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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
1216 (RP Instrument Room)							10% of all such equipment 1 point	
1217 (RA Exit/PCM Room)								
1218 (RP Gear Supply Room)								
1219 (RP Equipment Room)							10% of all such equipment 1 point	
1220 (Respirator Room)								
1221 (Change Room 1)								
1222 (Change Room 2)								
2001 (HVAC Room)	**2 480V MCCs** EEN0-MCC-00005 • **7 cabs** EEN0-MCC-00006 • **6 cabs** **1 277V Lighting Panel** 060-EUL0-PL-00003	2 HEPA Filter Units (hpn/a) 060-VCT0-FLT-00001 060-VCT0-FLT-00002 2 Exhaust Fans 060-VCT0-EXH-00001 060-VCT0-EXH-00002 • 5 hp(ea.) 2 Air Handling Units 060-VCT0-AHU-00001 060-VCT0-AHU-00002 • 75 hp(ea.) 55 kVA						5.9% of all such equipment • 4 points
2002 (Unassigned)					Portable Welding Receptacle – WWF = 5 points			
2003 (Closure Support Room N)	**WP Closure Spt. Rm. Crane** 060-HW00-CRN-00002 • **1 Electrical Panel** **10 Equipment Racks**		WP Closure Spt. Rm. Crane 060-HW00-CRN-00002 • 1 ~~+ 2~~ motors @ 20, ~~1, & 3 hp~~ • 24 hp • 48 kVA ~~Closure SupportRoom Door~~ ~~• 2 kVA~~ ~~1 motor @ 2 hp~~					1.5% of all such equipment • 1 point
2003A (Personnel Access Room)								

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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
2004 (Canister Transfer Room)		**2 Air Handling Units** 060-VCT0-AHU-00003 060-VCT0-AHU-00004 **75 hp(ea.)**	CTM Maintenance Cranes 060-HTC0-CRN-00001 060-HTC0-CRN-00002 • 2 ~~+ 1~~ motors @ 35, ~~2,~~ & 7.5 hp x 2 - 4 • 44.5 hp • 67.5 kVA Canister Trans. Machines 060-HTC0-FHM-00001 • 5 ~~+ 1~~ motors @ 45, ~~3,~~ 7.5, 7.5, 60, & 5 hp 060-HTC0-FHM-00002 • 5 ~~+ 1~~ motors @ 45, ~~3,~~ 7.5, 7.5, 60, & 5 hp • 120.5 hp (ea.) • 140 kVA (ea.) ~~5 DOE Canister Slide Gates~~ ~~060-HTC0-HTCH-00005(thru 9)~~ ~~• 1 Motor @ 3 hp~~ ~~2 TAD Slide Gates~~ ~~060-HTC0-HTCH-00010 & 11~~ ~~• 2 Motors @ 1.5 hp~~ ~~2 Cask Port Slide Gates~~ ~~060- HTC0-HTCH-00001~~ ~~060- HTC0-HTCH-00002~~ ~~• 1 hp (ea.)~~ ~~• 2 motors~~ ~~2 Cask Port Slide Gates~~ ~~060- HTC0-HTCH-00003~~ ~~060- HTC0-HTCH-00004~~ ~~• 1 kVA (ea.)~~ ~~1 hp (ea.)~~		2 Portable Welding Receptacle – WWF = 10 points			1.5% of all such equipment • 1 point

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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
2005 (HVAC Room)	**2 480V MCCs** EEN0-MCC-00007 • **9 cabs** EEN0-MCC-00008 • **9 cabs** **1 480-208/120V Xfmr** 060-EEN0-XFMR-00053 **1 480-208/120 Distribution Pnl** 060-EEN0-PL-00053 **1 277V Lighting Panel** 060-EUL0-PL-00005	2 Air Handling Units 060-VCT0-AHU-00005 060-VCT0-AHU-00006 75 hp(ea.)						5.9% of all such equipment • 4 points
2005A (Communications Room)								
2006A (Corridor)								
2006B (Corridor)								
2006D (Corridor)								
2006E (Corridor)								
2006F (Corridor)								
2006G (Corridor)								
2006H (Corridor)								
2006J (Corridor)								
2006K (Corridor)								

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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
2007 (Waste Package Closure Room)			WP Closure Room Crane 060-HW00-CRN-00001 • 2 ~~+ 1~~ motors @ 35, ~~2,~~ & 7.5 hp • 34.5 hp • 67.5 kVA Closure Support Cart 060-HL00-TRLY-00003 • 1 motor • 5 hp • 5 kVA ~~Burnishing Tool~~ ~~HWS0-TOOL-00001~~ ~~• low hp motors~~ **Weld Dressing End Effectors** 060-HWW0-TOOL-00003 & 4 • **2 machining/sparks** ~~• 2 motors @ 4.5 hp~~ ~~Remote Handling System~~ ~~060-HWH0-HEQ-00003~~ ~~• various small motors~~ ~~2 WP Closure System Robot Arms~~ ~~060-HWH0-HEQ-00001 & 2~~ ~~• various small motors~~ ~~2 MP WP Inverting Vac Pump~~ ~~• 2 hp (ea.)~~ ~~WP Closure Sys. Chiller~~ ~~• 3 motors @ 1hp~~ ~~Waste Package Closure Room Door 1~~ ~~• 2 kVA~~ ~~1 motor @ 2 hp~~		**WPCS Weld End Effectors – WWF = 946 points** HWW0-TOOL-00001& 2			2.9% of all such equipment • 2 points

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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
2007A (Closure Equipment Room N)	**9 Equipment Racks**							1.5% of all such equipment • 1 point
2007B (Closure Equipment Room S)								1.5% of all such equipment • 1 point
2008 (HVAC Room)	**480V MCC** 060-EEN0-MCC-00009 • **9 cabs** 060-EEN0-MCC-00010 • **12 cabs** **1 75 kVA 480-208/120V Xfmr** 060-EEN0-XFMR-00052 **1 75 kVA 480-208/120V Xfmr** 060-EEN0-XFMR-00055 **2 480-208/120 Distribution Pnls** 060-EEN0-PL-00055 060-EEN0-PL-00052 **2 Lighting Panels** 060-EUL0-PL-00004 060-EUL0-PL-00006	2 Air Handling Units 060-VCT0-AHU-00007 060-VCT0-AHU-00008 **75 hp(ea.)**						5.9% of all such equipment • 4 points
2010 (Unassigned)					Portable Welding Receptacle – WWF = 5 points			
2011 (Closure Support Room S)	WP Closure Spt. Rm. Crane 060-HW00-CRN-00003 • 1 Electrical Panel 10 Equipment Racks		WP Closure Spt. Rm. Crane 060-HW00-CRN-00003 • 1 + 2 motors @ 20, 1, & 3 hp • 24 hp • 48 kVA ~~Closure Support Room Door~~ ~~• 2 kVA~~ ~~1 motor @ 2 hp~~					1.5% of all such equipment • 1 point
2011A (Personnel Access Room)								

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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
2012 (HVAC Room)	**480V MCC** 060-EEN0-MCC-00011 • **9 cabs** 060-EEN0-MCC-00012 • **8 cabs** **1 75 kVA 480-208/120V Xfmr** 060-EEN0-XFMR-00054 **1 480-208/120 Distribution Pnl** 060-EEN0-PL-00054 **1 480-208/120 Lighting Pnl** 060-EUL0-PL-00007	2 HEPA Filter Units (hpn/a) 060-VCT0-FLT-00003 060-VCT0-FLT-00004 2 Exhaust Fans 060-VCT0-EXH-00003 060-VCT0-EXH-00004 40 hp(ea.)						5.9% of all such equipment • 4 points
2038 (Stair #1)								
2039 (Stair #2)								
2040 (Stair #3)								
2041 (Stair #4)								
2042 (Stair #5)								
2043 (Stair #6)								
2045 (Corridor)								
2045A (Storage Room)								
2046 (Elevator Lobby)								
2048 (Elevator Lobby)			~~2 Elevator Lobby Doors~~ ~~• 1 motor each @ 2 hp~~					
2050 (Elevator Lobby)			~~2 Elevator Lobby Doors~~ ~~1 motor each @ 2 hp~~					
3001 (Corridor)								
3002 (Corridor)								
3038 (Stair #1)								
3041 (Stair #4)								
3045 (Corridor)								

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Table F5.4-1. Ignition Source Population by Room (Continued)

Ignition Source / Room Number	Electrical Equipment	Mechanical/ Electrical HVAC Equipment	Mechanical Process Equipment	Heat Generating Process Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/Kitchen Equipment	Portable and Special Equipment
3045A (Storage Room)								
3046 (Elevator Lobby)								
3048 (Elevator Lobby)			~~1 Elevator Lobby Door~~ ~~1 motor @ 2 hp~~					
3050 (Elevator Lobby)			~~1 Elevator Lobby Door~~ ~~1 motor @ 2 hp~~					

NOTE: 1. The equipment shown crossed out is included on the table to show completeness in the process of identifying equipment and locations. However, in accordance with the counting guidance cited in the methodology section these pieces of equipment are not considered as ignition sources because they are motors of less than 5hp.
2. In accordance with the counting guidance, the cabinet count for each MCC is for energized cabinets only (i.e., cabinets that have a load assigned). De-energized (i.e., spare) cabinets are not counted.
3. RWF is room weighting factor for equipment that can be in multiple rooms. Factor represents the percentage of exposure (i.e., waste residence) time that the piece of equipment spends in the particular room.
4. WWF is the welding weighting factor, which represents the relative number of total welding activity (hours/year) that occurs in each location where welding is performed. The number of hours for maintenance-related welding is based on about 8 hours/week in the primary maintenance welding location and 5 hours per year in each satellite welding location (for repairs that must be performed locally). Waste package closure room welding is estimated based in the IHF throughput Gantt chart and the total number of waste packages expected to be handled, as follows: (1) the preclosure period is 50 years; (2) the welding machine actually operates for 13 hours per waste package; (3) here are three CRCFs, each with two closure welding machines, both of which are in the same room. Since they are both in the same room, the welding score for the room is 1/3 of the CRCF total; (4) the three CRCFs combined will process 10,911 waste packages. (10,911x13/50)/3 = 946 hours per year (both machines combined, 472 hrs/machine). Note that for any given waste package being processed, the total welding score is "at" the WP.
5: Power ratings are for each motor unless otherwise noted.

Blank cells in this table are intentional and have been verified.

HEPA = high-efficiency particulate air (filter); hp = horse power; HVAC = heating, ventilation, and air conditioning; kVA = kilo-volt amperes; LLW = low-level radioactive waste; MCC = motor control center; WP = waste package; WWF = ; Xfmr = transformer

Source: Original

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F5.4.1 Electrical Equipment

Information regarding electrical equipment was gathered solely from the following single line diagrams and electrical room layout drawings.

- *Canister Receipt & Closure Facility #1 Normal Electrical Room Equipment Layout.* (Ref. F2.2.12)
- *Canister Receipt & Closure Facility #1 ITS Train "A" Electrical Room Equipment Layout.* (Ref. F2.2.10)
- *Canister Receipt & Closure Facility #1 ITS Train "B" Electrical Room Equipment Layout.* (Ref. F2.2.11)
- *Canister Receipt & Closure Facility #1 Equipment Layout Second Floor.* (Ref. F2.2.6)
- *Canister Receipt & Closure Facility #1 Equipment Layout Second Floor.* (Ref. F2.2.7)
- *Canister Receipt & Closure Facility #1 Equipment Layout Second Floor.* (Ref. F2.2.8)
- *Canister Receipt & Closure Facility #1 Equipment Layout Second Floor.* (Ref. F2.2.9)
- *CRCF 1 480 V Load Center 060-EEN0-LC-00001 Single Line Diagram.* (Ref. F2.2.16)
- *CRCF 1 480 V Load Center 060-EEN0-LC-00002 Single Line Diagram.* (Ref. F2.2.17)
- *CRCF 1 480V Load Center 060-EEN0-LC-00003 Single Line Diagram.* (Ref. F2.2.18)
- *CRCF 1 480V MCC 060-EEN0-MCC-00001 Single Line Diagram.* (Ref. F2.2.21)
- *CRCF 1 480V MCC 060-EEN0-MCC-00002 Single Line Diagram.* (Ref. F2.2.22)
- *CRCF 1 480V MCC 060-EEN0-MCC-00003 Single Line Diagram.* (Ref. F2.2.23)
- *CRCF 1 480V MCC 060-EEN0-MCC-00004 Single Line Diagram.* (Ref. F2.2.24)
- *CRCF 1 480V MCC 060-EEN0-MCC-00005 Single Line Diagram.* (Ref. F2.2.25)
- *CRCF 1 480V MCC 060-EEN0-MCC-00006 Single Line Diagram.* (Ref. F2.2.26)
- *CRCF 1 480V MCC 060-EEN0-MCC-00007 Single Line Diagram.* (Ref. F2.2.27)
- *CRCF 1 480V MCC 060-EEN0-MCC-00008 Single Line Diagram.* (Ref. F2.2.28)
- *CRCF 1 480V MCC 060-EEN0-MCC-00009 Single Line Diagram.* (Ref. F2.2.29)
- *CRCF 1 480V MCC 060-EEN0-MCC-00010 Single Line Diagram.* (Ref. F2.2.30)

- *CRCF 1 480V MCC 060-EEN0-MCC-00011 Single Line Diagram.* (Ref. F2.2.31)
- *CRCF 1 480V MCC 060-EEN0-MCC-00012 Single Line Diagram.* (Ref. F2.2.32)
- *CRCF 1 480V MCC 060-EEN0-MCC-00013 Single Line Diagram.* (Ref. F2.2.33)
- *CRCF 1 480V ITS MCC – Train A 060-EEE0-MCC-00001 Single Line Diagram.* (Ref. F2.2.19)
- *CRCF 1 480V ITS MCC – Train B 060-EEE0-MCC-00002 Single Line Diagram.* (Ref. F2.2.20)
- *CRCF 1 UPS 060-EEP0-UJX-00001 Single Line Diagram.* (Ref. F2.2.68)
- *CRCF 1 UPS 060-EEP0-UJX-00002 Single Line Diagram.* (Ref. F2.2.69)
- *CRCF 1 ITS UPS – Train A 060-EEU0-UJX-00001 Single Line Diagram.* (Ref. F2.2.61)
- *CRCF 1 ITS UPS – Train B 060-EEU0-UJX-00002 Single Line Diagram.* (Ref. F2.2.62)

The electrical equipment category consists of computers, equipment racks, load centers, motor control centers (MCCs), uninterruptable power supply (UPSs), transformers, lighting panels, digital control and management information system (DCMISs), programmable logic controller panels, batteries, and electrical panels. In general, each piece of electrical equipment constitutes a single ignition source and therefore has a count of one. However, MCCs, load centers, and equipment racks are assigned a count based on the total number of active vertical cabinets making up the overall unit. Every vertical cabinet in an equipment rack is treated as active. In the case of MCCs and load centers, a cabinet is considered active if the single line diagram shows that a load is attached (i.e., unused breakers are not counted).

F5.4.2 HVAC Equipment

HVAC equipment locations and horsepower were obtained from the following facility general layout drawings and HVAC equipment lists.

- *CRCF 1 Composite Vent Flow Diagram Tertiary Conf ITS Exhaust & Non-ITS HVAC Supply Systems.* (Ref. F2.2.36)
- *CRCF 1 Composite Vent Flow Diagram Tertiary Confinement Non-ITS Exhaust & HVAC Supply Systems.* (Ref. F2.2.37)
- *CRCF 1 Composite Vent Flow Diagram Tertiary Confinement Ground Floor HVAC Systems.* (Ref. F2.2.38)
- *CRCF 1 Composite Vent Flow Diagram Tertiary Confinement Non- ITS HVAC System Supply & Exhaust.* (Ref. F2.2.39)

- *CRCF 1 Composite Vent Flow Diagram Tertiary Confinement ITS HVAC Systems. Elect & Battery RMS.* (Ref. F2.2.40)
- *CRCF 1 Composite Vent Flow Diagram Non-Confinement Non-ITS HVAC Systems. Support & Operations.* (Ref. F2.2.35)
- *CRCF 1 ITS Confinement WP Loadout Room HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.60)
- *CRCF 1 ITS Confinement Areas HEPA Exhaust System Train A Ventilation & Instrumentation Diagram.* (Ref. F2.2.58)
- *CRCF 1 ITS Confinement Areas HEPA Exhaust System - Train B Ventilation & Instrumentation Diagram.* (Ref. F2.2.59)
- *CRCF 1 Confinement Cask Prep Room HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.45)
- *CRCF 1 Non-Confinement Transport. Cask/Annex Vest HVAC System Ventilation & Instrumentation Diagram.* (Ref. F2.2.66)
- *CRCF 1 Confinement Ground Flr North Areas HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.47)
- *CRCF 1 Confinement Utility Room HVAC System Ventilation & Instrumentation Diagram*. (Ref. F2.2.41)
- *CRCF 1 Confinement Non-ITS Battery Room Exhaust System Ventilation & Instrumentation Diagram.* (Ref. F2.2.55)
- *CRCF 1 Confinement Ground Flr South Areas HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.48)
- *CRCF 1 Confinement Ground Floor Non-ITS HEPA Exhaust System Ventilation & Instrumentation Diagram.* (Ref. F2.2.46)
- *CRCF 1 Confinement Canister Transfer Room HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.44)
- *CRCF 1 Confinement 2nd Floor North Areas HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.42)
- *CRCF 1 Confinement 2nd Floor South HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.43)
- *CRCF 1 Confinement Non-ITS HEPA Exhaust System – 2nd Floor Ventilation & Instrumentation Diagram.* (Ref. F2.2.56)

- *CRCF 1 Confinement LLW & Misc. Areas HVAC Supply System Ventilation & Instrumentation Diagram*. (Ref. F2.2.53)
- *CRCF 1 Confinement LLW & Misc. Areas Non-ITS HEPA Exhaust System Ventilation & Instrumentation Diagram.* (Ref. F2.2.54)
- *CRCF 1 Confinement ITS Electrical Room HVAC System – Train A Ventilation & Instrumentation Diagram.* (Ref. F2.2.51)
- *CRCF 1 Confinement ITS Battery Room Exhaust System – Train A Ventilation & Instrumentation Diagram.* (Ref. F2.2.49)
- *CRCF 1 Confinement ITS Electrical Room HVAC System – Train B Ventilation & Instrumentation Diagram.* (Ref. F2.2.52)
- *CRCF 1 Confinement ITS Battery Room Exhaust System – Train B Ventilation & Instrumentation Diagram.* (Ref. F2.2.50)
- *CRCF 1 Non-Confinement Areas HVAC Supply System Ventilation & Instrumentation Diagram.* (Ref. F2.2.63)
- *CRCF 1 Non-Confinement Misc. Areas Air Distribution System Ventilation & Instrumentation Diagram.* (Ref. F2.2.64)
- *CRCF 1 Non-Confinement WP Loadout Vestibule HVAC System Ventilation & Instrumentation Diagram.* (Ref. F2.2.67)
- *CRCF 1 Non-Confinement Site Transporter Vest. HVAC Syst Ventilation & Instrumentation Diagram.* (Ref. F2.2.65)
- *CRCF 1 Non-Confinement Transport, Cask/Annex Vest. HVAC System Ventilation & Instrumentation Diagram.* (Ref. F2.2.66)

HVAC equipment consists of HEPA filters, exhaust fans, air handling units, fan coil units, and sump pumps. Because any motor with a horse power of five or more is considered to be an initiator, the number of motors and the horsepower of each motor is determined for all applicable HVAC equipment identified. A piece of equipment containing motors is assigned a count based on the number of motors with a horsepower of five or more. Because HEPA filter units are not applicable to this process, a count of one is assigned for each.

F5.4.3 Mechanical Process Equipment

Information regarding mechanical process equipment locations and horsepower were obtained from the following facility general layout drawings, mechanical equipment lists, and equipment process and instrumentation drawings:

- *Canister Receipt and Closure Facility 1 General Arrangement Ground Floor Plan.* (Ref. F2.2.13)
- *Canister Receipt and Closure Facility 1 General Arrangement Second Floor Plan.* (Ref. F2.2.14)
- *Canister Receipt and Closure Facility 1 General Arrangement Third Floor Plan.* (Ref. F2.2.15)
- *Equipment Motor Horsepower and Electrical Requirements Analysis.* (Ref. F2.2.72)
- *CRCF, RF, WHF, and IHF Cask Transfer Trolley Process and Instrumentation Diagram.* (Ref. F2.2.71)
- *CRCF 1 Chilled Water System Piping & Instrument Diagram.* (Ref. F2.2.34)
- *CRCF 1 Hot Water System Piping & Instrument Diagram.* (Ref. F2.2.57)
- *CRCF Cask Cavity Gas Sampling System Piping & Instrument Diagram.* (Ref. F2.2.70)

Mechanical process equipment includes most of the motorized equipment to include cranes, trolleys, doors, and platforms. These are counted in the method described in Section F5.4.2 (i.e., each motor of five horsepower or more contributes a count of one). Because some of the equipment in this category is mobile, and counts are done for each room individually, it was necessary to consider the counts for equipment which can occupy more than one room. To accomplish this, the amount of time a piece of equipment spends in each room was identified using the process throughput Gantt charts (Ref. F2.2.3). The two waste package transfer trolleys (WPTT) and two cask transfer trolleys were identified as the only pieces of mobile equipment that occupy more than one room.

The total time a cask transfer trolley spends in either the Cask Unloading Room North (1023) or South (1024) is calculated from the following procedures identified in the process throughput:

- Move WPTT into waste package Positioning Room under waste package port—15 minutes
- Move canister transfer to waste package or staging or aging overpack—119 minutes
- Close waste package—2,445 minutes

- Change rigging on waste package handling crane—25 minutes
- Move loaded, sealed waste package to Waste Package Loadout Room and engage WPTT docking station—20 minutes.

The total time the WPTT spends in the Waste Package Loadout Room (1015) is calculated by subtracting the total amount of time the WPTT is in either room 1018 or 1019 from the total time of the procedure (3,722 minutes).

The time a mobile equipment item spends in each room is utilized to determine the percentage of time the equipment occupies a room, which directly corresponds to the percentage of the total count assigned to that room. This is represented on the equipment list as the residence weighting factor (RWF).

F5.4.4. Heat Generating Process Equipment

This equipment refers to such things as furnaces, dryers and other such equipment except for those associated with the HVAC, which are counted separately as discussed above. There is no equipment for any of the facilities that falls under this category.

F5.4.5 Torches, Welders, and Burners

Welding operations are the only contributors to this category. The assignment of residency in this case is based on the estimated number of hours per year that welding operations are expected to occur in the area. This provides a suitable relative weight for apportioning fire ignition caused by welding operations. Portable welding receptacles are provided in various areas of the facility for the purpose of occasional welding of stationary equipment that may show signs of cracking. These are provided for convenience, and are not expected to see significant use. Each station is estimated to see on the order of five hours of use per year, and so is assigned a score of five points each. The primary maintenance area also contains a welding receptacle (the "primary welding station"), intended to perform all of the maintenance related welding for repair and fabrication that does not require direct work on a stationary piece of equipment (including on components of stationary pieces of equipment that are easily removed). The primary welding station is estimated to be utilized about eight hours per week, and so is assigned a score of 400 points. The CRCF also has the waste package closure system, which has weld end effectors. The number of hours of operation per year for the weld end effectors on the waste package closure system is estimated based on the throughput time-and-motion study and the number of waste packages expected to be handled, as follows:

- The preclosure period is 50 years.
- The welding machine actually operates for 13 hours per waste package (*Preliminary Throughput Study for the Canister Receipt and Closure Facility* (Ref. F2.2.3)).
- The CRCF will process 11,668 waste packages (*Waste Form Throughputs for Preclosure Safety Analysis* (Ref. F2.2.5)); 11,668 × 13/50/3 is 1,011 hours per year (a score of 1,011).

The locations of portable welding receptacles were determined as an engineering judgment on the part of the design team based on preliminary electrical and general layout drawings. The resultant fire initiating event frequencies are insensitive to the precise distribution of the portable welding receptacles, so a more rigorous analysis of the distribution is not required.

F5.4.6 Internal Combustion Engines

There are two transporters that utilize internal combustion engines in the CRCF, which provide the entire contribution of fire ignition to the internal combustion engines category. The site transporter and site prime mover (SPM) are assigned a total of 100 points each. The points are allocated to the rooms where these vehicles could be located by use of a RWF, as discussed in Section F5.4.3.

The site transporter occupies rooms 1027 (Site Transporter Vestibule) and 1026 (Cask Preparation Room). The times necessary to determine the percentage of time the site transporter spends in each room are given in Sections 1.3.1, 2.1, and 1.6 of the CRCF process throughput diagram. There are 28 total minutes that are assigned to both rooms because the doors between them are open. Resultant times are 56 minutes in the Site Transporter Vestibule (1027), and 510 minutes in the Cask Preparation Room (1026).

The SPM/tractor occupies rooms 1026 (Cask Preparation Room), 1036 (Transportation Cask Vestibule), and 1036A (Vestibule Annex). The times necessary to determine the percentage of time the SPM/tractor spends in each room are given in Sections 1.1.1a through 1.1.1c of the CRCF process throughput diagram. There are 18 total minutes that are assigned to both rooms 1036A and 1036 because the doors between them are open. Similarly, there are a total of 18 minutes that are assigned to both rooms 1036 and 1026. Resultant times are 22 minutes in the Vestibule Annex (1036A), 36 minutes in the Transportation Cask Vestibule (1036), and 38 minutes in the Cask Preparation Room (1026).

The times internal combustion engines spend in each room is utilized to determine the percentage of time the engine occupies a room, which directly corresponds to the percentage of the total count assigned to that room. This is represented on the equipment list as the RWF, or residence weighting factor.

Locations of the internal combustion engines were determined solely from the general layout drawings.

F5.4.7 Office/Kitchen Equipment

This category consists of miscellaneous office and kitchen equipment such as: shredders, vending machines, microwaves, computers, radios and printers. The location and quantity of such equipment was inferred by the description and layout of the rooms to come up with a reasonable distribution of such equipment in the facility. Work rooms, break rooms, briefing rooms, and offices were considered to possess such equipment. A judgment was made by the analysis team based on the function and size of the room as to how much of such equipment might reside in these rooms. Points were assigned to each room expected to contain office or kitchen equipment based on this judgment (one point per room). The resultant fire initiating

event frequencies are quite insensitive to the precise distribution of this equipment, so a more rigorous analysis of the distribution is not required.

Locations of the office and kitchen equipment were determined solely from the general layout drawings.

F5.4.8 Portable and Special Equipment

This category consists of portable hand tools, monitoring devices, portable heaters, diagnostic equipment and the like. Rooms where there were significant amounts of equipment that would expect to be maintained on a regular basis or where monitoring would take place were considered to possess such equipment. Determinations for the portable and special equipment category were inferred from the description and layout of the rooms, as described in Section F5.4.7. Each room containing such equipment was assigned one to four points, depending on the quantity expected in that room. The resultant fire initiating event frequencies are quite insensitive to the precise distribution of this equipment, so a more rigorous analysis of the distribution is not required.

F5.5 ROOM IGNITION FREQUENCY

Ignition Frequencies for each room are determined as a function of the number of units of ignition sources in the room, and the area of the room. The spreadsheet used to determine these frequencies is displayed as Table F5.5-1.

Table F5.5-1. Fire Ignition Frequencies by Room

	Ignition Source Category and Room-by-Room Population									
Room	Electrical	HVAC	Mechanical Equipment	Heat Generating Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/ Kitchen Equipment	Portable Equipment	No Equipment Involved	Room Ignition Frequency
1001					5				233	8.8E-03
1001A		2						2	141	2.5E-02
1002									74	1.9E-03
1002A									13	3.2E-04
1003		4						2	164	3.5E-02
1004	1	4						2	119	3.5E-02
1005A									103	2.6E-03
1005B									68	1.7E-03
1005C									51	1.3E-03
1005D									67	1.7E-03
1005E									116	2.9E-03
1005F									109	2.8E-03
1005G									53	1.3E-03
1005H									58	1.5E-03
1005J									141	3.6E-03
1007	88							2	410	1.2E-01
1007A	2								36	3.1E-03
1008	23	2						2	164	5.1E-02
1008A	1								25	1.7E-03
1009		4			5			2	46	3.5E-02
1010		2						2	129	2.5E-02
1011		4						2	313	3.8E-02
1012									147	3.7E-03
1013	16						1		164	4.6E-02
1013A									11	2.8E-04
1014		2	2					1	385	4.0E-02
1015	1	2	9.2					2	1326	1.3E-01
1016									33	8.5E-04
1017									37	9.4E-04
1018			2.4					1	213	3.0E-02
1019			2.4					1	213	3.0E-02

Table F5.5-1. Fire Ignition Frequencies by Room (Continued)

Room	Electrical	HVAC	Mechanical Equipment	Heat Generating Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/ Kitchen Equipment	Portable Equipment	No Equipment Involved	Room Ignition Frequency
1020									33	8.5E-04
1021									31	7.8E-04
1022									28	7.0E-04
1023			1.05					1	78	1.6E-02
1024			1.05					1	78	1.6E-02
1025									28	7.0E-04
1026	1		19.9			130		4	2143	2.8E-01
1027		2	2		5	10			342	4.0E-02
1028	14	2	4		400				423	3.0E-01
1029	23	2						2	164	5.1E-02
1029A	1								25	1.7E-03
1030		4						2	46	3.2E-02
1031		2						2	139	2.5E-02
1032		4						2	307	3.8E-02
1033									144	3.7E-03
1034									48	1.2E-03
1035		4						2	184	3.5E-02
1036		2				37			239	2.9E-02
1036A		2				23			208	2.3E-02
1036B									20	5.2E-04
1037									51	1.3E-03
1038									39	9.8E-04
1039									39	9.9E-04
1040									39	9.9E-04
1041									48	1.2E-03
1042									42	1.1E-03
1043									36	9.2E-04
1044			1						20	8.1E-03
1044A									7	1.9E-04
1045									27	6.9E-04
1046									7	1.6E-04
1047			1						76	9.5E-03
1047A									66	1.7E-03

Table F5.5-1. Fire Ignition Frequencies by Room (Continued)

Room	Electrical	HVAC	Mechanical Equipment	Heat Generating Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/ Kitchen Equipment	Portable Equipment	No Equipment Involved	Room Ignition Frequency
1048									42	1.1E-03
1049			1						76	9.5E-03
1049A									66	1.7E-03
1050									42	1.1E-03
1051									32	8.1E-04
1052									32	8.1E-04
1053									28	7.0E-04
1054									29	7.4E-04
1201 - 1210							5		226	1.2E-01
1211 - 1213 & 1215 - 1222							4		295	1.0E-01
1214									54	1.4E-03
2001	14	6						4	433	7.9E-02
2002					5				183	7.6E-03
2003	11		1					1	211	3.1E-02
2003A									19	4.9E-04
2004		2	14		10			1	3846	2.2E-01
2005	21	2						4	511	7.0E-02
2005A									33	8.2E-04
2006A									90	2.3E-03
2006B									71	1.8E-03
2006D									90	2.3E-03
2006E									52	1.3E-03
2006F									38	9.6E-04
2006G									129	3.3E-03
2006H									40	1.0E-03
2006J									89	2.2E-03
2006K									73	1.8E-03
2007			5		946			2	247	6.1E-01
2007A	9							1	27	1.7E-02
2007B								1	27	7.0E-03
2008	27	2						4	433	7.5E-02
2010					5				186	7.6E-03
2011	11		1					1	224	3.2E-02

Table F5.5-1. Fire Ignition Frequencies by Room (Continued)

Room	Electrical	HVAC	Mechanical Equipment	Heat Generating Equipment	Torches, Welders, Burners	Internal Combustion Engines	Office/ Kitchen Equipment	Portable Equipment	No Equipment Involved	Room Ignition Frequency
2011A									19	4.8E-04
2012	20	4						4	493	7.8E-02
2038									40	1.0E-03
2039									42	1.1E-03
2040									42	1.1E-03
2041									48	1.2E-03
2042									42	1.1E-03
2043									36	9.2E-04
2045									15	3.8E-04
2045A									15	3.8E-04
2046									6	1.5E-04
2048									42	1.1E-03
2050									43	1.1E-03
3001									121	3.0E-03
3002									61	1.5E-03
3038									40	1.0E-03
3041									48	1.2E-03
3045									15	3.8E-04
3045A									15	3.8E-04
3046									7	1.6E-04
3048									42	1.1E-03
3050									43	1.1E-03
TOTAL	284	66	68	0	1381	200	10	60		3.1E+00

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

Blank cells in this table are intentional and have been verified.

Source: Original

The major input to the spreadsheet is the number of units per category for each room (green text). These values are taken from the equipment list Table F5.4-1, which is formulated from equipment and general layout drawings, and equipment lists (see Section F5.4). The total number of units in each category is the result of a sum across all rooms, and can be found in the bottom total row. It is this value that is used in Table F5.3-1 in the column entitled "Category Population" for all categories except no equipment involved, as explained in Section F5.3.

The no equipment involved column of Table 5.5-1 is the area of the rooms, as a unit in this category is represented by a single square meter. These values are taken from Table F5.2-1, in the "A" column (square meters).

The final column on Table F5.5-1, entitled "Room Ignition Frequency," implements the generic forms of equations F-6 and F-7. It calculates the room ignition frequency, which utilizes the frequency per unit from Section F5.3. It takes the required per unit ignition frequencies directly from the spreadsheet represented by Table F5.3-1, the column entitled "Frequency per Unit". Per Equation F-6, the number of units in each category (green text) is multiplied by the corresponding frequency per unit for that category. Per Equation F-7, summing these multiplications across a row provides the room ignition frequency for that room. The sum of all rooms is the building ignition frequency. This value is shown in the lower right hand column of the Table. Note that this value does not match the value shown at the bottom of Table F5.2-1. That value, which is based only on building area, pre-supposes that the ignition sources in the building cover each of entire ignition source categories used in the analysis. However, the CRCF does not have any equipment that fits the definition of heat generating equipment (welders have their own category), so this contribution does not apply to CRCF.

F5.6 PROPAGATION PROBABILITIES

Propagation probabilities are utilized in this analysis to define the probability of a fire spreading to various defined points. The first two columns of Table F5.6-1 define the maximum extent of propagation, and the conditional probability column is the probability associated with that extent of propagation. The remaining columns in Table F5.6-1 are utilized in the uncertainty distribution for the conditional probability. The structure of this spreadsheet is analogous to Table F5.3-1. The right hand group of columns is used by Crystal Ball to apply an uncertainty distribution to each of the propagation probability values for the purpose of developing uncertainty distributions on initiating event frequency. The mean fraction, 97.5% value, and 97.5th percentile add columns show the parameters of these distributions. The development of all of the values is detailed in Appendix F.II. When Crystal Ball is run, it creates a sampled value for each fraction in the sampled value column. The spreadsheet then determines a normalized value by first assuring that each sampled value is not negative (minimum value of zero) and then normalizing the values so that the sum is always equal to one. The normalized value for each trial then replaces the category fraction value in the calculation. These probabilities must always add to one, as the groupings include all possible propagation outcomes.

Table F5.6-1. Fire Propagation Probabilities

Automatic Suppression Functional		Conditional Probability		Normalized Value	Sampled Value	Mean Fraction	97.5% Value	97.5th percentile add
Extent of Propagation	Alternative Definition							
Confined to Object of Origin	No Propagation	0.551		0.551	0.551	0.551	0.667	0.117
Confined to Part of Room of Origin	Spreads Through Part of Room of Origin	0.317		0.317	0.317	0.317	0.426	0.109
Confined to Room of Origin	Spreads Throughout Room of Origin	0.028		0.028	0.028	0.028	0.066	0.038
Confined to Fire-Rated Area of Origin	Spreads Throughout Fire-Rated Area of Origin	0.005		0.005	0.005	0.005	0.020	0.016
Confined to Floor of Origin	Spreads Throughout Floor of Origin	0.069		0.069	0.069	0.069	0.128	0.059
Confined to Structure of Origin	Spreads Throughout Building	0.028		0.028	0.028	0.028	0.055	0.028
Extended Beyond Structure of Origin	Breaches Building Boundary	0.005		0.005	0.005	0.005	0.020	0.016
		1.000		1.000				
		0.101						
Automatic Suppression Fails								
Extent of Propagation	Alternative Definition							
Confined to Object of Origin	No Propagation	0.621		0.621	0.621	0.621	0.725	0.104
Confined to Part of Room of Origin	Spreads Through Part of Room of Origin	0.149		0.149	0.149	0.149	0.226	0.076
Confined to Room of Origin	Spreads Throughout Room of Origin	0.004		0.004	0.004	0.004	0.017	0.013
Confined to Fire-Rated Area of Origin	Spreads Throughout Fire-Rated Area of Origin	0.057		0.057	0.057	0.057	0.107	0.050
Confined to Floor of Origin	Spreads Throughout Floor of Origin	0.004		0.004	0.004	0.004	0.017	0.013
Confined to Structure of Origin	Spreads Throughout Building	0.161		0.161	0.161	0.161	0.240	0.079
Extended Beyond Structure of Origin	Breaches Building Boundary	0.004		0.004	0.004	0.004	0.017	0.013
		1.000		1.000				

NOTE: Blank cells in this table are intentional and have been verified.

Source: Original

F5.7 INITIATING EVENT FREQUENCIES

Initiating event frequencies are the final results of the fire hazard analysis, and are a factor of all of the previously discussed data and residence fractions. The following sections shall describe the culmination of this data to conclude with initiating event frequencies.

F5.7.1 Residence Fractions

Residence fractions have been developed from process throughputs to determine the length of time a waste form is vulnerable in a particular area of the building and in a particular configuration. The source for all of the times related to transportation, aging, and disposal (TAD) canister, high-level radioactive waste (HLW), and U.S. Department of Energy (DOE)-spent nuclear fuel (SNF) is the CRCF throughput study (Ref. F2.2.3). Table F5.7-1 shows the vulnerabilities for the TAD canister, and the times that contribute to the overall time of vulnerability. The column labeled BFD Task refers to the task number from the process block flow diagram that was used in the throughput study. These numbers appear directly on the Gantt charts and provide a reference for the task that was considered. The total shows the total number of minutes that the waste form was in the specified configuration in the specified location. The fraction column implements the approach discussed in Section F4.4.1 to calculate the fraction of time that a specific waste form spends in the particular configuration and location over the 50-year pre-closure period. Similarly to the TAD canister residence fractions, the process throughputs have been utilized to determine residence fractions for HLW and DOE SNF (see Table F5.7-2).

In addition to the processing of TAD canisters, HLW, and DOE SNF for emplacement, it is possible that the CRCF is used as a back-up to the Receipt Facility (RF) for moving dual-purpose canister from a transportation cask that is upended on a railcar to an aging overpack for transport to the aging pads. As this is not a primary function of the CRCF, this is not included in the CRCF throughput study. In order to incorporate this into the fire analysis, the information from the throughput study for the RF (Ref. F2.2.4) is used to determine the needed residence times. This is valid because the equipment design for both the RF and CRCF and the process for performing this function are identical in both facilities. The result of this analysis for dual-purpose canister is provided in Table F5.7-3.

F5.7.2 Localized Fires

Initiating event frequencies have been divided into two types of calculations; localized and large fires. Table F5.7-4 contains all of the calculations contributing to the localized fire initiating event frequencies.

F5.7.2.1 Room Groupings

The first column of Table F5.7-4 identifies the room(s) of origin. If the vulnerability is expected to occur in a single room with no gates or doors open and that is surrounded by qualified fire barriers (i.e., it is a single room fire area), this room is listed as the only room of origin. However, there are several cases in which the vulnerability takes place as the waste form moves between multiple rooms, or the room where the vulnerability occurs has open doors or gates with other rooms, or it shares a qualified fire area with other rooms. Table F5.7-5 lists all of the vulnerabilities that have more than one room of origin, and the justification for the multiple room listing. Whenever such a condition exists, the quantification of the localized fire considers not only fires that start in the room where the waste form resides, but also the contribution of other rooms that could directly communicate with that room through non-qualified or open fire barriers. Rooms within the same fire area of a room of origin are listed under each vulnerability in the column labeled "propagation from rooms in fire zone."

For rooms of origin, the frequency per unit column is populated by the results in Section F5.3. This is discussed further in Section F5.7.2.2. Propagation rooms populate the frequency per unit column with the total ignition frequency for that room, as calculated and reviewed in Section F4.4 (Room Ignition Frequency).

Table F5.7-1. TAD Residence Fractions

Section I - Localized Fires								
BFD Task	**Steps (if needed)**	**Time (m)**	**Fraction**		**BFD Task**	**Steps (if needed)**	**Time (m)**	**Fraction**
TC/TAD on Rail Car in Vestibule/Prep Area w/SPM (Diesel Present)					**TAD in AO in Vestibule/Prep Area (Diesel Present)**			
1.1.1a	Steps 3-7	16			1.3.1		31	
1.1.1a (typo?)		10			1.3.2		169	
1.1.1b		10			1.3.3		20	
1.1.1c	Steps 1-6	18			**Total**		**220**	**8.4E-06**
Total		**54**	**2.1E-06**					
TC/TAD on Rail Car in Prep Area w/o SPM (No Diesel Present)								
1.1.1c	Step 7	2						
1.1.1d		0						
1.1.4a	Change rigging	25						
1.1.4b		73						
1.1.4c	Change rigging	15						
1.1.4d		78						
1.1.4e	Change rigging	15						
1.1.5		70						
1.1.6		52						
Not in BFD	Change rigging	35						
1.1.7		30						
Total		**395**	**1.5E-05**					

Table F5.7-1. TAD Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction		BFD Task	Steps (if needed)	Time (m)	Fraction
TC/TAD on CTT in Prep Area								
1.1.8		35						
1.1.9		25						
Not in BFD	Change rigging	25						
Not in BFD	Helium Gas Sampling	45						
1.1.10		182						
1.1.11		2						
1.1.12		30						
Not in BFD	Prep Clean CHC	25						
1.1.13		2						
1.1.14		25						
1.1.20 (sic)		15						
Total		**411**	**1.6E-05**					
TC/TAD on CTT in Unloading Room					**TAD in AO in Unloading Room (Diesel Present)**			
1.1.20	again	15			1.3.3	Again	20	
2.1.1		10			2.1.1		10	
2.1.2		2			2.1.2		2	
2.1.3a		15			2.1.3a		15	
2.1.3b		2			2.1.3b		2	
2.1.4		17			2.1.4		17	
2.1.5		5			2.1.5		5	
2.1.6		2			2.1.6		2	
2.1.7		20			2.1.7		20	
Total		**88**	**3.3E-06**		**Total**		**93**	**3.5E-06**
TAD in CTM in Transfer Room					**Same From This Point On**			
2.1.7	Step 3 (again)	10						
2.1.8		2						
2.1.17		5						
2.1.18		2						
2.1.19	Step 1	10						
Total		**29**	**1.1E-06**					

Table 5.7-1. TAD Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
TAD in WP in Positioning/Closure Room			
2.1.19		20	
2.1.20		2	
2.1.21		15	
3.1		2445	
Not in BFD	Change rigging	25	
4.2.1		20	
Total		**2527**	**9.6E-05**
TAD in WP in Loadout Room			
4.2.1	Again	20	
Not in BFD	TEV into Facility	46	
4.2.2		40	
4.2.3		60	
4.2.4	Steps 1-4	20	
Total		**186**	**7.1E-06**
TAD/WP in TEV in Loadout Room			
4.2.4	Steps 5-11	31	
Total		**31**	**1.2E-06**
Section II - Large Fire			
TC/TAD w/SPM Present (Diesel)			
1.1.1a	Steps 3-7	16	
1.1.1a (typo?)		10	
1.1.1b		10	
1.1.1c	Steps 1-6	18	
Total		**54**	**2.1E-06**

Table 5.7-1. TAD Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
TC/TAD w/o SPM	**Present (No Diesel)**		
1.1.1c	Step 7	2	
1.1.1d		0	
1.1.4a	Change rigging	25	
1.1.4b		73	
1.1.4c	Change rigging	15	
1.1.4d		78	
1.1.4e	Change rigging	15	
1.1.5		70	
1.1.6		52	
Not in BFD	Change rigging	35	
1.1.7		30	
1.1.8		35	
1.1.9		25	
Not in BFD	Change rigging	25	
Not in BFD	Helium Gas Sampling	45	
1.1.10		182	
1.1.11		2	
1.1.12		30	
Not in BFD	Prep Clean CHC	25	
1.1.13		2	
1.1.14		25	
1.1.20 (sic)		15	
2.1.1		10	
2.1.2		2	
2.1.3a		15	
2.1.3b		2	
2.1.4		17	
2.1.5		5	
2.1.6		2	
Total		**859**	**3.3E-05**
TAD in CTM			
2.1.7		30	
2.1.8		2	
2.1.17		5	
2.1.18		2	
Total		**39**	**1.5E-06**
TAD in WP in WPTT			
2.1.19		20	
2.1.20		2	
2.1.21		15	
3.1		2445	
Not in BFD	Change rigging	25	
4.2.1		20	
Not in BFD	TEV into Facility	46	
4.2.2		40	
4.2.3		60	
4.2.4		5	
Total		**2678**	**1.0E-04**

Table 5.7-1. TAD Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
TAD in WP in TEV			
4.2.4		46	
Total		**46**	**1.8E-06**
TAD in AO (Diesel Present)			
1.3.1		31	
1.3.2		169	
1.3.3		20	
2.1.1		10	
2.1.2		2	
2.1.3a		15	
2.1.3b		2	
2.1.4		17	
2.1.5		5	
2.1.6		2	
2.1.7		20	
Total		**293**	**1.1E-05**

NOTE: Blank cells in this table are intentional and have been verified.

AO = aging overpack; BFD = block flow diagram; CTM = canister transfer machine; CTT = cask transfer trolley; SPM = site prime mover; TAD = transportation, aging, and disposal; TC = transportation cask; TEV = transport and emplacement vehicle; WP = waste package; WPTT = waste package transfer trolley.

Source: Original

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Table F5.7-2. HLW and DOE-SNF Residence Fractions

Section I - Localized Fires									
BFD Task	Steps (if needed)	Time (m)	Fraction			BFD Task	Steps (if needed)	Time (m)	Fraction
TC/HLW on Rail Car in Vestibule/Prep Area w/SPM (Diesel Present)						**TC/DOE-SNF on Rail Car in Vestibule/Prep Area w/SPM (Diesel Present)**			
1.1.1a	Steps 3-7	18				Same as HLW			
1.1.1a (typo?)		10							
1.1.1b		10							
1.1.1c	Steps 1-6	18							
Total		**56**	**2.1E-06**						
TC/HLW on Rail Car in Prep Area w/o SPM (No Diesel Present)						**TC/DOE-SNF on Rail Car in Prep Area w/o SPM (No Diesel Present)**			
1.1.1c	Step 7	2				1.1.1c	Step 7	2	
1.1.1d		75				1.1.1d		0	
1.1.4a	.	25				1.1.4a	.	25	
1.1.4b		73				1.1.4b		73	
1.1.4c	.	15				1.1.4c	.	15	
1.1.4d		78				1.1.4d		78	
1.1.4e	.	15				1.1.4e	.	15	
1.1.5		70				1.1.5		70	
1.1.6		52				1.1.6		52	
Not in BFD	Change rigging	35				Not in BFD	Change rigging	35	
1.1.7		30				1.1.7		30	
Total		**470**	**1.8E-05**			**Total**		**395**	**1.5E-05**
TC/HLW on CTT in Prep Area						**TC/DOE-SNF on CTT in Prep Area**			
1.1.8		35				1.1.8		35	
1.1.9		25				1.1.9		25	
Not in BFD	Secure CHC	25				Not in BFD	Helium Gas Sampling	45	
1.1.10		182				1.1.10		182	
1.1.11		2				1.1.11		2	
1.1.12		30				1.1.12		30	
Not in BFD	Prep Clean CHC	25				Not in BFD	Prep Clean CHC	25	
1.1.13		2				1.1.13		2	
1.1.14		25				1.1.14		25	
1.1.15		15				1.1.20		15	
Total		**366**	**1.4E-05**			**Total**		**386**	**1.5E-05**
TC/HLW on CTT in Unloading Room						**TC/DOE-SNF on CTT in Unloading Room**			
1.1.15	again	15				1.1.20	again	15	
2.1.1		10				2.1.1		10	
2.1.2		2				2.1.2		2	
2.1.3a		15				2.1.3a		15	
2.1.3b		2				2.1.3b		2	
2.1.4		17				2.1.4		17	
2.1.5-6, 34-35, 44-47	x5 (five canisters)	289				2.1.5-6 & 2.1.34-39	x9 (nine canisters)	493	
Total		**350**	**1.3E-05**			**Total**		**554**	**2.1E-05**

pja:
It takes 67 minutes to move each HLW canister from the TC to the WP (BFD tasks 2.1.5-6, 2.1.34-35 and 2.1.44-47, repeated five times). 67*5=335 minuties. For the last 46 minutes of this process there are no canisters in the TC (the last one is on its way to the WP upon completion of BFD task 2.1.5.34 for the fifth time). 335-46 = 289 minutes. This is the time period over which at least one canister would be in the TC during the unloading process.

pja:
It takes 58 minutes to move each DOE-SNF canister from the TC to the Staging Area (BFD tasks 2.1.5-6 and 2.1.34-39, repeated nine times). 58*9=522 minutes. For the last 29 minutes of this process there are no canisters in the TC (the last one is on its way to the WP upon completion of BFD task 2.1.5.34 fot the fifth time). 522-29 = 493 minutes. This is the time period over which at least one canister would be in the TC during the unloading process.

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Table F5.7-2. HLW and DOE-SNF Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
HLW in CTM in Transfer Room (per HLW Canister!!)			
2.1.34	Step 3 (again)	5	
2.1.35		2	
2.1.44		15	
2.1.45		2	
2.1.46	Step 1	10	
Total		34	**1.3E-06**
HLW in WP in Positioning Room			
2.1.5-6, 34-35, 44-47	x5 (five canisters)	295	
2.1.40		5	
2.1.41		2	
2.1.42		20	
2.1.43		2	
2.1.44		5	
2.1.45		2	
		331	**1.3E-05**
HLW and DOE-SNF in WP in Positioning Room			
2.1.46		20	
2.1.48 (sic)		5	
2.1.49		17	
2.1.50		5	
2.1.51		22	
2.1.20		2	
2.1.21		15	
3.1		2445	
Not in BFD	Change rigging	25	
4.2.1		20	
Total		2576	**9.8E-05**
HLW and DOE-SNF in WP in Loadout Room			
4.2.1	Again	20	
Not in BFD	TEV into Facility	46	
4.2.2		40	
4.2.3		60	
4.2.4	Steps 1-4	20	
Total		186	**7.1E-06**
HLW and DOE-SNF in WP in TEV in Loadout Room			
4.2.4	Steps 5-11	31	
Total		31	**1.2E-06**

BFD Task	Steps (if needed)	Time (m)	Fraction
DOE-SNF in CTM in Transfer Room (per SNF Canister!!!)			
2.1.34	Step 3 (again)	10	
2.1.35		2	
2.1.36		5	
2.1.37		2	
2.1.38	Step 1	10	
Total		29	**1.1E-06**

pja:
This timeframe is the same for bringing SNF from staging to WP, although BFD numbers are different (42-46)

pja:
As with the unloading room, the process of moving five canisters means that at least one canister will be in the WP from the time the first one enters until the last one enters. As previously stated, moving all five canisters takes 335 minutes. The first canister takes 40 minutes to reach the WP (BFD 2.1.5-6, 2.1.34-35, and 2.1.44-45 the first time). 335-40=295, which accounts for the entire time period that there is at least one canister in the WP during the loading process.

pja:
Steps 40-45 represent bringing the DOE-SNF canister from staging to above the WP. During this time there is only HLW in the WP.

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Table F5.7-2. HLW and DOE-SNF Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction	BFD Task	Steps (if needed)	Time (m)	Fraction
Section II - Large Fire							
TC/HLW w/SPM Present (Diesel)				**TC/DOE-SNF w/SPM (Diesel Present)**			
1.1.1a	Steps 3-7	16		Same as HLW			
1.1.1a (typo?)		10					
1.1.1b		10					
1.1.1c	Steps 1-6	18					
Total		54	**2.1E-06**				
TC/HLW w/o SPM Present (No Diesel)				**TC/DOE-SNF w/o SPM (No Diesel Present)**			
1.1.1c	Step 7	2		1.1.1c	Step 7	2	
1.1.1d		75		1.1.1d		0	
1.1.4a	.	25		1.1.4a	.	25	
1.1.4b		73		1.1.4b		73	
1.1.4c	.	15		1.1.4c	.	15	
1.1.4d		78		1.1.4d		78	
1.1.4e	.	15		1.1.4e	.	15	
1.1.5		70		1.1.5		70	
1.1.6		52		1.1.6		52	
Not in BFD	Change rigging	35		Not in BFD	Change rigging	35	
1.1.7		30		1.1.7		30	
1.1.8		35		1.1.8		35	
1.1.9		25		1.1.9		25	
Not in BFD	Secure CHC	25		Not in BFD	Helium Gas Sampling	45	
1.1.10		182		1.1.10		182	
1.1.11		2		1.1.11		2	
1.1.12		30		1.1.12		30	
Not in BFD	Prep Clean CHC	25		Not in BFD	Prep Clean CHC	25	
1.1.13		2		1.1.13		2	
1.1.14		25		1.1.14		25	
1.1.15		15		1.1.20		15	
2.1.1		10		2.1.1		10	
2.1.2		2		2.1.2		2	
2.1.3a		15		2.1.3a		15	
2.1.3b		2		2.1.3b		2	
2.1.4		17		2.1.4		17	
2.1.5		5		2.1.5		5	
2.1.6		1		2.1.6		1	
Total		**888**	**3.4E-05**	**Total**		**833**	**3.2E-05**
HLW in CTM in Transfer Room (per HLW Canister!!)				**DOE-SNF in CTM in Transfer Room (per SNF Canister!!!)**			
2.1.34		20		2.1.34	Step 3 (again)	10	
2.1.35		2		2.1.35		2	
2.1.44		5		2.1.36		5	
2.1.45		2		2.1.37		2	
2.1.46	Step 1	10		2.1.38	Step 1	10	
Total		**39**	**1.5E-06**	**Total**		**29**	**1.1E-06**

pja:
The movement of multiple canisters must be handled differently for large fire. Considering all the possible combinations of canisters and locations during the movement phase would overly complicate the analysis. Since the assumption is being made that there are always DOE-SNF canisters in the staging area, the analysis will assume that all nine canisters are in the staging area from the time the first canister arrives, and that if any canister fails they will all fail. To add the residence time for the DOE-SNF canisters for the entire time they are in the TC would be to significantly double count the residence time, since we are already simplifying the analysis by double counting by considering nine DOE-SNF canisters to reside in the staging area while nine DOE-SNF canisters reside in other areas of the facility, so further double-counting is not appropriate. This is a conservative assumption that will bound the release frequency and magnitude from a large fire during DOE-SNF canister movement to staging.

pja:
The movement of multiple canisters must be handled differently for large fire. Considering all the possible combinations of canisters and locations during the movement phase would overly complicate the analysis. Since the canisters are most vulnerable when they are in a waste package, the analysis will assume that all five canisters are in the waste package from the time the first canister arrives, and that if any canister fails they will all fail. This is a conservative assumption that will bound the release frequency and magnitude from a large fire during HLW canister movement.

pja:
This timeframe is the same for bringing SNF from staging to WP, although BFD numbers are different (42-46)

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Table F5.7-2. HLW and DOE-SNF Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
HLW in WP			
2.1.5-6, 34-35, 44-47	x5 (five canisters)	295	
2.1.40		5	
2.1.41		2	
2.1.42		20	
2.1.43		2	
2.1.44		5	
2.1.45		2	
Total		**331**	**1.3E-05**
HLW and DOE-SNF in WP			
2.1.46		20	
2.1.48 (sic)		5	
2.1.49		17	
2.1.50		5	
2.1.51		22	
2.1.20		2	
2.1.21		15	
3.1		2445	
Not in BFD	Change rigging	25	
4.2.1		20	
Not in BFD	TEV into Facility	46	
4.2.2		40	
4.2.3		60	
4.2.4		51	
Total		2773	**1.1E-04**

BFD Task	Steps (if needed)	Time (m)	Fraction
DOE-SNF in Staging Area			
Assume there is always DOE-SNF in the staging area.			
Residence time fraction is 1.0			

pja:
The operational approach for receiving DOE-SNF and HLW has not been established. It is unclear whether the process will be coordinated such that HLW will always follow DOE-SNF so that the staging area will be emptied soon after it is filled. It is conceivable that DOE-SNF will be staged and simply await HLW to arrive. The SNF could be in staging for extended periods.

pja:
The movement of multiple canisters must be handled differently for large fire. Considering all the possible combinations of canisters and locations during the movement phase would overly complicate the analysis. Since the canisters are most vulnerable when they are in a waste package, the analysis will assume that all five canisters are the waste package from the time the first canister arrives, and that if any canister fails they will all fail. This is a conservative assumption that will bound the release frequency and magnitude from a large fire during HLW canister movement. the process of moving five canisters means that at least one canister will be in the WP from the time the first one enters until the last one enters. As previously stated, moving all five canisters takes 290 minutes. The first canister takes 36 minutes to reach the WP (BFD 2.1.5-6 and 2.1.34-37, the first time). 290-36=254, which accounts for the entire time period that there is at least one canister in the WP during the loading process.

pja:
Steps 40-45 represent bringing the DOE-SNF canister from staging to above the WP. During this time there is only HLW in the WP.

NOTE: Blank cells in this table are intentional and have been verified.

BFD = block flow diagram; CTM = canister transfer machine; CTT = cask transfer trolley; DOE = U.S. Department of Energy; HLW = high-level radioactive waste; SNF = spent nuclear fuel; SPM = site prime mover; TC = transportation cask; TEV = transport and emplacement vehicle; WP = waste package.

Source: Original

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Table F5.7-3. DPC Residence Fractions

BFD Task	Steps (if needed)	Time (m)	Fraction
TC/DPC (VTC) in Vestibule/Prep Area w/SPM/Truck (Diesel Present)			
1.1.1		56	
Total		**56**	**2.1E-06**
TC/DPC (VTC) on Railcar/Trailer in Prep Area w/o SPM/Truck (No Diesel Present)			
1.1.4		138	
Not in BFD	Inspections and Survey	55	
1.1.5		83	
1.1.7		55	
1.3.1	Steps 1-2	15	
Total		**346**	**1.3E-05**
TC/DPC (VTC) on CTT in Prep Area			
1.3.1	Steps 3-8	50	
1.3.2		5	
1.3.3		108	
1.3.4		5	
1.3.5		35	
1.3.6		5	
1.3.7		40	
1.3.8		5	
1.3.9		50	
1.3.10		40	
1.3.11		5	
1.3.12		20	
1.3.13		20	
Total		**388**	**1.5E-05**
TC/DPC (VTC) in CTT in Unloading Room			
1.1.13	Again	20	
2.1.5		6	
2.1.6		1	
2.1.11	Steps 1-3	20	
Total		**47**	**1.8E-06**
DPC (VTC) in CTM in Transfer Room			
2.1.11	Step 3-4 (again)	15	
2.1.12		1	
2.1.13		5	
2.1.14		1	
2.1.15	Step 1	10	
Total		**32**	**1.2E-06**

L. Plumb:
DPCs shall be processed at the CRCF if the RF is overwhelmed with DPCs. Because this function is not in the CRCF Process Throughput diagram, the residence times from the RF were used for this column.

Table F5.7-3. DPC Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
DPC (VTC) in AO in Unloading Room (Diesel)			
2.1.15	again	21	
2.1.16		1	
2.1.17		22	
2.1.18		5	
2.1.19		17	
2.1.20		1	
1.5.1		20	
Total		**87**	**3.3E-06**
DPC (VTC) in AO in Vestibule/Preparation Area (Diesel)			
1.5.1	Again	20	
1.5.2		242	
Not in BFD	Rad Inspection	30	
1.5.3	Steps 1-5	26	
Total		**318**	**1.2E-05**
Section II - Large Fire			
TC/DPC (VTC) w/SPM (Diesel)			
1.1.1		56	
Total		**56**	**2.1E-06**
TC/DPC (VTC) w/o SPM Present (No Diesel)			
1.1.4		138	
Not in BFD	Inspections and Survey	55	
1.1.5		83	
1.1.7		55	
1.3.1	Steps 1-2	15	
1.3.1		65	
1.3.2		5	
1.3.3		108	
1.3.4		5	
1.3.5		35	
1.3.6		5	
1.3.7		40	
1.3.8		5	
1.3.9		50	
1.3.10		40	
1.3.11		5	
1.3.12		20	
1.3.13		20	
2.1.5		6	
2.1.6		1	
2.1.11	Steps 1-3	20	
Total		**776**	**3.0E-05**

Table F5.7-3. DPC Residence Fractions (Continued)

BFD Task	Steps (if needed)	Time (m)	Fraction
DPC (VTC) in CTM			
2.1.11	Step 3-4 (again)	15	
2.1.12		1	
2.1.13		5	
2.1.14		1	
2.1.15	Step 1	10	
Total		**32**	**1.2E-06**
DPC (VTC) in AO (Diesel Present)			
2.1.15	again	21	
2.1.16		1	
2.1.17		22	
2.1.18		5	
2.1.19		17	
2.1.20		1	
1.5.1		20	
1.5.2		242	
Not in BFD	Rad Inspection	30	
1.5.3	Steps 1-5	26	
Total		**385**	**1.5E-05**

NOTE: Blank cells in this table are intentional and have been verified.

AO = aging overpack; BFD = block flow diagram; CTM = canister transfer machine; CTT = cask transfer trolley; DPC = dual-purpose canister; SPM = site prime mover; TC = transportation cask; VTC = a transportation cask that is upended on a railcar; WP = waste package; WPTT = waste package transfer trolley.

Source: Original

F5.7.2.2 Ignition Source Distribution Within a Room

Per the methodology discussion in Section F4.4.2.1, the location of the ignition sources within the room are identified relative to the target and assigned a location at the target, near the target, and away from the target. This is shown in the so-named columns of Table F5.7-4, and must sum to the 'number in room' column entry. These columns are designators of where the ignition sources are in relation to the vulnerable waste form.

For all categories except no equipment involved, the distribution is determined by analysis of the room layout to determine whether the ignition source unit is at a distance within about three meters (at target), between about 3 and 7 meters (near target), or further (away from target) of the vulnerable waste form. For vulnerable waste forms in motion (e.g., in the railcar), ignition sources within the aforementioned distances of any portion of the path of motion are counted in the class representing its closest point to the waste form.

The ignition source units for the no equipment involved category are the area of the room (square meters). For vulnerabilities that are not waste forms in motion, the numbers for at target and near target are 30 and 120, respectively (i.e., a floor area of approximately 30 square meters is

considered at the target and the next 120 square meters near the target). The remaining square meters are entered as away from target. For vulnerable waste forms in motion, the "at target" value is the total square meters covered by the full range of motion plus a three meter ring. Similarly, the number near target is figured to be a seven meter ring around the at target area. Remaining square meters are entered as away from target.

The distribution of ignition sources are used to determine how far a fire must spread before it reaches the vulnerable waste form. The propagation values are taken from Table F5.6-1 for the no suppression case, per the boundary conditions, in accordance with the guidance discussed in Section F4.4.2 (in particular, F4.4.2.1). The frequency per (ignition source) unit is taken from Table F5.3-1, the column labeled frequency per unit. The target exposure time (fraction), which is the probability that there is a waste form in the room is taken from Table F5.7-1, F5.7-2, and F5.7-3 as appropriate. The column labeled "Contribution to IE Frequency" implements Equation F-8 to provide the total initiating event frequency contribution from fire that start in the room where the waste form resides.

There is also a section of the Table F5.7-4 that addresses the contribution from nearby rooms in the same fire area (i.e., that are separated from the room by walls or doors, but those barriers are not qualified fire barriers). In this case, the location of the ignition sources within these rooms is not important, only the probability that the fire spreads beyond the room within the same fire area matters as to whether the fire reaches the target. In this case, the frequency per unit column refers to the overall frequency of ignition in the room, which comes from the last column in Table F5.5-1. In this case, the appropriate propagation value for spread of a fire beyond the room is taken from Table F5.6-1, again for the no suppression case, as discussed in Section F4.4.2 (in particular, F4.4.2.2). For these rooms, the Contribution to IE Frequency column implements the generic form of Equation F-9 as applied to a fire throughout a fire area (zone) where the next largest fire is a floor fire.

The overall fire initiating event frequency, provided in a shaded cell for each defined initiating event shown in bold, is the sum of all the individual contributors.

F5.7.3 Large Fires

Calculation of the initiating event frequencies is completed similarly to the localized fire contributions from other rooms. Table F5.7-6 provides the analysis. In this case, the fire can start in any room in the facility and become a large fire. Since the fire can start in any room, and the methodology applies the same probability of fire propagation to each room, the starting point is the total ignition frequency from all rooms, from Table F5.6-1. The propagation probability is applied as discussed in Section F4.4.2 (in particular, F4.4.2.2) to implement Equation F-10. The target exposure time (fraction) is once again taken from Tables F5.7-1, -2, and -3; that large fires always propagate beyond the fire area of the room of origin.

F5.7.4 Contribution to Initiating Event Frequency

The probability of a fire reaching the vulnerable waste form and the target exposure time (residence fractions; refer to Section F5.7.1) contribute to the final calculation of the contribution

to initiating event frequency (cells highlighted in blue on Tables F5.7-4 and F5.7-6). Section F4.4 details the calculations performed to arrive at the initiating event frequency.