F2.56 *Ahrens, M. 2000. *Fires in or at Industrial Chemical, Hazardous Chemical and Plastic Manufacturing Facilities, 1988-1997 Unallocated Annual Averages and Narratives.* Quincy, Massachusetts: National Fire Protection Association. TIC: 259997.

F2.57 *Aherns, M. 2007. *Structure Fires in Radioactive Material Working Facilities and Nuclear Energy Plants of Non-Combustible Construction.* Quincy, Massachusetts: National Fire Protection Association. TIC: 259983.

F2.58 *SAIC (Science Applications International Corporation) 2002. *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology.* SAIC-01/2650. Abingdon, Maryland: Science Applications International Corporation. ACC: MOL.20080115.0138.

F2.59 *Tillander, K. 2004. *Utilisation of Statistics to Assess Fire Risks in Buildings.* Ph.D. dissertation. Espoo, Finland: VTT Technical Research Centre of Finland. TIC: 259928.

F2.60 *Winkler, R. L., and Hays, W. L. 1975. *Statistics: Probability, Inference, and Decision.* Series in Quantitative Methods for Decision Making. 2nd Edition. Winkler, R.L., ed., New York, New York: Holt, Rinehart, and Winston. TIC: 259976. ISBN-10: 0030140110.

## F3 BOUNDARY CONDITIONS

The general boundary conditions used during the analysis of fire vulnerabilities and fire model development are clearly stated and documented. In general, the boundary conditions are compatible with those ones usually applied to internal events due to fire events. The principal boundary conditions for the fire analysis are listed below:

### F3.1 PLANT OPERATIONAL STATE

Initial state of the facility is normal with each system operating within its limiting condition of operation limits.

### F3.2 CREDIT FOR AUTOMATIC FIRE SUPPRESSION SYSTEMS

The automatic fire suppression systems, although designed to meet all requirements and standards for fire suppression systems in nuclear facilities, are considered non-important to safety and thus no credit is taken for their operation.

### F3.3 NUMBER OF FIRE EVENT TO OCCUR

The facility is analyzed to respond to one fire event at a given time. Additional fire events as a result of independent causes or of re-ignition once a fire is extinguished are not considered.

## F3.4 IGNITION SOURCE COUNTING

Ignition sources are counted in accordance with applicable counting guidance contained in NUREG/CR-6850 (Ref. F2.54) and (Ref. F2.55).

## F3.5 FIRE CABLE AND CIRCUIT FAILURE ANALYSIS

Unlike nuclear power plants, which depend on the continued operation of equipment to prevent fuel damage, the YMP facilities cease operating on loss of power or control. Therefore, fire damage in rooms that do not contain waste cannot result in an increased level of radiological exposure. Cable and circuit analysis in these rooms is not required.

## F3.6 HEATING, VENTILATION, AND AIR-CONDITIONING FIRE ANALYSIS

Heating, ventilation, and air conditioning (HVAC) is not relied upon to mitigate potential releases associated with large fire event sequences. In recognition of a large amount of fire generated, non-radiological particulates could render the HVAC filters ineffective. HVAC can be credited for localized fires unless HVAC control or power circuits are present in the area of the fire.

## F3.7 NO OTHER SIMULTANEOUS INITIATING EVENTS

It is standard practice to not consider the occurrence of other initiating events (human-induced and naturally occurring) during the time span of an event sequence because (a) the probability of two simultaneous initiating events within the time span is small and, (b) each initiating event will cease operations of the waste handling facility, which further reduces the conditional probability of the occurrence of a second initiating event, given the first has occurred.

## F3.8 DATA COLLECTION SCOPE

The fire ignition data collection and analysis are performed for locations relevant to waste handling in the facilities.

## F3.9 COMPONENT FAILURE MODES

The failure mode of a structure, system, or component affected by a fire is the most severe with respect to consequences. For example, the failure mode for a canister could be the overpressurization of a reduced strength canister.

## F3.10 COMPONENT FAILURE PROBABILITY

Fires large enough to fail waste containment components will be large enough to fail all active components in the same room. Active components fail in a de-energized state for such fires.

## F3.11 INTERNAL EVENTS PRECLOSURE SAFETY ANALYSIS MODEL

To implement the systems analysis guidance contained herein, the fire PCSA team uses the internal events PCSA model, which is developed concurrently with the fire PCSA. This internal events PCSA is used as the basis for the fire PCSA. The internal events PCSA is in general conformance with the American Society of Mechanical Engineers probabilistic risk assessment *Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications* (Ref. F2.2).

# F4 ANALYSIS METHOD

## F4.1 INTRODUCTION

Nuclear power plant fire risk assessment techniques, as discussed in the following sections, have limited applicability to facilities such as the Receipt Facility (RF) or other facilities in the geologic repository operations area (GROA). The general methodological basis of this analysis is the *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.58), which is similar to those in the GROA in that these facilities are handling and disposal facilities for highly hazardous materials. This is a "data based" approach in that it utilizes actual historical experience on fire ignition and fire propagation to determine fire initiating event frequencies. That approach has been adapted to utilize data applicable to the YMP waste handling facilities. To the extent applicable to a non-reactor facility, NUREG/CR-6850 (Ref. F2.54) and (Ref. F2.55) are also considered in the development of this analysis method. The method complies with the applicable requirements of the American Nuclear Society fire probabilistic risk assessment standard (Ref. F2.1) that is relevant to a non-reactor facility. Many of the definitions, modeling approximations, and requirements of these documents were used to develop this document.

## F4.2 IDENTIFICATION OF INITIATING EVENTS

Current techniques in fire risk assessment for nuclear power plants focus on fire that can damage electrical and control circuits or impact other equipment that can compromise process and safety systems. This type of approach is not generally applicable to YMP because loss of electric power is a safe state except for the need for HVAC after a release of radionuclides. In general, when systems are affected by fire, they cease to function. While at a nuclear power plant this is of concern, at YMP this means that fuel handling stops and initiating events capable of producing elevated levels of radioactivity are essentially unrealizable. While it is theoretically possible that a fire could inadvertently result in a drop of a cask or canister, it is difficult (if not impossible) to identify any mechanisms by which this would occur due to fire that would not be much more likely to occur by other means. Of much greater concern at YMP is the potential for a fire to directly affect the waste containers and cause a breach that would result in a release. The fire analysis, therefore, focused on potential for a fire to directly affect the waste containers and cause a breach that would result in a release, rather than analyzing fires that would remove power from fuel handling systems. After a release of radionuclides, the HVAC system, with its high-efficiency particulate air (HEPA) filter filtration, aids in the abatement of radioactivity that is released from buildings. However, the occurrence of fires tends to significantly reduce the effectiveness of HEPA filtration and the fire event sequence analysis, therefore, does not rely on this system. Consideration is given both to fires that start in rooms containing waste and fires that start in other rooms and propagate to where the waste is located. The steps of this process are outlined in Section F4.2.1 thru F4.2.4.

### F4.2.1 Identify Fire-Rated Barriers and Designate Fire Zones

The facility is broken into fire zones based on the location of fire-rated barriers. The rating of the barriers is not significant to the methodology, so all rated barriers are considered. In order for a fire zone to exist, the penetrations, doorways, and ducts must also be limited to the perimeter of the zone. Note that a floor is always considered to be a fire barrier as long as it is solid. Zones are identified by a number determined by the analyst, and will consist of one or more rooms.

### F4.2.2 Identify the Rooms Where Waste can be Present

Each room where waste can be present, even if only for a brief time, is listed. The first set of fire initiating events to be considered in the PCSA is fires that affect each of these rooms, but do not affect other rooms that could contain waste.

### F4.2.3 Define Local Initiating Events

Fire ignition occurrences are identified for each room within a fire zone. The total occurrences of a fire within a room containing a waste form is composed of the occurrences of ignitions in that room plus the occurrences of ignitions in surrounding rooms, within the fire zone, which propagate across room boundaries to the room containing the waste form. The locations of fire initiating events were identified in the master logistic diagram.

### F4.2.4 Define Large Fire Initiating Events

Traditional fire risk studies for nuclear power plants have tended to ignore large fires, arguing that the fire barriers in place will prevent such occurrences. However, actual observed historical data shows that large fires in buildings occur. Large fires are defined for this study as those that spread to encompass the entire building. This is recognized in the latest fire risk guidance from U.S. Nuclear Regulatory Commission (NRC) and Electrical Power Research Institute ((Ref. F2.54, Section 11.5.4) and (Ref. F2.55)). There, potential large fire initiating events are identified. The general approach is as follows:

In the YMP facilities waste forms, except during the short time being lifted by a canister transfer machine (CTM), are on the ground floor. Continuing with the focus on rooms that contain waste forms, large fires may be divided two ways. One is associated with fires that start on the ground floor and spread to the entire building. The other is a fire that starts anywhere else in the building and spreads to the entire building.

As a practical analysis technique, any fire that spreads out of a fire area is considered a large fire.

## F4.3 QUANTIFICATION OF FIRE IGNITION FREQUENCY

The quantification of initiating event frequency involves three steps. First, the overall frequency of fire ignition for the facility is determined, then that frequency is allocated to the individual room in the facility based on the number and types of ignition sources in the rooms. Types of ignition sources are characterized in general terms such as mechanical, electrical, combustible liquid. Finally, propagation probabilities are applied to determine the overall frequency that a fire reaches the area of the waste. Quantification uses data from the following sources for equipment ignition frequencies and conditional probabilities of propagation:

*Detailed Methodology. Volume 2 of EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities.* EPRI TR-1011989 and NUREG/CR-6850 (Ref. F2.54)

*Summary & Overview. Volume 1 of EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities.* EPRI-1011989 and NUREG/CR-6850 (Ref. F2.55)

*Fires in or at Industrial Chemical, Hazardous Chemical, and Plastic Manufacturing Facilities: 1988 - 1997 Unallocated Annual Averages and Narratives* (Ref. F2.56)

*Structure Fires in Radioactive Material Working Facilities and Nuclear Energy Plants of Non-Combustible Construction* (Ref. F2.57)

*Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.58)

*Utilisation of Statistics to Assess Fire Risks in Buildings* (Ref. F2.59).

### F4.3.1 Determine the Overall Facility Fire Frequency

There is insufficient data available regarding the total frequency of fires in facilities comparable to YMP. NUREG/CR-6850 (Ref. F2.54) and (Ref. F2.55) provides an overall frequency for a typical nuclear power plant, but these are much larger and complex than the YMP facilities. Therefore, it has been decided to use a more generic fire ignition frequency approach that relates building size to total fire frequency for various broad categories of facilities (Ref. F2.59). This approach applies the following equation to overall fire ignition frequency.

Determine the Fire Frequency per Unit Area – The frequency per unit area is expressed by the following equation:

$$_{fm}(A) = {}_{c1}A^r + c_2A^s \qquad \text{(Eq. F-1)}$$

where $f_m$ is the fire ignition frequency per $m^2$-yr, A is the floor area (in $m^2$) and $c_1$, $c_2$, r, and s are coefficients that were determined from historical data observations for different types of facilities.

For industrial buildings, the parameter values are as follows:

c1 = 3×10-4; c2 = 5×10-6; r = -0.61; and s = -0.05

This first equation relates the frequency per unit area to the total area of the facility. This correlation was determined from the historical data, which showed that total fire frequency was not linearly related to the size of the facility. Rather, the frequency per unit area was affected by the size of the facility, and the larger the facility the lower the frequency per unit area was.

Determine the Total Fire Frequency for the Facility – The total frequency of fire ignition for the building is thus represented by the following equation:

$$f_{fire} = f_m(A) \times A \qquad \text{(Eq. F-2)}$$

### F4.3.2 Determine the Fire Ignition Frequency in Each Room

The approach to allocating the fire ignition frequency is based on the approach used in NUREG/CR-6850 (Ref. F2.54) and (Ref. F2.55), and *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.58). Both of these approaches determine the fraction of the total facility ignition frequency associated with various categories of equipment (i.e., ignition source category), then determine a facility-specific ignition frequency for each piece of equipment in each category, and then determine the total ignition frequency in the room based on the ignition source population in the room.

#### F4.3.2.1 Fraction of Fire Ignition Frequency Associated with Each Ignition Source Category

NUREG/CR-6850 (Ref. F2.54) and (Ref. F2.55) have data for these fractions for nuclear power plants, and *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.58) has data for these frequencies for chemical process plants. Neither of these data sets is the best for the facilities at YMP. Therefore, the National Fire Protection Association (NFPA) was requested to provide an analysis (Ref. F2.57) of the data in their proprietary database on the distribution of fires by equipment type in all nuclear facilities of non-combustible construction. NFPA distinguishes between a large number of equipment types that can cause ignition of a fire. There is an insufficient amount of data to justify retaining this number of equipment types, so the equipment types were consolidated into a set of ignition source categories. These categories are defined in Appendix F.I.

Using the data by category, an analysis is performed to determine the fraction of fires that are caused by each category. That analysis is documented in Appendix F.II.

The total fire ignition frequency from Section F4.3.1 is multiplied by each of these factors to determine the total fire ignition frequency due to each equipment type. For example, the total ignition frequency due to electrical equipment for a given facility is:

$$f_{elec\text{-}all} = f_{fire} \times 0.086 \qquad \text{(Eq. F-3)}$$

#### F4.3.2.2 Individual Ignition Source Fire Ignition Frequency

The next step is to determine the fire ignition frequency from each piece of equipment in each category. As is done in NUREG/CR-6850 (Ref. F2.54) and (Ref. F2.55), and *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.58), divide the frequency contribution for each equipment type by the total number of pieces of equipment in the facility. For example, take 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 is:

$$f_{elec\text{-}each} = f_{elec\text{-}all} / 50 \quad \text{(Eq. F-4)}$$

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 is done 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 is:

$$f_{elec\text{-}1} = f_{elec\text{-}each} \times 6 \quad \text{(Eq. F-5)}$$

Doing this 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:

$$f_1 = f_{elec\text{-}1} + f_{hvac\text{-}1} + f_{\ldots\text{-}1} \quad \text{(Eq. F-6)}$$

### 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:

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

$P_{wz}$ = 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.

Note the specific phrasing. This probability pertains to each individual waste form (i.e., one of the approximately 11,000 waste forms that will be handled at YMP). For example, if each waste form that passes through the RF spends 60 minutes in the Cask Preparation Room, the probability that it is present when a fire occurs is 60 min/(50 yrs × 8,760 hrs/yr × 60 min/hr). This 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 will only be one case of interest, (i.e., there will be 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 will define 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; but if it spreads to adjacent rooms, 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 will be 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 are as follows:

- 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:

$$fier\text{-}i = Pwri\ [fi\ (FRa + (FRn \times (Ppc + Prc)) + (FRf \times Prc))] \qquad \text{(Eq. F-7)}$$

where

$f_{ier\text{-}I}$ = frequency of fire affecting waste form, i-th room
$P_{wri}$ = probability that a waste form is in the i-th room
$f_i$ = 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 (Ref. F2.57). The derivation of the values is provided in Appendix F.II for two cases (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

[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.

sources at, near, and far from the waste form was developed from equipment layout drawings such as *Receipt Facility General Arrangement Ground Floor Plan* (Ref. F2.21).

#### F4.4.2.2 Fire Propagation Beyond Rooms

This section provides propagation probabilities for fires spreading beyond the room in which they start. This type of propagation will be 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 are as follows:

- 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 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 is:

$$f_{ief\text{-}fj\text{-}ri} = f_i \times P_{fc} \qquad \text{(Eq. F-8)}$$

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 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 is:

$$f_{ief+\text{-}ri} = f_i \times (P_{fc} + P_{bc} + P_{b+c}) \qquad \text{(Eq. F-9)}$$

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.

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

### 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 over the 50-year preclosure period) times the probability that a waste form is present (fraction of time over the 50-year preclosure period per waste form). This yields the initiating event frequency for a fire of a specific severity affecting a waste form, per waste form processed, over the preclosure period.

# F5 ANALYSIS

## F5.1 INTRODUCTION

Fire initiating event frequencies have been calculated using Excel spreadsheets ("RF Fire Frequency_NoSuppression.xls" and "RF CB Report.xls" in Attachment H) for each fire initiating event identified for the RF. This section details the analysis performed to determine these frequencies, using the methodology documented in Section F4. The discussion of the analysis below presupposes that the reader has developed a thorough understanding of the details of that methodology, as those details are not repeated in this section. Note that 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 RF 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.

### F5.2.1 Room Area

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

- *Receipt Facility General Arrangement Ground Floor Plan* (Ref. F2.21)
- *Receipt Facility General Arrangement Second Floor Plan* (Ref. F2.22)
- *Receipt Facility General Arrangement Third Floor Plan* (Ref. F2.23).

In some cases, the dimension intervals shown on the general arrangement drawings matched the boundaries of the rooms. Where this was the case these values were used to define the dimensions of the rooms. In cases where these the dimension intervals did not accurately represent a room, the drawing scale and a straightedge was utilized 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 1002 and 2007 occupy two floors of building space. The area obtained for these rooms was doubled to account for this. Similarly, rooms 1017/1017A and 1028 occupy three floors of building space, and the area for these rooms was tripled. Rooms 1003E, 1017/1017A, 1028A, 1029, 1201A, 2029, and 3029 are not of a standard rectangular shape whose area can be calculated by a single length and width. Thus, these rooms were divided into two to three rectangles, each with a determined length and width. Addition of the area of these rectangles provides the total room area. Rooms 1005, 1018, 1019, 1020, 1221, 1223, 2005, and 2012 contain smaller room(s) within themselves. To account for this, the red text indicates a reference to the cells that contain the dimensions of the smaller room(s), the area of which is subtracted from the area of the room containing it. All areas calculated in square feet were multiplied by 0.09290304 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(sq-m) | L3 (ft) | L4(ft) | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1001 | 39 | 46 | 1794 | 167 | | | | | |
| 1002 | 43 | 46 | 3956 | 368 | *Area multiplied by two - Room extends two floors | | | | |
| 1003A | 6 | 71 | 426 | 40 | | | | | |
| 1003B | 82 | 10 | 820 | 76 | | | | | |
| 1003C | 82 | 7 | 574 | 53 | | | | | |
| 1003D | 84 | 18 | 1512 | 140 | | | | | |
| 1003E | 155.667 | 8 | 1429 | 133 | 8 | 23 | | | |
| 1003F | 10 | 72 | 720 | 67 | | | | | |
| 1003G | 6 | 80 | 480 | 45 | | | | | |
| 1004 | 51 | 55 | 2805 | 261 | | | | | |
| 1004A | 51 | 21 | 1071 | 99 | | | | | |
| 1005 | 38.66667 | 71 | 2529 | 235 | 24 | 9 | | | |
| 1005A | 24 | 9 | 216 | 20 | | | | | |
| 1011 | 35 | 30 | 1050 | 98 | | | | | |
| 1012 | 74 | 43 | 3182 | 296 | | | | | |
| 1013 | 41 | 46 | 1886 | 175 | | | | | |
| 1014 | 33 | 46 | 1518 | 141 | | | | | |
| 1015 | 41 | 41 | 1681 | 156 | | | | | |
| 1016 | 33 | 41 | 1353 | 126 | | | | | |
| 1017/1017A | 74 | 91 | 21452.34 | 1993 | 40.3334 | 31 | *Area multiplied by three (3 floors) | | |
| 1018 | 46 | 72 | 2760 | 256 | 46 | 12 | | | |
| 1018A | 46 | 12 | 552 | 51 | | | | | |
| 1019 | 50 | 72 | 2850 | 265 | 50 | 15 | | | |
| 1019A | 50 | 15 | 750 | 70 | | | | | |
| 1020 | 38.667 | 72 | 2550 | 237 | 26 | 9 | | | |
| 1020A | 26 | 9 | 234 | 22 | | | | | |
| 1021 | 40.3334 | 51 | 2057 | 191 | | | | | |
| 1021A | 47 | 80 | 3760 | 349 | | | | | |
| 1021B | 11 | 12 | 132 | 12 | | | | | |
| 1022 | 32 | 17 | 544 | 51 | | | | | |
| 1023 | 34 | 17 | 578 | 54 | | | | | |
| 1025 | 32 | 19 | 608 | 56 | | | | | |

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

| Room | L1(ft) | L2(ft) | A(sq-ft) | A(sq-m) | L3 (ft) | L4(ft) | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1026 | 33 | 13 | 429 | 40 | | | | | |
| 1027 | 13 | 25 | 325 | 30 | | | | | |
| 1028 | 18 | 15 | 810 | 75 | *Area multiplied by three - Room extends three floors | | | | |
| 1028A | 30 | 24 | 552 | 51 | 12 | 14 | | | |
| 1029 | 23 | 24 | 454 | 42 | 7 | 14 | | | |
| 1030 | 18 | 18 | 324 | 30 | | | | | |
| 1031 | 18 | 19 | 342 | 32 | | | | | |
| 1200 | 9 | 9 | 81 | 8 | | | | | |
| 1201A | 7 | 64 | 508 | 47 | 10 | 6 | | | |
| 1201B | 108 | 10 | 1080 | 100 | | | | | |
| 1202 | 15 | 15 | 225 | 21 | | | | | |
| 1203 | 20 | 25 | 500 | 46 | | | | | |
| 1204 | 15 | 25 | 375 | 35 | | | | | |
| 1205 | 10 | 9 | 90 | 8 | | | | | |
| 1206 | 15 | 26 | 390 | 36 | | | | | |
| 1207 | 23 | 32 | 736 | 68 | | | | | |
| 1208 | 16 | 34 | 544 | 51 | | | | | |
| 1209 | 17 | 34 | 578 | 54 | | | | | |
| 1210 | 18 | 34 | 612 | 57 | | | | | |
| 1211 | 11 | 34 | 374 | 35 | | | | | |
| 1212 | 35 | 12 | 420 | 39 | | | | | |
| 1212A | 10 | 8 | 80 | 7 | | | | | |
| 1213 | 8 | 17 | 136 | 13 | | | | | |
| 1214 | 8 | 17 | 136 | 13 | | | | | |
| 1215 | 19 | 17 | 323 | 30 | | | | | |
| 1216 | 10 | 17 | 170 | 16 | | | | | |
| 1217 | 45 | 9 | 405 | 38 | | | | | |
| 1218 | 13 | 17 | 221 | 21 | | | | | |
| 1219 | 13 | 17 | 221 | 21 | | | | | |
| 1220 | 20 | 17 | 340 | 32 | | | | | |
| 1221 | 18 | 34 | 522 | 48 | 10 | 9 | | | |
| 1222 | 9 | 5 | 45 | 4 | | | | | |
| 1223 | 16 | 26 | 371 | 34 | 9 | 5 | | | |

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

| Room | L1(ft) | L2(ft) | A(sq-ft) | A(sq-m) | L3 (ft) | L4(ft) | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1224 | 28 | 28 | 784 | 73 | | | | | |
| 2001 | 39 | 46 | 1794 | 167 | | | | | |
| 2002A | 9 | 82 | 738 | 69 | | | | | |
| 2002B | 142 | 10 | 1420 | 132 | | | | | |
| 2002C | 9 | 20 | 180 | 17 | | | | | |
| 2002D | 10 | 94 | 940 | 87 | | | | | |
| 2002E | 196 | 10 | 1960 | 182 | | | | | |
| 2002F | 9 | 72 | 648 | 60 | | | | | |
| 2002G | 9 | 20 | 180 | 17 | | | | | |
| 2003 | 50 | 72 | 3600 | 334 | | | | | |
| 2004 | 38.667 | 72 | 2784 | 259 | | | | | |
| 2005 | 52.333 | 72 | 3588 | 333 | 9 | 20 | | | |
| 2006 | 74 | 43 | 3182 | 296 | | | | | |
| 2007 | 74 | 105 | 15540 | 1444 | *Area multiplied by two - Room extends two floors | | | | |
| 2008 | 33 | 87 | 2871 | 267 | | | | | |
| 2009 | 46 | 72 | 3312 | 308 | | | | | |
| 2010 | 50 | 72 | 3600 | 334 | | | | | |
| 2011 | 38.667 | 72 | 2784 | 259 | | | | | |
| 2012 | 52.333 | 72 | 3588 | 333 | 9 | 20 | | | |
| 2022 | 32 | 18 | 576 | 54 | | | | | |
| 2023 | 34 | 17 | 578 | 54 | | | | | |
| 2025 | 31 | 19 | 589 | 55 | | | | | |
| 2026 | 31 | 14 | 434 | 40 | | | | | |
| 2027 | 15 | 27 | 405 | 38 | | | | | |
| 2029 | 23 | 24 | 454 | 42 | 7 | 14 | | | |
| 3001 | 20 | 13 | 260 | 24 | | | | | |
| 3026 | 31 | 14 | 434 | 40 | | | | | |
| 3029 | 23 | 24 | 454 | 42 | 7 | 14 | | | |
| | | | | | | | | | |
| Total Area (sq-m) | | | | 12842 | | 50% Value | | 97.5% Value | |
| Ignition Frequency (per sq-m/yr) | | | | 4.05E-06 | 4.05E-06 | 4.05E-06 | | 9.64E-06 | |
| Ignition Frequency (per yr) | | | | 5.20E-02 | | | | | |
| Ignition Frequency (50 years - preclosure period) | | | | 2.60E+00 | | | | | |

NOTE: The blank cells in this table are intentional and have been verified.
A = area; ft = foot; m = meter; sq = square.

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 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-2. 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 approximately four.

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 on the table. Refer to Appendix F.II for 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
- HVAC
- Mechanical equipment
- Heat generating equipment
- Torches, welders, and burners
- Internal combustion engines
- Office/kitchen equipment
- Portable 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 (50 years) implements the generic form of Equation F-3 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 is either 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-4 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 | 2.22E-01 | 157 | 1.42E-03 | | 0.086 | 0.086 | 0.086 | 1.26E-01 | 4.05E-02 |
| HVAC | 0.080 | 2.09E-01 | 36 | 5.79E-03 | | 0.080 | 0.080 | 0.080 | 1.20E-01 | 3.93E-02 |
| Mechanical Equipment | 0.139 | 3.62E-01 | 32 | 1.13E-02 | | 0.139 | 0.139 | 0.139 | 1.89E-01 | 5.01E-02 |
| Heat Generating Equipment | 0.155 | 4.03E-01 | 0 | 0.00E+00 | | 0.155 | 0.155 | 0.155 | 2.07E-01 | 5.24E-02 |
| Torches, welders, burners | 0.219 | 5.69E-01 | 440 | 1.29E-03 | | 0.219 | 0.219 | 0.219 | 2.79E-01 | 5.99E-02 |
| Internal combustion engines | 0.021 | 5.46E-02 | 200 | 2.73E-04 | | 0.021 | 0.021 | 0.021 | 4.23E-02 | 2.09E-02 |
| Office/kitchen equipment | 0.064 | 1.66E-01 | 10 | 1.66E-02 | | 0.064 | 0.064 | 0.064 | 9.97E-02 | 3.55E-02 |
| Portable Equipment | 0.102 | 2.65E-01 | 36 | 7.37E-03 | | 0.102 | 0.102 | 0.102 | 1.45E-01 | 4.37E-02 |
| No equipment involved | 0.134 | 3.48E-01 | 12842 | 2.71E-05 | | 0.134 | 0.134 | 0.134 | 1.83E-01 | 4.93E-02 |
| | 1.000 | 2.6E+00 | | | | 1.000 | | | | |

NOTE: The blank cells in this table are intentional and have been verified.
HVAC = heating, ventilation, and air conditioning.

Source: Original

As stated previously, these 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 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 sources of ignition.

## F5.4 IGNITION SOURCE DISTRIBUTION (EQUIPMENT LIST)

Compiling an initiating event frequency for the RF is dependant on identifying many characteristics of the building, to include ignition sources. Ignition sources are defined as items which 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 eight categories: electrical equipment; mechanical/electrical HVAC equipment; mechanical process equipment; heat generating process equipment; torches, welders and burners; internal combustion engines; office/kitchen equipment; and portable and special equipment. Once the grouping for a source is determined, it is assigned a count (points), a number which 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 RF. 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. The x-out information shows pieces of equipment that are in the room in question, but they do not count as ignition sources per the counting rules. The following sections describe how the equipment was identified, categorized, and counted for the building.

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

| 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 |
|---|---|---|---|---|---|---|---|---|
| 1001 (Site Transporter Vestibule) | | ~~2 Site Transporter Vestibule Fan coil units~~<br>~~200-VNI0-FCU-00003~~<br>~~200-VNI0-FCU-00004~~<br>~~3 HP (ea.)~~ | ~~Overhead Door~~<br>~~2 motors @ 3hp ea.~~ | | | **7% Site Transporter**<br>1002 & 1013<br>**7 points**<br>**200 hp diesel/elec.** | | |
| 1002 (Lid Bolting Room) | | | **Lid Bolting Rm. 10 ton Crane**<br>200-HMC0-CRN-00001<br>• **1 + 2 motors @ 25, 1.5, & 3 hp**<br>• **29.5 hp**<br>**Lid Bolting Platform**<br>200-HMC0-PLAT-00003<br>• **10 hp**<br>• **2 motors @ 5, & 5 hp**<br>~~Overhead Door~~<br>~~2 motors @ 3hp ea.~~ | | | **59% Site Transporter**<br>1001 & 1013<br>• **59 points**<br>• **200 hp diesel/elec.** | | |
| 1003A (Corridor) | | | | | | | | |
| 1003B (Corridor) | | | | | | | | |
| 1003C (Corridor) | | | | | | | | |
| 1003D (Corridor) | | | | | | | | |
| 1003E (Corridor) | | | | | | | | |
| 1003F (Corridor) | | | | | | | | |
| 1003G (Corridor) | | | | | | | | |
| 1003H (Utility Chase) | | | | | | | | |
| 1004 (HVAC Room) | | **Exhaust Fan**<br>200-VCT0-EXH-00005<br>• **1 Motor**<br>• **200 hp**<br>**3 HEPA Filter Units** (hp n/a)<br>200-VCT0-FLT-00005<br>200-VCT0-FLT-00006<br>200-VCT0-FLT-00007 | | | **Portable Welding Receptacle – WWF = 5 points** | | | **11.1% of all such equipment**<br>• **4 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 |
|---|---|---|---|---|---|---|---|---|
| 1004A (HVAC Room) | | **2 Exhaust Fans**<br>200-VCT0-EXH-00009<br>200-VCT0-EXH-00010<br>• **7.5 hp (ea.)**<br>**2 HEPA Filter Units** (hp n/a)<br>200-VCT0-FLT-00003<br>200-VCT0-FLT-00004 | | | | | | **5.6% of all such equipment**<br>• **2 points** |
| 1005 (Electrical Room) | **480 V Load Center**<br>200-EEE0-LC-00001<br>• **2 cabs**<br>**480 V MCC ITS**<br>200-EEE0-MCC-00001<br>• **10 cabs**<br>**1 480 V UPS ITS**<br>200-EEU0-UJX-00001<br>**1 45 kVA ITS Dist. Xfmr**<br>200-EEE0-XFMR-00003<br>**1 480 kVA ITS UPS**<br>200-EEE0-XFMR-00004<br>**1 40 kVA ITS Bypass Xfmr**<br>200-EEU0-XFMR-00001<br>**1 208/120 V Distribution Panel**<br>200-EEE0-PL-00003<br>**1 480/277 V ITS Lighting Panel**<br>200-EUL0-PL-00002<br>**1 208/120 V UPS Dist. Panel**<br>200-EEU0-PL-00001<br>**2 PLC Panels**<br>**2 DCMIS** | **2 Fan Coil Units**<br>200-VCT0-FCU-00001<br>200-VCT0-FCU-00002<br>• **20 hp (ea.)** | | | | | | |
| 1005A (Battery Room) | **1 125 V Battery**<br>**200-EEU0-BTRY-00001** | | | | | | | |
| 1011 (LLW Vestibule) | | ~~2 LLLW Entrance Vestibule Fan coil units~~<br>~~200-VNI0-FCU-00007~~<br>~~200-VNI0-FCU-00008~~<br>~~3 HP (ea.)~~ | ~~Overhead Door~~<br>~~1 motor @ 2hp~~ | | | | | |

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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 |
|---|---|---|---|---|---|---|---|---|
| 1012 (LLW Staging Room) | | ~~MP LLW Liquid Samp. Pump~~<br>~~200-MWL0-P-00001~~<br>~~0.5 hp~~<br><br>~~MP LLW Liquid Sump Pump~~<br>~~200-MWL0-P-00002~~<br>~~2 hp~~ | ~~Overhead Door~~<br><br>~~1 motor @ 2hp~~ | | **Portable Welding Receptacle – WWF = 5 points** | | | |
| 1013 (Loading Room) | | | **Shield Door**<br>200-RF00-DR-00002<br>**2 motors @ 7.5 & 7.5 hp** | | | **34% Site Transporter**<br>**1001 & 1002**<br>• **34 points**<br>**200 hp diesel/elec.** | | |
| 1014 (Maint. Room) | | | **2 Chilled Water Pumps**<br>200-PSC0-P-00001A<br>200-PSC0-P-00001B<br>• **1 motor (ea.)**<br>• **50 hp (ea.)**<br>**2 Hot Water Pumps**<br>200-PSH0-P-00001A<br>200-PSH0-P-00001B<br>• **1 motor (ea.)**<br>**15 hp** | | **Portable Welding Receptacle – WWF = 5 point** | | | |
| 1015 (Cask Unloading Room) | | | **Shield Door**<br>200-RF00-DR-00001<br>• **2 motors @ 7.5 hp**<br>• **15 hp**<br>**3% in 1015**<br>**Cask Transfer Trolley**<br>200-HM00-TRLY-00001<br>• **1 power drive x RWF 0.03**<br>• **5 hp**<br>Shared w/ room 1017 | | | | | **2.8% of all such equipment**<br>**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 |
|---|---|---|---|---|---|---|---|---|
| 1016 (CTM Maint. Room) | | | ~~Overhead Door~~<br>~~1 motor @ 2hp~~ | | | | | |
| 1017/1017A (Cask Preparation Room and Annex) | | | **Cask Handling Crane**<br>200-HM00-CRN-00001<br>• **4 motors @ 90, 45, 7.5, & 30 hp**<br>• **120 hp**<br>**Cask Preparation Platform**<br>200-HMH0-PLAT-00001<br>• **10 hp**<br>• **2 motors @ 5 hp ea**<br>**Mobile Access Platform**<br>200-HMC0-PLAT-00001<br>• **40 hp**<br>• **4 motors @ 1 hp**<br>• **4 motors @ 4 hp**<br>• **2 motors @ 10 hp**<br>**97% in 1017**<br>**Cask Transfer Trolley**<br>200-HM00-TRLY-00001<br>• **1 power drive x RWF 0.97**<br>• **5 hp**<br>Shared w/ room 1015<br>~~Cask Handling Yoke~~<br>~~200-HM00-BEAM-00001~~<br>~~2 hp~~ | | **Primary Welding Station**<br>**400 points** | **35% Site Prime Mover**<br>• **35 points**<br>**Split w/ rooms 1021 & 1021A** | | **11.1% of all such equipment**<br>**4 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 |
|---|---|---|---|---|---|---|---|---|
| 1018 (Electrical Room) | **480 V Load Center**<br>200-EEN0-LC-00001<br>• **6 cabs**<br>**480 V MCCs**<br>200-EEN0-MCC-00001<br>• **11 cabs**<br>200-EEN0-MCC-00002<br>• **14 cabs**<br>200-EEN0-MCC-00003<br>• **14 cabs**<br>200-EEN0-MCC-00004<br>• **8 cabs**<br>200-EEN0-MCC-00005<br>• **6 cabs**<br>200-EEN0-MCC-00006<br>• **7 cabs**<br>~~2 Xfmrs~~<br>~~200-EEN0-XFMR-00001~~<br>~~200-EEN0-XFMR-00002~~<br>~~• 13.8 kVA~~<br>~~• located outside~~<br>**1 480 V UPS**<br>200-EEP0-UJX-00001<br>**1 208/120 V UPS Panel**<br>200-EEP0-PL-00001<br>**2 75 kVA Distribution Xfmrs**<br>200-EEN0-XFMR-00003<br>200-EEN0-XFMR-00004<br>**1 480-208/120 V Bypass Xfmr**<br>200-EEP0-XFMR-00001<br>**2 208/120 V Distribution Panels**<br>200-EEN0-PL-00003<br>200-EEN0-PL-00004<br>**3 480/277 V Lighting Panels**<br>200-EUL0-PL-00001<br>200-EUL0-PL-00002<br>200-EUL0-PL-00006<br>**2 PLC Panels**<br>**2 DCMIS** | | | | **Portable Welding Receptacle – WWF = 5 points** | | | **5.6% of all such equipment**<br>**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 |
|---|---|---|---|---|---|---|---|---|
| 1018A (Battery Room) | 2 **125 V Batteries**<br>200-EEP0-BTRY-00001<br>200-EEP0-BTRY-00002 | | | | | | | |
| 1019 (HVAC Room) | | **Exhaust Fan**<br>200-VCT0-EXH-00006<br>• 1 **motor**<br>• **200 hp**<br>3 **HEPA Filter Units** (hp n/a)<br>200-VCT0-FLT-00008<br>200-VCT0-FLT-00009<br>200-VCT0-FLT-00010 | | | | | | **11.1% of all such equipment**<br>4 **points** |
| 1019A (HVAC Room) | | 2 **Exhaust Fans**<br>200-VCT0-EXH-00011<br>200-VCT0-EXH-00012<br>• **15 hp (ea.)**<br>2 **HEPA Filter Units** (HP n/a)<br>200-VCT0-FLT-00011<br>200-VCT0-FLT-00012 | | | | | | **5.6% of all such equipment**<br>2 **points** |
| 1020 (Electrical Room) | 1 **ITS Xfmr**<br>200-EEE0-XFMR-00002<br>• **13.8 kVA**<br>**480 V Load Center**<br>200-EEE0-LC-00002<br>• 2 **cabs**<br>**480 V ITS MCC**<br>200-EEE0-MCC-00002<br>• 10 **cabs**<br>1 **480 V ITS UPS**<br>200-EEU0-UJX-00002<br>1 **480 kVA ITS Dist. Xfmr**<br>200-EEE0-XFMR-00004<br>1 **40 kVA ITS Bypass Xfmr**<br>200-EEU0-XFMR-00002<br>1 **208/120 V Distribution Panel**<br>200-EEE0-PL-00004<br>1 **480/277 V ITS Lighting Panel**<br>200-EUL0-PL-00001-B<br>1 **208/120 V UPS Dist. Panel**<br>200-EEU0-PL-00002<br>2 **PLC Panels**<br>2 **DCMIS** | 2 **Fan coil units**<br>200-VCT0-FCU-00003<br>200-VCT0-FCU-00004<br>• **20 hp (ea.)** | | | | | | **5.6% of all such equipment**<br>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 |
|---|---|---|---|---|---|---|---|---|
| 1020A (Battery Room) | **1 125 V Battery**<br>200-EEU0-BTRY-00002 | | | | | | | |
| 1021 (Transport Cask Vestibule Annex) | | ~~2 Transportation Cask Vestibule Fan coil units~~<br>~~200-VNI0-FCU-00005~~<br>~~200-VNI0-FCU-00006~~<br>~~1.5 HP (ea.)~~ | **Overhead Door**<br>• **1 motor @ 5 hp** | | | **33% Site Prime Mover**<br>• **33 points**<br>**Split w/ rooms 1021A & 1017/1017A** | | |
| 1021A (Transport Cask Vestibule) | | **2 Transportation Cask Vest Fan Coil Units**<br>200-VNI0-FCU-00001<br>200-VNI0-FCU-00002<br>**7.5 hp (ea.)** | **2 Overhead Doors**<br>• **1 motor ea. @ 5 hp** | | | **32% Site Prime Mover**<br>• **32 points**<br>**Split w/ rooms 1021 & 1017/1017A** | | |
| 1021B (Personnel Vestibule) | | | | | | | | |
| 1022 (Stair #1) | | | | | | | | |
| 1023 (Stair #2) | | | | | | | | |
| 1025 (Stair #3) | | | | | | | | |
| 1026 (Stair #4) | | | | | | | | |
| 1027(Stair #5) | | | | | | | | |
| 1028 (Freight Elevator) | | | **7000 lb Freight Elevator**<br>• **50 kVA**<br>**1 motor** | | | | | |
| 1028A (Vestibule) | | | ~~Overhead Door~~<br>• ~~1 motor @ 2hp~~<br>~~Elevator Door~~<br>• ~~1 motor @ 2hp~~ | | | | | |
| 1029 (Elevator Lobby) | | | ~~Elevator Door~~<br>• ~~1 motor @ 2hp~~ | | | | | |
| 1030 (Fire Water Rinser Valve #1) | | | | | | | | |
| 1031 (Fire Water Rinser Valve #2) | | | | | | | | |
| 1200 (Entry/Exit Vestibule) | | | | | | | | |
| 1201A (Entry Lobby) | | | | | | | | |
| 1201B (Corridor) | | | | | | | | |
| 1202 (Security Post) | | | | | | | | |
| 1203 (RA Control Post) | | | | | | | | |

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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 |
|---|---|---|---|---|---|---|---|---|
| 1204 (Men's Locker) | | ~~1 Exhaust Fan~~ ~~200-VNI0-EXH-00002~~ • ~~0.5 HP (ea.)~~ | | | | | | |
| 1205 (RA Exit Vestibule) | | | | | | | | |
| 1206 (Women's Locker) | | ~~1 Exhaust Fan~~ ~~200-VNI0-EXH-00003~~ ~~0.5 HP (ea.)~~ | | | | | | |
| 1207 (Operations Room) | | | | | | | **10% of all such equipment 1 point** | |
| 1208 (Communications Rm.) | **6 Equipment Racks** | | | | | | **10% of all such equipment 1 point** | |
| 1209 (RP Staff Work Room) | | | | | | | **20% of all such equipment 2 points** | |
| 1210 (Briefing/ Break Rm.) | | | | | | | **20% of all such equipment 2 points** | |
| 1211 (Janitor Closet) | | ~~1 Exhaust Fan~~ ~~200-VNI0-EXH-00001~~ ~~0.5 HP (ea.)~~ | | | | | | |
| 1212 (RP Gear Supply Room) | | | | | | | **10% of all such equipment 1 point** | |
| 1212A (RA Entrance Vestibule) | | | | | | | | |
| 1213 (Change Room 1) | | | | | | | | |
| 1214 (Change Room 2) | | | | | | | | |
| 1215 (RP Equipment Room) | | | | | | | | |
| 1216 (Respirator Room) | | | | | | | | |
| 1217 (Corridor) | | | | | | | | |
| 1218 (RP Lab / Count Room) | | | | | | | **10% of all such equipment 1 point** | |
| 1219 (RP Lab/Sample Prep Rm.) | | | | | | | **10% of all such equipment 1 point** | |
| 1220 (Decon Room) | | | | | | | **10% of all such equipment 1 point** | |
| 1221 (RA Exit/PCM 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 |
|---|---|---|---|---|---|---|---|---|
| 1222 (Janitor Closet) | | | | | | | | |
| 1223 (Gas Sampling Room) | | | **Cask Cavity Gas Sample System**<br>200-MRE0-DET-00001<br>• **1 motor** | | | | | |
| 1224 (RP Instrument Room) | | | | | | | | |
| 2001 (Ops/Maint. Storage Room) | | | | | | | | |
| 2002A (Corridor) | | | | | | | | |
| 2002B (Corridor) | | | | | | | | |
| 2002C (Corridor) | | | | | | | | |
| 2002D (Corridor) | | | | | | | | |
| 2002E (Corridor) | | | | | | | | |
| 2002F (Corridor) | | | | | | | | |
| 2002G (Corridor) | | | | | | | | |
| 2003 (HVAC Room) | | **2 Air Handling Units**<br>200-VCT0-AHU-00001<br>200-VCT0-AHU-00002<br>• **125 hp (ea.)** | | | **Portable Welding Receptacle – WWF = 5 point** | | | **5.6% of all such eq.**<br>**2 points** |
| 2004 (HVAC Room) | | **1 Air Handling Unit**<br>200-VCT0-AHU-00003<br>• **125 hp** | | | | | | **5.6% of all such eq.**<br>**2 points** |
| 2005 (Instrument and Elec. Shop) | | | | | **Portable Welding Receptacle – WWF = 5 point** | | | |
| 2006 (HVAC Room) | | **3 Exhaust Fans**<br>200-VCT0-EXH-00001<br>200-VCT0-EXH-00002<br>200-VCT0-EXH-00013<br>• **75 hp (ea.)**<br>**3 HEPA Filter Units** (hp n/a)<br>200-VCT0-FLT-00001<br>200-VCT0-FLT-00002<br>200-VCT0-FLT-00013 | | | | | | **5.6% of all such eq.**<br>**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 |
|---|---|---|---|---|---|---|---|---|
| 2007 (Canister Transfer Room) | | | **CTM Maintenance Crane**<br>200-HTC0-CRN-00001<br>• **44.5 hp**<br>• **2 + 1 motors @ 35, 2, & 7.5 hp**<br>• **62. kVA**<br>**Canister Trans. Machine**<br>200-HTC0-FHM-00001<br>• **120.5 hp**<br>• **5 + 1 motors @ 45, 3, 7.5, 7.5, 60, & 5 hp**<br>• **133kVA (ea.)**<br>~~AO/STC Port Slide Gate~~<br>~~200-HTC0-HTCH-00002~~<br>~~2 motors @ 0.5 hp~~<br>~~Cask Port Slide Gate~~<br>~~200-HTC0-HTCH-00001~~<br>~~2 motors @ 0.5 hp~~ | | | | | **2.8% of all such eq.**<br>**1 point** |
| 2008 (HVAC Room) | | **2 Air Handling Units**<br>200-VNI0-AHU-00001<br>200-VNI0-AHU-00002<br>• **40 hp (supply)**<br>• **20 hp (return)** | | | | | | **5.6% of all such eq.**<br>**2 points** |
| 2009 (HVAC Room) | | **1 Air Handling Unit**<br>200-VCT0-AHU-00004<br>• **100 hp** | | | | | | **5.6% of all such eq.**<br>**2 points** |
| 2010 (HVAC Room) | | **2 Air Handling Units**<br>200-VCT0-AHU-00005<br>200-VCT0-AHU-00006<br>• **100 hp (ea.)** | | | **Portable Welding Receptacle – WWF = 5 points** | | | **5.6% of all such eq.**<br>**2 points** |
| 2011 (HVAC Room) | | | | | | | | **5.6% of all such eq.**<br>**2 points** |
| 2012 (Receiver / Dryer Equipment Room) | **480 V Load Center**<br>200-EEN0-LC-00002<br>• **5 cabs**<br>**480 V MCCs**<br>200-EEN0-MCC-00007<br>• **6 cabs**<br>200-EEN0-MCC-00008<br>• **7 cabs**<br>**1 480 kVA Distribution Xfmr**<br>200-EEN0-XFMR-00005<br>**1 208/120 V Distribution Panel**<br>200-EEN0-PL-00005<br>**1 480/277 V Lighting Panels**<br>200-EUL0-PL-00007 | | | | **Portable Welding Receptacle – WWF = 5 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 |
|---|---|---|---|---|---|---|---|---|
| 2022 (Stair #1) | | | | | | | | |
| 2023 (Stair #2) | | | | | | | | |
| 2025 (Stair #3) | | | | | | | | |
| 2026 (Stair #4) | | | | | | | | |
| 2027 (Stair #5) | | | | | | | | |
| 2029 (Elevator Lobby) | | | ~~Elevator Door 1 motor @ 2hp~~ | | | | | |
| 3001 (Corridor) | | | | | | | | |
| 3026 (Stair #4) | | | | | | | | |
| 3029 (Elevator Lobby) | | | ~~Elevator Door 1 motor @ 2hp~~ | | | | | |

NOTE: [1]The equipment shown shaded in grey 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 5 hp.
[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.
The blank cells in this table are intentional and have been verified.
cabs = cabinet; DCIMS = digital control and management information system; Dist. = distribution; HEPA = high-efficiency particulate air (filter); hp = horsepower; HVAC = heating, ventilation, and air conditioning; ITS = important to safety; kVA = kilovolt amperes; LLW = low-level radioactive waste; MCC = motor control center; PLC = programmable logic controller; RA = radiological access; RP = radiological protection; RWF = residence weighting factor; UPS = uninterruptable power supply; V = volt; WWF = welding weighting factor; 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 layout drawings:

*Receipt Facility General Arrangement Ground Floor Plan* (Ref. F2.21)

*Receipt Facility General Arrangement Second Floor Plan* (Ref. F2.22)

*Receipt Facility 480V Load Center 200-EEN0-LC-00001 Single Line Diagram* (Ref. F2.43)

*Receipt Facility 480V MCC 200-EEN0-MCC-00001 Single Line Diagra*m (Ref. F2. 45)

*Receipt Facility 480V MCC 200-EEN0-MCC-00002 Single Line Diagram* (Ref. F2.46)

*Receipt Facility 480V MCC 200-EEN0-MCC-00003 Single Line Diagram* (Ref. F2.47)

*Receipt Facility 480V MCC 200-EEN0-MCC-00004 Single Line Diagram* (Ref. F2.48)

*Receipt Facility 480V ITS MCC Train A 200-EEE0-MCC-00001 Single Line Diagram* (Ref. F2.39)

*Receipt Facility 480V ITS MCC Train B MCC 200-EEE0-MCC-00002 Single Line Diagram* (Ref. F2.40)

*Receipt Facility ITS UPS Train A 200-EEU0-UJX-00001 Single Line Diagram* (Ref. F2.30)

*Receipt Facility ITS UPS Train B 200-EEU0-UJX-00002 Single Line Diagram* (Ref. F2.31)

*Receipt Facility UPS 200-EEP0-UJX-00001 Single Line Diagram* (Ref. F2.32).

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 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:

*Receipt Facility Composite Vent Flow Diagram Tertiary Confinement Non-ITS HVAC Supply Sys & ITS Exhaust* (Ref. F2.13)

*Receipt Facility Composite Vent Flow Diagram Tertiary Confinement Non-ITS HVAC Supply & Exhaust System* (Ref. F2.12)

*Receipt Facility Composite Vent Flow Diagram Tertiary Conf ITS HVAC Systems, Elect & Battery RMS* (Ref. F2.11)

*Receipt Facility Composite Vent Flow Diagram Non-Confinement Non-ITS HVAC Sys Support & Operations* (Ref. F2.10)

*Receipt Facility ITS Confinement Areas HEPA Exhaust System – Train A Ventilation & Instrumentation Diagram* (Ref. F2.27)

*Receipt Facility ITS Confinement Areas HEPA Exhaust System – Train B Ventilation & Instrumentation Diagram* (Ref. F2.28)

*Receipt Facility ITS Confinement Areas HVAC Supply System Ventilation & Instrumentation Diagram* (Ref. F2.29)

*Receipt Facility Confinement South Areas HVAC Supply System Ventilation & Instrumentation Diagram* (Ref. F2.19)

*Receipt Facility Confinement Non-ITS HEPA Exhaust System Ventilation & Instrumentation Diagram* (Ref. F2.18)

*Receipt Facility Confinement 2$^{nd}$ Floor North Areas HVAC Supply System Ventilation & Instrumentation Diagram* (Ref. F2.20)

*Receipt Facility Confinement ITS Electrical Room HVAC System – Train A Ventilation & Instrumentation Diagram* (Ref. F2.16)

*Receipt Facility Confinement ITS Battery Room Exhaust System – Train A Ventilation & Instrumentation Diagram* (Ref. F2.14)

*Receipt Facility Confinement ITS Electrical Room HVAC System – Train B Ventilation & Instrumentation Diagram* (Ref. F2.17)

*Receipt Facility Confinement ITS Battery Room Exhaust System – Train B Ventilation & Instrumentation Diagram* (Ref. F2.15)

*Receipt Facility Non-Confinement Areas HVAC Supply System Ventilation & Instrumentation Diagram* (Ref. F2.34)

*Receipt Facility Transportation Cask Vestibule Non-Confinement HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.38)

*Receipt Facility Site Transporter Vestibule Non-Confinement HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.37)

*Receipt Facility Site Transp Cask Vestibule Annex Non-Confinement HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.36)

*Receipt Facility LLW Vestibule Non-Confinement HVAC System Ventilation & Instrumentation Diagram* (Ref. F2.33).

HVAC equipment consists of HEPA filters, exhaust fans, air handling units, fan coil units, and sump pumps. Because any motor with a horsepower rating 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 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 piping and instrument diagram (P&ID) drawings.

*Receipt Facility General Arrangement Ground Floor Plan* (Ref. F2.21)

*Receipt Facility General Arrangement Second Floor Plan* (Ref. F2.22)

*Receipt Facility General Arrangement Third Floor Plan* (Ref. F2.23)

*Equipment Motor Horsepower and Electrical Requirements Analysis* (Ref. F2.4)

*CRCF, RF, WHF, and IHF Cask Transfer Trolley Process and Instrumentation Diagram* (Ref. F2.3)

*Receipt Facility Chilled Water System Piping & Instrument. Diagram* (Ref. F2.7)

*Receipt Facility Chilled Water System Piping & Instrument. Diagram* (Ref. F2.8)

*Receipt Facility Chilled Water System Piping & Instrument. Diagram* (Ref. F2.9)

*Receipt Facility Hot Water System Piping & Instrument. Diagram* (Ref. F2.24)

*Receipt Facility Hot Water System Piping & Instrument. Diagram* (Ref. F2.25)

*Receipt Facility Hot Water System Piping & Instrument. Diagram* (Ref. F2.26)

*Receipt Facility Cask Cavity Gas Sampling System Piping & Instrument. Diagram* (Ref. F2.6).

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 (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. F2.5). The cask transfer trolley (CTT) was identified as the only piece of mobile equipment that occupies more than one room.

The total time the CTT spends in the Cask Unloading Room (1015) is calculated from the following procedures identified in the process throughput:

- 1.3.13 Move transportation cask into Cask Unloading Room – 20 minutes
- 2.1 Move TAD canister To aging overpack – 243 minutes
- 1.6.1 Move transportation cask into Cask Preparation Room – 20 minutes

The total time the CTT spends in the Cask Preparation Room (1017) is calculated by subtracting the total amount of time the CTT will be in room 1015 from the total time of the procedure (8,345 minutes).

The times 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 require repair. 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 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 RF, which provide the entire contribution of fire ignition to the internal combustion engines category. The site transporter and site prime mover 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 1001 (Site Transporter Vestibule), 1002 (Lid Bolting Room), and 1013 (Loading Room). The times necessary to determine the percentage of time the site transporter spends in each room are given in sections 1.4, 2.1, and 1.5 of the RF process throughput diagram. There are a total of 68 minutes that are assigned to two rooms because the doors between them are open. Resultant times are 56 minutes in the Site Transporter Vestibule (1001), 486 minutes in the Lid Bolting Room (1002), and 283 minutes in the Loading Room (1013).

The site prime mover/tractor occupies rooms 1017/1017A (Cask Preparation Room), 1021 (Transportation Cask Vestibule Annex), and 1021A (Transportation Cask Vestibule). The times necessary to determine the percentage of time the prime mover/tractor spends in each room are given in Section 1.1.1 of the RF process throughput diagram. There are 36 total minutes that are assigned to two or more rooms because the doors between them are open. Resultant times are 38 minutes in the Transportation Cask Vestibule (1021A), 36 minutes in the Transportation Cask Vestibule Annex (1021), and 40 minutes in the Cask Preparation Room (1017/1017A).

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.

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 two 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.

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 (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 F5.5-1 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 column entitled A (sq-m).

The final column on Table F5.5-1, entitled "Room Ignition Frequency," implements the generic forms of equations F-5 and F-6. 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-5, the number of units in each category (green text) is multiplied by the corresponding frequency per unit for that category. Per Equation F-6, 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 RF 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 RF.

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 | | | | | | 7 | | | 167 | 6.4E-03 |
| 1002 | | | 3 | | | 59 | | | 368 | 6.0E-02 |
| 1003A | | | | | | | | | 40 | 1.1E-03 |
| 1003B | | | | | | | | | 76 | 2.1E-03 |
| 1003C | | | | | | | | | 53 | 1.4E-03 |
| 1003D | | | | | | | | | 140 | 3.8E-03 |
| 1003E | | | | | | | | | 133 | 3.6E-03 |
| 1003F | | | | | | | | | 67 | 1.8E-03 |
| 1003G | | | | | | | | | 45 | 1.2E-03 |
| 1004 | | 4 | | | 5 | | | 4 | 261 | 6.6E-02 |
| 1004A | | 4 | | | | | | 2 | 99 | 4.1E-02 |
| 1005 | 23 | 2 | | | | | | | 235 | 5.1E-02 |
| 1005A | 1 | | | | | | | | 20 | 2.0E-03 |
| 1011 | | | | | | | | | 98 | 2.6E-03 |
| 1012 | | | | | 5 | | | | 296 | 1.4E-02 |
| 1013 | | | 2 | | | 34 | | | 175 | 3.7E-02 |
| 1014 | | | 4 | | 5 | | | | 141 | 5.5E-02 |
| 1015 | | | 2.03 | | | | | 1 | 156 | 3.5E-02 |
| 1016 | | | | | | | | | 126 | 3.4E-03 |
| 1017/1017A | | | 8.97 | | 400 | 35 | | 4 | 1993 | 7.1E-01 |
| 1018 | 80 | | | | 5 | | | 2 | 256 | 1.4E-01 |
| 1018A | 2 | | | | | | | | 51 | 4.2E-03 |
| 1019 | | 4 | | | | | | 4 | 265 | 6.0E-02 |
| 1019A | | 4 | | | | | | 2 | 70 | 4.0E-02 |
| 1020 | 23 | 2 | | | | | | 2 | 237 | 6.5E-02 |
| 1020A | 1 | | | | | | | | 22 | 2.0E-03 |
| 1021 | | | 1 | | | 33 | | | 191 | 2.5E-02 |
| 1021A | | 2 | 2 | | | 32 | | | 349 | 5.2E-02 |
| 1021B | | | | | | | | | 12 | 3.3E-04 |
| 1022 | | | | | | | | | 51 | 1.4E-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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1023 | | | | | | | | | 54 | 1.5E-03 |
| 1025 | | | | | | | | | 56 | 1.5E-03 |
| 1026 | | | | | | | | | 40 | 1.1E-03 |
| 1027 | | | | | | | | | 30 | 8.2E-04 |
| 1028 | | | 1 | | | | | | 75 | 1.3E-02 |
| 1028A | | | | | | | | | 51 | 1.4E-03 |
| 1029 | | | | | | | | | 42 | 1.1E-03 |
| 1030 | | | | | | | | | 30 | 8.2E-04 |
| 1031 | | | | | | | | | 32 | 8.6E-04 |
| 1200 | | | | | | | | | 8 | 2.0E-04 |
| 1201A | | | | | | | | | 47 | 1.3E-03 |
| 1201B | | | | | | | | | 100 | 2.7E-03 |
| 1202 | | | | | | | | | 21 | 5.7E-04 |
| 1203 | | | | | | | | | 46 | 1.3E-03 |
| 1204 | | | | | | | | | 35 | 9.5E-04 |
| 1205 | | | | | | | | | 8 | 2.3E-04 |
| 1206 | | | | | | | | | 36 | 9.8E-04 |
| 1207 | | | | | | | 1 | | 68 | 1.8E-02 |
| 1208 | 6 | | | | | | 1 | | 51 | 2.7E-02 |
| 1209 | | | | | | | 2 | | 54 | 3.5E-02 |
| 1210 | | | | | | | 2 | | 57 | 3.5E-02 |
| 1211 | | | | | | | | | 35 | 9.4E-04 |
| 1212 | | | | | | | 1 | | 39 | 1.8E-02 |
| 1212A | | | | | | | | | 7 | 2.0E-04 |
| 1213 | | | | | | | | | 13 | 3.4E-04 |
| 1214 | | | | | | | | | 13 | 3.4E-04 |
| 1215 | | | | | | | | | 30 | 8.1E-04 |
| 1216 | | | | | | | | | 16 | 4.3E-04 |
| 1217 | | | | | | | | | 38 | 1.0E-03 |
| 1218 | | | | | | | 1 | | 21 | 1.7E-02 |
| 1219 | | | | | | | 1 | | 21 | 1.7E-02 |
| 1220 | | | | | | | 1 | | 32 | 1.7E-02 |
| 1221 | | | | | | | | | 48 | 1.3E-03 |
| 1222 | | | | | | | | | 4 | 1.1E-04 |

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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1223 | | | 1 | | | | | | 34 | 1.2E-02 |
| 1224 | | | | | | | | | 73 | 2.0E-03 |
| 2001 | | | | | | | | | 167 | 4.5E-03 |
| 2002A | | | | | | | | | 69 | 1.9E-03 |
| 2002B | | | | | | | | | 132 | 3.6E-03 |
| 2002C | | | | | | | | | 17 | 4.5E-04 |
| 2002D | | | | | | | | | 87 | 2.4E-03 |
| 2002E | | | | | | | | | 182 | 4.9E-03 |
| 2002F | | | | | | | | | 60 | 1.6E-03 |
| 2002G | | | | | | | | | 17 | 4.5E-04 |
| 2003 | | 2 | | | 5 | | | 2 | 334 | 4.2E-02 |
| 2004 | | 1 | | | | | | 2 | 259 | 2.8E-02 |
| 2005 | | | | | 5 | | | | 333 | 1.6E-02 |
| 2006 | | 6 | | | | | | 2 | 296 | 5.8E-02 |
| 2007 | | | 7 | | | | | 1 | 1444 | 1.3E-01 |
| 2008 | | 2 | | | | | | 2 | 267 | 3.4E-02 |
| 2009 | | 1 | | | | | | 2 | 308 | 2.9E-02 |
| 2010 | | 2 | | | 5 | | | 2 | 334 | 4.2E-02 |
| 2011 | | | | | | | | 2 | 259 | 2.2E-02 |
| 2012 | 21 | | | | 5 | | | | 333 | 4.5E-02 |
| 2022 | | | | | | | | | 54 | 1.5E-03 |
| 2023 | | | | | | | | | 54 | 1.5E-03 |
| 2025 | | | | | | | | | 55 | 1.5E-03 |
| 2026 | | | | | | | | | 40 | 1.1E-03 |
| 2027 | | | | | | | | | 38 | 1.0E-03 |
| 2029 | | | | | | | | | 42 | 1.1E-03 |
| 3001 | | | | | | | | | 24 | 6.6E-04 |
| 3026 | | | | | | | | | 40 | 1.1E-03 |
| 3029 | | | | | | | | | 42 | 1.1E-03 |
| | | | | | | | | | | |
| TOTAL | 157 | 36 | 32 | 0 | 440 | 200 | 10 | 36 | | 2.2E+00 |

NOTE: The blank cells in this table are intentional and have been verified.
HVAC = heating, ventilation, and air conditioning.

Source: Original