REQUEST FOR ADDITIONAL INFORMATION
VOLUME 2 - Preclosure
CHAPTER 2.1.1.3 - Identification of Hazards and Initiating Events
2nd SET (RAIs #1 to #18)

The following questions pertain to DOE's fire and explosion hazards assessment that is used to support its Preclosure Safety Analysis (PCSA) in the Safety Analysis Report (SAR). This information is needed to assess whether or not DOE has demonstrated compliance with 10 CFR 63.112(b), (c), and (d), which require DOE to include in the PCSA (SAR sections 1.6 and 1.7) an identification and systematic analysis of naturally occurring and human-induced hazards, the data used, and the technical basis for either inclusion or exclusion of these hazards in the safety analysis. In addition to the SAR, these questions also refer to other preclosure documents on the docket.

Note: Unless otherwise specified, references cited in the following RAIs are from SAR section 1.7.

RAI # 1

(a) Justify the applicability of the fire hazard assessment methodology in SAIC (2002), "Chemical Agent Disposal Facility Fire Hazard Assessment Methodology". This methodology, developed for chemical agent disposal facilities, is used to assess the fire potential at the repository facilities. The applicability of this methodology to nuclear operations involving high level waste has not been provided.

(b) Provide the fire hazard assessment methodology documented in SAIC (2002).

(c) Explain why NUREG/CR-6850 is needed to supplement the methodology documented in SAIC (2002) and demonstrate that these two methodologies have been implemented in a consistent manner. Explicitly identify where each methodology (described in SAIC 2002 and in NUREG/CR-6850) has been used. For example, see Attachment F of BSC (2008b).

RAI # 2

Justify the applicability of the values for parameters C_1, C_2, r, and s, to determine the annual fire frequency per unit floor area for the repository facilities. Although the reference is to the Canister Receipt and Closure Facility, the same equation was used for the other facilities of the repository.

The specific values for these four parameters of equation F.III 1, as used in BSC (2008b), were developed using a Finnish fire-related accident database, maintained by the Finnish Ministry of the Interior, for industrial buildings. No justification has been made with regard to the fire events or the buildings in the Finnish database being similar to potential fire events and the facilities at the repository, response of the fire departments, and types of fires.

RAI # 3

Provide the technical basis for the scoring methodology and individual point scores used to develop the ignition source frequencies.

SAR Section 1.7.1.2.2, Event Sequences Initiated by Fire Events, and Attachment F Fire Analysis of BSC (2008b) discuss the methodology used to quantify ignition frequencies from different sources in different rooms of a facility. DOE assigned a score to a particular equipment type to estimate the ignition frequency. For each type of equipment, a score has been assigned by weighting the individual ignition frequency by “either the actual count of sources, a weighted point score of sources, or, for the case of no equipment involved, the total floor area of the facility” (BSC, 2008b, Section F5.3 Ignition Source Frequency). The method for assigning weights to each equipment category differs based on the piece of equipment, but has not been justified. For example, internal combustion engines are given a score of 100 whereas electrical motors are given a score of 1 only if it is over 5 hp. On the contrary, welding units are given a score of 1 per hour of use. No consideration for the duration through which the motor would be running has been given.

RAI # 4

Explain why the fire ignition frequency of a facility over the preclosure period (3.1 events during the preclosure period), given in Table F5.2-1 of BSC (2008b), is not same as the overall facility ignition frequency (3.7 events during the preclosure period), given in Table F5.5-1 of BSC (2008j).

The overall facility frequency was calculated using Equation F-1 of BSC (2008b). The calculation method is provided in “CRCF Fire Frequency – No Suppression jwm.xls” included in Attachment H of BSC (2008b), and in Table F5.5-1 of BSC (2008b). In addition, the overall frequency is distributed by ignition category and by room, as described in Sections F4.3.2.1 through F4.3.2.3 of BSC (2008b).

RAI # 5

(a) Justify the creation of new categories of flame damage extent, used to estimate the propagation probability for fires away from the ignition source. The data used, Table 29 of Ahrens (2007) (see BSC 2008b) shows zero observations.

(b) Justify using 0.33 events for these new categories when there was no observed event resulting in a change of estimated probability values.

Table F.II-2 of BSC (2008b) uses the information presented in Table 29 of Ahrens (2007) although it added three new categories with zero observation. Addition of 0.33 events to a new category has resulted in a conclusion that the propagation probability of ignition sources away from the waste package would not be identical to the propagation probability for ignition sources originating in adjacent rooms.

RAI # 6

Verify that the derivation of the overall initiating event probabilities accounts for all large fire initiating event probabilities outlined in Attachment H ("CRCF Fire Frequency – No Suppression jwm.xls") of BSC (2008b). Although the reference is to the Canister Receipt and Closure Facility, the same equation was used for the other facilities of the repository.

The "Initiating Event Frequency" sheet of, "CRCF Fire Frequency – No Suppression jwm.xls" describes 19 large-fire initiating events for the CRCF. These events provide initiating event frequencies per waste form and for different locations within the CRCF. Review of the probabilities given in Column D of the "Crystal Ball Results" sheet of "CRCF Fire Frequency – No Suppression jwm.xls" indicates that the probabilities found in Cells K205 to K223 on the "Initiating Event Frequency" sheet are inconsistently applied. For example, Cell K215, "Large Fire Threatens HLW and DOE-SNF in WP" and Cell K222, "Large Fire Threatens DPC (VTC) in CTM" are omitted from the calculations on the "Crystal Ball Results" sheet. Similarly, "Large Fire Threatens TC/DOE SNF (Diesel Present)," "Large Fire Threatens TC/DOE SNF (No Diesel)," and "Large Fire Threatens DOE SNF-MCO in CTM (per canister)" are counted in two cumulative probabilities. No explanation has been provided.

RAI # 7

(a) Justify using data for Chemical, Plastic, or Petroleum Production Facilities or Industrial Chemical, Hazardous Chemical, and Plastic Facilities to estimate frequencies of fire related initiating events at the repository (BSC, 2008j). DOE has assumed that the intra-site operations at the repository are similar to Chemical, Plastic, or Petroleum Production Facilities. In DOE's alternative analysis, intra-site operations are assumed similar to Industrial Chemical, Hazardous Chemical, and Plastic Facilities without any justification. Since none of these facilities handle any nuclear materials, justification is necessary to establish the appropriateness of these databases for estimating the ignition frequency of the intra-site operations.

(b) Explain the applicability of the two databases and resulting uncertainties used to estimate the frequency of initiating events at the intra-site facilities. Neither database deals with facilities handling nuclear materials. DOE used the National Fire Protection Association (NFPA) database for Chemical, Plastic, or Petroleum Products. As responses to NFPA query seeking information for this database are voluntary, NFPA adjusts the database to account for the uncertainty. The other database used is the Census Bureau database for 1997, also for Petroleum and Coal Products manufacturing, Chemical Manufacturing, and Plastic Product Manufacturing, but these two databases do not deal with exactly the same population. Consequently, as the census database is used as the denominator to estimate the ignition frequency, it is expected that it will result in a low estimate of facilities manufacturing chemical, plastic, and petroleum products. Although in Section F5.2.4 Uncertainty, BSC (2008b) has acknowledged the quality of these databases and arbitrarily added a large uncertainty associated with estimation (error factor = 15), the appropriateness of the estimated mean ignition frequency is not established. The categorization based on the frequency of occurrence is conducted at the mean level.

(c) Provide the calculations used to estimate the fire-related initiating event frequencies, provided in BSC (2008j). BSC (2008j) has calculated the annual frequency of potentially significant outside fire using census data of 1997 (codes 324, 325, and 3261) of chemical, plastic, or petroleum production facilities in the country; however, the full calculation is not provided.

RAI # 8

Explain why the methodology used to estimate the margin of error for fire ignition sources, described on page F-102 of BSC (2008b), could be applied to data sets containing only a few events. Although the reference is to the Canister Receipt and

Closure Facilities, the same need applies to analyses of fire-related initiating event frequencies for other facilities.

The confidence interval associated with the ignition source category (Tables FII-5 and FII-6 of BSC, 2008b) and extent of flame damage (Tables FII-7 through FII-10 of BSC, 2008b) for fire related event scenarios is calculated based upon the margin of error. Estimation of the margin of error assumes that the frequency associated with each event follows a binomial distribution and the sample size is large enough to use a normal distribution approximation to the binomial distribution in obtaining the interval limits. The normal approximation is appropriate when the sample size is large. This often is interpreted to mean that there are at least 10 occurrences of the event in question and at least 10 occurrences of other outcomes. However, Table F.II-1 of BSC (2008b) lists four events involving the internal combustion ignition source, a number not large enough to be used for normal distribution approximation. Similarly, both Tables F.II-2 and F.II-3 of BSC (2008b) list several categories of fire damage with only five or less events.

RAI # 9

(a) Explain how the confidence limits for the fire ignition frequency, shown on Figure FIII-5 of BSC (2008b), capture the 95% confidence interval for ignition frequency.

(b) Provide the calculations to estimate the confidence intervals and the correct Figures F.III-3 and F.III-4, as they are currently blank figures in BSC (2008j). Although the reference is to the Canister Receipt and Closure Facility, the same equation was used for the other facilities of the repository.

The confidence limits were developed from eight data values read from Figure F-III.1 of BSC (2008b). The development of the confidence interval, described on pages F-112 and F-113 of BSC (2008b), involves a regression analysis. No information in terms of the value of the coefficient of determination has been provided to show how well the eight data points fit a linear relationship in the log of the ignition frequency and the log of the floor area space. Additionally, it is not clear how the confidence intervals have been calculated using Equations FIII-2 through F.III-4.

RAI # 10

(a) Explain how the statistical distribution was determined for a basic event, shown in Table 6.3-10 of BSC (2008b), which was input to the SAPHIRE model.

(b) Explain the rationale behind the selected statistical distribution of ignition frequency, ignition source category, and extent of flame damage in the fire analysis.

It is not clear how the statistical distribution of a basic event with associated parameter values was determined. For example, cells E4 and E5 of Table 6.3-9 of BSC (2008b) indicate values of 1.2E–07 and 1.3E–07 for “On CTT in cask Unloading Room” and “Cask Unloading Room (diesel present),” respectively. Table 6.3-10 of BSC (2008b) indicates for basic event 060-TADAO-CUR-DIESEL that the frequency has been calculated to be 2.5E-07 by summing cells E4 and E5 of Table 6.3-9. Excel spreadsheet, “CRCF Fire Frequency – No Suppression jwm.xls,” included in Attachment H to BSC (2008j), and Table 6.5-4 of BSC (2008b) show that 1.2E–07 and 1.3E–07 are the mean values of lognormal distributions and were used to develop the distribution for the basic event 060-TADAO-CUR-DIESEL. It is not clear how DOE determined the resulting distribution for this basic event would also be lognormal with a mean of 2.5E-07 and, as determined from the SAPHIRE model “CRCF Event Trees 2008-02-27 Locked.zip” included in Attachment H to BSC (2008b), an error factor of 2.3. Generally, addition of two lognormally distributed parameters would not result in a lognormally distributed parameter with mean equal to summation of two individual mean values. In addition, the Excel spreadsheet, “CRCF Fire Frequency – No Suppression jwm.xls” indicates an error factor of 2.2 for the same basic event, not 2.3 as in the SAPHIRE model. Moreover, no justification has been provided why the ignition source category and extent of flame damage would be normally distributed.

RAI # 11

Justify the methodology used to determine the statistical distribution of the fire-related initiating event frequencies.

Appendix F.IV of BSC (2008b) Attachment F discusses how statistical distribution of the fire-related initiating event frequencies has been determined. No technical basis, such as goodness-of-fit tests, has been provided to justify why the resulting distribution of fire-related initiating event frequencies would be lognormal. Although the reference is to the Canister Receipt and Closure Facilities, the same need applies to analyses of fire-related initiating event frequencies for other facilities.

RAI # 12

Provide the input and formulas that were used in Crystal Ball to generate the results displayed in spreadsheets, “CRCF Fire Frequency – No Suppression jwm.xls” and

"CRCF CB Report.xls" included in Attachment H of BSC (2008b). Although the reference is to the Canister Receipt and Closure Facilities, the same need applies to analyses of fire-related initiating event frequencies for other facilities.

RAI # 13

Show that fuel tanks of the site transporter, cask tractor, cask transfer trailer, and site prime mover, constructed using low-temperature melt material, would be able to conduct their intended safety functions.

BSC (2008j, Table 6.0-2) excluded any potential explosions of fuel tank of site transporter, cask tractor, cask transfer trailer, and site prime mover as an initiating event based on using a low-temperature melt material to construct the fuel tanks without identifying the material or its characteristics, usability, and effectiveness for the intended purpose. Additionally, there is no discussion whether there would be any adverse effects on the fire characteristics by using such material.

RAI # 14

Demonstrate that the missiles generated from explosion of the tanker truck, supplying diesel fuel to the diesel storage tank, described in SAR Section 1.6.3.4.9 Onsite Hazardous Material Release, would not initiate an event sequence associated with the transportation cask.

In BSC (2008j), DOE concluded that the transportation cask would not suffer any adverse effects from explosion of the supply tanker truck as the transportation cask is designed for an air overpressure of 140 kPa [20 psi]. NRC Regulatory Guide 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants." Washington, DC: U.S. Nuclear Regulatory Commission, states that if the air overpressure from the explosion is larger than 7 kPa [1 psi], additional analysis to asses the effects of missiles resulting from the explosion shall be conducted.

RAI # 15

Justify why a vegetation fire from outside the GROA or within the GROA, as described in SAR Section 1.6.3.4.10 External Fires, would not contribute to the intra-site fire potential.

BSC (2008j) assumed that the frequency of fires at the intra-site operations would be similar to those from other industrial facilities and estimated the frequency; however, no rationale has been provided for ignoring the potential contribution from vegetation fires outside the GROA or within the GROA at the Yucca Mountain facilities.

RAI # 16

Provide the analysis that justifies the minimum standoff separation distance for structures from the effects of a wildfire and the procedural safety control that will be placed to maintain safe distances from vegetation, as described in SAR Section 1.6.3.4.10 External Fires.

BSC (2004) ("Wildfire Exposure Calculation". 000–00C–MGR0–00400–000–00A) from SAR section 1.6 has analyzed the minimum distance necessary between the vegetation and the structures to protect them from range fires; however, this document is not on the docket.

RAI # 17

Provide the technical basis for the large fire propagation probability estimate for the Low Level Waste Facility, as provided in BSC (2008j).

The large fire propagation probability for the Low Level Waste Facility was changed from 0.105 to 0.165 in the *000-PSA-MGR0-00900-000a09-Mar-11-2008.xls* spreadsheet under the 'oldL Plumb LLWF Fire' tab, accounting for a failed fire suppression system. However, no explanation has given what factors have been considered to make such changes and how the new value has been established.

RAI # 18

Justify the error factor of 2 used for fire ignition frequency at Low Level Waste Facility in BSC (2008j), Intra-Site Operations and BOP Reliability and Event Sequence Categorization Analysis." 000–PSA–MGR0–00900–000, Rev. 00A.

The error factor for the estimated fire frequency of the Low Level Waste Facility is taken as 2 in BSC (2008j). Two sources are given for this value: 1) Appendix F.I in Attachment F of BSC (2008j) and 2) an email copied under the 'L Plumb LLWF Fire Feb 27' tab of spreadsheet *000-PSA-MGR0-00900-000a09-Mar-11-2008.xls* from BSC (2008j). However, Table F.I-2 of Attachment F.I of BSC (2008j), which gives the error factor equal to 2, notes that mean and median values used to calculate error factor are not values estimated for the Low Level Waste Facility at Yucca Mountain repository. They are for fires in industrial buildings in Finland. On the contrary, analysis for event sequence ISO-ESD07-LLW, given under the ESD07 tab of the *000-PSA-MGR0-00900-000a09-Mar-11-2008.xls* spreadsheet, assumed the error factor to be 10.