Table 19.1-21—Probability Distributions (Lognormal) for the Six Dominant Failure Modes

Failure location	Pmedian (psi)	ß (=σ)
Cylinder wall	260	0.034
Center of dome	189	0.029
Base of cylinder	284	0.25
Base of dome	187	0.16
Eq hatch V2	227	0.16
Eq hatch H2	288	0.13

Table 19.1-22—Containment Isolation Valves Assessed in Level 2 PRA
Sheet 1 of 3

CI Valve ID	CI Line Description	Line size (inches)	CI Valve Type	Normal Position	Failure Mode on Loss of Power	Isolation Signal
JMM10AA006	Leakage Exhaust and Monitoring System, Containment Inflation Deflation - inboard (IB)	10	MO	Closed	Closed	CI Stage 1
JMM10AA007	Leakage Exhaust and Monitoring System, Containment Inflation Deflation - outboard (OB)	10	MO	Closed	Closed	CI Stage 1
KLA10AA001	Containment Sweep Vent System, Small Flow Supply Line - OB	N/A	air switch damper (2 SOVs)	Open (5% per year)	Closed	CI Stage 1
KLA10AA003	Containment Sweep Vent System, Small Flow Supply Line - IB	N/A	air switch damper (3 SOVs)	Open (5% per year)	Closed	CI Stage 1
KLA20AA001	Containment Sweep Vent System, Small Flow Exhaust Line - IB	N/A	air switch damper (3 SOVs)	Open (5% per year)	Closed	CI Stage 1
KLA20AA003	Containment Sweep Vent System, Small Flow Exhaust Line - OB	N/A	air switch damper (2 SOVs)	Open (5% per year)	Closed	CI Stage 1
KLA30AA002	Containment Sweep Vent System, Large Flow Supply Line - OB	N/A	air switch damper (1 SOV)	Closed at Power/ Open in SD	Closed	CI Stage 1
KLA30AA003	Containment Sweep Vent System, Large Flow Supply Line - IB	N/A	air switch damper (1 SOV)	Closed at Power/ Open in SD	Closed	CI Stage 1
KLA40AA001	Containment Sweep Vent System, Large Flow Exhaust Line – IB	N/A	air switch damper (1 SOV)	Closed at Power/ Open in SD	Closed	CI Stage 1
KLA40AA002	Containment Sweep Vent System, Large Flow Exhaust Line - OB	N/A	air switch damper (1 SOV)	Closed at Power/ Open in SD	Closed	CI Stage 1

Table 19.1-22—Containment Isolation Valves Assessed in Level 2 PRA
Sheet 2 of 3

CI Valve ID	CI Line Description	Line size (inches)	CI Valve Type	Normal Position	Failure Mode on Loss of Power	Isolation Signal
KPL84AA002	Gaseous Waste Processing, Inflow Line- OB	2	MO	Open	as is	CI Stage 1
KPL84AA003	Gaseous Waste Processing, Inflow Line - IB	2	MO	Open	as is	CI Stage 1
KPL85AA003	Gaseous Waste Processing, Outflow Line - IB	2	MO	Open	as is	CI Stage 1
KPL85AA004	Gaseous Waste Processing, Outflow Line - OB	2	MO	Open	as is	CI Stage 1
KTA10AA018	Reactor Building Primary Drain - OB	2	MO	Open (1% per year)	as is	CI Stage 1
KTA10AA017	Reactor Building Primary Drain - IB	2	MO	Open (1% per year)	as is	CI Stage 1
KTC10AA005	Contaminated Containment Sump - IB	2	MO	Open (1% per year)	as is	CI Stage 1
KTC10AA006	Contaminated Containment Sump - OB	2	MO	Open (1% per year)	as is	CI Stage 1
KTC10AA010	Contaminated Containment Sump Reinjection Line - OB	2	MO	Open (1% per year)	as is	CI Stage 1
KTC10AA029	Contaminated Containment Sump Reinjection Line - IB	2	Check	Open (1% per year)	as is	N/A
KTD10AA015	Non-Contaminated Containment Sump - OB	2	MO	Open (1% per year)	as is	CI Stage 1
KTD10AA024	Non-Contaminated Containment Sump - IB	2	MO	Open (1% per year)	as is	CI Stage 1
LBA40AA002	Main Steam Isolation Valve	27.5	Oleo-Pneumatic	Open	Closed	MSIV Train 4 isolation

Table 19.1-22—Containment Isolation Valves Assessed in Level 2 PRA
Sheet 3 of 3

CI Valve ID	CI Line Description	Line size (inches)	CI Valve Type	Normal Position	Failure Mode on Loss of Power	Isolation Signal
LBA40AA441	Main Steam Drain Line – OB	2	MO	Closed	as is	MSIV Train 4 isolation
LBA41AA191	Main Steam Safety Valve	8	Spring Safety	Closed	Closed	N/A
LBA42AA191	Main Steam Safety Valve	8	Spring Safety	Closed	Closed	N/A
LBA43A001	Main Steam Relief Train	14	Oleo-Pneumatic	Closed during normal operation-open to provide relief	Closed	MSR Train 4 isolation
LBA43AA101	Main Steam Relief Train	14	MO	Open	as is	MSR Train 4 isolation
LBA44AA001	Main Steam line MSIV bypass – OB	6	MO	Closed	as is	MSIV Train 4 isolation
LCQ51 AA002	SG Blowdown Demin Line - IB	6	MO	Open	as is	CI Stage 1
LCQ51 AA003	SG Blowdown Demin Line - OB	6	MO	Open	as is	CI Stage 1
LCQ52 AA001	SG Blowdown Flash Line - IB	12	MO	Open	as is	CI Stage 1
LCQ52 AA002	SG Blowdown Flash Line - OB	12	MO	Open	as is	CI Stage 1

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 1 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
Containment isolation system	Containment isolation	No support systems inside containment Note: For each of the containment penetrations, the isolation valves are supplied from 480V buses that are located in the applicable train's Safeguard Building. Pneumatically operated dampers on ventilation penetrations fail closed on loss of pneumatic supply or power to the pilot solenoids.	Evaluation of survivability: With the containment successfully isolated all pathways to the active components of this system are isolated from the containment environmental conditions. In the event of any other containment failure, the operation of this system is irrelevant. All signals modeled (in the fault tree model) required for actuation of the containment isolation system are present before the onset of core damage and therefore not subjected to severe accident conditions. Therefore the CET model assumes no impact of severe accident conditions on the operation of this system.
Pressurizer safety valves Severe accident depressurization valves	Depressurization before vessel failure	No support systems inside containment: Note: The pressurizer safety valves are pilot operated valves with power supplied from 120V buses that are located in the applicable train's Safeguard Building. The Severe Accident Depressurization valves are Motor-Operated Valves (MOVs) with power supplied from 480V buses that are located in the applicable train's Safeguard Building.	Evaluation of survivability: These systems are to be qualified for severe accident conditions. Therefore the Level 2 PRA assumes no impact of accident conditions on equipment survivability. Qualification will include any connecting/controlling cables needed for actuation.

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 2 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
Secondary relief and safety valves	Induced SGTR	No support systems inside containment – these valves are located in the main steam line "bridge" areas, that are physically separated from the Reactor Building	Evaluation of survivability: These valves will not be subject to severe accident temperatures or pressures, as the temperature and pressure conditions are controlled by the valve setpoint pressure. Therefore the Level 2 PRA assumes no impact of accident conditions on equipment survivability and only normal "failure to reclose" probabilities will be modeled.
Hydrogen recombiners	Operation is implicitly assumed for the following headers: No containment failure before vessel breach No containment failure at the time of vessel breach No late containment failure due to hydrogen deflagration or FA/ DDT	No support systems – these hydrogen recombiners are passive catalytic media that require no motive power or other support.	Evaluation of survivability: This system will be qualified for severe accidents. However, there are a number of recombiners in the MAAP containment nodes 3, 5, 6, 7, 10, and 23 that have a small susceptibility to the phenomenon of flame acceleration. The phenomenological evaluation for Hydrogen includes the susceptibility of these recombiners to this failure mode. Otherwise, the CET model assumes that the performance of this system is not degraded or impacted by severe accident conditions.

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 3 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
Safety Injection System	Melt retention in-vessel Containment Steam Pressurization Controlled	No support systems inside containment The MHSI and LHSI systems are normally lined up for injection into the primary system, and there are no motor operator valves inside containment that need to operate for safety injection success.	Evaluation of survivability The active, electrically actuated components in this system are not exposed to severe accident conditions. The system connects directly to the RCS but is protected by check valves in the case that it is not operating. Therefore there is no impact of severe accident conditions on the operation of the system. The system model for SIS also includes failure probabilities for the clogging of the suction strainers during accident conditions. These probabilities are considered reasonable for severe accident conditions.
SAHRS passive flooding	Melt stabilization ex-vessel	No support systems inside containment	Evaluation of survivability: This system will be qualified for severe accidents. Furthermore, the passive nature of the operation of the system reduces any potential susceptibility to adverse environmental conditions. On this basis, the CET models will assume that the performance of this system is not degraded or impacted by severe accident conditions.

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 4 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
SAHRS active flooding	Melt stabilization ex-vessel Containment steam pressurization controlled No basemat failure (implicitly assumes continued op of melt stabilization)	No support systems inside containment The valve that operates to initiate active flooding is an MOV with power supplied from a 480V bus that is located in the Train 4's safeguard building	Evaluation of survivability: This system will be qualified for severe accident conditions. Therefore the CET models will assume that the performance of this system is not degraded or impacted by severe accident conditions.
SAHRS Sprays	Melt stabilization ex-vessel Containment steam pressurization controlled No basemat failure (implicitly assumes continued op of melt stabilization)	No support systems inside containment The valve that operates to initiate active flooding is an MOV with power supplied from a 480V buses that is located in the Train 4's SB	Evaluation of survivability: This system will be qualified for severe accidents. Therefore the CET models will assume that the performance of this system is not degraded or impacted by severe accident conditions.

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 5 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
SAHRS sprays (continued operation following containment failure)	Melt stabilization ex-vessel SAHRS sprays actuated to control source term	The dedicated train of CCWS provides cooling water to the SAHRS Heat Exchanger. This CCWS train is supported by a dedicated, separate ESWS train. SAHRS and its support components are supplied by the 480 and 6900V networks of electrical Division 4, and are provided with power from the Division 4 Emergency Diesel Generator and the Division 4 Station Blackout (SBO) Diesel Generator.	Evaluation of survivability: This system will be qualified for severe accidents. Furthermore, the containment is expected to fail at the base of the dome, a location that will not lead to releases into compartments containing SAHRS components.
SAHRS active flooding (continued operation following containment failure for continued melt stabilization)	Melt stabilization ex-vessel	The dedicated train of CCWS provides cooling water to the SAHRS Heat Exchanger. This CCWS trains is supported by a dedicated, separate ESWS train. SAHRS components are supplied by the 480 and 6900V networks of electrical Division 4, and are provided with power from the Division 4 Emergency Diesel Generator and the Division 4 Station Blackout Diesel Generator.	Evaluation of survivability: This system will be qualified for severe accidents. As discussed above, containment failure is not expected to lead to releases into compartments containing SAHRS components, nor to components of its support systems.

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 6 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
Safety injection (continued operation with isolation failure of containment or very early containment failure)	Melt retention in-vessel	The CCWS and ESWS support the LHSI heat exchanger for all four trains, and the LHSI Trains 2 and 3 and MHSI motor pumps and the corresponding sealing fluid. The cooling coils of the LHSI pump motor and seals Trains 1 and 4 are supplied from the air cooled SCWS QK SIS components are supplied by the 480 and 6900V networks of electrical Divisions 1- 4, and are provided with power from the division's Emergency Diesel Generator.	Evaluation of survivability: The evaluation performed for in-vessel recovery applies here, except as follows: 1. The possibility of long term water loss with a failed containment is considered to be unimportant since once sub-cooled conditions are achieved in the RCS there will be no further water loss. 2. As with the SAHRS system, containment failure is not expected to lead to releases into compartments containing SIS components, nor to components of its support systems.

Table 19.1-23—Evaluation of Equipment Survivability for Level 2
Sheet 7 of 7

System	Relevant CET Headers	Support Systems	Comments and Evaluation of Survivability
Instrumentation	Depressurization before vessel failure Melt retention in-vessel Melt stabilization ex-vessel Containment steam pressurization controlled SAHRS sprays actuated to control source term	No support systems inside containment	Evaluation of survivability: The following Severe Accident Instrumentation are required to support the following operator actions: Depressurization of RCS ● Core outlet thermocouples ● RCS wide and narrow range pressure ● Depressurization valve actuation and position Actuation of safety injection for in-vessel core cooling ● Core outlet thermocouples ● RCS wide and narrow range pressure ● IRWST Level and temperature Actuation of SAHRS sprays, active flooding ● Containment pressure ● SAHRS pump inlet and outlet pressure ● SAHRS volumetric flow rate ● SAHRS passive flooding, active flooding, and spray line valve position These instruments will be qualified to the temperatures, pressures, and to the doses expected during their Severe Accident mission time, and are judged to be adequate in supporting their function in the Level 2 CET.

Table 19.1-24—Internal Events Release Category Results - Large Release Frequency
Sheet 1 of 2

Release Category	Description	Mean	Contribution to LRF	Conditional Containment Failure Probability
RC201	Containment fails before vessel breach due to isolation failure, melt retained in vessel	4.5E-10	2.1%	0.0016
RC202	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex vessel, with containment sprays	3.8E-14	0.0%	0.0
RC203	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex vessel, without containment sprays	5.9E-13	0.0%	0.0
RC204	Containment fails before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex vessel with containment sprays	2.4E-11	0.1%	0.0001
RC205	Containment failures before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex vessel without containment sprays	3.3E-10	1.5%	0.0011
RC301	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex vessel, with containment sprays	1.3E-12	0.0%	0.0
RC302	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex vessel, without containment sprays	3.1E-12	0.0%	0.0
RC303	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex vessel, with containment sprays	1.7E-09	7.7%	0.0058

Table 19.1-24—Internal Events Release Category Results - Large Release Frequency
Sheet 2 of 2

Release Category	Description	Mean	Contribution to LRF	Conditional Containment Failure Probability
RC304	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex vessel, without containment sprays	1.4E-08	66.4%	0.049
RC702	Steam Generator Tube Rupture without Fission Product Scrubbing	4.6E-09	21.0%	0.016
RC801	Interfacing System LOCA with Fission Product Scrubbing	0.00E+00	0.0%	0.0
RC802	Interfacing System LOCA without Fission Product Scrubbing but building credited	2.6E-10	1.2%	0.0009
	Total LRF:	2.2E-08	100.0%	0.076

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 1 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC201	2.29E-11	0.1054%	IE SLOCA	Initiator - Small LOCA (0.6 to 3-Inch Diameter)	Level 1: • SLOCA initiator • SW CCF disables SI signal, therefore MHSI does not inject. • Failure of the operators to perform FCD leads to CD.
			CL-PS-B-SWCCF	SW CCF of Protection System diversity group	
			OPE-FCD-40M	Operator Fails to Initiate Fast Cooldown for SLOCA	
			L2FLCDES-SL1	Level 2 FLAG: SL1 CDES	Level 2: • Operators successfully depressurize the primary and recover the core with limited damage • Sequence enters Limited Core Damage CET • SW CCF fails automatic CI signal. • Operators fail to initiate manual CI signal with Containment Sweep Ventilation
			L2FLCET LIMITED CD	Level 2 FLAG: CET LIMITED CD	
			PROB KLA10/20 OP	Probability that the Containment Sweep Vent System Small Flow Lines are Open	
			OPD-L2-CIH	Dependent operator failure to close containment isolation valves	
Internal RC202	2.91E-15	0.0000%	IE SLOCA	Initiator - Small LOCA (0.6 to 3-Inch Diameter)	Level 1: • SLOCA initiator • SW CCF disables SI signal, therefore MHSI does not inject. • Failure of the operators to perform FCD leads to CD.
			CL-PS-B-SWCCF	SW CCF of Protection System diversity group	
			OPE-FCD-40M	Operator Fails to Initiate Fast Cooldown for SLOCA	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 2 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
			L2FLCDES-SL1 L2FLCET1 HI PRESSURE	Level 2 FLAG: SL1 CDES Level 2 FLAG: CET1 HI PRESSURE	Level 2: • Sequence enters CET1 High Pressure • Operators fail to depressurize in both the EOPs and OSSA/SAGs • Sequence enters CET2 High Pressure • SW CCF fails automatic CI signal. • Operators fail to initiate manual CI signal with Containment Sweep Ventilation Small Flow Line Ventilation Valves initially open. • Pit damaged due to overpressure from complete circumferential rupture of the vessel • MCCI occurs due to early melt release from pit
			OPD-L2-DEPRESSH	Operators fail to open enough depress valves (High Dep.)	
			OPD-L2-DEPRESS-40M		
			L2PH LOCA-DEPRESS=N		
			L2FLCET2 HI PRESSURE	Level 2 FLAG: CET2 HI PRESSURE	
			PROB KLA10/20 OP	Probability that the Containment Sweep Vent System Small Flow Lines are Open	
			OPD-L2-CIH	Dependent operator failure to close containment isolation valves	
			L2PH CBV HP	Complete circumferential rupture of vessel	
			L2PH CP-PITF-VF(CBV)	Pit overpressure at high pressure vessel failure fails melt plug given CBV occurs	
			L2PH CCI-EARLYREL=Y	MCCI occurs, following early melt release from pit.	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 3 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC203	1.55E-14	0.0001%	IE SLBI	Initiator - Steam Break Inside Containment	Level 1: • SLBI initiator with consequential LOOP. EDG 2 fails to run, failure to crosstie results in the loss of all Division 2 power. • SAC4 is in maintenance, and LOOP fails the maintenance HVAC train • Operator fails to recover room cooling locally, so electrical buses in Division 4 fail, failing Division 3 ventilation • The MSRTs close due to the loss of Division 2 and 4. Steam relief via MSSVs require 2 EFWs. Only train 1 is available. • Primary bleed is lost due to loss of Division 4
			LOOPCON+REC	Consequential LOOP and Failure of Recovery Within 1 Hour for LOCA IEs	
			XKA20_____DFR	ELEC, Emergency Diesel Generator XKA20, Fails to Run	
			OPF-XTDIV-NSC	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Divison 3 During Non-SBO Conditions	
			SAC04/QKA40 PM4	Normal SAC04/QKA40 Train Unavail due to Preventive Maint	
			OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 4 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
			L2FLCDES-TR1D	Level 2 FLAG: TR1 CDES	Level 2: • Sequence enters CET1 High Pressure • Operators fail to depressurize in both the EOPs and OSSA/SAGs • Sequence enters CET2 High Pressure • SLBI requires SG blowdown line to isolate on CI signal. One line fails to isolate on loss of Division 2 and 3. • Pit damaged due to overpressure from complete circumferential rupture of the vessel • MCCI occurs due to early melt release from the pit. • SAHRS sprays fail to control source term due to the loss of electrical train 4
			L2FLCET1 HI PRESSURE	Level 2 FLAG: CET1 HI PRESSURE	
			L2PH LOCA-DEPRESS=N	Primary remains pressurized until vessel failure	
			L2FLCET2 HI PRESSURE	Level 2 FLAG: CET2 HI PRESSURE	
			L2PH CBV HP	Complete circumferential rupture of vessel	
			L2PH CP-PITF-VF(CBV)	Pit overpressure at high pressure vessel failure fails melt plug given CBV occurs	
			L2PH CCI-EARLYREL=Y	MCCI occurs, following early melt release from pit.	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 5 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC204	2.29E-12	0.0105%	IE SLOCA	Initiator - Small LOCA (0.6 to 3-Inch Diameter)	Level 1: ● SLOCA Initiator ● SW CCF disables SI signal, therefore MHSI does not inject. ● Failure of the operators to perform FCD leads to CD.
			CL-PS-B-SWCCF	SW CCF of Protection System diversity group	
			OPE-FCD-40M	Operator Fails to Initiate Fast Cooldown for SLOCA	
			L2FLCDES-SL1	Level 2 FLAG: SL1 CDES	Level 2: ● Sequence enters CET1 High Pressure ● Operators depressurize primary ● Sequence enters CET Low Pressure ● SW CCF fails automatic CI signal. ● Operators fail to initiate manual CI signal with Containment Sweep Ventilation ● In vessel recovery of core fails, core is released from vessel and successfully cooled in core spreading area
			L2FLCET1 HI PRESSURE	Level 2 FLAG: CET1 HI PRESSURE	
			L2FLOP DEPRESS	Level 2 FLAG: Depressurization of high CDES by operator	
			L2FLCET LO PRESSURE	Level 2 FLAG: CET LO PRESSURE	
			PROB KLA10/20 OP	Probability that the Containment Sweep Vent System Small Flow Lines are Open	
			OPD-L2-CIH	Dependent operator failure to close containment isolation valves	
			L2PH INVREC(S-DEP)=N	In-vessel recovery, phenomenological failure given sufficient injection	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 6 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC205	9.67E-12	0.0446%	IE SLBI	Initiator - Steam Break Inside Containment	Level 1: ● SLBI initiator with consequential LOOP. EDG 2 fails to run, failure to crosstie results in the loss of all Division 2 power. ● SAC4 is in maintenance, and LOOP fails the maintenance HVAC train ● Operator fails to recover room cooling locally, so electrical buses in Division 4 fail, failing of Division 3 ventilation ● The MSRTs close due to the loss of Division 2 and 4. Steam relief via MSSVs require 2 EFWs. Only train 1 is available. ● Primary bleed is lost due to loss of Division 4
			LOOPCON+REC	Consequential LOOP and Failure of Recovery Within 1 Hour for LOCA IEs	
			XKA20_____DFR	ELEC, Emergency Diesel Generator XKA20, Fails to Run	
			OPF-XTDIV-NSC	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During Non-SBO Conditions	
			SAC04/QKA40 PM4	Normal SAC04/QKA40 Train Unavailable due to Preventive Maintenance	
			OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	
			L2FLCDES-TR1D	Level 2 FLAG: TR1 CDES	Level 2: ● Sequence enters CET1 High Pressure ● Operators fail to depressurize in both the EOPs and OSSA/SAGs ● Sequence enters CET2 High Pressure ● SLBI requires SG blowdown line to isolate on CI signal. One valve fails to close on loss of Division 2 and 3. ● Melt successfully stabilized ex vessel, but ● SAHRS spray fail to control source term due to the loss of electrical train 4
			L2FLCET1 HI PRESSURE	Level 2 FLAG: CET1 HI PRESSURE	
			L2PH LOCA-DEPRESS=N	Primary remains pressurized until vessel failure	
			L2FLCET2 HI PRESSURE	Level 2 FLAG: CET2 HI PRESSURE	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 7 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC301	8.60E-14	0.0004%	IE SLOCA	Initiator - Small LOCA (0.6 to 3-Inch Diameter)	Level 1: SLOCA Initiator plus failure of common discharge of MHSI/ACC/ LHSI, failing all injection.
			JNG13AA005CFO_D-ALL	CCF to Open LHSI/MHSI Common Injection Check Valves	
			L2FLCDES-SL1D	Level 2 FLAG: SL1 CDES	Level 2: ● Sequence enters CET1 High Pressure ● Operators depressurize primary ● Sequence enters CET Low Pressure ● Containment fails before vessel rupture due to hydrogen flame acceleration ● Significant CCI occurs with no system failures
			L2FLCET1 HI PRESSURE	Level 2 FLAG: CET1 HI PRESSURE	
			OPE-FCD-40M=Y	Operator Successfully Depressurizes primary	
			L2FLOP DEPRESS	Level 2 FLAG: Depressurization of high CDES by operator	
			L2FLCET LO PRESSURE	Level 2 FLAG: CET LO PRESSURE	
			L2PH VECF-FA(H)	Very early containment failure due to H2 Flame Acceleration (Hi pressure sequences)	
			L2PH CCI	Level 2 phenomena: significant MCCI, no system failures	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 8 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC302	1.26E-13	0.0006%	IE LOOP	Initiator - Loss Of Offsite Power	Level 1: • LOOP Initiator with non recovery of OSP • CCF of ventilation in Division 1 and 4 and failure to recover room cooling result in failure of ventilation in all SBs • All EFW trains fail on loss of ventilation. PBL fails on loss of Division 4.
			REC OSP 2HR	Failure to Recover Offsite Power Within 2 Hours	
			QKA10GH001_FS_B-ALL	CCF of the Air Cooled SCWS Chiller Units to Start	
			OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 9 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
			L2FLCDES-TP	Level 2 FLAG: TP CDES	Level 2: • Sequence enters CET1 High Pressure • Induced hot leg rupture depressurizes primary • Sequence enters CET Low Pressure • Containment fails before vessel rupture due to hydrogen flame acceleration • Significant CCI occurs with no system failures • SAHRS sprays fail to control source term due to loss of Division 1 and 4. Offsite power recovery does not play a role since the buses are failed.
			L2FLCET1 HI PRESSURE	Level 2 FLAG: CET1 HI PRESSURE	
			L2PH CPIHLR-TR,TP=Y	Induced hot leg rupture. Conditional probability given no ISGTR. TR, TRD, TP, TPD cases.	
			L2FLHLR DEPRESS	Level 2 FLAG: Depressurization of high CDES by HLR	
			L2FLCET LO PRESSURE	Level 2 FLAG: CET LO PRESSURE	
			L2PH VECF-FA(H)	Very early containment failure due to H2 Flame Acceleration (Hi pressure sequences)	
			L2PH CCI	Level 2 phenomena: significant MCCI, no system failures	
			L2 REC=Y OSP 2-7H	Offsite power recovered between 2 and 7 hours	
			L2FLREC OSP 2-7H	Level 2 FLAG to mark recovery of OSP in 2-7H	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 10 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC303	1.07E-10	0.4908%	IE SLOCA	Initiator - Small LOCA (0.6 to 3-Inch Diameter)	Level 1: • SLOCA Initiator • MSRIVs fail to open for PCD • Operator fails to initiate F&B
			LBA13AA001PFO_D-ALL	CCF to Open Main Steam Relief Isolation Valves	
			OPE-FB-40M	Operator Fails to Initiate Feed & Bleed for SLOCA	
			L2FLCDES-SL	Level 2 FLAG: SL CDES	Level 2: • Sequence enters CET1 High Pressure • Operators depressurize primary • Sequence enters CET Low Pressure • Containment fails before vessel rupture due to hydrogen flame acceleration
			L2FLCET1 HI PRESSURE	Level 2 FLAG: CET1 HI PRESSURE	
			L2FLOP DEPRESS	Level 2 FLAG: Depressurization of high CDES by operator	
			L2FLCET LO PRESSURE	Level 2 FLAG: CET LO PRESSURE	
			L2PH VECF-FA(H)	Very early containment failure due to H2 Flame Acceleration (Hi pressure sequences)	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 11 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC304 -1, 2, 3, 4, 5, 6, 7, 8	8.54E-09	39.3767%	IE SLBI	Initiator - Steam Break Inside Containment	Level 1 and 2: • This family of cutsets includes SLBI Initiator plus failure of I&C signals for MSIV and MFW Isolation of at least 3 SGs • This leads to uncontrolled reactivity event due to overcooling
			SG4 PRES CCF-ALL or SG4 PRES CCF-234 or SG4 PRES CCF-123 or SG4 PRES CCF-134 or SG4 PRES CCF-124 or APU4 CCF NS-ALL or ALU-B CCF NS-ALL	CCF of SG4 level sensors (WR & NR) or CCF of SG4 level sensors (WR & NR)or CCF of SG4 level sensors (WR & NR) or CCF of SG4 level sensors (WR & NR) or CCF of SG4 level sensors (WR & NR) or CCF of APU-4 Protection Sys Computer Processors (Non-Self-Monitored) CCF of ALU-B Protection System Computer Processors (Non-Self-Monitored)	
			L2FLCDES-ATI	Level 2 FLAG: ATI CDES	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 12 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal RC304 -9, 10, 11, 12	9.76E-10	4.4971%	IE SLBI	Initiator - Steam Break Inside Containment	Level 1 and 2: ● SLBI Initiator, ● At least 3 MSIVs fail to close ● Operator fails to initiate EBS ● This leads to uncontrolled reactivity event due to overcooling
			LBA10AA002PFC_D-ALL or LBA10AA002PFC_D-234 or LBA10AA002PFC_D-134 or LBA10AA002PFC_D-123	CCF to Close 3 or more Main Steam Isolation Valves	
			OPF-EBS-30M	Operator Fails to Manually Actuate EBS (SLB & ATWS)	
			L2FLCDES-ATI	Level 2 FLAG: ATI CDES	
Internal 702	1.21E-09	5.5856%	IE IND SGTR	Initiator – Induced Steam Generator Tube Rupture	Level 1: Induced Steam Generator Tube Rupture with a failure to establish RHR cooling.
			OPE-RHR-4H	Operator Fails to Initiate RHR Within 4 Hours	
			L2FLCDES-SG	Level 2 FLAG: SG CDES	Level 2: SGTR Releases from a SG with feedwater not available
			L2FLCET SGTR	Level 2 FLAG: CET SGT – SGTR with Feedwater Not Available	

Table 19.1-25—Level 2 Internal Events Large Release Significant Cutsets
Sheet 13 of 13

Release Category	Freq /yr	Contribution to LRF (%)	Event Identifier	Event Description	Sequence of events that lead to CD and to Containment Failure
Internal 802	1.28E-10	0.5917%	IE ISL-CVCS HPTR	Initiator - ISLOCA - Tube Rupture High Pressure Letdown Cooler	Level 1: Interfacing system LOCA from a tube rupture in the CVCS high pressure letdown line with a failure to establish RHR
			OPD-RHR4H/ISLOCA	Dependency (MED) Between Operator Actions for Isolating ISLOCA and Initiating RHR	
			L2FLCDES-IS	Level 2 FLAG: IS CDES	Level 2: Interfacing System LOCA release, unscrubbed by submergence
			L2FLCET ISL	Level 2 FLAG: CET ISL	
			L2CP ISL BL NO WATER	Level 2 conditional probability: break location not under water (ISL)	

Table 19.1-26—U.S. EPR Core Damage End States Contributions - Level 2 Internal Events

CDES	LRF (1/yr)	Contribution (Total)
ATI	1.2E-08	57%
SG	2.1E-09	10%
TP	1.7E-09	8%
SG2	1.1E-09	5%
SG1	8.9E-10	4%
TR1	7.3E-10	3%
SG3	4.8E-10	2%
TP1	4.2E-10	2%
SL	4.0E-10	2%
IS	2.7E-10	1%
SPD	2.3E-10	1%
RV	1.7E-10	1%
TR1D	1.6E-10	1%
SL1D	1.3E-10	1%
SP1	1.2E-10	1%
Total	2.2E-08	100%

Table 19.1-27—U.S. EPR Initiating Events Contributions - Level 2 Internal Events

Internal Events IE	Description	Frequency	LRF (1/yr)	Contribution (Total)
IE SLBI	Initiator - Steam Break Inside Containment	1.0E-03	1.3E-08	58%
IE SGTR	Initiator - Steam Generator Tube Rupture	3.5E-03	2.9E-09	13%
IE LOOP	Initiator - Loss Of Offsite Power	1.9E-02	2.6E-09	12%
IE IND SGTR	Initiator - Induced Steam Generator Tube Rupture	1.2E-06	1.7E-09	8%
IE SLOCA	Initiator - Small LOCA (0.6 to 3-Inch Diameter)	1.4E-03	6.6E-10	3%
IE GT	Initiator - General Transient (Includes Turbine Trip and Reactor Trip)	7.5E-01	4.9E-10	2%
IE LOMFW	Initiator - Total Loss of Main Feedwater	9.6E-02	1.6E-10	1%
IE LBOP	Initiator - Loss of Balance of Plant - Closed Loop Cooling Water or Aux Cooling Water	5.1E-02	1.4E-10	1%
IE ISL-CVCS HPTR	Initiator - ISLOCA - Tube Rupture High Pressure Letdown Cooler	9.1E-10	1.3E-10	1%
IE LOC	Initiator - Loss of Main Condenser (Includes MSIV Closure etc.)	8.1E-02	1.0E-10	<1%
IE LOCCW-CH1L	Initiator - Loss of CCWS/ESWS - Leak in Common Header 1	2.0E-01	1.0E-10	<1%
		Total	2.2E-08	100%

Table 19.1-28—U.S. EPR Risk-Significant Phenomena based on FV Importance - Level 2 Internal Events

Rank	ID	Description	Nominal Value	FV	RAW
1	L2PH VECF-FA(H)	Very early containment failure due to H2 Flame Acceleration (Hi pressure sequences)	1.6E-02	0.169	11.4
2	L2PH CPIHLR-TR, TP=Y	Induced hot leg rupture. Conditional probability given no ISGTR. TR, TRD, TP, TPD cases.	9.5E-01	0.104	1.0
3	L2PH LOCA-DEPRESS=N	Level 2 phenomena. Small LOCA remains at high pressure.	1.0E+00	0.011	1.0
4	L2PH VECF-FA(HL)	Very early flame acceleration loads fail containment following induced Hot Leg Rupture	1.3E-03	0.010	9.1
5	L2PH INVREC(NR)=N	In vessel recovery phenomenological failure. Default, non-recoverable cases	1.0E+00	0.008	1.0

Table 19.1-29—U.S. EPR Risk-Significant Phenomena based on RAW Importance - Level 2 Internal Events

Rank	ID	Description	Nominal Value	RAW	FV
1	L2PH VECF-FA(H)	Very early containment failure due to H2 Flame Acceleration (Hi pressure sequences)	1.6E-02	11.4	0.169
2	L2PH VECF-FA(HL)	Very early flame acceleration loads fail containment following induced Hot Leg Rupture	1.3E-03	9.1	0.010
3	L2PH VECF-H2DEF(HL)	Very early CF due to hydrogen deflagration. High pressure CDES with Induced Hot Leg Rupture	1.4E-04	7.1	0.001
4	L2PH STM EXP INV LP	Level 2 phenomena: containment failure due to in-vessel steam explosion. Low pressure CET sequences.	5.6E-06	2.7	0.000

Table 19.1-30—U.S. EPR Risk-Significant Equipment based on FV Importance - Level 2 Internal Events

RANK	System	Component ID	Description	FV	RAW
1	MSS	30LBA40AA002	MSS, Main Steam Isolation Train 4	0.067	12.1
2	ELEC	30XKA10/20/30/40	ELEC, Emergency Diesel Generator Train	0.058	1.5
3	SCWS	30QKA10/40GH001	SCWS, Chiller Unit Train	0.058	8.3
4	MSS	30LBA10/20/30AA002	MSS, Main Steam Isolation Valve, Trains 1, 2, and 3	0.041	1.1
5	ELEC	31/34BTD01_BAT	ELEC, 250V 1E 2-hr Battery Trains 1 and 4	0.025	17.2
6	EFWS	30LAS11/41AP001	EFWS, Motor Driven Pump Trains 1 and 4	0.016	1.9
7	MSS	30LBA13/23/33/43AA001	MSS, MSRIV Train	0.016	1.6
8	ELEC	30XKA50/80	ELEC, SBO Diesel Generator Train	0.015	1.2
9	HVAC	30SAC01/04AN001 30SAC31/34AN001	SAC, Normal Air Supply/Exhaust Fan	0.014	7.8
10	EFWS	30LAS21/31AP001	EFWS, Motor Driven Pump Train 2 and 3	0.013	1.4
11	ELEC	32/33 BTD01-BAT	ELEC, 250V 1E-2hr Battery, Trains 2 and 3	0.013	1.4
12	SCWS	30QKA10/40AP107	SCWS, Motor Driven Safety Chiller Pump Trains 1 and 4	0.010	7.7
13	HVAC	20SAC02/03AN001/ 30SAC32/33AN001	SAC, Normal Air Supply/Exhaust Fan Trains 2 and 3	0.010	1.3
14	MSS	30LBA43AA101	MSS, MSRCV Train 4	0.009	3.7
15	SCWS	30QKA20/30AP107	SCWS, Motor Driven Safety Chiller Pump Trains 2 and 3	0.006	1.0
16	SIS/RHRS	30JNG13/23/33/43AA005	LHSI, First SIS Isolation Valve CL Train	0.006	1.1
17	ELEC	30BRW70BUW71	ELEC, 24V DC I&C Power Rack	0.005	226.0

Table 19.1-31—U.S. EPR Risk-Significant Equipment based on RAW Importance - Level 2 Internal Events

Rank	System	Component ID	Description	RAW	FV
1	ELEC	30BRW70BUW71/ 30BRW52BUW53/ 30BRW32BUW33/ 30BRW10BUW11	ELEC, 24V DC I&C Power Rack	226.0	0.005
2	ELEC	31/32/33/34BRA	ELEC, 480V MCC 34BRA	18.3	0.003
3	ELEC	31/34BTD01_BAT	ELEC, 250V 1E 2-hr Battery	17.2	0.025
4	ELEC	34BUC	ELEC, 250V DC Bus 34BUC	12.6	0.000
5	MSS	30LBA40AA002	MSS, Main Steam Isolation Valve Train 4	12.1	0.067
6	MSS	30LBA41/42AA191	MSS, Main Steam Safety Relief Valve	11.7	0.002
7	SCWS	30QKA10/40GH001	SCWS, Chiller Unit Train 1 and 4	8.3	0.058
8	HVAC	30SAC01/04/31/34AN001	SAC, Normal Air Supply/Exhaust Fan	7.8	0.014
9	SCWS	30QKA10/40AP107	SCWS, Motor Driven Safety Chiller Pump Trains 1 and 4	7.7	0.010
10	EFWS	30LAR10/20/30/40BB001	EFWS, EFW Storage Tank Train	7.3	0.000
11	ELEC	31/34BNB01	ELEC, 480V MCC	6.1	0.001
12	ELEC	31/32BTB01_BAT	ELEC, 250V Non 1E 12-hr Battery	5.8	0.003
13	HVAC	30SAC01/04AA005	SAC, Normal Air Inlet Supply Fan Discharge Check Damper	5.2	0.000
14	ELEC	31BUC	ELEC, 250V DC Bus 31BUC	4.7	0.000
15	ELEC	34BDA	ELEC, 6.9kV SWGR 34BDA	4.7	0.000
16	CCWS	30KAB20/30AA192	CCWS, CCWS CH2 Return Safety Valve Train	4.4	0.000
17	MSS	30LBA43AA101	MSS, Train 4 MSRCV	3.7	0.009
18	ELEC	31/34BRB	ELEC, 480V MCC	3.4	0.000
19	ELEC	31/32BUD	ELEC, Non 1E 250V DC Distribution Panel	3.3	0.000
20	ELEC	31/32BRU03	ELEC, Inverter	2.3	0.000
21	ELEC	34BDB/BDC	ELEC, 6.9kV SWGR	2.2	0.000
22	ELEC	34BMB	ELEC, 480V Load Center	2.2	0.000
23	ELEC	31/32BRC	ELEC, 480V MCC	2.1	0.000

Table 19.1-32—U.S. EPR Risk-Significant Human Actions based on FV Importance - Level 2 Internal Events

Rank	ID	Description	Nominal Value	FV	RAW
1	OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	1.3E-02	0.172	14.0
2	OPE-RHR-4H	Operator Fails to Initiate RHR Within 4 Hours	1.0E-03	0.080	79.6
3	OPF-EBS-30M	Operator Fails to Manually Actuate EBS (SLB & ATWS)	2.2E-02	0.051	3.3
4	OPF-XTDIV-NSC	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Divison 3 During Non-SBO Conditions	5.0E-01	0.028	1.0
5	OPE-FB-40M	Operator Fails to Initiate Feed & Bleed for SLOCA	1.3E-01	0.018	1.1
6	OPE-FB-90M	Operator Fails to Initiate Feed & Bleed for Transient	5.0E-04	0.011	22.0
7	OPD-RHR4H/SGTR1H	Dependency (MED) Between Operator Actions for Stabilizing SGTR and Initiating RHR	1.4E-01	0.009	1.1
8	OPF-SGTR-1H	Operator Fails to Isolate SGTR and Initiate Cooldown	2.0E-03	0.009	5.7
9	OPD-RHR4H/ISLOCA	Dependency (MED) Between Operator Actions for Isolating ISLOCA and Initiating RHR	1.4E-01	0.009	1.1
10	OPF-XTLDSBO-NSC	Operator Fails to Connect and Load SBO DGs to Div 1 or 4 During Non-SBO Conditions	1.0E-01	0.008	1.1
11	OPE-FCD-40M	Operator Fails to Initiate Fast Cooldown for SLOCA	1.3E-01	0.006	1.0

Table 19.1-33—U.S. EPR Risk-Significant Human Actions based on RAW Importance - Level 2 Internal Events

Rank	ID	Description	Nominal Value	RAW	FV
1	OPE-RHR-4H	Operator Fails to Initiate RHR Within 4 Hours	1.0E-03	79.6	0.080
2	OPF-SGTR-4H	Operator Fails to Isolate Blowdown Line for SGTR	1.1E-04	41.3	0.004
3	OPE-FB-90M	Operator Fails to Initiate Feed & Bleed for Transient	5.0E-04	22.0	0.011
4	OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	1.3E-02	14.0	0.172
5	OPF-SAC-1H	Operator Fails to Start Maintenance HVAC Trains After Failure of Normal SAC Safety Train	2.0E-04	7.0	0.001
6	OPF-SGTR-1H	Operator Fails to Isolate SGTR and Initiate Cooldown	2.0E-03	5.7	0.009
7	OPF-EBS-30M	Operator Fails to Manually Actuate EBS (SLB & ATWS)	2.2E-02	3.3	0.051
8	OPF-XTLDSBO-2H	Operator Fails to Connect and Load SBO DGs to Div 1 and 4	6.0E-04	2.0	0.001

Table 19.1-34—U.S. EPR Risk-Significant Common Cause Events based on RAW Importance - Level 2 Internal Events
Sheet 1 of 2

Rank	System	ID	Description	Nominal Value	RAW
1	ELEC	BTD01_BAT__ST_D-ALL	CCF of Safety-related Batteries on Demand	2.9E-07	35,900.0
2	HVAC	SAC01/31AN001EFR_D-ALL	CCF to Run Normal Air Supply/Exhaust Fans	1.3E-06	6,310.0
3	SCWS	QKA10AP107EFR_D-ALL	CCF of SCWS Pumps to Run	6.4E-07	6,210.0
4	SIS/RHRS	JNG13AA005CFO_D-ALL	CCF to Open LHSI/MHSI Common Injection Check Valves	4.5E-06	1,290.0
5	IRWST	JNK10AT001SPG_P-ALL	CCF of IRWST Sump Strainers - Plugged	5.7E-07	1,230.0
6	MSS	LBA10AA002PFC_D-ALL	CCF to Close Main Steam Isolation Valves	1.2E-05	1,190.0
7	MSS	LBA13AA001PFO_D-ALL	CCF to Open Main Steam Relief Isolation Train	3.7E-05	302.0
8	ELEC	XKA10_____DFR_D-ALL	CCF of EDGs to Run (Start)	1.0E-04	279.0
9	SCWS	QKA10GH001_FR_B-ALL	CCF of the Air Cooled SCWS Chiller Units to Run	2.2E-05	181.0
10	CCWS	KAA12AA005EFO_D-ALL	CCF to Open CCWS to LHSI HTX Cooling MOV	2.2E-05	146.0
11	ESWS	PED10AN002EFS_D-ALL	CCF to Start Standby Cooling Tower Fans (Run)	1.9E-05	146.0
12	EFWS	LAS11AP001EFS_D-ALL	CCF of EFWS Pumps to Start (Run)	1.1E-05	130.0
13	SIS/RHRS	JNG10AP001EFS_D-ALL	CCF of LHSI Pumps to Start (Run)	1.9E-06	128.0
14	ESWS	PEB10AA004CFO_D-ALL	CCF to Open ESWS Pump Discharge Check Valves	4.5E-07	123.0
15	MSS	LBA11AA191SFO_H-ALL	CCF to Open Main Steam Safety Relief Valves	1.1E-05	118.0
16	SCWS	QKA10GH001_FS_B-ALL	CCF of the Air Cooled SCWS Chiller Units to Start	1.6E-04	112.0
17	SIS/RHRS	JNG10AA011CFO_D-ALL	CCF to Open LHSI Discharge Check Valves	2.3E-07	108.0
18	SCWS	QKA10AP107EFS_D-ALL	CCF of SCWS Pumps to Start	2.6E-06	106.0
19	HVAC	SAC01AN001EFS_D-ALL	CCF to Start Normal Air Supply Fans	8.1E-07	88.7

Table 19.1-34—U.S. EPR Risk-Significant Common Cause Events based on RAW Importance - Level 2 Internal Events
Sheet 2 of 2

Rank	System	ID	Description	Nominal Value	RAW
20	SIS/RHRS	JNA10AA003EFO_D-ALL	CCF to Open LHSI Pump Suction from RCS MOVs	1.1E-05	75.3

Table 19.1-35—U.S. EPR Risk-Significant I&C Events based on RAW Importance - Level 2 Internal Events

Rank	ID	Description	Nominal Value	RAW
1	CL-TXS-OSCCF	SW CCF of TXS operating system or multiple diversity groups	1.0E-07	56,000.0
2	CL-PS-B-SWCCF	SW CCF of Protection System diversity group B	5.0E-06	48,200.0
3	ALU-B CCF NS/SM-ALL	CCF of ALU-B Protection System Computer Processors	3.3E-07/ 9.0E-08	48,100.0
4	APU4 CCF NS/SM-ALL	CCF of APU-4 Protection System Computer Processors	3.3E-07/ 9.0E-08	47,600.0
5	SG4 PRES CCF-ALL	CCF of SG4 pressure sensors	8.4E-07	47,600.0
6	SAS CCF-ALL	CCF of SAS Divisions	5.0E-07	659.0
7	APU3 CCF NS/SM-ALL	CCF of APU-3 Protection System Computer Processors	3.3E-07/ 9.0E-08	519.0
8	PZR PRES CCF-ALL	CCF of pressurizer (RCS) pressure sensors	8.4E-07	296.0
9	SG4 LVL CCF-ALL	CCF of SG4 level sensors (WR & NR)	1.7E-06	186.0
10	CL-PS-A-SWCCF	SW CCF of Protection System diversity group A	5.0E-06	127.0
11	ALU-A CCF NS/SM-ALL	CCF of ALU-A Protection System Computer Processors	3.3E-07/ 9.0E-08	92.9
12	APU2 CCF NS/SM-ALL	CCF of APU-2 Protection System Computer Processors	3.3E-07/ 9.0E-08	92.9

Table 19.1-36—U.S. EPR Risk-Significant PRA Parameters - Level 2 Internal Events Sheet 1 of 2

ID	Description	Nominal Value	FV	RAW
PRA Modeling Parameters				
L2CP ISL BL NO WATER	Level 2 conditional probability: break location not under water (ISL)	1.0E+00	0.013	1.0
PROB KTA10 17/18 OP	Probability that Primary Drain line KTA10 is open.	1.0E-02	0.006	1.6
PROB KTC10 05/06 OP	Probability that Containment Sump Line KTC is Open.	1.0E-02	0.006	1.6
PROB KTD10 24/15 OP	Probability that NCS line is open.	1.0E-02	0.006	1.6
PROB SEAL LOCA	Probability of seal LOCA Occurring Given a Loss of Seal Cooling	2.0E-01	0.016	1.1
STUCK ROD	Stuck Control Rods	4.1E-08	0.008	203,000.0
Preventive Maintenance				
CCWS/ESWS PM2	CCWS/ESWS Train 2 Pump Unavailable due to Preventive Maintenance	6.0E-02	0.008	1.1
CCWS/ESWS PM3	CCWS/ESWS Train 3 Pump Unavailable due to Preventive Maintenance	6.0E-02	0.007	1.1
EDG PM2	EDG Train 2 Unavailable due to Preventive Maintenance	4.0E-02	0.006	1.1
EDG PM3	EDG Train 3 Unavailable due to Preventive Maintenance	4.0E-02	0.005	1.1
EFWS PM1	EFWS Train 1 Unavailable due to Preventive Maintenance	4.0E-02	0.009	1.2
EFWS PM4	EFWS Train 4 Unavailable due to Preventive Maintenance	4.0E-02	0.024	1.6
SAC01/QKA10 PM1	Normal SAC01/QKA10 Train Unavailable due to Preventive Maintenance	3.0E-02	0.049	2.6
SAC04/QKA40 PM4	Normal SAC04/QKA40 Train Unavailable due to Preventive Maintenance	3.0E-02	0.042	2.4

Table 19.1-36—U.S. EPR Risk-Significant PRA Parameters - Level 2 Internal Events Sheet 2 of 2

Offsite Power Related Events				
L2 REC OSP 2-7H	Offsite power not recovered between 2 and 7 hours	3.2E-01	0.036	1.1
L2 REC OSP 7-31H	Offsite power not recovered between 7 and 31 hours	3.0E-01	0.010	1.0
L2 REC=Y OSP 2-7H	Offsite power recovered between 2 and 7 hours	6.8E-01	0.082	1.0
L2 REC=Y OSP 7-31H	Offsite power recovered between 7 and 31 hours	7.0E-01	0.026	1.0
LOOP24+REC	Loss Of Offsite Power During Mission Time and Failure of Recovery Within 1 Hour	4.8E-05	0.002	39.9
LOOPCON+REC	Consequential LOOP and Failure of Recovery Within 1 Hour for IEs Leading to Auto Scram	1.8E-03	0.096	54.1
LOOPCONL+REC	Consequential LOOP and Failure of Recovery Within 1 Hour for IEs Leading to a LOCA (No Recovery)	5.3E-03	0.009	2.7
LOOPCSD+REC	Consequential LOOP and Failure of Recovery Within 1 Hour for IEs Leading to a Controlled Shutdown	1.8E-04	0.001	9.1
REC OSP 1HR	Failure to Recover Offsite Power Within 1 Hour	5.3E-01	0.011	1.0
REC OSP 2HR	Failure to Recover Offsite Power Within 2 Hours	3.2E-01	0.098	1.2

Table 19.1-37—Summary of Cutsets for Seismic Sequences with LOOP
Sheet 1 of 2

Seismic Failures[1]	Non-Seismic Failures of Equipment	Human Failure Events	Description
AC	—	—	Total loss of AC power, leading to loss of secondary cooling and failure of feed-and-bleed cooling.
I&C	—	—	No auto actuation or instrumentation for operators.
EDG	—	—	Total loss of AC power, leading to loss of secondary cooling and failure of feed-and-bleed cooling.
BAT	—	—	Failure of DC power, causing unavailability of diesel-generators, and total loss of AC power.
ESWS	—	—	Failure of ESW causing unavailability of diesel-generators, and total loss of AC power.
SAC	—	—	Failure of room cooling, leading to total loss of AC power and failure of I&C.
EFW	—	OPE-FB-90M	Failure of secondary cooling due to seismic failure of EFW, and failure of operators to effect feed-and-bleed cooling.
CCWS	PROB SEAL LOCA	—	Seismic failure of CCWS causes loss of cooling for RCP seals, and a seal LOCA results. Unavailability of CCWS precludes cooling of IRWST.
SEAL LOCA and MHSI	—	OPE-FCD-40M	Seismically induced seal LOCA and failure of MHSI, with failure of the operators to perform a fast cooldown to permit use of LHSI.
SEAL LOCA and (MSRT or EFW)	—	OPE-FB-40M	Seismically induced seal LOCA and failure of secondary cooling, with failure of the operators to effect feed-and-bleed cooling.

Table 19.1-37—Summary of Cutsets for Seismic Sequences with LOOP
Sheet 2 of 2

Seismic Failures[1]	Non-Seismic Failures of Equipment	Human Failure Events	Description
EFW	EDG1or EDG2 or EDG3 or EDG4	OPF-XTDIV-NSC	Seismic failure of EFW and failure of an emergency diesel generator with failure of operator action to cross-tie AC division. Battery depleting causes loss of DC power at 2 hours, leading to closure of a PSV and failure of feed-and-bleed cooling.
EFW	CCWS/ESWS PM2 or CCWS/ESWS PM3	OPF-XTDIV-NSC	Seismic failure of EFW and failure of cooling for emergency diesel-generator with failure of operator action to cross-tie AC division. Battery depletion causes loss of DC power at 2 hr, leading to closure of a PSV and failure of feed-and-bleed cooling. Note that CCWS/ESWS Divisions 1 and 4 have the same non-seismic failure impact as Divisions 2 and 3, but do not show up because they are assumed to be normally running in the model (no maintenance, PM).
EFW	SAC PM1 or SAC PM2 or SAC PM3 or SAC PM4	OPF-SAC-2H	Seismic failure of EFW and failure of room cooling, leading to loss of DC power at 2 hr, which causes the PSV to close, resulting in failure of feed-and-bleed cooling.

NOTE:

1. Only single element seismic failure cutsets are shown except as required to show random equipment failure and human action failure contributions.

Table 19.1-38—U.S. EPR Locations Selected for the Flooding Analysis and Corresponding Flooding Frequencies

U.S. EPR Location	Systems Considered in the Flooding Frequency Calculation	Flooding Frequency (1/yr)	Basis for Frequency
Safeguard Building 1 or 4	CCWS, DWS, ESWS, FWDS, SIS, Seal Water System	1.4E-03	Segment count for the systems considered
	EFWS	3.3E-04	Segment count for the EFW system
Safeguard Building 2 or 3	CCWS, DWS, ESWS, FWDS, SIS	9.4E-04	Segment count for the systems considered
	EFWS	3.6E-04	Segment count for the EFW system
Fuel Building	CCWS, CVCS, DWS, FPCS, FPPS, RBWMS, Seal Water System	3.0E-03	Segment count for the systems considered
Reactor Building Annulus	FWDS	3.2E-04	Segment count for the FWD system
ESW Cooling Tower Structures	ESWS, FWDS	1.8E-04	Segment count for the systems considered
Turbine Building	N/A	3.3E-02	Generic frequency from NUREG/CR-2300

Table 19.1-39—Flooding Scenarios Description and Frequency Calculation
Sheet 1 of 2

Flooding Scenario	Description	Unavailable Mitigating Systems	Frequency (1/yr)	Distribution Type (parameter)	Basis for Frequency
FLD-SAB 14 FB	Flood in the Safeguard Building 1 or 4 (Pump Room) including the FB, from all flooding sources except EFW	SB 4 systems (CCW4, CCW CH2, EFW4, MHSI4, LHSI4, SAHRS), FB systems (EBS and CVCS)	5.8E-03	Beta (0.5, 85)	SB 1 + SB 4 + FB frequency (excluding EFW)
FLD-SAB 23	Flood in the Safeguard Building 2 or 3 (Pump Room), from all flooding sources except EFW	SB2 systems (CCW2, MHSI2, LHSI2, EFW2)	1.9E-03	Beta (0.5, 260)	SB2 + SB 3 frequency (excluding EFW)
FLD-EFW	EFW-caused flood in the SB 1 or SB 4 propagating to the FB	SB 4 systems (CCW4, CCW CH2, EFW4, MHSI4, LHSI4, SAHRS), FB systems (EBS/CVCS) If isolation fails, or in case of LOOP, all 4 EFW trains	1.4E-03	Beta (0.5, 360)	SB 1 + SB2 + SB 3 + SB 4 EFW frequency
FLD-TB	Flood in the TB	MFW and SSS (LBOP)	3.3E-02	Beta (0.49, 14)	NUREG/CR-2300
FLD-ESW	Flood in the ESW Building	UHS4 / SAHRS	7.2E-04	Beta (0.5, 690)	4*ESWB frequency
FLD-ANN ALL	Flood in the RB Annulus (contained)	Probability of failure of the connection boxes to the containment (general failure) estimated to be 0.5	6.4E-08	Beta (0.5, 7.8E+6)	Event tree based on annulus frequency
FLD-ANN SB23	Flood in the RB Annulus, propagating to the SB2 and 3 (Pump Room)	SB 1 systems (CCW1, CCW CH1, EFW1, MHSI1, LHSI1) and SB 3 systems (CCW3, CCW CH3, EFW3, MHSI3, LHSI3)	5.8E-07	Beta (0.5, 8.7E+5)	Event tree based on annulus frequency

Table 19.1-39—Flooding Scenarios Description and Frequency Calculation
Sheet 2 of 2

Flooding Scenario	Description	Unavailable Mitigating Systems	Frequency (1/yr)	Distribution Type (parameter)	Basis for Frequency
FLD-ANN SB2	Flood in the RB Annulus, propagating to the SB2 (Pump Room)	SB 1 systems (CCW1, CCW CH1, EFW1, MHSI1, LHSI1)	5.8E-06	Beta (0.5, 8.7E+4)	Event tree based on annulus frequency

Table 19.1-40—U.S. EPR Initiating Events Contributions - Level 1 Internal Flooding

Flood IE	Description	Frequency (1/yr)	CDF (1/yr)	CDF (%)
IE FLD-ANN ALL	Flood in the RB Annulus (contained)	6.4E-08	3.2E-08	50.0%
IE FLD-SAB14 FB	Flood in the Safeguard Building 1 or 4 (Pump Room) including Fuel Building, excluding EFW-caused floods	5.8E-03	2.1E-08	32.3%
IE FLD-EFW	EFW-caused flood in the Safeguard Building 1 or 4 propagating to the Fuel Building	1.4E-03	7.2E-09	11.3%
IE FLD-TB	Flood in the Turbine Building	3.3E-02	4.0E-09	6.3%
IE FLD-SAB23	Flood in the Safeguard Building 2 or 3 (Pump Room) , excluding EFW-caused floods	1.9E-03	3.3E-11	0.1%
IE FLD-ESW	Flood in the Essential Service Water Building	7.2E-04	4.0E-11	0.1%
IE FLD-ANN SAB23	Flood in the RB Annulus, propagating to the Safeguard Building 2 and 3 (Pump Room)	5.8E-07	8.9E-13	0.0%
IE FLD-ANN SAB2	Flood in the RB Annulus, propagating to the Safeguard Building 2 (Pump Room)	5.8E-06	1.3E-12	0.0%
		Total:	6.4E-08	100.0%
		Total RS:	6.1E-08	

Next File