RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/11/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-66

Table 17.4-1 (Risk-Significant SSCs) of the US-APWR DCD, Revision 3, provides the dominant failure modes for each risk-significant SSC. The staff requests that the applicant address the following comments related to the dominant failure modes.

(a) For the following risk-significant SSCs, provide the basis for not including the associated failure modes in DCD Table 17.4-1.

Component ID in DCD Table 17.4-1 Potentially Dominant Failure Mode

SIS-MOV-101A, B, C, D (Item # 3 on page 17.4-7 of DCD): CD, OM

[Note, risk-significant operator action PZROO02PORV-DP3 requires these valves to be closed (see page 9-36 of the US-APWR PRA, MUAP-07030(R3)).]

NCS-MOV-323A(B) and NCS-MOV-326A(B) (Item # 51 on page 17.4-16 of DCD): OD, CM, PR

[Note, risk-significant operator action ACWOO02CT-DP2 requires opening these valves (see page 9-19 of the US-APWR PRA).]

VWS-MOV-401 and VWS-MOV-409 (Item # 2 on page 17.4-29 of DCD): CD, OM, IL

[Note, risk-significant operator action NCCOO02CCW requires closing these valves (see page 9-34 of the US-APWR PRA).]

MSS-TCV-550A,B,C,D,E,F,G,H,J,K,L,M,N,P,Q (Item # 6 on page 17.4-40 of DCD): OD, CM

[Note, risk-significant operator action MFWOO02R requires opening these valves (see page 9-29 of

the US-APWR PRA).]

(b) Based on request for additional information (a) above, various dominant failure modes may not have been identified in DCD Table 17.4-1 from the risk-significant operator actions in the US-APWR PRA. Therefore, the applicant should ensure that DCD Table 17.4-1 captures the dominant failure modes from the risk-significant operator actions.

(c) Various seismic failure modes may not have been identified in DCD Table 17.4-1 from the seismic margins analysis (SMA). For example, based on a cursory review of DCD Tables 19.1-54 and 19.1-55, the seismic failure modes for the refueling water storage pit (RWS-MCP-001), essential chilled water pumps (VWS-MPP-001B,C), turbine driven emergency feedwater pump actuation valves (EFS-MOV-103A,D), and feedwater line check valves (EFS-VLV-018A,B,C,D) were not included in DCD Table 17.4-1. Therefore, the applicant should ensure that DCD Table 17.4-1 captures the dominant seismic failure modes from the SMA.

(d) For the following risk-significant SSCs, provide the basis for including the associated failure modes in DCD Table 17.4-1.

Component ID in DCD Table 17.4-1 Failure Mode in DCD Table 17.4-1

NCS-MTK-001B (Item # 44 on page 17.4-16 of DCD) IL, OM

Piping (Item # 49 on page 17.4-16 of DCD) IL

STP1 (2) (Item # 9 on page 17.4-27 of DCD) SO

ANSWER:

a & b)

For SSCs related to risk-significant operator actions, MHI performed systematic search as follows:

1. For SSCs utilized for risk-significant operator actions *that are* modeled in the PRA, the estimated risk importance measures used to determine risk significance are FV importance and RAW. The threshold for determining risk-significance for each SSC is a FV ≥ .005 and/or RAW≥ 2.0.

2. For those SSCs which *are not* explicitly modeled in the PRA, risk importance for a given SSC is determined according to the risk importance measures associated with the operator actions listed in Tables 17.04.66-1 through 17.04.66-3. These tables list risk importance measures for operator actions for Level 1 and Level 2 PRA at-power and low-power shutdown (LPSD). When screening SSCs according to this method, considering that the RAW for an operator failure has the same impact on CDF as a component failure, SSCs having an operator action with a RAW value ≥ 2.0 are considered risk significant. Similarly, the FV importance of the SSC failure can be approximated from the relative contribution of the human error probability *and* the probability of *the SSC failure mode of interest*. If the estimated FV of the SSC failure mode exceeds the risk significance criteria, the SSC failure mode are identified as risk significant.

SSCs cited in Question (a) are evaluated using these criteria, as summarized above:

SIS-MOV-101A, B, C, D

The US-APWR PRA does not explicitly model “failure-to-close” (CD) for these valves. However the importance of this failure mode can be estimated based on the importance of the operator action. Basic events PZROO02PORV, PZROO02PORV-DP2, and PZROO02PORV-DP3 represent unsuccessful operator actions to depressurize the RCS. The cumulative Level 2 FV importance for these events is approximately 2.0E-02. Based on this cumulative FV importance and nominal HEP, 6.2xE-3 for PZROO02PORV (the smallest of the three events per Table 17.04-66.2), the estimated FV importance value for *each* valve (given a probability of 1.0E-3 for CD) is smaller than 3.3xE-3. (Failure probability of “OD” is approximately one-sixth of the HEP so that FV importance of “OD” is also approximately one-sixth of that of the HEP) Because the failure mode CD does not meet the FV criterion for risk significance (≥5E-3), “CD” is not identified as risk-significant.

The spurious open failure mode “OM” is much less probable than that of failure mode “CD” (Table 7.1-2 of MUAP-07030). Therefore spurious open failure mode “OM” is not identified as risk-significant.

If the RAW values for the failure modes CD and OM are assumed equal to that of the RAW values for the human error PZROO02PORV, PZROO02PORV-DP2, and PZROO02PORV-DP3 in this sequence, then the calculated RAW values associated with CD and OM do not exceed 2.0.

In summary, the CD and OM failure modes for these valves will not be added to Table 17.4-1 based on the estimated RAW or FV values.

NCS-MOV-323A, B and -326A, B

Whereas the operator action associated with these valves has a FV of 0.17, each failure mode for these SSC and basic event were also explicitly modeled and the *greatest* SSC FV and RAW values for failure mode OD at power are 4.4E-6 and 1.01 respectively. Similarly, the FV and RAW values OD for CDF and LRF for Fire, Flooding and LPSD modes 4-3 and 8-1 are also below the risk significance threshold. Regarding failure modes CM and PR, there is negligible contribution to risk. Therefore, it is inappropriate to add failure modes OD, CM, and PR in Table 17.4-1.

VWS-MOV-401 and 409

As pointed out in the Q17.04-67(i), MHI has revised the fault tress associated with these particular valves. Accordingly, failure modes CD, IL, and OM will be added to corresponding Table 17.4-1 entry.

MSS-TCV-550

The operator action associated with these valves has a RAW value of 2.5. Closure of these valves is essential to success of this operator action; therefore the RAW value to close and maintain isolation should be approximately the same. The failure modes OD and CM will be added to Table 17.4-1.

The same approach was applied to SSCs related to risk-significant human errors not discussed above and no other risk important failure modes have been identified.

c)

Results of the SMA have been reviewed to identify seismic failure modes that should be identified in DCD Table 17.4-1, in accordance with NEI 00-04, "10 CFR 50.69 SSC Categorization Guideline," Section 5.3 if they are credited as part of the safe shutdown path. Likewise, although failure of ceramic insulators used in the offsite power system will lead to a loss of offsite power (LOOP) initiating event, they are not essential SSCs for safe shutdown and therefore are not risk significant. Table 17.4-1 will be revised to be consistent with SSCs and their failure modes listed in Table 19.1-54, as shown in attached markups.

d)

Considering the risk significant failure modes "IL" and "OM" are specific to valves, MHI will delete failure mode "OM" for NCS-MTK-001B and failure modes "IL" for NCS-MTK-001B and CCWS Piping, as shown in attached markups. Similarly, considering failure mode SO is specific to circuit breakers, MHI will delete this failure mode for STP1 (2).

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17.04-66-12

17.04-66-13

17.04-66-14

17.04-66-15

17.04-66-16

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17.04-66-18

17.04-66-19

17.04-66-21

17.04-66-22

Impact on DCD

DCD Table 17.4-1 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

PRA model for alternate containment cooling will be revised after closure of all RAIs that require PRA model changes.

Impact on Technical/Topical Report

PRA Technical Report, MUAP-07030 “US-APWR Probabilistic Risk Assessment”, will be revised after the PRA model updating.

Table 17.4-1 Risk-significant SSCs (Sheet 1 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
1	**Accumulator injection system**			
1	Discharge line secondary isolation check valves [SIS-VLV-102A (B, C, D)]	RAW(L1, L1-CC, L2-CC) SM	OD, EL, PR, FS	The accumulator provides safety injection function for refill and re-flooding of the reactor vessel following a loss of coolant accident (LOCA). Also provides negative reactivity to shutdown the reactor. Single failure of any SSCs listed here has potential to cause failure of its dedicated train to inject coolant to RCS. DCD_17.04-66 DCD_17.04-66
2	Boundary check valves (Discharge line) [SIS-VLV-103A (B, C, D)]	RAW(L1, L1-CC, L2-CC) SM	OD, EL, PR, FS	
3	Discharge line isolation motor operated valves [SIS-MOV-101A (B, C, D)]	RAW(L1)	EL, PR	
4	Discharge line orifices train A through D [SIS-SRO-006A (B, C, D)]	RAW(L1)	PR	
5	Piping train A through D (Accumulator injection line)	RAW(L1) SM	EL, SS	
6	Accumulators [SIS-MTK-001A (B, C, D)]	EJ SM	SR, SS	

Table 17.4-1 Risk-significant SSCs (Sheet 7 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
3	**Component cooling water system (CCWS)**			
1	CCW pump discharge line check valves [NCS-VLV-016A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FL2, FR1, FR1-CC, FR2) SM	EL, PR, OD, FS	The component cooling water system (CCWS) transfer heat from plant safety-related components to the essential service water system (ESWS). This system supports various safety and non-safety mitigation systems. Accordingly, reliability of CCWS emergency feedwater system (EFWS) has significant impact on risk. CCWS has four trains, each having a component cooling water pump and a component cooling water heat exchanger. Two trains compose a subsystem, which shares a supply / return header and a surge tank. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause large external leak are risk significant. Since the two trains that compose a subsystem are not physically isolated, large external leak from SSCs that result in loss of inventory is assumed to result in degradation or failure of two trains.
2	Component cooling water pumps [NCS-MPP-001A (B, C, D)]	FV(L1-CC, L2-CC, LP- CC, FL1, FL2, RF2-SUM) RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FL2-CC, FL2, FR1, FR1-CC, FR2, FR2-CC,) SM	BD, YR, EL, SS, FS	
3	Component cooling water heat exchangers [NCS-MHX-001A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2, FR2-CC) SM	PR, EL, SS	
4	CCW pump discharge cross tie-line motor operated valves [NCS-MOV-020A (B, C, D)]	RAW(L1- CC, L2, L2-CC, LP, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2-CC) SM	CD, EL, OD, FS	
5	CCW pump suction line cross tie-line motor operated valves [NCS-MOV-007A (B, C, D)]	RAW(L1-CC, L2, L2-CC, LP, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2-CC) SM	CD, EL, OD, FS	
6	CCW surge tank outlet manual valves [NCS-VLV-005A (B, C, D)]	EJ RAW(L1,L2, LP, FL1,FL2, FR1, FR2)	PR, EL	
7	CCW pump inlet manual valves [NCS-VLV-008 A (B, C, D)]	RAW(L1, L2, LP, FL1, FL2, FR1, FR2)	PR, EL	
8	CCW heat exchanger outlet manual valves [NCS-VLV-018 A (B, C D)]	RAW(L1, L2, LP, FL1, FL2, FR1, FR2)	PR, EL	

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Table 17.4-1 Risk-significant SSCs (Sheet 11 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
43	B-CCW Surge tank vent valves [NCS-RCV-056B]	RAW/(L2)	EL, IL, OM	The "Insights and Assumptions" for these SSCs are described on the previous page.	
44	~~B-Component cooling water surge tank [NCS-MTK-001B]~~Component cooling water surge tank [NCS-MTK-001A (B)]	RAW/(L2) SM	EL, SS~~, IL, OM~~		DCD_17.04-66 DCD_17.04-67
45	B-CCW Surge tank safety valve [NCS-SRV-003B]	RAW/(L2)	OM		
46	B-CCW Surge tank nitrogen supply stop bypass valve [NCS-VLV-045B]	RAW/(L2)	EL		
47	Charging pump alternate CCW supply line valves [NCS-MOV-322A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	EL, OD, CM, PR		
48	Charging pump alternate CCW return line valves [NCS-MOV-324A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	CM, EL, OD, PR		
49	Piping (Fire service water tank line Piping, Alternate charging pump cooling suction line piping, Alternate charging pump cooling discharge line piping, CCW surge tank line piping, CCWS train piping, ~~CCWS heater~~ CCWS header piping)	RAW(L1, L2, LP, FL1) SM	EL, ~~IL~~SS		DCD_17.04-66 DCD_17.04-67 DCD_17.04-67 S01
50	FSS - CCWS boundary motor operated valves [NCS-MOV-321A (B)] [NCS-MOV-325A (B)]	FV(LP) RAW(L1, L1-CC, L2, LP)	CM, EL, OD, PR	Large external leak from these valves result in loss of alternative component cooling water from both non-essential chilled water system and fire protection water supply system. On the other hand, external leak from other SSCs degrade the fire protection water supply system but the non-essential chilled water system is still available for alternative component cooling. Therefore these valves are risk-significant SSCs in preventing core damage.	
51	CCWS - non-essential chilled water system boundary motor operated valves [NCS-MOV-323A (B)] [NCS-MOV-326A (B)]	RAW(L1, L2, LP)	EL, IL		

Table 17.4-1 Risk-significant SSCs (Sheet 13 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
7	Containment low volume purge supply containment isolation valves [VCS-AOV-356], [VCS-AOV-357]	SM RAW (L2-CC, FL2-CC, FR2-CC)	FS, CD	

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Table 17.4-1 Risk-significant SSCs (Sheet 14 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	Emergency feedwater system (EFWS)			
1	EFW pit discharge line check valves [EFS-VLV-008A (B)]	FV(FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	EL, OD, PR, FS	The emergency feedwater system (EFWS) supplies feedwater to the steam generators in order to remove reactor decay heat and RCS residual. This system is required after all initiating events exceeding large and medium LOCA. Accordingly, reliability of EFW system has significant impact on risk. Two trains share one emergency feedwater pit, which has 50% capacity to perform cold shutdown. Large leak from SSCs or failure that result in degradation of water supply from EFW pit will lead to lack of EFW. In this case manual action to supply feedwater from Secondary Demineralizer Water Tank is required. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause large leak or failure that result in degradation of water supply from EFW pit will lead are risk important. If such failure occurs, manual action to supply feedwater from secondary demineralizer water tank will be required.
2	Turbine driven emergency feedwater pump actuation valves [EFS-MOV-103A (D)]	FV(FR2) RAW(L1, L1-CC, L2, L2-CC FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC LP SM	CM, EL, OD, PR, FS	
3	Motor driven emergency feedwater pumps [EFS-MPP-001B (C)]	FV(FL2) RAW(L1-CC, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	AD, EL, LR, SR, FS	
4	Turbine driven emergency feedwater pumps [EFS-MPP-001A (D)]	FV(L1, L1-CC, L2, L2- CC, L2-SUM, FL1, FR1, FR1-SUM, FL2 ,FR2, FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FR2, FR2-CC) LP SM	AD, EL, LR, SR, FS	
5	Feedwater line check valves [EFS-VLV-018A (B, C, D)]	FV(FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	EL, OD, PR, FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 15 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	EFW pump discharge line check valves [EFS-VLV-012A (B, C, D)]	FV(FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	EL, OD, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
7	Minimum/Full flow line check valves [EFS-VLV-020A (B, C D)] [EFS-VLV-022A (B, C, D)]	RAW(L1, L2, FL1) LP	EL	
8	Minimum/Full flow line manual valves [EFS-VLV-021A (B, C, D)] [EFS-VLV-023A (B, C, D)]	RAW(L1, L2 , FL1, FR1, FR2) LP	EL, IL	
9	Emergency feedwater control valves [EFS-MOV-017A (B, C, D))	FV(FL1-SUM, FR1-SUM, FR2-SUM) RAW(L1, L1-CC, L2, L2- CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FR2, FR2-CC) LP SM	CM, IL, PR. EL, FC, FS	
10	Emergency feedwater isolation valves [EFS-MOV-019A (B, C, D)]	RAW(L1, L2, FL1, FR1, FL2, FR2) SM	CM, PR, EL, FS	
11	Emergency feedwater line orifices [EFS-FE-016 (026, 036, 046)]	RAW (FL1, FR1, FL2, FR2)	PR	
12	Emergency feedwater line tie-line valves [EFS-MOV-014A (B, C, D)]	RAW(L1, L2, L2-CC, FL1, FL2, FR1, FR1-CC, FR2, FR2-CC)	OD, EL	
13	EFW system pipng (EFW pit discharge line piping, EFW pit discharge line tie-line piping, A~D-emergency feedwater line piping, Minimum/Full flow line piping)	RAW(L1, L2, LP, FL1) SM	EL, SS	

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Table 17.4-1 Risk-significant SSCs (Sheet 16 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
14	T/D EFW pump steam supply line piping	RAW(L1,L2, FL1)/LP/SM	EL, SS	The "Insights and Assumptions" for these SSCs are described on the previous page.
15	Emergency feedwater pits [EFS-MPT-001A (B)]	RAW(L1, L2, FL1, FR1, FR2) LP / SM	EL, SS	
16	Minimum/Full flow line manual valves [EFS-VLV-026A (B)]	RAW(L1, L2, FL1, FR1, FR2) LP	EL	
17	EFW pump suction line manual valves [EFS-VLV-009A (B, C, D)]	RAW(L1, L2, FL1, FR1, FR2) LP	EL, PR	
18	EFW pump discharge line manual valves [EFS-VLV-013A (B, C, D)]	RAW(L1, L2, FL1, FR1, FR2) LP	EL, PR	
19	EFW pit discharge line manual valves [EFS-VLV-007A (B)]	FV(FL1, FL2, FR2-SUM) RAW(L1, L2, FL1, FL2, FR1, FR2)	CD, EL, PR	
20	Secondary demineralizer water tank discharge line manual valves [EFS-VLV-006A (B)]	FV(FL1, FL2, FR2-SUM) RAW(L1, L2, FL1, FL2, FR1, FR2) LP	EL, OD,PR	
21	Secondary demineralizer water tank discharge line check valve [EFS-VLV-005]	RAW(L1, L2, FL1)	EL, OD,PR	
22	Secondary demineralizer water tank discharge line manual valve [EFS-VLV-004]	FV(FL1) RAW(FL1, FL2)	EL, OD,PR	
23	Turbine driven pump steam supply line check valves [EFS-VLV-102A (B, C, D)]	SM	FS	
24	Emergency feedwater pump actuation cabinets	SM	FS	
25	Turbine driven EFW pump steam supply line motor-operated valves [EFS-MOV-101A (B, C, D,)]	EJ	CM, EL, PR	
26	EFW outlet flow control valve panels	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 17 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
7	Emergency power source (EPS)			
1	Class 1E 480V motor control centers (MCC) [MCC-A (B, C, D)], [MCC-A1 (D1)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) LP SM	FF,~~SS~~FS	The EPS consists of four separate trains. Each safety train consists of one 6.9kV AC medium voltage bus and 480V AC low voltage buses (Load Centers, Motor Control Centers). Each AC medium voltage bus connects to class 1E gas turbine generator. This system supports various safety mitigation systems and therefore, reliability of the EPS system has significant impact on risk. Since the EPS consists of four separate trains, single failure in trains not significantly impact risk. However, failure of multiple trains is have significant impact on risk. Accordingly, SSCs that have potential to cause common cause failures among multiple trains are risk significant
2	Class 1E 480V load centers [LC-A (B, C, D)], [LC-A1 (D1)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) LP SM	FF,~~SS~~FS	
3	Class 1E 6.9kV switchgears [MC-A (B, C, D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) EJ / LP / SM	FF, ~~SS~~ FS	
4	Class 1E DC switchboards [DCC-A (B, C, D)], [DCC-A1 (D1)]	RAW (L1, L2, LP, FL1, FR1, FL2, FR2) SM	FF, FS	
5	Class 1E AC 120V panelboards [IBD-A (B, C, D)]	RAW(L1, L2, FL1, FR1, FL2, FR2) SM	FF, FS	
6	Circuit breakers between Class 1E 480V load centers A, B (C, D) and A1(D1) [52/LLAA, LLBB, LLDA, LLBA] [52/LLBC, LLAD, LLBD, LLDD]	RAW(L1-CC, L2, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC)	SO	
7	Class 1E Batteries and racks [BAT-A (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC ,FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	FF, SO, FS	
8	Class 1E Battery chargers [BCP-A (B, C, D)]	RAW(FL1) SM	FF, WR, ~~SS~~FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 19 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
15	Class 1E gas turbine generators [A (B, C, D)-EGTG]	FV(L1,L1-CC,L1-SUM, L2, L2-CC, L2-SUM, LP, LP-CC, FL1, FL1-SUM, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC,) RAW(L1-CC, L2-CC, LP-CC, FL1-CC, FR1-CC, FL2, FL2-CC, FR2-CC) LP SM	AD, LR, SR, FS	The “Insights and Assumptions” for these SSCs are described on the previous page.

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Table 17.4-1 Risk-significant SSCs (Sheet 20 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
16	Class 1E gas turbines generator sequencers [EPBA (B, C, D)]	FV(L1-CC, L2-CC, L2-SUM, FL2-SUM, FR1, FR1-CC) RAW(L1-CC, L2-CC, LP-CC, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2-CC) LP	FF	The "Insights and Assumptions" for these SSCs are described on the previous page.
17	MOV Inverters [MVIA1, MVIA2, MVIB, MVIC, MVID1, MVID2]	RAW(L1-CC, L2-CC, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2, FR2-CC)/ LP / SM	FF, FS	
18	Main transformers [MT]	RAW(L2, FL1, FL2)	FF	
19	Reserve auxiliary transformer 3 and 4 [RAT3(4)]	RAW(L2, FL1, FL2, PL)	FF	
20	Class 1E station service transformers [STA (B, C, D)]	RAW(L1, L2, PL, FL1, FR1, FL2, FR2) / LP SM	FF, FS	
21	Circuit breakers between AAC and Class 1E 6.9kV switchgear [52/AACA (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FR1-CC, FR2-CC)	FC, SO	
22	Circuit breakers between Class 1E 480V load center A1 (D1) and MCC A1 (D1) [52/LCA1 (D1)]	RAW(L1, L1-CC, L2, L2-CC, LP-CC, FL1, FL1-CC, FL2, FL2-CC, FR1, FR1-CC, FR2, FR2-CC)	SO	
23	Circuit breakers between Class 1E 480V load center and Class 1E station service transformer [52/STLA (B, C, D)]	FV(L2-CC) RAW(L1, L1-CC, L2, L2-CC,LP, LP-CC, FL1, FL1-CC, FL2, FL2-CC, FR1, FR1-CC, FR2, FR2-CC)	SO	
24	Circuit breakers between Class 1E UPS unit and Class 1E AC 120V panelboard [52/UAA (B, C,D)]	RAW(L1-CC, L2-CC, LP-CC, FR1-CC)	SO	

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Table 17.4-1 Risk-significant SSCs (Sheet 21 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
25	Circuit breakers between unit auxiliary transformer and Class 1E 6.9 kV switchgear [52/UATA (B, C, D)]	FV(L1-CC, L2-CC, LP-CC, LP-SUM, FL2, FR1-SUM) RAW(L1, L1-CC, L2, L2-CC,LP, LP-CC, FL1, FL1-CC, FR1-CC, FL2, FL2-CC, FR2-CC)	FO,SC	The "Insights and Assumptions" for these SSCs are described on the previous page.	
26	Circuit breakers between Class 1E DC switchboard and Class 1E UPS unit [72/AUA (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FR1-CC)	SO		
27	Circuit breakers between Class 1E battery and Class 1E DC switchboard [72/DBA (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FR1, FR1-CC, FL2, FR2, FR2-CC)	SO		
28	Circuit breakers between Class 1E DC switchboard and DC Switchboard A1 (D1) [72/DDAA (DDBB, DDBC, DDAD)] [72/DDDA (DDBA, DDBD, DDDD)]	RAW(L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR2)	SO		DCD_17.04-66
29	Class 1E UPS Units [IBC-A (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FL2-CC, FR1-CC, FR2-CC) SM	~~FF~~FS, FF		DCD_17.04-66 S01
30	Class 1E Gas turbine generators control centers	SM	FS~~, SS~~		DCD_17.04-66
31	Class 1E I&C power transformers [IBB-A (B, C, D)]	SM	~~SS~~FS, FF		DCD_17.04-66
32	Cable trays (safety related SSCs)	SM	~~FS~~SS		DCD_17.04-66
33	Switches between Class 1E MOV 480V MCC and MOV inverter	RAW(L2-CC) SM	FF, FS		DCD_17.04-66
34	Breakers between Class 1E 480V MCC and switch	RAW(L2-CC)	SO		
35	Class 1E MOV 480V MCC [MVCA1, MVCA2, MVCB, MVCC, MVCD1, MVCD2]	Raw(L1, L2, FL1, FL2, FR1, FR2) SM	FF, FS		DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 22 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
36	Breakers between Class 1E DC switchboard and MOV inverters [DUA1, DUD1]	RAW(L2-CC)	SO	
37	Class 1E gas turbine generator control cabinet	SM	FS	
38	Solenoid distribution panels	SM	FS	
39	Safety logic system cabinet	SM	FS	
40	Reactor protection system cabinets	SM	FS	
41	ESF actuation system cabinet	SM	FS	
42	Safety remote I/O cabinets	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 23 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
8	Alternative AC power sources (Permanent bus)			
1	Non-Class 1E gas turbine generators (AAC) [ACC-A(B)]	FV(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1-SUM, FR1, FR1-CC, FR1-SUM, FR2, FR2-CC, FL2) RAW(L1-CC, L2, L2-CC, LP, LP-CC, FR1-CC, FR2-CC, FL2, FL2-CC) LP	AD, SR, LR	Two non-safety buses called "Permanent bus", which is connected to Alternative AC (AAC), which consists of non-class 1E gas turbine generators respectively. Each non-class 1E gas turbine generators is manually connected to two safety medium voltage buses via selector circuit under the occurrence of loss of safety AC power. The AAC is a countermeasure against station blackout events. SSCs that have potential to cause failures that degrade the availability to supply AAC power to safety medium voltage are risk significant. Systems for the mitigation of core damage accident are connected to permanent bus.
2	P1, P2 Non-Class 1E 480V load center [LC-P1 (P2)]	RAW(L2)	FF	
3	P1, P2 Non-Class 1E 6.9kV switchgears [MC-P1 (P2)]	RAW(L2)	FF	
4	Circuit breakers between P1 (P2) Non-Class 1E 6.9kV switchgear and station service transformer [52/STHP1 (2)]	RAW(L2, L2-CC, FL1, FR1, FR2)	SO, WR	
5	N1, N2 Non-Class 1E batteries [BAT-N1(N2)]	RAW(FR1-CC) LP	FF,	
6	Circuit breakers between Non-class 1E gas turbine generator (AAC) and P1 (P2) Non-Class 1E 6.9kV switchgear [52/AACP1 (2)]	RAW(FR1-CC, FR2-CC) LP	TD	
7	Circuit breakers between Non-Class 1E gas turbine generator (AAC) and selector switch [52/AACAP (52/AACBP)]	RAW(L1-CC, L2, L2-CC, LP, LP-CC, FR1-CC,FR2-CC) LP	FC, SO	
8	Non-Class 1E gas turbine generators (AAC) sequencers [AAS-A (B)]	FV(L2, LP) RAW(L1-CC, L2, L2-CC, LP, LP-CC, FL2, FR1-CC, FR2-CC)	FF	
9	P1, P2 Non-Class 1E station service transformers [STP1 (2)]	RAW(L2, L2-CC) LP	FF~~, SO~~	

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Table 17.4-1 Risk-significant SSCs (Sheet 25 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
9	Non-essential chilled water system			
~~1~~	~~Non-essential chilled water system CCWS boundary motor operated valves [VWS-MOV-424] [VWS-MOV-425]~~	~~FV(L2) RAW(L2) LP~~	~~CM, EL, OD, PR~~	In the case of loss of component cooling water events, non-essential chilled water system or fire protection water supply system provides alternative component cooling water to charging pumps in order maintain RCP seal water injection. These SSCs are risk significant because large external leak from these valves result in loss of alternative component cooling water from both non-essential chilled water system and fire protection water supply system. On the other hand, failure of other SSCs of this system affects only the non-essential chilled water system itself.
~~2~~1	Containment fan cooler unit supply line changeover valve [VWS-MOV-401] [VWS-MOV-409]	FV(L2) RAW(L2)	EL,CD,IL,OM	
~~3~~2	Containment fan cooler unit containment isolation valves [VWS-MOV-403] [VWS-MOV-407] [VWS-MOV-422]	FV(L2) RAW(L2)	CM,EL,OD,PR	
~~4~~3	Containment fan cooler unit cooling coil inlet valve [VWS-MOV-411A (B,C,D)]	FV(L2) RAW(L2, L2-CC)	CM, EL, OD, PR	
~~5~~4	CRDM cooling unit cooling coil inlet valve [VWS-MOV-414]	FV(L2) RAW(L2)	CD, EL, IL, OM	
~~6~~5	Containment fan cooler unit line piping	RAW(L2)	EL	
~~7~~6	Containment fan cooler unit outlet air operated valves [VWS-TCV-041A (B), 042A (B)]	RAW(L2)	CM, EL, PR	
~~8~~7	Containment fan cooler unit outlet manual valves [VWS-VLV-412A (B,C,D)]	RAW(L2)	EL, PR	

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Table 17.4-1 Risk-significant SSCs (Sheet 28 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
11	High head safety injection system			
1	Safety injection pump discharge check valves [SIS-VLV-004A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) SM	EL, OD, PR, FS	In the case of LOCA, high head safety injection system injects coolant from refueling water storage pit (RWSP) into the reactor vessel via the Direct Vessel Injection (DVI) line by the safety injection pumps. This system is also essential for bleed and feed operation. Since this system consists of four independent trains, failure of one train does not have significant impact on risk. However, failures of SSCs that impact multiple trains are risk significant. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause loss of RWSP inventory out side the containment due to large external leaks. Loss of RWSP inventory impacts not only all four trains of high head safety injection system but also other systems that use RWSP as water source.
2	Safety injection pump outlet orifices [SIS-FE-062 (063, 064, 065)]	RAW(FL1, FR1)	PR	
3	Minimum flow line orifices [SIS-FE-072 (073, 074, 075)]	RAW(FL1, FR1)	PR	
4	Containment isolation check valves [SIS-VLV-010A (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2-CC, FR2-CC) SM	OD, EL, PR, FS	
5	Containment isolation motor operated valves [SIS-MOV-011 A(B, C, D)]	RAW(L2, FL1, FR1) FV(FL1)	FF, CM, EL, PR	
6	RV injection line orifices [SIS-SRO-001A (B, C, D)]	RAW(FL1, FR1)	PR	
7	Injection line secondary isolation check valves [SIS-VLV-012A (B,C,D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2-CC, FR2-CC) SM	OD,EL,PR,FS	
8	Injection line boundary check valves [SIS-VLV-013A (B,C,D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2-CC, FR2-CC) SM	OD, EL, PR,FS	

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DCD_17.04-66

DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 30 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
12	**Heating, ventilation, and air conditioning (HVAC) system**			
1	B,C-Emergency feedwater pump room fans [VRS-MFN-401B, C]	FV(FL1, FR2) RAW(FL1, FL1-CC, FR1, FR1-CC, FR2, FR2- CC), LP	AD, LR, SR	EFW M/D pump room fans maintain room temperature when pumps are running. EFW M/D pumps are assumed to be unavailable within the mission time without room cooling due to high room temperature. HVAC systems of other rooms are considered not to be risk significant for the following reasons. - HVAC of emergency gas turbine room Gas turbine units itself has function to intake outer air to remove heat out to atmosphere. Accordingly, HVAC is considered not essential to maintain gas turbine function. - HVAC of ESF room (RHR/CSS pump, SI pump) According to room temperature analysis, room temperature will not exceeds limit of the system during the mission time regardless of availability of HVAC. - HVAC of class1E electric power room (Class 1E I&C, switch gear, battery, battery charger) This system is running during normal operation and continues to run after initiating events. Reliability of normally operating HVAC systems are considered to be high and failure of this system is unlikely to occur during the mission time. - HVAC of EFW T/D pump room Since T/D driven EFW pump room can operate under high room temperature conditions, they are assumed to be available regardless of room cooling during the mission time.
2	B,C-Emergency feedwater pump air handling unit [VRS-MAH-401B, C]	FV(FR1-SUM, FR2) RAW(L1-CC, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) SM	AD, LR, SR, FS	

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DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 36 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
17	**Main feedwater system (MFWS)**			
1	Main feedwater system	FV(L1)	SR	The Main feedwater system is credited as a function to secondary side cooling during general transients, which does not involve loss of main feedwater.
2	Main feedwater isolation check valves [FWS-VLV-511A (B, C, D)]	SM	FS	
3	Main feedwater isolation valves [FWS-SMV-512A (B, C, D)]	SM	FS	
18	**Main steam supply system (MSS)**			
1	Main steam isolation valves [MSS-SMV-515A (B,C,D)]	FV(L1-SUM ,FR1, FR1-CC, FR2-CC) RAW(L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) SM	CD, IL, OM, FS	Main steam isolation valve isolates the ruptured Steam Generator (SG) at the Steam Generator Tube Rupture (SGTR). In case of secondary line break, main steam isolation is required to prevent unlimited steam release. DCD_17.04-66 Main steam line piping is required to be intact to isolate the ruptured SG at SGTR events. DCD_17.04-66
2	Main steam bypass isolation valves [MSS-HCV-565 (575, 585,595)]	FV(FR2) RAW(L2, FR1, FR2)	IL, OM	
3	Main steam line piping	RAW(L1, L2) SM	EL, SS	
4	Main steam line isolation check valves [MSS-VLV-516A(B, C, D)]	RAW(L1, FL1)	CD, IL	

Table 17.4-1 Risk-significant SSCs (Sheet 37 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
5	-Main steam safety valves [MSS-SRV-509A (B, C, D)] [MSS-SRV-510A (B, C, D)] [MSS-SRV-511A (B, C, D)] [MSS-SRV-512A (B, C, D)] [MSS-SRV-513A (B, C, D)] [MSS-SRV-514A (B, C, D)]	RAW(L1, L2)	CD, OM	Main steam safety valves are designed to have different actuation pressure and relieving capacity.
6	A,B,C,D,E,F,G,H,J,K,L,M,N,P,Q-Turbine bypass valves [MSS -TCV-550A(B,C,D,E,F,G,H,J,K, L,M,N, P,Q)]	FV(L1, L2-SUM) RAW(L2)	CD, OD, CM	
7	Main steam relief valve isolation valves [MSS -MOV-507A (B,C,D)]	RAW(L2)	CD	
8	Main steam depressurization valves [MSS -MOV-508A (B,C,D)]	RAW(L2-CC) LP	OD, CD	
9	Main steam relief valves [MSS -PCV-515 (525, 535, 545)]	RAW(L2, L2-CC)	OD, CD	

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Table 17.4-1 Risk-significant SSCs (Sheet 39 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
21	Containment spray / residual heat removal (CS/RHR) system			
1	Heat exchanger bypass valves [RHS-FCV-021] [RHS-FCV-031]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL, OM	The Containment Spray / Residual Heat Removal (CS/RHR) System consists of four independent trains. The CS/RHR System has the following three functions. a. Containment Spray b. Alternative Core Cooling c. RHR Operation during operating modes 4 , 5 and 6.. Since CS/RHR system consists of four independent trains, failure of one train does not have significant impact on risk. However, failures of SSCs that impact multiple trains are risk significant. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause loss of RWSP inventory outside the containment due to large external leaks. Loss of RWSP inventory impacts not only all four trains of CS/RHR system but also other systems that use RWSP as water source.
2	RHR line heat exchanger discharge air operated valves [RHS-HCV-023] [RHS-HCV-033]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL, CM, PR	
3	Pump suction line check valves [RHS-VLV-004A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR1, FR1- CC, FL2, FL2-CC, FR2,FR2-CC) SM	EL,OD,PR, FS	
4	RHR line containment isolation check valves [RHS-VLV-022A (B, C, D)]	RAW(LP, LP-CC)	OD,PR	
5	RHR line containment isolation motor operated valves [RHS-MOV-021A (B, C, D)]	RAW(L1, L2, LP, LP-CC, FL1, FR1, FR2)	CM, PR, OD, EL	

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Table 17.4-1 Risk-significant SSCs (Sheet 41 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
11	CS line containment isolation motor operated valves [CSS-MOV-004A (B, C, D)]	FV(L2-SUM, FR1-CC, FL1, FL1-CC, FL2, FL2-CC, FR2, FR2- CC,) RAW(L1,L1-CC,L2,L2- CC,LP, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) SM	OD, CM, EL, FC, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
12	CS line check valves [CSS-VLV-005A (B, C, D)]	RAW(L1,L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1- CC, FL2, FL2-CC, FR2, FR2-CC) SM	EL, OD, PR, FS	
13	Piping (between RWST and CSS-MOV-001A (B, C, D), between RHS-MOV-034A (D) and CS/RHR Pump, between RHS-VLV-031A (D) and alternate core cooling, RHS-FCV-021 (031) line, between CSS-MOV-001A (B, C, D) and A (B, C, D)- CS/RHR pump, A (B, C, D)--CS/RHR pump line, CS/RHR pump line, alternate core cooling line A (B, C, D) (outside C/V) piping, Containment spray nozzles)	RAW(L1, L2, LP) SM	EL, SS	
14	CS line heat exchanger discharge manual valves [CSS-VLV-002A (B, C, D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
15	Minimum flow line manual valves [RHS-VLV-013A (B, C, D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
16	Minimum flow line orifices [RHS-SRO-001A (B, C, D)]	RAW(LP, FL1, FR1, FL2, FR2)	PR	
17	Minimum flow line orifices [RHS-FE-014 (024, 034, 044)]	RAW(LP, FL1, FR1, FL2, FR2)	PR	
18	CS/RHR - spent fuel pit boundary manual valves (discharge line) [RHS-VLV-031A (D))	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL	

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Table 17.4-1 Risk-significant SSCs (Sheet 43 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[(1)]	Failure Mode[(2)]	Insights and Assumptions
22	**Refueling water storage system (RWS)**			
1	Refueling water storage pit (RWSP) sump strainers [SIS-SST-001A (B, C, D)]	FV(L1-CC, L2-CC, LP- CC, FL1-SUM, FL2-CC, FL2, FR2-SUM) RAW (L1, L1-CC, L2, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) SM	PR, SS	The RWSP is the source of borated water for containment spray and safety injection. During LPSD operation, RWSS has the following functions. a. Refill refueling water strage auxiliary tank (RWAT) for RCS injection via charging pumps. b. Refill SFP for gravitational injection to RCS.
2	Refueling water storage pit [RWS-MCP-001]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) SM	EL, FS	SSCs that have either of the following characteristics are risk significant. DCD_17.04-66 DCD_17.04-66 - SSCs that have potential to cause common cause failures among multiple trains. Sump strainers have potential of sump screen, which may occur in multiple trains. - SSCs that have potential to cause resulting loss of RWSP inventory out side the containment due to large external leaks are risk significant, since such failure impacts all systems that use RWSP as water source.
3	Refueling water recirculation pump suction line manual valves [RWS-VLV-006A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
4	Refueling water recirculation pump discharge line check valves [RWS-VLV-012A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
5	Refueling water recirculation pump discharge line manual valves [RWS-VLV-013A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
6	RWSP discharge line containment isolation motor operated valves [RWS-MOV-002] [RWS-MOV-004]	RAW(L1, L2, LP, FL1, FR1, FR2) SM	EL, CM, PR, FS	SSCs that have potential to cause failure to supply RWSP water to RWAT or SFP during LPSD operation are also considered risk significant. DCD_17.04-66 DCD_17.04-66
7	Refueling water recirculation pumps [RWS-MPP-001A (B)]	RAW(L1, L2 ,LP, LP-CC, FL1, FL2, FR1, FR2)	EL, AD, LR, SR	
8	RWSP discharge line manual valve [RWS-VLV-001]	RAW(L1, L2, LP, FL1, FL2, FR1, FR2)	EL, PR	
9	Refueling water recirculation pump suction cross tie line manual valve [RWS-VLV-005]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	

Table 17.4-1 Risk-significant SSCs (Sheet 44 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
10	Refueling water recirculation pump discharge cross tie line manual valve [RWS-VLV-014]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	The "Insights and Assumptions" for these SSCs are described on the previous page.
11	Refueling water storage auxiliary tank [RWS-MTK-002]	RAW(L1, L2, LP)	EL	
12	Refueling water storage auxiliary tank inlet line manual valve [RWS-VLV-052]	RAW(LP)	EL, OD, PR	
13	Refueling water storage auxiliary tank discharge line manual valve [RWS-VLV-101]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
14	Refueling water storage auxiliary tank suction line manual valves [RWS-VLV-021], [RWS-VLV-051]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL,OD,PR	
15	Refueling water storage auxiliary tank line orifice	RAW(LP)	EL	
16	RWSP suction line containment isolation air operated valve [RWS-AOV-022]	LP, SM	EL, CD, OM, FS	
17	RWSP return line check valve [RWS-VLV-023]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) SM	EL, FS	
18	RWSP Return Line Manual Valve [RWS-VLV-024]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL	
19	Piping (between RWSP and RWS-VLV-023 ,between RWSP and RWS-MOV -002, between RWS-MOV-002 and RWS-MOV -004 ,between RWS-MOV -004 and RWSAT ,between RWS-VLV-021 and RWSAT)	RAW(L1, L2, LP, FL1, FR1)	EL	

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Table 17.4-1 Risk-significant SSCs (Sheet 45 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
23	**Reactor trip system (RTS)**				
1	Reactor trip breakers	RAW(L1-CC, L2-CC)	FF	These systems are necessary to provide negative reactivity for plan t trip.	
2	Control rods	FV(L1) RAW(L1,L2, L1-CC, L2-CC)	FS, FR		
3	Control rod drive mechanism	RAW(L1, L2) SM	~~FS~~SS		DCD_17.04-66
4	Fuel assembly (Reactor internals and core assembly)	SM	~~FS~~SS		DCD_17.04-66
24	**Chilled water system (VWS)**				
1	Essential chiller units [VWS-MEQ-001B (C)]	FV(L1, FL1, FR1, FR2, FR2-SUM) RAW(L1-CC, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) LP SM	YR, BD, SS, FS	The safety related water system supplies chilled water to safety related HVAC systems. SSCs that have potential to cause common cause failures among trains B and C are risk significant since such failures results in loss room cooling in M/D EWF pump area. SSCs that compose train A and D are not risk significant because the PRA assumes only the M/D EFW pumps to be dependent on room cooling during the mission time.	
2	Essential chilled water pumps [VWS-MPP-001B (C)]	RAW(L1-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) LP SM	BD, YR, FS		DCD_17.04-66 DCD_17.04-66
3	Essential chilled water compression tanks [VWS-MTK-001B (C)]	RAW(FL1) SM	~~FS~~SS, EL		DCD_17.04-66
4	HVAC chiller system piping	RAW(FL1) SM	~~FS~~SS, EL		DCD_17.04-66
5	Essential chilled water pump discharge line check valves [VWS-VLV-005B (C)]	RAW(FL1, FR2) EJ SM	OD, EL, PR, FS		DCD_17.04-66 DCD_17.04-66
6	Essential chilled water system orifice [VWS-FE-051, 101]	RAW(FL1, FR2)	PR		

Table 17.4-1 Risk-significant SSCs (Sheet 46 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
7	Essential chilled water system three way valve [VMS-TMV-412 and 422]	RAW(FL1)	CM, EL, PR	
8	Essential chilled water inlet manual valve [VWS-VLV-001B, C]	RAW(FL1)	EL, PR	
9	Essential chilled water system manual valve [VWS-VLV-006B, C]	RAW(FL1)	EL, PR	
10	Emergency Feedwater pump air handling unit manual valve [VWS-VLV-101B, C]	RAW(FL1)	EL, PR	
11	Emergency Feedwater pump air handling bypass line valve [VWS-VLV-102B, C]	RAW(FL1)	EL	
12	Emergency Feedwater pump air handling unit manual valve [VWS-VLV-105B, C)	RAW(FL1)	EL, PR	
13	Ventilation chiller control cabinets	SM	FS	

DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 47 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
25	**Essential service water system (ESWS)**			
1	EWS pump discharge line check valves [EWS-VLV-502A (B,C,D)]	RAW(L1, L1-CC, L2,L2-CC, LP ,LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FR2, FR2-CC,) SM	EL,PR,OD, FS	The essential service water system (ESWS) transfers heat from the CCW system as Ultimate Heat Sink (UHS). This system supports the CCW system, which supports various safety and non-safety mitigation systems. Accordingly, reliability of CCWS EFW system has significant impact on risk. Since ESWS consists of four independent trains, failure of one train does not have significant impact on risk. However, failures of SSCs that impact multiple trains have risk-significant impact on risk. Accordingly, SSCs that have potential to cause common cause failures among multiple trains are risk significant.
2	Essential service water pumps [EWS-MPP-001A (B,C,D)]	FV(L1-CC, L2-CC, LP-CC, FL1, FR1-CC, FR1-SUM, FL2, FR2, FR2-CC) RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC,FR2, FR2-CC) SM	BD, YR, EL, SS, FS	
3	CCW heat exchanger inlet strainers [EWS-SST-003A (B, C, D)]	FV(FL2) RAW(L1, L2, LP, FL1, FR1, FL2, FR2) LP	PR	
4	Essential service water pump outlet strainers [EWS-SST-001A (B,C,D)] [EWS-SST-002A(B,C,D)]	FV(FL2) RAW(L1, L2, LP, FL1, FR1, FR2, FL2)	PR	
5	Main piping orifices [EWS-FE-034(035, 036, 037)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) / SM	PR, SS	

DCD_17.04-66
DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 48 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	ESW pump discharge line motor operated valves [EWS-MOV-503 A(B,C,D)]	FV(FL2, FR2) RAW(L1, L2, LP, LP-CC, FL1, FR1, FL2, FR2) SM	CM, EL, OD, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
7	Manual valves in main piping [EWS-VLV-506 A(B,C,D)] [EWS-VLV-507 A(B,C,D)] [EWS-VLV508 A(B,C,D)] [EWS-VLV-509 A(B,C,D)] [EWS-VLV-511 A(B,C,D)] [EWS-VLV-514 A(B,C,D)] [EWS-VLV-517 A(B,C,D)] [EWS-VLV-520 A(B,C,D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
8	Piping [ESW pump discharge line, ~~ESW pump cooling line,~~ CCW Hx cooling line A(B,C,D)]	RAW(L1, L2, LP, FL1) SM	EL, SS	
9	Orifices (between EWS-FE-034 (035, 036, 037) and EWS-VLV-520A (B, C, D)	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	PR	

DCD_17.04-66

DCD_17.04-67

Table 17.4-1 Risk-significant SSCs (Sheet 49 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
10	Essential chiller unit cooling line manual valves [EWS-VLV-701A (B-D)] [EWS-VLV-704A (B-D)]	RAW(L1, L2, FL1) EJ*1	EL, PR	
11	Essential service water intake structure	SM	~~FS~~SS	
12	Essential service water pipe tunnel	SM	~~FS~~SS	
13	Essential chiller unit cooling line orifice [EWS-SRO-003B, C]	RAW(FL1, FR2)	PR	
14	Essential chiller unit cooling line flow mater [EWS-FE-055, 056]	RAW(FL1, FR2)	PR	

DCD_17.04-66

DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 50 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
26	**Spent fuel pit cooling and purification system (SFPCS)**			
1	RWS - SFP inlet line boundary check valves [SFS-VLV-027]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	Large external leak of valves that form boundary between RWS result in loss of inventory of the RWS system. Accordingly, systems that relies on the RWS as water source is affected by failure of these valves. During RCS is atmospheric pressure at LPSD operation, the spent fuel pit is used as water source of gravitational injection in case loss of decay heat removal function occurs. SSCs associated with gravitational injection line are considered to be risk significant.
2	RWS - SFP inlet line manual valve [SFS-VLV-028]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
3	RWS - SFP demineralizer line boundary manual valves [SFS-VLV-103A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
4	RWS - SFP inlet line manual valves [SFS-VLV-029] [SFS-VLV-015] [SFS-VLV-017]	LP	EL	
5	Spent fuel pit [SFS-MPT-001]	LP / SM	EL, SS	
6	Spent fuel pit strainers	LP	EL	
7	Spent fuel pit discharge line manual valves [SFS-VLV-021A(D)]	LP	EL	
8	Spent fuel pit discharge cross tie-line manual valve [SFS-VLV-022]	LP	EL	
9	Spent fuel pit heat exchangers [SFS-MHX-001A(B)]	SM	~~FS~~SS	
10	Spent fuel pit pumps [SFS-MPP-001A(B)]	SM	SS, FS	
11	Spent fuel pit water cooling system piping	SM	SS	
27	**Remote Shutdown Panel (RSP)**			
1	Remote shutdown console	EJ	FF	In case of Fire event at power some operations are required to be carried out in remote shutdown panel therefore remote shut down panel are considered risk significant.
2	Transfer switches	EJ	FF	The switch can transfer the plant control system from the MCR to remote shutdown console.

DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 51 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
28	**Buildings**			
1	Reactor building	SM	~~FS~~SS	Considering the secondary effect to Reactor building and Safety power source buildings, Turbine building, Auxiliary building are risk significant.
2	Safety power source	SM	~~FS~~SS	
3	Turbine building	SM	FS	
4	Auxiliary building	SM	FS	
29	**Reactor Coolant System**			
1	Steam generators (including Steam generator tubes) [RCS-MHX-001A (B,C,D)]	SM	~~FS~~SS	SSCs that compose boundary with primary system are risk significant.
2	RCS piping	SM	~~FS~~SS	
3	DVI piping	SM	~~FS~~SS	
4	Reactor coolant pumps [RCS-MPP-001A (B,C,D)]	SM	~~FS~~SS	
5	Reactor vessel [RCS-MTK-001]	SM	~~FS~~SS	
6	RCS instrumentation letdown piping	SM	~~FS~~SS	
7	In-core instrumentation tube	SM	~~FS~~SS	
8	Emergency letdown piping	SM	~~FS~~SS	
30	**Other Equipments**			
1	Flood barriers	SM	FS	The flood barriers that separate the reactor building between east side and west side and between restricted area and non-restricted area are important to safety for the operation of the facility.

DCD_17.04-66

DCD_17.04-66

DCD_17.04-66

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/11/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-67

Table 17.4-1 of the US-APWR DCD, Revision 3, provides the list of risk-significant SSCs. The staff requests that the applicant address the following comments related to the list of risk-significant SSCs.

(a) Condenser water pump VWS-MPP-351A and cooling tower fan VWS-MEQ-371A (see Figure 4.1-21 of the US-APWR PRA (MUAP-07030(R3)) are not considered risk-significant in DCD Table 17.4-1. However, risk-significant operator action ACWOO02CT-DP2 (failure to establish the alternate CCWS by non-essential chilled water system cooling tower) requires starting and running these SSCs (see page 9-19 of the US-APWR PRA). This may suggest that these SSCs are risk-significant.

Provide the basis for not including these SSCs in DCD Table 17.4-1.

(b) Based on request for additional information (a) above, various risk-significant SSCs may not have been identified in DCD Table 17.4-1 from the risk-significant operator actions (e.g., equipment manipulated for risk-significant local operator actions).

Therefore, the applicant should ensure that DCD Table 17.4-1 captures the risk significant SSCs from the risk-significant operator actions.

(c) Chapter 22 of the US-APWR PRA describes the internal flood risk assessment and states:

"Flooding by the ESW system is assumed to be isolated within 15 minutes. If the isolation is failed, flood water released from the ESWS is assumed to be propagated to other areas (including areas in the upper floors) in the east side (or west side) non-restrictive area in the R/B. Flooding from the ESW system is assumed to be detectable using the leak detectors.”

Provide the basis for not including these leak detectors in DCD Table 17.4-1.

(d) Item # 42 on page 17.4-11 of DCD Table 17.4-1 identifies as risk-significant the “CVS charging injection line piping between RWSAT and CVS-VLV-595”. However, this is not consistent with the piping defined under basic events CHIPNELPIPE1 (CVS charging injection line piping external leak large) and CHIPNELPIPE2 (CVS piping between RWSAT and CVS pump external leak large), which are considered risk significant based on their risk importance in Tables 18.2-2 and 20.11-4 of the USAPWR PRA, respectively. Clarify in DCD Table 17.4-1 the risk-significant piping for the CVS system.

(e) Item # 4 on page 17.4-31 of DCD Table 17.4-1 identifies the following FSS piping as risk-significant: “from tank to tie line piping” and “from FWT to tie line.” However, these two piping segments seem redundant. Clarify in DCD Table 17.4-1 the risk significant piping for the FSS system.

Also, the FSS injection line piping does not appear to be risk-significant based on DCD Table 17.4-1. However, the SSCs on the FSS injection line piping (e.g., FSSVLV-006, FSS-MOV-004, Orifice FSO2) are risk-significant in DCD Table 17.4-1.

Provide the basis for not including the FSS injection line piping in DCD Table 17.4-1.

(f) Item # 44 on page 17.4-16 of DCD Table 17.4-1 identifies NCS-MTK-001B (B component cooling water surge tank) as risk-significant and does not include the A component cooling water surge tank. However, based on DCD Tables 19.1-54 (page 19.1-509) and 19.1-55 (page 19.1-516) for the SMA and using the methodology in DCD Section 17.4.7.1, both the A and B component cooling water surge tanks appear to be risk-significant. Provide the basis for not including the A component cooling water surge tank in DCD Table 17.4-1.

(g) Based on request for additional information (f) above and a cursory review of DCD Tables 19.1-54 and 19.1-55, various risk-significant SSCs may not have been identified in DCD Table 17.4-1 from the SMA (e.g., offsite power system ceramic insulators, battery racks). Therefore, the applicant should ensure that DCD Table 17.4-1 captures the risk-significant SSCs from the SMA.

(h) Item # 49 on page 17.4-16 of DCD Table 17.4-1 identifies the risk-significant piping for the component cooling water system. The staff found the text “CCWS heater piping” in Item # 49 to be unclear (i.e., this may be CCWS header piping). Clarify in DCD Table 17.4-1 the “CCWS heater piping.”

(i) Item # 2 on page 17.4-29 of DCD Table 17.4-1 identifies VWS-MOV-401 and VWSMOV-409 as risk-significant with external leakage as their dominant failure mode.

For alternate containment cooling, the text in Section 6A.14.1 (Part b on page 6A.14.1-3) of the US-APWR PRA suggests that both VWS-MOV-401 and VWSMOV-409 need to close to isolate the non-essential chilled water system in order to prevent CCWS pump run out and to maintain heat removal capability. Therefore, isolation failure of the non-essential chilled water system occurs if VWS-MOV-401 **or** VWS-MOV-409 fails to close. However, fault tree event NCC-02-2 in Section 6A.14.1.B (page 6A.14.1.B-3) of the US-APWR PRA suggests that isolation failure of the non-essential chilled water system occurs if VWS-MOV-401 **and** VWS-MOV-409 fail to close. Clarify whether both VWS-MOV-401 and VWS-MOV-409 need to close to isolate the non-essential chilled water system for alternate containment cooling.

Also, clarify whether the gate under fault tree event NCC-02-2 should be an AND gate or an OR gate. The US-APWR PRA and DCD should be updated accordingly.

(j) DCD Section 9.2.1.2.2.1 (ESWPs) states: “The mode of cooling of the ESWP motors is site-specific and will be determined by the COL Applicant.” US-APWR PRA Section 6A.9.1.1 (System Description) states: “ESW pump motor is supported by either air cooling or water cooling, which is chosen by COL Applicant.” The US-APWR PRA model assumes the ESW pump motors are water cooled and provides a simplified system diagram for water cooling of the ESW pump motors. However, DCD Table 17.4-1 assumes the ESW pump motors are air cooled (i.e., identifies the ESW pump room exhaust fans as risk-significant). Since no design-specific information is provided for the ESW pump motor air cooling system, the staff is not able to determine whether the identification of risk-significant SSCs for the ESW pump motor air cooling system in DCD Table 17.4-1 is acceptable. It may be more appropriate, during the design certification phase, not to include in DCD Table 17.4-1 the SSCs associated with ESW pump motor cooling, because the design of this system is site specific and determined by the COL applicant. Alternatively, it would be acceptable to simply specify the risk-significant SSCs of this system at the system level (i.e., specify in DCD Table 17.4-1 the ESW pump motor cooling system). It should be mentioned that Item # 8 on page 17.4-51 of DCD Table 17.4-1 includes the text “ESW pump cooling line,” which may no longer be applicable. The US-APWR DCD should be updated accordingly.

(l) Based on Table 18.3-1 in the US-APWR PRA, containment isolation valves VCS-AOV-356 and 357 appear to be risk-significant (basic event CIACF2AVCDCIV-ALL in Table 18.3-1). Also, these valves appear to be risk-significant based on the SMA (page 19.1-526 of DCD Table 19.1-55). However, these valves do not appear in DCD Table 17.4-1. Provide the basis for not including in DCD Table 17.4-1 these containment isolation valves. Include in your discussion: the associated risk importance measures (e.g., RAWs and FVs), if available, the consideration of risk evaluations that cover the full spectrum of potential events and the range of plant operating modes considered in Chapter 19 of the US-APWR DCD, and the expert panel’s deliberation for not including this SSC in RAP

ANSWER:

The following addresses each aspect of Question 17.04-67:

a)

As per RAI question, as described in Table 17.04.66-1, FV importance of ACWOO02CT-DP2 exceeds 0.005 and would be identified as a risk significant human error. Because these SSCs used in the operator action (condenser water pump VWS-MPP-351A and cooling tower fan VWS-MEQ-371A) have been modeled in the US-APWR PRA, inclusion into Table 17.4-1 was discussed using risk importance measures of not operator actions but these SSCs.

The estimated FV importance and RAW of the SSCs were less than 0.005 and 2.0, respectively. The estimated risk importance measures did not exceed the criterion for risk-significant SSCs. Therefore, SSCs with regard to the operator actions will not be inserted in Table 17.4-1. Refer to Table 18.2-1 in the US-APWR PRA.

b)

Risk significant human errors are identified using risk importance measure, i.e., FV importance and RAW. Human errors having FV importance with greater than or equal 0.005 and/or RAW with greater than or equal 2.0 can be identified as risk significance.

For SSCs regarding to risk significant human error identified by the above, see the response to RAI #891-6268 Question 17.04-66 (a & b).

c)

MHI has identified the Component Cooling Water Pump Room Floor Drain Pit Water Level Sensors as a risk significant SSC in light of their functionality being cited as a key assumption in DCD Rev.3 Ch 19 Table 19.1-119. The sensors will be added to the D-RAP list under the rationale engineering judgment having a failure to operate (FF) failure mode, as depicted in the attached markup.

d)

MHI will revise the description for CVCS Piping, as depicted in the attached markup to clarify the risk significant CVCS piping.

e)

MHI will clarify the entry for FSS Piping by replacing the existing description with the following:

> Piping between the FWT, the FSS-CSS line connection, and the injection line to the reactor cavity.

f)

MHI will add CCW surge tank, NCS-MTK-001A, under the rationale SM having a SS failure mode.

g)

See the response to Q17.4-16(c).

h)

MHI will revise the CCWS item # 49 to read CCWS ~~heater~~ header piping.

i)

See the response to Question 17.04-66 (a & b).

j)

In the response to DCD RAI Question RAI 585-4464, Q09.02.01-32, the ESWP motors are specified as to be air cooled. See the accompanying markup of DCD Rev. 3 Section 9.2.1.2.2.1.

Table 17.4-1 is also developed, in accordance with the EFW pump motor cooling system in DCD Section 9.2.1.2.2.1. On the other hand, PRA assumes that EFW pump motors are water cooled, which is one assumption in used in the PRA.

In addition to the above, MHI will revise DCD Ch 17.04-1 to delete the reference to the *ESW pump cooling line* in description for ESWS risk significant piping.

l)

The basic event corresponding to common cause failure of these valves (i.e., VCS-AOV-356/357) to close has a RAW value of greater than 2.0 for large release risk at power operation. The valves will be added to Table 17.4-1 under the rationale RAW (Level 2 for internal, internal flood and internal fire) having the failure mode CD (failure to close).

Impact on DCD

DCD Tables 17.4-1 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

The US-APWR PRA will be revised in accordance with the response to Q17.04-67(i).

Impact on Topical/Technical Report

There is no impact on Topical and Technical Reports from this RAI. (See the response to Q17.04-66)

Table 17.4-1 Risk-significant SSCs (Sheet 6 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
42	Piping ~~(CVS charging injection line piping between RWSAT and CVS-VLV-595)~~(Charging pump suction line from volume control tank (VCT) and from RWSAT, CVS charging injection line to RCP seal and to RCS cold leg)	RAW(L1, L2, LP)	EL	

DCD_17.04-67

Table 17.4-1 Risk-significant SSCs (Sheet 11 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
43	B-CCW Surge tank vent valves [NCS-RCV-056B]	RAW/(L2)	EL, IL, OM	The "Insights and Assumptions" for these SSCs are described on the previous page.	
44	~~B-Component cooling water surge tank [NCS-MTK-001B]~~Component cooling water surge tank [NCS-MTK-001A (B)]	RAW/(L2) SM	EL, SS~~, IL, OM~~		DCD_17.04-66 DCD_17.04-67
45	B-CCW Surge tank safety valve [NCS-SRV-003B]	RAW/(L2)	OM		
46	B-CCW Surge tank nitrogen supply stop bypass valve [NCS-VLV-045B]	RAW/(L2)	EL		
47	Charging pump alternate CCW supply line valves [NCS-MOV-322A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	EL, OD, CM, PR		
48	Charging pump alternate CCW return line valves [NCS-MOV-324A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	CM, EL, OD, PR		
49	Piping (Fire service water tank line Piping, Alternate charging pump cooling suction line piping, Alternate charging pump cooling discharge line piping, CCW surge tank line piping, CCWS train piping, ~~CCWS heater~~ CCWS header piping)	RAW(L1, L2, LP, FL1) SM	EL, ~~IL~~SS		DCD_17.04-66 DCD_17.04-67 DCD_17.04-67 S01
50	FSS - CCWS boundary motor operated valves [NCS-MOV-321A (B)] [NCS-MOV-325A (B)]	FV(LP) RAW(L1, L1-CC, L2, LP)	CM, EL, OD, PR	Large external leak from these valves result in loss of alternative component cooling water from both non-essential chilled water system and fire protection water supply system. On the other hand, external leak from other SSCs degrade the fire protection water supply system but the non-essential chilled water system is still available for alternative component cooling. Therefore these valves are risk-significant SSCs in preventing core damage.	
51	CCWS - non-essential chilled water system boundary motor operated valves [NCS-MOV-323A (B)] [NCS-MOV-326A (B)]	RAW(L1, L2, LP)	EL, IL		

Table 17.4-1 Risk-significant SSCs (Sheet 13 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
7	Containment low volume purge supply containment isolation valves [VCS-AOV-356], [VCS-AOV-357]	SM RAW (L2-CC, FL2-CC, FR2-CC)	FS, CD	

DCD_17.04-66
DCD_17.04-67
DCD_17.04-67 S01

Table 17.4-1 Risk-significant SSCs (Sheet 27 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
10	**Fire protection water supply system (FSS)**			
1	FSS pump discharge motor operated valve	FV(L2) RAW(L2)	EL, OD, PR	In the case of core damage accident, fire protection water supply system (FSS) injects water from Raw Water Tank into the reactor cavity via the direct injection line by the fire water pumps. The containment spray system and/or safety injection system perform the reactor cavity flooding through the drain line at loop compartment to prevent core-concrete interaction when the reactor vessel is failed. The FSS performs as alternative function for the reactor cavity flooding. In the case of loss of component cooling water events, FSS or non-essential chilled water system provides alternative component cooling water to charging pumps in order maintain RCP seal water injection.
2	FSS pump discharge flow meter	RAW(L2)	FF, PR	
3	Reactor cavity injection line orifice	RAW(L2)	PR	
4	FSS piping ~~(from tank to tie line piping, from tie line to CSS-VLV-012 piping, from FWT to tie line)~~between the fire suppression water tank, the FSS-CSS line connection, and the injection line to the reactor cavity	RAW(L2)	EL	
5	Fire suppression water tank	RAW(L1, L2)	EL	
6	FSS pump discharge manual valve	RAW(L2, LP)	EL,PR	
7	Motor driven fire suppression pump	EP	BD, YR, EL	
8	Diesel driven fire suppression pump	EP	BD, YR, EL	
9	Reactor cavity injection line motor operated valve [FSS-MOV-004]	EJ	EL, OD, PR	
10	Reactor cavity injection line check valve [FSS-VLV-006]	EJ	EL, OD, PR	
11	Reactor cavity injection line orifice	EJ	PR	

DCD_17.04-67

Table 17.4-1 Risk-significant SSCs (Sheet 35 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
22	Reactor coolant hot leg temperature sensor (Wide range) [RCS-TE-020 (030, 040, 050)]	EJ	FF	These sensors are necessary to perform operator action.
23	Reactor coolant cold leg temperature sensor (Wide range) [RCS-TE-025 (035, 045, 055)]	EJ	FF	
24	Reactor coolant pressure sensor [RCS-PT-020 (030, 040, 050)]	EJ	FF	
25	Pressurizer water level sensor [RCS-LT-061 (062, 063, 064, 065)]	EJ	FF	
26	RCS mid-loop water level sensor (Wide range) [RCS-LT-011]	EJ	FF	
27	Boric acid transfer tank water level transmitter [CVS-LT-116, 118]	EJ	FF	
28	Core exit thermocouples	EJ	FF	
29	Component cooling water pump room floor drain pit water level sensors	EJ	FF	Flooding in the ESWS is isolated within 15 minutes upon a signal from these water level sensors to prevent its propagation to other areas. DCD_17.04-67 DCD_17.04-67 S01
16	**Waste management system (WMS)**			
1	Refueling water storage (RWS) system - WMS line boundary check valve [LMS-VLV-037]	RAW(L1, L2, PL, FL1, FR1, FR2)	EL	Large External leak of the boundary check valve results in loss of inventory from the RWS system. Systems that relies on the RWS as water source is affected by this failure mode.

Table 17.4-1 Risk-significant SSCs (Sheet 48 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	ESW pump discharge line motor operated valves [EWS-MOV-503 A(B,C,D)]	FV(FL2, FR2) RAW(L1, L2, LP, LP-CC, FL1, FR1, FL2, FR2) SM	CM, EL, OD, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
7	Manual valves in main piping [EWS-VLV-506 A(B,C,D)] [EWS-VLV-507 A(B,C,D)] [EWS-VLV508 A(B,C,D)] [EWS-VLV-509 A(B,C,D)] [EWS-VLV-511 A(B,C,D)] [EWS-VLV-514 A(B,C,D)] [EWS-VLV-517 A(B,C,D)] [EWS-VLV-520 A(B,C,D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
8	Piping [ESW pump discharge line, ~~ESW pump cooling line,~~ CCW Hx cooling line A(B,C,D)]	RAW(L1, L2, LP, FL1) SM	EL, SS	
9	Orifices (between EWS-FE-034 (035, 036, 037) and EWS-VLV-520A (B, C, D)	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	PR	

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DCD_17.04-67