EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities (Ref. F2.36), and *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.39), the frequency contribution for each equipment type is divided by the total number of pieces of equipment in the facility. For example, in the case following from the above example for the frequency of fire ignition from electrical equipment, if there are 50 pieces of electrical equipment in the facility, the ignition frequency for each piece of equipment follows:

$$f_{elec\text{-}each} = f_{elec\text{-}all} / 50 \qquad \text{(Eq. F-5)}$$

For the case of the category "no equipment involved," the ignition frequency is per unit area, so the total for this category is divided by the total floor area of the facility (which was already determined in Section F4.3.1).

F4.3.2.3 Allocation of Fire Ignition Frequency to Each Room

The final step is to use the per equipment values to allocate fire frequency to each room. This step is accomplished by counting the number of ignition sources of each type contained in each room, multiplying by the ignition frequency for each ignition source type, and summing across all types. For example, if Room 1 has six pieces of electrical equipment, then the ignition frequency in that room due to electrical equipment follows:

$$f_{elec\text{-}1} = f_{elec\text{-}\mathrm{each}} * 6 \qquad \text{(Eq. F-6)}$$

Determining this frequency for each ignition source type (including multiplying the "no equipment involved" per unit area by the floor area of the room) and summing them together yields the total fire ignition frequency for the room, as follows:

$$f_1 = f_{elec\text{-}1} + f_{hvac\text{-}1} + f_{\ldots\text{-}1} \qquad \text{(Eq. F-7)}$$

F4.4 DETERMINE INITIATING EVENT FREQUENCY

The definition of each initiating event includes the implicit condition that the fire actually threatens a target that contains radioactive material. Therefore, for each initiating event, the initiating event frequency considers two aspects: the fraction of time there is a waste container in the room and the probability a fire propagates to that waste container.

F4.4.1 Probability of Presence of a Target

The probability of the presence of a target waste form is the fraction of time that the waste form(s) is in the area affected by the fire (e.g., for a room fire it is the fraction of time a waste form is in the room). For use in initiating event frequency equations, the probability is represented as follows:

P_{wri} = probability that a particular waste form is in room *i* during the preclosure period

P_{wzi} = probability that a particular waste form is in zone *i* during the preclosure period

P_{wfi} = probability that a particular waste form is on floor i during the preclosure period

P_{wb} = probability that a particular waste form is in the building during the preclosure period.

The specific phrasing should be noted. This probability pertains to each individual waste form (i.e., one of the approximately 11,000 waste forms handled at the YMP). For example, if each waste form that passes through the IHF spends 60 minutes in the Cask Preparation Area, the probability that it is present when a fire occurs is 60 min/(50 yrs × 8,760 hrs/yr × 60 min/hr). This probability is used to correct the final initiating event frequency for fires (normally expressed as per year) to be per operation over the preclosure period, so that it is equivalent to the other internal initiating events (e.g., drops) and can be multiplied by the number of operations in same manner.

F4.4.2 Probability of Propagation to a Target

Of key interest for assessing the fire risk is the extent to which fires that start in a "benign" area can spread to sensitive areas (i.e., areas where nuclear waste is present). The likelihood of fire propagation within the building is strongly dependent on the building construction and the presence of automatic fire suppression systems.

Both probabilities of exceedance and conditional probabilities were determined. The probabilities of exceedance are the probabilities that a fire propagates up to a specified limit or beyond. The conditional probabilities are probabilities that a fire spreads to a specified limit.

Probabilities of exceedance are not independent, but rather represent the total probability that a fire spreads up to the specified limit or beyond. These values are provided because for many fire sequences there is only one case of interest (i.e., there is only one target of concern, and once the fire reaches that target, the fact that the fire may propagate even further does not change the outcome of the sequence in terms of release). For example, this value could be applied to a case where a fire that spreads throughout a room affects the waste form in that room, and there are no additional waste forms in adjacent rooms or fire zones.

Conditional probabilities are independent, as they represent the probability that a fire spreads to precisely the specified limit. These values are provided to address those cases where the extent of propagation defines the number of targets involved in the fire. For example, these values would be applied when a fire that spreads throughout a room affects a waste form in that room; if it spreads to adjacent rooms, however, additional forms would be involved.

There are two types of propagation that are considered: propagation within a room and propagation between rooms.

F4.4.2.1 Fire Propagation Within Rooms

An important consideration in the fire risk assessment is propagation within a given room. This scenario is referred to as "in-room propagation." Propagation within the room is important for fires initiated in a room where waste is present. In this case, the question is whether the fire, which can ignite wherever there is an ignition source in the room, reaches the area within the room in which the waste is located.

This section provides a table with the in-room propagation values for the cases with and without automatic fire suppression systems functioning. To use this table to determine whether the fire spreads sufficiently to threaten waste forms, it is necessary to consider where the fire occurs in the room of interest. The steps in this process follow:

- Determine the distribution of the ignition sources (identified under Section F4.3.2.3) within the room by counting the total number of potential ignition sources that are "at," "near," or "far from" the target waste form.[1]
- Calculate the fraction of ignition sources "at," "near," and "far from" the target waste form by dividing the number at each location by the total in the room.
- Calculate the frequency of the fire reaching the waste form using the following equation:

$$f_{ier\text{-}i} = P_{wri}\ [f_i\ (FR_a + (FR_n \times (P_{pc} + P_{rc})) + (FR_f \times P_{rc}))] \qquad \text{(Eq.F-8)}$$

where

f_i	=	frequency of ignition, *i-th* room
FR_a	=	fraction of ignition sources at the waste form
FR_n	=	fraction of ignition sources near the waste form
P_{pc}	=	conditional probability for fire confined to part of room of origin
FR_f	=	fraction of ignition sources far from the waste form
P_{rc}	=	conditional probability for confined to room of origin.

The values for P in the previous equation were developed from the analysis performed by NFPA (*Structure Fires in Radioactive Material Working Facilities and Nuclear Energy Plants of Non-Combustible Construction, 1980-1998* (Ref. F2.38)). The derivation of the values is provided in Appendix F.II for two cases (i.e., automatic fire suppression available and automatic fire suppression unavailable). The frequency f_i is the sum of frequencies of ignition of all ignition sources in the room. The fraction of ignition sources at, near, and far from the waste form was developed from equipment layout drawings such as the following:

- *Initial Handling Facility Electrical Room Equipment Layout* (Ref. F2.24)
- *Initial Handling Facility General Arrangement Ground Floor Plan* (Ref. F2.25).

F4.4.2.2 Fire Propagation Beyond Rooms

[1] In the context of this method, an ignition source within a few feet of the waste source would be "at" the source, whereas an ignition source beyond this distance but within a few yards of the waste source would be "near" the source. Ignition sources more that a few yards distant would be "far from" the waste source. This definition coordinates with the fire response model given in Attachment D.

This section provides propagation probabilities for fires spreading beyond the room in which they start. This type of propagation is referred to as "ex-room propagation."

This section provides a table with the ex-room propagation values for the cases with and without automatic fire suppression systems functioning. To use this table to determine whether the fire spreads sufficiently to threaten waste forms, it is necessary to consider the various rooms where the fire could start and spread to the extent defined by the initiating event. The steps in this process follow:

- For each initiating event, identify all of the rooms within the area defined by the initiating event. For example, for a fire involving a specific fire zone, list all the rooms in that zone. For a fire involving an entire floor, list all the rooms on the floor. For a fire involving the entire building, list all the rooms in the building.

- For each room, calculate the probability that a fire that starts within the room is not confined to the next smaller fire initiating event but is confined to less than the definition of the next largest initiating event by multiplying the ignition frequency for the room by the conditional probability (or sum of conditional probabilities) that the fire spreads at least as far as defined but no further. For example, for a fire involving a floor where there is also an initiating event for a fire involving a zone on the floor and an initiating event involving the entire building (multiple floors or beyond), the equation follows:

$$f_{ief\text{-}fj\text{-}ri} = f_i \times P_{fc} \tag{Eq. F-9}$$

where

$f_{ief\text{-}fj\text{-}ri}$	=	frequency of fire in zone j starting in room *i*
f_i	=	frequency of ignition, *i-th* room
P_{fc}	=	conditional probability for fire confined to the floor of origin.

Similarly, for a fire involving a floor where there is an initiating event for a fire in a zone on the floor and no specific initiating event for a fire involving the entire building the equation follows:

$$f_{ief+\text{-}ri} = f_i \times (P_{fc} + P_{bc} + P_{b+c}) \tag{Eq. F-10}$$

where

$f_{ief+\text{-}ri}$	=	frequency of fire involving an entire floor or greater starting in room i
f_i	=	frequency of ignition, *i-th* room
P_{fc}	=	conditional probability for fire confined to floor of origin
P_{bc}	=	conditional probability for fire confined to building of origin

P_{b+c} = conditional probability for fire extending beyond building of origin[2].

The total fire frequency of the defined severity is the sum across all rooms relevant to the initiating event, as discussed previously.

F4.4.3 Initiating Event Frequency

The final initiating event frequency is determined by multiplying the frequency of the fire reaching the waste form (in occurrences per year) times the probability that a waste form is present (fraction of time per waste form) time 50 (years in the preclosure period). This multiplication yields the initiating event frequency for a fire of a specific severity affecting a waste form, per waste form handled, over the preclosure period.

F5 ANALYSIS

F5.1 INTRODUCTION

Fire initiating event frequencies have been calculated for each initiating event identified for the IHF. This section details the analysis performed to determine these frequencies, using the methodology documented in Section F4. The following discussion of the analysis presupposes that the reader has developed a thorough understanding of the details of that methodology, as those details are not repeated in this section. The tables presented in this section, unless otherwise noted, are images of the actual spreadsheets used to perform the calculations. Therefore, there are no typographical errors in the translation of the results of the calculations into this report. The spreadsheet cells are color-coded to aid the analyst. Green numbers indicate values that are input by the analyst specific to the facility. Black numbers result from "off-line" calculations performed for this study. That is, they are facility-specific parameters whose values were determined as part of this analysis, but are not directly linked to the cell (i.e., they needed to be entered by the analyst). The source for these values is indicated in the text description of the spreadsheet. Orange numbers are values based on the analysis of operational experience (e.g., NFPA data), and should generally not be changed unless the analysis of operational experience changes or is updated. Red numbers are calculated values and should never be changed by the analyst. Green shaded cells are parameters that are assigned distributions that are used for the Crystal Ball Monte Carlo simulation runs discussed in Section F5.8. The aqua shaded cells are the final initiating event frequencies. The values shown in the cells are the baseline, point estimate values. The Monte Carlo simulation runs convert these values into distributions for use in the event sequence quantification.

F5.2 INITIATING EVENT FREQUENCIES

Fire ignition frequencies are based upon the total floor area of the building. Thus, the assessment of the area of each room of the IHF is the first step in obtaining initiating event frequencies. Table F5.2-1 shows the calculations that were performed to identify individual room areas, total ignition frequency, and uncertainty distributions.

[2] Note that the definition of a fire extending beyond the building of origin does not imply that the fire crosses some distance to affect other buildings or objects, but rather that the fire (i.e., flame damage) affects the outside surfaces of the building and items attached thereto.

F5.2.1 Room Area

Dimensions for room area calculations were obtained from the following IHF general layout drawings:

- *Initial Handling Facility General Arrangement Ground Floor Plan* (Ref. F2.25)
- *Initial Handling Facility General Arrangement Second Floor Plan* (Ref. F2.27)
- *Initial Handling Facility General Arrangement Plan at Elevation +73'-0"* (Ref. F2.26).

In some cases, the dimension intervals shown on the general arrangement drawings matched the boundaries of the rooms. Where this condition was the case, these values were used to define the dimensions of the rooms. In cases where the dimension intervals did not accurately represent a room, the drawing scale and a straightedge were used to determine the dimensions. The length and width figures obtained were entered into the L1(ft) and L2(ft) columns of Table F5.2-1 and multiplied to produce the area in square feet. Rooms 1015/31/30/2009/15, 1016/2016, 1017/2017, 1018/2018 and 1022/24/2024 occupy two floors of building space. The area obtained for these rooms was doubled to account for this fact. Rooms 1014, 2001/2010, and 2007 are not of a standard rectangular shape whose area can be calculated by multiplying a single length and width. Thus, these rooms were divided into two or three rectangles, each with a determined length and width. Addition of the area of these rectangles provides the total room area. All areas calculated in square feet were multiplied by 0.093 to obtain the area in square meters, since Equation F-1 is based in square meters.

Table F5.2-1. Room Areas and Total Ignition Frequency

Room	L1(ft)	L2(ft)	A(sq ft)	A(m^2)	L3 (ft)	L4(ft)		
1001	37	46	1702	158				
1002	127	46	5402	502	10	44		
1003	10	44	440	41				
1200 - 1225	83	90	7470	694				
1005	136	37	5032	467				
1006	39	37	1443	134				
1007	50	37	1850	172				
1008	25	37	925	86				
1009	50	37	1850	172				
1012/1011	164	88	14000	1301	24	18		
1013	6	12	72	7				
1014	4	22	192	18	8	13		
1015/31/30/2009/15	17	22	748	69	area doubled for two floors			
1016/2016	8	22	352	33	area doubled for two floors			
1017/2017	33	10	660	61	area doubled for two floors			
1018/2018	25	12	600	56	area doubled for two floors			
1019	8	22	176	16				
1020	9	10	90	8				
1021	9	12	108	10				
1022/24/2024	15	11	330	31	area doubled for two floors			
1023	62	32	1984	184				
1026	24	18	432	40				
1027	34	35	1190	111				
2001/2010	64	32	2348	218	25	12		
2002	17	37	629	58				
2003	44	75	3300	307				
2004	32	50	1600	149				
2005	42	78	3276	304				
2006	32	74	2368	220				
2007	7	25	247	23	6	12		
2008	6	12	72	7				
Total Area (m^2)				5657		50% Value		97.5% Value
Ignition Frequency (per m^2/yr)				4.79E-06	4.79E-06	4.79E-06		1.14E-05
Ignition Frequency (per yr)				2.71E-02				
Ignition Frequency (50 years - preclosure period)				1.35E+00				

NOTE: Red numbers are calculated values; green shaded cells are parameters that are assigned distributions for Crystal Ball input.

ft = foot; m2 = square meter; sq ft = square foot; yr = year.

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

Source: Original

F5.2.2 Building Ignition Frequency

Ignition frequency calculations are presented at the bottom of Table F5.2-1 and begin with the total area calculation. This calculation is obtained by summing the areas (in square meters) of all rooms in the building. The ignition frequency per square meter per year line implements Equation F-1. The ignition frequency per year line implements Equation F-3. The ignition frequency over the 50 year period is obtained by multiplying the latter value by 50. As can be seen from the table, the expected number of ignition events over the preclosure period is somewhat in excess of one.

The values shown are the baseline mean values for ignition frequency. An uncertainty analysis was performed on the results of Equation F-1 for the use of Crystal Ball software to run Monte Carlo simulations to obtain fire initiating event frequency distributions. The geometric mean and 97.5% values of the resulting distribution for Equation F-1 are shown in the table. Appendix F.III contains the calculations performed to develop the uncertainty distribution.

F5.3 IGNITION SOURCE FREQUENCY

As discussed in Section F4.3.2.1, an industrial building fire can begin as the result of numerous types of ignition sources, which have been grouped into nine categories:

- Electrical equipment
- HVAC equipment
- Mechanical process equipment
- Heat-generating process equipment
- Torches, welders, and burners
- Internal combustion engines
- Office and kitchen equipment
- Portable and special equipment
- No equipment involved.

Each category has a fraction representing the probability that, given an ignition, that category is the source of the ignition. The mean values of these fractions are shown in the column labeled "category fraction" in Table F5.3-1. The derivation of these values is discussed in Appendix F.II. The column labeled "category frequency" implements the generic form of Equation F-4 to determine the mean ignition frequency associated with each ignition source. The next column, "category population," contains the total number of ignition sources in each category in the facility. This number is the actual count of sources, a weighted point score of sources, or (for the case of "no equipment involved") the total floor area of the facility. The source of the count or score is presented in the next section. The floor area is taken from Table F5.2-1, fourth row from the bottom. The fifth column uses the previous two columns to implement Equation F-5 to determine the frequency per ignition source unit (i.e., per ignition source, per ignition source weighted point, or per square meter of floor area). These values are used in the next section to allocate fire ignition frequency to each room in the facility.

Table F5.3-1. Ignition Frequency by Ignition Source

Category	Category Fraction	Category Frequency (50 years)	Category Population	Frequency per Unit (50 years)			Sampled Value	Mean Fraction	97.5% Value	97.5th Percentile Add
Electrical	0.086	1.16E-01	137	8.46E-04		0.086	0.086	0.086	1.26E-01	4.05E-02
HVAC	0.080	1.09E-01	23	4.72E-03		0.080	0.080	0.080	1.20E-01	3.93E-02
Mechanical equipment	0.139	1.88E-01	64	2.94E-03		0.139	0.139	0.139	1.89E-01	5.01E-02
Heat-generating equipment	0.155	2.10E-01	0	0.00E+00		0.155	0.155	0.155	2.07E-01	5.24E-02
Torches, welders, burners	0.219	2.97E-01	542	5.47E-04		0.219	0.219	0.219	2.79E-01	5.99E-02
Internal combustion engines	0.021	2.84E-02	100	2.84E-04		0.021	0.021	0.021	4.23E-02	2.09E-02
Office/kitchen equipment	0.064	8.67E-02	10	8.67E-03		0.064	0.064	0.064	9.97E-02	3.55E-02
Portable equipment	0.102	1.38E-01	20	6.91E-03		0.102	0.102	0.102	1.45E-01	4.37E-02
No equipment involved	0.134	1.81E-01	5657	3.21E-05		0.134	0.134	0.134	1.83E-01	4.93E-02
	1.000					1.000				

NOTE: Red numbers are calculated values; green shaded cells are parameters that are assigned distributions for Crystal Ball input.

HVAC = heating, ventilation, and air conditioning.

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

Source: Original

As stated previously, these values are mean values. The right hand group of columns is used by Crystal Ball to apply an uncertainty distribution to each of the category fraction 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 ensuring 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 sources of ignition.

F5.4 IGNITION SOURCE DISTRIBUTION (EQUIPMENT LIST)

Compiling an initiating event frequency for the IHF is dependent on identifying many characteristics of the building, including ignition sources. Ignition sources are defined as items that exist in the rooms of the building that have the potential to contribute to the initiation and/or propagation of a fire. These sources are grouped into the following eight categories:

- Electrical equipment
- HVAC equipment
- Mechanical process equipment
- Heat-generating process equipment
- Torches, welders, and burners
- Internal combustion engines
- Office and kitchen equipment
- Portable and special equipment.

Once the grouping for a source is determined, it is assigned a count (points), a number that specifies the significance of the source by its contribution to fire ignition. Counts are integral to the calculations, as the total count for each category and room are multiplied by the ignition source frequency and summed to obtain the room ignition frequency. Table F5.4-1 shows the results of the ignition source distribution assessment for the IHF. The red numbers on this table highlight the actual count used, so as to make identification of the equipment count values easy to pick out from the other equipment identification information provided. Pieces of equipment that are in the room in question but do not count as ignition sources per the counting rules are shown as [*italicized in square brackets*]. The following sections describe how the equipment was identified, categorized, and counted for the building.

Table F5.4-1. Ignition Source Population by Room

Ignition Source / Room Number	Electrical Equipment	HVAC Equipment	Mechanical Process Equipment	Heat-Generating Process Equipment	Torches, Welders, and Burners	Internal Combustion Engines	Office and Kitchen Equipment	Portable and Special Equipment
1001 (HVAC Room)		Tertiary confinement HEPA filter units - 3 (VCT0-FLT-00001, 2, 3) HP n/a Tertiary confinement exhaust fans – 3 (VCT0-EXH-00001, 2, 3) 50 HP						Estimated 5% of all such equipment - 1
1002 (Electrical Equipment Area)	480V Load Centers – 6 cabs (EEN0-LC-00001,2) 480V MCCs – 65 cabs (EEN0-MCC-00001-6) 75 kVA 480-208/120 Dist Xfrmr 20A, B, C, D – 4 (EEN0-XFMR-00003, 4, 5, 6) 208/120V Dist Pns – 4 (EEN0-PL-00003, 4, 5, 6) 480/277V Ltng Pnl – 4 (EUL0-PL-00001, 2, 3, 4) Uninterruptible Power System 20A, B – 2 (EEP0-UJX-00001, 2) 480/277V UPS Dist Pnl 20A, B, C, D, E – 5 (EEP0-PL-00003, 4, 5, 6, 7) 40 kVA Maintenance Bypass Xfrmr 20A – 1 (EEP0-XFMR-00001) 160 kVA Maintenance Bypass Xfrmr 20B – 1 (EEP0-XFMR-00002) 2 DCMIS Cabinets 1 PLC Cabinet	Electrical MCC fan coil units – 2 (VCT0-FCU-00005, 6) 25 HP [*Battery Room exhaust fans – 2 (VCT0-EXH-00004, 5) 3 HP*] Battery Room HEPA filter units – 2 (VCT0-FLT-00004, 5)						Estimated 10% of all such equipment – 2
1003 (Battery Room)	125VDC battery 20A – 1 (EEP0-BTRY-00001) 250VDC battery 20B – 1 (EEP0-BTRY-00002)							
1200-1225 (Support Area)		Support area toilet exhaust fans – 2 (VNI0-EXH-00001, 2) 5 HP					Estimated 90% of all such equipment – 9	

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

Ignition Source / Room Number	Electrical Equipment	HVAC Equipment	Mechanical Process Equipment	Heat-Generating Process Equipment	Torches, Welders, and Burners	Internal Combustion Engines	Office and Kitchen Equipment	Portable and Special Equipment
1005 (WP Loadout Room)	WP handling crane panel – **1**	WP Loadout Room fan coil units – **2** (VCT0-FCU-00007, 8) 15 HP	WP handling crane – **4** motors, including 2 on WP pallet yoke (HMP0-CRN-00001, BEAM-00001) 100 kVA total; 60HP, 45HP, 7.5HP, 20HP, [2@*1HP*] WP Loadout Room shield door – **2** motors (IH00-DR-00004) 2@5HP 76% WP transfer trolley – **4** motors x RWF **3.04** (HL00-TRLY-00001) 150kVA total; 2@75HP, 2@30HP WP loadout platforms – **2** motors (HL00-PLAT-00001, 2) 2@5HP WP transfer carriage docking station – **1** motor (HL00-75-00001) 30 HP		Portable welding receptacle – WWF=**5** point (EEN0-RCP-00003)			Estimated 10% of all such equipment – **2**
1006 (WP Positioning Room)			WP Positioning Room shield doors 1 & 2 – **4** motors (IH00-DR-00002, 3) 4@7.5HP 22% WP transfer trolley – **4** motors x RWF **0.88** (HL00-TRLY-00001) 150kVA total; 2@75HP, 2@30HP					Estimated 5% of all such equipment – **1**
1007 (WP Loading Room)			2% WP transfer trolley – **4** motors x RWF **0.08** (HL00-TRLY-00001) 150kVA total; 2@75HP, 2@30HP					Estimated 5% of all such equipment – **1**
1008 (Cask Unloading Room)			Cask Unloading Room shield door – **1** motors (IH00-DR-00001) 20 HP 3% Cask transfer trolley – **1** power drive x RWF **0.03** (HM00-TRLY-00001) 5 HP					Estimated 5% of all such equipment – **1**
1009 (CTM Maintenance Area)					Portable welding receptacle – WWF=5 point (EEN0-RCP-00002)			Estimated 10% of all such equipment – 2

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

Ignition Source / Room Number	Electrical Equipment	HVAC Equipment	Mechanical Process Equipment	Heat-Generating Process Equipment	Torches, Welders, and Burners	Internal Combustion Engines	Office and Kitchen Equipment	Portable and Special Equipment
1012 (Cask Preparation Area) incl. 1011 (Cask Sampling Equipment Area)	Cask handling crane pnl – 1	Tertiary confinement fan coil units – 4 (VCT0-FCU-00001, 2, 3, 4) 25 HP	Mobile access platform – 7 motors (HMC0-PLAT-00001) 40 kVA total; 1@15 HP, 2@10 HP, 4@5 HP [*2@0.5 HP*] 97% cask transfer trolley – 1 power drive x RWF 0.97 (HM00-TRLY-00001) 5 HP Cask handling crane – 3 motors, including 2 cask yoke motors (HM00-CRN-00001, BEAM-00001) 180 kVA total; 120HP, 12.5HP, 40HP, [*2@1HP*] Cask preparation crane – 3 motors (HM00-CRN-00002) 90kVA total; 60HP, 25HP, 10HP, [*4HP*] Cask preparation platform - 7 motors (HMHO-PLAT-00001) 4@5HP Cask receipt area overhead rollup doors 1 & 2 – 2 motors, 5kVA MP cask cooling – 1 motor, 5 HP [*Cask cavity gas sampling vacuum pump – 1 motor, 1 HP*] [*WP inerting vacuum pump – 1 motor, 2 HP*] [*Cask cavity gas sampling cooling unit, 1 motor, <5hp*]		3 portable welding receptacles – WWF=15 points (EEN0-RCP-00004, 5, 6)	Site prime mover 100 points		Estimated 20% of all such equipment – 4
1013 (Corridor)								
1014 (Corridor)								
1015/1031/1030/2009/2015 (Stair/ Elevator)			Passenger elevator 1 – 1 motor, 50 kVA					
1016/2016 (Stair)								
1017/2017 (Stair)								
1018/2018 (Stair)								
1019 (Fire Water Valve Riser Room)								
1020 (Fire Water Valve Riser Room)								

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

Ignition Source / Room Number	Electrical Equipment	HVAC Equipment	Mechanical Process Equipment	Heat-Generating Process Equipment	Torches, Welders, and Burners	Internal Combustion Engines	Office and Kitchen Equipment	Portable and Special Equipment
1021 (Fire Water Valve Riser Room)								
1022/1024/2024 (Elevator)			Passenger elevator 2 – **1** motor, 50 kVA					
1023 (Utility Room)	480V Load Center – **5** cabs (EEN0-LC-00003) 480V MCC – **10** cabs (EEN0-MCC-00007)		HVAC chilled water pumps – **2** motors (PSCO-P-00001-A, B) 2@50 HP Hot water pumps – **2** motors (PSH0-P-00001-A, B) 2@15 HP		Primary welding station – **400** points			
1026 (Dry LLW Storage Room)								
1027 (LLW Sump Room)		[*Liquid LLW sampling pump – 1 motor (MLW0-P-00001) 0.5HP*] [*Liquid LLW sump pump – 1 motor (MLW0-P-00002) 2HP*]						
2001/2010 (Operations Room)	Control consoles – **6**	Operations Room fan coil units – **2** (VNI0-FCU-00001, 2) 15 HP					Estimated 10% of all such equipment – **1**	
2002 (WP Closure Equipment Room)	Control system and electrical cabinets – **13**							Estimated 5% of all such equipment - **1**
2003 (HVAC Equipment Area)		Tertiary confinement air handling units – 3 (VCT0-AHU-00001, 2, 3) 100 HP						Estimated 5% of all such equipment - 1

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

Ignition Source / Room Number	Electrical Equipment	HVAC Equipment	Mechanical Process Equipment	Heat-Generating Process Equipment	Torches, Welders, and Burners	Internal Combustion Engines	Office and Kitchen Equipment	Portable and Special Equipment
2004 (Waste Package Closure Room)			Waste Package Closure Room crane - 2 motors (HW00-CRN-00001) 52.5kVA total; 35HP, 7.5HP, [*2HP*] [*Burnishing tool (HWS0-TOOL-00001), low HP motors*] Weld dressing end effectors – 2 (HWW0-TOOL-0003, 4) machining/sparking, [*2 motors @4.5 HP*] [*Remote handling system (HWH0-HEQ-00003) – various small motors*] [*Waste package closure system robot arms – 2 (HWH0-HEQ-00001, 2) – various small motors*] Waste package closure system vacuum pump – 1 motor, 1@10HP [*Waste package closure system chiller – 3 motors, 3@1HP*] Waste package closure system hydraulic pump – 1		Weld end effectors – WWF=117 points (HWW0-TOOL-00001, 2)			Estimated 10% of all such equipment – 2
2005 (Canister Transfer Area)	CTM panel – 1		CTM maintenance crane – 2 motors (HTC0-CRN-0001) 62.5 kVA total; 35HP, 7.5HP, 2HP [*Cask and WP port slide gates – 4 motors (HTC0-HTCH-00001, 2) 1 kVA; 4@0.5HP*] Canister transfer machine – 5 motors (HTC0-FHM-00001) 133 kVA total; 2@7.5HP, 45HP, 60HP, 5HP, [*3HP*]					Estimated 5% of all such equipment – 1

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

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

Ignition Source / Room Number	Electrical Equipment	HVAC Equipment	Mechanical Process Equipment	Heat-Generating Process Equipment	Torches, Welders, and Burners	Internal Combustion Engines	Office and Kitchen Equipment	Portable and Special Equipment
2006 (Waste Package Closure Support Room)								Estimated 5% of all such equipment - 1
2007 (Corridor)								
2008 (Corridor)								

NOTE: Red numbers indicate the actual count used. Equipment displayed in italicized text do not count as ignition sources per the counting rules.

RWF is room weighting factor for equipment that can be in multiple rooms. The factor represents the percentage of exposure (i.e., waste residence) time that the piece of equipment spends in the particular room. For the office and kitchen equipment and for the portable/process equipment, these percentages were distributed across various locations of the building where such equipment is likely to be used. The results of the analysis are largely insensitive to this distribution. For the other types of major equipment used in the facility to move waste forms around, the residence fraction is based on the facility throughput analysis.

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 hr/wk in the primary maintenance welding location and 5 hr/yr in each satellite welding location (for repairs that must be performed locally). Waste package closure room welding is estimated based on 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) the IHF will process 450 waste packages. Also, 450 × 13/50 is 117 hours per year (a score of 117).

Power ratings are for each motor unless otherwise noted.

Pieces of equipment that are in the room in question but do not count as ignition sources per the counting rules are shown as [italicized in square brackets].

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

CTM = canister transfer machine; HEPA = high-efficiency particulate air; HP = horsepower; HVAC = heating, ventilation, and air conditioning; IHF = Initial Handling Facility; kVA = kilovolts-ampere; LW = low-level radioactive waste; MCC = motor control center; MP = mechanical process; n/a = not applicable; pnl = panel; RWF = room weighting factor; V = volt; VDC = volt direct current; WP = waste package; WWF = welding weighting factor; Xfrmr = 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:

- *Initial Handling Facility 480 V Load Center 51A-EEN0-LC-00001 Single Line Diagram* (Ref. F2.4)
- *Initial Handling Facility 480 V Load Center 51A-EEN0-LC-00002 Single Line Diagram.* (Ref. F2.5)
- *Initial Handling Facility 480 V Load Center 51A-EEN0-LC-00003 Single Line Diagram.* (Ref F2.6)
- *Initial Handling Facility 480V MCC 51A-EEN0-MCC-00001 Single Line Diagram.* (Ref. F2.7)
- *Initial Handling Facility 480 V MCC 51A-EEN0-MCC-00002 Single Line Diagram.* (Ref. F2.8)
- *Initial Handling Facility 480 V MCC 51A-EEN0-MCC-00003 Single Line Diagram.* (Ref. F2.9)
- *Initial Handling Facility 480 V MCC 51A-EEN0-MCC-00004 Single Line Diagram.* (Ref. F2.10)
- *Initial Handling Facility 480 V MCC 51A-EEN0-MCC-00005 Single Line Diagram.* (Ref. F2.11)
- *Initial Handling Facility 480 V MCC 51A-EEN0-MCC-00006 Single Line Diagram.* (Ref. F2.12)
- *Initial Handling Facility 480 V MCC 51A-EEN0-MCC-00007 Single Line Diagram.* (Ref. F2.13)
- *Initial Handling Facility UPS 51A-EEP0-UJX-00001 Single Line Diagram.* (Ref. F2.33)
- *Initial Handling Facility UPS 51A-EEP0-UJX-00002 Single Line Diagram* (Ref. F2.32)
- *Initial Handling Facility General Arrangement Ground Floor Plan* (Ref. F2.25).

The electrical equipment category consists of computers, equipment racks, load centers, motor control centers (MCCs), uninterruptable power supply, transformers, lighting panels, digital control and management information system, 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:

- *Initial Handling Facility Composite Vent Flow Diagram Tertiary Confinement HVAC Supply & Exhaust Systems* (Ref. F2.18)
- *Initial Handling Facility Composite Vent Flow Diagram Tertiary Confinement HVAC Miscellaneous Areas* (Ref. F2.17)
- *Initial Handling Facility Composite Vent Flow Diagram Non-Confinement HVAC Systems* (Ref. F2.16)
- *Initial Handling Facility Confinement Areas HVAC Supply System Ventilation & Instrumentation Diagram* (Ref. F2.20)
- *Initial Handling Facility Confinement Areas HEPA Exhaust System Ventilation & Instrumentation Diagram* (Ref. F2.19)
- *Initial Handling Facility Confinement Electrical and Battery Room HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.23)
- *Initial Handling Facility Confinement Battery Room HEPA Exhaust System Ventilation & Instrumentation Diagram* (Ref. F2.21)
- *Initial Handling Facility Confinement Cask Prep Area and WP Loadout Rm HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.22)
- *Initial Handling Facility Non-Confinement Areas HVAC Supply System Ventilation & Instrumentation Diagram* (Ref. F2.30)
- *Initial Handling Facility Non-Confinement Areas Air Distribution System (North) Ventilation & Instrumentation Diagram* (Ref. F2.29)
- *Initial Handling Facility Non-Confinement Operations Area HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.31).

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 are determined for all applicable HVAC equipment identified. A piece of equipment containing a motor 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:

- *Initial Handling Facility General Arrangement Ground Floor Plan* (Ref. F2.25)
- *Initial Handling Facility General Arrangement Second Floor Plan* (Ref. F2.27)
- *Initial Handling Facility General Arrangement Plan At Elevation +73'-0"* (Ref. F2.26)
- *Equipment Motor Horsepower and Electrical Requirements Analysis* (Ref. F2.3)
- *Initial Handling Facility Cask Cavity Gas Sampling System Piping & Instrument Diagram* (Ref. F2.14)
- *Initial Handling Facility Chilled Water System P&ID* (Ref. F2.15)
- *Initial Handling Facility Hot Water System P&ID* (Ref. F2.28).

Mechanical process equipment includes most of the motorized equipment, including cranes, trolleys, doors, and platforms. These pieces of equipment 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 that can occupy more than one room. To accomplish this task, the amount of time a piece of equipment spends in each room was identified using the *Preliminary Throughput Study for the Initial Handling Facility* (Ref. F2.34). The waste package transfer trolley (WPTT) and cask transport trolley (CTT) were identified as the only two pieces of mobile equipment that occupy more than one room.

The total time the CTT spends in the Cask Unloading Room (1008) is calculated from the following procedures (in parenthesis) identified in the process throughput:

- Move loaded transportation cask on CTT to Cask Unloading Room—52 minutes (1.2.13)
- Remove naval spent fuel canister from naval transportation cask—56 minutes (2.2)
- Place canister in waste package—151 minutes (2.3)
- Move empty transportation cask to Cask Preparation Area—47 minutes (1.4.1).

The total time the CTT spends in the Cask Preparation Area (1012) is calculated by subtracting the total amount of time the CTT is in either room from the total time of the procedure (11,679 minutes).

Movement of the WPTT in the IHF includes rooms 1005, 1006, and 1007. The total time the WPTT spends in the Waste Package Positioning Room (1006) is calculated from the following procedures (in parenthesis) identified in the process throughput:

- Move WPTT in vertical position through Waste Package Positioning Room into Waste Package Loading Room—40 minutes (4.1.13)
- Close waste package—2,510 minutes (3.1)
- Move loaded, sealed waste package to Waste Package Loadout Room—20 minutes (4.2.1).

The total time the WPTT spends in the Waste Package Loading Room (1007) is calculated from the following procedures (in parenthesis) identified in the process throughput:

- Move WPTT in vertical position through Waste Package Positioning Room into Waste Package Loading Room—40 minutes (4.1.13)
- Place canister in waste package—151 minutes (2.3)
- Receive loaded waste package in Waste Package Positioning Cell—20 minutes (3.1.1).

The total time the WPTT spends in the Waste Package Loadout Room (1005) is calculated by subtracting the total amount of time the WPTT is in either room 1006 or 1007 from the total time of the process (11,679 minutes).

The time a mobile equipment item spends in each room is used 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 count is represented on the equipment list as the residence weighting factor.

F5.4.4 Heat-Generating Process Equipment

This equipment includes such things as furnaces, dryers, and other such equipment, except for that equipment associated with the HVAC, which is counted separately as discussed previously. 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 determination 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 receptacles are provided for convenience and are not expected to see significant use. Each station is estimated to see on the order of 5 hours of use per year, and so each is assigned a score of 5 points. 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 components of stationary pieces of equipment that are easily removed). The primary welding station is estimated to be used about 8 hours per week, and so it is assigned a score of 400 points. The IHF 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.
- The IHF processes 450 waste packages; $450 \times 13/50$ is 117 hours per year (a score of 117).

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 is one transporter in the IHF that uses internal combustion engines, which provides the entire contribution of fire ignition from the internal combustion engines category. The site prime mover/tractor is assigned a total of 100 points. While the prime mover is mobile, it moves only within the combined open rooms 1012 and 1011. Because these rooms are open to each other and treated as a single room, it was not necessary to account for movement of the site prime mover; the 100 points are assigned to room 1012/1011.

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

F5.4.7 Office and 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		6						1	158	4.03E-02
1002	95	4						2	502	1.29E-01
1003	2								41	3.00E-03
1200-1225		2					9		694	1.10E-01
1005	1	2	12.04		5			2	467	7.73E-02
1006			4.88					1	134	2.56E-02
1007			0.08					1	172	1.27E-02
1008			1.03					1	86	1.27E-02
1009					5			2	172	2.21E-02
1012/1011	1	4	23.97		15	100		4	1301	1.96E-01
1013	1								7	1.06E-03
1014									18	5.72E-04
1015/31/30/2009/15			1						69	5.17E-03
1016/2016									33	1.05E-03
1017/2017									61	1.97E-03
1018/2018									56	1.79E-03
1019			1						16	3.47E-03
1020			1						8	3.21E-03
1021			1						10	3.26E-03
1022/24/2024			1						31	3.93E-03
1023	15		4		400				184	2.49E-01
1026									40	1.29E-03
1027									111	3.55E-03
2001	6	2					1		218	3.02E-02
2002	13							1	58	1.98E-02
2003		3						1	307	3.09E-02
2004			6		117			2	149	1.00E-01
2005	1		7					1	304	3.81E-02
2006	1							1	220	1.48E-02
2007	1								23	1.58E-03
2008									7	2.15E-04
TOTAL	137	23	64	0	542	100	10	20		1.14E+00

NOTE: Red numbers are calculated values.

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

HVAC = heating, ventilation, and air conditioning.

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 lists and equipment and general layout drawings (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 "category population" column for all categories except "no equipment involved," as explained in Section F5.3.

The "no equipment involved" column of Table F5.5-1 is equal to the area of the room, because each unit in this category is a single square meter.[3] These values are taken from Table F5.2-1, in the "A" column (square meters).

The final column on Table F5.5-1, the "room ignition frequency" column, implements the generic forms of Equations F-6 and F-7. It calculates the room ignition frequency, which uses 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 "frequency per unit" column. 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. It should be noted 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, presupposes that the ignition sources in the building cover each of the ignition source categories used in the analysis. However, the IHF does not have any equipment that fits the definition of heat-generating process equipment (welders have their own category), so this contribution does not apply to IHF.

F5.6 PROPAGATION PROBABILITIES

Propagation probabilities are used 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 used 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 ensuring 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.

[3] As discussed in the methodology section, in the case where no equipment is involved the size of the room represents the relative contribution to the overall frequency.

Table F5.6-1. Fire Propagation Probabilities

Automatic Suppression Functional		Conditional Probability			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				
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: Red numbers are calculated values; green shaded cells are parameters that are assigned distributions for Crystal Ball input.

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 describe the culmination of these data, concluding 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 naval spent nuclear fuel (NSNF) and high-level radioactive waste (HLW) is the *Preliminary Throughput Study for the Initial Handling Facility* (Ref. F2.34). Table F5.7-1 shows the vulnerabilities for NSNF 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 period of surface preclosure operations. Similar to the NSNF residence fractions, the process throughputs have been used to determine residence fractions for HLW (Table F5.7-2).

F5.7.2 Localized Fires

Initiating event frequencies have been divided into two types of calculations: localized and large fires. Table F5.7-3 contains all of the calculations contributing to the localized fire initiating event frequencies.

F5.7.2.1 Room Groupings

The first column of Table F5.7-3 identifies the room(s) of origin. If the vulnerability is expected to occur in a single room that has 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, where the room where the vulnerability occurs has open doors or gates to other rooms, or where the room shares a qualified fire area with other rooms. Table F5.7-4 lists all of the vulnerabilities that have more than one room of origin, as well as 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 nonqualified 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. Frequency per unit 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 F5.5 (Room Ignition Frequency).

Table F5.7-1. NSNF Residence Fractions

IHF Residence Times and Fractions			
Section I - Localized Fires			
BFD Task	Steps (if needed)	Time (min)	Fraction
TC/NSNF on Railcar in Vestibule/Prep Area w/SPM (Diesel Present)			
1.1.4	Steps 1-4	46	
Total		**46**	**1.8E-06**
TC/NSNF on Railcar in Prep Area w/o SPM (No Diesel Present)			
1.1.4	Step 5	70	
1.3.1		136	
1.3.2		120	
1.3.3		30	
1.3.4		138	
1.3.5		17	
1.3.6		20	
Total		**531**	**2.0E-05**
TC/NSNF on CTT in Prep Area			
1.3.7		25	
1.3.8		78	
Not in BFD	Cavity gas sampling	45	
1.3.9		95	
1.3.10		32	
1.3.11		241	
1.3.12		65	
1.3.13	Steps 1-5	30	
Total		**611**	**2.3E-05**
TC/NSNF on CTT in Unloading Room			
1.3.13	Steps 5-9	32	
2.2.1		35	
2.2.2		2	
2.2.3		15	
Total		**84**	**3.2E-06**
NSNF in CTM in Transfer Room			
2.2.3	Step 2 (again)	10	
2.2.4		2	
2.3.1		6	
2.3.2		2	
2.3.3	Step 1	15	
Total		**35**	**1.3E-06**

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

BFD Task	Steps (if needed)	Time (min)	Fraction
NSNF in WP in Loading Room			
2.3.3	again	20	
2.3.14		7	
2.3.15		1	
2.3.16		15	
2.3.17		1	
2.3.18		18	
2.3.19		2	
2.3.20		18	
2.3.21		2	
2.3.5		30	
2.3.6		11	
2.3.7		2	
2.3.8		15	
2.3.9		2	
3.1.1	Step 1	20	
Total		**164**	**6.2E-06**
NSNF in WP in Positioning/Closure Room			
3.1		7005	
4.2.1	Steps 1-2	15	
Total		**7020**	**2.7E-04**
NSNF in WP in Loadout Room			
4.2.1	Steps 2-4	20	
Not in BFD	TEV into facility	32	
4.2.2		25	
4.2.3		60	
4.2.4	Steps 1-3	15	
Total		**152**	**5.8E-06**
NSNF/WP in TEV in Loadout Room			
4.2.4	Steps 3-7	27	
Total		**27**	**1.0E-06**
Section II - Large Fire			
TC/NSNF w/SPM Present (Diesel)			
1.1.4	Steps 1-4	46	
Total		**46**	**1.8E-06**

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

BFD Task	Steps (if needed)	Time (min)	Fraction
TC/NSNF w/o SPM Present (No Diesel)			
1.1.4	Step 5	70	
1.3.1		136	
1.3.2		120	
1.3.3		30	
1.3.4		138	
1.3.5		17	
1.3.6		20	
1.3.7		25	
1.3.8		78	
Not in BFD	Cavity gas sampling	45	
1.3.9		95	
1.3.10		32	
1.3.11		241	
1.3.12		65	
1.3.13		47	
2.2.1		35	
2.2.2		2	
Total		**1196**	**4.6E-05**
NSNF in CTM			
2.2.3		15	
2.2.4		2	
2.3.1		6	
2.3.2		2	
Total		**25**	**9.5E-07**
NSNF in WP			
2.3.3		20	
2.3.14		7	
2.3.15		1	
2.3.16		15	
2.3.17		1	
2.3.18		18	
2.3.19		2	
2.3.20		18	
2.3.21		2	
2.3.5		30	
2.3.6		11	
2.3.7		2	
2.3.8		15	
2.3.9		2	
3.1		7005	
4.2.1		20	
Not in BFD	TEV into facility	32	
4.2.2		25	
4.2.3		60	
4.2.4		42	
Total		**7328**	**2.8E-04**

NOTE: Blank cells in this table are intentional and have been verified.
BFD = block flow diagram; CTT = cask transfer trolley; IHF = Initial Handling Facility; min = minute; NSNF = naval spent nuclear fuel; SPM = site prime mover; TC = transportation cask; TEV = transport and emplacement vehicle; w/o = without; WP = waste package.

Source: Original

Table F5.7-2. HLW Residence Fractions

IHF Residence Times and Fractions			
Section I - Localized Fires			
BFD Task	Steps (if needed)	Time (min)	Fraction
TC/HLW on Railcar in Vestibule/Prep Area w/SPM (Diesel Present)			
1.1.4		31	
Total		**31**	**1.2E-06**
TC/HLW on Railcar in Prep Area w/o SPM (No Diesel Present)			
1.2.2		161	
1.2.3		20	
1.2.4		40	
1.2.5		15	
1.2.6	Steps 1-2	10	
Total		**246**	**9.4E-06**
TC/HLW on CTT in Prep Area			
1.2.6	Steps 2-5	20	
1.2.7		35	
Not in BFD	Cavity gas sampling	45	
1.2.8		46	
Not in BFD	Prep cask crane	15	
1.2.9		55	
1.2.10	Steps 1-6	35	
Total		**251**	**9.6E-06**

pja:
IMPORTANT: Analysis boundary condition, in conformance with the throughput analysis, is that all HLW arrives in truck casks (one HLW canister to a cask). All frequency values up through the CTM are **per canister**. All frequency values for the WP are **per waste package**. Since five canisters are placed in a waste package, the waste form count for fire effects on WP is one-fifth of the waste form count for canisters. This boundary condition is bounding since it maximizes the residence time of HLW in the facility (i.e., it takes much more time to process five truck casks than a single rail cask containing five canisters).

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

BFD Task	Steps (if needed)	Time (m)	Fraction
TC/HLW on CTT in Unloading Room			
1.2.10	Steps 6-10	32	
2.1.1		35	
2.1.25		2	
2.1.3		17	
2.1.4		15	
Not in BFD		34	
2.1.5		7	
2.1.6		15	
Total		**157**	**6.0E-06**
HLW in CTM in Transfer Room			
2.1.6	Step 2 (again)	10	
2.1.7		2	
2.3.1		6	
2.3.2		2	
2.3.3	Step 1	10	
Total		**30**	**1.1E-06**
HLW in WP in Loading Room			
1.4	x4 (casks 2-5)	2288	
1.1.4	x4 (canisters 2-5)	124	
1.2	x4 (canisters 2-5)	1956	
2.1	x4 (canisters 2-5)	508	
2.3	x4 (canisters 1-5)	470	
3.1.1	Step 1	20	
Total		**5366**	**2.0E-04**
HLW in WP in Positioning/Closure Room			
3.1		7116	
4.2.1	Steps 1-2	15	
Total		**7131**	**2.7E-04**

pja:
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. The rate limiting step once the first canister enters is the amount of time it takes to export the empty TC after the canister is removed by the CTM. This process takes 572 minutes per cask (BFD 1.4). Once the first canister enters the WP, 572 minutes later the next TC can enter the facility. The sum total of this critical path "delay" is four times this amount (while the second through fifth casks are processed).

pja :
Similarly, each of the subsequent casks needs to have its canister removed and plaved in the WP and the TC lid plaved back on the TC prior to sending the empty TC from the facility, which delays provessing of the subsequent TC. Again, this applies only to the second through fifth canisters, except for BFD 2.3, which includes putting the TC lid back on. This delay applies to all 5 canisters because it also delays closure of the WP after the last canister is loaded.

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

BFD Task	Steps (if needed)	Time (min)	Fraction
HLW in WP in Loadout Room			
4.2.1	Steps 2-4	20	
Not in BFD	TEV into facility	32	
4.2.2		25	
4.2.3		60	
4.2.4	Steps 1-3	15	
Total		**152**	**5.8E-06**
HLW/WP in TEV in Loadout Room			
4.2.4	Steps 3-7	27	
Total		**27**	**1.0E-06**
Section II - Large Fire			
TC/HLW w/SPM Present (Diesel)			
1.1.4		31	
Total		**31**	**1.2E-06**
TC/HLW w/o SPM Present (No Diesel)			
1.2.2		161	
1.2.3		20	
1.2.4		40	
1.2.5		15	
1.2.6		25	
1.2.7		35	
Not in BFD	Cavity gas sampling	45	
1.2.8		46	
Not in BFD	Prep cask crane	15	
1.2.9		55	
1.2.10		47	
2.1.1		35	
2.1.2		2	
2.1.3		17	
2.1.4		15	
Not in BFD		34	
2.1.5		7	
2.1.6		15	
Total		**629**	**2.4E-05**

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

BFD Task	Steps (if needed)	Time (min)	Fraction
HLW in CTM in Transfer Room			
2.1.34		20	
2.1.35		2	
2.1.36		5	
2.1.37		2	
2.1.38	Step 1	10	
four more		156	
Total		**195**	**7.4E-06**
HLW in WP			
1.4	x4 (casks 2-5)	2288	
1.1.4	x4 (canisters 2-5)	124	
1.2	x4 (canisters 2-5)	1956	
2.1	x4 (canisters 2-5)	508	
2.3	x5 (canisters 1-5)	470	
3.1		7116	
4.2		159	
Total		**12621**	**4.8E-04**

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

BFD = block flow diagram; CTM = canister transfer machine; CTT = cask transfer trolley; HLW = high-level radioactive waste; IHF = Initial Handling Facility; m = minute; NSNF = naval 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. Localized Fire Initiating Event Frequencies

Localized Fires that Threaten Waste Form												
Contributions from Rooms Containing Waste Form												
Room of Origin (includes comments field as needed)	Ignition Source (If Applicable)	Number in Room	Frequency per Unit (50 years)	Number at Target	Number Near Target	Propagation Probability to Target	Number Away from Target	Propagation Probability to Target	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)
Entry represents a vulnerability due to the WP transfer trolley									WP/NSNF		WP/HLW	
1005	Electrical	1	8.46E-04	1		0.211		0.061	5.8E-06	4.9E-09	5.8E-06	4.9E-09
	HVAC	2	4.72E-03	2		0.211		0.061	5.8E-06	5.5E-08	5.8E-06	5.5E-08
	Mechanical equipment	12.04	2.94E-03	12.04		0.211		0.061	5.8E-06	2.0E-07	5.8E-06	2.0E-07
	Heat-generating equipment	0	0.00E+00			0.211		0.061	5.8E-06	0.0E+00	5.8E-06	0.0E+00
	Torches, welders, burners	5	5.47E-04	5		0.211		0.061	5.8E-06	1.6E-08	5.8E-06	1.6E-08
	Internal combustion engines	0	2.84E-04			0.211		0.061	5.8E-06	0.0E+00	5.8E-06	0.0E+00
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	5.8E-06	0.0E+00	5.8E-06	0.0E+00
	Portable equipment	2	6.91E-03	2		0.211		0.061	5.8E-06	8.0E-08	5.8E-06	8.0E-08
	No equipment involved	467	3.21E-05	467		0.211		0.061	5.8E-06	8.7E-08	5.8E-06	8.7E-08
Localized Fire Threatens Waste Form in WPTT in Loadout Room												
	Localized Fire Threatens WP/NSNF in WPTT in Loadout Room									**4.5E-07**		
	Localized Fire Threatens WP/HLW in WPTT in Loadout Room											**4.5E-07**
Entry represents a vulnerability due to the TEV									WP/NSNF		WP/HLW	
1005	Electrical	1	8.46E-04	1		0.211		0.061	1.0E-06	8.7E-10	1.0E-06	8.7E-10
	HVAC	2	4.72E-03	2		0.211		0.061	1.0E-06	9.7E-09	1.0E-06	9.7E-09
	Mechanical equipment	12.04	2.94E-03	12.04		0.211		0.061	1.0E-06	3.6E-08	1.0E-06	3.6E-08
	Heat-generating equipment	0	0.00E+00			0.211		0.061	1.0E-06	0.0E+00	1.0E-06	0.0E+00
	Torches, welders, burners	5	5.47E-04	5		0.211		0.061	1.0E-06	2.8E-09	1.0E-06	2.8E-09
	Internal combustion engines	0	2.84E-04			0.211		0.061	1.0E-06	0.0E+00	1.0E-06	0.0E+00
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	1.0E-06	0.0E+00	1.0E-06	0.0E+00
	Portable equipment	2	6.91E-03	2		0.211		0.061	1.0E-06	1.4E-08	1.0E-06	1.4E-08
	No equipment involved	467	3.21E-05	467		0.211		0.061	1.0E-06	1.5E-08	1.0E-06	1.5E-08
Localized Fire Threatens Waste Form in WP in TEV Loadout Room												
	Localized Fire Threatens WP/NSNF in TEV in Loadout Room									**7.9E-08**		
	Localized Fire Threatens WP/HLW in TEV in Loadout Room											**7.9E-08**

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Table F5.7-3. Localized Fire Initiating Event Frequencies (Continued)

Room of Origin (includes comments field as needed)	Ignition Source (If Applicable)	Number in Room	Frequency per Unit (50 years)	Number at Target	Number Near Target	Propagation Probability to Target	Number Away from Target	Propagation Probability to Target	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)
Entry represents a vulnerability due to the cask transfer trolley									TC/NSNF		TC/HLW	
1008	Electrical	0	8.46E-04			0.211		0.061	3.2E-06	0.0E+00	6.0E-06	0.0E+00
	HVAC	0	4.72E-03			0.211		0.061	3.2E-06	0.0E+00	6.0E-06	0.0E+00
	Mechanical equipment	1.03	2.94E-03		1.03	0.211		0.061	3.2E-06	2.0E-09	6.0E-06	3.8E-09
	Heat-generating equipment	0	0.00E+00			0.211		0.061	3.2E-06	0.0E+00	6.0E-06	0.0E+00
	Torches, welders, burners	0	5.47E-04			0.211		0.061	3.2E-06	0.0E+00	6.0E-06	0.0E+00
	Internal combustion engines	0	2.84E-04			0.211		0.061	3.2E-06	0.0E+00	6.0E-06	0.0E+00
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	3.2E-06	0.0E+00	6.0E-06	0.0E+00
	Portable equipment	1	6.91E-03		1	0.211		0.061	3.2E-06	4.7E-09	6.0E-06	8.7E-09
	No equipment involved	86	3.21E-05	30	56	0.211		0.061	3.2E-06	4.3E-09	6.0E-06	8.0E-09
Localized Fire Threatens Waste Form in Unloading Room												
	Localized Fire Threatens TC/NSNF in Unloading Room									**1.1E-08**		
	Localized Fire Threatens TC/HLW in Unloading Room											**2.1E-08**
Entry represents a vulnerability due to the WP transfer trolley									WP/NSNF		WP/HLW	
FA-00-05	Electrical	0	8.46E-04			0.211		0.061	2.7E-04	0.0E+00	2.7E-04	0.0E+00
	HVAC	0	4.72E-03			0.211		0.061	2.7E-04	0.0E+00	2.7E-04	0.0E+00
	Mechanical equipment	10.88	2.94E-03	10.88		0.211		0.061	2.7E-04	8.6E-06	2.7E-04	8.7E-06
	Heat-generating equipment	0	0.00E+00			0.211		0.061	2.7E-04	0.0E+00	2.7E-04	0.0E+00
	Torches, welders, burners	117	5.47E-04	117		0.211		0.061	2.7E-04	1.7E-05	2.7E-04	1.7E-05
	Internal combustion engines	0	2.84E-04			0.211		0.061	2.7E-04	0.0E+00	2.7E-04	0.0E+00
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	2.7E-04	0.0E+00	2.7E-04	0.0E+00
	Portable equipment	3	6.91E-03			0.211	3	0.061	2.7E-04	3.4E-07	2.7E-04	3.4E-07
	No equipment involved	283	3.21E-05	134	120	0.211	29	0.061	2.7E-04	1.4E-06	2.7E-04	1.4E-06
Propagation from rooms in FA-00-02												
1002			1.29E-01			0.057			2.7E-04	2.0E-06	2.7E-04	2.0E-06
1003			3.00E-03			0.057			2.7E-04	4.6E-08	2.7E-04	4.7E-08
1009			2.21E-02			0.057			2.7E-04	3.4E-07	2.7E-04	3.4E-07
1012			1.96E-01			0.057			2.7E-04	3.0E-06	2.7E-04	3.1E-06
1026			1.29E-03			0.057			2.7E-04	2.0E-08	2.7E-04	2.0E-08
1027			3.55E-03			0.057			2.7E-04	5.4E-08	2.7E-04	5.5E-08
2003			3.09E-02			0.057			2.7E-04	4.7E-07	2.7E-04	4.8E-07
2005			3.81E-02			0.057			2.7E-04	5.9E-07	2.7E-04	5.9E-07
2006			1.48E-02			0.057			2.7E-04	2.3E-07	2.7E-04	2.3E-07
Localized Fire Threatens Waste Form in Positioning Room												
	Localized Fire Threatens WP/NSNF in Positioning Room									**3.4E-05**		
	Localized Fire Threatens WP/HLW in Positioning Room											**3.5E-05**

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Table F5.7-3. Localized Fire Initiating Event Frequencies (Continued)

Room of Origin (includes comments field as needed)	Ignition Source (If Applicable)	Number in Room	Frequency per Unit (50 years)	Number at Target	Number Near Target	Propagation Probability to Target	Number Away from Target	Propagation Probability to Target	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)
Entry represents a vulnerability due to the WP transfer trolley									WP/NSNF		WP/HLW	
FA-00-06	Electrical	1	8.46E-04			0.211	1	0.061	6.2E-06	3.2E-10	2.0E-04	1.1E-08
	HVAC	0	4.72E-03			0.211		0.061	6.2E-06	0.0E+00	2.0E-04	0.0E+00
	Mechanical equipment	7.08	2.94E-03	5.08		0.211	2	0.061	6.2E-06	9.6E-08	2.0E-04	3.1E-06
	Heat-generating equipment	0	0.00E+00			0.211		0.061	6.2E-06	0.0E+00	2.0E-04	0.0E+00
	Torches, welders, burners	0	5.47E-04			0.211		0.061	6.2E-06	0.0E+00	2.0E-04	0.0E+00
	Internal combustion engines	0	2.84E-04			0.211		0.061	6.2E-06	0.0E+00	2.0E-04	0.0E+00
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	6.2E-06	0.0E+00	2.0E-04	0.0E+00
	Portable equipment	2	6.91E-03			0.211	2	0.061	6.2E-06	5.3E-09	2.0E-04	1.7E-07
	No equipment involved	476	3.21E-05	172	120	0.211	184	0.061	6.2E-06	4.2E-08	2.0E-04	1.4E-06
Propagation from rooms in FA-00-02												
1002			1.29E-01			0.057			6.2E-06	4.6E-08	2.0E-04	1.5E-06
1003			3.00E-03			0.057			6.2E-06	1.1E-09	2.0E-04	3.5E-08
1009			2.21E-02			0.057			6.2E-06	7.9E-09	2.0E-04	2.6E-07
1012			1.96E-01			0.057			6.2E-06	7.0E-08	2.0E-04	2.3E-06
1026			1.29E-03			0.057			6.2E-06	4.6E-10	2.0E-04	1.5E-08
1027			3.55E-03			0.057			6.2E-06	1.3E-09	2.0E-04	4.2E-08
2003			3.09E-02			0.057			6.2E-06	1.1E-08	2.0E-04	3.6E-07
2004			1.00E-01			0.057			6.2E-06	3.6E-08	2.0E-04	1.2E-06
2006			1.48E-02			0.057			6.2E-06	5.3E-09	2.0E-04	1.7E-07
Localized Fire Threatens Waste Form in Loading Room												
	Localized Fire Threatens WP/NSNF in Loading Room									**3.2E-07**		
	Localized Fire Threatens WP/HLW in Loading Room											**1.1E-05**
Entry represents a vulnerability due to the cask transfer trolley									TC/NSNF		TC/HLW	
FA-00-02	Electrical	97	8.46E-04			0.211	97	0.061	2.3E-05	1.2E-07	9.6E-06	4.8E-08
	HVAC	11	4.72E-03			0.211	11	0.061	2.3E-05	7.4E-08	9.6E-06	3.0E-08
	Mechanical equipment	30.97	2.94E-03	4.97	2	0.211	24	0.061	2.3E-05	4.7E-07	9.6E-06	1.9E-07
	Heat-generating equipment	0	0.00E+00			0.211		0.061	2.3E-05	0.0E+00	9.6E-06	0.0E+00
	Torches, welders, burners	20	5.47E-04			0.211	20	0.061	2.3E-05	1.6E-08	9.6E-06	6.4E-09
	Internal combustion engines	100	2.84E-04			0.211	100	0.061	2.3E-05	4.1E-08	9.6E-06	1.7E-08
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	2.3E-05	0.0E+00	9.6E-06	0.0E+00
	Portable equipment	10	6.91E-03		1	0.211	9	0.061	2.3E-05	1.2E-07	9.6E-06	5.0E-08
	No equipment involved	2585	3.21E-05	30	120	0.211	2435	0.061	2.3E-05	1.5E-07	9.6E-06	6.3E-08
Propagation from rooms in FA-00-02												
1003			3.00E-03			0.057			2.3E-05	4.0E-09	9.6E-06	1.6E-09
1026			1.29E-03			0.057			2.3E-05	1.7E-09	9.6E-06	7.1E-10
1027			3.55E-03			0.057			2.3E-05	4.7E-09	9.6E-06	1.9E-09
2006			1.48E-02			0.057			2.3E-05	2.0E-08	9.6E-06	8.1E-09
2004			1.00E-01			0.057			2.3E-05	1.3E-07	9.6E-06	5.5E-08
Localized Fire Threatens Waste Form in CTT in Cask Preparation Area												
	Localized Fire Threatens TC/NSNF in CTT in Cask Preparation Area									**1.2E-06**		
	Localized Fire Threatens TC/HLW in CTT in Cask Preparation Area											**4.7E-07**

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Table F5.7-3. Localized Fire Initiating Event Frequencies (Continued)

Room of Origin (includes comments field as needed)	Ignition Source (If Applicable)	Number in Room	Frequency per Unit (50 years)	Number at Target	Number Near Target	Propagation Probability to Target	Number Away from Target	Propagation Probability to Target	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)
Entry represents a vulnerability due to the railcar (diesel present)									TC/NSNF		TC/HLW	
FA-00-02	Electrical	97	8.46E-04			0.211	97	0.061	1.8E-06	8.8E-09	1.2E-06	5.9E-09
	HVAC	11	4.72E-03	4		0.211	7	0.061	1.8E-06	3.7E-08	1.2E-06	2.5E-08
	Mechanical equipment	30.97	2.94E-03	10.97	3	0.211	17	0.061	1.8E-06	6.5E-08	1.2E-06	4.4E-08
	Heat-generating equipment	0	0.00E+00			0.211		0.061	1.8E-06	0.0E+00	1.2E-06	0.0E+00
	Torches, welders, burners	20	5.47E-04			0.211	20	0.061	1.8E-06	1.2E-09	1.2E-06	7.9E-10
	Internal combustion engines	100	2.84E-04	100		0.211		0.061	1.8E-06	5.0E-08	1.2E-06	3.4E-08
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	1.8E-06	0.0E+00	1.2E-06	0.0E+00
	Portable equipment	10	6.91E-03		1	0.211	9	0.061	1.8E-06	9.2E-09	1.2E-06	6.2E-09
	No equipment involved	2585	3.21E-05	274	120	0.211	2191	0.061	1.8E-06	2.4E-08	1.2E-06	1.6E-08
Propagation from rooms in FA-00-02												
1003			3.00E-03			0.057			1.8E-06	3.0E-10	1.2E-06	2.0E-10
1026			1.29E-03			0.057			1.8E-06	1.3E-10	1.2E-06	8.7E-11
1027			3.55E-03			0.057			1.8E-06	3.6E-10	1.2E-06	2.4E-10
2006			1.48E-02			0.057			1.8E-06	1.5E-09	1.2E-06	1.0E-09
2004			1.00E-01			0.057			1.8E-06	1.0E-08	1.2E-06	6.8E-09
Localized Fire Threatens Waste Form on Railcar in the Cask Preparation Area w/SPM (Diesel Present)												
	Localized Fire Threatens TC/NSNF on Railcar in the Cask Preparation Area w/SPM (Diesel Present)									**2.1E-07**		
	Localized Fire Threatens TC/HLW on Railcar in the Cask Preparation Area w/SPM (Diesel Present)											**1.4E-07**
Entry represents a vulnerability due to the railcar (no diesel present)									TC/NSNF		TC/HLW	
FA-00-02	Electrical	97	8.46E-04			0.211	97	0.061	2.0E-05	1.0E-07	9.4E-06	4.7E-08
	HVAC	11	4.72E-03	4		0.211	7	0.061	2.0E-05	4.2E-07	9.4E-06	2.0E-07
	Mechanical equipment	30.97	2.94E-03	10.97	3	0.211	17	0.061	2.0E-05	7.5E-07	9.4E-06	3.5E-07
	Heat-generating equipment	0	0.00E+00			0.211		0.061	2.0E-05	0.0E+00	9.4E-06	0.0E+00
	Torches, welders, burners	20	5.47E-04			0.211	20	0.061	2.0E-05	1.4E-08	9.4E-06	6.3E-09
	Internal combustion engines	0	2.84E-04			0.211		0.061	2.0E-05	0.0E+00	9.4E-06	0.0E+00
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	2.0E-05	0.0E+00	9.4E-06	0.0E+00
	Portable equipment	10	6.91E-03		1	0.211	9	0.061	2.0E-05	1.1E-07	9.4E-06	4.9E-08
	No equipment involved	2585	3.21E-05	274	120	0.211	2191	0.061	2.0E-05	2.8E-07	9.4E-06	1.3E-07
Propagation from rooms in FA-00-02												
1003			3.00E-03			0.057			2.0E-05	3.5E-09	9.4E-06	1.6E-09
1026			1.29E-03			0.057			2.0E-05	1.5E-09	9.4E-06	6.9E-10
1027			3.55E-03			0.057			2.0E-05	4.1E-09	9.4E-06	1.9E-09
2006			1.48E-02			0.057			2.0E-05	1.7E-08	9.4E-06	8.0E-09
2004			1.00E-01			0.057			2.0E-05	1.2E-07	9.4E-06	5.4E-08
Localized Fire Threatens Waste Form on Railcar in the Cask Preparation Area w/oSPM (No Diesel Present)												
	Localized Fire Threatens TC/NSNF on Railcar in the Cask Preparation Area w/oSPM (No Diesel Present)									**1.8E-06**		
	Localized Fire Threatens TC/HLW on Railcar in the Cask Preparation Area w/oSPM (No Diesel Present)											**8.4E-07**

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Table F5.7-3. Localized Fire Initiating Event Frequencies (Continued)

Room of Origin (includes comments field as needed)	Ignition Source (If Applicable)	Number in Room	Frequency per Unit (50 years)	Number at Target	Number Near Target	Propagation Probability to Target	Number Away from Target	Propagation Probability to Target	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)	Target Exposure Time (Fraction)	Contribution to IE Frequency (50 years)
Entry represents a vulnerability due to the canister transfer machine									NSNF		HLW	
FA-00-02	Electrical	97	8.46E-04	1		0.211	96	0.061	1.3E-06	7.8E-09	1.1E-06	6.6E-09
	HVAC	11	4.72E-03			0.211	11	0.061	1.3E-06	4.2E-09	1.1E-06	3.6E-09
	Mechanical equipment	30.97	2.94E-03	7	0	0.211	23.97	0.061	1.3E-06	3.3E-08	1.1E-06	2.8E-08
	Heat-generating equipment	0	0.00E+00			0.211		0.061	1.3E-06	0.0E+00	1.1E-06	0.0E+00
	Torches, welders, burners	20	5.47E-04			0.211	20	0.061	1.3E-06	8.9E-10	1.1E-06	7.7E-10
	Internal combustion engines	100	2.84E-04			0.211	100	0.061	1.3E-06	2.3E-09	1.1E-06	2.0E-09
	Office/kitchen equipment	0	8.67E-03			0.211		0.061	1.3E-06	0.0E+00	1.1E-06	0.0E+00
	Portable equipment	10	6.91E-03			0.211	10	0.061	1.3E-06	5.6E-09	1.1E-06	4.8E-09
	No equipment involved	2585	3.21E-05	30	120	0.211	2435	0.061	1.3E-06	8.7E-09	1.1E-06	7.5E-09
Propagation from rooms in FA-00-02												
1003			3.00E-03			0.057			1.3E-06	2.3E-10	1.1E-06	2.0E-10
1026			1.29E-03			0.057			1.3E-06	9.9E-11	1.1E-06	8.4E-11
1027			3.55E-03			0.057			1.3E-06	2.7E-10	1.1E-06	2.3E-10
2006			1.48E-02			0.057			1.3E-06	1.1E-09	1.1E-06	9.7E-10
2004			1.00E-01			0.057			1.3E-06	7.7E-09	1.1E-06	6.6E-09
Localized Fire Threatens Waste Form in CTM in Transfer Room												
	Localized Fire Threatens NSNF in CTM in Transfer Room									**7.2E-08**		
	Localized Fire Threatens HLW in CTM in Transfer Room											**6.2E-08**

NOTE: Red numbers are calculated values; blue shaded cells are the resultant median initiating event frequencies.

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

CTM = canister transfer machine; CTT = cask transfer trolley; HLW = high-level radioactive waste; IE = initiating event; NSNF = naval spent nuclear fuel; SPM = site prime mover; TC = transportation cask; TEV = transport and emplacement vehicle; WP = waste package; WPTT = waste package transfer trolley.

Source: Original

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