Attachment 6A.14.9.

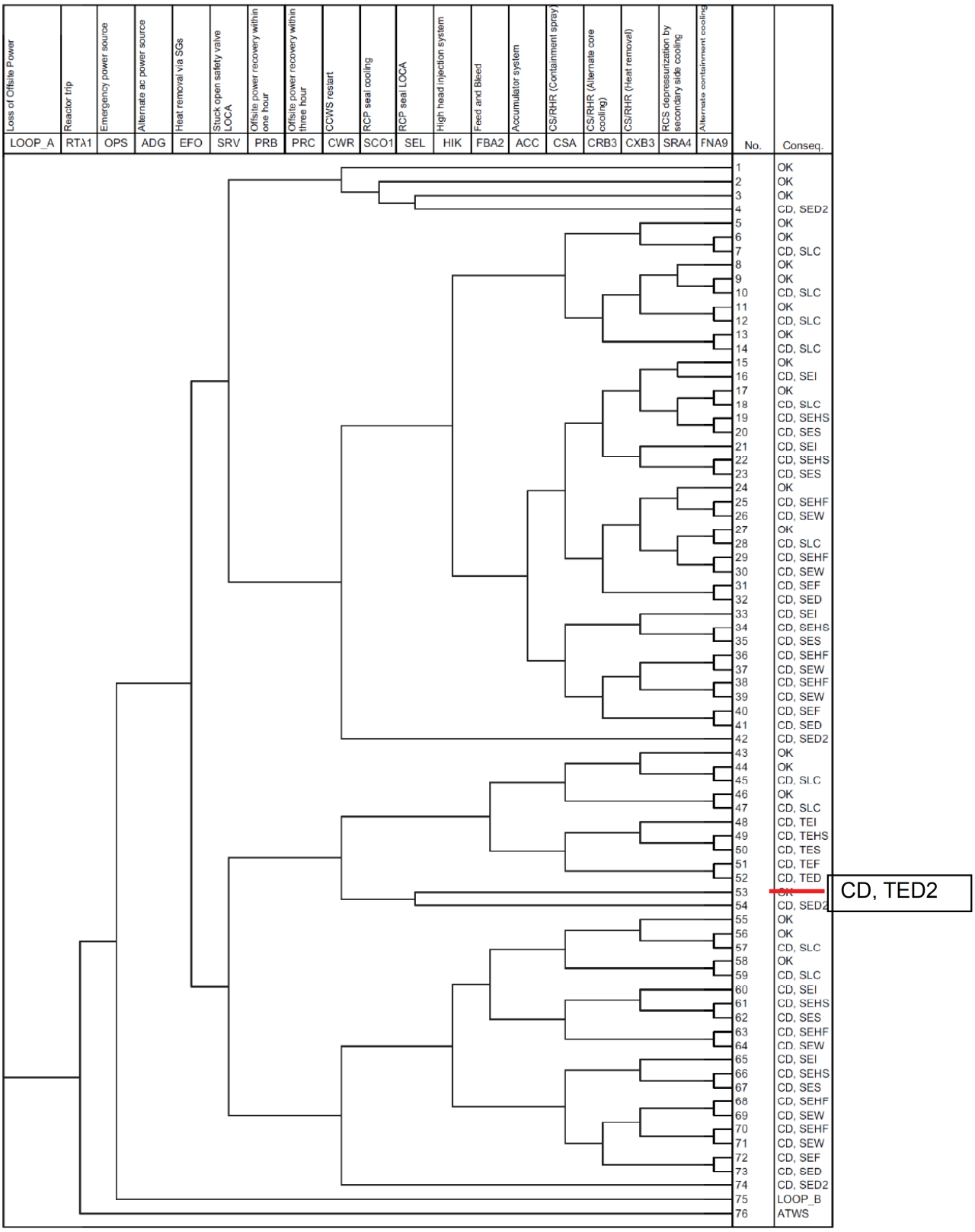


Figure 19.513-7 Event Tree (Loss of Offsite Power [1/4])
(Same as DCD Figure 19.1-1 Sheet 13 of 19)

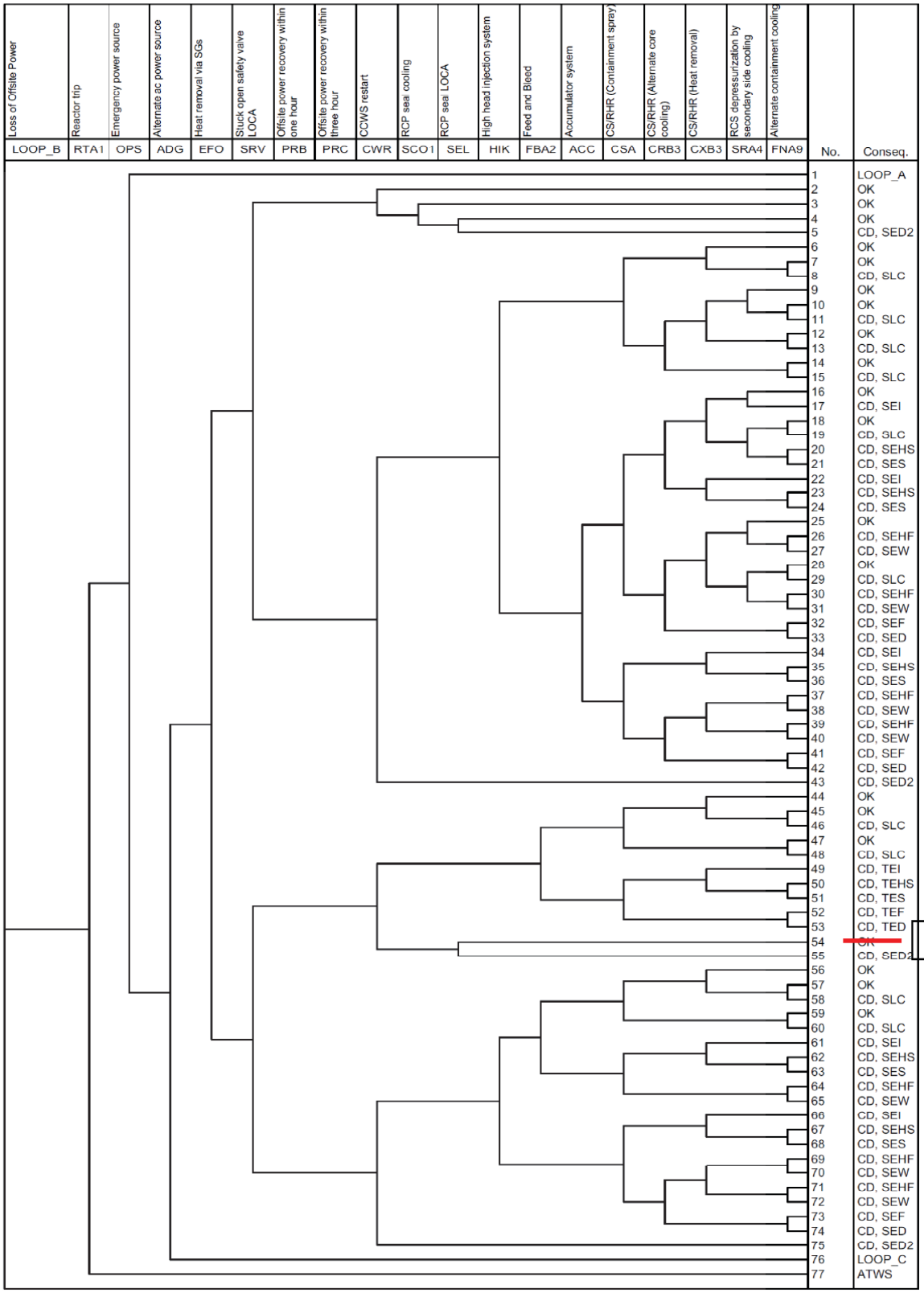


Figure 19.513-7 Event Tree (Loss of Offsite Power [2/4])
(Same as DCD Figure 19.1-1 Sheet 14 of 19)

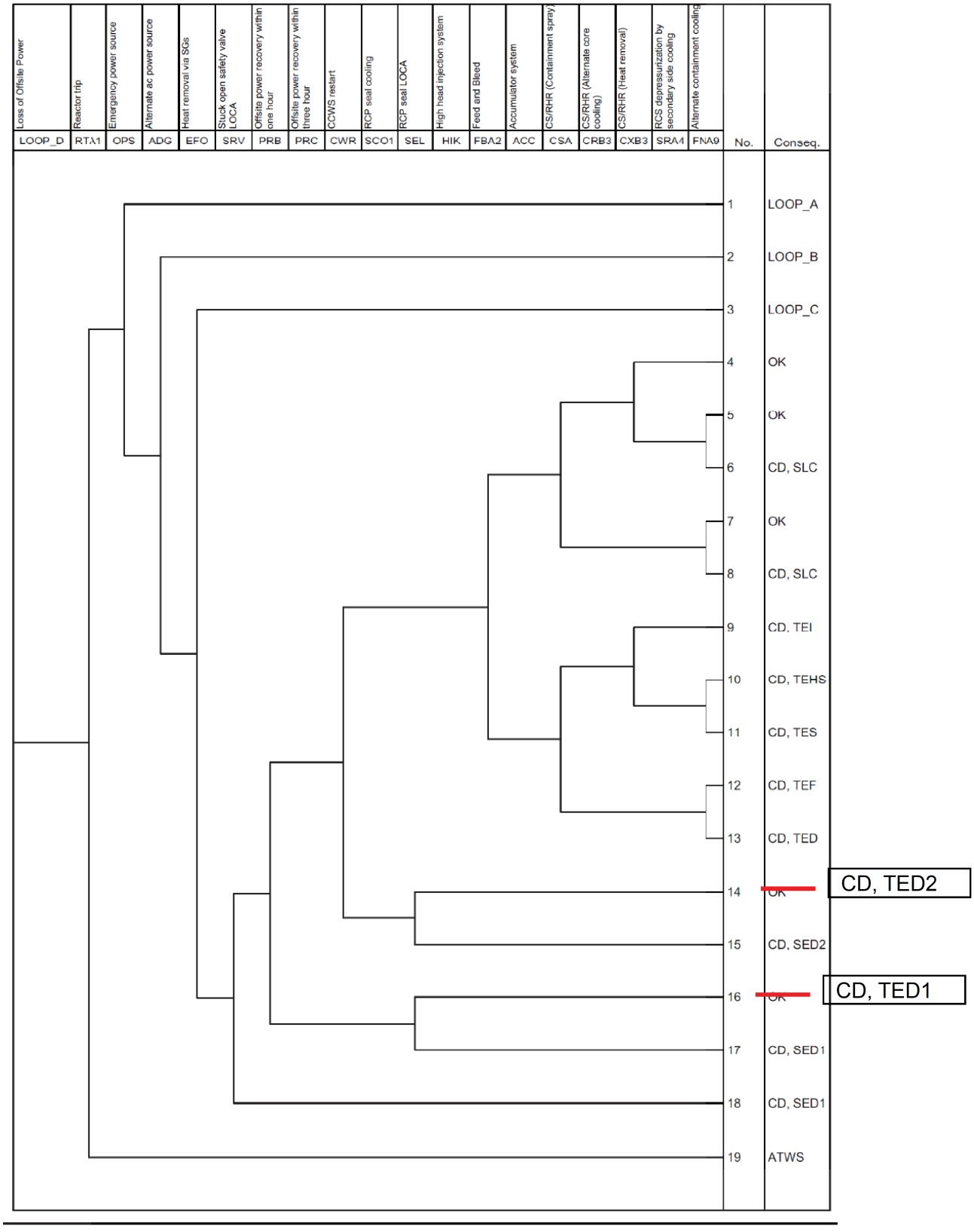


Figure 19.513-7 Event Tree (Loss of Offsite Power [4/4])
(Same as DCD Figure 19.1-1 Sheet 16 of 19)

Impact on DCD

Changes associated with the original RAI response (Ref. UAP-HF-11201, dated June 30, 2011) to DCD Table 19.1-15 were incorporated in DCD Rev.4.

As part of this amended response, DCD Tables 19.1-15 and 19.1-16 will be revised as shown in the attached markup. Note that the attached markup of DCD Table 19.1-15 also includes the changes discussed in the amended response to RAI 750-5675 Question 19-514.

The PRA results in the DCD will be updated as part of the next revision of the PRA. After the PRA is revised, then DCD Figure 19.1-1 sheets 5, 13, 14, and 16 will be revised as described in this amended response (note that the revision to sheet 5 also includes the discussion in the amended response to RAI 750-5675 Question 19-514).

Impact on R-COLA

Site-specific PRA model and results will be updated after the DCD PRA is revised.

Impact on PRA

SGTR event tree and the success criteria will be revised to incorporate the discussion in this RAI response. As discussed in this response, the model change has an insignificant impact on the PRA results and risk profile.

Impact on Topical/Technical Report

US-APWR PRA Technical Report (MUAP-07030) will be revised to reflect the updated PRA modeling and results in the next revision.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/12/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 750-5675 REVISION 2**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19**
DATE OF RAI ISSUE:	**04/28/2011**

QUESTION NO. : 19-514

In RAI Question 19-108 the staff requested more information regarding the basis for not having modeled in SGTR sequences an operator action to depressurize the RCS in order to equalize primary and secondary pressures and stop the leak after the ruptured SG is isolated. MHI responded that this operator action was assumed to be always successful because the operator has plenty of time to perform such an action. The staff followed up with RAI Question 19-366 requesting more detailed justification. In response, MHI included a top event (event DEP) in the SGTR event tree, which represents operator failure to equalize primary and secondary pressures, without any quantification. The staff review finds that event DEP is highly risk significant (e.g., risk achievement worth (RAW) value is about $4x10^{+3}$) and it is not obvious without the benefit of a T-H analysis that its contribution to risk (e.g., as measured by the Fussell-Vesely risk importance measure) is insignificant. Furthermore, if a cutoff probability of $1x10^{-5}$ is used for DEP, the sequence CDF would be $4x10^{-8}$ per year, which is comparable to the CDF of some of the reported dominant accident sequences. For these reasons, the failure probability of DEP must be estimated and documented together with all key assumptions and bases (e.g., T-H analysis) used in the estimation. In addition, event DEP should be addressed in the accident sequence quantification and importance analysis.

ANSWER:

The SGTR event tree in DCD Rev. 4 Figure 19.1-1 Sheet 5 will be revised to match Figure 19.514-1, which illustrates the revisions. Model changes from the DCD Rev. 4 are discussed below:

1. Unreliability of Event Heading “DEP”

Event heading “DEP”, which represents RCS depressurization, has been considered in a ruptured SG isolation scenario. Any one of the following operator actions to depressurize

the RCS, combined with termination of SI, will terminate leakage from a ruptured tube:

(1) Open safety depressurization valves (SDVs)

(2) Start pressurizer auxiliary spray

(3) Open depressurization valves for severe accident

(4) Actuate pressurizer spray by re-starting reactor coolant pumps (RCPs)

There are several methods to depressurize the RCS and there is considerable time to take the necessary operator actions. MHI estimated the time to overfill the ruptured SG using the MARVEL-M code (the code is the same code used in DCD Chapter 15), with the following conditions:

- Main feedwater system is isolated following a reactor trip
- EFW actuation and isolation signals are generated upon detection of low and high SG water level, respectively. This calculation assumes conservatively that operators manually actuate EFW pumps immediately following main feedwater isolation.
- In the three intact loops, EFW is supplied to the three intact SGs following reactor trip. (Note that this assumption is made for analyzing the time for operator actions to depressurize and is different than the success criteria for secondary side cooling.)

Table 19.514-1 and Figure 19.514-2 show the analysis results and time variation of the ruptured SG water volume, respectively. The estimated time to SG overfill following a SGTR event is approximately 2.7 hours after event initiation and the allowable time for these operator actions is more than 2 hours after operators detect the reactor trip. For the scenario in which the operator successfully isolates the ruptured loop, any one of the four aforementioned operator actions plus termination of SI will result in successful depressurization. The analysis result will be added in DCD Table 19.1-15, No. 3.7.

Other T-H analyses using the MARVEL-M code were conducted to demonstrate that there are multiple methods for operator action to depressurize the RCS (“pressure equalization”), based on the system conditions described in Table 19.514-2. Table 19.514-3 and Figure 19.514-3 show the analysis results and time variation of pressure of the RCS, a ruptured loop and intact loop for each case, respectively. In all cases, any of the four operator actions identified earlier can depressurize the primary system. For Cases 1 through 3, when RCS pressure is depressurized down to the ruptured SG loop pressure, the depressurization action is terminated. After that, the RCS is slightly pressurized due to the decay heat from the reactor core, eventually ECCS (i.e., SI pumps) termination will stop leakage via the ruptured tube. For Case 4, pressurizer spray with re-starting RCPs can depressurize the RCS and ECCS termination enables leakage from the ruptured tube to stop, as well as Cases 1 through 3. These results show that there are multiple options for operator action to depressurize the RCS. The analysis result will be added in DCD Table 19.1-15, No. 3.8.

US-APWR emergency operating procedures (EOPs) will be symptom-based EOPs. As provided in Chapter 9 of PRA Technical Report (MUAP-07030 Rev.3, Proprietary), the symptom-based EOP type is assumed in the evaluation of human error probability. Before

the operators implement any of the above four actions for depressurization, operators detect the SGTR symptoms and manually close the main steam isolation valve (MSIV) on the ruptured SG loop. This means that the operators identify the occurrence of the SGTR event prior to implementing the action for depressurization. Because operators have taken actions consistent with SGTR, the symptom-based procedures require depressurization; thus, the failure probability of the RCS depressurization decision is considered to be negligible. The human error probability of each of the above actions is evaluated by failure probability of both cognition and action aspects.

Based on the results, the latest PRA modeled the unreliability of "DEP" as 0.0 due to the multiple success paths for depressurization and the considerable time for the action. MHI will update the human error probability of 1.0E-05, considering the available time for operator action as well as number of alternate actions that operator can take as described above.

Failure of RCS depressurization will lead to the ruptured SG overfilling which in turn results in the failure to isolate the ruptured SG loop. The coolant traversing the ruptured SG tube will flow into the main steam line potentially causing water hammer and/or failure of the main steam safety valves to re-close, even if the EFW and main steam line are isolated. The scenario is similar to the event heading SGI – failure to isolate the ruptured SG (event heading "SGI"). In addition to human error probability for the RCS depressurization, the probability of the water hammer caused by a ruptured SG overfilling due to failure of RCS depressurization will be considered in this event heading.

2. Event Sequences following Failure of "DEP"

Event sequences following a ruptured SG overfilling (Figure 19.514-1 Sequences #2 – 11) are the same as those following isolation failure of the ruptured SG (Figure 19.514-1 Sequences #12 – 21). The thermal/hydraulic analysis results are provided in the revised response to RAI 750-5675 Question 19-513. The T-H analysis results in item (3) of the revised response to RAI 750-5675 Question 19-513 are applicable to the sequences of #2 and #12 and the scenarios #3 – 8 and #13 – 17 will be eliminated, as discussed in Item (6) of the response to RAI 750-5675 Question 19-513 (i.e., CS/RHR (RHR operation) failure directly leads to core damage. Note that the same mitigation systems defense barriers including RCS depressurization via "SRB," safety depressurization via valve "PZR", high head injection control "HT," and RHR operation "CRA" are available to prevent core damage.

Additionally, although the same components (i.e., SDVs) are used in the event headings "DEP" and "PZR", different basic events will be modeled in the PRA by reasons below:

- The action in "DEP" needs to be performed before the ruptured SG overfills and the action in "PZR" must be implemented after SG overfilling. Timing to manually open SDVs is different.
- The allowable time for "PZR" is much longer because the core is not damaged while the SI pumps are operating.

According to the results summarized above, the re-estimated CDF following a SGTR and total CDF are calculated to be 1.1E-08/RY and 1.0E-06/RY, respectively, which is an increase of 1.0E-10/RY from the base case. FV importance and RAW of operator actions for the RCS depressurization were estimated to be 7.5E-5 and 8.5, respectively. The estimated importance measures indicate that if the actions have a success probability of 1, the resulting CDF is decreased by 0.008% of the base case. Conversely, the CDF

assuming no operator action to depressurize the RCS is 8.5E-06/RY, which is approximately 8.5 times of the base case CDF. The operator failure contributes less than 0.01% of the total CDF. Likewise, human actions considered for “DEP” are identified as risk-significant. Thus, these actions will be documented in the DCD Rev. 4 Table 19.1-119.

To maintain the success criteria mapping established in Question 19-513, the supporting success criteria cases for SGTR from Table 19-513-8 that correspond to the successful sequences in Figure 19.514-4 are provided in Table 19.514-4.

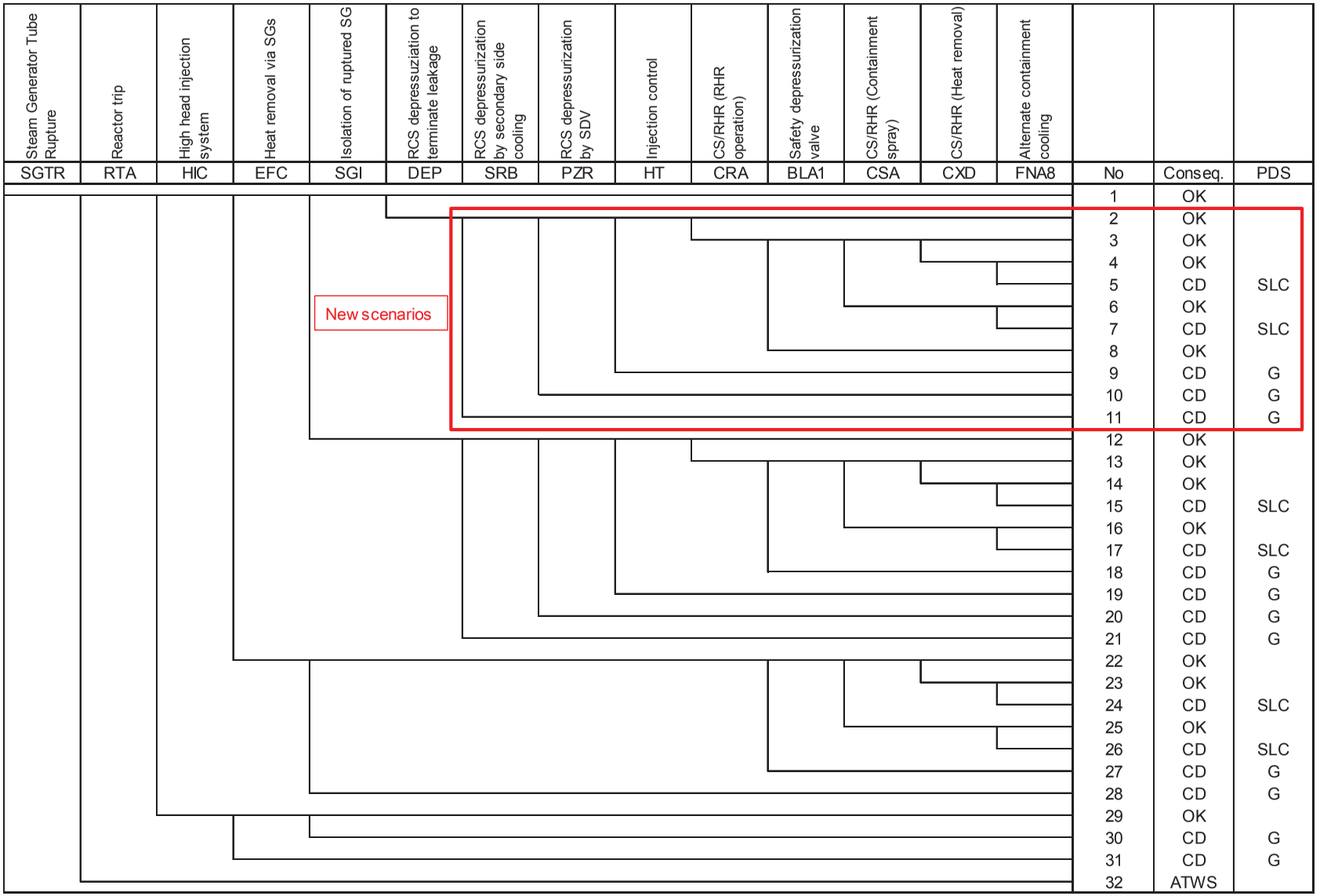


Figure 19.514-1 Event Tree (Steam Generator Tube Rupture)

Table 19.514-1 Time Sequence of SGTR Event (Time to SG Overfilling)

Event	Time (min.)
SG tube rupture	0
Reactor Trip	10.0
Main Feedwater Isolation	10.0
EFW Actuation Note 1	10.0
Main Steam Isolation Valve Close of a ruptured loop	20.0
EFW Isolation Note 2	25.0
ECCS Actuation Note 3	N/A
SG Overfilling Note 4	160.8

Note 1: Actuate all four EFW pumps followed by reactor trip
Note 2: Actuate EFW isolation upon detection of SG water level high
Note 3: ECCS not actuated because RCS pressure is not below the setpoint for ECCS under this condition.
Note 4: Reach SG water volume of 7220 ft^3

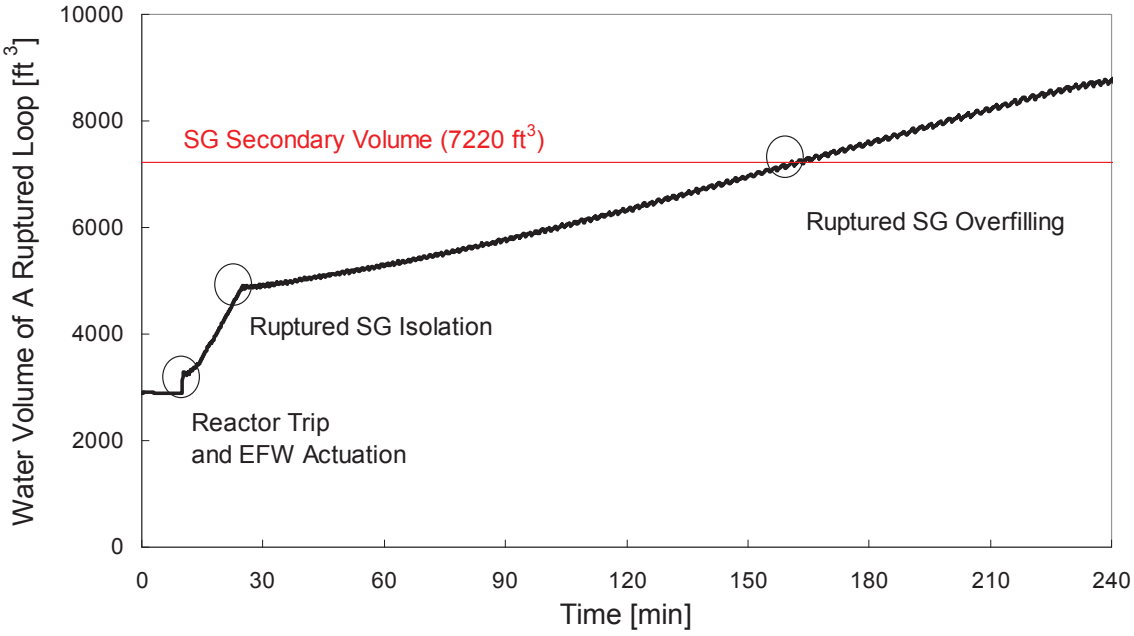


Figure 19.514-2 Time Variation of the Ruptured SG Water Volume

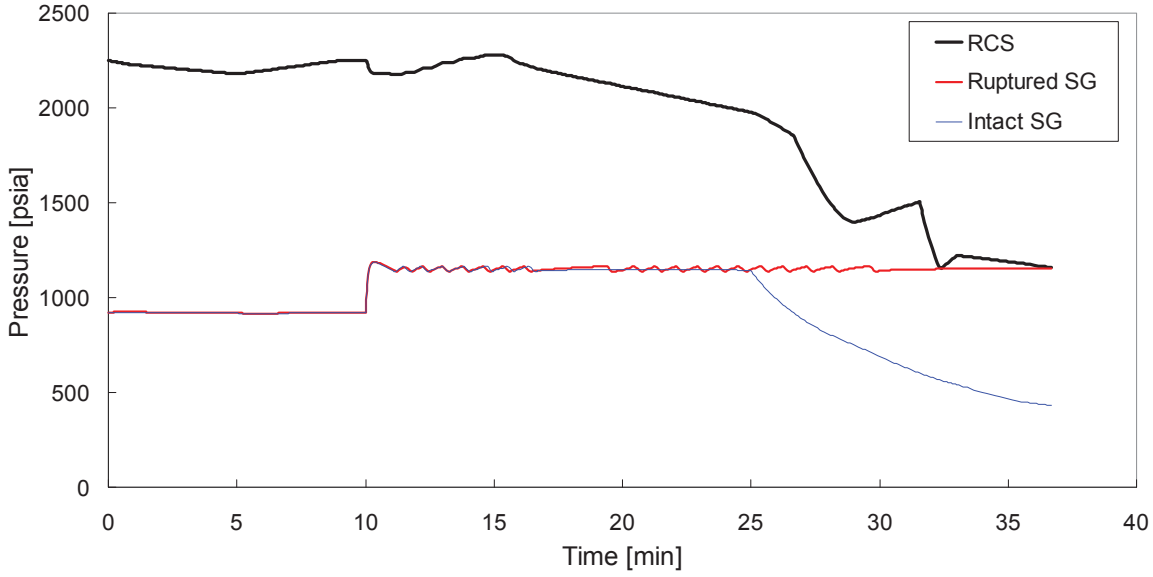
Table 19.514-2 System Conditions for Pressure Equalization in SGTR Event

Initiating Event / Accident Sequence		SGTR
Break Location		A-SG
Number of Ruptured Tubes		1
Break Size		0.664 inch diameter
Number of SI Pumps (ECCS)		4 / 4
Number of EFW Pumps Note1		4 / 4 to 4 SGs
Number of SG Secondary Side Cooling Note2		3 / 4
Pressure Equalization	Case 1	SDV (1 out of 2)
	Case 2	Pressurizer Auxiliary Spray
	Case 3	Depressurization Valve for Severe Accident
	Case 4	Pressurizer Spray with RCP Re-starting

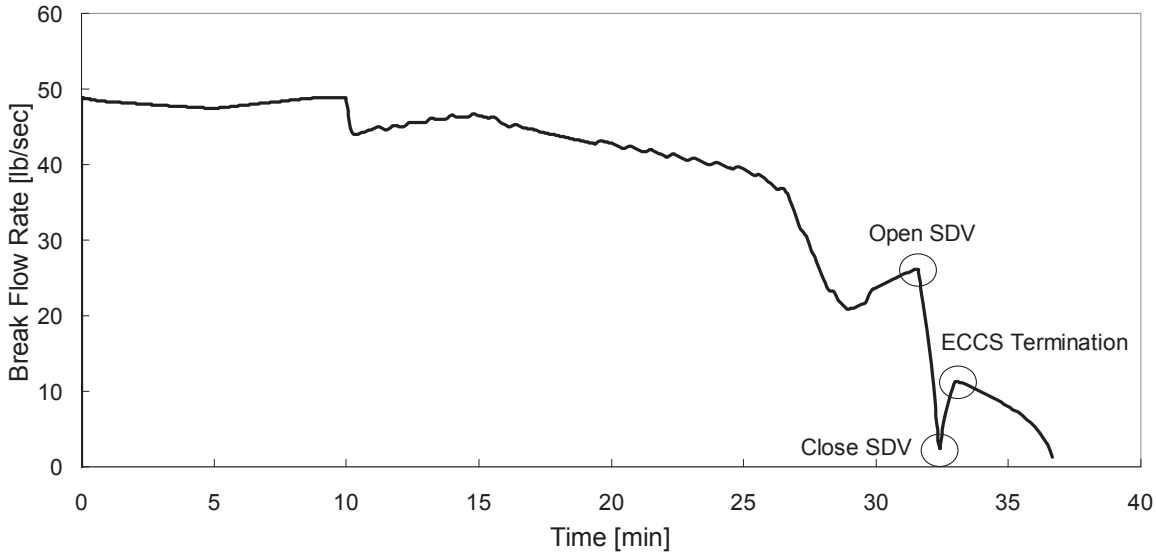
Note 1: EFW is supplied to all four SGs followed by reactor trip.
Note 2: SG secondary side cooling is performed using three intact SGs due to isolation of a ruptured SG.

Table 19.514-3 Time Following SGTR Event (Pressure Equalization)

Event	Time (min.)
SG tube rupture	0
Reactor Trip	10.0
Main Feedwater Isolation	10.0
EFW Actuation	12.3
ECCS Actuation (4 SI pumps)	15.0
Main Steam Isolation Valve Close of a ruptured loop	20.0
EFW Isolation	20.0
RCS Depressurization from the intact SGs	25.0
Case 1	
Open One SDV	31.6
Close One SDV	32.4
ECCS Termination	33.0
Primary Leakage Termination	36.7
Case 2	
Pressurizer Auxiliary Spray Actuation	31.6
Pressurizer Auxiliary Spray Termination	35.3
ECCS Termination	35.6
Primary Leakage Termination	39.2
Case 3	
Open One DV for Severe Accident	31.6
Close One DV for Severe Accident	32.1
ECCS Termination	32.7
Primary Leakage Termination	36.3
Case 4	
RCP Re-starting	36.6
Pressurizer Spray Actuation	36.6
Pressurizer Spray Termination	44.9
ECCS Termination	44.9
Primary Leakage Termination	46.8



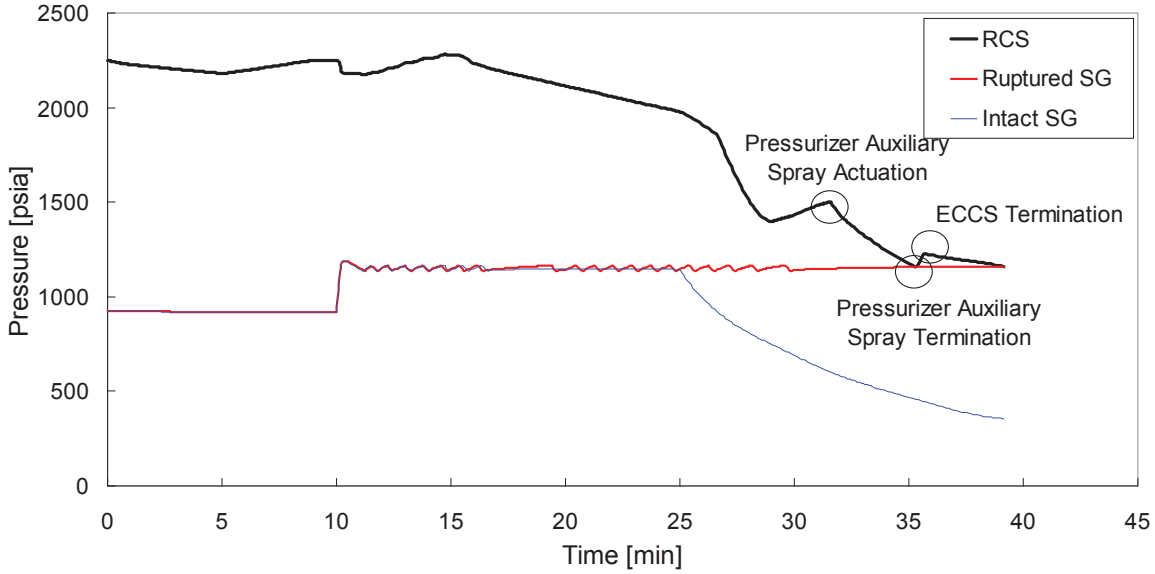
(a) Pressure of RCS, Ruptured and Intact Loops



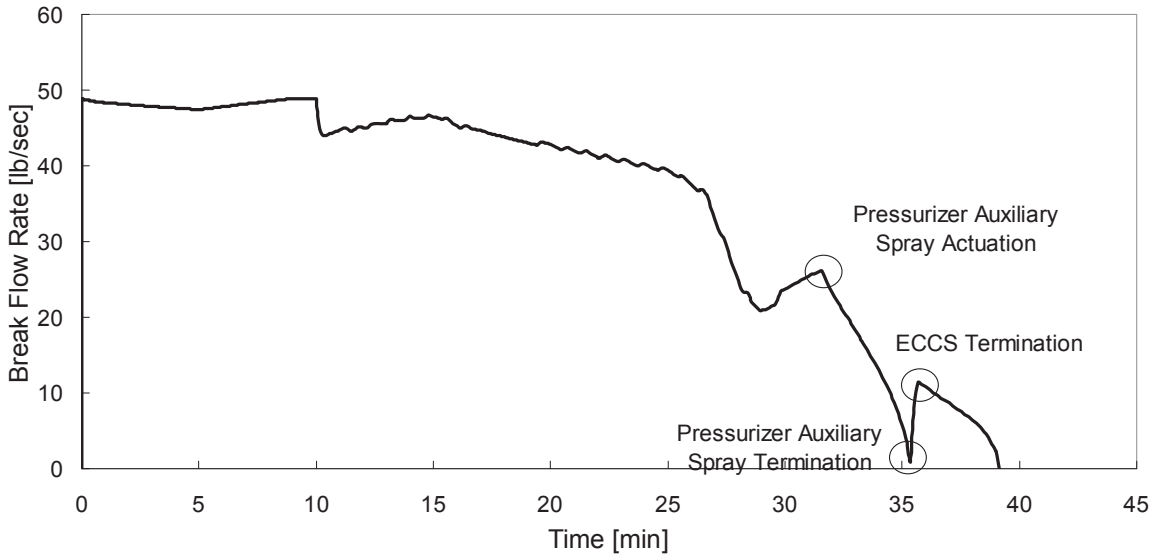
(b) Flow Rate from Break SG Tube

(1) Case 1 (Open SDV)

Figure 19.514-3 Time Variation of the RCS and Ruptured SG Pressure (1 out of 4)



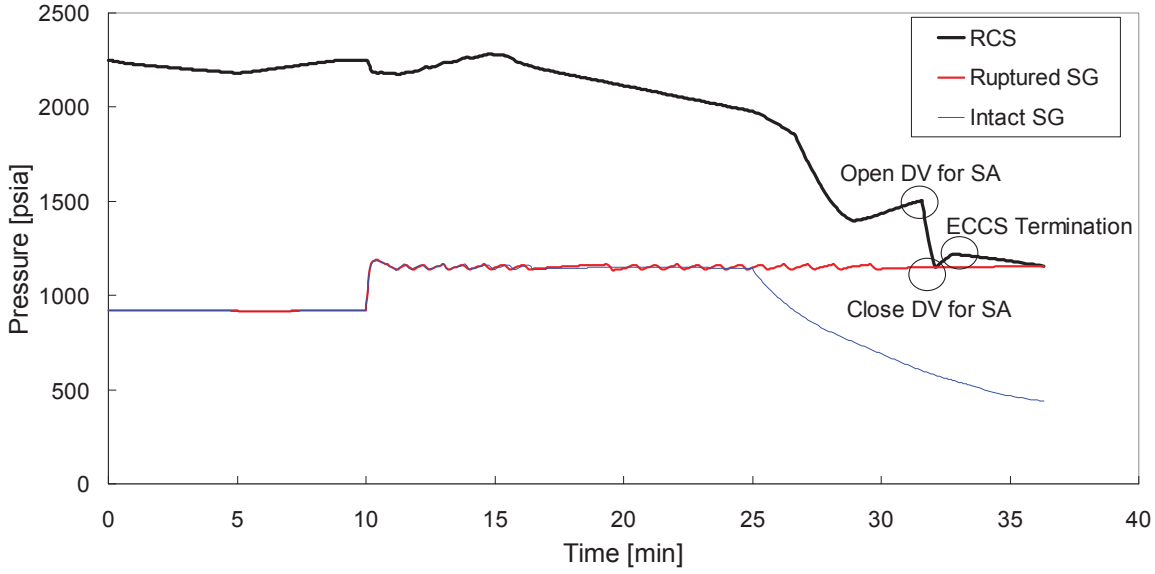
(a) Pressure of RCS, Ruptured and Intact Loops



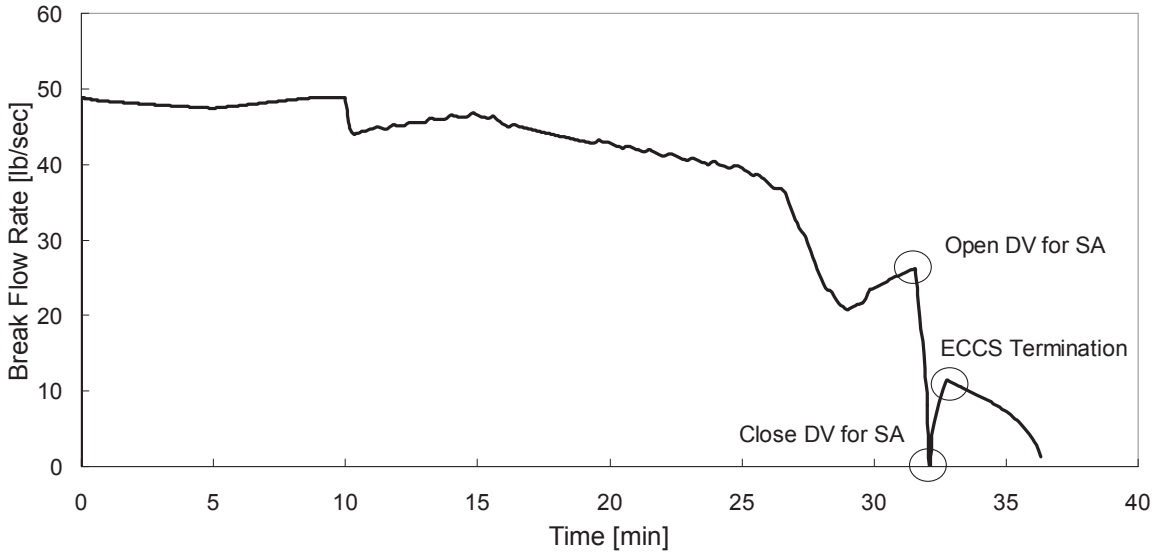
(b) Flow Rate from Break SG Tube

(2) Case 2 (Actuation of Pressurizer Auxiliary Spray)

Figure 19.514-3 Time Variation of the RCS and Ruptured SG Pressure (2 out of 4)



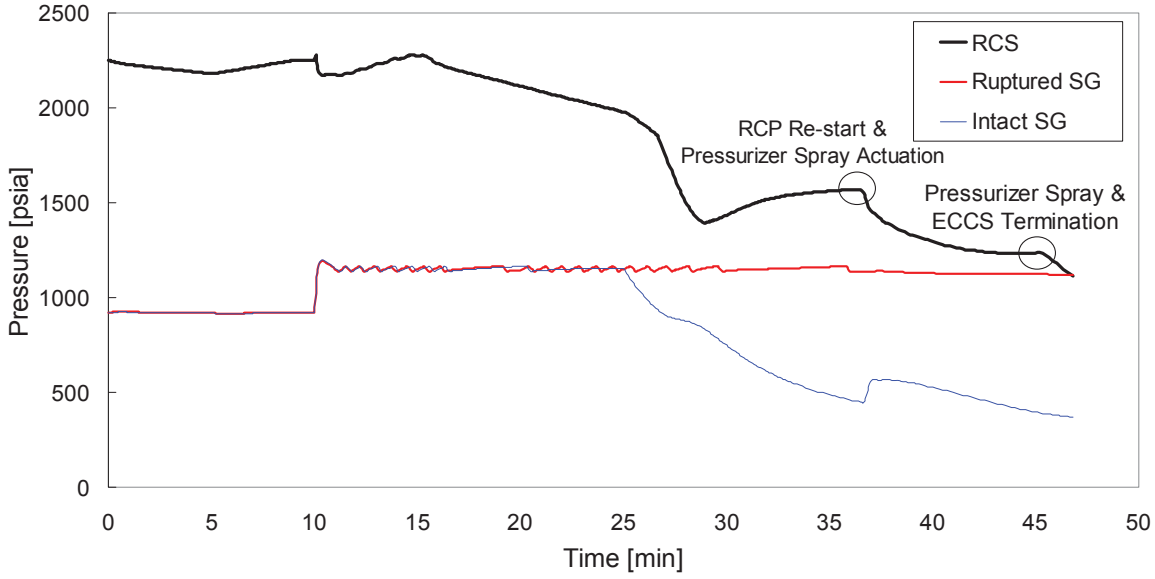
(a) Pressure of RCS, Ruptured and Intact Loops



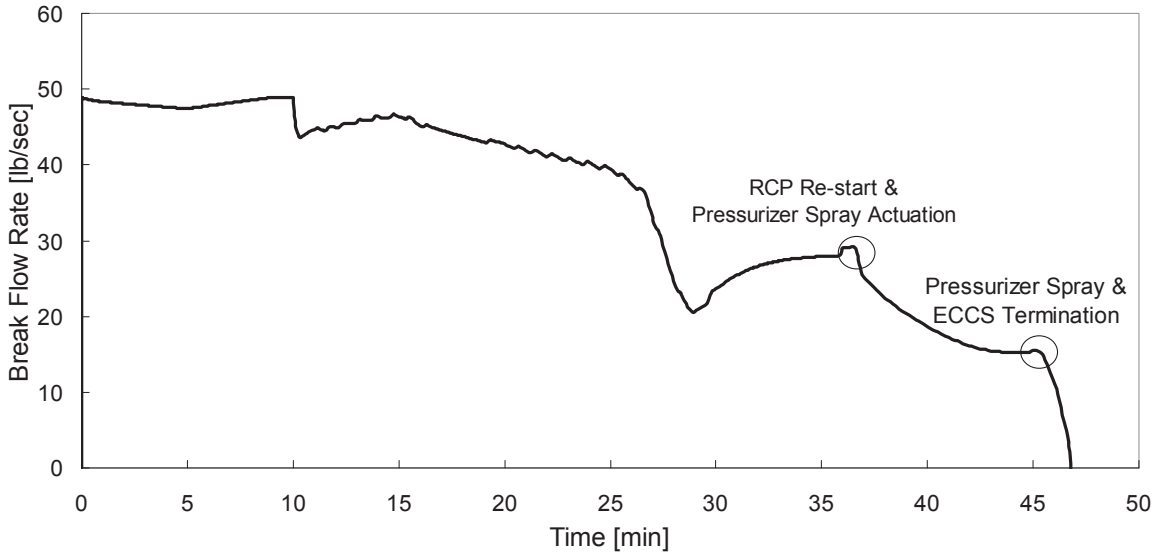
(b) Flow Rate from Break SG Tube

(3) Case 3 (Open DVs for Severe Accident)

Figure 19.514-3 Time Variation of the RCS and Ruptured SG Pressure (3 out of 4)



(a) Pressure of RCS, Ruptured and Intact Loops



(b) Flow Rate from Break SG Tube

(4) Case 4 (Actuation of Pressurizer Spray with RCP Re-starting)

Figure 19.514-3 Time Variation of the RCS and Ruptured SG Pressure (4 out of 4)

Table 19.514-4 SGTR Event Correspondence of Table 19.513-8 Success Criteria to Event Tree Figure 19.514-4

Success Criteria case from SGTR section of Table 19.513-8	Sequence number in event tree figure 19.514-4
1	#1
2	#2
2	#7
3	#12
4	#13
4	#15
5	#19

Impact on DCD

Changes associated with the original RAI response (Ref. UAP-HF-11201, dated June 30, 2011) to DCD Table 19.1-119 were incorporated in DCD Rev.4.

As part of this amended response, DCD Table 19.1-119 will be revised as shown in the attached markup. The changes to DCD Table 19.1-15 (No. 3.7 and 3.8) discussed in this amended response are included in the markup provided with the amended response to RAI 750-5675 Question 19-513.

The PRA results in the DCD will be updated as part of the next revision of the PRA. Figure 19.514-4 will be used as the SGTR event tree in the next revision of the PRA. After the PRA is revised, then DCD Figure 19.1-1 sheet 5 will be revised to be consistent with Figure 19.514-4.

Impact on R-COLA

R-COLA Part 2 FSAR Table 19.1-119R will be revised to be consistent with DCD Table 19.1-119.

Site-specific PRA model and results will be updated after the DCD PRA is revised.

Impact on PRA

SGTR event tree and the success criteria will be revised to incorporate the discussion in this RAI response. As discussed in this response, the model change has an insignificant impact on the PRA results and risk profile.

Impact on Topical/Technical Report

US-APWR PRA Technical Report (MUAP-07030) will be revised to reflect the updated PRA modeling and results in the next revision.

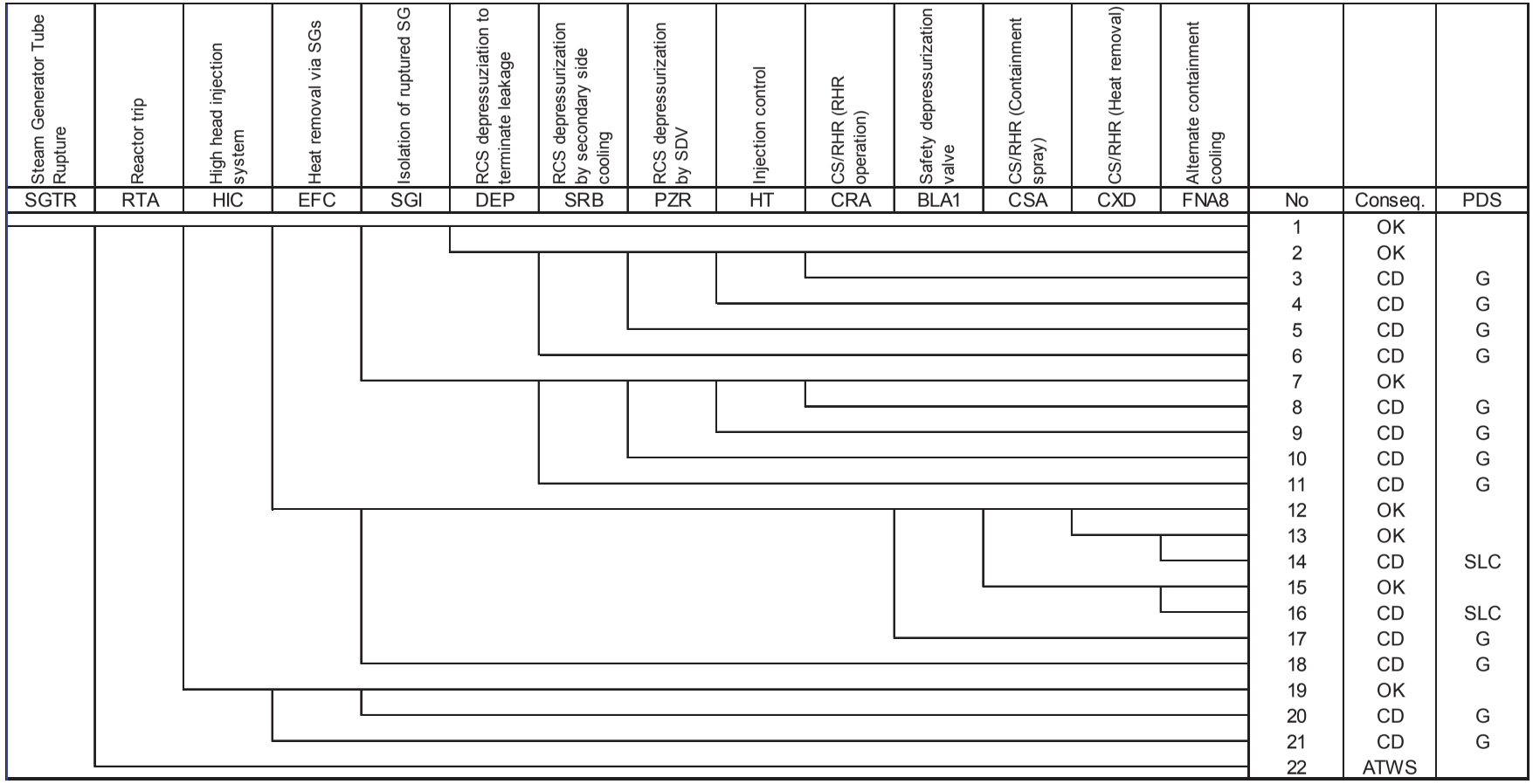


Figure 19.514-4 SGTR Event Tree Modeled in Next PRA Revision (Reflect discussion in the responses to Q19-513 and Q19-514)

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 5 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.4		Cold leg 480 gpm/ loop leak	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 2.4hr. PCT > 1400° F	
		Cold leg 300 gpm/ loop leak	0	4	4	4	-	MAAP4.0.6 The duration of time before core uncovers is 3.9hr. PCT > 1400° F	
1.5	To judge effectiveness of coolant injection into RV using CS/ RHR pumps with SG cooling as alternate core cooling for LOCA.	Hot leg 8 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 4 MS~~R~~RDVs ~~@~~at10min	MAAP4.0.6 PCT=643° F < 1400° F	The results show that the core cooling can be maintained with alternate core cooling using one(1) CS/RHR pump within 30 minutes when break size is less than 8 inches. For small size break, the secondary side cooling is necessary to make the coolant injection into RV effective. This is achieved by opening three(3) MS~~R~~RDVs. As described above, it can be concluded that the success criteria for alternate core cooling are one(1) CS/RHR pump and secondary side cooling by three(3) MS~~R~~RDVs within 30 minutes.

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 6 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis	
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures			
1.5		Hot leg 8 inch break	0	4	3	0	Alternate core cooling : 1 CS/RHR pump and 3 MSDVs at 10min	MAAP4.0.6 PCT=643° F < 1400° F		DCD_19-513 S01
		Hot leg 8 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 4 MS~~R~~DVs @at30min	MAAP4.0.6 PCT=643° F < 1400° F		DCD_19-513 S01
		Hot leg 8 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 3 MS~~R~~DVs @at10min	MAAP4.0.6 PCT=643° F < 1400° F		DCD_19-513 S01
		Hot leg 8 inch break	0	4	3	0	Alternate core cooling : 1 CS/RHR pump and 3 MSDVs at 30min	MAAP4.0.6 PCT=643° F < 1400° F		DCD_19-513 S01
		Hot leg 2 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 4 MS~~R~~DVs @at10min	MAAP4.0.6 PCT=639° F < 1400° F		DCD_19-513 S01

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 7 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
1.5		Hot leg 2 inch break	0	4	4	0	Alternate core cooling : 1 CS/RHR pump and 3 MS~~R~~DVs ~~@~~at 30min	MAAP4.0.6 PCT=639° F < 1400° F	
		Hot leg 2 inch break	0	4	3	0	Alternate core cooling : 1 CS/RHR pump and 3 MSDVs at 30min	MAAP4.0.6 PCT=643° F < 1400° F	
2.1	To judge required number of CS/ RHR pumps and heat exchangers as containment spray injection for LOCA.	Hot leg double ended guillotine break	4	4	4	1	-	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia (containment ultimate pressure)	The results show that containment heat removal can be maintained with one(1) containment spray pump without an excessive increase of containment pressure for any size of break. Therefore the success criteria for the number of containment spray pumps are evaluated to be one(1) for any accident sequences.
		Hot leg 8 inch break	4	4	4	1	-	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia	
		Hot leg 2 inch break	4	4	4	1	-	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia	

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 9 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
2.3	To judge effectiveness of coolant injection into RV using CS/RHR pumps as alternate containment heat removal for LOCA.	Hot leg double ended guillotine break	4	4	4	0	Alternate containment heat removal : 1 CS/RHR pump ~~@~~at 30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia (containment ultimate pressure)	The results show that the containment heat removal can be maintained without excessive increase in containment pressure. In the ~~medium and~~ large pipe break LOCA sequence~~s~~, containment heat removal is achieved by coolant injection into RV using one(1) CS/RHR pump. DCD_19-513 S01 In the medium and small pipe break LOCA sequences, although coolant injection into RV using CS/RHR pumps is not available because RCS pressure keeps relatively high due to operation of ~~HHI~~SI pumps, containment heat removal is possible by secondary side cooling with ~~four~~three(~~4~~3) MS~~R~~RDVs opened. DCD_19-513 S01 DCD_19-513 S01
		Hot leg 8 inch break	4	4	4	0	Alternate containment heat removal : 1 CS/RHR pump and 4 MS~~R~~RDVs ~~@~~at 30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia	

Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 10 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
2.3		Hot leg 8 inch break	4	4	3	0	Alternate containment heat removal : 1 CS/RHR pump and 3 MSDVs at 30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia	
		Hot leg 2 inch break	4	4	4	0	Alternate containment heat removal : 1 CS/RHR pump and 4 MS~~R~~DVs ~~@~~at 30min	MAAP4.0.6 C/V pressure is at most about 40 psia < 216 psia	As discussed in the No.1.5 analysis, if SI pumps are not available, coolant injection into RV using CS/RHR must be effective even in small pipe break LOCA sequences. Therefore the alternate containment heat removal by coolant injection into RV is judged to be effective for any accident sequences.

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 11 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
2.3		Hot leg 2 inch break	4	4	3	0	Alternate containment heat removal : 1 CS/RHR pump and 3 MSDVs at 30min	MAAP4.0.6 C/V pressure is at most about 50 psia < 216 psia	

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 12 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
2.4	To judge effectiveness of containment cooling using containment fan cooler units as alternate containment heat removal for LOCA	Hot leg 8 inch break	4	4	4	0	Alternate containment cooling: 2 containment fan cooler units after 30min at Pd	MAAP4.0.6 C/V pressure is at most about 75 psia < 216 psia and decreasing	~~The alternate measure using containment fan cooler system for alternate containment cooling is judged to be effective. However, the success criterion of containment fan cooler units is assumed that two containment fan cooler units are required for success~~The alternate containment cooling using two containment fan cooler units is judged to be effective and is used for the success criteria for alternate containment cooling Note; Pd: Containment design Pressure
		Hot leg 8 inch break	4	4	4	0	Alternate containment cooling: 1 containment fan cooler unit after 30min at Pd	MAAP4.0.6 C/V pressure is at most about 100 psia < 216 psia and ~~de~~increasing	

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 16 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
3.4	To judge effectiveness of feed and bleed for accident sequences without EFW.	Loss of feedwater flow	1	4	0	4	Feed and bleed : 1 SDV ~~@~~at SG dry out	MAAP4.0.6 PCT=1233° F < 1400° F	The results show that the core cooling can be maintained with the recovery of the water level in the core by implementing feed and bleed although the core uncovers temporarily before the RCS pressure decreases to the shut off pressure of HHI after the SDV opens. Therefore the success criteria for feed and bleed are assumed one(1) SDV and one(1) SI pump.
3.5	To judge effectiveness to achieve RHR operation following an isolation failure of a ruptured SG	SGTR with stuck open of MSRV on a ruptured SG loop	1	0	1	0	RCS depressurization: 3SGs with EFW tie-line valves open and 3 MSDVs, and 1 SDV Injection control: Stop running SI pump and start 1 charging pump	MARVEL-M RCS pressure reached 400 psig at approximately 75 minutes RCS temperature reaches 350° F at 175 minutes	The results show that RHR operation is achieved at 175 minutes following an initiating event. Success criteria for RHR operation following an isolation failure of a ruptured SG is - 1EFW pump with EFW tie-line valves opened - 3SGs and 3MSDVs - 1 SDV - Stop SI pump and start charging pump

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 17 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
3.6	To judge effectiveness to prevent core damage with no safety injection following isolation of a ruptured SG	SGTR with isolation of a ruptured SG	0	0	1	0	2SGs with EFW tie-line valves open and no MSDVs open	MARVEL-M Terminate leakage through a ruptured SG tube by equalizing the RCS and secondary system pressure.	The results show that the SG cooling is maintained without SG overfill. The success criterion of this scenario is as follows: - Success of a ruptured SG Isolation - 2SGs and no MSDV
3.7	To judge that there is allowable time for the actions to equalize the pressure between RCS and secondary system.	SGTR with isolation of a ruptured SG	4	0	4	0	Isolate EFW system when the SG water level is high.	MARVEL-M SG overfilling is more than 2 hours from an initiating event.	The results indicate that there is allowable time for the actions to equalize the pressure between RCS and secondary system.

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Table 19.1-15 Typical Results of Thermal/Hydraulic Analysis (Sheet 18 of 18)

No.	Objective of the analysis	Accident sequence description						Computer code and results	Insights from success criteria analysis
		Initiating event	SI pumps	Accumulators	EFW pumps	CS pumps	Other measures		
3.8	To judge that the actions for the pressure equalization have redundancy.	SGTR with isolation of a ruptured SG	4	0	4	0	A ruptured SG loop isolation Opening of 1/2 SDV	MARVEL-M Termination of leakage from RCS	One of the four operator actions is sufficient to equalize the RCS and secondary pressure. The results indicate that the actions for the pressure equalization have redundancy.
			4	0	4	0	A ruptured SG loop isolation Actuation of pressurizer auxiliary spray	MARVEL-M Termination of leakage from RCS	
			4	0	4	0	A ruptured SG loop isolation Opening of depressurization valves for severe accident	MARVEL-M Termination of leakage from RCS	
			4	0	4	0	A ruptured SG loop isolation Actuation of pressurizer spray with restarting RCPs	MARVEL-M Termination of leakage from RCS	

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Table 19.1-16 List of Success Criteria (Sheet 1 of 31)
Large Pipe Break LOCA (>8 inches) Event Success Criteria

	Core injection function			Decay heat removal & containment heat removal function		
	Accumulator system	High head injection system	CS/RHR (Alternate core cooling)(2)	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/3 ACCs(1)	2/4 SIPs (1)	-	1/4 CS/RHR pump and Hx	-	-
2	2/3 ACCs(1)	2/4 SIPs (1)	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units

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Note(1): RCS cold leg pipe break is assumed for large pipe break LOCA. Accumulator injection via the broken line is unavailable, and high head injection via DVI lines is available.

Note(2): Required operator action to change line-up to ~~low pressure injection~~CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode. For large pipe break LOCA, this mitigation system is assumed to be unavailable because there is not enough time to operate before core damage.

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Table 19.1-16 List of Success Criteria (Sheet 2 of 31)
Medium Pipe Break LOCA (2 – 8 inches) Event Success Criteria

	Core injection function			Decay heat removal & containment heat removal function				
	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	RCS depressurization by secondary side cooling	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling	
1	2/3 ACCs(3)	1/3 SIP (1)	-	-	1/4 CS/RHR pump and ~~heat exchanger~~Hx	-	-	DCD_19-513 S01
2	2/3 ACCs(3)	1/3 SIP (1)	-	-	-	-	~~2~~1/4~~2~~ CCWP~~s~~ and 2/4 Containment fan cooler units	DCD_19-513 S01
3	2/3 ACCs(3)	1/3 SIP (1)	-	3/4 SGs and 3/4 EFW pumps and 3/4 MS~~R~~RDVs opened	-	1/3 CS/RHR pump and ~~heat exchanger~~Hx (3)	-	DCD_19-513 S01
4	2/3 ACCs(3)	-	1/3 CS/RHR pump(3)	3/4 SGs and 3/4 EFW pumps and 3/4 MS~~R~~RDVs opened	-	1/3 CS/RHR pump and ~~heat exchanger~~ Hx(3)	-	DCD_19-513 S01
5	2/3 ACCs(3)	-	1/3 CS/RHR pump(3)	3/4 SGs and 3/4 EFW pumps and 3/4 MS~~R~~RDVs opened	-	-	~~2~~1/4~~2~~ CCWP~~s~~ and 2/4 Containment fan cooler units	DCD_19-513 S01
6	2/3 ACCs(3)	-	1/3 CS/RHR pump(3)	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	1/4 CS/RHR pump and Hx	-	-	DCD_19-513 S01

Note(1): DVI pipe break is assumed for high head injection system. High head injection via the broken line is unavailable.
Note(2): Required operator action to change line-up to ~~low pressure injection~~CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode. DCD_19-513 S01
Note(3): RCS cold leg pipe break is assumed for alternate core cooling and accumulator injection. Alternate core cooling and accumulator injection via the broken line is unavailable.

Table 19.1-16 List of Success Criteria (Sheet 3 of 31)
Small Pipe Break LOCA (1/2 – 2 inches) Event Success Criteria [1/3]

	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	1/4 CS/RHR pump and Hx	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	~~1/4 CS/RHR pump and Hx(3)~~ -	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/4 CS/RHR pump and Hx(3)	-

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Table 19.1-16 List of Success Criteria (Sheet 4 of 31)
Small Pipe Break LOCA (1/2 – 2 inches) Event Success Criteria [2/3]

	Reactor shutdown function	Core injection function				Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling	
4	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC (3)	-	1/4 CS/RHR pump ~~and Hx~~ (3)	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/4 CS/RHR pump and Hx (3)	-	DCD_19-513 S01
5	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC (3)	-	1/4 CS/RHR pump ~~and Hx~~ (3)	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units	DCD_19-513 S01
6	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC (3)	-	1/4 CS/RHR pump (3)	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	1/4 CS/RHR pump and Hx	-	-	DCD_19-513 S01

Table 19.1-16 List of Success Criteria (Sheet 5 of 31)
Small Pipe Break LOCA (1/2 – 2 inches) Event Success Criteria [3/3]

	Reactor shutdown function	Core injection function / Decay heat removal & containment heat removal function									
	Reactor trip	Accumulator system	High head injection system	CS/RHR (Alternate core cooling) (2)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (2) and CS/RHR (Heat removal)	Alternate containment cooling	
7	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	-	-	1/2 SDV	1/4 CS/RHR pumps and Hx	-	-	DCD_19-513 S01
~~7~~ 8	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/3 SIP (1)	-	-	-	1/2 SDV	-	-	1/2 CCWP and 2/4 Containment fan cooler units	DCD_19-513 S01

Note(1): DVI pipe break is assumed for high head injection. High head injection via the broken line is unavailable.

Note(2): Required operator action to change line-up to ~~low pressure injection~~CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode. DCD_19-513 S01

Note(3): Even if RCS cold leg pipe break is assumed for alternate core cooling and accumulator injection, alternate core cooling and accumulator injection via RCS cold leg pipe is available because of a little spilled water.

Table 19.1-16 List of Success Criteria (Sheet 6 of 31)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [1/4]

	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP OR 1/2 CHP	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	~~1/4 CS/RHR pump and Hx~~	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	~~1/4 SIP OR 1/2 CHP~~	1/4 CS/RHR pump	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	1/4 CS/RHR pump and Hx	-	~~1/2 CCWP and 2/4 Containment fan cooler units~~

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Table 19.1-16 List of Success Criteria (Sheet 7 of 31)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [2/4]

	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-1/4 ACC	~~1/4 SIP OR 1/2 CHP~~ -	1/4 CS/RHR pump ~~and Hx~~	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	~~1/4 CS/RHR pump and Hx~~ -	-1/2 CCWP and 2/4 Containment fan cooler units
4	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 ACC	-	1/4 CS/RHR pump ~~and Hx~~	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	-	-	1/4 CS/RHR pump and Hx	-

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Table 19.1-16 List of Success Criteria (Sheet 8 of 31)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [3/4]

	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function						
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling	
~~5~~	~~2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods~~	~~1/4 ACC~~	-	~~1/4 CS/RHR pump and Hx~~	~~2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened~~	~~3/4 SGs and 3/4 EFWs pumps and 3/4 MSDVs opened~~	-	-	-	~~1/2 CCWP and 2/4 Containment fan cooler units~~	DCD_19-513 S01
~~6~~ 5	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	-	-	-	1/2 SDV	1/4 CS/RHR pump and Hx	-	-	DCD_19-513 S01

Table 19.1-16 List of Success Criteria (Sheet 9 of 31)
Very Small Pipe Break LOCA (<1/2 inches) Event Success Criteria [4/4]

	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Reactor trip	Accumulator system	High head injection system OR Charging injection	CS/RHR (Alternate core cooling) (1)	Heat removal via SGs	RCS depressurization by secondary side cooling	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) (1) and CS/RHR (Heat removal)	Alternate containment cooling
~~7~~ 6	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP	-	-	-	1/2 SDV	-	-	1/2 CCWP and 2/4 Containment fan cooler units

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Note(1): Required operator action to change line-up to ~~low pressure injection~~CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode.

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Table 19.1-16 List of Success Criteria (Sheet 10 of 26)
Steam Generator Tube Rupture Event Success Criteria [1/3]

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	Condition		Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function			
	Isolation of faulted SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling (2) and RCS depressurization by SDV (3) and Injection control (4)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (5) and CS/RHR (Heat removal)	Alternate containment cooling
1	Succeeded	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS and 66/69 control rods	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened	-	-	-
2	Failed	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	X	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened	-	1/4 CS/RHR pump and Hx	-

Table 19.1-16 List of Success Criteria (Sheet 11 of 26)
Steam Generator Tube Rupture Event Success Criteria [2/3]

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	Condition		Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function			
	Isolation of faulted SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling (2) and RCS depressurization by SDV (3) and Injection control (4)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (5) and CS/RHR (Heat removal)	Alternate containment cooling
3	Failed	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	X	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	1/4 CS/RHR pump and Hx	-	-
4	Failed	Succeeded	66/69 control rods and 2/4 RPSs OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	X	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and isolation valves of pump discharge tie-line opened	-	-	1/2 CCWP and 2/4 Containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 12 of 26)
Steam Generator Tube Rupture Event Success Criteria [3/3]

	Condition		Rector shutdown function	Core injection function			Decay heat removal & containment heat removal function			
	Isolation of faulted SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling (2) and RCS depressurization by SDV (3) and Injection control (4)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (5) and CS/RHR (Heat removal)	Alternate containment cooling
5	Succeeded	Failed	66/69 control rods and 2/4 RPSs OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	-	-	1/4 CS/RHR pump and Hx	-	-
6	Succeeded	Failed	66/69 control rods and 2/4 RPSs OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units

Note(1): Closing the following valves for faulted SG isolation, EFW isolation valve and ((main steam relief valve or main steam relief valve block valve) and (MSIV or turbine bypass valve) and main steam safety valve).
Note(2): 1/3 SG and 1/3 EFW pumps and 1/3 MSRV opened, OR 1/3 SG and 1/4 EFW pumps and isolation valves of pump discharge tie line opened and 1/3 MSRV opened
Note(3): 1/2 SDV
Note(4): 1/2 CHP and Injection control
Note(5): Requires operator action to change line up to RHR operation mode

Table 19.1-16 List of Success Criteria (Sheet 10 of 31)
Steam Generator Tube Rupture Event Success Criteria [1/2]

	Condition		Reactor shutdown function	Core injection function			Condition	Decay heat removal & containment heat removal function			
	Isolation of ruptured SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling and RCS depressurization by SDV and injection control	Equalization of pressure between RCS and secondary system	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (2) and CS/RHR (Heat removal)	Alternate containment cooling
1	Succeeded	Succeeded	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	Note 3	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-
2	Failed	Succeeded	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	1/3 SG and 1/3 MSDV AND 1/2 SDV AND 1/2 charging pump and injection control	-	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	1/4 CS/RHR pump and Hx	-
3	Succeeded	Failed	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	-	-	-	1/4 CS/RHR pump and Hx	-	-
4	Succeeded	Failed	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	1/2 SDV	-	-	-	-	-	1/2 CCWPs and 2/4 containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 11 of 31)
Steam Generator Tube Rupture Event Success Criteria [2/2]

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	Condition		Reactor shutdown function	Core injection function			Condition	Decay heat removal & containment heat removal function			
	Isolation of ruptured SG (1)	Heat removal via SGs	Reactor trip	High head injection system	Safety depressurization valve	RCS depressurization by secondary side cooling and RCS depressurization by SDV and injection control	Equalization of pressure between RCS and secondary system	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (RHR operation) (2) and CS/RHR (Heat removal)	Alternate containment cooling
5	Succeeded	Succeeded	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-

Note(1): Closing the following valves for ruptured SG isolation, EFW isolation valve and {(main steam relief valve or main steam relief valve block valve) and (MSIV or turbine bypass valve) and main steam safety valve}.
Note(2): Required operator action to change line-up to RHR operation mode
Note(3): Required at least one of following four actions combined with termination of SI.
- Open 1/2 SDV
- Actuate pressurizer auxiliary spray
- Open 2/2 depressurization valves for severe accident
- Actuate pressurizer spray by re-starting reactor coolant pumps

Table 19.1-16 List of Success Criteria (Sheet 12 of 31)
Steam Line Break Downstream MSIV Event Success Criteria

	Reactor shutdown function	Decay heat removal function				Containment heat removal function		DCD_19-513 S01
	Reactor trip	Heat removal via SGs	Main steam line isolation	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/43 SGs and 2/43 EFW pumps OR 2/43 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/4 MSIVs closed	-	-	-	-	DCD_19-513 S01 DCD_19-513 S01
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and Hx	-	
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	-	1/2 CCWP and 2/4 Containment fan cooler units	

Table 19.1-16 List of Success Criteria (Sheet 13 of 31)
Steam Line Break Upstream MSIV Event Success Criteria

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	Reactor shutdown function	Decay heat removal function				Containment heat removal function	
	Reactor trip	Heat removal via SGs	Main steam line isolation	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/3 intact loop MSIVs closed OR 1/1 broken loop Main steam check valve closed OR 1/1 broken loop MSIV closed	-	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and Hx	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	-	1/2 CCWP and 2/4 Containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 14 of 31)
Feedwater Line Break Event Success Criteria

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	Reactor shutdown function	Decay heat removal function				Containment heat removal function	
	Reactor trip	Heat removal via SGs	Main steam line isolation	High head injection system	Safety depressurization valve	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/3 SGs and 2/3 EFW pumps OR 2/3 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	3/3 intact loop MSIVs closed OR 1/1 broken loop Main steam check valve closed OR 1/1 broken loop MSIV closed	-	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	1/4 CS/RHR pump and Hx	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	1/4 SIP	1/2 SDV	-	1/2 CCWP and 2/4 Containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 15 of 31)
General Transient Event Success Criteria

	Reactor shutdown function	Decay heat removal function			Containment heat removal function		DCD_19-513 S01
	Reactor trip	Feed and Bleed	Heat removal via SGs	Main feed water recovery	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling	
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	-	DCD_19-513 S01
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and ~~1~~2/4 MFW pump	-	-	DCD_19-513 S01
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	-	1/4 CS/RHR pump and Hx	-	
4	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units	

Table 19.1-16 List of Success Criteria (Sheet 16 of 31)
Loss of Feedwater Flow Event Success Criteria

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	Reactor shutdown function	Decay heat removal function		Containment heat removal function	
	Reactor trip	Heat removal via SGs	Feed and bleed	CS/RHR (Containment spray) and CS/RHR (Heat removal)	Alternate containment cooling
1	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	-
2	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP and 1/2 SDV	1/4 CS/RHR pump and Hx	-
3	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 SIP and 1/2 SDV	-	1/2 CCWP and 2/4 Containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 17 of 31)
Loss of Component Cooling Water Event Success Criteria

	Condition	Reactor shutdown function	Core injection function	Decay heat removal function
	Stuck open safety valve LOCA(1)	Reactor trip	Alternate ~~component~~charging pump cooling (Seal injection)(2)	Heat removal via SGs(3)
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 CH~~I~~P and 1/2 Fire protection water supply pump OR 1/2 CH~~I~~P and 1/1 Non-essential chilled water pump	2/4~~2~~ SGs and 2/2 T/D EFW pumps OR 2/4 SGs and 1/2 T/D EFW pump and ~~isolation~~ valves of pump discharge tie-line valves opened

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Note(1): Occurrence of stuck open safety valve LOCA during this initiating event is assumed to result in core damage.

Note(2): RCP seal LOCA is assumed to occur, when alternate ~~component~~charging pump cooling fails.

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Note(3): Two motor-driven EFW pumps are unavailable in a loss of CCW event.

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Table 19.1-16 List of Success Criteria (Sheet 19 of 26)
Partial Loss of Component Cooling Water Event Success Criteria [1/3]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA OR RCP seal LOCA (6)	Reactor trip	High head injection system (1) and Safety depressurization valve (2)	RCS depressurization by secondary side cooling (3) and Accumulator system (4) and CS/RHR (Alternate core cooling) (5)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie line opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	X	-	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie line opened	1/2 CS/RHR pump and heat exchanger		

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Table 19.1-16 List of Success Criteria (Sheet 20 of 26)
Partial Loss of Component Cooling Water Event Success Criteria [2/3]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA OR RCP seal LOCA (6)	Reactor trip	High head injection system(1) and Safety depressurization valve (2)	RCS depressurization by secondary side cooling(3) and Accumulator system(4) and CS/RHR (Alternate core cooling) (5)	Heat removal via SGs(7)	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
3	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	X	-	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie line opened	-	-	1/2 CCWP and 2/4 Containment fan cooler units
4	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	X	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and isolation valves of pump discharge tie line opened	-	1/2 CS/RHR pump and Hx	

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Table 19.1-16 ~~List of Success Criteria (Sheet 21 of 26)~~
~~Partial Loss of Component Cooling Water Event Success Criteria [3/3]~~

~~Note(1): 1/2 SIP~~
~~Note(2): 1/2 SDV~~
~~Note(3): 3/4 SG and 3/3 EFW pumps and 3/4 MSDV opened~~
~~Note(4): 1/4 ACC~~
~~Note(5): 1/2 CS/RHR pumps~~
~~Note(6): RCP seal LOCA is assumed to occur when RCP seal cooling by the stand-by charging pump fails.~~
~~Note(7): B-train motor-driven EFW pump is unavailable in a partial loss of CCW event.~~

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Table 19.1-16 List of Success Criteria (Sheet 18 of 31)
Partial Loss of Component Cooling Water Event Success Criteria [1/5]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (3)	Reactor trip	High head injection system (1)	Accumulator	CS/RHR (Alternate core cooling) (1)	Safety depressurization valve	RCS depressurization by secondary side cooling (2)	Heat removal via SGs (2)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (1, 4)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and tie-line valves opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and tie-line valves opened	1/2 CS/RHR pump and Hx	-	-

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Table 19.1-16 List of Success Criteria (Sheet 19 of 31)
Partial Loss of Component Cooling Water Event Success Criteria [2/5]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (3)	Reactor trip	High head injection system (1)	Accumulator	CS/RHR (Alternate core cooling) (1)	Safety depressurization valve	RCS depressurization by secondary side cooling (2)	Heat removal via SGs (2)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (1, 4)	Alternate containment cooling
3	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	-	-	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and tie-line valves opened	-	-	1/2 CCWP and 2/4 containment fan cooler units
4	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	2/3 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and tie-line valves opened	-	1/2 CS/RHR pump and Hx	-

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Table 19.1-16 List of Success Criteria (Sheet 20 of 31)
Partial Loss of Component Cooling Water Event Success Criteria [3/5]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (3)	Reactor trip	High head injection system (1)	Accumulator	CS/RHR (Alternate core cooling) (1)	Safety depressurization valve	RCS depressurization by secondary side cooling (2)	Heat removal via SGs (2)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (1, 4)	Alternate containment cooling
5	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/2 CS/RHR pump	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	-	1/2 CS/RHR pump and Hx	-	-
6	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/2 CS/RHR pump	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	-	-	-	1/2 CCWP and 2/4 containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 21 of 31)
Partial Loss of Component Cooling Water Event Success Criteria [4/5]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (3)	Reactor trip	High head injection system (1)	Accumulator	CS/RHR (Alternate core cooling) (1)	Safety depressurization valve	RCS depressurization by secondary side cooling (2)	Heat removal via SGs (2)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (1, 4)	Alternate containment cooling
7	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/2 CS/RHR pump	-	3/3 SGs and 3/3 EFW pumps and 3/3 MSDVs opened	-	-	1/2 CS/RHR pump and Hx	-
8	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	1/2 SDV	-	-	1/2 CS/RHR pump and Hx	-	-

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Table 19.1-16 List of Success Criteria (Sheet 22 of 31)
Partial Loss of Component Cooling Water Event Success Criteria [5/5]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (3)	Reactor trip	High head injection system (1)	Accumulator	CS/RHR (Alternate core cooling) (1)	Safety depressurization valve	RCS depressurization by secondary side cooling (2)	Heat removal via SGs (2)	CS/RHR (Containment spray) and CS/RHR (Heat removal) (1)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (1, 4)	Alternate containment cooling
9	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/2 SIP	-	-	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units

Note(1): A and B trains are unavailable in this initiating event.
Note(2): B M/D EFW pump is unavailable in this initiating event
Note(3): Failure of RCP seal cooling by standby charging pump is assumed to lead to RCP seal LOCA.
Note(4): Required operator action to change line-up to CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode

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Table 19.1-16 List of Success Criteria (Sheet 22 of 26)
Loss of Offsite Power Event Success Criteria [1/2]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA or RCP seal LOCA (4)	Reactor trip	Feed and Bleed	RCS depressurization by secondary side cooling (1) and Accumulator system (2) and CS/RHR (Alternate core cooling) (3)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened	1/4 CS/RHR pump and Hx	-	-

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Table 19.1-16 List of Success Criteria (Sheet 23 of 26)
Loss of Offsite Power Event Success Criteria [2/2]

	Condition	Rector shutdown function	Core injection function		Decay heat removal & containment heat removal function			
	Stuck open safety valve LOCA or RCP seal LOCA (4)	Reactor trip	Feed and Bleed	RCS depressurization by secondary side cooling (1) and Accumulator system (2) and CS/RHR (Alternate core cooling) (3)	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal)	Alternate containment cooling
3	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened	-	-	-
4	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP and 1/2 SDV	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and isolation valves of pump discharge tie line opened	1/4 CS/RHR pump and Hx	-	-

Note(1): 3/4 SG and 3/4 EFW pumps and 3/4 MSDV opened
Note(2): 1/4 ACC
Note(3): 1/4 CS/RHR pumps
Note(4): RCP seal LOCA is assumed to occur when all CCW pumps fail to restart and alternate component cooling fails.

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Table 19.1-16 List of Success Criteria (Sheet 23 of 31)
Loss of Offsite Power Event Success Criteria [1/6]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (2)	Alternate containment cooling
1	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	-	-	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	-	-
2	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	1/4 CS/RHR pump and Hx	-	-

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Table 19.1-16 List of Success Criteria (Sheet 24 of 31)
Loss of Offsite Power Event Success Criteria [2/6]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (2)	Alternate containment cooling
3	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	-	-	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	-	1/2 CCWP and 2/4 containment fan cooler units
4	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	1/4 CS/RHR pump and Hx	-

Table 19.1-16 List of Success Criteria (Sheet 25 of 31)
Loss of Offsite Power Event Success Criteria [3/6]

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	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (2)	Alternate containment cooling
5	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/4 CS/RHR pump	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	1/4 CS/RHR pump and Hx	-	-
6	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/4 CS/RHR pump	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	-	1/2 CCWP and 2/4 containment fan cooler units

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Table 19.1-16 List of Success Criteria (Sheet 26 of 31)
Loss of Offsite Power Event Success Criteria [4/6]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (2)	Alternate containment cooling
7	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	-	1/4 ACC	1/4 CS/RHR pump	-	3/4 SGs and 3/4 EFW pumps and 3/4 MSDVs opened	2/4 SGs and 2/4 EFW pumps OR 2/4 SGs and 1/4 EFW pump and tie-line valves opened	-	1/4 CS/RHR pump and Hx	-
8	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	1/4 CS/RHR pump and Hx	-	-

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Table 19.1-16 List of Success Criteria (Sheet 27 of 31)
Loss of Offsite Power Event Success Criteria [5/6]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (2)	Alternate containment cooling
9	Not occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units
10	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	1/4 CS/RHR pump and Hx	-	-

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Table 19.1-16 List of Success Criteria (Sheet 28 of 31)
Loss of Offsite Power Event Success Criteria [6/6]

	Condition	Reactor shutdown function	Core injection function			Decay heat removal & containment heat removal function					
	Stuck open safety valve LOCA or RCP seal LOCA (1)	Reactor trip	High head injection system	Accumulator	CS/RHR (Alternate core cooling)	Safety depressurization valve	RCS depressurization by secondary side cooling	Heat removal via SGs	CS/RHR (Containment spray) and CS/RHR (Heat removal)	CS/RHR (Alternate core cooling) and CS/RHR (Heat removal) (2)	Alternate containment cooling
11	Occurred	2/4 RPSs and 66/69 control rods OR 1/1 DAS and 66/69 control rods	1/4 SIP	-	-	1/2 SDV	-	-	-	-	1/2 CCWP and 2/4 containment fan cooler units

Note(1): Failure of RCP seal injection by standby charging pump results in RCP seal LOCA.
Note(2): Required operator action to change line-up to CS/RHR (Alternate core cooling) mode from CS/RHR (Containment spray) mode.

Table 19.1-16 List of Success Criteria (Sheet 29 of 31)
Loss of Vital AC Bus Event Success Criteria

	Core injection function	Decay heat removal & containment heat removal function			
	Feed and Bleed(1)	Heat removal via SGs(1)	Main feed water recovery	CS/RHR (Containment spray) and CS/RHR (Heat removal)(1)	Alternate containment cooling
1	-	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pump and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	-
2	-	-	2/4s SG and 1/4 MFW pump	-	-
3	1/3 SIP and 1/2 SDV	-	-	1/3 CS/RHR pump and Hx	-
4	1/3 SIP and 1/2 SDV	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units

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Note(1): B-train 6.9kV switchgear is unavailable in this initiating event.

Table 19.1-16 List of Success Criteria (Sheet 30 of 31)
Loss of Vital DC Bus Event Success Criteria

	Core injection function	Decay heat removal & containment heat removal function			
	Feed and Bleed(1)	Heat removal via SGs(1)	Main feed water recovery	CS/RHR (Containment spray) and CS/RHR (Heat removal)(1)	Alternate containment cooling
1	-	2/4 SGs and 2/3 EFW pumps OR 2/4 SGs and 1/3 EFW pumps and ~~isolation valves of pump discharge~~ tie-line valves opened	-	-	-
2	-	-	2/4 SGs and 1/4 MFW pump	-	-
3	1/3 SIP and 1/2 SDV	-	-	1/3 CS/RHR pump and Hx	-
4	1/3 SIP and 1/2 SDV	-	-	-	1/2 CCWP and 2/4 Containment fan cooler units

Note(1): A-train DC switchboard is unavailable in this initiating event.

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Table 19.1-119 Key Insights and Assumptions (Sheet 26 of 51)

Key Insights and Assumptions	Dispositions
35. Misalignment of remote-operated valves (e.g. motor-operated valves, air-operated valves), pumps and gas turbine generators after test and maintenance will be fixed before initiating events occur. Remote-operated valve open/close positions and control switch positions are monitored in the main control room, so they will be detected in a short time.	19.1.4 19.1.5 COL 13.5(5) COL 13.5(6)
36. The controls and displays available in the US-APWR control room are superior to conventional control room HSIs and, therefore, human error probabilities in the US-APWR operation would be less than those in conventional plants.	Chapter 18 19.1
37. In the SGTR event, operators perform at least one action in addition to the termination of SI to equalize primary and secondary pressure after the ruptured SG isolation. - Open safety depressurization valves - Start pressurizer auxiliary spray - Open depressurization valves for severe accident - Actuate pressurizer spray by restarting RCPs	19.2.5 COL 13.5(6) COL 19.3(6)

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