Data that is not defined as Active Component Reliability Data (Section 6.3.1) or Passive Equipment Failure Data (Section 6.3.2), but are used in the reliability analysis for this facility are listed in the following Table 6.3-11.

Table 6.3-9.Fire Analysis for Wastes Types in Specific Configuration

Location	Index	DPC	DOE SNF	HLW	MCO	TAD canister	H&D	H&M	Container Type or Location
		A	B	C	D	E	F	G	
WP Positioning/Closure Room (WPTT)	1	—	—	8.50E-06	—	6.50E-05	6.60E-05	6.60E-05	WPTT
WP in TEV in WP Loadout Room	2	—	—	—	—	1.90E-07	1.90E-07	1.90E-07	WPTT
WPTT in WP Loadout Room	3	—	—	—	—	7.30E-07	7.30E-07	7.30E-07	WPTT
On CTT in Cask Unloading Room	4	6.40E-08	7.50E-07	4.70E-07	7.50E-07	1.20E-07	—	—	TC
Cask Unloading Room (diesel Present)	5	1.20E-07	—	—	—	1.30E-07	—	—	AO
Vestibule/Cask Preparation Room w/SPM (diesel Present)	6	4.90E-07	4.90E-07	4.90E-07	4.90E-07	4.70E-07	—	—	TC
Cask Preparation Room w/o SPM (No diesel Present)	7	1.90E-06	2.20E-06	2.60E-06	2.20E-06	2.20E-06	—	—	TC
Vestibule/Cask Preparation Room (diesel Present)	8	4.20E-06	—	—	—	2.90E-06	—	—	AO
On CTT in Cask Preparation Room	9	2.50E-06	2.50E-06	2.30E-06	2.50E-06	2.60E-06	—	—	TC
In CTM in Canister Transfer Room	10	1.20E-07	1.10E-07	1.30E-07	1.10E-07	1.10E-07	—	—	CTM
Large Fire Threatens TC/TAD canister (diesel Present)	11	—	—	—	—	1.20E-06	—	—	TC
Large Fire Threatens TC/TAD canister (No diesel)	12	—	—	—	—	1.90E-05	—	—	TC
Large Fire Threatens TAD canister in AO (diesel Present)	13	—	—	—	—	6.50E-06	—	—	AO
Large Fire Threatens TAD canister in CTM	14	—	—	—	—	8.60E-07	—	—	CTM
Large Fire Threatens TAD canister in WP	15	—	—	—	—	5.90E-05	—	—	WPTT
Large Fire Threatens TAD canister in WP in TEV	16	—	—	—	—	1.00E-06	—	—	WP

Table 6.3-9. Fire Analysis for Wastes Types in Specific Configuration (Continued)

Location	Index	DPC	DOE SNF	HLW	MCO	TAD canister	H&D	H&M	Container Type or Location
		A	B	C	D	E	F	G	
Large Fire Threatens TC/HLW (diesel Present)	17	—	—	1.20E-06	—	—	—	—	TC
Large Fire Threatens TC/HLW (No diesel)	18	—	—	2.00E-05	—	—	—	—	TC
Large Fire Threatens HLW in CTM (per individual canister)	19	—	—	8.60E-07	—	—	—	—	CTM
Large Fire Threatens HLW in WP	20	—	—	7.30E-06	—	—	—	—	WP
Large Fire Threatens HLW and DOE-SNF in WP	21	—	—	—	—	—	6.10E-05	—	WP
Large Fire Threatens TC/DOE-SNF (diesel Present)	22	—	1.20E-06	—	—	—	—	—	TC
Large Fire Threatens TC/DOE-SNF (No diesel)	23	—	1.80E-05	—	—	—	—	—	TC
Large Fire Threatens DOE-SNF in CTM (per canister)	24	—	6.40E-07	—	—	—	—	—	CTM
Large Fire Threatens DOE-SNF in Staging Area	25	—	1.76E-04[1]	—	—	—	—	—	Staging Area
Large Fire Threatens HLW and MCO in WP	26	—	—	—	—	—	—	6.10E-05	WP
Large Fire Threatens TC/DOE-MCO (diesel Present)	27	—	—	—	1.20E-06	—	—	—	TC
Large Fire Threatens TC/DOE-MCO (No diesel)	28	—	—	—	1.80E-05	—	—	—	TC
Large Fire Threatens DOE-MCO in CTM (per canister)	29	—	—	—	6.40E-07	—	—	—	CTM
Large Fire Threatens TC/DPC (Vertical) (No diesel)	30	1.70E-05	—	—	—	—	—	—	TC
Large Fire Threatens TC/DPC (Horizontal) (diesel Present)	31	1.20E-06	—	—	—	—	—	—	TC

Table 6.3-9. Fire Analysis for Wastes Types in Specific Configuration (Continued)

Location	Index	DPC	DOE SNF	HLW	MCO	TAD canister	H&D	H&M	Container Type or Location
		A	B	C	D	E	F	G	
Large Fire Threatens AO/DPC (Vertical) (diesel)	32	8.50E-06	—	—	—	—	—	—	AO
Large Fire Threatens DPC (VTC) in CTM	33	7.10E-07	—	—	—	—	—	—	CTM

NOTE: [1] Since no time restriction exists for staging, frequency of 5.8E-1 from Attachment F was divided by the number of DOE Standardized canisters handled in the CRCF (i.e., 3300 canisters).

Source: Table 6.5-4

Table 6.3-10. Split Fractions for Waste Types in Various Configurations

Reference Index for Table 6.3-10	Waste Type and Configuration	Basic Event Identifier	Formula for Split Fraction	Value
DPC				
DPC-1	Cask Unloading Room (TC or AO)	060-DPC-CASK-UNLOAD-FIRE	SUM(A4:A5)	1.84E-07
DPC-2	Fraction in AO with diesel	060-PROB-DIESEL-AO-CUR	A5/SUM(A4:A5)	6.52E-01
DPC-3	Fraction in TC without diesel	060-PROB-NODIESEL-TC-CUR	A4/SUM(A4:A5)	3.48E-01
DPC-4	Cask Preparation Room	060-DPC-CASK-PREP-FIRE	SUM(A6:A9)	9.09E-06
DPC-5	Fraction in TC with diesel	060-PROB-DIESEL--TC-PREP	A6/SUM(A6:A9)	5.39E-02
DPC-6	Fraction in TC without diesel	060-PROB-NODIESE-TC-PREP	(A7+A9)/SUM(A6:A9)	4.84E-01
DPC-7	Fraction in AO with diesel	060-PROB-DIESEL-AO-PREP	A8/SUM(A6:A9)	4.62E-01
DPC-8	In CTM	060-DPC-CTM-FIRE	A10	1.20E-07
DPC-9	Large Fire (TC)	060-DPC-LARGE-FIRE	SUM(A30:A32)	2.67E-05
DPC-10	Fraction in TC with diesel	060-PROB-DPC-TC-DIESEL	A31/SUM(A30:A32)	4.38E-02
DPC-11	Fraction in TC without diesel	060-PROB-DPC-TC-NODIES	A30/SUM(A30:A32)	6.20E-01
DPC-12	Fraction in AO with diesel	060-PROB-DPC-AO-DIESEL	A32/SUM(A30:A32)	3.10E-01
DPC-13	Fraction in CTM	060-PROB-DPC-IN-CTM	A32/SUM(A30:A33)	2.59E-02
DOE SNF/DOE STD				
DSNF-1	Cask Unloading Room (TC)	060-DNSF-CASK-CUR-FIRE	B4	7.50E-07
DSNF-2	Cask Preparation Room (TC)	060-DSNF-CSK-CPA-FIRE	SUM(B6:B9)	5.19E-06
DSNF-3	Fraction in TC with diesel	060-SPMRC-DNSF-DIESEL	B6/SUM(B6:B9)	9.44E-02
DSNF-4	Fraction in TC without diesel	060-SPMRC-DNSF-WODIESEL	(B7+B9)/SUM(B6:B9)	9.06E-01
DSNF-5	In CTM	060-DNSF-CAN-CTM-FIRE	B10	1.10E-07
DSNF-6	Large Fire (TC)	060-DNSF-LARGE-FIRE	SUM(B22:B25)	1.96E-04
DSNF-7	Fraction in TC with diesel	060-PROB-DSTD-TC-DIES	B22/SUM(B22:B25)	6.14E-03
DSNF-8	Fraction in TC without diesel	060-PROB-DSTD-TC-NODIES	B23/SUM(B22:B25)	9.20E-02
DSNF-9	Fraction in CTM	060-PROB-DSTD-IN-CTM	B24/SUM(B22:B25)	3.27E-03
DSNF-10	Fraction in Staging Area	060-PROB-DSTD-STAGING	B25/SUM(B22:B25)	8.99E-01

Table 6.3-10. Split Fractions for Waste Types in Various Configurations (Continued)

Reference Index for Table 6.3-10	Waste Type and Configuration	Basic Event Identifier	Formula for Split Fraction	Value
MCO				
MCO-1	Cask Unloading Room (TC)	060-MCO-CASK-CUR-FIRE	D4	7.50E-07
MCO-2	Cask Preparation Room (TC)	060-MCO-CSK-CPA-FIRE	SUM(D6:D9)	5.19E-06
MCO-3	Fraction in TC with diesel	060-SPMRC-MCO-DIESEL	D6/SUM(D6:D9)	9.44E-02
MCO-4	Fraction in TC without diesel	060-SPMRC-MCO-WODIESEL	(D7+D9)/SUM(D6:D9)	9.06E-01
MCO-5	In CTM	060-MCO-CAN-CTM-FIRE	D10	1.10E-07
MCO-6	Large Fire	060-MCO-LARGE-FIRE	SUM(D27:D29)	1.98E-05
MCO-7	Fraction in TC with diesel	060-PROB-MCO-TC-DIES	D27/SUM(D27:D29)	6.05E-02
MCO-8	Fraction in TC without diesel	060-PROB-MCO-TC-NODIES	D28/SUM(D27:D29)	9.07E-01
MCO-9	Fraction in CTM	060-PROB-MCO-IN-CTM	D289/SUM(D27:D29)	3.23E-02
HLW				
HLW-1	Cask Unloading Room (TC)	060-HLW-CSK-UNLOAD-RM	C4	4.70E-07
HLW-2	Cask Preparation Room (TC)	060-HLW-FIRE-PREPAREA	SUM(C6:C9)	5.39E-06
HLW-3	Fraction in TC with diesel	060-SPMRC-HLW-DIESEL	C6/SUM(C6:C9)	9.09E-02
HLW-4	Fraction in TC without diesel	060-SPMRC-HLW-WODIESEL	(C7+C9)/SUM(C6:C9)	9.09E-01
HLW-5	In CTM	060-HLW-CAN-CTM-FIRE	C10	1.30E-07
HLW-6	In WP Positioning Room (WP)	060-FIRE-IN-POSITION-RM	C1	8.50E-06
HLW-7	Large Fire	060-HLW-LARGE-FIRE	SUM(C17:C20)	2.94E-05
HLW-8	Fraction in TC with diesel	060-HLW-TC-DIESEL	C17/SUM(C17:C20)	4.09E-02
HLW-9	Fraction in TC without diesel	060-HLW-TC-WO-DIESEL	C18/SUM(C17:C20)	6.81E-01
HLW-10	Fraction in CTM	060-HLW-CTM	C19/SUM(C17:C20)	2.93E-02
HLW-11	Fraction in WP	060-HLW-WP	C20/SUM(C17:C20)	2.49E-01
TAD				
TAD-1	Cask Unloading Room (TC or AO)	060-TADAO-CUR-DIESEL	SUM(E4:E5)	2.50E-07
TAD-2	Fraction in AO with diesel	060-PROB-TAD-AO-CURDIES	E5/SUM(E4:E5)	5.20E-01
TAD-3	Fraction in TC without diesel	060-PROB-TAD-TC-CURND	E4/SUM(E4:E5)	4.80E-01
TAD-4	Cask Preparation Room	060-TAD-FIRE-PREP-AREA	SUM(E6:E9)	8.17E-06
TAD-5	Fraction in TC with diesel	060-SPMRC-TAD-DIESEL	E6/SUM(E6:E9)	5.75E-02

Table 6.3-10. Split Fractions for Waste Types in Various Configurations (Continued)

Reference Index for Table 6.3-10	Waste Type and Configuration	Basic Event Identifier	Formula for Split Fraction	Value
TAD-6	Fraction in TC without diesel	060-SPMRC-TAD-WODIES	(E7+E9)/SUM(E6:E9)	5.88E-01
TAD-7	Fraction in AO with diesel	060-TAD-AO-DIESEL	E8/SUM(E6:E9)	3.55E-01
TAD-8	Loadout Room (WP)	060-TAD-WP-LOADOUT-RM	E2+E3	9.20E-07
TAD-9	In Positioning Room (WP)	060-TAD-WP-POSIT-RM-FIRE	E1	6.50E-05
TAD-10	In CTM	060-TAD-CAN-CTM-FIRE	E10	1.10E-07
TAD-11	Large Fire	060-TAD-LARGE-FIRE	SUM(E11:E16)	8.76E-05
TAD-12	Fraction in TC with diesel	060-PROB-TAD-TC-DIESEL	E11/SUM(E11:E16)	1.37E-02
TAD-13	Fraction in TC without diesel	060-PROB-TAD-TC-WODIESEL	E12/SUM(E11:E16)	2.17E-01
TAD-14	Fraction in AO with diesel	060-PROB-TAD-AO-DIES	E13/SUM(E11:E16)	7.42E-02
TAD-15	Fraction in CTM	060-PROB-TAD-CTM	E14/SUM(E11:E16)	9.82E-03
TAD-16	Fraction in WP	060-PROB-TAD-WP	E16/SUM(E11:E16)	1.14E-02
TAD-17	Fraction in WPTT	060-PROB-TAD-WPTT	E15/SUM(E11:E16)	6.74E-01
H&D (WP)				
H&D-1	In WP Positioning Room (WP)	060-H&D-WP-POSIT-RM-FIRE	F1	6.60E-05
H&D-2	WP Loadout Room (WP)	060-H&D-WP-LDOUT-RM	F2+F3	9.20E-07
H&D-3	Large Fire	060-H&D-LARGE-FIRE	F21	6.10E-05
H&M (WP)				
H&M-1	In WP Positioning Room	060-H&M-WP-POSIT-RM-FIRE	G1	6.60E-05
H&M-2	WP Loadout Room (WP)	060-H&M-WP-LDOUT-RM	G2+G3	9.20E-07
H&M-3	Large Fire	060-H&M-LARGE-FIRE	G26	6.10E-05

NOTE: AO = aging overpack; CTM = canister transfer machine; TC = transportation cask; WP = waste package; WPTT = waste package transfer trolley;

Source: Original

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-#EEE-LDCNTRA-BUA-MTN	ITS Load Center Train A OOS for Maintenance	1.03E-04	Load center A is out of service for maintenance with a frequency of 6.10E-07/hour. Out of service time is limited to one week, or 168 hours. Template data BUA-FOH was applied to BUA-MTN since the range of generic data was considered to capture a spectrum of maintenance actions.	Attachment B, Section B8
060-#EEE-LDCNTRA-BUA-ROE	Failure to Restore ITS Load Center Train A post maintenance	1.03E-05	Failure to restore load center after maintenance is taken as 10% of the probability of maintenance.	Attachment B, Section B8
060-#EEE-LDCNTRB-BUA-MTN	ITS Load Center Train B OOS for Maintenance	1.03E-04	Load center A is out of service for maintenance with a frequency of 6.10E-07/hour. Out of service time is limited to one week, or 168 hours. Template data BUA-FOH was applied to BUA-MTN since the range of generic data was considered to capture a spectrum of maintenance actions.	Attachment B, Section B8
060-#EEE-LDCNTRB-BUA-ROE	ITS Failure to Restore Load Center Train B post maintenance	1.03E-05	Failure to restore load center after maintenance is taken as 10% of the probability of maintenance.	Attachment B, Section B8
060-PWR-LOSS	Loss of Site Power	4.10E-06	Frequency of off site power loss (per hour)	Ref. 2.2.46, Ref. 2.2.33,and Attachment B, Section B8
060-PWR-LOSS-2	Loss of Power	4.10E-06	Frequency of off site power loss (per hour)	Ref. 2.2.46, Ref. 2.2.33 and Attachment B, Section B8
LOSP	Loss of offsite power	2.99E-03	Frequency of off site power loss (per hour) Multiplied by 720 hours (30 days) for diesels in HVAC system	Ref. 2.2.46, Ref. 2.2.33, and Attachment B, Sections B7 and B8
LOSP-4	Failure of Off Site Power	4.10E-06	Frequency of off site power loss (per hour)	Ref. 2.2.46, Ref. 2.2.33, and Attachment B, Section B8
060-7-FRACTION-OF-AOS	Fraction of DPCs in AOs Traversing SD	6.70E-01	DPCs in AOs pass through 2 shield doors on STs and DPCs in TCs pass through 1 shield door on CTTs. This represents the fraction of the total DPCs in AOs that could impact a shield door. Established in facility plan and operating procedures.	Ref. 2.2.33

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-7-FRACTION-OF-CASKS	Fraction of DPCs in Casks Traversing SD	3.30E-01	DPCs in AOs pass through 2 shield doors on STs and DPCs in TCs pass through 1 shield door on CTTs. This represents the fraction of the total DPCs in TCs that could impact a shield door. Established in facility plan and operating procedures.	Ref. 2.2.33
060-CR-CASK-UNLOADING	Canister is Exposed During Mid-Unloading	1.00E+00	Probability that the cask is exposed during unloading. A conservative value of 1.0 is applied.	N/A
060-CSKPREPLIFTNUMBER	Number of object Lifts for Cask Prep	1.00E+00	During preparation activities associated with a TC, there is one lift of a heavy object such as a lift fixture over the cask. Therefore, a value of 1 is assigned to this basic event.	N/A
060-CTMOBJLIFTNUMBER	Number of Object Lifts during MCO or DOE Std. canister transfers	2.00E+00	During transfer of DOE Std. canister, HLW, MCO or TAD from the TC to the WP, the CTM lifts a lid and the WP crane lifts a lid over the cask. Therefore, a value of 2 is assigned to this basic event.	N/A
060-CTMOBJLIFTNUMBERD	Number of Object Lifts during DPC Transfers	1.00E+00	During transfer of DPC from the AO to the WP, the DPC enters the unloading area without a lid on the AO and the WP crane lifts a lid over the cask. Therefore, a value of 1 is assigned to this basic event.	N/A
060-DNSF-CAN-CTM-FIRE	Localized fire threatens canister in the CTM	1.10E-07	Localized Fire Threatens DOE SNF in CTM in Canister Transfer Room (per individual canister)	Section 6.5, Table 6.5-4
060-DNSF-CASK-CUR-FIRE	Localized Fire Threatens TC/DOE SNF on CTT in Cask Unloading Room	7.50E-07	Localized Fire Threatens TC/DOE SNF on CTT in Cask Unloading Room	Section 6.5, Table 6.5-4
060-DNSF-LARGE-FIRE	Large fire threatens DNSF anywhere in CRCF	1.96E-04	Large Fire Threatens TC/DOE SNF (diesel Present), TC/DOE SNF (No diesel), in CTM (per canister), and in Staging Area	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-DPC-CASK-PREP-FIRE	Fire in Cask Preparation Room	9.09E-06	Localized Fire Threatens TC/DPC (VTC) in Vestibule/Cask Preparation Room (diesel Present), TC/DPC (VTC) in Cask Preparation Room (No diesel Present), DPC (VTC) in AO in Vestibule/Cask Preparation Room (diesel Present), and TC/DPC (VTC) on CTT	Section 6.5, Table 6.5-4
060-DPC-CASK-UNLOAD-FIRE	Fire in the Cask Unloading Room	1.84E-07	Localized Fire Threatens TC/DPC (VTC) or AO (diesel Present) in Cask Unloading Room	Section 6.5, Table 6.5-4
060-DPC-CTM-FIRE	Fire in Transfer Room Affecting Can in CTM	1.20E-07	Localized Fire Threatens DPC in CTM in Canister Transfer Room	Section 6.5, Table 6.5-4
060-DPC-LARGE-FIRE	Large Fire in CRCF	2.67E-05	Large Fire Threatens TC/DPC (VTC) (diesel), TC/DPC (VTC) (No diesel), DPC (VTC) in CTM, and DPC (VTC) in AO (diesel)	Section 6.5, Table 6.5-4
060-DPCPREPLIFTNUMBER	Number of object Lifts for DPC Prep	3.00E+00	During preparation activities associated with a DPC, there are three lifts of heavy objects over the cask; a lid lift fixture, the lid and a canister lift fixture. Therefore, a value of 3 is assigned to this basic event.	N/A
060-DSNF-CSK-CPA-FIRE	Probability of Fire in Cask Preparation Room	5.19E-06	Localized Fire Threatens TC/DOE SNF in Vestibule/Cask Preparation Room w/SPM (diesel Present), TC/DOE SNF in Cask Preparation Room w/o SPM (No diesel Present), and TC/DOE SNF on CTT (No diesel Present).	Section 6.5, Table 6.5-4
060-EXCESSIVE-WIND-SPEED	Sustained Wind Exceeds 40 MPH & Gust to 90 MPH	4.70E-03	Sustained wind with speed exceeding 40 MPH and gust to 90 MPH has an estimated frequency of 5.7E-02 per yr, and with a mission time of 720 hours, the probability of such an occurrence is 4.7E-3.	Ref. 2.2.30
060-FIRE-IN-POSITION-RM	Fire in WP Positioning/Closure Room Threatens WP	8.50E-06	Localized Fire Threatens HLW in WP in WP Positioning/Closure Room	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-FIRE-SUPPRESSION	Inadvertent Actuation of Fire Suppression System	1E-06	(Section 6.2.2.9)	Section 6.2.2.9
060-H&D-LARGE-FIRE	Large fire threatens H&D anywhere in CRCF	6.10E-05	Large Fire Threatens HLW and DOE SNF in WP	Section 6.5, Table 6.5-4
060-H&D-WP-LDOUT-RM	Localized fire threatens WP in the WP Loadout Room	9.20E-07	Localized Fire Threatens HLW and DOE SNF in WP in TEV in WP Loadout Room	Section 6.5, Table 6.5-4
060-H&D-WP-POSIT-RM-FIRE	Localized fire threatens H&D WP in WP Position Room	6.60E-05	Localized Fire Threatens HLW and DOE SNF in WP and TEV in WP Positioning/Closure Room	Section 6.5, Table 6.5-4
060-H&M-LARGE-FIRE	Large fire threatens H&M anywhere in CRCF	6.10E-05	Large Fire Threatens HLW and MCO in WP	Section 6.5, Table 6.5-4
060-H&M-WP-LDOUT-RM	Localized fire threatens WP in the WP Loadout Room	9.20E-07	Localized Fire Threatens HLW and MCO in WP in TEV in WP Loadout Room	Section 6.5, Table 6.5-4
060-H&M-WP-POSIT-RM-FIRE	Localized fire threatens H&M WP in WP Position Room	6.60E-05	Localized Fire Threatens HLW and MCO in WP and TEV in WP Positioning/Closure Room	Section 6.5, Table 6.5-4
060-HEPA-PLUG	HEPA Filters Plug in a Large Fire	1.00E+00	Burning embers and combustible byproducts generated by a large fire have the potential to plug filters. To ensure a conservative analysis, this value is set to a value of 1.0.	N/A
060-HLW-CAN-CTM-FIRE	Localized fire threatens HLW canister in CTM	1.30E-07	Localized Fire Threatens HLW in CTM in Canister Transfer Room (per individual canister)	Section 6.5, Table 6.5-4
060-HLW-CSK-UNLOAD-RM	Localized Fire threatens TC in Cask Unloading Room	4.70E-07	Localized Fire Threatens TC/HLW on CTT in Cask Unloading Room	Section 6.5, Table 6.5-4
060-HLW-CTM	Probability HLW in CTM	2.93E-02	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the CTM in a large fire.	Section 6.5, Table 6.5-4
060-HLW-FIRE-PREPAREA	Fire involving HLW in Cask Preparation Room	5.39E-06	Localized Fire Threatens TC/HLW in Vestibule/Cask Preparation Room w/SPM (diesel Present), w/o SPM (No diesel Present), and TC/HLW on CTT (No diesel Present).	Section 6.5, Table 6.5-4
060-HLW-LARGE-FIRE	Large fire threatens HLW anywhere in CRCF	2.94E-05	Large Fire Threatens TC/HLW (diesel Present), TC/HLW (No diesel), HLW in CTM (per Individual canister), and HLW in WP	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-HLW-MODERATOR	Moderator Infiltrates HLW Canister	0.00E+00	A moderator source has no impact on HLW criticality . Probability set to 0.00	N/A
060-HLW-TC-DIESEL	Probability HLW in TC with diesel Present	4.09E-02	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the TC when diesel fuel is present in a large fire.	Section 6.5, Table 6.5-4
060-HLW-TC-WO-DIESEL	Probability HLW in TC Without diesel Present	6.81E-01	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the TC when diesel fuel is not present in a large fire..	Section 6.5, Table 6.5-4
060-HLW-WP	Probability HLW in WP	2.49E-01	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the WP in a large fire.	Section 6.5, Table 6.5-4
060-LIFTS-PER-DPC-CAN	Number of CTM lifts per DPC Canister	1.00E+00	DPC is lifted out of a TC by the CTM and placed into an AO for transfer to aging pad. This occurs in one single lift, and thus, a value of 1 is assigned to this basic event.	N/A
060-LIFTS-PER-DSNF-CAN	Number of Lifts per DOE SNF Canister	2.00E+00	DOE SNF is lifted out of a TC by the CTM and placed into a staging area. Subsequently, it is lifted by the CTM from the staging area and placed into a WP. This occurs in 2 lifts, and thus, a value of 2 is assigned to this basic event.	N/A
060-LIFTS-PER-HLW-CAN	Number of Lifts per HLW Canister	1.20E+00	HLW is lifted out of a TC by the CTM; 80% is placed directly into a WP whereas 20% is placed into a staging area and subsequently lifted by the CTM from the staging area and placed into a WP. A value of 1.2 is assigned to this basic event.	Ref. 2.2.31
060-LIFTS-PER-MCO-CAN	Number of Lifts per MCO Canister	1.00E+00	MCO is lifted out of a TC by the CTM and placed into a WP. This occurs in one single lift, and thus, a value of 1 is assigned to this basic event.	N/A

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-LIFTS-PER-TAD-CAN	Number of Lifts per TAD canister	1.00E+00	TAD canister is lifted out of a TC by the CTM and placed into a WP. This occurs in one single lift, and thus, a value of 1 is assigned to this basic event.	N/A
060-MCO-CAN-CTM-FIRE	Localized fire threatens canister in the CTM	1.10E-07	Localized fire threatens MCO in CTM	Table 6.3-10 (MCO-5)
060-MCO-CASK-CUR-FIRE	Localized fire threatens TC Cask Unload Area	7.50E-07	Localized fire threatens TC/MCO in Cask Unloading Room	Table 6.3-10 (MCO-1)
060-MCO-CSK-CPA-FIRE	Probability of Fire in Cask Preparation Room	5.19E-06	Localized fire threatens TC/MCO in Cask Preparation Room	Table 6.3-10 (MCO-2)
060-MCO-LARGE-FIRE	Large fire threatens MCO anywhere in CRCF	1.98E-05	Large Fire Threatens TC/MCO (diesel Present), TC/MCO (No diesel), in CTM (per canister)	Table 6.3-10 (MCO-6)
060-MODERATOR-IN-FIRE	Water Moderator Enters Cask	1.00E-03	In the fire scenario, although the fire frequency was estimated without fire suppression, a sufficient amount of water moderator intrusion into a DPC, HLW or TAD canister to create conditions favorable for a criticality event is conservatively assigned with a value of 1E-3 to denote the potential of fire suppression with water. This will put an upper bound value to the event sequences that include water moderator event.	Section 6.2.2.9
060-MODERATOR-IN-FIREDOE	Water Moderator Enters Cask	1.00E-03	In the fire scenario, although the fire frequency was estimated without fire suppression, water moderator intrusion into a DOE Std. canister or MCO is conservatively assigned with a value of 1E-3 to denote the potential of fire suppression with water. This will put an upper bound value to the event sequences that include water moderator event.	Section 6.2.2.9
060-OIL-MODERATOR	Gear Box Leaks	9.E-05	Crane gearbox leaks oil during normal CRCF operations (no fire) that could potentially create a moderator source.	Section 6.2.2.9.2
060-OTHER-WATER	Water Moderator Sources Other Than Fire Suppression	2.00E-05	Water moderator sources other than inadvertent actuation of the fire suppression system is estimated at 2E-5 for this facility	Section 6.2.2.9

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-PERCENT-DPC--ON-RC	Percentage of Casks with DPCs Received by Rail	1.00E+00	DPCs can be received by rail or by truck. Due to the DPC size, the most likely method of transportation for the DPCs is by rail. Thus, it is conservatively considered that all DPCs received by the facility from outside of the GROA are by rail, or a probability of 1. Conversely, the probability of receiving DPCs by truck is 0.	N/A
060-PERCENT-DPC-ON-TT	Percentage of Casks with DPCs Received by Truck	0.00E+00	See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PERCENT-DSNF-ON-RC	Percentage of Casks with DOE Std. Can. Received by Rail	1.00E+00	Similar discussion. See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PERCENT-DSNF-ON-TT	Percentage of Casks with DOE Std. Can. Received by Truck	0.00E+00	Similar discussion. See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PERCENT-HLW-ON-RC	Percentage of Casks with HLW Received by Rail	1.00E+00	HLW canisters can be transported either by rail or by truck. Since there is no information on the anticipated method of delivery, a 50/50 chance between the two means of transport is selected	N/A
060-PERCENT-HLW-ON-TT	Percentage of HLW on TT	0.00E+00	See above - 060-FRACTION-HLW-ON-RC	N/A
060-PERCENT-MCO-ON-RC	Percentage of Casks with MCO Received by Rail	1.00E+00	Similar discussion. See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PERCENT-MCO-ON-TT	Percentage of Casks with MCO Received by Truck	0.00E+00	Similar discussion. See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PERCENT-TAD-ON-RC	Percentage TAD canister on RC	1.00E+00	Similar discussion. See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PERCENT-TAD-ON-TT	Percentage TAD canister on TT	0.00E+00	Similar discussion. See above – 060-FRACTION-DPC- -ON-RC	N/A
060-PROB-AO	Probability of AO in Process	4.60E-01	Fraction of unloading operations with CTM involving AOs.	N/A
060-PROB-CTT-TAD	Probability of CTT with TAD canister in TC	4.61E-01	Fraction of time that TAD canister is in TC (vs. in an AO).	N/A

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-PROB-DIESEL-AO-CUR	Probability of DPC in AO & diesel in CUR	6.52E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the AO in the Cask Unloading Room while diesel fuel is present.	Section 6.5, Table 6.5-4
060-PROB-DIESEL-AO-PREP	Probability of DPC in AO & diesel in Cask Preparation Room	4.62E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the AO in the cask preparation room while diesel fuel is present.	Section 6.5, Table 6.5-4
060-PROB-DIESEL--TC-PREP	Probability of DPC in TC & diesel in Cask Preparation Room	5.39E-02	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the TC in the cask preparation room while diesel fuel is present.	Section 6.5, Table 6.5-4
060-PROB-DPC-AO-DIESEL	Probability of DPC in AO with diesel	3.10E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the AO while diesel fuel is present in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DPC-IN-AO-LF	Probability DPC in AO in Large Fire	3.10E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the AO in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DPC-IN-CTM	Probability DPC in CTM in Large Fire	2.59E-02	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the CTM in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DPC-IN-TC-LF	Probability DPC in TC in Large Fire	6.64E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the TC in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DPC-TC-DIESEL	Probability of DPC in TC with diesel	4.38E-02	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the TC while diesel fuel is present in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DPC-TC-NODIES	Probability of DPC in TC without diesel	6.20E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the TC while diesel fuel is not present in a large fire.	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-PROB-DSTD-IN-CTM	Probability DOE Std. canister in CTM	3.27E-03	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in the CTM in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DSTD-IN-CTM-LF	Probability DOE Std. canister in CTM in Large Fire	3.27E-03	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in the CTM in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DSTD-IN-STG-LF	Probability DOE Std. canister in Staging Area in Large Fire	8.99E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in the staging area in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DSTD-IN-TC-LF	Probability DOE Std. canister in TC in Large Fire	9.82E-02	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in the TC in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DSTD-STAGING	Probability DOE Std. canister in Staging Area	8.99E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in the staging area in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DSTD-TC-DIES	Probability DOE Std. canister in TD with diesel Fire	6.14E-03	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in a TC while diesel fuel is present in a large fire.	Section 6.5, Table 6.5-4
060-PROB-DSTD-TC-NODIES	Probability DOE Std. canister in TC without diesel Fire	9.20E-02	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in a TC while diesel fuel is not present in a large fire.	Section 6.5, Table 6.5-4
060-PROB-HLW-IN-CTM-LF	Probability HLW in CTM in Large Fire	2.93E-02	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the CTM in a large fire.	Section 6.5, Table 6.5-4
060-PROB-HLW-IN-TC-LF	Probability HLW in TC in Large Fire	7.22E-01	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the TC in a large fire.	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-PROB-HLW-IN-WP-LF	Probability HLW in WP in Large Fire	2.49E-01	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in the WP in a large fire.	Section 6.5, Table 6.5-4
060-PROB-MCO-IN-CTM	Probability MCO in CTM	3.23E-02	Based on the fire frequency analysis, this value represents the fraction of time that a MCO is in the CTM. Data for MCO is the same as for the DOE Std. canister.	Section 6.5, Table 6.5-4
060-PROB-MCO-IN-CTM-LF	Probability MCO in CTM in Large Fire	3.23E-02	Based on the fire frequency analysis, this value represents the fraction of time that a MCO is in the CTM in a large fire. . Data for MCO is the same as for the DOE Std. canister.	Section 6.5, Table 6.5-4
060-PROB-MCO-IN-TC-LF	Probability MCO in TC in Large Fire	9.68E-01	Based on the fire frequency analysis, this value represents the fraction of time that a MCO is in the TC in a large fire. . Data for MCO is the same as for the DOE Std. canister.	Section 6.5, Table 6.5-4
060-PROB-MCO-TC-DIES	Probability MCO in TD with diesel Fire	6.05E-02	Based on the fire frequency analysis, this value represents the fraction of time that a MCO is in the TC while diesel fuel is present in a large fire. Data for MCO is the same as for the DOE Std. canister.	Section 6.5, Table 6.5-4
060-PROB-MCO-TC-NODIES	Probability MCO in TC without diesel Fire	9.07E-01	Based on the fire frequency analysis, this value represents the fraction of time that a MCO is in the TC while diesel fuel is not present in a large fire. . Data for MCO is the same as for the DOE Std. canister.	Section 6.5, Table 6.5-4
060-PROB-NODIESEL-TC-CUR	Probability of DPC in TC without diesel in CUR	3.48E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the TC in the Cask Unloading Room while diesel fuel is not present.	Section 6.5, Table 6.5-4
060-PROB-NODIESE-TC-PREP	Probability of DPC in TC & no diesel in Cask Preparation Room	4.84E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DPC is in the TC in the Cask Preparation Room while diesel fuel is not present.	Section 6.5, Table 6.5-4
060-PROB-ST-TAD	Probability of ST with TAD canister in AO	5.39E-01	Fraction of time that TAD canister is in AO on an ST (vs. in a TC on a CTT).	N/A

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-PROB-TAD-AO-CUR	Probability TAD canister in AO in Cask Unloading Room	5.20E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in an AO in the Cask Unloading Room.	Section 6.5, Table 6.5-4
060-PROB-TAD-AO-CURDIES	Probability TAD canister in AO in Unloading Room with diesel Fire	5.20E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in an AO in the Cask Unloading Room while diesel fuel is present.	Section 6.5, Table 6.5-4
060-PROB-TAD-AO-DIES	Probability TAD canister in AO in Fire with diesel	7.42E-02	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in an AO while diesel fuel is present in a large fire..	Section 6.5, Table 6.5-4
060-PROB-TAD-AO-PREP	Probability TAD canister in AO in Cask Preparation Room	3.55E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in an AO in the Cask Preparation Room.	Section 6.5, Table 6.5-4
060-PROB-TAD-CTM	Probability TAD canister in CTM in Fire	9.82E-03	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the CTM in a large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-IN-AO-LF	Probability TAD canister in AO in Large Fire	7.51E-02	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in an AO in a large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-IN-CTM-LF	Probability TAD canister in CTM in Large Fire	9.94E-03	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the CTM in large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-IN-TC-LF	Probability TAD canister in TC in Large Fire	2.33E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the TC in large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-IN-WP-LF	Probability TAD canister in WP in Large Fire	6.82E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the WP in large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-TC-CUR	Probability TAD canister in TC in Cask Unloading Room	4.80E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the TC in the Cask Unloading Room.	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-PROB-TAD-TC-CURND	Probability TAD canister in TC without diesel Fire	4.80E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the TC in the Cask Unloading Room while diesel fuel is not present.	Section 6.5, Table 6.5-4
060-PROB-TAD-TC-DIESEL	Probability TAD canister in TC with diesel Fire	1.37E-02	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the TC while diesel fuel is present in large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-TC-PREP	Probability TAD canister in TC in Cask Preparation Room	6.45E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the TC in the Cask Preparation Room.	Section 6.5, Table 6.5-4
060-PROB-TAD-TC-WODIESEL	Probability TAD canister in TC in Fire without diesel	2.17E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the TC while diesel fuel is not present in large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-WP	Probability TAD canister in WP in Fire	1.14E-02	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the WP in large fire.	Section 6.5, Table 6.5-4
060-PROB-TAD-WPTT	Probability TAD canister in WPTT in Fire	6.74E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister is in the WP in the WPTT in large fire.	Section 6.5, Table 6.5-4
060-RHSLIFTNUMBER-000001	Number of RHS Lifts	2.00E+00	This value represents the number of lifts performed by the remote handling system during the process of sealing the WP.	Attachment E, Table E6.6-1
060-SLIDEGATECLOSES-CAN	Slide gate impact damages canister	0.00E+00	The port slide gate and the CTM bell slide gate are designed to operate with a low-torque motor that prevent crushing a canister, should the canister be in transit through the gate. (see Section 6.0)	Attachment B4, Section B4.4.1.3
060-SPMRC-DNSF-DIESEL	Probability of Fire in Cask Preparation Room with diesel	9.44E-02	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in a TC in the Cask Preparation Room in a diesel fire.	Table 6.3-10 (DSNF-3)

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-SPMRC-DNSF-WODIESEL	Probability of Fire in Cask Preparation Room without diesel	9.06E-01	Based on the fire frequency analysis, this value represents the fraction of time that a DOE Std. canister is in a TC in the Cask Preparation Room in a non-diesel fire.	Table 6.3-10 (DSNF-4)
060-SPMRC-HLW-DIESEL	Fire in Cask Preparation Room SPMRC with diesel	9.09E-02	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in a TC in the Cask Preparation Room in a diesel fire.	Table 6.3-10 (HLW-3)
060-SPMRC-HLW-WODIESEL	Fire in Cask Preparation Room SPMRC without diesel	9.09E-01	Based on the fire frequency analysis, this value represents the fraction of time that a HLW canister is in a TC in the Cask Preparation Room in a non-diesel fire.	Table 6.3-10 (HLW-4)
060-SPMRC-MCO-DIESEL	Probability of Fire in Cask Preparation Room with diesel	9.44E-02	Based on the fire frequency analysis, this value represents the fraction of time that a MCO canister in a TC is in the Cask Preparation Room in a diesel fire. Data for MCO is the same as for the DOE Std. canister.	Table 6.3-10 (MCO-3)
060-SPMRC-MCO-WODIESEL	Probability of Fire in Cask Preparation Room without diesel	9.06E-01	Based on the fire frequency analysis, this value represents the fraction of time that a MCO canister in a TC is in the Cask Preparation Room in a non-diesel fire. Data for MCO is the same as for the DOE Std. canister.	Table 6.3-10 (MCO-4)
060-SPMRC-MILES-IN-CRCF	Miles Traveled in CRCF	4.00E-02	The distance the SPMRC travels in the CRCF is estimated to be 215 feet.	Ref. 2.2.32
060-SPMRC-TAD-DIESEL	Fire in Cask Preparation Room SPMRC with diesel	5.75E-02	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in a TC is in the Cask Preparation Room in a diesel fire.	Table 6.3-10 (TAD-5)

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-SPMRC-TAD-WODIES	Fire in Cask Preparation Room SPMRC without diesel	5.88E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in a TC is in the Cask Preparation Room in a non-diesel fire.	Table 6.3-10 (TAD-6)
060-STAGING-AREA-SHIELD	Failure of shielding in Staging Area	0.00E+00	Insulation provides protection to prevent loss of shielding	Table 6.3-6
060-ST-#-OF-SHIELD-DOORS	Number of Shield Doors ST Passes Through	2.00E+00	The ST is required to go across two shield doors during transit from outside of the facility into the Cask Unloading Room; (1) the door to the Cask Preparation Room, and (2) the Cask Unloading Room shield door.	Ref. 2.2.32
060-TADAO-CUR-DIESEL	Localized fire threatens TAD canister in Cask Unloading Room	2.50E-07	Localized Fire Threatens TAD canister in WP or TAD canister in AO (with diesel present) in Cask Unloading Room (diesel Present)in WP Loadout Room	Section 6.5, Table 6.5-4
060-TAD-AO-DIESEL	Fire in Cask Preparation Room with diesel - TAD canister in AO	3.55E-01	Based on the fire frequency analysis, this value represents the fraction of time that a TAD canister in an AO is in the Cask Preparation Room in a diesel fire.	N/A
060-TAD-CAN-CTM-FIRE	Localized fire threatens canister in the CTM	1.10E-07	Localized Fire Threatens TAD canister in CTM in Canister Transfer Room	Section 6.5, Table 6.5-4
060-TAD-FIRE-PREP-AREA	Probability of Fire Affecting TAD canister in Cask Preparation Room	8.17E-06	Localized Fire Threatens TC/TAD canister in Vestibule/Cask Preparation Room w/SPM (diesel Present), TC/TAD canister without SPM (No diesel Present), TAD canister in AO (diesel Present), and TC/TAD canister on CTT (No diesel Present).	Section 6.5, Table 6.5-4

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-TAD-LARGE-FIRE	Large fire threatens TAD canister anywhere in CRCF	8.76E-05	Large Fire Threatens TC/TAD canister (diesel Present), TC/TAD canister (No diesel), TAD canister in AO (diesel Present), TAD canister in CTM, TAD canister in WP in WPTT, and TAD canister in WP in TEV	Section 6.5, Table 6.5-4
060-TAD-WP-LOADOUT-RM	Localized fire threatens TAD canister in WP in Loadout Room	9.20E-07	Localized Fire Threatens TAD canister in WP and TEV in WP Loadout Room	Section 6.5, Table 6.5-4
060-TAD-WP-POSIT-RM-FIRE	Localized fire threatens TAD canister in WP in Position Room	6.50E-05	Mean probability that a Localized Fire Threatens TAD canister in WP in WP Positioning/Closure Room	Section 6.5, Table 6.5-4
060-TOTAL-SHIELD-DOORS	Total Number of Shield Doors	3.00E+00	Total number of shield doors traversed by the CTT or ST	Ref. 2.2.32
060-TRANSCTTLIFTNUMBER	Number of Crane Lifts	3.00E+00	Total number of lifts by the 200-ton crane during transfer of a TC from conveyance to preparation station. A number of 3 lifts per transfer (whether the transfer is directly from the conveyance – 1 lift – or has to be transferred to a cask stand then to a cask tilting frame – 2 lifts) is used to conservatively bind all possible methods for transferring the cask.	Attachment E

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-TRANSNSCTTLIFTNUMBER	Number of Crane Lifts without sling	1.00E+00	Horizontal casks can be lifted directly from the conveyance and transferred to a preparation station; therefore, it requires one lift. On the other hand, transfer of some casks may require sling. In that case, the cask is first transferred from the conveyance to a cask stand by sling. Then, from the cask stand to a cask tilting frame, the transfer is also done with sling. (Thus, 2 lifts are done with sling). From the tilting frame to the preparation station, the cask is lifted without sling. That's one lift without sling.	Attachment E
060-TRANSSTANDLIFTNUMBER	Crane Lifts with sling lift	2.00E+00	See above - 060-TRANSNSCTTLIFTNUMBER	Attachment E
060-UPENDOBJLIFTNUMBER	Number of object lifts	3.00E+00	During upending a horizontal TC from the railcar, the most bounding scenario is upending a cask with a sling lift. This involves (1) lifting the cask with a sling from the conveyance to the cask stand; (2) lifting the cask from the stand to the cask tilting frame with sling; and (3) lifting the cask from the tilting frame to the cask preparation station. For each lift, there is an opportunity to lift a heavy object over the cask and drop it onto the cask.	Attachment E
060-VCTO-CONTDOORS-OPEN	Vestibule Doors Open Receipt or Export from CRCF	1.00E+00	Set as "TRUE" that the vestibule doors are open during receipt or export of a TC or AO	N/A

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
060-VCTO-DRS0000-DRS-OPN	Vestibule Door Open During Receipt/Export	1.60E-04	During receipt of a transportation cask or aging overpack or during the export of a waste package or aging overpack, delta pressure is lost for a period of time not to exceed 7 minutes per event (this is a conservative estimate of the time it will take for the HVAC system to return the vestibule to a negative pressure). This occurs as a direct consequence of opening vestibule doors to allow the site transporter , the site prime mover or the transport and emplacement vehicle.	Attachment B, Section B7
060-VCTO-TRAINB-MAINT	Train B HVAC is Off-Line for Maintenance	4.57E-03	Value based on 40 hr of unavailability due to maintenance per year (8760 hr).	Attachment B, Section B7.2.10.
060-WPTT-MILES-IN-CRCF	Miles Traveled by WPTT During Transfer	4.00E-02	This value represents the number of miles that the WPTT will travel in the CRCF during normal operations.	N/A
11-CAN-FAIL-WP-WELD	TAD canister fails without WP	1.00E-08	Low welding temperature	Section 6.0, Table 6.0-2
11-H&D-FAIL-WP-WELD	DOE Std. canister fails in Open WP	0	Low welding temperature	Section 6.0, Table 6.0-2
26D-#EEY-ITSDG-A-#DG-MTN	ITS DG A OOS Maintenance	1.95E-03	Diesel Generator A out of service for maintenance	Attachment B, Section B8
26D-#EEY-ITSDG-A-#DG-RSS	Failure to properly return ITS DG A to service	1.95E-04	Operator fails to properly return diesel generator A to service after maintenance	Attachment B, Section B8
26D-#EEY-ITSDG-B-#DG-MTN	ITS DG B OOS Maintenance	1.95E-03	Diesel generator B out of service for maintenance	Attachment B, Section B8
26D-#EEY-ITSDG-B-#DG-RSS	Failure to properly restore ITS DG-B to service	1.95E-04	Operator fails to properly return diesel generator B to service after maintenance	Attachment B, Section B8
AO-TAD canister	Number of AOs containing TAD canisters processed during preclosure period	8.14E+03	Number of TAD canisters in AOs processed during the preclosure period as established in the throughput analysis.	Ref. 2.2.31
AO-TAD-IN	Number of AOs containing TAD canisters received during preclosure period	8.14E+03	Number of TAD canisters in AOs processed during the preclosure period as established in the throughput analysis.	Ref. 2.2.31

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
AO-TAD-OUT	Number of TAD canisters in AOs outgoing	6.98E+03	This basic event represents the number of AOs that are exported from the CRCF during the preclosure period. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
DPC	Number of DPCs processed during preclosure period	3.46E+02	This basic event represents the number of DPCs handled by the CTM during the preclosure period. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
DSTD	Number of DOE Std. Canisters moved during preclosure period	6.22E+03	This basic event represents the number of DOE Std. canisters handled by the CTM during the preclosure period. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
HLW	Number of HLW Canisters moved during preclosure period	9.80E+03	This basic event represents the number of HLW Canisters handled by the CTM during the preclosure period. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
MCO	Number of MCOs moved during preclosure period	4.51E+02	This basic event represents the number of MCOs handled by the CTM during the preclosure period. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
PROB-LEAD	Probability of Lead Casks	1.00E+00	The number of leaded TC received by the facility is unknown. This value is set to a value of 1.0 to ensure a conservative analysis.	N/A
PROB-NON-LEAD	Probability of Non-Lead Casks	0.00E+00	Since all TCs received by the facility are considered as leaded casks, then the probability of receiving non-leaded casks is 0.	N/A
SHIELD_DOOR_FAILURE	Shield Door Falls on Conveyance	0.00E+00	Design of shield door prevents failure due to low speed collisions within the CRCF.	Table 6.0-2

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
SHIELD-BELL-DROPS-SUBSUM	shield bell drops addressed in general CTM drop events	0.00E+00	Drops of canisters are subsumed in canister drop fault trees	N/A
TAD	Number of TAD canisters moved during preclosure period	1.51E+04	This basic event represents the number of TAD canisters transferred from a TC to an AO, from an AO to a WP, or from a TC to a WP. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TC-AO-TAD	Number of TCs and AOs containing TAD canisters moved during preclosure period	1.51E+04	This basic event represents the number of TAD canisters transferred from a TC to an AO, from an AO to a WP, or from a TC to a WP. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TC-DPC	Number of TCs containing DPCs moved during preclosure period	3.46E+02	This basic event represents the number of TCs containing DPC. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TC-DSTD	Number of TCs containing DOE Std. Canisters moved during preclosure period	3.85E+02	This basic event represents the number of TCs containing defense SNF. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TC-HLW	Number of TCs containing HLW Canisters moved during preclosure period	1.96E+03	This basic event represents the number of TCs containing HLW. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TC-MCO	Number of TCs containing MCOs received during preclosure period	1.13E+02	This basic event represents the number of TCs containing MCOs. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TC-TAD	Number of TCs containing TAD canisters moved during preclosure period	6.98E+03	This basic event represents the number of TCs containing MCOs. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
TEV_COLLISION	TEV collides with WPTT	0.00E+00	The TEV is in place and stationary when the WPTT enters the WP Loadout Room. The probability the TEV collides with the WEPTT is set to 0.	N/A

Table 6.3-11. Miscellaneous Data Used In the Reliability Analysis (Continued)

Basic Event (BE) ID	Basic Event Description	BE Value	Bases	References
WELD_DAMAGE	Weld Generates Sufficient Heat to Damage Can	0.00E+00	Welder malfunctions during the inner lid or outer lid welding. Since the welder can not generate sufficient heat to damage the WP, a value of 0.00 is assigned to the event.	N/A
WP-FIRE-SHIELDING	Probability of Shielding Degradation in a fire	0.00E+00	WPTT shielding remains intact	Table 6.3-6
WP-H&D	Number of WPs containing H&D	3.30E+03	This basic event represents the number of WPs containing 4 to 5 HLW canisters and 1 DOE SNF standard canister in the middle. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
WP-H&M	Number of WPs with MCOs moved during preclosure period	2.26E+02	This basic event represents the number of WPs containing 2 HLW canisters and 2 MCOs. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31
WP-TAD	Number of WPs containing TAD canisters	8.14E+03	This basic event represents the number of WPs containing TAD canister. The value for this basic event is obtained from the throughput analysis.	Ref. 2.2.31

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6.4 HUMAN RELIABILITY ANALYSIS

The PCSA has emphasized human reliability analysis (HRA) because the waste handling processes include substantial interactions between equipment and operating personnel. If there are human interactions that are typically associated with the operation, test, calibration, or maintenance of a certain type of SSC (e.g., drops from a crane when using slings) and this SSC has been treated using industry-wide data per Attachment C, then human failure events may be implicit in the reliability data. The analyst is tasked with determining whether that is the case. Otherwise, the analyst includes explicit identification, qualitative modeling, and quantification of HFEs, as described in this section. The detailed description of the HRA is presented in Attachment E.

6.4.1 HRA Scope

The scope of the HRA is established in order to focus the analysis on the issues pertinent to the goals of the overall PCSA. Thus, the scope is as follows:

1. HFEs are only considered if they contribute to a scenario that has the potential to result in a release of radioactivity, a criticality event, or a radiation exposure to workers. Such scenarios may include the need for mitigation of radionuclides, for example, provided by the confinement HVAC system.

2. Pursuant to the above, the following types of HFEs are excluded:

   A. HFEs resulting in standard industrial injuries (e.g., falls)

   B. HFEs resulting in the release of hazardous nonradioactive materials, regardless of amount

   C. HFEs resulting solely in delays to or losses of process availability, capacity, or efficiency.

3. The identification of HFEs is restricted to those areas of the facility that handle waste forms and only during the times that waste forms are being handled (e.g., HFEs are not identified for the Cask Preparation Room during the export of empty transportation casks).

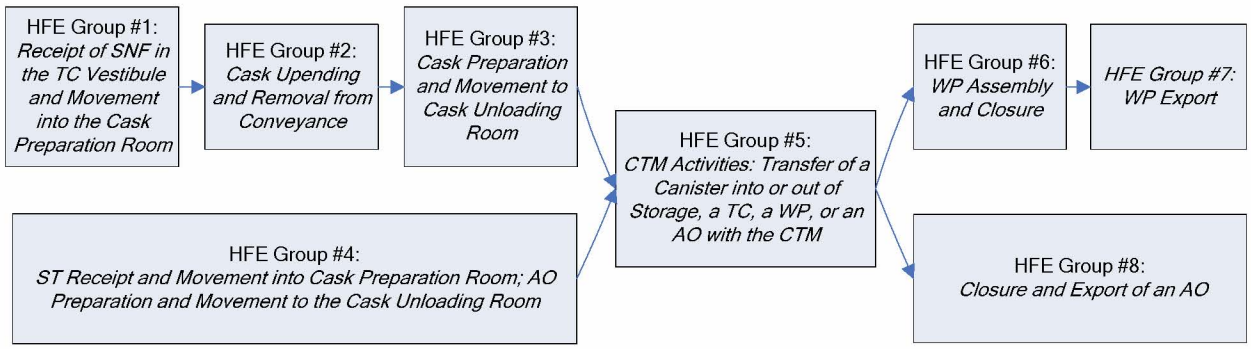
4. The exception to #3 is that system-level HFEs are considered for support systems (e.g., electrical power for confinement HVAC) when those HFEs could result in a loss of a safety function related to the occurrence or consequences associated with the events specified in #1.

5. Post-initiator recovery actions (as defined in Section E5.1.1.1) are not credited in the analysis; therefore, HFEs associated with them are not considered.

6. In accordance with Section 4.3.10.1 (on boundary conditions of the PCSA), initiating events associated with conditions introduced in SSCs before they reach the site are not, by definition of 10 CFR 63.2 (Ref. 2.3.2), within the scope of the PCSA nor, by extension, within the scope of the HRA.

6.4.2 Base Case Scenarios

The first step in this analysis is to describe the CRCF operations in sufficient detail such that the human reliability analysts can identify specific deviations that would lead to a radiation release, a direct exposure, or a criticality event. To do this, the CRCF operations were broken into eight separate operational steps, as depicted in Figure 6.4-1.



NOTE: AO = aging overpack; CTM = canister transfer machine; HFE =human failure event; SNF = spent nuclear fuel; ST = site transporter; TC = transportation cask; WP = waste package.

Source: Original

Figure 6.4-1. CRCF Operations

The base case scenario for each HFE group represents a realistic description of expected facility, equipment, and operator behavior for the selected operation. These scenarios are created from discussions between the human reliability analysts, other PCSA analysts, and personnel from engineering and operations. In addition to a detailed description of the operation itself, these base case scenarios include a brief description of the initial conditions and relevant equipment features (e.g., interlocks). The relationship between these HFE groups and the corresponding PFD nodes and ESDs are mapped in Attachment E, Table E6.0-1.

6.4.3 Identification of Human Failure Events

There are many possible human errors that could occur at YMP, the effects of which could be significant to safety. Human errors, based upon the three temporal phases used in PRA modeling, are categorized as follows:

- Pre-initiator HFEs

- Human-induced initiator HFEs
- Post-initiator HFEs[1]:
  - Non-recovery
  - Recovery.

Each of these types of HFEs is defined in Attachment E, Section E5.1.1.1. The PCSA model was developed and quantified with pre-initiator and human-induced initiator, and HFEs included in the model. Moreover, recovery post-initiator HFEs were not identified and not relied upon to reduce event sequence frequency. The safety philosophy of waste handling operations is that an operator need not take any action after an initiating event, and there are no actions identified that could exacerbate the consequences of an initiating event. This stems from the definitions and modeling of initiating events and subsequent pivotal events as described in Section 6.1 and Attachment A. All initiating events are proximal causes of either radionuclide release or direct exposure to personnel. With respect to the latter, personnel evacuation was not considered in reducing the frequency of direct exposure, but personnel action could cause an initiating event. With respect to the former, pivotal events address containment integrity, confinement availability, shielding integrity, and moderator availability that have no post-initiator human interactions. Containment and shielding integrity are associated only with the physical robustness of the waste containers. Confinement availability is associated with a continuously operating HVAC and the status of equipment confinement doors. Human interactions for HVAC are pre-initiator. Human actions for shielding are associated with the initiator phase. Thus, the focus of the HRA task is to support the other PCSA tasks to identify these two HFE phases.

Pre-Initiator HFEs

Pre-initiators are identified by the system analysts when modeling fault trees during the system analysis task. Special attention is paid to the possibility that an error can be repeated in similar redundant components or trains, leading to a human CCF.

Human-Induced Initiator HFEs

Human-induced initiator HFEs are identified through an iterative process whereby the human reliability analysts, in conjunction with other PCSA analysts and Engineering and Operations personnel, meet and discuss the design and operations of the facility and the SSCs in order to appropriately model the human interface. This iterative process began with the HAZOP evaluation, the MLD and event sequence development, and the event tree and fault tree modeling, and it culminated in the preliminary analysis and incorporation of HFEs into the model. Included in this process is an extensive information collection process where industry data for potential vulnerabilities and HFE scenarios are reviewed. The following sources were examined:

- *A Survey of Crane Operating Experience at U.S. Nuclear Power Plants from 1968 – 2002*, NUREG-1774 (Ref. 2.2.57)

[1] Terminology common to NPPs refer to post-initiator non-recovery events as Type C events and recovery events as Type CR events.

- *Control of Heavy Loads at Nuclear Power Plants*, NUREG-0612 (Ref. 2.2.67)

- Naval Facilities Engineering Command Internet Web Site, Navy Crane Center ("DOE Occurrence Reporting and Processing System (ORPS) Website and Naval Facilities Engineering Command (NAVFAC) Navy Crane Center Website." The database includes the following information:

  - NCC Quarterly Reports ("Crane Corner") 2001 through 2007
  - NCC Fiscal Year 2006 Crane Safety Reports (covers fiscal year 2001 through 2006)
  - NCC Fiscal Year 2006 Audit Report

- DOE Occurrence Reporting and Processing System (ORPS) Internet Web Site, Operational Experience Summaries (2002 through 2007) (http://www.hss.energy.gov/CSA/analysis/orps/orps.html)

- Institute of Nuclear Power Operations (INPO) database (https://www.inpo.org). The INPO database contains the following information:

  - Licensee event reports
  - Equipment Performance and Information Exchange System
  - Nuclear Plant Reliability Data System.

- *Savannah River Site Human Error Data Base Development for Nonreactor Nuclear Facilities (U)* (Ref. 2.2.13)

- All Scientech/Licensing Information Service (LIS) data on ISFSI events (1994 through 2007) and Dry Storage Information Forum (New Orleans, LA, May 2-3, 2001): This database includes the following information:

  - Inspection reports
  - Trip reports
  - Letters, etc.

HFEs identified include both EOOs and EOCs.

The result of this identification process is a list of HFEs and a description of each HFE scenario, including system and equipment conditions and any resident or triggered human factor concerns (e.g., PSFs). This combination of conditions and human factor concerns then becomes the EFC for a specific HFE. Additions and refinements to these initial EFCs are made during the preliminary and detailed analyses.

6.4.4 Preliminary Analysis

A preliminary analysis is performed to allow HRA resources for the detailed analyses to be focused on only the most risk-significant HFEs. The preliminary analysis includes verification of the validity of HFEs included in the initial PCSA model, assignment of conservative HEPs to all HFEs, and verification of those probabilities. The actual quantification of preliminary values is a six-step process that is described in detail in Appendix E.III of Attachment E. Once the

preliminary probabilities are assigned, the PCSA model is quantified (initial quantification) to determine which HFEs require a detailed quantification. HFEs are identified for a detailed analysis if (1) the HFE is a risk-driver for a dominant sequence, and (2) using the preliminary values, an aggregated event sequence is Category 1 or Category 2 according to 10 CFR 63.111 (Ref. 2.3.2) performance objectives.

In cases where HFEs are completely mitigated by hardware (i.e., interlocks), the HFE is generally assigned a value of 1.0 unless otherwise noted, and the hardware is modeled explicitly in the fault tree.

6.4.5 Detailed Analysis

Once preliminary values have been assigned, the model is run, and HFEs are identified for a detailed analysis if (1) the HFE is a risk-driver for a dominant sequence, and (2) using the preliminary values, that sequence is Category 1 or Category 2. A dominant sequence is one that does not meet the performance objectives according to the performance objectives in 10 CFR 63.111 (Ref. 2.3.2). The objective of a detailed analysis is to develop a more realistic HRA and identify design features to be added that will provide compliance with the aforementioned regulation. Many of the ITS features of Section 6.9 were identified during the HRA. The remaining HFEs retain their assigned preliminary values. For the preliminary analysis, many of the HFEs are modeled in a simplified form in the event trees and fault trees; although, for the preliminary analysis, each action is separated as much as possible for the detailed analysis. This separation is done to ensure that the detailed analysis is thorough and that the relationship between the system functionality and operations crew is transparent. First an HFE is broken down into the various scenarios that lead to the failure. Then, each scenario is further broken down into specific required actions and their applicable procedures, along with the systems and components that must be operated during performance of each action. Each action in each scenario has its own unique context, dependencies, and set of PSFs, and each is quantified independently. The failure probabilities for these unsafe actions are quantified by the HRA method appropriate to the HFE, its classification (e.g., EOC, EOO, observation error, execution error), and the context. For this analysis, several HRA methods were considered, and the following four methods were selected (Appendix E.IV of Attachment E provides a discussion of the selection process):

- CREAM (Cognitive Reliability and Error Analysis Method, CREAM (Ref. 2.2.56))
- HEART/NARA ("HEART - A Proposed Method for Assessing and Reducing Human Error" (Ref. 2.2.91)/, and *A User Manual for the Nuclear Action Reliability Assessment (NARA) Human Error Quantification Technique* (Ref. 2.2.42))
- THERP with some modifications (*Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications Final Report*. (Ref. 2.2.87))
- ATHEANA's expert elicitation approach (*Technical Basis and Implementation Guidelines for a Technique for Human Event Analysis (ATHEANA*). (Ref. 2.2.72)).

For the preliminary analysis, HFEs are modeled at a high level where several subtasks are combined into a single task so that explicit consideration of dependencies between subtasks is eliminated. For a detailed assessment, where the various actions that constitute an HFE are explicitly quantified, dependencies are also explicitly addressed using the basic formulae in Table 6.4-1 from the THERP method (Ref. 2.2.87), where N is the independently derived HEP.

Table 6.4-1. Formulae for Addressing HFE Dependencies

Level of Dependence	Zero	Low	Medium	High	Complete
Conditional Probability	N	$\frac{1 + 19N}{20}$	$\frac{1 + 6N}{7}$	$\frac{1 + N}{2}$	1.0

Source: Modified from Ref. 2.2.87, Table 20-17, p. 20–33

After estimates for HFE probabilities are generated, these results are reviewed by the HRA team and, in some cases, by knowledgeable operations personnel, as a "sanity check." Principally, such checks are used, for example, to compare the probabilities of different HFEs and determine whether or not these probabilities are consistent with the judgment of experts regarding the associated operator actions. A review of this type is particularly important for HFE probabilities that are generated using data from the THERP method (Ref. 2.2.87) since it is difficult to identify all important PSFs that are appropriate for repository operations. In addition, the HFE probability estimates are reviewed to ensure that they do not exceed the lower limit of credible human performance as defined by NARA (Ref. 2.2.42). HFE probabilities produced in this HRA are mean values; uncertainties are accounted for by applying an error factor to the mean value of the overall HFE according to the guidelines presented in Section E3.4 of Attachment E.

6.4.6 Human Failure Event Probabilities used in CRCF Event Sequences Analysis

The results of the HRA are the HFE probabilities used in the event tree and fault tree quantification process, which are listed in Table 6.4-2.

Table 6.4-2. Human Failure Event Probability Summary

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
060-#EEE-LDCNTRA-BUA-ROE	Operator fails to restore ITS load center Train A post maintenance	Electrical	OA (Pre-Initiator)	1.03E−05	10	Preliminary
060-#EEE-LDCNTRB-BUA-ROE	Operator fails to restore ITS load center Train B post maintenance	Electrical	OA (Pre-Initiator)	1.03E−05	10	Preliminary
060-Liddisplace1-HFI-NOD	Operator inadvertently displaces cask lid during platform activities	17	3, 4, 8	N/A[b]	N/A	Omitted from analysis
060-OpAOImpact01-HFI-NOW	Operator causes AO impact during AO platform activities (preparation or closure)	5, 12	4, 8	3.00E−03	5	Preliminary

Table 6.4-2. Human Failure Event Probability Summary (Continued)

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
060-OpCaskDrop01-HFI-NOD	Operator drops cask during cask preparation activities	4	3	N/A[b]	N/A	Omitted from analysis
060-OpClCTMGate1-HFI-NOD	Operator inappropriately closes slide or port gate during vertical canister movement and continues lifting	9	5	1.00E−03	5	Preliminary
060-OpCollide001-HFI-NOD	Operator causes low-speed collision of auxiliary vehicle with RC, TT, CTT, or TTC	3	2	3.00E−03	5	Preliminary
060-OpCraneIntfr-HFI-NOD	Operator causes WP handling crane to interfere with TEV or WPTT	15	7	1.00E−04	10	Preliminary
060-OpCTCollide1-HFI-NOD	Operator causes low-speed collision of auxiliary vehicle with ST/CTT	4, 5, 12	3, 4, 8	3.00E−03	5	Preliminary
060-OpCTCollide2-HFI-NOD	Operator causes low-speed collision of CTT with SSC during transfer from preparation station to Cask Unloading Room	6	3	1.00E−03	5	Preliminary
060-OpCTMDirExp1-HFI-NOD	Operator causes direct exposure during CTM activities (second floor)	18	5	8E−06	10	Detailed
060-OpCTMDrInt01-HFI-COD	Operator lifts object or canister too high with CTM (two-block)	9	5	1.0	N/A	Preliminary
060-OpCTMdrop001-HFI-COD	Operator drops object onto canister during CTM operations	9	5	4.00E−07	10	Detailed
060-OpCTMdrop002-HFI-COD	Operator drops canister during CTM operations	9	5	5.00E−07	10	Detailed
060-OpCTMImpact1-HFI-COD	Operator moves the CTM while canister or object is below or between levels	9	5	4.00E−08	10	Detailed
060-OpCTMImpact2-HFI-COD	Operator causes canister impact with lid during CTM operations (non-DPC)	9	5	N/A[b]	N/A	Omitted from analysis
060-OpCTMImpact3-HFI-COD	Operator causes two CTMs to collide.	9	5	1.00E−01	3	Preliminary
060-OpCTMImpact5-HFI-COD	Operator causes canister impact with SSC during CTM operations	9	5	1.0	N/A	Preliminary

Table 6.4-2. Human Failure Event Probability Summary (Continued)

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
060-OpCTTImpact1-HFI-NOD	Operator causes an impact between cask and SSC due to crane operations	4	3	3.00E−03	5	Preliminary
060-OpDirExpose1-HFI-NOD	Operator causes direct exposure during CTM activities (first floor)	18	5	1.00E−01	3	Preliminary
060-OpDirExpose2-HFI-NOD	Operator causes direct exposure during CTM activities (transfer into an AO)	18	5	1.00E−04	10	Preliminary
060-OpDirExpose3-HFI-NOD	Operator causes direct exposure during TEV loading	19	7	3.00E−05	10	Detailed
060-OpDPCShield1-HFI-NOW	Operator causes loss of shielding while installing DPC lift fixture	17	3	4.00E−04	10	Detailed
060-OpDSNFLoad-HFI-NOD	Operator misloads DOE SNF	N/A	5	1.00E−03	5	Preliminary
060-OpFailRstInt-HFI-NOM	Operator fails to restore interlock after maintenance	18	5, 7	1.00E−02	3	Preliminary
060-OpFailSG-HFI-NOD	Operator fails to close the CTM slide gate moving CTM with canister inside bell (direct exposure)	18	5	1E−03	5	Preliminary
060-OpFailStop-HFI-NOD	Operator fails to stop ST if tread fails	2, 16	4, 8	1.0	N/A	Preliminary
060-OpFLCollide1-HFI-NOD	Operator causes high-speed collision of auxiliary vehicle with RC, TT, ST, CTT or TTC	3, 4, 5, 12	2, 3, 4, 8	1.0	N/A	Preliminary
060-OpImpact0000-HFI-NOD	Operator causes impact of cask during transfer between preparation station and Cask Unloading Room	6, 14	3, 4, 8	N/A[b]	N/A	Omitted from analysis
060-OpLoadDrop-HFI-NOD	Operator causes ST to drop AO	2, 16	4, 8	N/A[b]	N/A	Omitted from analysis
060-OpNoDiscoAir-HFI-NOD	Operator fails to disconnect air supply from CTT in the Cask Unloading Room	9	5	1.00E−03	5	Preliminary
060-OpNoUnBolt00-HFI-NOD	Operator fails to fully unbolt the cask lid before moving CTT into the Cask Unloading Room (non-DPC)	9	5	1.00E−03	5	Preliminary

Table 6.4-2. Human Failure Event Probability Summary (Continued)

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
060-OpNoUnBoltDP-HFI-NOD	Operator fails to fully unbolt the cask lid before moving CTT into the Cask Unloading Room (DPC)	9	5	N/A[b]	N/A	Omitted from analysis
060-OpNoUnplugST-HFI-NOD	Operator fails to disconnect the power supply from the ST in the Cask Unloading Room	9	5	1.00E−03	5	Preliminary
060-OpRCCollide1-HFI-NOD	Operator causes low-speed collision between RC and facility SSCs	1	1	3.00E−03	5	Preliminary
060-OpRCIntCol01-HFI-NOD	Operator causes high-speed collision between RC and facility SSCs	1	1	1.0	N/A	Preliminary
060-OpRCIntCol02-HFI-NOD	Operator causes MAP to collide into RC	1	1	1.0	N/A	Preliminary
060-OpSDClose001-HFI-NOD	Operator closes shield door on conveyance	7	OA (1, 3, 4, 7, 8)	1.0	N/A	Preliminary
060-OpShieldRing-HFI-NOD	Operator fails to install WP shield ring in WPTT (direct exposure)	19	7	1.00E−04	10	Preliminary
060-OpSpurMove01-HFI-NOD	Operator causes spurious movement of CTT or ST in the Cask Preparation Room	3, 4, 5, 12	2, 3, 4, 8	1.00E−04	10	Preliminary
060-OpStageRack1-HFI-NOD	Operator causes direct exposure during canister staging	18	5	3.00E−05	10	Detailed
060-OpSTCollide1-HFI-NOD	Operator causes low-speed collision of ST with SSC while moving to the Cask Preparation Room	2	4	3.00E−03	5	Preliminary
060-OpSTCollide2-HFI-NOD	Operator causes low-speed collision of ST with SSC while moving to the Cask Unloading Room	6	4	3.00E−03	5	Preliminary
060-OpSTCollide3-HFI-NOD	Operator causes low-speed collision of ST with SSC while moving from the Cask Unloading Room to the Cask Preparation Room	14	8	3.00E−03	5	Preliminary
060-OpSTCollide4-HFI-NOD	Operator causes low-speed collision of ST with SSC while exporting the ST	16	8	3.00E−03	5	Preliminary

Table 6.4-2. Human Failure Event Probability Summary (Continued)

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
060-OpTCImpact01-HFI-NOD	Operator causes an impact between cask and SSC during upending and removal	3	2	3.00E−03	5	Preliminary
060-OpTEVDrClosd-HFI-NOD	Operator begins WP extraction before TEV doors open	15	7	1.00E−03	5	Preliminary
060-OpTiltDown01-HFI-NOD	Operator causes premature tilt-down of the WPTT	9, 10, 13	5, 6, 7	1.0	N/A	Preliminary
060-OpTipover001-HFI-NOD	Operator causes cask to tip over during cask upending and removal	3	2	1.00E−04	10	Preliminary
060-OpTipover002-HFI-NOD	Operator causes cask to tip over during cask preparation activities	4	3	1.00E−04	10	Preliminary
060-OpTipOver003-HFI-NOD	Operator causes tipover of ST	5, 12	4, 8	1.00E−04	10	Preliminary
060-OpTipOver3-HFI-NOD	Operator causes tipover of ST or CTT during movement between the Cask Unloading Room and Cask Preparation Area	6	3, 4	N/A[b]	N/A	Omitted from analysis
060-OpTTCollide1-HFI-NOD	Operator causes low-speed collision between TT and facility SSCs	1	1	3.00E−03	5	Preliminary
060-OpTTIntCol01-HFI-NOD	Operator causes high-speed collision between TT and facility SSCs	1	1	1.0	N/A	Preliminary
060-OpTTIntCol02-HFI-NOD	Operator causes MAP to collide into TT	1	1	1.0	N/A	Preliminary
060-OpTTRollover-HFI-NOD	Operator causes rollover of TT	1	1	N/A[b]	N/A	Omitted from analysis
060-OpWPCollide1-HFI-NOD	Operator causes low-speed collision of WPTT into SSC	10, 13	6, 7	3.00E−03	5	Preliminary
060-OpWPInnerLid-HFI-NOD	Operator fails to install WP inner lid (direct exposure)	19	6	6.00E−06	10	Detailed
060-OpWPTiltUp01-HFI-NOD	Operator prematurely tilts up the WPTT	15	7	1.0	N/A	Preliminary
060-OpWPTTSpur01-HFI-NOD	Operator causes spurious movement of WPTT during canister loading	9	5	1.00E−03	5	Preliminary

Table 6.4-2. Human Failure Event Probability Summary (Continued)

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
060-VCTO-DR00001-HFI-NOD	Operators open two or more Vestibule Doors in CRCF	HVAC	OA (Pre-Initiator)	1.00E−02	3	Preliminary
060-VCTO-HFIA000-HFI-NOM	Human error exhaust fan switch wrong position	HVAC	OA (Pre-Initiator)	1.00E−01	3	Preliminary
060-VCTO-HEPALK-HFI-NOD	Operator fails to notice HEPA filter leak in Train A	HVAC	OA (Pre-Initiator)	1.0	N/A	Preliminary
26D-#EEY-ITSDG-A-#DG-RSS	Operator fails to restore Diesel Generator A to service	Electrical	OA (Pre-Initiator)	1.95E−04	10	Preliminary
26D-#EEY-ITSDG-B-#DG-RSS	Operator fails to restore Diesel Generator B to service	Electrical	OA (Pre-Initiator)	1.95E−04	10	Preliminary
Crane drops (drop of cask or object onto cask)	Operator drops cask or drops object onto cask during crane operations	Various (3, 4, 11, 15)	OA (2, 3, 6, 7)	N/A[a]	N/A	Historical data
Gas sampling	Operator improperly performs gas sampling	N/A	3	N/A	N/A	Omitted from analysis
Improper WP closure	Operator damages canister or fails to properly weld the WP	11	6	N/A[b]	N/A	Omitted from analysis
Load too heavy	Operator causes drop of cask by attempting to lift a load that is too heavy for the crane	N/A	OA	N/A[b]	N/A	Omitted from analysis
Moderator	Operator introduces moderator into a moderator-controlled area of the CRCF	N/A	OA	N/A[b]	N/A	Omitted from analysis
RC derailment	Operator causes the RC to derail	1	1	N/A[a]	N/A	Historical data
Spurious movement of CTT/ST during CTM activities	Operator causes spurious movement of the CTT or ST during canister loading and unloading	9	5	N/A[b]	N/A	Omitted from analysis
ST rollover	Operator causes rollover of ST	2, 16	4, 8	N/A[b]	N/A	Omitted from analysis
TEV_Collision	Operator causes TEV to collide with WP or WPTT	15	7	N/A[b]	N/A	Omitted from analysis

Table 6.4-2. Human Failure Event Probability Summary (Continued)

Basic Event Name	HFE Description	ESD	HFE Group	Basic Event Mean Probability	Error Factor	Type of Analysis
WPTT derailment	Operator causes WPTT to derail	10, 13	6, 7	N/A[a]	N/A	Historical data
WPTT uncontrolled tilt-down	Operator causes an uncontrolled tilt-down of the WPTT	10, 15	6, 7	N/A[b]	N/A	Omitted from analysis

NOTES: [a] Historical data was used to produce a probability of crane drops; this historical data is not included as part of the HRA, but is addressed in Attachment C.

[b] These HFEs were initially identified, but omitted from analysis for various reasons, including a design change precluding the human failure, or the failure would require a series of unsafe actions in combination with mechanical failures, such that the event is no longer credible. See the appropriate HFE group in Attachment E for a case-by-case justification for these omissions.

AO = aging overpack; CRCF = Canister Receipt and Closure Facility; CTM = canister transfer machine; CTT = cask transfer trolley; DPC = dual-purpose canister; DOE = U.S. Department of Energy; ESD = event sequence diagram; HFE = human failure event; HVAC = heating, ventilation, and air conditioning; MAP = mobile access platform; MCC = motor control center; N/A = not applicable; OA = over arching (applies to multiple HFE groups (Section E6.0.2)); RC = railcar; SNF = spent nuclear fuel; SSC = structure, system, or component; SSCs = structures, systems, and components; ST = site transporter; TEV = transport and emplacement vehicle; TTC = a transportation cask that is upended using a tilt frame; TT = truck trailer; WP = waste package; WPTT = waste package transfer trolley.

Source: Original (Attachment E, Table E7-1)

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6.5 FIRE INITIATING EVENTS

Attachment F of this document describes the work scope, definitions and terms, method, and results for the fire analysis performed as a part of the PCSA. The internal events of the PCSA model are evaluated with respect to fire initiating events and modified as necessary to address fire-induced failures that lead to exposures. The list of fire-induced failures included in the model, are evaluated as to fire vulnerability, and fragility analyses are conducted as needed (Section 6.3.2 and Attachment D).

Fire initiating event frequencies have been calculated for each initiating event identified for the CRCF. Section F5 of Attachment F details the analysis performed to determine these frequencies, using the methodology described in Section F4 of Attachment F.

6.5.1 Input to Initiating Events

Room and building areas; ignition frequencies; ignition source distributions; propagation probabilities; and residence fractions are the set of calculated values which contribute to calculating initiating event frequencies.

Room dimensions (Section F5.2.1 of Attachment F) are utilized to determine individual room areas, and the total building area. The area of the CRCF is utilized to evaluate the building ignition frequency. From methodology and equations presented in Section F4.3.1 of Attachment F, the building ignition frequency over the 50 year facility operation period -- of 3.7 is obtained for the CRCF. The results of this portion of the analysis are summarized in Table 6.5-1.

As discussed in Section F4.3.2.1, F5.3, and F5.4 of Attachment F, an industrial building fire can begin as the result of numerous types of ignition sources, which are grouped into nine categories:

1. Electrical equipment
2. HVAC equipment
3. Mechanical process equipment
4. Heat generating process equipment
5. Torches, welders, and burners
6. Internal combustion engines
7. Office and kitchen equipment
8. Portable and special equipment
9. No equipment involved.

Table 6.5-1. Room Areas and Total Ignition Frequency

Room	Area (m2)	Room	Area (m2)	Room	Area (m2)	Room	Area (m2)
1001	233	1019	213	1045	27	2006J	89
1001A	141	1020	33	1046	7	2006K	73
1002	74	1021	31	1047	76	2007	247
1002A	13	1022	28	1047A	66	2007A	27
1003	164	1023	78	1048	42	2007B	27

Table 6.5-1. Room Areas and Total Ignition Frequency (Continued)

Room	Area (m2)	Room	Area (m2)	Room	Area (m2)	Room	Area (m2)
1004	119	1024	78	1049	76	2008	433
1005A	103	1025	28	1049A	66	2010	186
1005B	68	1026	2143	1050	42	2011	224
1005C	51	1027	342	1051	32	2011A	19
1005D	67	1028	423	1052	32	2012	493
1005E	116	1029	164	1053	28	2038	40
1005F	109	1029A	25	1054	29	2039	42
1005G	53	1030	46	1201 - 1210	226	2040	42
1005H	58	1031	139	1211 - 1213 & 1215 - 1222	295	2041	48
1005J	141	1032	307			2042	42
1007	410	1033	144	1214	54	2043	36
1007A	36	1034	48	2001	433	2045	15
1008	164	1035	184	2002	183	2045A	15
1008A	25	1036	239	2003	211	2046	6
1009	46	1036A	208	2003A	19	2048	42
1010	129	1036B	20	2004	3846	2050	43
1011	313	1037	51	2005	511	3001	121
1012	147	1038	39	2005A	33	3002	61
1013	164	1039	39	2006A	90	3038	40
1013A	11	1040	39	2006B	71	3041	48
1014	385	1041	48	2006D	90	3045	15
1015	1326	1042	42	2006E	52	3045A	15
1016	33	1043	36	2006F	38	3046	7
1017	37	1044	20	2006G	129	3048	42
1018	213	1044A	7	2006H	40	3050	43
Total Area (m^2)				19611			
Ignition Frequency (per m^2/yr)				3.77E-06			
Ignition Frequency (per yr)				7.40E-02			
Ignition Frequency (50 years - preclosure period)				3.70E+00			

NOTE: m = meter; yr = year.

Source: Table F5.2-1 of Attachment F

Each category has a fraction representing the probability that, given an ignition, that category is the source of the ignition. These fractions are combined with the number of units in each category to determine the ignition frequency per ignition source. Uncertainty distributions have been applied to the ignition frequencies (Appendix F.II of Attachment F), and contribute to the resulting distribution for fire initiating event frequencies. The number of ignition sources in each category is further divided by location into specific rooms. Each piece of equipment in a category is defined as one ignition source, with some exceptions:

- MCCs, load centers, and equipment racks contribute an ignition source for each active vertical cabinet.
- An ignition source is counted for each motor over 5 hp for all equipment with motors.
- A welding ignition source is counted for each hour of operation expected per year.
- The ignition sources for mobile equipment are split between the rooms the equipment occupies in proportion to the amount of time the equipment will spend in each room.
- An ignition source is counted for every square meter in the room for the no equipment involved category.

The distribution and determination of ignition sources is further discussed in Section F5.4 of Attachment F, and summarized in Table 6.5-2. Because the no equipment involved category ignition sources are equal to the square meters values (available in Table 6.5-1), and because there is no equipment for any of the facilities that falls under the heat-generating process equipment category (F5.4.4), those categories are not presented in the summary Table 6.5-2.

Table 6.5-2. Ignition Source Category and Room-by-Room Population

Room	Electrical	HVAC	Mechanical Equipment	Torches, welders, burners	Internal combustion engines	Office/ kitchen equipment	Portable Equipment
1001	–	–	–	5	–	–	–
1001A	–	2	–	–	–	–	2
1003	–	4	–	–	–	–	2
1004	1	4	–	–	–	–	2
1007	88	–	–	–	–	–	2
1007A	2	–	–	–	–	–	–
1008	23	2	–	–	–	–	2
1008A	1	–	–	–	–	–	–
1009	–	4	–	5	–	–	2
1010	–	2	–	–	–	–	2
1011	–	4	–	–	–	–	2
1013	16	–	–	–	–	1	–
1014	–	2	2	–	–	–	1
1015	1	2	9.2	–	–	–	2
1018	–	–	2.4	–	–	–	1

Table 6.5-2. Ignition Source Category and Room-by-Room Population (Continued)

Room	Electrical	HVAC	Mechanical Equipment	Torches, welders, burners	Internal combustion engines	Office/ kitchen equipment	Portable Equipment
1019	—	—	2.4	—	—	—	1
1023	—	—	1.05	—	—	—	1
1024	—	—	1.05	—	—	—	1
1026	1	—	19.9	—	130	—	4
1027	—	2	2	5	10	—	—
1028	14	2	4	400	—	—	—
1029	23	2	—	—	—	—	2
1029A	1	—	—	—	—	—	—
1030	—	4	—	—	—	—	2
1031	—	2	—	—	—	—	2
1032	—	4	—	—	—	—	2
1035	—	4	—	—	—	—	2
1036	—	2	—	—	37	—	—
1036A	—	2	—	—	23	—	—
1044	—	—	1	—	—	—	—
1047	—	—	1	—	—	—	—
1049	—	—	1	—	—	—	—
1201 - 1210	—	—	—	—	—	5	—
1211 - 1213 & 1215 - 1222	—	—	—	—	—	4	—
2001	14	6	—	—	—	—	4
2002	—	—	—	5	—	—	—
2003	11	—	1	—	—	—	1
2004	—	2	14	10	—	—	1
2005	21	2	—	—	—	—	4
2007	—	—	5	946	—	—	2
2007A	9	—	—	—	—	—	1
2007B	—	—	—	—	—	—	1
2008	27	2	—	—	—	—	4
2010	—	—	—	5	—	—	—
2011	11	—	1	—	—	—	1
2012	20	4	—	—	—	—	4
TOTAL	**284**	**66**	**68**	**1381**	**200**	**10**	**60**

NOTE: HVAC = heating, ventilation, and air conditioning.

Source: Table F5.5-1 of Attachment F

Propagation probabilities (Section F5.6, Attachment F) are utilized in the analysis to define the probability of a fire spreading to various points specifically identified as areas in which a waste form may be vulnerable. Uncertainty distributions have been applied to the propagation probabilities (Appendix F.II of Attachment F), and contribute to the resulting distribution for fire initiating event frequencies.

Residence fractions (Section F5.7.1, Attachment F) developed from process throughputs, define the length of time (in minutes) a waste form is vulnerable in a particular area of the building and in a particular configuration. The minutes are converted to the fraction of time the vulnerability is present over the 50 year preclosure surface operation period, and are summarized in Table 6.5-3.

Table 6.5-3. Residence Fractions

Initiating Event	Residence Fraction
Waste Form in WP in WP Positioning/Closure Room	
TAD canister in WP in WP Positioning/Closure Room	9.6E-05
HLW in WP in WP Positioning/Closure Room	1.3E-05
HLW and DOE-SNF in WP in WP Positioning/Closure Room	9.8E-05
Waste Form in TEV in WP Loadout Room	
TAD canister/WP in TEV in WP Loadout Room	1.2E-06
HLW and DOE-SNF in WP, in TEV in WP Loadout Room	1.2E-06
Waste Form in WP in WP Loadout Room	
TAD canister in WP in WP Loadout Room	7.1E-06
HLW and DOE-SNF in WP in WP Loadout Room	7.1E-06
Waste Form on CTT in Cask Unloading Room	
TC/TAD canister on CTT in Cask Unloading Room	3.3E-06
TC/HLW on CTT in Cask Unloading Room	1.3E-05
TC/DOE-SNF on CTT in Cask Unloading Room	2.1E-05
TC/DPC (VTC) in Cask Unloading Room	1.8E-06
Waste Form in AO in Cask Unloading Room (Diesel Present)	
TAD canister in AO in Cask Unloading Room (Diesel Present)	3.5E-06
DPC (VTC) in AO in Cask Unloading Room (Diesel Present)	3.3E-06
Waste Form in Vestibule/Cask Preparation Room w/SPM (Diesel Present)	
TC/TAD canister in Vestibule/Cask Preparation Room w/SPM (Diesel Present)	2.1E-06
TC/HLW in Vestibule/Cask Preparation Room w/SPM (Diesel Present)	2.1E-06
TC/DOE-SNF in Vestibule/Cask Preparation Room w/SPM (Diesel Present)	2.1E-06
TC/DPC (VTC) in Vestibule/Cask Preparation Room (Diesel Present)	2.1E-06
Waste Form in Cask Preparation Room w/o SPM (No Diesel Present)	
TC/TAD canister in Cask Preparation Room w/o SPM (No Diesel Present)	1.5E-05
TC/HLW in Cask Preparation Room w/o SPM (No Diesel Present)	1.8E-05
TC/DOE-SNF in Cask Preparation Room w/o SPM (No Diesel Present)	1.5E-05
TC/DPC (VTC) in Cask Preparation Room (No Diesel Present)	1.3E-05
Waste Form in AO in Vestibule/Cask Preparation Room (Diesel Present)	
TAD canister in AO in vestibule/Cask Preparation Room (diesel present)	8.4E-06
DPC (VTC) in AO in vestibule/Cask Preparation Room (diesel present)	1.2E-05
Waste Form on CTT in Cask Preparation Room	
TC/TAD canister on CTT in Cask Preparation Room	1.6E-05
TC/HLW on CTT in Cask Preparation Room	1.4E-05
TC/DOE-SNF on CTT in Cask Preparation Room	1.5E-05
TC/DPC (VTC) in Cask Preparation Room	1.5E-05
Waste Form in CTM in Canister Transfer Room	
TAD canister in CTM in Canister Transfer Room	1.1E-06
HLW in CTM in Canister Transfer Room (per individual canister)	1.3E-06

Table 6.5-3. Residence Fractions (Continued)

Initiating Event	Residence Fraction
DOE-SNF in CTM in Canister Transfer Room (per individual canister)	1.1E-06
DPC in CTM in Canister Transfer Room	1.2E-06
TC/TAD canister (Diesel Present)	2.1E-06
TC/TAD canister (No Diesel)	3.3E-05
TAD canister in AO (Diesel Present)	1.1E-05
TAD canister in CTM	1.5E-06
TAD canister in WP in WPTT	1.0E-04
TAD canister in WP in TEV	1.8E-06
TC/HLW (Diesel Present)	2.1E-06
TC/HLW (No Diesel)	3.4E-05
HLW in CTM (per individual canister)	1.5E-06
HLW in WP	1.3E-05
HLW and DOE-SNF in WP	1.1E-04
TC/DOE-SNF (Diesel Present)	2.1E-06
TC/DOE-SNF (No Diesel)	3.2E-05
DOE-SNF in CTM (per canister)	1.1E-06
DOE-SNF in Staging Area	1.0E+00
TC/DPC (VTC) (Diesel)	2.1E-06
TC/DPC (VTC) (No Diesel)	3.0E-05
DPC (VTC) in CTM	1.2E-06
DPC (VTC) in AO (Diesel)	1.5E-05

NOTE: AO = aging overpack; CTM = canister transfer machine; CTT = cask transfer trolley; DOE = U.S. Department of Energy; DPC = dual-purpose canister; HLW = high-level radioactive waste; SNF = spent nuclear fuel; SPM = site prime mover; TAD = transportation, aging, and disposal; TC = transportation cask; TEV = transport and emplacement vehicle; VTC = a transportation cask that is upended on a railcar; WP = waste package; WPTT = waste package transfer trolley.

Source: Tables F5.7-1, F5.7-2, and F5.7-3 of Attachment F

6.5.2 Initiating Event Frequencies

Uncertainty distributions are utilized in the contribution to initiating event frequency calculations to account for statistical uncertainty in the data. Uncertainty distributions utilized for this analysis are lognormal distribution, and normal distribution. The normal distribution can be accurately represented by a mean and 97.5% value, the lognormal distribution is represented by a median (50%) and 97.5% value. The mean and median can be inputs to calculate the error factor. The 97.5% value is also provided, and is a figure that represents a point at which only 2.5% of all possible outcomes will vary from the mean more significantly. Three uncertainty distributions were developed for this analysis, details for which are in Appendices F.II and F.III of Attachment F.

Monte Carlo simulations are performed to determine the mean, median, standard deviation, variance, minimum, and maximum values of each of the initiating event frequencies based on the variance of the contributing data. To accomplish this, the Microsoft Excel add-on package Crystal Ball is used (Section F5.8). This software requires input of two parameters (e.g., in the lognormal case, 50% and 97.5% values). Crystal Ball software allows probability distributions to be combined per formulas or equations representing initiating event frequency inputs entered into EXCEL. The software randomly selects a value from the possibilities defined by the distribution. Ten thousand Monte Carlo trials are performed.

Crystal Ball is run for all of the initiating events, the complete output of which is available in Appendix VI of Attachment F. In addition to showing the initiating event frequency distribution, the full output also shows the input distribution for the parameters that are varied, which match the distributions developed and documented in Appendices F.II and F.III of Attachment F.

Table 6.5-4. Results from Monte Carlo Simulation of Initiating Event Frequency Distributions

Initiating Event	Equipment	Mean	Median	97.5% Value	EF	Type
Localized Fire Threatens TAD canister in WP in WP Positioning/Closure Room	WP transfer trolley	6.5E-05	5.8E	1.4E-4	2.2E+00	Lognormal
Localized Fire Threatens HLW in WP in WP Positioning/Closure Room		8.5E-06	7.6E-06	1.9E-05	2.2E+00	Lognormal
Localized Fire Threatens HLW and DOE SNF in WP in WP Positioning/Closure Room		6.6E-05	5.9E-05	1.4E-04	2.2E+00	Lognormal
Localized Fire Threatens Waste Form in TEV in WP Loadout Room	Transportation emplacement vehicle					
Localized Fire Threatens TAD canister/WP in TEV in WP Loadout Room		1.9E-07	1.7E-07	4.1E-07	2.1E+00	Lognormal
Localized Fire Threatens HLW and DOE SNF in WP in TEV in WP Loadout Room		1.9E-07	1.7E-07	4.1E-07	2.1E+00	Lognormal
Localized Fire Threatens Waste Form in WP in WP Loadout Room	WP transfer trolley					
Localized Fire Threatens TAD canister in WP in WP Loadout Room		7.3E-07	6.6E-07	1.6E-06	2.0E+00	Lognormal
Localized Fire Threatens HLW and DOE SNF in WP in WP Loadout Room		7.3E-07	6.6E-07	1.6E-06	2.0E+00	Lognormal

Table 6.5-4. Results from Monte Carlo Simulation of Initiating Event Frequency Distributions (Continued)

Initiating Event	Equipment	Mean	Median	97.5% Value	EF	Type
Localized Fire Threatens Waste Form on CTT in Cask Unloading Room	Cask transfer trolley					
Localized Fire Threatens TC/TAD canister on CTT in Cask Unloading Room		1.2E-07	1.1E-07	2.8E-07	2.3E+00	Lognormal
Localized Fire Threatens TC/HLW on CTT in Cask Unloading Room		4.7E-07	4.2E-07	1.1E-06	2.2E+00	Lognormal
Localized Fire Threatens TC/DOE SNF on CTT in Cask Unloading Room		7.5E-07	6.7E-07	1.7E-06	2.2E+00	Lognormal
Localized Fire Threatens TC/DPC (VTC) in Cask Unloading Room		6.4E-08	5.6E-08	1.5E-07	2.3E+00	Lognormal
Localized Fire Threatens Waste Form in AO in Cask Unloading Room (Diesel Present)	Site transporter					
Localized Fire Threatens TAD canister in AO in Cask Unloading Room (Diesel Present)		1.3E-07	1.1E-07	2.9E-07	2.5E+00	Lognormal
Localized Fire Threatens DPC (VTC) in AO in Cask Unloading Room (Diesel Present)		1.2E-07	1.0E-07	2.7E-07	2.4E+00	Lognormal
Localized Fire Threatens Waste Form in Vestibule/Cask Preparation Room w/SPM (Diesel Present)	Site prime mover					
Localized Fire Threatens TC/TAD canister in Vestibule/Cask Preparation Room w/SPM (Diesel Present)		4.7E-07	4.2E-07	1.1E-06	2.2E+00	Lognormal
Localized Fire Threatens TC/HLW in Vestibule/Cask Preparation Room w/SPM (Diesel Present)		4.9E-07	4.3E-07	1.1E-06	2.2E+00	Lognormal
Localized Fire Threatens TC/DOE SNF in Vestibule/Cask Preparation Room w/SPM (Diesel Present)		4.9E-07	4.3E-07	1.1E-06	2.2E+00	Lognormal
Localized Fire Threatens TC/DPC (VTC) in Vestibule/Cask Preparation Room (Diesel Present)		4.9E-07	4.3E-07	1.1E-06	2.2E+00	Lognormal