ATTACHMENT F
SUBSURFACE FIRE ANALYSIS

F1 INTRODUCTION

This attachment describes the work scope, definitions and terms, method, and results for the fire analysis performed as a part of the Yucca Mountain Project (YMP) preclosure safety analysis (PCSA). Fire analysis is divided into four major areas:

1. Initiating event identification
2. Initiating event quantification (including both ignition frequency and propagation probability)
3. Fragility analysis (including convolution of fragility and hazard curves)
4. Fire analysis model development and quantification.

Within the task, the internal events PCSA model is evaluated with respect to fire initiating events and modified as necessary to address fire-induced failures that lead to exposures. The lists of fire-induced failures that are included in the model are evaluated as to fire vulnerability, and fragility analyses are conducted as needed.

F2 REFERENCES

Design Inputs

The PCSA is based on a snapshot of the design. The reference design documents are appropriately documented as design inputs in this section. Since the safety analysis is based on a snapshot of the design, referencing subsequent revisions to the design documents (as described in EG-PRO-3DP-G04B-00037, *Calculations and Analyses* (Ref. 2.1.1, Section 3.2.2.F)) that implement PCSA requirements flowing from the safety analysis would not be appropriate for the purpose of the PCSA.

The inputs in this section noted with an asterisk (*) fall into one of the designated categories described in Section 4.1, relative to suitability for intended use.

F2.1 *ASME RA-S-2002. *Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications*. New York, New York: American Society of Mechanical Engineers. TIC: 255508. ISBN: 0-7918-2745-3.

F2.2 *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.

F2.3 *EPRI (Electric Power Research Institute) and NRC (U.S. Nuclear Regulatory Commission) 2005. *Summary & Overview*. Volume 1 of *EPRI/NRC-RES Fire PRA*

Methodology for Nuclear Power Facilities. EPRI-1011989 and NUREG/CR-6850. Palo Alto, California: Electric Power Research Institute. ACC: MOL.20070323.0061.

F2.4 *EPRI and NRC 2005. *Detailed Methodology. Volume 2 of EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities*. EPRI TR-1011989 and NUREG/CR-6850. Palo Alto, California: Electric Power Research Institute. ACC: MOL.20070323.0062.

F2.5 *ANSI/ANS-58.23-2007. *Fire PRA Methodology*. La Grange Park, Illinois: American Nuclear Society. TIC: 259894.

F2.6 BSC (Bechtel SAIC Company) 2008. *Subsurface Operations Event Sequence Development Analysis*. 000-PSA-MGR0-00400-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080214.0004.

F2.7 *U.S. Census Bureau 2000. "Manufacturing United States." *1997 Economic Census: Summary Statistics for the United States.* Washington, D.C.: U.S. Census Bureau. Accessed March 7, 2008. ACC: MOL.20080310.0082. URL: http://www.census.gov/epcd/ec97/ustotals.htm.

F2.8 *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.

F2.9 *Nevada State Fire Marshal 2007. *2006 Annual Fire Statistics Report, National Fire Incident Reporting System (NFIRS).* Carson City, Nevada: Nevada Department of Public Safety. ACC: MOL.20070718.0052.

F2.10 *Amico, P.J. 2007. "Re: NFPA Correspondence." E-mail from P.J. Amico to J. Lorenz, December 3, 2007, with attachment. ACC: MOL.20071211.0227; MOL.20071211.0228.

F2.11 BSC 2007. *Waste Form Throughputs for Preclosure Safety Analysis*. 000-PSA-MGR0-01800-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071106.0001.

F3 BOUNDARY CONDITIONS

F3.1 INTRODUCTION

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

F3.1.1 Plant Operational State

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

F3.1.2 Number of Fire Events 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.

F3.1.3 Relationship to Process Buildings

Subsurface fires occur outside of the main process buildings. With regard to the frequency of such fires based on historical fire ignition frequencies from other facilities, the fire frequency across the site is proportional to the number of main process buildings on the site. That is, the number of opportunities for fires outside buildings is affected by the number of main process buildings being serviced. The number of main process buildings at YMP is six (Initial Handling Facility, Receipt Facility, Wet Handling Facility and three Canister Receipt and Closure Facilities).

F3.1.4 Irrelevancy of Industrial Facility Type to Outside Fire Frequency

The frequency of outside fires at YMP is expected to be similar to those from other industrial facilities. The specific type of facility, the type of construction of the buildings, and other features are not considered relevant to the frequency of outside fires since the ignition sources that exist outside of the buildings are considered to be generic to any industrial facility. This does not extend to the assessment of fire severity, since the type of facility could affect the type and availability of combustibles. Fire severity is addressed in Attachment D, and as such is not relevant here.

F3.1.5 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 (1) the probability of two simultaneous initiating events within the time span is small and (2) each initiating event will cause operations of the waste handling facility to cease, which further reduces the conditional probability of the occurrence of a second initiating event, given the first has occurred.

F3.1.6 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.

F3.1.7 Component Failure Probability

Fires large enough to fail waste containment components are large enough to fail all active components in the immediate vicinity. Active components fail in a de-energized state for such fires.

F3.1.8 Internal Events PCSA 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 (PRA) *Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications* (Ref. F2.1).

F4 ANALYSIS METHOD

F4.1 INTRODUCTION

The general methodological basis of this analysis is the *Chemical Agent Disposal Facility Fire Hazard Assessment Methodology* (Ref. F2.2). Chemical agent disposal facilities are similar to those in the geologic repository operations area in that these facilities are handling and disposal facilities for highly hazardous materials and so the analysis of fires in those facilities have similar issues and needs. This is a "data based" approach because it utilizes actual historical experience of 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. F2.3) and (Ref. F2.4) is also considered in the development of this analysis method. The method complies with the applicable requirements of the American Nuclear Society fire PRA standard (Ref. F2.5) that are 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 OUTSIDE FIRE INITIATING EVENTS

Outside fire initiating events at YMP are considered for 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 this potential. The initiating events for subsurface operations were identified in *Subsurface Operations Event Sequence Development Analysis* (Ref. F2.6). The steps of the fire analysis are provided in the following sections.

F4.2.1 Identify Areas On-Site Where Waste Forms Can Be Present

The processes for the movement of waste forms on site, while outside of buildings, are evaluated and the areas where the waste forms either sit or traverse are identified. Each area where waste can be present, even if only for a brief time, is listed.

F4.2.2 Correlate These Areas with NFPA Historical Database for Outside Fires

The National Fire Protection Association (NFPA) historical database (Ref. F2.8) identifies the areas outside buildings where fires have occurred. These have been grouped into broader categories for use in this study. These groupings are shown in Table F4.2-1.

Table F4.2-1. Outside Fire Area Categories

Area
Storage areas[a] – To include all areas where products are held while awaiting process, shipment, or use
Receiving areas[b] – To include all areas where products are moved into or out of a building while onsite but are still outside the building
Trash/rubbish areas
Areas containing equipment[c] – To include all areas outside the building that contain operating process, HVAC, maintenance, or other machinery and equipment
Open areas[d] – To include fields, roads, and right of ways
Vehicles[e]
Other – Primarily applies to exterior structural areas of buildings

NOTE: [a]The sum of the following NFPA areas are (1) product storage area, tank, or bin, (2) unclassified storage area, and (3) supply storage room or area.
[b]The sum of the following NFPA areas are (1) shipping, receiving, or loading area, (2) court, terrace, or patio, and (3) conveyor.
[c]The sum of the following NFPA areas are (1) process or manufacturing area, (2) unclassified service or equipment area, (3) heating equipment room or area, (4) incinerator room or area, (5) unclassified service facility, (6) machinery room or area, and (7) maintenance shop or area.
[d]The sum of the following NFPA areas are (1) lawn, field, or open areas, (2) railroad right of way or embankment, and (3) highway, public right of way, or street.
[e]The sum of the following NFPA areas are (1) engine, wheel, or running area of vehicle, (2) exterior surface of vehicle, (3) truck or load-carrying area of vehicle, and (4) unclassified vehicle area.
HVAC = heating, ventilation, and air conditioning; NFPA = National Fire Protection Association.

Source: Original

F4.2.3 Define Initiating Events

Fire ignition occurrences are identified for each outside area where a waste form can be present.

F4.3 QUANTIFICATION OF FIRE IGNITION FREQUENCY

In order to assess the total fire frequency, two pieces of information are required: the number of facilities and the number of fires at these facilities. The first piece of data is maintained by the U.S. Census Bureau, which conducts an economic census (Ref. F2.7). The second piece of data is tracked by NFPA. This approach uses historical data over a 10-year period (1988 to 1997) from these databases. Specifically, the fire data used in this report were taken from a report authored by the NFPA – Division of Fire Analysis and Research: *Fires in or at Industrial Chemical, Hazardous Chemical and Plastic Manufacturing Facilities, 1988-1997 Unallocated Annual Averages and Narratives* (Ref. F2.8)[1] These data are used to develop estimates for the total frequency of fires and the distribution of fires on the grounds of the facility.

The primary source of data on the number of fires is the National Fire Incident Reporting System (NFIRS) (Ref. F2.9), which is jointly administered by the Federal Emergency Management Agency (FEMA) and NFPA. NFIRS provides annual computerized databases of fire incidents. The NFIRS is a voluntary program wherein individual fire departments complete data forms and submit them through their state NFIRS coordinator to FEMA/NFPA. Because it is a voluntary

[1] As stated in the boundary conditions, the type of facility is considered to be irrelevant to the frequency of ignition of outside fires.

program, it is recognized that the NFIRS database only captures about one-third to one-half of all U.S. fires each year. Projecting the NFIRS results develops NFPA's national fire estimates. To project the NFIRS results, at least an estimate of the NFIRS fires as a fraction of the total is needed. However, the NFIRS data do not provide any information on the total population from which the data are collected, nor do they address the nonuniformity of the data due to the voluntary collection methods used. To address the limitations of the NFIRS data, and to extend the NFIRS data to provide a more complete analysis of the U.S. fire problem, the NFPA conducts an additional annual survey to augment the FEMA/NFIRS program.

The NFPA survey is based on a stratified random sample of roughly 3,000 (of 30,000) U.S. fire departments. The survey is stratified by the population size (i.e., the number of people protected by the department) to reduce the uncertainty of the final estimates. Small rural communities protect fewer people and are less likely to respond, so a large number are surveyed to obtain an adequate sample. Large city fire departments are few in number, so all are surveyed and have a high response rate so that an excellent estimate is obtained. A variety of data is collected during the NFPA survey process, which allows the NFIRS data to be projected on a nationwide basis with some accuracy. The NFPA survey also allows individual component parts of the NFIRS data to be projected on a national basis. This multiple-calibration approach makes use of the NFPA survey where its statistics design advantages are the strongest and yields scaling ratios to extend the fractional NFIRS data to a true nationwide estimate of the U.S. fire problem.

Data on the number and type of facilities are maintained by the U.S. Census Bureau, which conducts an economic census (Ref. F2.7). It performs a count of all businesses in the United States and categorizes them in accordance with the North American Industry Classification System (NAICS). As this program is not voluntary, these data are believed to be accurate as reported.

The NFPA does not use the NAICS to categorize the type of facility, so there is a need to correlate the two systems in order to ensure that both the number of facilities and the number of fires represent counts from the same population. This is relatively straightforward at the level of the major categories of facilities. Table F4.3-1 gives a cross-reference between the two systems at that level. Some of the cross-reference matching of categories shown in the table may not seem obvious from the titles, but a review of the definitions used by NFPA/FEMA (Ref. F2.8) and NAICS (Ref. F2.7) clearly leads to the classifications shown in the table.

Table F4.3-1. Types of Facilities: Cross Reference Between NFPA and NAICS

NFPA Facility Categories	NAICS Facility Categories
Food products	Food products
Beverage, tobacco, or related oil products	Beverage and tobacco products
Textiles	Textile mills Textile product mills
Wearing apparel, leather, rubber products	Apparel products Leather and allied products Plastics and rubber (rubber subgroup)
Wood, furniture, paper, or printing products	Wood products Paper products Printing and related support activities Furniture and related products
Chemical, plastic, or petroleum products	Petroleum and coal products Chemical products (except photographic) Plastics and rubber (plastics subgroup)
Metal or metal products	Primary metal products Fabricated metal products Machinery Computer and electronic products Electrical equipment, appliances, and components
Vehicle assembly or manufacturing	Transportation equipment
Other	Miscellaneous Chemical products (photographic)
Unclassified or unknown	Nonmetallic mineral products

NOTE: NFPA = National Fire Protection Association; NAICS = North American Industry Classification System.

Source: Ref. F2.8 and Ref. F2.7

Two different calculations are performed on two different subpopulations in order to test the sensitivity of the overall fire frequency to the type of process facility. The first calculation uses facilities classified by NFPA under chemical, plastic, or petroleum products. According to NFPA data (Ref. F2.10), there are approximately 287 outside fires involving property of value annually (2,870 total fires in the ten year period) in such facilities. Reference F2.10 is an e-mail that was sent from the author of *Fires in or at Industrial Chemical, Hazardous Chemical and Plastic Manufacturing Facilities, 1988-1997 Unallocated Annual Averages and Narratives* (Ref. F2.8) (M. Ahrens) to one of the originators of this Attachment, Paul Amico. The information from this correspondence is being used to provide information based on the NFIRS and NFPA survey to supplement the information from *Fires in or at Industrial Chemical, Hazardous Chemical and Plastic Manufacturing Facilities, 1988-1997 Unallocated Annual Averages and Narratives* (Ref. F2.8).

According to NAICS, the total number of facilities of this type is 29,303. Therefore, the frequency of potentially significant fires in these facilities is:

$$F = \frac{287 \text{ fires/yr}}{(29{,}303 \text{ facilities})} = 9.8 \times 10^{-3} \text{ fires/facility-yr} \qquad \text{(Eq. F-1)}$$

The second calculation uses subcategories within the classification systems to determine whether a particular subcategory of chemical, plastic, or petroleum products would yield a different result (i.e., whether the answer was significantly related to facility type).

According to NFPA data, each year there are approximately 62 outside fires involving property of value per year (620 total fires in the ten year period) in the subcategory industrial chemical, hazardous chemical, and plastics facilities. According to NAICS, the total number of facilities in the corresponding subcategories is 5,870. Therefore, the frequency of potentially significant fires in these facilities is:

$$F = \frac{62 \text{ fires/yr}}{(5{,}870 \text{ facilities})} = 1.1 \times 10^{-2} \text{ fires/facility-yr} \qquad \text{(Eq. F-2)}$$

Thus, the two estimates of the outside fire frequency are virtually the same. Overall, the use of a total mean outside fire frequency of 1×10^{-2} fires per facility per facility-year is deemed to be appropriate

The next refinement is to determine where these outside fires start. One analysis performed by the NFPA was in terms of this distribution (Ref. F2.8, Section 5). With some interpretation, these data can be used to estimate the fraction of the total fire frequency that should be assigned to the various onsite areas outside the building. The results of this assessment are provided in Table F4.3-2.

Table F4.3-2. Fraction of Fires and Fire Frequency for Outside Areas of a Facility

Area	# of Fires[a]	Fraction	Fire Frequency per facility-yr
Storage areas – to include all areas where products are held while awaiting process, shipment, or use	125	0.20	2.0×10^{-3}
Receiving areas – to include all areas where products are moved into or out of a building while onsite but are still outside the building	57	0.092	9.2×10^{-4}
Trash/rubbish areas	84	0.135	1.4×10^{-3}
Areas containing equipment – to include all areas outside the building that contain operating process, HVAC, maintenance, or other machinery and equipment	121	0.195	2.0×10^{-3}
Open areas – to include fields, roads, and right of ways	84	0.135	1.4×10^{-3}
Vehicles	16	0.025	2.5×10^{-4}
Other – primarily applies to exterior structural areas of buildings	136	0.22	2.2×10^{-3}

NOTE: [a]Does not total 620 due to rounding after weighted allocation of fires coded in database as starting in unknown location (6.2% of fires).
HVAC = heating, ventilation, and air conditioning; yr = year.

Source: Ref. F2.8, Section 5

As shown in Table F4.3-2, the frequency is expressed in terms of facility-year (since the number of NFPA fires is divided by the number of NAICS facilities). There is some uncertainty as to what is meant by a "facility" in this context. The NAICS does not make clear whether multiple process buildings can be considered a single facility, although noting in this context that the purpose of the NAICS is an economic census implies that the number of main process buildings (i.e., the throughput of a given site) is more important than the number of sites. Because of this, in order to avoid potentially non-conservative probabilistic results, a boundary condition has been established that each main process building at YMP constitutes a facility, and that the subsurface fire frequency pertains to each of them (i.e., each of these buildings generates the necessary conditions to contribute a full measure of potential fire ignitions). Subsurface operations will not be considered a separate facility, but rather a support area for the process buildings (i.e., it is an integral part of a typical facility in that it takes the "product" from the process). In addition, the other support buildings will also not be considered facilities for the purpose of determining the overall frequency of subsurface fires, for a similar reason. Therefore, the overall frequency of subsurface fires for the geologic repository operations area will be the frequency per facility-year times the number of main process buildings (six: Initial Handling Facility, Wet Handling Facility, Receipt Facility, and three Canister Receipt and Closure Facilities).

A suitable uncertainty distribution is applied to the results of the initiating event frequency analysis to represent the significant uncertainty that results from the application of this methodology. The distribution is selected to reflect that, in particular recognition of the discussion above, it is likely that the calculated mean is conservative.

F5 ANALYSIS

F5.1 INTRODUCTION

Fire initiating event frequencies have been calculated for each initiating event identified for subsurface operations. 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.

F5.2 INITIATING EVENT FREQUENCIES

There was one initiating event identified for subsurface:

- Fire Threatens a Waste Form During On-Site Transport (transport and emplacement vehicle (TEV))

The selection of these events is documented in *Subsurface Operations Event Sequence Development Analysis* (Ref. F2.6). This section addresses the quantification of these events.

F5.2.1 Fire Threatens a Waste Form in During Transport (TEV)

This represents fires that ignite on/in the transportation vehicles while moving waste forms around the site. The transportation vehicles include the TEV, site transporter, truck trailer, and the site prime mover. While it could be argued that a vehicle fire can occur at any time, it is more likely that it will occur while the vehicle is in use. For that reason, the fire frequency per year will be converted to a frequency per vehicle operation by dividing by the total average number of operations of all such vehicles (both when loaded with a waste form and when not) per year. This will allow initiating event frequencies over the preclosure period to be determined for each vehicle and waste form to be quantified by multiplying by the total number of operations for each vehicle and waste form when the waste form is present.

The outside area that is relevant to this event, from Table F4.3-2, is "vehicles." That is, the waste form is vulnerable to a vehicle fire during transport. The total frequency per facility-year of such fires is, from the same table, 2.5×10^{-4} per facility-year. As discussed in the methodology, this value is multiplied by six to determine the overall frequency of vehicle fires on the site.

$$\begin{aligned}\text{Site Vehicle Fire Frequency/year} &= 2.5 \times 10^{-4} \text{ fires/facility-year} \times 6 \text{ facilities} \\ &= 1.5 \times 10^{-3} \text{ fires/year}\end{aligned}$$

This is then converted to the total expected number of vehicle fires over the 50-year preclosure period.

$$\begin{aligned}\text{Site Vehicle Fire Frequency (preclosure period)} &= 1.5 \times 10^{-3} \text{ fires/year} \times 50 \text{ years} \\ &= 7.5 \times 10^{-2} \text{ fires}\end{aligned}$$

This needs to be converted into a frequency per vehicle operation, which is the final form of the initiating event frequency. In actuality, a vehicle fire can start in any type of vehicle (e.g., service vehicle, delivery vehicle, etc.), not just in a vehicle that transports waste. However, as the facility is not yet fully designed there is no estimate available for the number of such vehicle movements that will occur on site. The only thing that is known with any level of confidence is the number of waste form movements (since this is integral to the throughput of the site). Therefore, the potential for fires in other types of vehicles will be ignored, which will add a level of conservatism to the results.

The PCSA throughput analysis (Ref. F2.11) estimates that there are *approximately* 40,000 waste form movements outside of the process buildings during the preclosure period. This includes operations of the site transporter, truck trailer, site prime mover, and TEV.[2] For each waste form movement, there will be another movement of the vehicle when a waste form is not present. Thus, the total number of operations of the transport vehicles is *approximately* 80,000. The fire initiating event frequency per operation is therefore:

[2] When determining the fire ignition rate per operation on the site, the operation of all site vehicles needs to be considered in the allocation, not just those involved in subsurface operations. When assembling the risk model for subsurface, the resultant rate is used as the initiating event frequency and is multiplied only by the number of subsurface vehicle operations involving waste movements.

Fire Threatens a Waste Form during Onsite Transport = 7.5×10^{-2} fires / 80,000 operations
$= 9 \times 10^{-7}$ fires/operation[3]

F5.2.2 Uncertainty

Formal analysis of the uncertainties in this estimate is not appropriate given the sources of information used. It was decided that the use of analyst judgment was most appropriate. A team of three individuals held a discussion of the sources of uncertainty and their potential effects on the calculated mean value.

First, the uncertainties are expected to be large. The use of two different data bases for the numerator and denominator offer the opportunity for a mismatch in the populations covered. The accuracy of the databases is also unclear. The NFPA data on fires is based on voluntary compliance by fire departments, and while NFPA adjusts the data for this and has a substantial past history of this type of analysis, the level of uncertainty is still greater than for a more rigorous system of data collection. Further, the data collectors (the individuals assigned to collect the data by each fire department) are not subject to a single consistent training course.

The census bureau data is likely to be more accurate, however there is still a potential for error in determining the number of actual buildings that constitute a facility for counting purposes. The methodology states that "A company operating at more than one location is required to file a separate report for each store, factory, shop, or other location." This is clear as regards physical locations, but not clear as regards multiple operations at one location. The approach used in this analysis to consider each of the six process buildings as a facility for counting purposes is conservative, but it increases uncertainty and also skews the distribution towards the high side (i.e., there is more room for the actual value to be lower than higher).

Taking all of this into consideration, the team selected a lognormal distribution (to address the issue of the conservative mean) with an error factor of 15 (to address the nature of the uncertainties).

F5.3 RESULTS

The results of the analysis are the fire initiating event frequency and its associated distribution (Table F5.3-1). The initiating event frequency represents the probability that a fire will threaten the stated waste form during onsite transport over the length of the pre-closure period.

[3] Given the broad range of the approximations used in this analysis, there is no justification for using a mean to more than one significant digit.

Table F5.3-1. Onsite Transport Fire Initiating Event Frequency and Associated Distribution

Initiating Event	Mean frequency (per 50 years)	Error Factor	Distribution
Fire Threatens a Waste Form During Onsite Transport	9×10^{-7} fires/operation	15	lognormal

Source: Original

ATTACHMENT G
EVENT SEQUENCE QUANTIFICATION SUMMARY TABLES

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ATTACHMENT G
EVENT SEQUENCE QUANTIFICATION SUMMARY TABLE

Attachment G contains the event sequence quantification summary table (Table G-1), which is referenced in Section 6.7. It also contains Table G-2, *Event Sequence Grouping and Categorization*; Table G-3, *Beyond Category 2 Final Event Sequences Summary*; and Table G-4, *Important to Criticality Final Event Sequences Summary*, which are referenced in Section 6.8. The results in this attachment have been produced from the SAPHIRE model in Attachment H using SAPHIRE's "mincut" (minimal cut set upper bound) option with no frequency cutoff. This well-known method estimates the frequency of an event sequence (the union of the corresponding cut set frequencies) as 1 minus the product of the complements of the cut set frequencies. The mincut method economically computes accurate event sequence frequencies provided that the cut set frequencies are not too small (on the order of 10^{-15} or less). If a cut set frequency is actually zero, as it is in some cases, the lack of a contribution to the event sequence frequency is accurately reflected. Likewise, for event sequence frequencies of interest in this analysis, that is, within several orders of magnitude of the Category 2 threshold (10^{-4}), the mincut method produces accurate results. However, when a cut set frequency is very small but greater than zero, the method would encounter the limits of the numerical precision of the computer. To avoid numerical difficulties, SAPHIRE rounds the complement of the cut set frequency (1 minus the frequency) to 1 when the cut set frequency is less than about 10^{-15}. This rounding can result in an underestimate of the event sequence frequency and, in the extreme case, a computed value of zero if all of the complements are rounded to 1. As a result of rounding, very small frequency values may be reported as zero in this attachment. Even so, numbers less than 10^{-15} may appear, because they are calculated as 1 minus the product of the complements of numbers greater than about 10^{-15}.

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Table G-1. Event Sequence Quantification Summary

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
CRCF (sm. circ1) WP-impact facility shield door	SSO-ESD01	2-1	This sequence represents a structural challenge to a WP while inside the CRCF resulting in no release or potential direct exposure to facility workers due to an impact between the WP and a facility shield door. In this sequence the WP and shielding remain intact.	FACILITY-SHIELD-DOOR, /WP, /SHIELDING	OK	2.32E+01	1.45E+01	2.87E+01
	SSO-ESD01	2-2	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to an impact between the WP and a facility shield door. In this sequence the WP remains intact but shielding fails.	FACILITY-SHIELD-DOOR, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	2-3	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to an impact between the WP and a facility shield door. In this sequence the WP fails but the canister remains intact.	FACILITY-SHIELD-DOOR, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	2-4	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	2.24E-07	1.40E-07	2.77E-07
	SSO-ESD01	2-5	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release that is also important to criticality due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	4.70E-12	2.94E-12	5.83E-12
	SSO-ESD01	2-6	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-SHIELD-DOOR, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	1.44E-08	3.80E-09	9.81E-08
	SSO-ESD01	2-7	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release that is also important to criticality due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-SHIELD-DOOR, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	3.03E-13	7.98E-14	2.06E-12
CRCF (sm. circ 2) WP-impact TEV shield door	SSO-ESD01	3-1	This sequence represents a structural challenge to a WP while inside the CRCF resulting in no release or potential direct exposure to facility workers due to an impact between a WP and a TEV shield door. In this sequence the WP and shielding remain intact.	FACILITY-TEV-DOOR, /WP, /SHIELDING	OK	1.40E-01	9.36E-02	1.53E-01
	SSO-ESD01	3-2	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to an impact between a WP and a TEV shield door. In this sequence the WP remains intact but shielding fails.	FACILITY-TEV-DOOR, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	3-3	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to an impact between a WP and a TEV shield door. In this sequence the WP fails but the canister remains intact.	FACILITY-TEV-DOOR, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	3-4	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	1.35E-09	9.04E-10	1.48E-09
	SSO-ESD01	3-5	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release that is also important to criticality due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-TEV-DOOR, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	2.83E-14	1.90E-14	3.10E-14

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
CRCF (continued)	SSO-ESD01	3-6	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-TEV-DOOR, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	7.61E-11	2.45E-11	4.12E-10
(sm. circ 2) WP-impact TEV shield door (continued)	SSO-ESD01	3-7	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release that is also important to criticality due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-TEV-DOOR, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.60E-15	5.14E-16	8.64E-15
CRCF	SSO-ESD01	4-1	This sequence represents a structural challenge to a WP while inside the CRCF resulting in no release or potential direct exposure to facility workers due to a TEV collision. In this sequence the WP and shielding remain intact.	FACILITY-COLLISION, /WP, /SHIELDING	OK	1.15E+01	7.19E+00	1.36E+01
(sm. circ 3) TEV collision	SSO-ESD01	4-2	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to a TEV collision. In this sequence the WP remains intact but shielding fails.	FACILITY-COLLISION, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-3	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to a TEV collision. In this sequence the WP fails but the canister remains intact.	FACILITY-COLLISION, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-4	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release due to a TEV collision. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	1.11E-07	6.94E-08	1.32E-07
	SSO-ESD01	4-5	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release that is also important to criticality due to a TEV collision. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	2.34E-12	1.46E-12	2.76E-12
	SSO-ESD01	4-6	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release due to a TEV collision. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	6.52E-09	1.91E-09	3.82E-08
	SSO-ESD01	4-7	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release that is also important to criticality due to a TEV collision. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.37E-13	4.01E-14	8.03E-13
CRCF	SSO-ESD01	5-1	This sequence represents a structural challenge to a WP while inside the CRCF resulting in no release or potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP and shielding remain intact.	FACILITY-DROP, /WP, /SHIELDING	OK	1.56E-02	5.08E-03	2.98E-02
(sm. circ 4) Drop of WP	SSO-ESD01	5-2	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP remains intact but shielding fails.	FACILITY-DROP, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-3	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP fails but the canister remains intact.	FACILITY-DROP, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-4	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release due to the drop of a WP. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	1.51E-07	4.91E-08	2.87E-07

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
CRCF (continued)	SSO-ESD01	5-5	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release that is also important to criticality due to the drop of a WP. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	3.17E-12	1.03E-12	6.04E-12
	SSO-ESD01	5-6	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release due to the drop of a WP. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	9.38E-09	1.37E-09	7.60E-08
(sm. circ 4) Drop of WP (continued)	SSO-ESD01	5-7	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a WP. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.97E-13	2.87E-14	1.60E-12
CRCF	SSO-ESD01	6-1	This sequence represents a structural challenge to a WP while inside the CRCF resulting in no release or potential direct exposure to facility workers due to the drop of a WP or the drop of a heavy load onto the WP. In this sequence the WP and shielding remain intact.	FACILITY-DROPON, /WP, /SHIELDING	OK	1.25E+00	1.14E+00	6.74E-01
(sm. circ 5) Heavy load drop on WP	SSO-ESD01	6-2	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence the WP remains intact but shielding fails.	FACILITY-DROPON, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	6-3	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a potential direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence the WP fails but the canister remains intact.	FACILITY-DROPON, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	6-4	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release due to the drop of a heavy load onto the WP. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	1.21E-05	1.10E-05	6.51E-06
	SSO-ESD01	6-5	This sequence represents a structural challenge to a WP while inside the CRCF resulting in a filtered radioactive release that is also important to criticality due to the drop of a WP or the drop of a heavy load onto the WP. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-DROPON, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	2.53E-10	2.30E-10	1.37E-10
	SSO-ESD01	6-6	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release due to the drop of a heavy load onto the WP. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-DROPON, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	7.46E-07	2.78E-07	3.63E-06
	SSO-ESD01	6-7	This sequence represents a structural challenge to a WP while inside the CRCF resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a heavy load onto the WP. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-DROPON, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.57E-11	5.84E-12	7.62E-11
IHF	SSO-ESD01	2-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to an impact between the WP and a facility shield door. In this sequence the WP and shielding remain intact.	FACILITY-SHIELD-DOOR, /WP, /SHIELDING	OK	1.19E+00	7.46E-01	1.48E+00
(sm. circ1) WP-impact facility shield door	SSO-ESD01	2-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to an impact between the WP and a facility shield door. In this sequence the WP remains intact but shielding fails.	FACILITY-SHIELD-DOOR, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
IHF (continued)	SSO-ESD01	2-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to an impact between the WP and a facility shield door. In this sequence the WP fails but the canister remains intact.	FACILITY-SHIELD-DOOR, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	2-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
(sm. circ1) WP-impact facility shield door (continued)	SSO-ESD01	2-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	2-6	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-SHIELD-DOOR, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	1.19E-08	7.45E-09	1.48E-08
	SSO-ESD01	2-7	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release that is also important to criticality due to an impact between the WP and a facility shield door. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-SHIELD-DOOR, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.79E-11	1.12E-11	2.22E-11
IHF	SSO-ESD01	3-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to an impact between a WP and a TEV shield door. In this sequence the WP and shielding remain intact.	FACILITY-TEV-DOOR, /WP, /SHIELDING	OK	7.18E-03	4.82E-03	7.87E-03
(sm. circ 2) WP-impact TEV shield door	SSO-ESD01	3-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to an impact between a WP and a TEV shield door. In this sequence the WP remains intact but shielding fails.	FACILITY-TEV-DOOR, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD-01	3-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to an impact between a WP and a TEV shield door. In this sequence the WP fails but the canister remains intact.	FACILITY-TEV-DOOR, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	3-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	3-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-TEV-DOOR, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	3-6	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-TEV-DOOR, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	7.17E-11	4.81E-11	7.86E-11

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
IHF (continued)	SSO-ESD01	3-7	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release that is also important to criticality due to an impact between a WP and a TEV shield door. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-TEV-DOOR, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.08E-13	7.22E-14	1.18E-13
IHF (sm. circ 3) TEV collision	SSO-ESD01	4-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to a TEV collision. In this sequence the WP and shielding remain intact.	FACILITY-COLLISION, /WP, /SHIELDING	OK	5.94E-01	3.70E-01	7.01E-01
	SSO-ESD01	4-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to a TEV collision. In this sequence the WP remains intact but shielding fails.	FACILITY-COLLISION, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to a TEV collision. In this sequence the WP fails but the canister remains intact.	FACILITY-COLLISION, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to a TEV collision. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to a TEV collision. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD1	4-6	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release due to a TEV collision. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	5.93E-09	3.69E-09	7.00E-09
	SSO-ESD01	4-7	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release that is also important to criticality due to a TEV collision. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	8.90E-12	5.55E-12	1.05E-11
IHF (sm. circ 4) Drop of WP	SSO-ESD01	5-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP and shielding remain intact.	FACILITY-DROP, /WP, /SHIELDING	OK	8.03E-04	2.61E-04	1.53E-03
	SSO-ESD01	5-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP remains intact but shielding fails.	FACILITY-DROP, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP fails but the canister remains intact.	FACILITY-DROP, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to the drop of a WP. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to the drop of a WP. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
IHF (sm. circ 3) TEV collision	SSO-ESD01	4-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to a TEV collision. In this sequence the WP and shielding remain intact.	FACILITY-COLLISION, /WP, /SHIELDING	OK	5.94E-01	3.70E-01	7.01E-01
	SSO-ESD01	4-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to a TEV collision. In this sequence the WP remains intact but shielding fails.	FACILITY-COLLISION, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to a TEV collision. In this sequence the WP fails but the canister remains intact.	FACILITY-COLLISION, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to a TEV collision. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	4-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to a TEV collision. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD1	4-6	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release due to a TEV collision. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	5.93E-09	3.69E-09	7.00E-09
	SSO-ESD01	4-7	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release that is also important to criticality due to a TEV collision. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-COLLISION, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	8.90E-12	5.55E-12	1.05E-11
IHF (sm. circ 4) Drop of WP	SSO-ESD01	5-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP and shielding remain intact.	FACILITY-DROP, /WP, /SHIELDING	OK	8.03E-04	2.61E-04	1.53E-03
	SSO-ESD01	5-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP remains intact but shielding fails.	FACILITY-DROP, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to the drop of a WP. In this sequence the WP fails but the canister remains intact.	FACILITY-DROP, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to the drop of a WP. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to the drop of a WP. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	5-6	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release due to the drop of a WP. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	8.02E-09	2.61E-09	1.53E-08
	SSO-ESD01	5-7	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a WP. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-DROP, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	1.21E-11	3.92E-12	2.30E-11

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
IHF (sm. circ 5) Heavy load drop on WP	SSO-ESD01	6-1	This sequence represents a structural challenge to a WP while inside the IHF resulting in no release or potential direct exposure to facility workers due to the drop of a WP or the drop of a heavy load onto the WP. In this sequence the WP and shielding remain intact.	FACILITY-DROPON, /WP, /SHIELDING	OK	6.43E-02	5.84E-02	3.47E-02
	SSO-ESD01	6-2	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence the WP remains intact but shielding fails.	FACILITY-DROPON, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	6-3	This sequence represents a structural challenge to a WP while inside the IHF resulting in a potential direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence the WP fails but the canister remains intact.	FACILITY-DROPON, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	6-4	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release due to the drop of a heavy load onto the WP. In this sequence the WP and canister fail, but facility confinement is maintained and no moderator is introduced into the canister.	FACILTY-SHIELD-DOOR, WP, CANISTER, /CONFINEMENT, /MODERATOR	RRF	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	6-5	This sequence represents a structural challenge to a WP while inside the IHF resulting in a filtered radioactive release that is also important to criticality due to the drop of a WP or the drop of a heavy load onto the WP. In this sequence the WP and canister fail, but facility confinement is maintained; however, moderator is introduced into the canister.	FACILITY-DROPON, WP, CANISTER, /CONFINEMENT, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD01	6-6	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release due to the drop of a heavy load onto the WP. In this sequence the WP and canister fail, facility confinement is not maintained and no moderator is introduced into the canister.	FACILITY-DROPON, WP, CANISTER, CONFINEMENT, /MODERATOR	RRU	6.42E-07	5.83E-07	3.46E-07
	SSO-ESD01	6-7	This sequence represents a structural challenge to a WP while inside the IHF resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a heavy load onto the WP. In this sequence the WP and canister fail, facility confinement is not maintained and moderator is introduced into the canister.	FACILITY-DROPON, WP, CANISTER, CONFINEMENT, MODERATOR	RRC	9.64E-10	8.76E-10	5.20E-10
Transit (sm. circ1) TEV impact, collision, or derail	SSO-ESD02	2-1	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in no radioactive release or direct exposure to facility workers due to a TEV impact collision or derailment. In this sequence WP integrity and shielding are maintained.	TRANSIT-DERAIL, /WP, /SHIELDING	OK	2.89E-01	2.88E-01	3.19E-02
	SSO-ESD02	2-2	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to a TEV impact collision or derailment. In this sequence WP integrity is maintained but shielding fails.	TRANSIT-DERAIL, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD02	2-3	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to a TEV impact collision or derailment. In this sequence WP integrity fails but the canister remains intact.	TRANSIT-DERAIL, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD2	2-4	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release due to a TEV impact collision or derailment. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	TRANSIT-DERAIL, WP, CANISTER, /MODERATOR	RRU	2.89E-09	2.88E-09	3.19E-10
	SSO-ESD02	2-5	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to a TEV impact collision or derailment. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	TRANSIT-DERAIL, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
Transit	SSO-ESD02	3-1	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in no radioactive release or direct exposure to facility workers due to a TEV impact. In this sequence WP integrity and shielding are maintained.	TRANSIT-IMPACT, /WP, /SHIELDING	OK	3.55E+00	1.42E+00	7.88E+00
(sm. circ 2) TEV impact during transit	SSO-ESD02	3-2	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to a TEV impact. In this sequence WP integrity is maintained but shielding fails.	TRANSIT-IMPACT, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD02	3-3	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to a TEV impact. In this sequence WP integrity fails but the canister remains intact.	TRANSIT-IMPACT, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD02	3-4	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release due to a TEV impact. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	TRANSIT-IMPACT, WP, CANISTER, /MODERATOR	RRU	3.55E-08	1.42E-08	7.88E-08
	SSO-ESD2	3-5	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to a TEV impact. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	TRANSIT-IMPACT, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Transit	SSO-ESD02	4-1	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in no radioactive release or direct exposure to facility workers due the drop of a WP. In this sequence WP integrity and shielding are maintained.	TRANSIT-DROP, /WP, /SHIELDING	OK	1.35E-03	1.01E-03	1.22E-03
(sm. circ 3) Drop of WP during transit	SSO-ESD02	4-2	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due the drop of a WP. In this sequence WP integrity is maintained but shielding fails.	TRANSIT-DROP, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD02	4-3	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to the drop of a WP. In this sequence WP integrity fails but the canister remains intact.	TRANSIT-DROP, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD02	4-4	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release due to the drop of a WP. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	TRANSIT-DROP, WP, CANISTER, /MODERATOR	RRU	1.35E-08	1.01E-08	1.22E-08
	SSO-ESD02	4-5	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a WP. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	TRANSIT-DROP, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Transit	SSO-ESD02	5-1	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in no radioactive release or direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence WP integrity and shielding are maintained.	TRANSIT-DROPON, /WP, /SHIELDING	OK	0.00E+00	0.00E+00	0.00E+00
(sm. circ 4) Heavy load drop on TEV	SSO-ESD02	5-2	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence WP integrity is maintained but shielding fails.	TRANSIT-DROPON, /WP, SHIELDING	DEL	0.00E+00	0.00E+00	0.00E+00

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
Transit (continued)	SSO-ESD02	5-3	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in a direct exposure to facility workers due to the drop of a heavy load onto the WP. In this sequence WP integrity fails but the canister remains intact.	TRANSIT-DROPON, WP, /CANISTER	DEL	0.00E+00	0.00E+00	0.00E+00
(sm. circ 4) Heavy load drop on TEV (continued)	SSO-ESD02	5-4	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release due to the drop of a heavy load onto the WP. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	TRANSIT-DROPON, WP, CANISTER, /MODERATOR	RRU	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD02	5-5	This sequence represents a structural challenge to a WP in a TEV while in transit from a facility to the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a heavy load onto the WP. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	TRANSIT-DROPON, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Drift	SSO-ESD03	2-1	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to a TEV impact collision or derailment. In this sequence WP integrity does not fail.	DRIFT-TEV-IMPACT, /WP	OK	2.54E+01	2.54E+01	4.35E+01
(sm. circ 1) TEV impact collision or derail	SSO-ESD03	2-2	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to a TEV impact collision or derailment. In this sequence WP integrity fails but canister integrity does not fail.	DRIFT-TEV-IMPACT, WP, /CANISTER	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	2-3	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release due to a TEV impact collision or derailment. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	DRIFT-TEV-IMPACT, WP, CANISTER, /MODERATOR	RRU	2.54E-07	2.54E-07	4.35E-07
	SSO-ESD03	2-4	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to a TEV impact collision or derailment. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	DRIFT-TEV-IMPACT, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Drift	SSO-ESD03	3-1	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to a collision resulting in a direct impact to the WP. In this sequence WP integrity does not fail.	DRIFT-WP-IMPACT, /WP	OK	7.58E+00	7.58E+00	1.43E+01
(sm. circ 2) Direct impact to WP- collision	SSO-ESD03	3-2	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to a collision resulting in a direct impact to the WP. In this sequence WP integrity fails but canister integrity does not fail.	DRIFT-WP-IMPACT, WP, /CANISTER	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	3-3	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release due to a collision resulting in a direct impact to the WP. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	DRIFT-WP-IMPACT, WP, CANISTER, /MODERATOR	RRU	7.58E-08	7.58E-08	1.43E-07
	SSO-ESD03	3-4	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to a collision resulting in a direct impact to the WP. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	DRIFT-WP-IMPACT, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
Drift (sm. circ 3) Drop or drag of WP	SSO-ESD03	4-1	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to the drop or drag of the WP. In this sequence WP integrity does not fail.	DRIFT-DRAG, /WP	OK	5.40E-03	5.40E-03	3.08E-02
	SSO-ESD03	4-2	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to the drop or drag of the WP. In this sequence WP integrity fails but canister integrity does not fail.	DRIFT-DRAG, WP, /CANISTER	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	4-3	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release due to the drop or drag of the WP. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	DRIFT-DRAG, WP, CANISTER, /MODERATOR	RRU	5.40E-08	5.40E-08	3.08E-07
	SSO-ESD03	4-4	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to the drop or drag of the WP. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	DRIFT-DRAG, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Drift (sm. circ 4) Heavy load drop on TEV	SSO-ESD03	5-1	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to a heavy load drop onto the TEV. In this sequence WP integrity does not fail.	DRIFT-TEV-DROPON, /WP	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	5-2	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to a heavy load drop onto the TEV. In this sequence WP integrity fails but canister integrity does not fail.	DRIFT-TEV-DROPON, WP, /CANISTER	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	5-3	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release due to a heavy load drop onto the TEV. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	DRIFT-TEV-DROPON, WP, CANISTER, /MODERATOR	RRU	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	5-4	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to a heavy load drop onto the TEV. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	DRIFT-TEV-DROPON, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Drift (sm. Circ 5) WP impact due to TEV doors	SSO-ESD03	6-1	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to an impact between the TEV doors and the WP. In this sequence WP integrity does not fail.	DRIFT-DOOR-IMPACT, /WP	OK	9.85E-02	9.85E-02	1.61E-01
	SSO-ESD03	6-2	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to an impact between the TEV doors and the WP. In this sequence WP integrity fails but canister integrity does not fail.	DRIFT-DOOR-IMPACT, WP, /CANISTER	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	6-3	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release due to an impact between the TEV doors and the WP. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	DRIFT-DOOR-IMPACT, WP, CANISTER, /MODERATOR	RRU	9.85E-10	9.85E-10	1.61E-09
	SSO-ESD03	6-4	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to an impact between the TEV doors and the WP. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	DRIFT-DOOR-IMPACT, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
Drift (sm. Circ 6) Heavy load drop on WP	SSO-ESD03	7-1	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to the drop of a heavy load onto the WP. In this sequence WP integrity does not fail.	DRIFT-WP-DROPON, /WP	OK	2.54E-04	2.54E-04	3.12E-04
	SSO-ESD03	7-2	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift that does not result in an unfiltered radioactive release due to the drop of a heavy load onto the WP. In this sequence WP integrity fails but canister integrity does not fail.	DRIFT-WP-DROPON, WP, /CANISTER	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD03	7-3	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release due to the drop of a heavy load onto the WP. In this sequence WP and canister integrity fail but no moderator is introduced into the canister.	DRIFT-WP-DROPON, WP, CANISTER, /MODERATOR	RRU	2.54E-09	2.54E-09	3.12E-09
	SSO-ESD03	7-4	This sequence represents a structural challenge to a WP in a TEV during emplacement in the emplacement drift resulting in an unfiltered radioactive release that is also important to criticality due to the drop of a heavy load onto the WP. In this sequence WP and canister integrity fail and a moderator is introduced into the canister.	DRIFT-WP-DROPON, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Direct Exposure (sm. circ1) Inadvertent entry into drift	SSO-ESD04	2-1	This sequence represents a potential for a direct exposure to facility workers due to inadvertent entry into an emplacement drift. In this sequence the direct exposure is avoided; shielding is maintained	SHIELD-ENTRY, /SHIELD	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD04	2-2	This sequence represents a direct exposure to facility workers due to inadvertent entry into an emplacement drift. In this sequence a lack of adequate shielding is expected.	SHIELD-ENTRY, SHIELD	DEL	0.00E+00	0.00E+00	0.00E+00
Direct Exposure (sm. circ 2) Prolonged worker proximity to TEV	SSO-ESD04	3-1	This sequence represents a potential for a direct exposure to facility workers due to prolonged worker exposure to a TEV. In this sequence a direct exposure is avoided; shielding is maintained.	SHIELD-PROXIMITY, /SHIELD	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD04	3-2	This sequence represents a direct exposure to facility workers due to prolonged worker exposure to a TEV. In this sequence a lack of adequate shielding is expected.	SHIELD-PROXIMITY, SHIELD	DEL	0.00E+00	0.00E+00	0.00E+00
Direct Exposure (sm. circ 3) Inadvertent TEV door opening	SSO-ESD04	4-1	This sequence represents a potential for a direct exposure to facility workers due to inadvertent opening of a TEV door. In this sequence the direct exposure is avoided; shielding is maintained.	SHIELD-DOOR, /SHIELD	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD04	4-2	This sequence represents a direct exposure to facility workers due to inadvertent opening of a TEV door. In this sequence a lack of adequate shielding is expected.	SHIELD-DOOR, SHIELD	DEL	1.41E-03	5.43E-05	1.47E-02
Direct Exposure (sm. circ 4) Loss of Movement loss of shielding	SSO-ESD04	5-1	This sequence represents a direct exposure to facility workers due to a TEV loss of movement. In this sequence a direct exposure is avoided; shielding is maintained.	SHIELD-DOOR, /SHIELD	OK	8.50E+00	8.47E+00	7.43E-01
	SSO-ESD04	5-2	This sequence represents a direct exposure to facility workers due to a TEV loss of movement. In this sequence a lack of adequate shielding is expected.	SHIELD-DOOR, SHIELD	DEL	0.00E+00	0.00E+00	0.00E+00
Fire (sm. circ 1) TEV fire affects WP in drift	SSO-ESD05	2-1	This sequence represents a structural challenge to a WP but there is no radioactive release and no direct exposure to facility workers due to a fire in TEV located in an emplacement drift. In this sequence WP integrity and shielding are maintained.	FIRE-DRIFT, /WP, /SHIELD	OK	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD05	2-2	This sequence represents a structural challenge to a WP resulting in a direct exposure to facility workers due to a fire in TEV located in an emplacement drift. In this sequence WP integrity is maintained but shielding fails.	FIRE-DRIFT, /WP, SHIELD	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD05	2-3	This sequence represents a structural challenge to a WP resulting in a direct exposure to facility workers due to a fire in TEV located in an emplacement drift. In this sequence WP integrity is lost but the canister remains intact.	FIRE-DRIFT, WP, /CANISTER	DEL	3.54E-03	1.38E-03	7.47E-03

Table G-1. Event Sequence Quantification Summary (Continued)

Initiating Event	Event Tree	Seq.	Description	Logic	End State	Calc'd Mean	Calc'd Median	Calc'd Std. Deviation
Fire (continued)	SSO-ESD05	2-4	This sequence represents a structural challenge to a WP resulting in an unfiltered radioactive release due to a fire in TEV located in an emplacement drift. In this sequence WP and canister integrity is lost but no moderator is introduced into the canister.	FIRE-DRIFT, WP, CANISTER, /MODERATOR	RRU	1.13E-06	4.43E-07	2.39E-06
(sm. circ 1) TEV fire affects WP in drift (continued)	SSO-ESD05	2-5	This sequence represents a structural challenge to a WP resulting in an unfiltered radioactive release that is also important to criticality due to a fire in TEV located in an emplacement drift. In this sequence WP and canister integrity is lost and a moderator is introduced into the canister.	FIRE-DRIFT, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Fire	SSO-ESD05	3-1	This sequence represents a structural challenge to a WP but there is no radioactive release and no direct exposure to facility workers due to a fire on a TEV on the subsurface rail. In this sequence WP integrity and shielding are maintained.	FIRE-SUBSURFACE, /WP, /SHIELD	OK	0.00E+00	0.00E+00	0.00E+00
(sm. circ 2) TEV fire Affects WP on subsurface rail	SSO-ESD05	3-2	This sequence represents a structural challenge to a WP resulting in a direct exposure to facility workers due to a fire on a TEV on the subsurface rail. In this sequence WP integrity is maintained but shielding fails.	FIRE-SUBSURFACE, /WP, SHIELD	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD05	3-3	This sequence represents a structural challenge to a WP resulting in a direct exposure to facility workers due to a fire on a TEV on the subsurface rail. In this sequence WP integrity is lost but the canister remains intact.	FIRE-SUBSURFACE, WP, /CANISTER	DEL	3.54E-03	1.38E-03	7.47E-03
	SSO-ESD05	3-4	This sequence represents a structural challenge to a WP resulting in an unfiltered radioactive release due to a fire on a TEV on the subsurface rail. In this sequence WP and canister integrity is lost but no moderator is introduced into the canister.	FIRE-SUBSURFACE, WP, CANISTER, /MODERATOR	RRU	1.13E-06	4.43E-07	2.39E-06
	SSO-ESD05	3-5	This sequence represents a structural challenge to a WP resulting in an unfiltered radioactive release that is also important to criticality due to a fire on a TEV on the subsurface rail. In this sequence WP and canister integrity is lost and a moderator is introduced into the canister.	FIRE-SUBSURFACE, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00
Fire	SSO-ESD05	4-1	This sequence represents a structural challenge to a WP but there is no radioactive release and no direct exposure to facility workers due to a fire on the TEV on the surface rail. In this sequence WP integrity and shielding are maintained.	FIRE-SURFACE, /WP, /SHIELD	OK	0.00E+00	0.00E+00	0.00E+00
(sm. circ 3) TEV fire Affects WP on surface rail	SSO-ESD05	4-2	This sequence represents a structural challenge to a WP resulting in a direct exposure to facility workers due to a fire on the TEV on the surface rail. In this sequence WP integrity is maintained but shielding fails.	FIRE-SURFACE, /WP, SHIELD	DEL	0.00E+00	0.00E+00	0.00E+00
	SSO-ESD05	4-3	This sequence represents a structural challenge to a WP resulting in a direct exposure to facility workers due to or a fire on the TEV on the surface rail. In this sequence WP integrity is lost but the canister remains intact.	FIRE-SURFACE, WP, /CANISTER	DEL	3.54E-03	1.38E-03	7.47E-03
	SSO-ESD05	4-4	This sequence represents a structural challenge to a WP resulting in an unfiltered radioactive release due to a fire on the TEV on the surface rail. In this sequence WP and canister integrity is lost but no moderator is introduced into the canister.	FIRE-SURFACE, WP, CANISTER, /MODERATOR	RRU	1.13E-06	4.43E-07	2.39E-06
	SSO-ESD05	4-5	This sequence represents a structural challenge to a WP resulting in an unfiltered radioactive release that is also important to criticality due to a fire on the TEV on the surface rail. In this sequence WP and canister integrity is lost and a moderator is introduced into the canister.	FIRE-SURFACE, WP, CANISTER, MODERATOR	RRC	0.00E+00	0.00E+00	0.00E+00

NOTE: circ = circle; Calc'd = calculated; CRCF = Canister Receipt and Closure Facility; ESD = event sequence diagram; IHF = Initial Handling Facility; Seq. = sequence; sm = small; SSO = Subsurface Operations; Std. = standard; TEV = transport and emplacement vehicle; WP = waste package.

Source: Original

Table G-2. Event Sequence Grouping and Categorization

Event Sequence Group ID	End State	Description	Material at Risk	Mean[a]	Median[a]	Standard Deviation[a]	Event Sequence Category	Basis for Categorization
SSO01-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in a direct exposure from loss of shielding. In this sequence, the waste package remains intact, and the shielding fails.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ3-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in a direct exposure from loss of shielding. In this sequence, the waste package fails, and the canister remains intact.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ4-RRF	Filtered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the CRCF, resulting in a filtered radionuclide release. In this sequence, the waste package fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	1.E-05	1.E-05	7.E-06	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ5-RRC	Filtered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the CRCF, resulting in a filtered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister.	1 waste package with canister(s) inside	3.E-10	2.E-10	1.E-10	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ6-RRU	Unfiltered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	1.E-06	5.E-07	4.E-06	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ7-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, the confinement boundary fails, and a moderator enters the canister.	1 waste package with canister(s) inside	1.E-09	9.E-10	5.E-10	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in a direct exposure from loss of shielding. In this sequence, the waste package remains intact, and the shielding fails.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ3-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in a direct exposure from loss of shielding. In this sequence, the waste package fails, and the canister remains intact.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ4-RRU	Unfiltered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	5.E-08	3.E-08	8.E-08	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ5-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO03-WP-SEQ3-RRU	Unfiltered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during emplacement activities in an emplacement drift, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	7.E-07	5.E-07	6.E-07	Beyond Category 2	Mean of distribution for number of occurrences of event sequence

Table G-2. Event Sequence Grouping and Categorization (Continued)

Event Sequence Group ID	End State	Description	Material at Risk	Mean[a]	Median[a]	Standard Deviation[a]	Event Sequence Category	Basis for Categorization
SSO03-WP-SEQ4-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during emplacement activities in an emplacement drift, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO04-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a direct exposure due to inadvertent TEV door opening or prolonged immobilization of the TEV in the heat causing a loss of shielding. In this sequence there are no pivotal events.	1 waste package with canister(s) inside	1.E-03	1.E-04	1.E-02	Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in a direct exposure from loss of shielding. In this sequence, the waste package remains intact, and the shielding fails.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ3-DEL	Direct exposure, loss of shielding	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in a direct exposure from loss of shielding. In this sequence, the waste package fails, and the canister remains intact.	1 waste package with canister(s) inside	1.E-02	7.E-03	1.E-02	Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ4-RRU	Unfiltered radionuclide release	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	3.E-06	2.E-06	4.E-06	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ5-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence

NOTE: [a]The mean, median, and standard deviation displayed are for the number of occurrences, over the preclosure period, of the event sequence under consideration.
CRCF = Canister Receipt and Closure Facility; ID = identification; IHF = Initial Handling Facility; TEV = transport and emplacement vehicle.

Source: Original

Table G-3. Beyond Category 2 Final Event Sequences Summary

Event Sequence Group ID	End State	Description	Material at Risk	Mean[a]	Median[a]	Standard Deviation[a]	Event Sequence Category	Basis for Categorization
SSO01-WP-SEQ4-RRF	Filtered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of a CRCF, resulting in a filtered radionuclide release. In this sequence, the waste package fails, the canister fails, the confinement boundary remains intact, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	1.E-05	1.E-05	7.E-06	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ4-RRU	Unfiltered radionuclide release	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	3.E-06	2.E-06	4.E-06	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ6-RRU	Unfiltered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, the confinement boundary fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	1.E-06	5.E-07	4.E-06	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO03-WP-SEQ3-RRU	Unfiltered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during emplacement activities in an emplacement drift, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	7.E-07	5.E-07	6.E-07	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ4-RRU	Unfiltered radionuclide release	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in an unfiltered radionuclide release. In this sequence, the waste package fails, the canister fails, and a moderator is excluded from entering the canister.	1 waste package with canister(s) inside	5.E-08	3.E-08	8.E-08	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ7-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, the confinement boundary fails, and a moderator enters the canister.	1 waste package with canister(s) inside	1.E-09	9.E-10	5.E-10	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ5-RRC	Filtered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of a CRCF, resulting in a filtered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister.	1 waste package with canister(s) inside	3.E-10	2.E-10	1.E-10	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in a direct exposure from loss of shielding. In this sequence, the waste package remains intact, and the shielding fails.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ3-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in a direct exposure from loss of shielding. In this sequence, the waste package fails, and the canister remains intact.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in a direct exposure from loss of shielding. In this sequence, the waste package remains intact, and the shielding fails.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ3-DEL	Direct exposure, loss of shielding	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in a direct exposure from loss of shielding. In this sequence, the waste package fails, and the canister remains intact.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ5-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO03-WP-SEQ4-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during emplacement activities in an emplacement drift, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence

Table G-3. Beyond Category 2 Final Event Sequences Summary (Continued)

Event Sequence Group ID	End State	Description	Material at Risk	Mean[a]	Median[a]	Standard Deviation[a]	Event Sequence Category	Basis for Categorization
SSO05-WP-SEQ2-DEL	Direct exposure, loss of shielding	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in a direct exposure from loss of shielding. In this sequence, the waste package remains intact, and the shielding fails.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ5-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence

NOTE: [a]The mean, median, and standard deviation displayed are for the number of occurrences, over the preclosure period, of the event sequence under consideration.
CRCF = Canister Receipt and Closure Facility; IHF = Initial Handling Facility; TEV = transport and emplacement vehicle; WP = waste package.

Source: Original

Table G-4. Important to Criticality Final Event Sequences Summary

Event Sequence Group ID	End State	Description	Material-At-Risk	Mean	Median	Std Dev	Event Sequence Cat.	Basis for Categorization
SSO01-WP-SEQ5-RRC	Filtered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of a CRCF, resulting in a filtered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, the confinement boundary remains intact, and a moderator enters the canister.	1 waste package with canister(s) inside	3.E-10	2.E-10	1.E-10	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO01-WP-SEQ7-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during TEV operations in the WP loadout area of the IHF or a CRCF, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, the confinement boundary fails, and a moderator enters the canister.	1 waste package with canister(s) inside	1.E-09	9.E-10	5.E-10	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO02-WP-SEQ5-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during transit to the subsurface facility, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO03-WP-SEQ4-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a structural challenge to a canister inside a waste package, during emplacement activities in an emplacement drift, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence
SSO05-WP-SEQ5-RRC	Unfiltered radionuclide release, important to criticality	This event sequence represents a thermal challenge to a canister inside a waste package, due to a fire, resulting in an unfiltered radionuclide release also important to criticality. In this sequence, the waste package fails, the canister fails, and a moderator enters the canister.	1 waste package with canister(s) inside	0.E+00	0.E+00	0.E+00	Beyond Category 2	Mean of distribution for number of occurrences of event sequence

NOTE: [a]The mean, median, and standard deviation displayed are for the number of occurrences, over the preclosure period, of the event sequence under consideration.
CRCF = Canister Receipt and Closure Facility; IHF = Initial Handling Facility; ST = site transporter; TEV = transport and emplacement vehicle; WP = waste package.

Source: Original

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ATTACHMENT H
SAPHIRE MODEL AND SUPPORTING FILES

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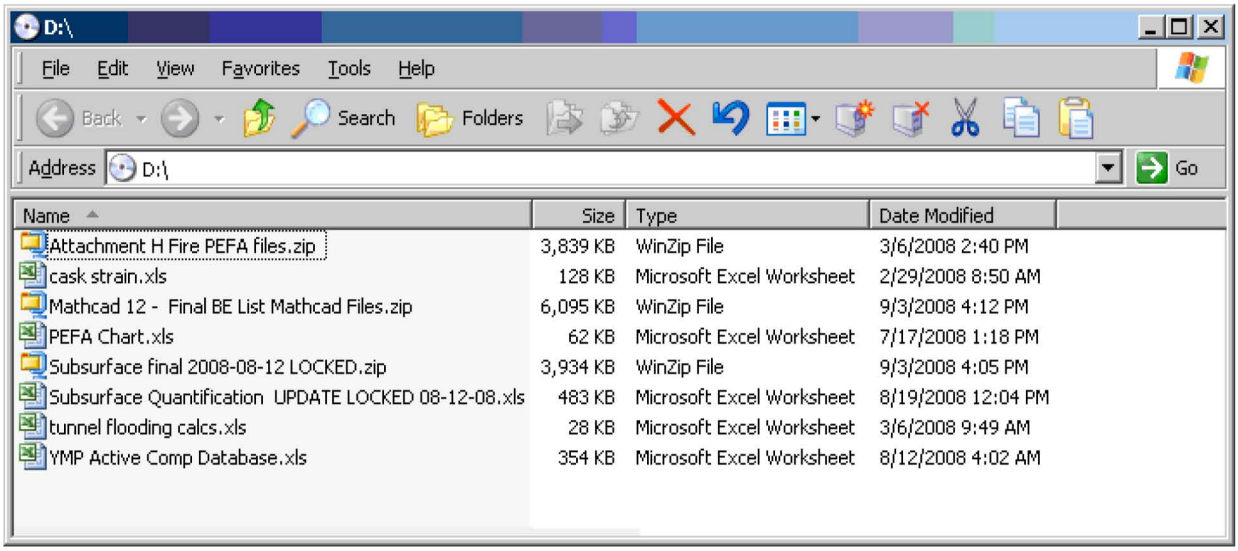
ATTACHMENT H
SAPHIRE MODEL AND SUPPORTING FILES

This attachment is the CD containing the SAPHIRE model and supporting files. The electronic files contained on the CD are identified below.



Name	Size	Type	Date Modified
Attachment H Fire PEFA files.zip	3,839 KB	WinZip File	3/6/2008 2:40 PM
cask strain.xls	128 KB	Microsoft Excel Worksheet	2/29/2008 8:50 AM
Mathcad 12 - Final BE List Mathcad Files.zip	6,095 KB	WinZip File	9/3/2008 4:12 PM
PEFA Chart.xls	62 KB	Microsoft Excel Worksheet	7/17/2008 1:18 PM
Subsurface final 2008-08-12 LOCKED.zip	3,934 KB	WinZip File	9/3/2008 4:05 PM
Subsurface Quantification UPDATE LOCKED 08-12-08.xls	483 KB	Microsoft Excel Worksheet	8/19/2008 12:04 PM
tunnel flooding calcs.xls	28 KB	Microsoft Excel Worksheet	3/6/2008 9:49 AM
YMP Active Comp Database.xls	354 KB	Microsoft Excel Worksheet	8/12/2008 4:02 AM

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