Table 19.1-81—U.S. EPR Risk-Significant Equipment based on FV Importance -Level 2 Internal Fires

System	Component ID	Description	FV	RAW
ELEC	31/32BRA	ELEC, 480V MCC	0.038	217.0
SCWS	30QKA10GH001	SCWS, Chiller Unit Train 1	0.030	28.6
ESWS	30PED10AN002	UHS, Cooling Tower Cooling Fan Train 1	0.023	2.8
ELEC	30XKA20	ELEC, Emergency Diesel Generator, Train 2	0.022	1.5
ESWS	30PED20/30AN002	UHS, Cooling Tower Cooling Fan, Trains 2 and 3	0.018	2.1
CCWS	30KAA12AA005	CCWS, LHSI HTX Cooling MOV Train 1	0.017	2.6
SCWS	30QKA40GH001	SCWS, Train 4 Chiller Unit	0.016	15.2
ELEC	30XKA10	ELEC, Emergency Diesel Generator, Train 3	0.015	1.3
CCWS	30KAA22/32AA005	CCWS, LHSI HTX 20 Cooling MOV Trains 2 and 3	0.014	2.0
MSS	30LBA13/23/33/43	MSS, MSRIV Train	0.014	1.1
HVAC	30SAC01/31AN001	SAC, Normal Air Supply/Exhaust Fan Train 1	0.012	25.7
ELEC	30XKA30	ELEC, Emergency Diesel Generator Train 3	0.012	1.1
EFWS	30LAS11AP001	EFWS, Motor Driven Pump Train	0.011	1.3
ESWS	30PEB20/30AP001	ESWS, Motor Driven Pump Trains 2 and 3	0.010	2.6
ESWS	30PED40AN002	UHS, Cooling Tower Cooling Fan Train 4	0.009	1.0
MSS	30LBA10/20AA002	MSS, Main Steam Isolation Valve Trains 1 and 2	0.009	5.6
CCWS	30KAA42AA005	CCWS, LHSI HTX 40 Cooling MOV	0.008	1.0
HVAC	30SAC34/04AN001	SAC, Normal Air Supply/Exhaust Fan Train 4	0.008	15.0
ELEC	30XKA40	ELEC, Emergency Diesel Generator Train 4	0.007	1.0
SCWS	30QKA20/30GH001	SCWS, Chiller Unit Trains 2 and 3	0.006	8.9
SIS/ RHRS	30JNG13/23/ 33AA005	LHSI, First SIS Isolation Check Valve to CL1, 2 and 3	0.006	1.8
SIS/ RHRS	30JND10/30AP001	MHSI, MHSI Motor Driven Pump Trains 1 and 3	0.006	1.2
OCWS	30QNA21/24AN001	OCWS, Chiller Unit Trains 1 and 4	0.006	9.3
MSS	30LBA30AA002	MSS, Train 3 Main Steam Isolation Valve	0.005	2.5
ELEC	30XKA50	ELEC, SBO Diesel Generator	0.005	1.1

Table 19.1-82—U.S. EPR Risk-Significant Equipment based on RAW Importance – Level 2 Internal Fires
Sheet 1 of 2

Rank	System	Component ID	Description	RAW	FV
1	ELEC	31BRA/32BRA	ELEC, 480V MCC	217.0	0.038
2	ELEC	31BDA/BDB/BDC	ELEC, 6.9kV SWGR	204.0	0.005
3	ELEC	30BRW32BUW33/ 30BRW10BUW11	ELEC, 24V DC I&C Power Rack	195.0	0.005
4	ELEC	31/32BMB	ELEC, 480V Load Center	195.0	0.005
5	ELEC	32BDA/BDB	ELEC, 6.9kV SWGR	195.0	0.005
6	SCWS	30QKA10GH001	SCWS, Chiller Unit Train	28.6	0.025
7	HVAC	30SAC01/31AN001	SAC, Normal Air Supply/ Exhaust Fan, Train 1	25.7	0.011
8	CCWS	30KAB10AA192	CCWS, CCWS CH Safety Valve	15.6	0.001
9	SCWS	30QKA40GH001	SCWS, Chiller Unit Train 4	15.2	0.016
10	HVAC	30SAC04/34AN001	SAC, Normal Air Supply/ Exhaust Fan, Train 4	15.0	0.008
11	OCWS	30QNA21/24AN001	OCWS, Chiller Unit, Trains 1 and 4	9.3	0.006
12	SCWS	30QKA20/30GH001	SCWS, Chiller Unit, Trains 2 and 3	8.9	0.006
13	HVAC	30SAC02/32AN001	SAC, Normal Air Supply/ Exhaust Fan, Train 2	8.7	0.005
14	SIS/RHRS	30JNA10AA101	RHR, LHSI Train 1 HTX Bypass MOV	7.9	0.000
15	HVAC	30SAC03AN001/ 30SAC33AN001	SAC, Normal Air Supply/ Exhaust Fan, Train 3	7.2	0.004
16	ELEC	33/34BMB	ELEC, 480V Load Center	7.1	0.000
17	ELEC	34BDA/BDB 33BDB/34BDC	ELEC, 6.9kV SWGR	7.1	0.000
18	ELEC	33/34BMT02	ELEC, 6.9kV-480V Transformer	7.1	0.000
19	ELEC	30BRW52BUW53/ 30BRW70BUW71	ELEC, 24V DC I&C Power Rack	6.7	0.000
20	ELEC	35/36BBA	ELEC, 13.8kV SWGR	6.3	0.000
21	ELEC	35/36BFE	ELEC, 480V Load Center	6.3	0.000
22	ELEC	35/36BBG	ELEC, 6.9kV SWGR	5.6	0.000
23	SIS/RHRS	30JNA20AA101	RHR, LHSI Train 2 HTX Bypass MOV	5.6	0.000

Table 19.1-82—U.S. EPR Risk-Significant Equipment based on RAW Importance – Level 2 Internal Fires
Sheet 2 of 2

Rank	System	Component ID	Description	RAW	FV
24	MSS	30LBA10/20AA002	MSS, Main Steam Isolation Valve Train 1 and 2	5.6	0.009
25	ESWS	30PEB10AP001	ESWS, Motor Driven Pump Train 1	4.5	0.000
26	CCWS	30KAA10AP001	CCWS, Motor Driven Pump Train 1	4.0	0.000
27	ELEC	33BDA	ELEC, 6.9kV SWGR 33BDA	3.8	0.000
28	HVAC	30SAC05/35AN001	SAC, Maintenance Division Air Supply/Exhaust Fan	3.0	0.001
29	ELEC	31BTD01_BAT	ELEC, 250V 1E 2-hr Battery	2.9	0.001
30	ESWS	30PED10AN001/2	UHS, Cooling Tower Cooling Fan Train 1	2.8	0.023
31	ESWS	30PEB20AP001	ESWS, Motor Driven Pump Train 2	2.6	0.010
32	MSS	30LBA30AA002	MSS, Main Steam Isolation Valve, Train 3	2.5	0.005
33	CVCS	30KBA31AP001	CVCS, HP Motor Driven Charging Pump	2.1	0.000
34	SIS/RHRS	30JNG10AP001	LHSI, LHSI Motor Driven Pump	2.1	0.002
35	RCS	30JEB10/20/30/40AA010/020	RCP Seal, RCP Isolation MOV Train	2.1	0.004

Table 19.1-83—U.S. EPR Risk-Significant Human Actions based on FV Importance-Level 2 Internal Fires

Rank	ID	Description	Nominal Value	FV	RAW
1	OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	1.3E-02	0.352	27.8
2	OPE-RHR-4H	Operator Fails to Initiate RHR Within 4 Hours	1.0E-03	0.139	138.1
3	OPE-MCR-RSS-90M	Operator Fails to Transfer to the RSS in 90 Mins Given A MCR Fire	7.0E-05	0.118	1686.0
4	OPF-RCP-10M	Operator Fails to Trip RCPs on a Loss of Seal Injection	6.0E-02	0.077	2.2
5	OPF-XTDIV-NSC	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During Non-SBO Conditions	5.0E-01	0.060	1.1
6	OPF-RCP-30M	Operator Fails to Trip RCPs on a Loss of Bearing Cooling	4.0E-02	0.053	2.3
7	OPF-XTIE BC	Operator Fails to Align Backup Battery Charger to BUC Bus	1.0E+00	0.039	1.0
8	OPE-FB-40M	Operator Fails to Initiate Feed & Bleed for SLOCA	1.3E-01	0.036	1.2
9	OPF-XTLDSBO-NSC	Operator Fails to Connect and Load SBO DGs to Div 1 or 4 During Non-SBO Conditions	1.0E-01	0.014	1.1
10	OPF-EBS-30M	Operator Fails to Manually Actuate EBS (SLB & ATWS)	2.2E-02	0.012	1.5
11	OPE-FCD-40M	Operator Fails to Initiate Fast Cooldown for SLOCA	1.3E-01	0.010	1.1

Table 19.1-84—U.S. EPR Risk-Significant Human Actions based on RAW Importance-Level 2 Internal Fires

Rank	ID	Description	Nominal Value	RAW	FV
1	OPE-MCR-RSS-90M	Operator Fails to Transfer to the RSS in 90 Mins Given A MCR Fire	7.0E-05	1686.0	0.118
2	OPE-RHR-4H	Operator Fails to Initiate RHR Within 4 Hours	1.0E-03	138.1	0.139
3	OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	1.3E-02	27.8	0.352
4	OPE-FB-90M	Operator Fails to Initiate Feed & Bleed for Transient	5.0E-04	2.9	0.001
5	OPF-RCP-30M	Operator Fails to Trip RCPs on a Loss of Bearing Cooling	4.0E-02	2.3	0.053
6	OPF-RCP-10M	Operator Fails to Trip RCPs on a Loss of Seal Injection	6.0E-02	2.2	0.077

Table 19.1-85—U.S. EPR Risk-Significant Common Cause Events based on RAW Importance – Level 2 Internal Fires

Rank	System	ID	Description	Nominal Value	RAW
1	HVAC	SAC01/31AN001EFR_D-ALL	CCF to Run Normal Air Exhaust Fans	1.3E-06	767.0
2	SCWS	QKA10AP107EFR_D-ALL	CCF of SCWS Pumps to Run	6.4E-07	671.0
3	SIS/RHRS	JNG13AA005CFO_D-ALL	CCF to Open LHSI/MHSI Common Injection Check Valves	4.5E-06	419.0
4	CCWS	KAA12AA005EFO_D-ALL	CCF to Open CCWS to LHSI HTX Cooling MOV	2.2E-05	339.0
5	ESWS	PED10AN002EFS_D-ALL	CCF to Start/Run Standby Cooling Tower Fans	1.9E-05	339.0
6	ESWS	PED10AN001EFR_D-ALL	CCF to Run Normally Running Cooling Tower Fans	2.7E-06	331.0
7	SIS/RHRS	JNG10AP001EFS_D-ALL	CCF of LHSI Pumps to Start	1.9E-06	319.0
8	MSS	LBA13AA001PFO_D-ALL	CCF to Open Main Steam Relief Isolation Train	3.7E-05	280.0
9	IRWST	JNK10AT001SPG_P-ALL	CCF of IRWST Sump Strainers - Plugged	5.7E-07	265.0
10	SCWS	QKA10GH001_FR_B-ALL	CCF of the Air Cooled SCWS Chiller Units to Run	2.2E-05	262.0
11	EFWS	LAS11AP001EFS_D-ALL	CCF of EFWS Pumps to Start/ Run	1.1E-05	163.0
12	SIS/RHRS	JNA10AA003EFO_D-ALL	CCF to Open LHSI Pump Suction from RCS MOVs	1.1E-05	137.0
13	ELEC	BTD01_BAT__ST_D-ALL	CCF of Safety-related Batteries on Demand	2.9E-07	69.1
14	MSS	LBA10AA002PFC_D-ALL	CCF to Close Main Steam Isolation Valves	1.2E-05	59.8
15	ELEC	XKA10_____DFR_D-ALL	CCF of EDGs to Run/Start	1.0E-04	42.5
16	SIS/RHRS	JND10AP001EFR_D-ALL	CCF of MHSI Pumps to Run/ Start	3.8E-05	37.3
17	SCWS	QKA20GH001_FR_B-ALL	CCF of the CCWS Cooled SCWS Chiller Units to Run	2.2E-05	33.4
18	ESWS	PEB20AP001EFS_B-ALL	CCF of ESWS Pumps 2 and 3 to Start (Standby)	9.9E-05	21.2

Table 19.1-86—U.S. EPR Risk-Significant I&C Common Cause Events based on RAW Importance – Level 2 Internal Fires

ID	Description	Nominal Value	RAW
CL-TXS-OSCCF	SW CCF of TXS operating system or multiple diversity groups	1.0E-07	19,100.0
SAS CCF-ALL	CCF of SAS Divisions	5.0E-07	290.0
PAS	Process Automation System (PAS) Fails (Estimate)	1.0E-03	185.0
CL-PS-A-SWCCF	SW CCF of Protection System diversity group A	5.0E-06	153.0
CL-PS-B-SWCCF	SW CCF of Protection System diversity group B	5.0E-06	80.5
PZR PRES CCF-ALL	CCF of pressurizer (RCS) pressure sensors	8.4E-07	36.8

Table 19.1-87—Plant Operating States (POS)
Sheet 1 of 2

POS	Description	RCS Conditions				Transition Boundaries
		T (F)	P(psia)	Integrity	Level	
A	Power Operation	Nominal	Nominal	Closed	Normal	Reactor is Critical (all rods are not in)
B	Hot Standby	Nominal to 248	Nominal to 460	Closed	Normal	From 0% power (all rods in) until RHR operation (<248°F and 460 psia)
CA_{d1}	RHR: RCS Normal Level with 2 RHR and SG (shutting down)	248 to 212	460 to 380	Closed	Normal	From start of RHR operation until 4 RHR in operation
CA_{d2}	RHR: RCS Solid with 4 RHR and SG (shutting down)	212 to 131	380	Vent	PZR 90% to Solid	From 4 RHR operation till all RCPs stopped at 131°F (Secondary cooling with SG stopped earlier)
CA_{d3}	RHR: RCS Solid 4 RHR (shutting down)	131	380 to Atm	Vent	PZR Solid	From 131°F (no RCPs running) until start of drain down
CB_d	RHR: Mid-loop w/ RPV head on (shutting down)	131	Atm	Vent	Mid-loop	From start of drain down until RPV head off
D_d	RHR: Mid-loop w/ RPV head off (shutting down)	131	Atm	RPV head off	Mid-loop	From RPV head off until cavity is flooded
E	Cavity Flooded (fuel off load)	131	Atm	RPV head off	Cavity	From cavity is flooded until fuel in SFP with gates/transfer tube closed
F	Core Off-load					Fuel is in SFP with gates/ transfer tube closed
E	Cavity Flooded (fuel load)	131	Atm	RPV head off	Cavity	From opening of transfer tube/gates until start of draining the cavity
D_u	RHR: Mid-loop w/ RPV head off (starting up after refueling)	131	Atm	RPV head off	Mid-loop	From start of cavity draining until RPV head on
CB_u	RHR: Mid-loop w/ RPV head on (starting up after refueling)	131	Atm	Vent	Mid-loop	From RPV head on till level in the pressurizer

Table 19.1-87—Plant Operating States (POS)
Sheet 2 of 2

POS	Description	RCS Conditions				Transition Boundaries
		T (F)	P(psia)	Integrity	Level	
CA_u	RHR: RCS Normal Level (starting up after refueling)	131 to 248	Atm to 460	Vent	Normal	From level in the pressurizer until RHR is secured
B	Startup	248 to Nominal	460 to Nominal	Closed	Normal	From RHR secured until criticality
A	Power Operation	Nominal	Nominal	Closed	Normal	Reactor is Critical

Table 19.1-88—LPSD Initiating Event List

Initiating Event		Basis
Loss of RHR		
IE RHR CAd	Loss of 4 running RHR trains	Fault Tree Analysis
IE RHR CBd	Loss of 3 running/1 Stand-by RHR trains	
IE RHR Dd	Loss of 3 running/1 Stand-by RHR trains	
IE RHR Du	Loss of 2 running/2 Stand-by RHR trains	
IE RHR CBu	Loss of 2 running/2 Stand-by RHR trains	
IE RHR CAu	Loss of 2 running/2 Stand-by RHR trains	
Loss of Inventory		
IE LOCA CAd	Flow diversions and leaks in POS CAd	Generic SLOCA Frequency, Flow Diversion Analysis, Fault Tree Analysis
IE LOCA CBd	Flow diversions and leaks in POS CBd	
IE LOCA Dd	Flow diversions and leaks in POS Dd	
IE LOCA E	Flow diversions and leaks in POS E	
IE LOCA Du	Flow diversions and leaks in POS Du	
IE LOCA CBu	Flow diversions and leaks in POS CBu	
IE LOCA CAu	Flow diversions and leaks in POS CAu	
IE ULD CBd	Uncontrolled Level drop during POS CBd	Fault Tree Analysis
IE ULD Dd	Uncontrolled Level drop during POS Dd	
IE ULD Du	Uncontrolled Level drop during POS Du	
IE ULD CBu	Uncontrolled Level drop during POS CBu	
IE RHR ISLOCA CAd	RHR LOCA Outside Containment in POS CAd	Pipe Break Frequency and Operator Recovery
IE RHR ISLOCA CBd	RHR LOCA Outside Containment in POS CBd	
IE RHR ISLOCA Dd	RHR LOCA Outside Containment in POS Dd	
IE RHR ISLOCA E	RHR LOCA Outside Containment in POS E	
IE RHR ISLOCA Du	RHR LOCA Outside Containment in POS Du	
IE RHR ISLOCA CBu	RHR LOCA Outside Containment in POS CBu	
IE RHR ISLOCA CAu	RHR LOCA Outside Containment in POS CAu	

Table 19.1-89—System Availability During Shutdown
Sheet 1 of 2

POS	Description	LHSI/RHR Availability				Secondary Cooling Availability		SIS		SAHR	Hatch	Comment
		Trains Avail	RHR Run	RHR Stdby	LHSI Stdby	SG with MSRT	EFW	Signal	MHSI			
CA_d	RHR Heat Removal with Level in PZR (shutting down)	4	4	0	0	2	2 (Trains 1 and 2 w/ P13)	Low delta Psat	4	1	Closed	MSRT set at 148 psia
CB_d	RHR Heat Removal at mid-LOOP with RPV Head On (shutting down)	4	3	0	1 (Train 1 or 4)	2	2 (Trains 1 and 2 w/ P13)	Low Loop Level	4	1	Closed	MSRT set at 148 psia
D_d	RHR Heat Removal at mid-LOOP with RPV Head Off (shutting down)	4	3	0	1 (Train 1 or 4)	NA	NA	Low Loop Level	4	NA	Closed	
E	Reactor Cavity Flooded (fuel off load)	3	2 (Train 2 & 3)	0	1 (Train 4)	NA	NA	Low Loop Level	3	NA	Open	
F	Core Off-load	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
E	Reactor Cavity Flooded (fuel load)	3	2 (Train 1 & 2)	0	1 (Train 4)	NA	NA	Low Loop Level	3	NA	Open	
D_u	RHR Heat Removal at mid-LOOP with RPV Head OFF (starting up after refueling)	4	2 (Train 1 & 2)	1 (Train 3)	1 (Train 4)	NA	NA	Low Loop Level	4	NA	Closed	

**Table 19.1-89—System Availability During Shutdown
Sheet 2 of 2**

POS	Description	LHSI/RHR Availability				Secondary Cooling Availability		SIS		SAHR	Hatch	Comment
		Trains Avail	RHR Run	RHR Stdby	LHSI Stdby	SG with MSRT	EFW	Signal	MHSI			
CB_u	RHR: Mid-loop w/ RPV head on (starting up after refueling)	4	2 (Train 1 & 2)	1 (Train 3)	1 (Train 4)	2	2	Low Loop Level	4	1	Closed	MSRT set at 148 psia
CA_u	RHR: RCS Normal Level (starting up after refueling)	4	2 (Train 1 & 2)	1 (Train 3)	1 (Train 4)	2 to 4	2 to 4	Low delta Psat	4	1	Closed	MSRT set at 148 psia

Table 19.1-90—U.S. EPR Initiating Events Contributions – Level 1 Shutdown

Initiating Event ID	Initiating Event Description	IE Frequency [1/yr]	CDF [1/yr]	Contribution (SD Total)
SD ULD CBD D	SD Uncontrolled Level Drop in State CBd (Demand)	1.4E-02	8.1E-09	14.0%
SD ULD DU D	SD Uncontrolled Level Drop in State Du (Demand)	1.4E-02	7.9E-09	13.5%
SD LOCA CBD	SD LOCA in State CBd	1.1E-03	7.7E-09	13.3%
SD RHR CBD	SD Loss of RHR in State CBd	1.7E-06	7.3E-09	12.6%
SD RHR CBU	SD Loss of RHR in State CBu	1.3E-06	5.5E-09	9.4%
SD RHR CAD	SD Loss of RHR in State Cad	1.2E-06	5.4E-09	9.3%
SD LOCA CBU	SD LOCA in State CBu	5.7E-04	3.8E-09	6.6%
SD RHR CAU	SD Loss of RHR in State CAu	8.3E-07	3.7E-09	6.4%
SD LOCA DU	SD LOCA in State Du	5.7E-04	3.1E-09	5.3%
SD LOCA DD	SD LOCA in State Dd	2.5E-04	1.4E-09	2.3%
SD RHR DU	SD Loss of RHR in State Du	1.3E-06	1.2E-09	2.1%
SD RHR ISLOCA E	SD RHR ISLOCA in State E	7.9E-10	7.9E-10	1.4%
Total SD CDF:			5.8E-08	

Table 19.1-91—U.S. EPR Shutdown State (POS) Contributions – Level 1 Shutdown

Shutdown State (POS)	POS Description	Estimated POS Duration [days]	CDF [1/yr]	CDF [1/day]	Contribution to Total
CAD	RHR Heat Removal with Level in PZR -- Shutting Down	1.5	6.1E-09	4.1E-09	10.6%
CBD	RHR Heat Removal at mid-LOOP with RPV Head On -- Shutting Down	2	2.3E-08	1.2E-08	40.0%
DD	RHR Heat Removal at mid-LOOP with RPV Head Off -- Shutting Down	0.5	1.9E-09	3.9E-09	3.3%
E	Reactor Cavity Flooded	10	9.9E-10	9.9E-11	1.7%
DU	RHR Heat Removal at mid-LOOP with RPV Head Off -- Starting Up	1.5	1.2E-08	8.1E-09	21.1%
CBU	RHR Heat Removal at mid-LOOP with RPV Head On -- Starting Up	1.5	9.4E-09	6.2E-09	16.2%
CAU	RHR Heat Removal with Level in PZR -- Starting Up	1	4.0E-09	4.0E-09	7.0%
TOTAL SD CDF:		18 (+ POS F)	5.8E-08	3.8E-08	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
Sheet 1 of 14

Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%)		Sequence Type and a Representative Cutset		Sequence Description
			Group	Cumulative	Event Identifier	Event Description	
0	**Uncontrolled Level Drop Sequences**						
1	1, 4, 10, 17, 39, 41, 100	3.39E-09 – 6.34E-11	12.0	12.0	**SD ULD D-3: ISOLSD, OP ISOLSD**		
					IE SD ULD DU D	Initiator - Uncontrolled Level Drop in Shutdown State Du (Demand)	**Shutdown State DU**: An uncontrolled level drop IE is caused by CC failure of CVCS LP reducing station MOVs to close, this also fails a second chance to isolate, the mitigating systems are available, but a long term operator failure to isolate, leads to a slow RCS drain outside containment.
					KBA14AA004E FC_B-ALL	CCF to Close CVCS Low Pressure Reducing Station MOVs	
					OPE-ISOCSLPRS	Operator Fails to Isolate the CVCS Low Pressure Reducing Station	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
Sheet 2 of 14

Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%)		Sequence Type and a Representative Cutset		
			Group	Cumulative	Event Identifier	Event Description	Sequence Description
2	2, 5, 9, 18, 38, 40	3.39E-09 – 1.84E-10	11.9	23.9	**SD ULD CB-3: SISOLSD, OP ISOLSD**		
					IE SD ULD CBD D	Initiator - Uncontrolled Level Drop in Shutdown State CBd (Demand)	**Shutdown State CBD**: An uncontrolled level drop IE is caused by CC failure of CVCS LP reducing station MOVs to close, this also fails a second chance to isolate, the mitigating systems are available, but a long term operator failure to isolate, leads to a slow RCS drain outside containment
					KBA14AA004E FC_B-ALL	CCF to Close CVCS Low Pressure Reducing Station MOVs	
					OPE-ISOCSLPRS	Operator Fails to Isolate the CVCS Low Pressure Reducing Station	
3	30, 49	2.276E-10 – 1.54E-10	0.7	24.6	**SD ULD D-6: ISOLSD, MHSISD, LHSISD**		
					IE SD ULD DU D	Initiator - Uncontrolled Level Drop in Shutdown State Du (Demand)	**Shutdown State DU**: An uncontrolled level drop IE is caused by CC Failure of CVCS LP reducing station MOVs to close, this also fails a second chance to isolate, the injection systems MHSI and LHSI fail because of a CC failure of the common injection check valves.
					KBA14AA004E FC_B-ALL	CCF to Close CVCS Low Pressure Reducing Station MOVs	
					JNG13AA005C FO_D-ALL	CCF to Open LHSI/ MHSI Common Injection Check Valves (SIS First Isolation Valves)	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
Sheet 3 of 14

Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
4	31, 50	2.76E-10 – 1.54E-10	0.7	25.3	**SD ULD CB-39: ISOLSD, MHSISD, LHSISD**		
					IE SD ULD CBD D	Initiator - Uncontrolled Level Drop in Shutdown State CBd (Demand)	**Shutdown State CBD**: An uncontrolled level drop IE is caused by CC failure of CVCS LP reducing station MOVs to close, this also fails a second chance to isolate, the injection systems MHSI and LHSI fail because of a CC failure of the common injection check valves
					KBA14AA004E FC_B-ALL	CCF to Close CVCS Low Pressure Reducing Station MOVs	
					JNG13AA005C FO_D-ALL	CCF to Open LHSI/ MHSI Common Injection Check Valves (SIS First Isolation Valves)	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
Sheet 4 of 14

Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%)		Sequence Type and a Representative Cutset		
			Group	Cumulative	Event Identifier	Event Description	Sequence Description
5	3, 6, 7, 8, 29, 33, 34, 35, 42, 43, 51, 52, 57, 58, 66, 70, 95	2.46E-09 – 7.11E-11	16.5	41.8	**SD RHR C-15: EFWSD, MHSISD, LHSISD, SAHRSD**		
					IE SD RHR CBD	Initiator - RHR in Power State CBd	**Shutdown State CBD**: A loss of RHR IE is caused by a LOOP during the CBD state and a CC failure of all EDGs; failure of SBODG Division 1 disables all EFW (only SG1 & 2 are assumed to be available in the CBD state); a loss of CCW (not supplied from SBODGs) disables MHSI and RHR heat exchangers; a loss of Division 1 disables SAHR This sequence also occurs in shutdown states CAU, CAD, & CBU
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					XKA10_____D FR_D-ALL	CCF of EDGs to Run	
					XKA50_____D FR	ELEC, SBO Diesel Generator XKA50, Fails to Run	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
6	32, 36, 37, 55	2.62E-10 – 1.31E-10	1.4	43.2	**SD RHR C-15: EFWSD, MHSISD, LHSISD, SAHRSD**		
					IE SD RHR CBD	Initiator - RHR in Power State CBd	**Shutdown State CBD**: A loss of RHR IE is caused by a LOOP during the CBD state and a CC failure of all EDGs; operator failure to x-tie divisions disables all MSRTs and EFW; a loss of CCW (not supplied from SBODGs) disables MHSI and RHR heat exchangers; a loss of UHS4 disables SAHR This sequence also occurs in shutdown states CAU, CAD, & CBU
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					XKA10_____DFR_D-ALL	CCF of EDGs to Run	
					OPF-XTDIVSBO-2H	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During SBO Conditions	
					SA-ESWS UHS4 SBO	Failure of SA-ESWS/ UHS4 in SBO Conditions	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Event Description	Sequence Description
7	54, 62, 63, 94	1.43E-10 – 7.14E-11	0.7	43.9	**SD RHR C-15: EFWSD, MHSISD, LHSISD, SAHRSD**		
					IE SD RHR CBD	Initiator - RHR in Power State CBd	**Shutdown State CBD**: A loss of RHR IE is caused by a LOOP during the CBD state and a CC failure of all EDGs; operator failure to x-tie divisions disables all MSRTs and EFW; a loss of CCW (not supplied from SBODGs) disables MHSI and RHR heat exchangers; a loss of SBO DG4 disables SAHR This sequence also occurs in shutdown states CAU, CAD, & CBU
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					XKA10_____DFR_D-ALL	CCF of EDGs to Run	
					OPF-XTDIVSBO-2H	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During SBO Conditions	
					XKA80_____DFR	ELEC, SBO Diesel Generator XKA80, Fails to Run	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%)		Sequence Type and a Representative Cutset		
			Group	Cumulative	Event Identifier	Event Description	Sequence Description
8	56, 67, 69, 99	1.29E-10 – 6.44E-11	0.7	44.6	**SD RHR C-15: EFWSD, MHSISD, LHSISD, SAHRSD**		
					IE SD RHR CBD	Initiator - RHR in Power State CBd	**Shutdown State CBD:** • A loss of RHR IE is caused by a LOOP during the CBD state and a CC failure of all batteries (disabling all EDGs and possibility to connect SBODGs). Result is a total station blackout. • This sequence also occurs in shutdown states CAU, CAD, & CBU
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					BTD01_BAT__ST_D-ALL	CCF of Safety-related Batteries on Demand	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
9	64, 83, 84	1.01E-10 – 7.60E-11	0.4	45.0	**SD RHR C-12: EFWSD, LHSISD, SAHRSD**		
					IE SD RHR CBD	Initiator - RHR in Power State CBd	**Shutdown State CBD:** • A loss of RHR IE is caused by a LOOP during the CBD state, a CC failure of 3 EDGs and failure of air chiller cooling to LHSI/RHR pump1; operator failure to crosstie divisions disables all MSRTs and EFW; LHSI/RHR heat exchangers are lost; a loss of Division 4 (ESW80-crosstie was not credited for non-SBO conditions) disables SAHR • This sequence also occurs in shutdown states CAU, CAD, & CBU
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					XKA10_____DFR_D-234	CCF of EDGs to Run	
					QKA10GH001_FS	SCWS, Train 1 Chiller Unit QKA10GH001, Fails to Start on Demand	
					OPF-XTDIV-NSC	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During Non-SBO Conditions	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Event Description	Sequence Description
10	65	1.00E-10	0.2	45.2	**SD RHR D-3: MHSISD, LHSISD**		
					IE SD RHR DU	Initiator - RHR in Power State Du	**Shutdown State DU:** • A loss of RHR IE is caused by a LOOP during the DU state, a CC failure of all EDGs.Failure of both SBODGs. The result is a total station blackout.
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					XKA10_____D FR_D-ALL	CCF of EDGs to Run	
					XKA50_____D FR	ELEC, SBO Diesel Generator XKA50, Fails to Run	
					XKA80_____D FR	ELEC, SBO Diesel Generator XKA80, Fails to Run	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
11	68	9.67E-11	0.2	45.4	**SD RHR D-3: MHSISD, LHSISD**		
					IE SD RHR DU	Initiator - RHR in Power State Du	**Shutdown State DU:** • A loss of RHR IE is caused by a LOOP during the DU state and a CC failure of all batteries (disabling all EDGs and the possibility to connect SBODGs). The result is a total station blackout.
					SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	
					BTD01_BAT__ST_D-ALL	CCF of Safety-related Batteries on Demand	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
12	81, 82	8.00E-11	0.3	45.7	**SD RHR C-16: EFWSD, PBLSD**		
					IE SD RHR CBD	Initiator - RHR in Power State CBd	**Shutdown State CBD:** • A loss of RHR IE is caused by a CC failure of SAC air supply fans during the CBD state and two operator failures to recover HVAC, disabling all divisions. Result is a total station blackout. • This sequence also includes shutdown state CBU.
					SAC01AN001EFR_D-ALL	CCF to Run Normal Air Supply Fans	
					OPF-SAC-1H	Operator Fails to Start Maintenance HVAC Trains after Failure of Normal SAC Safety Train	
					OPD-SAC2H/SAC1H	Dependency (MED) Between OAs for Starting HVAC Maintenance Trains Recovering Room Cooling Locally	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%)		Sequence Type and a Representative Cutset		Sequence Description
			Group	Cumulative	Event Identifier	Event Description	
13	11, 12, 13, 14, 15, 16, 19, 20, 24, 25, 59, 60, 61, 71, 72, 73, 74, 75, 76, 79, 80, 85, 86, 87, 88, 89, 90, 91, 92, 93	6.45E-10 – 7.52E-11	12.9	58.6	**SD LOCA C-30: MHSISD, LHSISD**		
					IE SD LOCA CBD	Initiator - LOCA During Shutdown State CBd	**Shutdown State CBD:** • A LOCA IE is caused by a premature opening of an RHR/LHSI safety valve and an operator failure to isolate flow diversion; MHSI/LHSI injection fails due to a CC failure of common cold leg injection check valves.
					JNG10AA192SPO	LHSI, LHSI/RHR Train 10 Overpressure Protection Safety Valve JNG10AA192, Premature Opening	
					OPF-ISORHRFD-CB	Operator Fails to Isolate RHR Flow Diversion (LOCA) in State CB	
					JNG13AA005CFO_D-ALL	CCF to Open LHSI/ MHSI Common Injection Check Valves (SIS First Isolation Valves)	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
14	21, 22, 23, 26, 44, 45, 46, 47, 48, 53, 77, 78	4.84E-10 – 8.06E-11	5.3	63.9	**SD LOCA DE-3: MHSISD, LHSISD**		
					IE SD LOCA DU	Initiator - LOCA During Shutdown State Du	**Shutdown State DU:** • A LOCA IE is caused by a premature opening of a RHR/LHSI safety valve and an operator failure to isolate flow diversion; MHSI/LHSI injection fails due to a CC failure of common cold leg injection check valves.
					JNA10AA191SPO	RHR, LHSI Train 1 Safety Valve JNA10AA191, Premature Opening	
					OPF-ISORHRFD-CB	Operator Fails to Isolate RHR Flow Diversion (LOCA) in State CB	
					JNG13AA005CFO_D-ALL	CCF to Open LHSI/ MHSI Common Injection Check Valves (SIS First Isolation Valves)	

Table 19.1-92—U.S. EPR Important Cutset Groups – Level 1 Shutdown
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Group No	Cutset Numbers	Group Frequencies	Contribution to CDF (%) Group	Contribution to CDF (%) Cumulative	Sequence Type and a Representative Cutset: Event Identifier	Sequence Type and a Representative Cutset: Event Description	Sequence Description
15	27, 28, 96, 97, 98	3.43E-10 – 6.86E-11	1.6	65.5	**SD RHR ISLOCA E-02/CBD-2: RHR ISLOCA SD**		
					IE SD RHR ISLOCA E	RHR ISLOCA During Shutdown State E	**Shutdown State E:** • A ISLOCA IE is caused by a pipe break in one RHR train, a failure of PAS disables automatic isolation and operator failure to isolate leads to unisolated LOCA outside containment. • This sequence also occurs in shutdown state CBD.
					RHR TR1 PIPE BRK	Pipe Break in RHR Train 1	
					PAS	Process Automation System (PAS) Fails (Estimate)	
					OPF-ISORHRBRK	Operator Fails to Isolate RHR Pipe Break	

Table 19.1-93—U.S. EPR Risk-Significant Equipment based on FV Importance – Level 1 Shutdown

Rank	System	Component ID	Description	FV	RAW
1	ELEC	30XKA10/20/30/40	ELEC, Emergency Diesel Generator Train	0.291	1.8
2	SIS/RHRS	30JNG13/23/33/43AA005	LHSI, First SIS CL Isolation Check Valve Train	0.244	3.2
3	CVCS	30KBA14AA004/106	CVCS, Low Pressure Reducing Station Isolation MOV Train	0.239	1E-NA
4	ELEC	30XKA50/80	ELEC, SBO Diesel Generator Train	0.226	4.6
5	SIS/RHRS	30JNA10/20/30AA191 30JNG10/20/30AA192	RHR, LHSI Safety Valve Train	0.042	1E-NA
6	SIS/RHRS	30JND10/20/30/40AP001	MHSI, Motor Driven Pump Train	0.041	1.6
7	IRWST	30JNK10AT001/002 30JNK11AT001/002	IRWST, SIS Sump Strainer to MHSI/LHSI Pumps	0.029	1.2
8	IRWST	30JNK11AT003	IRWST, SAHR Sump Strainer	0.028	2.3
9	SCWS	30QKA10/40GH001	SCWS, Chiller Unit Train	0.019	4.4
10	ELEC	31/32/33/34BTD01_BAT	ELEC, 250V 1E 2-hr Battery Train	0.018	10.2
11	CCWS	30KAA10/20/30/40AP001	CCWS, Motor Driven Pump Train	0.012	3.7
12	SIS/RHRS	30JNG10/20AA001	LHSI, LHSI Pump Suction from IRWST MOV Train	0.011	1E-NA
13	SAHRS	30JMQ42AA001	SAHR, Recirculation Line MOV	0.011	3.8
14	EFWS	30LAS11AP001	EFWS, Motor Driven Pump	0.011	1.7
15	HVAC	30SAC01/02/03/04AN001 30SAC31/32/33/34AN001	SAC, Normal Air Supply/Exhaust Fan	0.010	1.6

Table 19.1-94—U.S. EPR Risk-Significant Equipment based on RAW Importance – Level 1 Shutdown

Rank	System	Component ID	Description	RAW	FV
1	ELEC	31/34BMB 34BMC/ 31/34BMD	ELEC, 480V Load Center	50.6	0.001
2	ELEC	31BBH/34BDA 31/34BDB 31/34BDC 31/ 33/34BDD	ELEC, 6.9kV SWGR	50.6	0.001
3	ELEC	31BNB01/02/03 34BNB02/03	ELEC, 480V MCC	42.8	0.001
4	ELEC	31/34BTD01_BAT	ELEC, 250V 1E 2-hr Battery	10.2	0.018
5	ELEC	31/34BUC	ELEC, 250V DC Bus	10.0	0.000
6	ELEC	31/32BUD	ELEC, Non 1E 250V DC Distribution Panel	5.7	0.000
7	SIS/RHRS	30JNG1323/33AA005	LHSI, CL First SIS Isolation Check Valve	4.6	0.236
8	ELEC	30XKA50	ELEC, SBO Diesel Generator	4.6	0.226
9	ELEC	31BTB01_BAT	ELEC, 250V Non 1E 12-hr Battery	4.6	0.002
10	SCWS	30QKA10/40GH001	SCWS, Chiller Unit	4.4	0.019
11	ELEC	31BRV31BUV/ 30BRW10BUW11/ 30BRX10BUX11/30BRX70BUX71	ELEC, 24V DC I&C Power Rack	4.2	0.000
12	SIS/RHRS	30JNG10/30AP001	LHSI, Motor Driven Pump Train	3.7	0.008
13	SAHRS	30JMQ40AP001	SAHR, Motor Driven Pump	3.6	0.002

Table 19.1-95—U.S. EPR Risk-Significant Human Actions at Shutdown based on FV Importance – Level 1 Shutdown

Rank	Basic Event	Description	Nom Value	FV	RAW
1	OPE-ISOCSLPRS	Operator Fails to Isolate the CVCS Low Pressure Reducing Station	5.5E-05	0.249	4,531.0
2	OPF-ISORHRFD-CB	Operator Fails to Isolate RHR Flow Diversion (LOCA) in State CB	1.0E+00	0.185	1.0
3	OPF-ULD	Operator Fails to Stop Draindown at Mid-Loop	1.0E-02	0.107	1E-NA
4	OPF-ISORHRFD-D	Operator Fails to Isolate RHR Flow Diversion (LOCA) in State D	1.0E+00	0.072	1.0
5	OPF-XTDIVSBO-2H	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During SBO Conditions	5.8E-02	0.036	1.6
6	OPF-XTDIV-NSC	Operator Fails to Xtie Division 1 to Division 2 or Division 4 to Division 3 During Non-SBO Conditions	5.0E-01	0.030	1.0
7	OPF-ISORHRBRK	Operator Fails to Isolate RHR Pipe Break	1.1E-01	0.025	1.2
8	OPD-SAC2H/SAC1H	Dependency (MED) Between OAs for Starting HVAC Maintenance Trains Recovering Room Cooling Locally	1.5E-01	0.019	1.1
9	OPF-SAC-1H	Operator Fails to Start Maintenance HVAC Trains After Failure of Normal SAC Safety Train	2.0E-04	0.019	96.6
10	OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	1.3E-02	0.018	2.4
11	OPF-XTLDSBO-NSC	Operator Fails to Connect and Load SBODGs to Div 1 or 4 During Non-SBO Conditions	1.0E-01	0.011	1.1
12	OPF-ISOIRWSTFD-CB	Operator Fails to Isolate RHR Suction to IRWST (Valve JNGX0AA001) in CB	1.0E+00	0.011	1.0
13	OPF-ISOIRWSTFD-CA	Operator Fails to Isolate RHR Suction to IRWST (Valve JNGX0AA001) in CA	1.0E+00	0.010	1.0

Table 19.1-96—U.S. EPR Risk-Significant Human Actions based on RAW Importance – Level 1 Shutdown

Rank	Basic Event	Description	Nom Value	RAW	FV
1	OPE-ISOCSLPRS	Operator Fails to Isolate the CVCS Low Pressure Reducing Station	5.5E-05	4,531.0	0.249
2	OPF-SAC-1H	Operator Fails to Start Maintenance HVAC Trains After Failure of Normal SAC Safety Train	2.0E-04	96.6	0.019
3	OPF-LHSIRHR-DU	Operator Fails to Start LHSI Pump in DU, given a loss of RHR	2.0E-04	7.4	0.001
4	OPF-XTLDSBO-2H	Operator Fails to Connect and Load SBO DGs to Div 1 and 4	7.0E-04	5.6	0.003
5	OPF-SAHR/ IRWST-4H	Operator Fails to Initiate IRWST Cooling with SAHR	4.0E-04	3.6	0.001
6	OPF-LHSIRHR-DD	Operator Fails to Start LHSI Pump in DD, given a loss of RHR	2.0E-04	3.1	0.000
7	OPE-RHRLO-CBD	Operator Fails to Start RHR in CBd (LOCA Initiator)	1.1E-03	2.7	0.002
8	OPF-SAC-2H	Operator Fails to Recover Room Cooling Locally	1.3E-02	2.4	0.018

Table 19.1-97—U.S. EPR Risk-Significant Common Cause Events based on RAW Importance – Level 1 Shutdown

Rank	System	ID	Description	RAW
1	SIS/RHRS	JNG13AA005CFO_D-ALL	CCF to Open LHSI/MHSI Common Injection Check Valves (SIS First Isolation Valves)	50,890.0
2	IRWST	JNK10AT001SPG_P-ALL	CCF of IRWST Sump Strainers - Plugged	50,250.0
3	ELEC	BTD01_BAT__ST_D-ALL	CCF of Safety-related Batteries on Demand	30,590.0
4	HVAC	SAC01/31AN001EFR_D-ALL	CCF to Run Normal Air Exhaust/Supply Fans	5,100.0
5	SCWS	QKA10AP107EFR_D-ALL	CCF of SCWS Pumps to Run	5,078.0
6	CVCS	KBA14AA004EFC_B-ALL	CCF to Close CVCS Low Pressure Reducing Station MOVs	2,099.0
7	ESWS	PEB10AP001EFS_D-ALL	CCF of the ESWS Pumps to Start	1,977.0
8	ELEC	XKA10_____DFR_D-ALL	CCF of EDGs to Run/Start	1,933.0
9	SIS/RHRS	JND10AP001EFR_D-ALL	CCF of MHSI Pumps to Run/Start	751.6
10	SIS/RHRS	JNG10AP001EFS_D-ALL	CCF of LHSI Pumps to Start	525.0
11	SCWS	QKA10AP107EFS_D-ALL	CCF of SCWS Pumps to Start	401.0
12	HVAC	SAC01/31AN001EFS_D-ALL	CCF to Start Normal Air Supply/Exhaust Fans	398.0
13	SIS/RHRS	JNG10AA006CFO_D-ALL	CCF to Open LHSI Check Valves (SIS Second Isolation Valves)	287.2
14	CCWS	KAA10AP001EFS_D-ALL	CCF of the CCWS Pumps to Start	52.4

Table 19.1-98—U.S. EPR Risk-Significant Common Cause I&C Events based on RAW Importance – Level 1 Shutdown

ID	Description	Nominal Value	RAW
CL-TXS-OSCCF	SW CCF of TXS operating system or multiple diversity groups	1.0E-07	8,059.0
SAS CCF-ALL	CCF of SAS Divisions	5.0E-07	5,673.0
CL-PS-B-SWCCF	SW CCF of Protection System diversity group B	5.0E-06	617.3
HL LVL CCF-ALL	CCF of hot leg loop level	1.3E-06	552.6
APU3 CCF NS-ALL	CCF of APU-3 Protection System Computer Processors (Non-Self-Monitored)	3.3E-07	368.7
ALU-B CCF NS-ALL	CCF of ALU-B Protection System Computer Processors (Non-Self-Monitored)	3.3E-07	368.7
APU3 CCF SM-ALL	CCF of APU-3 Protection System Computer Processors (Self-Monitored)	9.0E-08	290.8
ALU-B CCF SM-ALL	CCF of ALU-B Protection System Computer Processors (Self-Monitored)	9.0E-08	290.8
PAS	Process Automation System (PAS) Fails	1.0E-03	54.6
HL TEMP CCF-ALL	CCF of hotleg WR temperature sensors	4.3E-06	53.6
HL PRES CCF-ALL	CCF of hotleg WR pressure sensors	6.7E-07	42.5
CL WRTEMP CCF-ALL	CCF of cold leg WR temp sensors	4.3E-06	29.5

Table 19.1-99—U.S. EPR Risk-Significant PRA Parameters – Level 1 Shutdown

ID	Description	Nominal Value	FV	RAW
PRA Modeling Parameters				
JEF-PSRV-FRC	PZR, Pressurizer Safety Relief Valve Fails to Reclose or to Reseat	3.0E-03	0.003	2.0
RHR TR1 PIPE BRK	Pipe Break in RHR Train 1	3.1E-07	0.012	39,520.0
RHR TR2 PIPE BRK	Pipe Break in RHR Train 2	3.1E-07	0.012	39,490.0
RHR TR3 PIPE BRK	Pipe Break in RHR Train 3	3.1E-07	0.003	8,767.0
RHR TR4 PIPE BRK	Pipe Break in RHR Train 4	3.1E-07	0.001	3,296.0
SIG P14 PERM	Failure of P-14 Permissive - MSRT Set Point to 145 psia	1.0E-04	0.000	5.3
Offsite Power Related Events				
SD LOOP24+REC	Loss Of Offsite Power During Shutdown and Failure of Recovery Within 1 Hour	2.2E-04	0.373	1,695.0

Table 19.1-100—U.S. EPR LEVEL 1 Internal Events Sensitivity Studies - Level 1 Shutdown

Sensitivity Case Group	Case #	Sensitivity Case Description	SC CDF [1/yr]	Delta CDF [%]
0	0	Base Case (Shutdown CDF)	5.8E-08	0%
1		**Common Cause Assumption**		
	1a	Common cause events not considered	1.1E-08	-81%
	1b	EDGs & SBODGs in the same CC group	2.4E-07	307%
2		**Assumptions on Electrical Dependencies**		
	2a	UHS 4 assumed unavailable during SBO Conditions (no credit for SBO x-tie for dedicated ESW)	7.4E-08	28%
	2b	The same credit given to the operators to X-tie two divisions in SBO (HEP=7.0E-02) & non-SBO conditions (HEP=0.5)	5.6E-08	-3%
3		**Assumptions on HVAC Recoveries**		
	3a	Room heat-up was not considered	5.6E-08	-4%
	3b	Operator recovery of HVAC not credited	1.4E-07	148%
	3c	Circular logic adjustment: Failure of HVAC 1 disables HVAC 2 (HVAC4 disables HVAC 3)	7.7E-08	34%
4		**Sensitivity to HEPs Values**		
	4a	All HEPs Set to 5% Value	3.4E-08	-40%
	4b	All HEPs Set to 95% Value	1.8E-07	217%
5		**UHS Requirement in Shutdown**		
	5	UHS Fans not required	5.8E-08	0%
6		**Assumptions on Preventive Maintenance**		
	6	Train 3 in preventive maintenance during shutdown states CBU and DU	8.5E-08	48%

Table 19.1-101—Level 2 Low Power Shutdown Plant Operating States Release Categories

Release Category	RC Freq for State C	RC % of LRF in State C	RC Freq for State D	RC % of LRF in State D	RC Freq for State E	RC % of LRF in State E
RC 201	2.9E-11	2.39%	3.2E-14	0.02%	0.0E+00	0.00%
RC 202	6.3E-15	0.00%	2.0E-17	0.00%	0.0E+00	0.00%
RC 203	1.2E-14	0.00%	0.0E+00	0.00%	0.0E+00	0.00%
RC 204	4.9E-12	0.41%	0.0E+00	0.00%	0.0E+00	0.00%
RC 205	1.1E-11	0.96%	0.0E+00	0.00%	9.9E-10	100.00%
RC 301	1.1E-13	0.01%	0.0E+00	0.00%	0.0E+00	0.00%
RC 302	2.1E-13	0.02%	3.9E-14	0.02%	0.0E+00	0.00%
RC 303	3.1E-10	26.07%	0.0E+00	0.00%	0.0E+00	0.00%
RC 304	1.6E-10	13.48%	0.0E+00	0.00%	0.0E+00	0.00%
RC 702	0.0E+00	0.00%	0.0E+00	0.00%	0.0E+00	0.00%
RC 802	6.7E-10	56.65%	1.8E-10	99.96%	0.0E+00	0.00%

Table 19.1-102—Summary of Insights from the PRA for the U.S. EPR
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Insight	
1	**High level of redundancy and independence for safety systems** The U.S. EPR design incorporates four trains of most safety systems, and provides for significant separation: Four trains of the safety injection systems (LHSI, MHSI, and accumulators). Four trains of emergency feedwater (EFW), supplying four steam generators. Each train has an EFW water storage tank for its suction source. Four safety trains of support systems (cooling trains, building HVAC, and electric power).
2	**Physical separation of safety systems** In addition to being highly redundant, the four trains of safety systems are physically separated by being located in different safeguard buildings. This significantly reduces the potential for core-damage accidents due to internal flooding, internal fires, or external events for which spatial considerations are important.
3	**In-containment refueling water storage tank (IRWST)** The design of the IRWST eliminates some failure modes that have been important for current-generation plants: Use of the IRWST eliminates the need to change system alignment by switching suction sources for safety injection following a LOCA. The failure to accomplish this switchover has been an important contributor to failure of long term safety injection for many current-generation PWRs. Eliminating the need for switchover also obviates the need to isolate the suction path used during the injection phase. For some current-generation PWRs, failure to isolate this path has been assessed to result in inadequate NPSH for the safety injection paths, and may create a release path after the recirculation path is opened. The reactor containment building affords the IRWST better protection against some types of external events than is the case for equivalent tanks at current-generation plants.
4	**High level of redundancy and independence for onsite power supply system** The U.S. EPR design includes both emergency diesel-generators (EDGs) and station blackout diesel generators that serve as an alternate AC source. These onsite power sources have the following features: • There are four EDGs, one supporting each safety division. This provides substantial redundancy to maintain the function of safety systems following a loss of offsite power. • There are two backup SBO diesel-generators for AAC. The SBO diesel-generators are diverse from the EDGs in design, manufacturer, cooling, actuation and control, fuel oil and operating environment. This affords significant defense against potential common-cause failures that might affect all of the diesel generators. • The SBO diesel-generators can be aligned to back up two divisions of the safety loads if the EDGs are unavailable, and can be used to support systems provided to mitigate severe-accident conditions.

Table 19.1-102—Summary of Insights from the PRA for the U.S. EPR
Sheet 2 of 6

Insight	
5	**Reliability of normal AC power supplies** Among the provisions incorporated into the design of the U.S. EPR to provide for improved reliability of the normal supply of AC power, reducing the demand for emergency power from the diesel-generators, are the following: • The design includes the capability to withstand a full load rejection without tripping the reactor. In the event of a load rejection, the reactor and turbine would automatically run back to a power level sufficient to allow the main generator to continue to supply the plant auxiliary loads. This design would reduce the potential for reactor trip and challenge to onsite emergency power systems for grid-centered loss of power events. • During normal operation, two auxiliary transformers supply power directly from the switchyard to all four safety-related switchgear divisions. An additional three transformers supply the non-safety-related switchgear. Since the main generator does not normally supply auxiliary loads in this configuration, a reactor trip does not create a demand for fast transfer to an offsite power source. Moreover, there are redundant feeds for each switchgear (safety-related and non-safety-related), so that loss of an individual auxiliary transformer will not affect the continued supply of offsite power to plant loads.
6	**Significance of AC power to the core-damage results** Despite the provisions made for the reliable supply of offsite and onsite AC power, the risk results indicate that losses of offsite power are among the dominant contributors to the frequency of core damage. Since the U.S. EPR employs active safety systems that derive their motive power from AC sources, this is to be expected. The CDF remains low because of the level of redundancy and diversity incorporated into the AC systems.
7	**Modest contribution of SLOCA** Small LOCAs are less significant than are losses of offsite power. This is large part due to the four-train redundancy of the safety injection systems. The contribution from SLOCAs is, however, still important on a relative basis, because of the potential for common-cause failures of the systems needed to prevent core damage (e.g., common injection check valves, MHSI and actuation systems).
8	**Provisions to limit the impact of sequences involving failure to scram** The extra borating system (EBS) provides manual injection capability of highly borated water into the reactor pressure vessel (RPV) in the event that the reactor shutdown system does not function properly. EBS is a two-train system which further reduces the potential contribution of accidents involving a failure to scram
9	**Reduced potential for a small LOCA due to failure of reactor coolant pump (RCP) seals** The potential for RCS leakage or small LOCA (SLOCA) due to failure of reactor coolant pump (RCP) shaft seals has been an important risk contributor for many PWRs. The U.S. EPR design includes a stand still seal for each RCP. The stand still seal is a pneumatic, “metal-to-metal” seal that serves as a back-up seal, and is independent of the normal shaft seal. The stand still seal system reduces the risk of a LOCA event as a result of postulated RCP seal degradation.

Table 19.1-102—Summary of Insights from the PRA for the U.S. EPR
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	Insight
10	**Reduced potential for release pathway following a steam generator tube rupture (SGTR)** • Among the features of the MHSI system is the provision for a shutoff head below the setpoints for the main steam safety valves (MSSV). In the event of an SGTR, the lower MHSI shutoff head limits the pressure differential that forces reactor coolant through the broken tube. The lower MHSI pressure will not challenge the associated MSSV to open (with possible failure to re-close). This reduces the potential for a release pathway from the RCS through the MSSV.
11	**A state-of-the-art digital instrumentation and control (I&C) system** The U.S. EPR uses state-of-the-art digital systems for I&C functions. The reliability of these systems enhances the automatic initiation of functions important to maintaining core cooling, including the following: • Reactor shutdown, • Emergency feedwater, and • Safety injection The man-machine interface implemented through a fully computerized control room also optimizes the information available to the operators. Because of the level of redundancy of such systems, concerns regarding the potential for common-cause failures must be addressed. A number of important measures have been taken to limit the potential for CCFs for the digital I&C systems of the U.S. EPR, including the following: • The Protection System employs subsystems called diversity groups to accomplish essential actuations. These subsystems are functionally diverse and independent. The diversity results from the use of different application programs and different parameter/sensor inputs. No information is shared between diversity groups via network connections. • The outputs of the protective system (PS) are connected to diverse reactor trip devices. • The ESF functions are also divided between the diverse subsystems to obtain maximum functional diversity. In addition to the functional diversity provided by the subsystems within the PS and the diversity of the reactor trip devices, there is additional defense-in-depth provided in the I&C architecture. This includes the following: • Trip reduction features of the RCSL and PAS systems, which provide control, surveillance, and limitation functions to reduce reactor trips and PS challenges. Among these features is the automatic power reduction that is not credited in the PRA. • Backup trip and actuation functions are performed by the non-safety-related I&C system (i.e., the PAS). The potential for software CCFs is minimized by such measures as the following: • High quality software design tools, • A deterministic operating system, • Built in monitoring and testing, and • Built in functional diversity.

Table 19.1-102—Summary of Insights from the PRA for the U.S. EPR
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	Insight
12	**Diversity of some elements of HVAC** Diversity is incorporated into the design of the safety chilled water system through the use of air cooling for the refrigeration units in Divisions 1 and 4, and CCW cooling for the refrigeration units of Divisions 2 and 3.
13	**Potential cross-train impact of loss of HVAC** Because of the normal configuration with two trains of CCW in operation, a loss of HVAC for the building in which one CCW operating train is located can have consequences that affect HVAC for the building in which the standby CCW train is located. For example, as the systems are modeled in the PRA, a failure of HVAC with failure to recover cooling for SB 1 has a potential to result in the following effects: • A complete loss of the AC and DC buses in Division 1. • Loss of operating CCW pump Division 1 and failure of CCW common header switchover • Loss of CCW flow for thermal-barrier and motor cooling of RCPs 1 and 2. • Loss of charging pump 1. • Loss of cooling to the safety chillers Division 2 and loss of HVAC in SB 2
14	**A large, robust containment** The U.S. EPR has a containment that can withstand a variety of challenges, including the following: • The containment has a free volume of about 2.8×10^6 ft^3, and a design pressure of 62 psig. This volume and relatively high design pressure provide significant capacity to accommodate the loadings due to a LOCA, a main steam-line break inside containment, or severe-accident phenomena. • The containment is also designed to maintain its integrity when challenged by external forces, including the impact from aircraft and the loadings from seismic events.
15	**Primary depressurization system (PDS)** The U.S. EPR is equipped with a PDS that goes well beyond the capabilities for depressurization in current-generation PWRs to address the potential for accidents that might progress with the RCS at high pressure. This system is comprised of two trains with four depressurization valves, independent of three pressurizer safety valves, that can provide the following benefits: • The SADVs can be used to provide a bleed path independent of the PSVs to support feed-and-bleed cooling in the event of a total loss of feedwater to the steam generators. This feature of the system further reduces the potential for occurrence of a core-damage accident. • In the event of a severe accident, the primary purpose of the SADVs is to prevent the progression from taking place with the RCS at high pressure. Depressurization of the RCS limits the potential for induced failures of the RCS due to the generation of high-temperature gases. This is of particular interest because it further reduces the potential for induced failure of tubes in the steam generators; such failure could create the possibility of a path for radionuclide release that would bypass the containment boundary. • Depressurization of the RCS also limits the dispersion of core debris to the containment atmosphere, essentially eliminating the possibility of direct containment heating.

Table 19.1-102—Summary of Insights from the PRA for the U.S. EPR
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	Insight
16	**Provisions to control combustible gases** The containment is equipped with passive autocatalytic recombiners. These recombiners prevent the buildup of hydrogen concentration so as to limit the size of any hydrogen deflagration and prevent hydrogen detonation
17	**Core-melt retention system** A passive device allows water from the IRWST to flood the corium spreading area to remove heat from below the core debris via the cooling water channels. This design limits the potential for core-concrete interactions that could cause pressurization of the containment via the generation of non-condensable gases.
18	**Severe-accident heat removal system** The severe accident heat removal system (SAHRS) provides a means for removing heat from containment following a severe accident. Feature of the SAHRS that play an important role in the Level 2 PRA include the following: • The system supports passive cooling of the molten core debris. • The system includes a containment spray mode that enhances scrubbing of fission products from the containment atmosphere. • The system provides for active recirculation of cooling water for the molten core debris. • Active elements of the SAHRS rely on the SBO diesel generators, providing a degree of diversity and independence from the safety systems involved in core cooling. • In addition to containment heat removal credited in Level 2, the SAHRS is also credited in some Level 1 sequences for cooling IRWST if the heat removal function of LHSI fails. The demands/challenges to the SAHRS are relatively low in frequency due to the four train reliability of LHSI heat removal and overall low CDF. The SAHRS is a single train, which has a dedicated CCW and ESW cooling capability. The system is manually initiated.
19	**Main steam relief trains for reliable heat removal** Each main steam line is equipped with a MSRT. To provide for both reliable operation and limited potential for spurious operation, each MSRT is equipped with four solenoid valves. The configuration of the solenoid valves is, however, such that two 480 VAC MCCs must be available to support operation of each MSRT. Therefore, if selected pairs of MCCS are lost (e.g., 32BRA and 33BRA), all four MSRTs will fail closed.
20	**Sensitivity to human reliability** The Level 1 internal events CDF is sensitive to probabilities for human failure events. The U.S. EPR employs active safety systems, and in unlikely sequences of multiple trains failures, operators are credited to initiate recovery actions (e.g., loss of HVAC recovery, feed and bleed, or fast cooldown function).

Table 19.1-102—Summary of Insights from the PRA for the U.S. EPR
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	Insight
21	**Nature of the probability distribution for CDF** Uncertainty in the CDF has been quantified explicitly by propagating distributions for the parameters of the basic events that comprise the models for core damage. It is typical for the mean value of such a distribution to be somewhat higher than the point estimate obtained by propagating only the mean values for each parameter. For the U.S. EPR, however,the mean value from the Monte Carlo simulation is significantly larger than the point estimate. This is due "state of knowledge correlation" as defined in the ASME PRA Standards, which is most important for cutsets that contain multiple basic events whose probabilities are based on the same data, in particular when the uncertainty on the parameter value is large. Given redundancy of the U.S. EPR safety trains, such cutsets are common in the EPR PRA model. For example, cutsets with multiple DG failure to run may include up to six basic events with the same data. In this case, in the Monte Carlo sampling approach, the same value is used for each basic event probability, since the "state of knowledge" about the parameter value is the same for each event. This results in a mean value for the joint probability that is larger than the product of the mean values of the event probabilities.

Table 19.1-103—U.S. EPR Level 1 Top Initiating Event Contributions to the Total CDF at Power

IE Rank	IE ID	CDF	CDF	Cumulative CDF
1	LOOP - General	9.6E-08	17.4%	17.4%
2	FIRE-SAB14-AC	7.9E-08	14.3%	31.7%
3	SLOCA	5.1E-08	9.2%	40.9%
4	FIRE-MS-VR	3.4E-08	6.2%	47.1%
5	FLD-ANN ALL	3.2E-08	5.8%	52.9%
6	LOOP - SBO	3.1E-08	5.7%	58.6%
7	GT	2.7E-08	4.9%	63.5%
8	FIRE-MCR	2.5E-08	4.6%	68.1%
9	FIRE-SWGR	2.2E-08	3.9%	72.0%
10	FLD-SAB14 FB	2.1E-08	3.8%	75.8%
11	All SLBs	1.9E-08	3.4%	79.2%
12	LOCCWS (ESWS/UHS)	1.7E-08	3.1%	82.3%
13	LOOP - Seal LOCA	1.7E-08	3.0%	85.3%
14	FIRE-SAB-MECH	1.6E-08	2.9%	88.2%
15	SGTR	1.3E-08	2.3%	90.5%
16	ATWS	1.0E-08	1.8%	92.4%
17	FLD-EFW	7.2E-09	1.3%	93.7%
18	LBOP	6.2E-09	1.1%	94.8%
19	LOMFW	5.8E-09	1.0%	95.8%
	TOTAL CDF	5.3E-07		

Table 19.1-104—U.S. EPR Level 1 Total Events Sensitivity Studies
Sheet 1 of 3

Sensitivity Case Group	Case #	Sensitivity Case Description	SC CDF [1/yr]	Delta CDF [%]
0	0	Base Case (Total CDF)	5.3E-07	0%
1	**Common Cause Assumption**			
	1a	Common cause events not considered	3.7E-07	-31%
	1b	EDGs & SBODGs in the same CC group	1.4E-06	159%
	1c	CC for I&C Software - recovery not credited	5.4E-07	2%
2	**LOOP Assumptions**			
	2a	No Credit was given for LOOP recoveries (DG MT also set back to 24 hours)	1.1E-06	100%
	2b	DG Mission Time set to 24 hours	6.5E-07	24%
	2c	SBO DG Mission Time set to 18 hours	5.2E-07	-1%
	2d	Consequential LOOP events were not considered	4.6E-07	-13%
	2e	All Consequential LOOP values set to 5.3E-03 (value for LOCA)	1.1E-06	100%
3	**Assumptions on Electrical Dependencies**			
	3a	MSRT Realignment to One Power Train per Train	4.4E-07	-16%
	3b	For CVCS seal injection, assume that a switchover from the VCT to the IRWST is always required (Div1 & Div4 required)	1.1E-06	102%
	3c	UHS 4 assumed unavailable during SBO Conditions (no credit for SBO x-tie for dedicated ESW)	5.4E-07	2%
	3d	The same credit given to the operators to X-tie two divisions in SBO (HEP=7E-2) & non-SBO conditions (HEP=0.5)	5.0E-07	-5%

Table 19.1-104—U.S. EPR Level 1 Total Events Sensitivity Studies
Sheet 2 of 3

Sensitivity Case Group	Case #	Sensitivity Case Description	SC CDF [1/yr]	Delta CDF [%]
4		**Assumptions on HVAC Recoveries**		
	4a	Room heat-up was not considered	3.7E-07	-30%
	4b	Operator recovery of HVAC not credited	1.3E-05	2426%
	4c	Circular logic adjustment: Failure of HVAC 1 disables HVAC 2 (HVAC4 disables HVAC 3)	5.4E-07	2%
5		**Sensitivity to HEPs Values**		
	5a	All HEPs Set to 5% Value	2.2E-07	-59%
	5b	All HEPs Set to 95% Value	1.6E-06	203%
6		**Assumptions on Probabilities of an RCP LOCA**		
	6a	RCP Seal LOCA Probability - 1.0	1.1E-06	102%
	6b	RCP Seal LOCA Probability - 0.5	7.3E-07	38%
	6c	RCP Seal LOCA Probability - 0.1	4.6E-07	-12%
7		**Assumptions on Long Term Cooling Mission Time**		
	7a	SAHR Mission Time set to 36 hours	5.3E-07	0%
	7b	SAHR Mission Time set to 72 hours	5.3E-07	0%
8		**Preventive Maintenance Assumptions**		
	8a	Train 3 assumed to be in PM for all year	1.3E-06	140%
	8b	W/o Preventive Maintenance	3.1E-07	-41%
9		**Isolation of EFW Tank Leak**		
	9	EFW Isolation not possible	5.3E-07	1%

Table 19.1-104—U.S. EPR Level 1 Total Events Sensitivity Studies
Sheet 3 of 3

Sensitivity Case Group	Case #	Sensitivity Case Description	SC CDF [1/yr]	Delta CDF [%]
10	**Location of CCW Switchover Valves**			
	10	Flood in SAB14 doesn't disable CCWS SO	5.1E-07	-3%
11	**Physical Separation of Non-safety Cables**			
	11	Fire in CSR kills Safety Train 4 and all Non-Safety Divisions	8.3E-07	58%
12	**Simultaneous Hot Shorts not Considered**			
	12	Simultaneous hot shorts not considered, therefore no inadvertent valve openings for PZR cubicle or MS valve room fire	4.9E-07	-7%
13	**Assumptions on MS isolation, given a Fire in MS Valve Room**			
	13a	MSIV3 & MSIV4 isolation not credited for a fire in MS valve room	1.1E-06	114%
	13b	MSIV3 and MSIV4 assumed not to be separated by a fire barrier, for a fire in MS4 Valve Room	5.0E-07	-6%
14		**Combination of Different Cases**		
	14	Combination of Cases 1b, 2b, 2e, 3a, 3b, 5b, 6a	7.5E-06	1318%

Table 19.1-105—U.S. EPR Release Category Contributions to Total LRF from at Power Internal Events, Fire and Flooding
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	5.0E-10	1.9%	0.001
RC202	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex vessel, with containment sprays	4.0E-14	0.0%	0.000
RC203	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex vessel, without containment sprays	8.5E-13	0.0%	0.000
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%	0.000
RC205	Containment failures before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex vessel without containment sprays	4.1E-10	1.5%	0.001
RC301	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex vessel, with containment sprays	1.6E-12	0.0%	0.000
RC302	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex vessel, without containment sprays	1.5E-11	0.1%	0.000
RC303	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex vessel, with containment sprays	2.3E-09	8.7%	0.004

Table 19.1-105—U.S. EPR Release Category Contributions to Total LRF from at Power Internal Events, Fire and Flooding
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	1.8E-08	66.5%	0.033
RC702	Steam Generator Tube Rupture without Fission Product Scrubbing	5.4E-09	20.3%	0.010
RC801	Interfacing System LOCA with Fission Product Scrubbing		0.0%	0.000
RC802	Interfacing System LOCA without Fission Product Scrubbing but building credited	2.6E-10	1.0%	0.001
	Total LRF:	**2.7E-08**	**100.0%**	**0.050**