15 ACCIDENT ANALYSIS

15.1 Conduct of Review

The staff evaluated the Foster Wheeler Environmental Corporation accident analysis by reviewing Chapter 8, “Accident Analysis,” of the Safety Analysis Report (SAR) (Foster Wheeler Environmental Corporation, 2003a), documents cited in the SAR, and other relevant publicly available information, including web sites on the Internet. The selection of off-normal and accident event scenarios is based on the generic list identified in NUREG–1567 (U.S. Nuclear Regulatory Commission, 2000). In addition, the Idaho Spent Fuel (ISF) Facility SAR included facility-specific events.

The staff reviewed the accident analysis to determine if the following regulatory requirements have been met:

- 10 CFR §72.90 requires that (a) site characteristics that may directly affect the safety or environmental impact of the Independent Spent Fuel Storage Installation (ISFSI) must be investigated and assessed; (b) proposed sites for the ISFSI must be examined with respect to the frequency and the severity of external natural and man-induced events that could affect the safe operation of the ISFSI; (c) design basis external events must be determined for each combination of proposed site and proposed ISFSI design; (d) proposed sites with design basis external events for which adequate protection cannot be provided through ISFSI design shall be deemed unsuitable for the location of the ISFSI; (e) pursuant to subpart A of Part 51 of Title 10 for each proposed site for an ISFSI, the potential for radiological and other environmental impacts on the region must be evaluated with due consideration of the characteristics of the population, including its distribution, and of the regional environs, including its historical and esthetic values; and (f) the facility must be sited so as to avoid to the extent possible the long-term and short-term adverse impacts associated with the occupancy and modification of floodplains.

- 10 CFR §72.92 requires that (a) natural phenomena that may exist or that can occur in the region of a proposed site must be identified and assessed according to their potential effects on the safe operation of the ISFSI. The important natural phenomena that affect the ISFSI design must be identified; (b) records of the occurrence and severity of those important natural phenomena must be collected for the region and evaluated for reliability, accuracy, and completeness. The applicant shall retain these records until the license is issued; and (c) appropriate methods must be adopted for evaluating the design basis external natural events based on the characteristics of the region and the current state of knowledge about such events.

- 10 CFR §72.94 requires that (a) the region must be examined for both past and present man-made facilities and activities that might endanger the proposed ISFSI. The important potential man-induced events that affect the ISFSI design must be identified; (b) information concerning the potential occurrence and severity of such events must be collected and evaluated for reliability, accuracy, and completeness; and (c) appropriate methods must be adopted for evaluating the design basis external man-induced events, based on the current state of knowledge about such events.

- 10 CFR §72.98(a) requires that the regional extent of external phenomena, man-made or natural, that are used as a basis for the design of the ISFSI be identified.

- 10 CFR §72.98(c) requires that those regions identified pursuant to paragraphs §72.98(a) and §72.98(b) be investigated as appropriate with respect to (1) the present and future character and the distribution of population, (2) consideration of present and projected future uses of land and water within the region, and (3) any special characteristics that may influence the potential consequences of a release of radioactive material during the operational lifetime of the ISFSI.

- 10 CFR §72.106(b) requires that any individual located on or beyond the nearest boundary of the controlled area not receive from any design basis accident the more limiting of a total effective dose equivalent (TEDE) of 0.05 Sv [5 rem], or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 0.5 Sv [50 rem]. The lens of the eye dose equivalent shall not exceed 0.15 Sv [15 rem], and the shallow dose equivalent to skin or to any extremity shall not exceed 0.5 Sv [50 rem]. The minimum distance from the spent fuel or high-level radioactive waste handling and storage facilities to the nearest boundary of the controlled area must be at least 100 m [328 ft].

- 10 CFR §72.122(b) requires that (1) structures, systems, and components important to safety be designed to accommodate the effects of, and to be compatible with, site characteristics and environmental conditions associated with normal operation, maintenance, and testing of the ISFSI and to withstand postulated accidents; and (2) structures, systems, and components important to safety must be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, lightning, hurricanes, floods, tsunami, and seiches, without impairing their capability to perform safety functions. The design bases for these structures, systems, and components must reflect (i) structures, systems, and components important to safety must be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, lightning, hurricanes, floods, tsunami, and seiches, without impairing their capability to perform their intended design functions. The design bases for these structures, systems, and components must reflect (A) appropriate consideration of the most severe of the natural phenomena reported for the site and surrounding area, with appropriate margins to take into account the limitations of the data and the period of time in which the data have accumulated, and (B) appropriate combinations of the effects of normal and accident conditions and the effects of natural phenomena. (ii) The ISFSI also should be designed to prevent massive collapse of building structures or the dropping of heavy objects as a result of building structural failure on the spent fuel, high-level radioactive waste, or on to structures, systems, and components important to safety.

- 10 CFR §72.122(c) requires that structures, systems, and components important to safety must be designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions. Noncombustible and heat-resistant materials must be used wherever practical throughout the ISFSI, particularly in locations vital to the control of radioactive materials and to the maintenance of safety control functions. Explosion and fire detection, alarm, and suppression systems shall be designed and provided with sufficient capacity and

capability to minimize the adverse effects of fires and explosions on structures, systems, and components important to safety. The design of the ISFSI must include provisions to protect against adverse effects that might result from either the operation or the failure of the fire suppression system.

- 10 CFR §72.122(h)(1) requires that the spent fuel cladding must be protected during storage against degradation that leads to gross ruptures or the fuel must be otherwise confined such that degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage. This may be accomplished by canning of consolidated fuel rods or unconsolidated assemblies or other means as appropriate.

- 10 CFR §72.122(h)(4) requires that storage confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions. For dry spent fuel storage, periodic monitoring is sufficient provided that periodic monitoring is consistent with the dry spent fuel storage cask design requirements. The monitoring period must be based upon the spent fuel storage cask design requirements.

- 10 CFR §72.122(h)(5) requires that the waste must be packaged in a manner that allows handling and retrievability without the release of radioactive materials to the environment or radiation exposures in excess of part 20 limits. The package must be designed to confine the high-level radioactive waste for the duration of the license.

- 10 CFR §72.122(i) requires that instrumentation and control systems must be provided to monitor systems that are important to safety over anticipated ranges for normal operation and off-normal operation.

- 10 CFR §72.122(l) requires that storage systems must be designed to allow ready retrieval of spent fuel, high-level radioactive waste for further processing or disposal.

- 10 CFR §72.124(a) requires spent fuel handling, packaging, transfer, and storage systems must be designed to be maintained subcritical and to ensure that, before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. The design of handling, packaging, transfer, and storage systems must include margins of safety for the nuclear criticality parameters that are commensurate with the uncertainties in the data and methods used in calculations and demonstrate safety for the handling, packaging, transfer, and storage conditions and in the nature of the immediate environment under accident conditions.

- 10 CFR §72.128(a)(2) requires that spent fuel storage be designed with suitable shielding for radioactive protection under normal and accident conditions.

The proposed ISF Facility must be sited, designed, constructed, and operated in compliance with the previously mentioned regulatory requirements, so that the public health and safety is adequately protected during all credible off-normal and accident events.

15.1.1 Off-Normal Events

The off-normal events are described in Section 8.1, "Off-normal Events," of the SAR. This section of the Safety Evaluation Report (SER) discusses results from the review of potential off-normal conditions arising from facility operations. The off-normal events, referred to as Design Event II, according to American National Standards Institute/American Nuclear Society (ANSI/ANS) ANSI/ANS 57.9 (1984), are those events expected to occur with moderate frequency, or approximately once per calendar year. The off-normal events identified in the SAR have been categorized as transfer cask events, fuel packaging events, fuel storage events, and waste handling events based on specific operations and areas in the ISF Facility where these operations are conducted. Additional events not related to any specific operations are categorized as other events.

15.1.1.1 Misventing of Transfer Cask

The staff reviewed the information presented in Section 8.1.1.1 of the SAR, "Misventing of Transfer Cask," as an off-normal event. This event is postulated to occur as a result of operator error or failure of equipment during venting of the U.S. Department of Energy transfer cask in the decontamination zone of the Transfer Tunnel. In the venting operation, the transfer cask is attached to the portable continuous air monitor and flammable gas monitor. The transfer cask atmosphere is filtered, monitored, and released through the portable continuous air monitor to the building system. The misventing event could potentially release the contaminated gases of the transfer cask directly into the cask decontamination zone. The event would be detected by operator observation, area radiation monitors, and continuous air monitors, including additional monitoring by health physicists. The SAR evaluated the potential for generating hydrogen gas in a flammable concentration in the cask. The SAR determined that the time required to generate a flammable quantity of hydrogen gas in the transfer cask cavity is 5.8 days. Because the turnover period (receive, unload, and return) of the transfer cask is typically within 48 hours, generation of a flammable quantity of hydrogen gas without detection and mitigation is considered highly unlikely and was not further analyzed.

The total effective dose equivalent (TEDE) to the worker for this event is estimated to be 0.1 mSv [10 mrem], received by inhalation of the gaseous radionuclides released by misventing of the transfer cask. The worker is assumed to be exposed for a duration of 10 minutes. This TEDE is significantly less than the occupational dose limit of 50 mSv/yr [5 rem/yr] as specified in 10 CFR Part 20. The SAR stated the radiological consequences to the public at the site boundary from this event would be minimal because the radionuclides would be significantly dispersed over such a great distance, if there was any leakage from the confinement area. If the event occurred, the venting operations would be terminated, and the cask decontamination zone would be decontaminated. In addition, the cause of the event would be determined and corrective actions implemented to prevent recurrence of the event.

The staff reviewed the analysis including methodology, assumptions, and data used for assessing the potential for flammable gas generation and potential consequences from release of radionuclides to the workers and public. Based on the information and analysis provided, the staff concludes that the applicant's evaluation of misventing of the transfer cask as an off-normal event is adequate in providing assurance that the ISF Facility operations can be conducted without endangering the health and safety of the public.

15.1.1.2 Cask Drop Less Than Design Allowable Height

This off-normal event is bounded by the transfer cask drop accident. Evaluation of a transfer cask drop accident during hoisting operations is discussed in Section 15.1.2.2 of this SER.

15.1.1.3 Attempt to Lower Fuel Container into Occupied Fuel Station

The staff reviewed the information presented in Section 8.1.2.1 of the SAR, “Attempt to Lower Fuel Container into Occupied Fuel Station,” as an off-normal fuel packaging event. The postulated event is attributed to potential operator error during fuel handling activities in the fuel packaging area (FPA). The operator, using the fuel handling machine (FHM), may attempt to lower the U.S. Department of Energy baskets, the ISF baskets, or canisters into fuel stations (bench containment vessel) or the trolley that is already occupied by containers loaded with spent nuclear fuel (SNF). As the container ceases to descend, the event would be detected by visual observation of the load indicator instrumentation located at the control station, FHM hoist trip caused by slack in the hoist rope, or both. The SAR considers this event to be unlikely because the fuel handling activities would be monitored from the shielded windows at the operator station and by video monitor. Additionally, procedures would require operators to confirm that the fuel stations are not occupied before lowering the containers. The FHM hoist, designed to operate at variable speeds ranging from 0.15 to 4.27 m/min [0.5 to 14 ft/min], would be operated at creep speeds during the final descent of the containers. The ISF basket descending at maximum descent speed of 4.27 m/min [14 ft/min] will result in deceleration of 6.7g on impact. The deceleration analysis presented in the SAR is based on the impact of an elastic bar onto a hard unyielding surface. The calculated deceleration impact of an ISF basket is bounded by the vertical load of 10g used in seismic design, discussed in Section 5.1 of this SER. As discussed in Section 8.1.2.1 of Appendix A of the SAR, U.S. Department of Energy containers and baskets are designed for deceleration resulting from the event. Therefore, retrievability of the U.S. Department of Energy basket, ISF basket, or canister is ensured.

The criticality analysis was conducted in Section 4.7.3.4 of the SAR and examined two adjacent TRIGA fuel baskets, one TRIGA canister on top of another, and two closely packed groupings of 18 Peach Bottom elements side-by-side. The Shippingport fuel modules are not enriched, and fissile material is not present in sufficient quantity for a criticality safety concern. A bounding criticality analysis, discussed in Section 4.7.3.4 of the SAR, concludes the criticality potential is not significant for the postulated events. Demonstration of compliance with criticality requirements is discussed in Chapter 8, “Criticality Evaluation,” of this SER. Therefore, the radiological consequence is insignificant from this postulated impact. Additionally, the FPA provides confinement for the fuel, thereby protecting the public or workers from radiological consequences. If the event occurred, the baskets, canisters, and lifting devices would be examined to ensure they would remain within design basis for further use. The fuel would be transferred to another basket, if required. In addition, the cause of the event would be determined, and corrective actions would be implemented by the licensee to prevent recurrence of the event.

Based on the preceding information, the staff concludes that the applicant’s evaluation of the attempt to lower fuel containers into an occupied fuel station as an off-normal event is adequate in providing assurance that ISF Facility operations can be conducted without endangering the health and safety of the public.

15.1.1.4 Attempt to Load Fuel Element into Full ISF Basket

The staff reviewed the information presented in Section 8.1.2.2 of the SAR, “Attempt to Load Fuel Element into Full ISF Basket,” as an off-normal fuel packaging event. The event is postulated to occur during transfer of fuel elements from the U.S. Department of Energy containers to the ISF basket in the FPA. The operator, using the FHM, may attempt to lower the fuel elements into fully loaded ISF baskets. As the fuel ceases to descend, the event would be detected by visual observation of the load indicator instrumentation located at the control station, FHM hoist trip caused by slack in the hoist rope, or both. The applicant considers this event to be unlikely because the fuel handling activities would be monitored from the shielded windows of the operator station and by video monitor. Additionally, procedures would be required to verify the ISF basket is not occupied before lowering the fuel elements. The FHM hoist, which is designed to operate at variable speeds ranging from 0.15 to 4.27 m/min [0.5 to 14 ft/min], would be operated at creep speeds during the final descent. Failure of fuel element during handling is discussed in Section 15.1.1.5 of this SER.

As indicated in Section 4.7.3.4 and Appendix 4A of the SAR, the criticality analysis for this event is bounded by the criticality evaluation of two adjacent TRIGA fuel baskets or two closely packed groupings of 18 Peach Bottom elements side-by-side. In addition, the SAR concludes that no significant consequence would result from the event because the FPA provides confinement for the fuel. If the event occurred, the fuel element can be recovered and placed in a temporary storage location. In addition, the cause of the event would be determined, and corrective actions would be implemented by the licensee to prevent recurrence of the event.

The staff concludes that the applicant’s evaluation of the attempt to lower a fuel element into a full ISF basket as an off-normal event is adequate in providing assurance that ISF Facility operations can be conducted without endangering the health and safety of the public.

15.1.1.5 Failure of Fuel Element During Handling

The staff reviewed the information presented in Section 8.1.2.3 of the SAR, “Failure of Fuel Element During Handling,” as an off-normal event in the FPA. Several types of operator errors during fuel element handling are postulated as potential initiators for this event, for example, hitting the suspended fuel element with a master/slave manipulator (MSM) or the power manipulator system (PMS) during inspection, moving the FHM transversely with the fuel element partially inserted in the fuel container or fuel station, or the fuel element striking an object outside the intended load path. The event is considered unlikely because the movement and operation of the FHM are controlled through a programmable logic controller (PLC). The FHM will be operated at creep speed when SNF and SNF containers are lifted or inserted into a fuel container or FPA fuel station. In addition, the interlocks in the FHM allow only a single action during operation (i.e., hoisting and transverse travel are precluded at the same time). Administrative controls would also be enforced on the movement and operation of the FHM. The TRIGA and Shippingport fuel elements are in metal cladding, whereas the Peach Bottom fuel is clad in pyrolytic carbon. Consequently, if the event occurred, only the Peach Bottom fuel element is expected to be damaged. The event, however, would take place within the confinement area of the FPA, therefore, the consequences to the public and workers from this event are not likely to exceed the regulatory limits. Criticality of the TRIGA or Peach Bottom fuel is bounded by the scenarios involving two adjacent TRIGA fuel baskets or two closely

packed groupings of 18 Peach Bottom elements side-by-side. Demonstration of compliance with criticality requirements for this event is discussed in Chapter 8, “Criticality Evaluation,” of the this SER. If this event occurred, a recovery procedure would be developed and implemented to retrieve any pieces of the fuel element and place them in a temporary storage location. In addition, the cause of the event would be determined, and corrective actions would be implemented by the licensee to prevent recurrence of the event.

The staff concludes that the applicant’s evaluation of the failure of a fuel element during handling as an off-normal event is adequate in providing assurance that ISF Facility operations can be conducted without endangering the health and safety of the public.

15.1.1.6 Drop of Fuel Element During Handling

The staff reviewed the information presented in Section 8.1.2.4, “Drop of Fuel Element During Handling,” of the SAR as an off-normal event.

The fuel elements will be transferred in the FPA using the single-failure-proof FHM crane and hoist and single-failure-proof lifting devices. As discussed in Section 8.1.2.4 of the SAR, drop events for the Peach Bottom Core 1, non-instrumented TRIGA, and Shippingport fuel elements are precluded because these fuel types have single-failure-proof lifting fixtures. Drop events are postulated for the Peach Bottom Core 2, instrumented TRIGA, and Shippingport reflector fuel elements because these fuel types use friction-grip lifting fixtures, which are not single failure-proof lifting devices. As discussed in Section 8.1.2.4 of the SAR, several configurations resulting from a drop of the Peach Bottom Core 2 fuel, which bounds the other fuels, were evaluated for criticality. The analysis determined that dropped fuel will not cause criticality for the postulated configurations. Demonstration of compliance with criticality requirements is discussed in Chapter 8, “Criticality Evaluation,” of this SER. This event would occur within the confinement boundary of the FPA. Therefore, offsite and onsite doses would not exceed regulatory limits.

The staff finds that the potential drop of a fuel element during handling will not impair the ability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.7 Fuel Container Binding or Impact During Handling

The staff reviewed the information presented in Section 8.1.2.5 of the SAR, “Fuel Container Binding or Impact During Handling,” as an off-normal event.

Binding of a fuel container could occur during hosting as a result of the introduction of debris into the U.S. Department of Energy transfer cask or FPA fuel station, or misalignment of the FHM hoist. In addition, loaded fuel containers (both U.S. Department of Energy and ISF basket) in the FPA could impact with other equipment while lowering the basket in the fuel station or during transverse movement. The impact also may result from transverse movement of the fuel while the SNF is partially inserted in a container or fuel station. The FHM is used to handle the fuel basket, and the postulated event could occur because of operator error.

As indicated in the SAR, the impact would be detected by observation by the operators and binding would be detected by a FHM load indicator or activation of overload or underload interlocks. Damage to the container from impact and binding potential is not likely to be significant because the FHM operation is controlled with a PLC, interlocks, and load cell indicator. These features would ensure that the FHM would move at a creep speed near the activity area, allow only single action (longitudinal, transverse, or hoist movement) of the FHM, prevent a lift from the cask trolley unless the trolley is properly positioned and secured with locking pins, and prevent hoisting loads greater than the allowable load. If the event occurred, the damage will be contained within the FPA confinement area to preclude radiological consequences. Additionally, the damage will be localized. Therefore, any concern regarding retrievability and criticality of the SNF would be precluded.

Based on the information provided, the staff finds that the potential for fuel container binding or impact during handling will not impair the ability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.8 Malfunction of the ISF Canister Heating System

The staff reviewed the information presented in Section 8.1.2. 6 of the SAR, “Malfunction of ISF Canister Heating System,” as an off-normal event.

A loss of control of the canister heater module caused by equipment failure or operator error could result in worst-case heating of the ISF canisters in the canister closure area (CCA). The ISF canister is heated by the canister heater module to remove moisture. The temperature of the canister is the primary controlling parameter to ensure the canister is ready for closure. The canister heater includes a temperature monitor, control, and an alarm to indicate excess or loss of heat. As indicated in the SAR, the out-of-range temperature would be detected by instrumentation or personnel observation. The normal canister temperatures range from 26.7 EC [80 EF] to 37.8 EC [100 EF], and the maximum allowable clad temperature for the bounding TRIGA fuel is 204.4 EC [400 EF]. Assuming the minimum operating temperature at the Transfer Tunnel and the carbon fuel assembly saturated with water, a 10-kW [13.4-hp] heater would be required to support the required cycle time. In case the heater failed, the estimated time to reach the maximum temperature of 204 EC [400 EF] for aluminum-clad TRIGA fuel (limiting fuel type) is 48 hours. Thereby, the heater can be shut down within 48 hours and corrective action taken by the licensee. Radiological consequences and criticality are precluded for this event because there is no change of the fuel structural configuration.

Based on the information provided, the staff finds that the potential malfunction of the ISF canister heating system will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.9 Malfunction of the ISF Canister Vacuum Drying/Helium Fill System

The staff reviewed the information presented in Section 8.1.2.7 of the SAR, “Malfunction of ISF Canister Vacuum Drying/Helium Fill System,” as an off-normal event.

The loaded ISF canister will be vacuum dried and backfilled with helium at the CCA prior to the final seal weld of the canister vent plug. Equipment failure or operator error could cause

inadequate drying, insufficient helium backfill, or overpressurization of the canister with helium. This event potentially could lead to canister oxidation or an increase in the peak fuel temperature. As discussed in Section 8.1.2.7 of the SAR, this event would be detected by instrumentation provided in the vacuum drying system to monitor canister pressure and temperature. Failure to achieve required temperature, vacuum, or backfill pressure may require the process for vacuum or backfill pressure to be repeated. For a worst-case scenario with the bounding TRIGA fuel and no inert gas fill in an air-vacuumed canister, thermal calculations show that the temperature rise is below the allowable temperature. Overpressurization of the canister also is not credible because the helium fill system is designed to limit the pressure in the canister at 10–30 percent below the design pressure. In addition, the canister design includes an allowance for corrosion or erosion reduction in wall thickness, even though the internal and external walls of the canister will be immersed in an inert atmosphere, inhibiting corrosion during the storage period. No radiological consequences and no criticality are likely from this event as no change to the fuel or structural configuration is involved.

Based on the information provided, the staff finds that a malfunction of the ISF canister vacuum drying/helium fill system will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.10 Loss of Confinement Barrier

The staff reviewed the information presented in Section 8.1.2.8 of the SAR, "Loss of Confinement Barrier," as an off-normal event.

The event concerns the FPA and FHM maintenance area (collectively, the Transfer Area), because this area forms the confinement boundary when spent fuel transfer and handling activities are performed. The loss of the confinement boundary could result in potentially significant radiological consequences. The components that provide the confinement barrier are enclosure walls and doors, shield windows, transfer ports, exhaust high-efficiency particulate air (HEPA) filters, supply HEPA filters, through-wall penetration and seals, and ducts and dampers. A loss of confinement could be postulated to occur from component failure or potential operator error. As discussed in Section 8.1.2.8 of the SAR, the event would be detected by a sudden change in differential pressure; changes in operating parameters of the heating, ventilation, and air conditioning (HVAC) component; or observation of the HVAC system. The status of the HVAC system, including differential pressure and other operating parameters, is monitored from the visual indicators on the control panel. In addition, contamination resulting from the failure of ISF Facility systems or features to function as designed would be detected by monitoring instruments (e.g., fixed area radiation monitoring instrumentation and continuous airborne monitoring instrumentation) and routine area surveys. If loss of a confinement barrier is detected, processing would be suspended, and the barrier restored. Other recovery actions are discussed in the SAR.

The FPA and FHM maintenance areas are maintained at a negative pressure differential by the HVAC system, ensuring that air flows from clean to contaminated areas. The air is exhausted through the HEPA filters. The HVAC system is designed to detect the presence of significant size openings in the confinement barrier and to compensate by adjusting the controls. According to the SAR, loss of confinement because of a breach in the barrier would most likely occur at the transfer ports while moving SNF and waste canisters into and out of the FPA. The

ports between the transfer tunnel and the FPA are equipped with inflatable seals to fill the gap between the transfer ports and the transfer cask or trolley components. The seal will remain inflated during a loss of power event, ensuring a safe configuration of the fuel during unexpected shutdown of the ISF Facility. The maximum size of the opening developed as a result of failure of the inflatable seal is approximately 0.36 m^2 [4 ft^2], significantly smaller than an open port. Air will still flow into the FPA even if the seal fails and, therefore, would not lead to a loss of the confinement. The waste ports are not equipped with inflatable seals; however, they open into the enclosed solid waste processing area (SWPA). These ports will not be opened if fuel packaging activity is ongoing. Additionally, the enclosure of the waste area must be closed to open the waste ports. Therefore, any radiological contamination could be contained within the proposed ISF Facility.

Opening a wrong transfer port with no canister, cask, or waste vessel in place would develop an opening with a maximum size of approximately 2.52 m^2 [28 ft^2]. The most severe consequence from this event would be the release of radioactive materials in the transfer tunnel. The controlled HEPA filter environment in the transfer tunnel would contain the release of the radionuclides into the atmosphere while maintaining the pressure differential.

The HVAC system is designed to perform its safety-related functions. Redundant components will ensure that the confinement barrier remains intact during postulated conditions and events. Therefore, radiological consequences from loss of a confinement barrier are unlikely to exceed the 10 CFR Part 72 dose requirements. Additionally, this event does not change the fuel or its structural configuration. Therefore, it is also unlikely to have any criticality-related consequences.

Based on the information provided, the staff finds that the loss of a confinement barrier will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.11 Binding or Impact of the ISF Canister During Hoisting/Lowering Operations

The staff reviewed the information presented in Section 8.1.3.1 of the SAR, “Binding or Impact of ISF Canister During Hoisting/Lowering Operations,” as an off-normal event.

The ISF canister potentially could encounter binding in the storage area because of inadvertent transverse movement of the canister handling machine (CHM) while lifting the canister out of the canister trolley or lowering the canister into the storage tubes. Potential binding is prevented by the design features and interlocks that ensure that the trolley and CHM are seismically restrained before the canister is hoisted from the trolley. Interlocks also ensure that the CHM is locked into position before the canister is inserted into the storage tubes. A postulated collision of a loaded CHM with a CHM maintenance trolley left on the storage area floor because of an operator error would not cause the ISF canister to impact the CHM interior because of the low travel speed of the CHM and the significantly low weight of the trolley (approximately 1.5 percent of the weight of the CHM). In addition, interlocks and controls are provided to prevent collision of a loaded CHM with the building structure. Therefore, significant radiological consequences or criticality concerns from this event are not credible. Additionally, this event does not change the fuel or its structural configuration. Hence, any significant concern on criticality also is not credible.

Based on the information provided, the staff finds that binding or impact of the ISF canister during hoisting/lowering operations will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.12 ISF Canister External Contamination in Excess of Limits

The staff reviewed the information presented in Section 8.1.3.2 of the SAR, “ISF Canister External Contamination in Excess of Limits,” as an off-normal event.

This event involves radioactive contamination of exterior surfaces of the ISF canister above allowable limits resulting from incorrect or inadequate installation of contamination barriers, equipment failures, poor housekeeping, or operator error. The contamination would occur in the FPA or during transfer to the CCA. External surface contamination could also potentially occur during welding preparation activities. As discussed in Section 8.1.3.2 of the SAR, excessive contamination levels would be detected by routine monitoring by fixed radiation sensors and portable counters. Monitoring instruments are set to detect specific radiation levels and rates of change. Personnel access to the CCA process area will be controlled based on radiation levels monitored using area radiation monitors or continuous airborne monitors. The SAR provided recovery plans including descriptions of cleanup and decontamination activities if this event were to occur. Radiological consequences and criticality are precluded as there is no change in fuel or structural configuration.

Based on the information provided, the staff finds that ISF canister external contamination in excess of limits will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.13 Extended Operations with the ISF Canister in the CHM

The staff reviewed the information presented in Section 8.1.3.3 of the SAR, “Extended Operation with ISF Canister in CHM,” as an off-normal event.

For this postulated event, the ISF canister is retained in the CHM for an extended period because of work stoppage, equipment malfunction, or operator error. As discussed in Section 8.1.3.3 of the SAR, the bounding scenario involves canister heatup within the CHM at maximum off-normal temperature of 67.78 EC [154 EF]. A bounding thermal calculation in the storage area shows the maximum steady-state temperature for the fuel is 83.33 EC [182 EF] and for the CHM guide tube (the hottest component of the CHM), 71.67 EC [161 EF]. The calculated temperatures are within the design allowable fuel, equipment (CHM and canister), and ISF Facility temperatures. Therefore, the ISF canister integrity would be maintained, and CHM shielding would remain intact, precluding radiological consequence or criticality concerns.

Based on the information provided, the staff finds that extended operation with the ISF canister in the CHM will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.14 Malfunction of Storage Tube Evacuation/Helium Fill System

The staff reviewed the information presented in Section 8.1.3.4 of the SAR, "Malfunction of Storage Tube Evacuation/Helium Fill System," as an off-normal event.

The loaded ISF canister will be placed inside the storage tube in the storage area. After placement of the canister, the storage tube will be helium filled and sealed using the storage tube evacuation and helium fill system. The storage cell is backfilled with inert gas for preventing corrosion of the canister exterior. Equipment failure or operator error could cause insufficient helium in the tube or overpressurization of the tube with helium. As discussed in Section 8.1.3.4, this event would be detected by instrumentation provided in the vacuum drying system to monitor the storage pressure and temperature during the storage tube evacuation and filling process. Any equipment process failure or inadequate parameters are indicated to the operators by the instruments. Thermal calculations for a worst-case scenario with no inert gas in the tube and the bounding TRIGA fuel in the canister show the maximum steady-state temperature of 75.5 EC [168 EF] in the tube would not exceed the maximum allowable temperature. Overpressurization of the tube also is not credible because the helium fill system is designed to operate at 10–30 percent below the canister design pressure. Loaded storage tubes would be periodically tested to ensure the inert atmosphere is maintained during the storage period. In addition, the canister design includes an allowance for corrosion or erosion reduction in wall thickness. Malfunction of the storage tube evacuation and helium fill system would not adversely affect the canister, nor the fuel integrity, because the event would be detected during the evacuation and filling process and during the storage period. Therefore, no radiological consequences or criticality concerns are expected from this event.

Based on the information provided, the staff finds that a malfunction of the storage tube evacuation/helium fill system will not impair the ability of structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.15 Partial Air Inlet/Outlet Vent Blockage

The staff reviewed the information presented in Section 8.1.3.5 of the SAR, "Partial Air Inlet/Outlet Vent Blockage." In addition, the staff also reviewed the information presented in Section 8.2.4.1, "Adiabatic Heatup," of the SAR. Blockage may be caused by wind-driven debris, snow, ice, or volcanic ash accumulation, or inadvertent blocking caused by personnel error (Foster Wheeler Environmental Corporation, 2003a). Blockage would be detected during storage operations and routine surveillance. Identification of an overheated condition caused by blockage of airflow would dictate the frequency of monitoring. Partial blockage that may reach the maximum allowable fuel temperature limit would be detected well in advance, enabling personnel to take corrective measures. Foreign materials blocking cooling air inlets, outlets, or both can be observed easily and removed. Blockage of exterior vents can be rectified from outside the building without significant dose consequence. Blockage resulting from personnel error would be evaluated, and corrective actions would be taken.

In the SAR, the applicant asserted that 50-percent blockage of the cooling air inlets, outlets, or both for the storage area vaults, in accordance with NUREG–1567 (U.S. Nuclear Regulatory Commission, 2000), is not a credible off-normal event assumed to occur once a year at the proposed ISF Facility; rather, 25-percent blockage may be defined as a credible off-normal

event. Blockage of 50 percent of the cooling air inlets, outlets, or both would be an accident condition. SAR Section 8.2.4.1, "Adiabatic Heatup," provides information of the analysis conducted with 50-percent blockage of cooling air inlets, outlets, or both. The staff agreed with the applicant's position. A scenario in which 50 percent of the storage vault air inlet vents are blocked bounds the off-normal event of 25-percent blocked cooling air inlets and outlets.

The analysis with 50-percent blockage, reviewed in Section 15.1.2.10, "Adiabatic Heatup," of this SER, demonstrated partial vent blockage would not impair the storage tube's ability to maintain subcriticality, confinement, and sufficient shielding of the stored fuel. Additional review of 50-percent blockage of the cooling air inlets, outlets, or both is given in Section 6.1.1, "Decay Heat Removal Systems," of this SER.

15.1.1.16 Breach of Waste Package in the Radioactive Waste Area

The staff reviewed the information presented in Section 8.1.4.1 of the SAR, "Breach of Waste Package in the Radioactive Waste Area," as an off-normal event.

The event involves breach of waste containers within the SWPA. Radioactive waste from various sources may be placed in these containers, but they do not contain SNF. Equipment failure or operator error could potentially drop or impact waste containers with sufficient force to cause a breach. Other specific scenarios postulated are drops of waste containers from the FPA to the SWPA through the transfer port and impacting of a waste container with a fork lift. As discussed in Section 8.1.4.1 of the SAR, the SWPA is designed as a radiological enclosure with features to control spread of contamination to the environment or other areas of the ISF Facility. Any breach of contamination above the allowable limits, resulting from drop of a waste container from the FPA, would be detected by routine radiological monitoring, and the waste would be isolated to prevent release. During lift operations, for example, the speed will be controlled to minimize damage to waste containers. The SWPA will be designed with isolation door and controlled airflow to limit the spread of contamination. The SAR also addressed the drop of a waste container while loading it onto the offsite transport vehicle outside the ISF Facility. As indicated by the SAR, the drop event of waste containers is bounded by the design requirements of U.S. Department of Transportation performance-based standards, precluding radiological consequences and criticality concerns.

Based on the information provided, the staff finds that a breach of a waste package in the radioactive waste area will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.17 High Dose Rate to Radioactive Waste Area

The staff reviewed the information presented in Section 8.1.4.2 of the SAR, "High Dose Rate to Radioactive Waste Area," as an off-normal event.

The postulated bounding scenario for this off-normal event is moving a loaded fuel canister from the FPA to the SWPA through the waste transfer port. Other potential scenarios include moving a waste container containing objects with high dose rates and dropping these objects through an open waste transfer port from the FPA to the SWPA. As discussed in Section 8.1.4.2 of the SAR, the SWPA is designed to contain the spread of contamination and to

provide shielding to the operators. Procedures will exclude facility personnel from the SWPA when the transfer port plug is open. In addition, the fixed radiation alarm and back-up radiation monitors would detect a high dose and alert personnel to evacuate the area. Procedures and the preselected logic path of fuel handling operations would prevent fuel processing operations in the FPA when the waste ports are open. Exposure to workers is not likely to exceed acceptable limits because operational controls, monitoring, facility design, and administrative procedures would prevent this event.

Based on the information provided, the staff agrees with the applicant that events resulting in a high dose rate to the radioactive waste area are unlikely, and appropriate controls will be provided to minimize the potential for this event.

15.1.1.18 Ventilation System Failure

The staff reviewed the information presented in Section 8.1.5. 1 of the SAR, “Ventilation System Failures.” Ventilation system failure within the ISF Facility may occur as the result of one or more of the following system or component failures:

- Full-system shutdown caused by loss of normal and standby power;
- Inlet fan failure;
- Exhaust fan failure;
- Blocked HEPA filters;
- Unintended closure of a ventilation damper caused by a faulty sensor;
- Breached HEPA filter; or
- Insufficient ventilation airflow.

Section 8.1.5.1 of the SAR summarizes the causes of these system or component failures and the various means by which the causes can be detected.

An assessment of the potential effects that this postulated event can have on the ISF Facility was limited to the FPA. According to Section 8.1.5.1 of the SAR, the maximum SNF and nonstructural concrete temperatures that can occur within the FPA as the result of a loss of the ventilation system are 151.7 EC [305 EF] and 77.8 EC [172 EF]. The maximum SNF and concrete temperatures do not exceed the maximum allowable limits of 204 EC [400 EF] and 93 EC [200 EF] (see Table 4.2-53 of the SAR). Note the maximum nonstructural concrete temperature of 77.8 EC [172 EF], however, exceeds the normal temperature limit of 66 EC [150 EF]. Note the 93 EC [200 EF] maximum allowable concrete temperature cited in Section 8.1.5.1 of the SAR applies only for local areas, such as around a penetration (American Concrete Institute, 1998, Section A.4). The short-term allowable concrete temperature, however, is 177 EC [350 EF]. As a result, given the large thermal inertia of the concrete and the relatively large margin between the maximum concrete temperature and the short-term allowable concrete temperature, sufficient time to recover from the loss of a ventilation event is likely to be available before any appreciable damage can occur.

Based on the information provided, the staff finds that the SAR discussions on loss of a ventilation event recovery actions are acceptable, and that this event will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.1.19 Loss of External Power Supply for a Limited Duration

The staff reviewed the information presented in Section 8.1.5.2 of the SAR, “Loss of External Power Supply for a Limited Duration.” This off-normal event involves loss of power from sources external to the ISF Facility for 24 hours. Loss of external power to the facility may occur as a result of an external accident, malfunction or failure of equipment, or natural phenomena. The event would be detected by observation through loss of lighting, services, or process operation. The standby power system would automatically illuminate and activate or continue operations of some specific systems.

As discussed in Section 8.1.5.2 of the SAR, the ISF Facility is designed to shut down in a safe mode following a power loss. While certain systems or components are provided with power through a dedicated uninterruptible power supply, these functions are not required for safe shutdown of the facility. The HVAC system is designed to maintain neutral pressure in the FPA, in the event of a power loss, with negligible air flowing into or out of the confinement area. HEPA filters, provided in inlet and outlet ducts, confinement barriers, and dampers would prevent contamination of the environment from the FPA in other areas of the ISF Facility.

Maximum and minimum temperatures caused by an HVAC outage were evaluated, based on extreme off-normal ambient temperatures, and determined to be within the limits for each process area provided in Table 4.3-2 of the SAR. If required, the FHM, CHM, and receipt crane can be operated with manual backup capabilities to move the SNF or equipment to attain safe facility status. There would be no radiological consequences because a short-term power loss would not result in damage to SNF or the SNF container.

Based on the discussion presented in this section, the staff finds that loss of external power for a limited duration will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and shielding of the SNF.

15.1.1.20 Off-Normal Ambient Temperatures

The staff reviewed the information presented in Section 8.1.5.3 of the SAR, “Off-Normal Ambient Temperatures.” This event considers severe and sustained high-or low-temperature scenarios as a result of some extreme weather phenomena. A loaded transfer cask, in-process fuel containers, and stored canisters are all subjected to these maximum high or minimum low temperatures for an extended period of time. Diurnal variation of the temperature was considered. This off-normal event can be detected easily by the operations personnel and confirmed by ambient temperature monitors.

The HVAC system, designed to maintain temperatures within normal ranges in the proposed ISF Facility except in the cask receipt area (CRA) and the storage area, would continue to operate during these extreme temperature fluctuations but may not be capable of keeping the facility temperatures within the prescribed range. The CRA and storage area have exhaust fans and heaters for personnel comfort only.

The proposed ISF Facility is designed for a full range of off-normal temperatures anticipated during the proposed life of the facility. Extreme low temperatures generally will not have an effect. Some lifting equipment, however, requires a minimum operating temperature to meet

code requirements for structural materials. Additionally, a minimum temperature is required for removal of moisture from the ISF canisters (Foster Wheeler Environmental Corporation, 2003a). If this process in the CCA results in unacceptable parameters caused by extreme low temperatures, the process would be repeated or operations would be suspended until acceptable conditions are achieved.

An assessment of the maximum temperature for any fuel type from maximum off-normal temperatures has been performed. The maximum SNF and nonstructural concrete temperatures that can occur are in the FPA and are equal to 151.7 EC [305 EF] and 77.8 EC [172 EF] as a result of the loss of the ventilation system (see Section 8.1.5.1 of the SAR). The maximum SNF and concrete temperatures do not exceed the maximum allowable 204 EC [400 EF] and 93 EC [200 EF] (see Table 4.2-53 of the SAR). Given the large thermal inertia of the concrete and the relatively large margin between the maximum concrete temperature and the short-term allowable concrete temperature, sufficient time to recover from this event is possible without any appreciable damage. Therefore, the maximum off-normal temperatures would not have any adverse effects resulting in radiological consequences.

Structures at the proposed ISF Facility are designed to withstand the full range of off-normal temperatures. Additionally, the storage vault is designed to operate safely with no input from HVAC during maximum off-normal temperatures. Furthermore, operations in other areas of the proposed ISF Facility will be limited or suspended if the temperature exceeds or drops below the normal operating temperature range. There would be no radiological consequences because there would not be any damage to the SNF or SNF containers.

According to the SAR, the ISF Facility procedures to be developed would suspend operations in an area if the temperature exceeds the allowable operating temperature ranges. The facility can be restarted using standard ISF procedures. The staff finds that the procedures for suspension of operations when the temperature exceeds the allowable range will be sufficient to address this condition, and that off-normal temperatures will not impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2 Accidents

The accident events are described in Section 8.2 of the SAR. This section of the SER discusses results from the review of the potential accident events arising from natural phenomena and facility operations. The accident events, referred as the Design Events III and IV (American National Standards Institute/American Nuclear Society, 1984), are those events expected to occur infrequently during the lifetime of the facility. Each event was examined to ensure it includes (i) a discussion of the cause of events, (ii) the means for detection of events, (iii) an analysis of the consequences and the protection provided by devices or systems designed to limit the extent of the consequences, and (iv) any actions required by the operator. The accident events have been categorized in the SAR as transfer cask events, fuel packaging events, fuel storage events, other postulated accidents, and external events.

15.1.2.1 Vehicular Collision with Transporter

The staff reviewed the information presented in Section 8.2.1.1 of the SAR, “Vehicular Collision with Transporter,” and Appendix A, Section 8.2.1.1. This accident event involves the collision of a vehicle with the transfer cask during transport from the ISF site boundary to the CRA.

As described in Section 8.2.1.1, Appendix A, of the SAR, the transporter carrying the Peach Bottom cask would travel a short distance {approximately 460 m [1,500 ft]} in the controlled area with restricted access to vehicles. Vehicle traffic at the ISF Facility is minimal. In addition, the traffic would be controlled administratively during fuel transfer activities. The Peach Bottom casks previously were licensed for highway transportation accidents, and the associated analyses bound the potential frequency and consequences from the onsite vehicle collision.

Based on the discussion presented in this section, the staff agrees that subcriticality, confinement, and shielding will not be impaired by potential vehicular collision at the ISF Facility site.

15.1.2.2 Transfer Cask Drop During Hoisting Operations

The staff reviewed the information presented in Section 8.2.1.2 of the SAR, “Transfer Cask Drop Design Hoisting Operations,” as an accident. This accident event involves the drop of a transfer cask during hoisting operations at the CRA.

Each transfer cask arriving on a transporter will be received at the CRA and positioned under a cask receipt crane. The lifting device of the cask receipt crane will be attached to the trunnions of the transfer cask for upending the cask from the horizontal position and lifting the cask vertically from the transporter. The highest elevation of the transfer cask bottom above the concrete floor would be approximately 3.05 m [10 ft]. The transporter then would be moved away, and the cask trolley would be placed under the transfer cask. The cask receipt crane would lower the cask into the cask trolley. As discussed in Section 8.2.1.2 of the SAR, the potential for a transfer cask drop during hoisting operation is not credible because the 141-tonne [155-ton] fixed position cask receipt crane and the interfacing lifting devices comply with the single-failure-proof design requirements. The crane system and lifting device are designed in accordance with NUREG–0612, NUREG–0554 (U.S. Nuclear Regulatory Commission, 1980, 1979), and ANSI N14.6–1993 (American National Standards Institute, 1993).

In reviewing the trunnion design, the staff concludes, in Section 4.1.3.2 of this SER, that the trunnion design satisfies the design criteria for single-failure-proof systems in accordance with NUREG–0612. The structural integrity of the transfer cask and the spent fuel will be protected because the drop event is precluded by the single-failure-proof design of the crane system, lifting devices, and the transfer cask trunnions. Furthermore, relevant drop analysis shows that the transfer cask will maintain its integrity for the postulated drop scenarios. Therefore, no radiological consequences, nor inadvertent criticality events are anticipated for this postulated accident.

Based on the analysis and description provided in the SAR for the CRA receipt crane, lifting devices, and trunnion design on the transfer cask, the staff agrees that this drop event of a transfer cask is precluded and would not impair subcriticality, confinement, and shielding of the SNF.

15.1.2.3 Transfer Cask Tipover

The staff reviewed the information presented in Section 8.2.1.3 of the SAR, “Transfer Cask Tipover.” This accident event involves tipover of the transfer cask at the CRA and while on the cask trolley.

As discussed in Section 8.2.1.3 of the SAR, the transfer cask will not overturn as a result of credible explosions and natural phenomena including tornados, earthquakes, and floods. The transfer cask will be placed on the cask trolley and remain on the trolley for the entire operation involving the cask. The trolley is designed with a wide footprint and uplift and overturn restraints. The design also limits the trolley to a 2.54-cm [1-in] drop, precluding the concern for tipover of a transfer cask if the trolley axle fails. The recovery plans involving the cask trolley for a hypothetical off-normal and accident event have been presented in the response to the staff’s request for additional information (Foster Wheeler Environmental Corporation, 2003b). The structural integrity of the transfer cask and the spent fuel will be protected because the tipover of the transfer cask while on the trolley is prevented by the trolley design. Therefore, no radiological consequences, nor inadvertent criticality events are anticipated for this postulated accident.

Based on the design of the cask trolley system, the site characteristics, the equipment to be used at the facility, and the analysis and description provided in the SAR, the staff agrees that the transfer cask tipover event is not credible and therefore, the safety functions of maintaining subcriticality, confinement, and shielding of the SNF will not be impacted.

15.1.2.4 Cask Trolley Collision

The staff reviewed the information presented in Section 8.2.1.4 of the SAR, “Cask Trolley Collision Events.” This accident event involves potential collisions of the cask trolley with the inner or outer Transfer Tunnel doors, or the canister trolley in the Transfer Tunnel.

The cask trolley, traveling on steel rails, will move the transfer cask from the CRA through the outer tunnel door to the cask decontamination zone for venting, sampling, and unbolting of the cask lid bolts following cask preparation operations. The inner tunnel door would be opened, and the trolley would be moved below the FPA cask port. The canister trolley that moves between the CCA and FPA in the Transfer Tunnel also drives on the same rail system. The cask trolley could potentially collide with the tunnel doors, when closed, or the canister trolley. As discussed in the Section 8.2.1.4 of the SAR, the operations and functions of the cask trolley are controlled by interlocks, speed controllers, and an overtravel limit switch. In addition, safety features include bumpers to minimize impact against the canister trolley, rail-mounted end stops, and closed tunnel doors. In addition, the cask trolley is designed to withstand impact at a maximum travel speed of 3.05 m/min [10 fpm]. As discussed in Section 8.2.1.4 and Appendix A, Section 8.2.1.4, of the SAR, deceleration forces generated from the impact with the bumpers are within design limits for the trolley and transfer cask. The recovery plans involving the cask trolley for a hypothetical off-normal and accident event have been presented in the response to the staff’s request for additional information (Foster Wheeler Environmental Corporation, 2003b).

The confinement barrier and shielding of the transfer cask would not be damaged because safety features (e.g., interlock, speed controller, and overtravel limit switches) would prevent a

cask trolley collision. Therefore, fuel integrity would be maintained, precluding any radiological consequences or criticality.

Based on the design of the cask trolley, safety systems, and the analysis and description provided in the SAR, the staff agrees that a transfer cask collision would not impair the cask's ability to maintain subcriticality, confinement, and shielding for the SNF.

15.1.2.5 Drop of U.S. Department of Energy Fuel Container During Handling

The staff reviewed the information presented in Section 8.2.2.1 of the SAR, "Drop of DOE Fuel Container During Handling." This accident event involves the drop of a U.S. Department of Energy fuel container from the maximum height of the FHM onto a Peach Bottom cask or onto the FPA floor.

The FHM would be used to move the DOE fuel container from the transfer cask to the fuel basket operations and monitoring station. The event is postulated to occur because of operator error, mechanical or electrical failure, hoist system failure, or earthquake. As described in Sections 8.2.2.1; 4.7.3.2.5; and Appendix A, of the SAR, the FHM crane, including the hoist, is designed to meet the single-failure-proof requirements of NUREG–0612 (U.S. Nuclear Regulatory Commission, 1980) and NUREG–0554 (U.S. Nuclear Regulatory Commission, 1979). The single-failure-proof lifting devices, complying with ANSI N14.6–1993 (American National Standards Institute, 1993), would be used to handle the fuel containers. In addition, the FHM is designed with redundant electrical systems such as hoist motor, gear reducers, and hoist cables to move and hold the load. The lifting devices are attached mechanically to the FHM by operators and secured with a safety latch using the remotely operated PMS or MSM. Operators will use visual indicators to inspect to ensure the lifting device is engaged and locked before the handling operation. In addition, a seismic switch would interrupt the power system to the FHM, preventing the load drop in the event of an earthquake. As discussed in Section 8.2.2.1 and Appendix A, Section 8.2.2.1, of the SAR, DOE fuel containers do not comply with the single-failure-proof design criteria of NUREG–0612 (U.S. Nuclear Regulatory Commission, 1980). In the event of a drop of DOE fuel containers, the release to the environment would be minimized because the containers would be handled within the confinement boundary of the FPA. The radiological consequences for this event are bounded by the Maximum Hypothetical Accident Dose as discussed in Section 15.1.2.14 of this SER. Criticality from the drop event is precluded based on the criticality evaluation as discussed in Section 4.7.3 of the SAR. Demonstration of compliance with criticality requirement is discussed in Chapter 8, "Criticality Evaluation," of this SER.

Based on the analysis and description provided in the SAR of the FHM crane, hoist and lifting devices, and the safety system, the staff agrees that the postulated drop events for DOE fuel containers during handling would not impair the ability of the FPA to maintain subcriticality, confinement, and shielding of the SNF.

15.1.2.6 Drop of the ISF Basket During Handling

The staff reviewed the information presented in Section 8.2.2.2 of the SAR, "Drop of ISF Basket During Handling." This accident event involves the drop of an ISF basket from the maximum height of the FHM into an ISF canister or onto the FPA floor.

The FHM would be used to move the ISF basket from the fuel loading station to the ISF canister port. The drop event of an ISF basket during loading is an event postulated to occur because of operator error, mechanical or electrical failure, hoist system failure, or earthquake. As described in Sections 8.2.2.2 and 4.7.3.2.5 of the SAR, the FHM crane, including the hoist, is designed to meet the single-failure-proof requirements of NUREG–0612 and NUREG–0554 (U.S. Nuclear Regulatory Commission, 1980, 1979). Lifting devices used to handle the ISF baskets also are designed to comply with the single-failure-proof criteria of ANSI/ANS N14.6–1993 (American National Standards Institute, 1993). In addition, the FHM is designed with redundant electrical systems, such as hoist motor, gear reducers, and hoist cables to remove and hold the load. The lifting devices are attached mechanically to the FHM and secured with the safety latch using the remotely-operated PMS or MSM. Operators will use visual indicators to inspect to ensure the lifting device in engaged and locked before the handling operation. In addition, a seismic switch would interrupt the power system to the FHM, preventing the load drop in event of an earthquake. As discussed in Section 8.2.2.2 of the SAR, the design of the ISF basket meets the single-failure-proof criteria of NUREG–0612 (U.S. Nuclear Regulatory Commission, 1980). Therefore, the drop event of the ISF basket is not considered credible because of the single-failure-proof design of the FHM, lifting devices, and the ISF basket. Therefore, the ISF basket would not be damaged, and spent fuel integrity would be maintained, precluding radiological consequences or criticality concerns from this event.

Based on the analysis and description of the FHM crane, hoist, lifting devices, and safety systems, the staff agrees that the drop events for ISF baskets are precluded, and therefore, would not impair the ability of the FPA to maintain subcriticality, confinement, and shielding of the SNF.

15.1.2.7 Canister Trolley Movement in Raised Position

The staff reviewed the information presented in Section 8.2.2.3 of the SAR, “Canister Trolley Movement in Raised Position.” This accident event involves movement of the canister trolley containing a loaded canister at an elevated position in the Transfer Tunnel.

The canister trolley will be used to move a canister to the CCA, FPA, and storage area ports. At each port location, the canister will be raised and lowered using a jacking mechanism. The canister trolley operations are controlled manually from the CCA based on the video monitor and sensor input. The accident is postulated to occur as a result of operator error or electrical faults while attempting to move the trolley in the raised position. As discussed in Section 8.2.2.3 of the SAR, when the canister is positioned under the appropriate port, a locking pin will be secured at each port location to provide seismic restraint to the trolley during fuel transfer activities. An interlock prevents release of the locking pin unless the jacking system is in a fully lowered position. The locking pin and the interlock are items important to safety. Radiological consequences and criticality are precluded because the event would be prevented by the design of these important to safety features.

Based on the analyses and descriptions of the canister trolley functions and the safety systems, the staff agrees that movement of the canister trolley with a canister in a raised position is not credible; therefore the safety functions of maintaining subcriticality, confinement, and shielding for the SNF will not be impacted from this postulated event.

15.1.2.8 ISF Canister Drop

The staff reviewed the information presented in Section 8.2.3.1 of the SAR, "ISF Canister Drop." This accident event involves the drop of an ISF canister from the maximum height of the CHM into an open storage tube in the storage area.

The CHM consists of a bridge and trolley with an attached shielded cask and turret assembly. The CHM will be used to hoist the loaded ISF canister from the canister trolley at the storage area port, move the canister to the storage location, and lower the canister into a storage tube. The ISF canister drop event is postulated to occur because of operator error, mechanical or electrical failure, hoist system failure, or earthquake. As described in Sections 8.2.3.1 and 4.7.3.2.13 of the SAR, the CHM crane, including the hoist, is designed to meet the single-failure-proof requirements of NUREG–0612 and NUREG–0554 (U.S. Nuclear Regulatory Commission, 1980, 1979). In addition, the canister grapple is designed in compliance with the single-failure-proof criteria of ANSI/ANS N14.6–1993 (American National Standards Institute, 1993). Additionally, the CHM is provided with mechanical and electrical interlocks to prevent ISF canister drop accidents during operation and seismic events. This event is not considered credible because the design features of the CHM would preclude a canister drop. Therefore, radiological consequences and criticality concerns also would be precluded.

Based on the analyses and descriptions of the CHM crane, hoist, lifting devices, and safety systems, the staff agrees that the hypothetical drop event of ISF canisters from the CHM is not credible, and therefore, the safety functions of maintaining subcriticality, confinement, and shielding during the handling of canisters in the storage area would not be impaired.

15.1.2.9 Transverse Movement of the CHM with an ISF Canister Partially Inserted

The staff reviewed the information presented in Section 8.2.3.2 of the SAR, "Transverse Movement of the CHM with an ISF Canister Partially Inserted." The accident event is postulated to occur when the canister is moved transversely during hoisting from the trolley at the storage port or lowering into the storage tube. The relative motion could result from movement of the CHM bridge or trolley, rotation of the turret assembly, or lateral acceleration of the turret produced by a seismic event when the canister is in a partially raised or lowered position.

As described in Section 8.2.3.2 of the SAR, this event is not considered credible because the inadvertent movement of the CHM caused by operator error would be prevented by a combination of operational procedures and multiple interlocks. The CHM bridge trolley and the turret would be seismically restrained with clamps and locking pins during canister hoist operations. The interlocks would prevent release of the seismic restraints unless the canister hoist is in the fully raised position. In addition, the turret locking pin cannot be disengaged, and the turret cannot be rotated unless the canister hoist is fully raised. Seismic clamps and the locking pin would restrain lateral motion of the CHM turret during a seismic event. The seismic restraints and interlocks are items important to safety. These important safety features would ensure canister and fuel integrity during this event, thereby precluding radiological consequences or inadvertent criticality.

Based on the analyses and descriptions of the CHM crane, hoist, lifting devices, and safety systems to be used, the staff agrees that the transverse movement of the ISF canisters in a partially inserted position is not credible, and therefore, the canisters' ability to maintain subcriticality, confinement, and shielding during handling operations in the storage area would not be impaired.

15.1.2.10 Adiabatic Heatup

The postulated, nonmechanistic adiabatic heat-up accident event is evaluated in Section 8.2.4.1 of the SAR. The temperature increase rate of the storage tube, ISF canister, and SNF during adiabatic heat-up conditions was calculated to be 0.19 EC/hr [0.35 EF/hr]. This rate of temperature increase was conservatively assumed to be the same for the storage vault concrete charge face. The concrete temperature limit of 93.3 EC [200 EF] was determined to be the controlling limit for this event. In the SAR analysis, the applicant assumed a concrete charge face initial temperature of 49 EC [120 EF], the normal operational maximum temperature of the vault storage tube. The time required to exceed the 93.3 EC [200 EF] concrete temperature limit was determined to be 9.5 days.

In response to staff questions, the applicant provided a more conservative estimate of the time to reach the concrete temperature limit for this event (Foster Wheeler Environmental Corporation, 2004). The time required to exceed the limit was calculated assuming the concrete charge face is initially at a temperature of 63.5 EC [146.3 EF]. This initial temperature is extremely conservative, as it is equivalent to the maximum storage tube temperature associated with a SNF decay heat load of 120 W. The maximum decay heat for any ISF canister will be limited to 36 W, as identified in Table 2-3 of the ISF Facility Technical Specifications. For this analysis, the time required to exceed the 93.3 EC [200 EF] concrete temperature limit was determined to be 6.4 days.

The staff has determined that the applicant has acceptably calculated the time required to recover from a blockage of the storage vault vents. In addition, the calculated recovery time is sufficient for the ISF Facility operations staff to detect the blockage and perform the necessary recovery actions.

15.1.2.11 Loss of Shielding

The staff reviewed the information presented in Section 8.2.4.2 of the SAR, "Loss of Shielding." The accident event involves degradation or loss of shielding caused by natural phenomena or operational events. Potential loss of shielding resulting from earthquake, tornado missile impact, fire, explosion, and vehicular impact are discussed in the respective sections of this SER.

Loss of shielding also may occur in the FPA, CCA, and storage area during operations because of operator error. As discussed in Section 8.2.4.2 of the SAR, postulated scenarios for loss of shielding caused by operator errors include failure to install the shield plug in a filled fuel basket at the FPA canister port, failure to install the storage tube shield plug in the storage area, and inadvertent removal of the shield plug from a loaded canister at the CCA port. The fuel handling operations in the FPA, CCA, and storage area will be controlled administratively and records for loading patterns or status will be updated routinely.

In the event a shield plug is not installed in the canister with the loaded fuel basket in the FPA because of operator error and the canister trolley is moved to the CCA, the radiation monitor in the Transfer Tunnel would trigger the local and ISF Facility alarms. If the first monitor fails, there is a second radiation monitor to detect radiation when the CCA plug is opened. The canister would be returned to the FPA for installation of the shield plug.

In the storage area, the shield plug over the storage tube may not be placed because of operator error or failure of the CHM. This event would be detected by the operator by observing indicators in the control room. The interlocks provided in the CHM would prevent raising the shield skirt, releasing the seismic restraint, or moving the bridge or trolley without the shield plug being in place. In addition, capabilities are provided for manual placement of the shield plug over the storage tube.

In the CCA, the shield plug could be inadvertently removed from the filled canisters by the operator. The lifting features used to lift shield plugs in the CCA and FPA are two different designs to ensure the shield plug is not removed in the CCA. In the event the operator replaces the lifting device in the CCA and lifts the shield plug, radiation monitors in the CCA would activate to alert the ISF Facility personnel.

These postulated accidents would not affect the subcriticality of the spent fuel because the integrity of the fuel is maintained. Consequently, radiation exposure caused by loss of shielding would be limited and confined to localized areas. Radiation monitors and alarms would ensure detection of elevated radiation levels for implementation of recovery actions.

Based on the previously mentioned description of the administrative controls, design features and safety systems used to detect loss of shielding, the staff agrees that the loss of shielding event would not impact the safety functions of maintaining subcriticality, confinement, and shielding conditions in the transfer area.

15.1.2.12 Building Structural Failure onto Structures, Systems, Components

The staff reviewed the information presented in Section 8.2.4.3 of the SAR, “Building Structural Failure onto Structures, Systems, Components.” The accident event involves the failure of building structures and the potential to impact other important to safety structures, systems, and components in the ISF Facility. Vehicular impact, extreme natural phenomena, and overstressing of lifting mechanisms could be several postulated causes for failure of ISF Facility structures.

As discussed in Section 8.2.4.3 of the SAR and Section 4.1.4 of this SER, the structures required to protect and support the lifting of structures, systems, and components important to safety are designed to the same load combinations and to withstand the same design basis events as the important to safety structures. In addition, the crane systems in the CRA, FPA, and storage area are single-failure-proof, and are supplemented with mechanical and electrical interlocks to prevent load drops or collision with building structures.

As discussed in Section 8.2.4.3 of the SAR, the transporter with a loaded cask can impact the CRA structure and may cause the transfer cask to drop from the trailer bed. As discussed in

Sections 4.1.3.2 and 5.1.1.4 of this SER, the drop analysis referenced by the applicant demonstrates that the transfer casks will remain sealed and thus safely contain the SNF.

An additional scenario, discussed in Section 8.2.4.3 of the SAR, is the transporter impacting the CRA structure when the transporter is moved from the area with the transfer cask in an elevated position hoisted by the CRA crane. Administrative procedures will ensure that the transporter is moved from the CRA in limited increments to prevent impacts with the CRA structure.

Based on the previously mentioned description, the staff agrees that building structural failure onto structures, systems, components is precluded, and subcriticality, confinement, and shielding conditions would not be impaired.

15.1.2.13 Fire and Explosion

Fire

The staff has reviewed the information presented in Section 8.2.4.4 of the SAR, “Fire and Explosion.” Additional information presented in Sections 2.3.1.3.9, “Thunderstorms and Lightning;” 4.3.8, “Fire Protection System;” 3.3.6, “Fire and Explosion Protection;” and 7.3.1, “Installation Design Features,” of the SAR also was used in this review.

A credible fire accident affecting structures, systems, and components important to safety at the proposed ISF Facility is possible during transportation or handling of SNF. A credible fire at the ISF Facility may begin by the ignition of vehicle diesel fuel, electrical insulation and equipment, lightning, or human activity. Information regarding the fire design features, fire detection systems, and fire suppression systems is evaluated in Chapter 6 of the SER.

As described in SAR Section 8.2.4.4, significant sources of combustibles within the restricted area include the following:

- Diesel fuel in cask transporters;
- Gasoline and diesel fuels in waste processing or delivery vehicles;
- Tires of the transporter, trailer, or other vehicles;
- Lubricating oil in various hoist gear boxes and trolley drives; or
- Diesel generator fuel tank in the switch yard.

The applicant has conducted an analysis of potential fires at the proposed ISF Facility including wildfires. The applicant has divided the facility into three fire areas for fire hazard evaluation. Fire Area 1 includes the areas where SNF is transferred from the U.S. Department of Energy transfer cask, placed into the ISF canisters, and prepared for storage. Fire Area 2 includes the storage area in which the SNF will be stored. Fire Area 3 includes the remaining facility, support structures, and the yard area. A fire hazard analysis has been conducted to evaluate the potential fire hazards in each area (Utility Engineering, 2003). The staff reviewed the applicant’s description of the fire scenarios and assessment of the potential fire hazards, including analysis, and has determined that the analysis is acceptable. Technical discussions on the potential fire hazards in each area are provided next.

Potential for Wildfires

Potential wildfires ignited by lightning or human activity have taken place on or near the Idaho National Engineering and Environmental Laboratory (INEEL) site. Foster Wheeler Environmental Corporation (2003a) has estimated that approximately two to three thunderstorm-days take place at INEEL each month. Potential lightning associated with the thunderstorms may start a range fire.

Some exterior walls of the proposed ISF Facility are not fire rated. Therefore, any accumulated brush could ignite and spread fire into the proposed ISF Facility. To protect against this event, the proposed ISF Facility will be located on an open-gravel surface. The outer perimeter fence is at least 33 m [100 ft] from the buildings. The zone between the fence and buildings will be covered with gravel. A maintenance program will control any significant growth of vegetation in this zone. Therefore, the surface of the restricted zone will be noncombustible. Vegetation is sparse, and no trees are outside the fence. Therefore, the proposed ISF Facility will have a fire barrier of at least 33 m [100 ft] to prevent a wildfire affecting the facility. By comparison, the U.S. Fire Administration (1993) suggests a 33-m [100-ft] fuel break for wildfires in pine forests.

Potential Fires at Fire Area 1

This fire area boundary will isolate the fuel handling and packaging activities from any credible fire ignited outside this area. Fire Area 1 includes the FPA, FHM maintenance area, CCA, north Transfer Tunnel, and the decontamination area (south Transfer Tunnel).

The postulated fire in the FPA is associated with the fuel packaging and maintenance activities of the FHM. Administrative controls will limit the quantity of combustible materials in the area. Postulated combustible materials are classified as Class A and Class B, defined in accordance with National Fire Protection Association (NFPA) NFPA 10 (1998a), with low combustible loadings; therefore, the worst-case fire load is less than a 30-minute equivalent fire duration (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003). Fire in the CCA is postulated to be associated with electric arc welding of the fuel canister and weld inspection activities (Foster Wheeler Environmental Corporation, 2003a). Operations of cask and canister trolleys at the north Transfer Tunnel and cask decontamination activities in the south Transfer Tunnel have been identified to develop the postulated fire. In all cases, administrative controls will limit the quantity of combustible materials. Postulated combustible materials in this area are also classified as Class A and Class B with low combustible loadings; therefore, the worst-case fire load is less than a 30-minute equivalent fire duration (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1).

The FPA is a reinforced concrete structure with a Uniform Building Code Type I fire-resistance construction (International Conference of Building Officials, 1997). Floors, ceilings, and walls surrounding Fire Area 1 are 3-hour fire rated. Penetrations such as doors, shield windows, and ducts are 1-hour fire rated (Foster Wheeler Environmental Corporation, 2003a). Fire-detection equipment has been provided, along with remote air sampling, at the FPA where SNF will be handled outside any container. To avoid potential radiological consequences, fire sprinklers are not provided in Fire Area 1.

Potential Fires at Fire Area 2

This fire area boundary will isolate the SNF storage areas from any credible fire outside this area. Fire Area 2 includes the storage vaults. The Transfer Tunnel connects this area with Fire Area 1.

This high-radiation area is not accessible after SNF is placed in the storage tubes. The exterior wall inlets are placed approximately 6.6 m [20 ft] above ground level and are designed with a right-angle turn for shielding. Lack of available combustible materials, the indirect path of the air inlets, and their height above ground will ensure adequate protection against fire propagation. Small annular gaps of approximately 6.4 mm [0.25 in] around each storage tube through the charge face of thickness 0.76 m [2.5 ft] are not conducive for propagating the postulated fire hazard from a single largest Class B fluid container from the second floor storage area. The worst-case fire load is postulated to be less than a 10-minute equivalent fire duration (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Floors, ceilings, and walls surrounding this fire area are 3-hour fire rated. Penetrations such as doors, shield windows, and ducts are 1-hour fire rated. Fire detection or fire sprinklers are not provided because of lack of credible fire hazard in this area.

Potential Fires at Fire Area 3

The boundary of this fire area isolates Fire Areas 1 and 2 from exposure to fire and minimizes potential radiological releases. This fire area includes the remaining facility structures and general yard area, including the following: (i) CRA, (ii) second-floor storage area, (iii) operating gallery, (iv) workshop, (v) operator’s office and change area, (vi) electrical room, (vii) battery room, (viii) HEPA filter room, (ix) HVAC exhaust room, (x) new canister receipt area, (xi) solid waste storage area, (xii) SWPA, (xiii) liquid waste storage tank area, (xiv) first-floor operations area, second-floor operations area, and (xvi) ISF Facility yard area.

Cask Receipt Area

The CRA is a single-story, steel-frame structure attached to the Transfer Tunnel. It is separated from the Transfer Tunnel by a 1-hour fire-rated barrier. Remaining walls are exterior walls made of noncombustible materials with construction equivalent to Uniform Building Code Type II–N (International Conference of Building Officials, 1997) and are not fire rated. This area contains the U.S. Department of Energy transfer cask, cask trolley, and cask receipt crane to move the cask to the cask trolley, which have been classified as items important to safety.

A postulated fire for this area is associated with transport vehicle receipt and handling of the transfer cask by the crane. Administrative controls will either limit the fuel capacity of the transport vehicles or exclude them from entering this area. Postulated combustibles consist of only Class A and Class B materials that constitute low combustible loading (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003). Therefore, a 1-hour fire-rated wall between this area and the Transfer Tunnel will ensure adequate fire protection. Because of the slope of the floor, any postulated diesel spill will drain to the west side of the structure and collect in a trench. A postulated lubricant spill between the cask trolley rails would run along the rails and will minimize the spill size. These design features will minimize the heat

load transferred to items important to safety in the event of a fire. Additionally, the volume of the CRA limits heating of structures by direct flame impingement from small postulated fires for all locations much above the floor level. The transfer cask and cask trolley are inherently fire resistant. As structural steel is expected to maintain its ability to support design loads for as much as 10 minutes, the crane will be protected by 1-hour fire-rated materials up to a height determined by the fire hazard analysis to mitigate any consequences.

Second Floor Storage Area

This area is separated from the Transfer Tunnel and storage vaults below by 1-hour fire-rated barriers. The steel structure has fire-resistant construction of 0.6-m [2-ft]-thick reinforced concrete, equivalent to Uniform Building Code Type I fire-resistive construction (International Conference of Building Officials, 1997) with a 3-hour fire rating for the lower 2.7 m [9 ft] of the walls. The rest of the structure is constructed equivalent to Uniform Building Code Type II–N (International Conference of Building Officials, 1997). Important to safety items in this area include the CHM with rails and grapple, ISF canisters, and storage area fixed building ventilation (Foster Wheeler Environmental Corporation, 2003a).

The postulated fire is associated with the operation of the CHM. Primary contributors to the fire are lubricants, electric cable insulation, and neutron shielding on the CHM. The worst-case fire results from high flashpoint lubricants in various machineries and is equivalent to a fire less than 10-minute duration (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Administrative controls will limit the fuel in this area. The postulated combustibles consist of only Class A and Class B materials that constitute low combustible loading (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003). Therefore, a 1-hour fire-rated wall between this area and the Transfer Tunnel and storage vaults will ensure adequate fire protection.

The CHM is a massive structure that contains the grapple and ISF canisters. A postulated fire within this area would not adversely impact any safety-related functions of the grapple and canisters, including the support rails. The canisters will be in the CHM during transport in this area. Therefore, these canisters will not be exposed directly to the postulated fire. The storage area fixed ventilation is not susceptible to any damage from the postulated fire. Fire detection will be provided in this area.

Operating Gallery

The operating gallery is on the second floor. It is a steel-frame structure, and the exterior walls are not fire rated with construction equivalent to Uniform Building Code Type II–N (International Conference of Building Officials, 1997). The gallery is separated from the FPA, CCA, workshop, and the operators office and change area by 1-hour fire-rated barriers. The postulated fire is associated with operational activities in this area. The postulated combustibles are Class A materials that provide low fire loading. The worst-case fire loading has been postulated to be less than a 10-minute-equivalent fire duration (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour-rated fire barriers will provide sufficient protection to safety-related structures, systems, and components in the fuel handling area. Fire detection equipment, along with a full sprinkler system, is provided in this area.

Workshop

The workshop is located on the second floor adjacent to the south wall of the FPA. It is a steel-frame structure, and the exterior walls are 1-hour fire rated with construction equivalent to Uniform Building Code Type II (International Conference of Building Officials, 1997). The workshop is separated from the FHM maintenance area by a 1-hour fire-rated wall which also has a 1-hour fire-rated door. The wall between the workshop, the corridor, and the door are also 1-hour fire rated. The floor is made of concrete on metal deck. The ceiling is a steel-frame protected by gypsum. Both floor and ceiling are 1-hour fire rated.

The postulated fire in the workshop is associated with welding, machining, and repair equipment and materials. The applicant will impose administrative controls to limit the quantity of materials and the use of flammable storage cabinets (Foster Wheeler Environmental Corporation, 2003a). Combustible materials in this area will consist of only Class A and Class B materials that constitute low combustible loading (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003). Therefore, a 1-hour fire-rated wall between this area and the Transfer Tunnel will ensure adequate fire protection. Fire detection equipment and an automatic fire suppression system are provided in the workshop.

Operator's Office and Change Area

The operator's office and change area are on the second floor of a steel-frame structure. A potential fire in this area may pose a fire hazard to the CCA, FHM maintenance area, and FPA; therefore, this area is separated from them by 1-hour fire-rated barrier walls. The area opens into a walkway connecting the second floor operations area with the operating gallery. The walls adjoining the second-floor operations area and the operating gallery are 1-hour fire rated. The remaining walls are exterior walls with no fire rating.

The postulated fires in the operator's office and change area are associated with canister closure operations and health physics activities in the adjoining areas. The applicant will impose administrative controls to limit the quantity of materials to minimize fire loads (Foster Wheeler Environmental Corporation, 2003a). Combustible materials in this area will consist only of Class A materials that constitute medium combustible loads equivalent to a fire of 30- to 45-minute (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls will ensure adequate fire protection. Fire detection equipment and an automatic fire-suppression system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

Electrical Room

The electrical room is on the first floor of a steel-frame structure adjacent to the north wall of the FPA. A postulated fire in this area may pose a fire hazard to the FPA, Transfer Tunnel, and CCA. Therefore, the electrical room is separated from these areas by 1-hour fire-rated barrier walls. Other walls facing the new canister receipt area and the ceiling are also 1-hour fire rated.

Postulated fires in the electrical room are associated with motor control centers and electrical cables. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist only of Class A materials that constitute

medium combustible loads equivalent to a fire of less than 45-minute duration (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and an automatic fire suppression system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

Battery Room

A postulated fire in the battery room, located on the first floor of a two-story building, poses a potential fire hazard to the FPA. The west wall of the battery room adjoins the electrical room. All walls and the ceiling are 1-hour fire rated.

The postulated fire is associated with the batteries, uninterruptible power supply system, and electrical cables. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area consist only of Class A materials that constitute medium combustible loads equivalent to a fire of less than 45 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and an automatic fire suppression system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

HEPA Filter Room

A postulated fire in the HEPA filter room, located on the first floor of a two-story building, poses a potential fire hazard to the FPA and Transfer Tunnel. The walls adjoining the FPA and Transfer Tunnel are 1-hour fire rated. Additionally, other walls and the ceiling also have a 1-hour fire rating.

The postulated fire is associated with the HVAC equipment. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist only of Class A materials with low combustible loads equivalent to a fire of less than 10 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and an automatic fire suppression system are provided in this area. Additionally, the HEPA filters are protected by an automatic or manual deluge water spray system (Foster Wheeler Environmental Corporation, 2003a).

HVAC Exhaust Room

A postulated fire in the HVAC exhaust room, located on the first floor of a two-story building, poses a potential fire hazard to the FPA. The wall adjoining the FPA is 1-hour fire rated. The remaining walls, including those adjoining the battery room and HEPA filter room, and the ceiling have 1-hour fire ratings.

The postulated fire is associated with the HVAC equipment. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist only of Class A materials with medium combustible loads equivalent to a fire of less than 45 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering,

2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and an automatic fire-suppression system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

New Canister Receipt Area

A postulated fire in the new canister receipt area, located on the first floor of a steel-frame structure, poses a potential fire hazard to the Transfer Tunnel and CCA. The walls separating the Transfer Tunnel and the CCA are 1-hour fire rated. The wall separating the solid waste storage area and electrical room is also 1-hour fire rated. The remaining wall, ceiling, and doors are not fire rated.

The postulated fire in this area is associated with canister receipt operations. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist only of Class A materials with low combustible loads equivalent to a fire of less than 15-minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and a sprinkler system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

Solid Waste Storage Area

A postulated fire in the solid waste storage area, located in the first floor, poses a potential fire hazard to a portion of the Transfer Tunnel. The wall separating the Transfer Tunnel is 1-hour fire rated. Remaining walls, except the wall adjoining the SWPA, ceiling, and doors are also 1-hour fire rated. The wall adjoining the SWPA with associated doors is not fire rated.

The postulated fire in this area is associated with waste processing equipment and miscellaneous dry combustibles. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist only of Class A and Class B materials with medium combustible loads equivalent to a fire of less than 45-minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and a sprinkler system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

SWPA

A postulated fire in the SWPA, located on the first floor, poses a potential fire hazard to a portion of the Transfer Tunnel, the FPA, and the FHM maintenance area. The walls separating the Transfer Tunnel, the FPA, and the FHM maintenance area are 1-hour fire rated. The remaining walls, except the walls adjoining the solid waste storage area and liquid waste storage area, ceiling, and doors, are also 1-hour fire rated. The walls adjoining the solid waste storage area and liquid waste storage area with associated doors are not fire rated.

The postulated fire in this area is associated with waste processing equipment and miscellaneous dry combustibles. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads (Foster Wheeler Environmental Corporation, 2003a).

Combustible materials in this area will consist only of Class A and Class B materials with medium combustible loads equivalent to a fire of less than 45 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and a sprinkler system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

Liquid Waste Storage Tank Area

A postulated fire in the liquid waste storage area, located on the first floor, poses a potential fire hazard to a portion of the Transfer Tunnel. The wall separating the Transfer Tunnel is 1-hour fire rated. The remaining walls, except the walls adjoining the SWPA, ceiling, and doors, also are 1-hour fire rated. The wall adjoining the SWPA with associated doors is not fire rated. Exterior walls on the south side are 1-hour fire rated to protect against fire hazards associated with vehicle fires.

The postulated fire in this area is associated with transient materials. Combustible materials in this area will be equivalent to a fire of less than 5 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and a sprinkler system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

First Floor Operations Area

A postulated fire in the first floor operations area poses a potential fire hazard to the FHM maintenance area support structure in addition to the solid and liquid waste areas. The wall separating the solid and liquid waste areas is 1-hour fire rated. The remaining walls and ceiling are not fire rated.

The postulated fire in this area is associated with administrative, recordkeeping, and health physics activities. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist of only Class A and Class B materials with medium combustible loads equivalent to a fire of less than 45 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and a sprinkler system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

Second Floor Operations Area

A postulated fire in the second floor operations area poses a potential fire hazard to the FHM maintenance area. The wall separating the FHM Maintenance Area is 1-hour fire rated. The wall separating this area from the second floor transfer area of the workshop and operator’s office and change area is also 1-hour fire rated. The remaining walls, floor, and ceiling are not fire rated.

The postulated fire in this area is associated with administrative, recordkeeping, and health physics activities. Administrative controls will be imposed to limit the quantity of materials to minimize fire loads. Combustible materials in this area will consist of only Class A and Class B

materials with medium combustible loads equivalent to a fire of less than 45 minutes (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003, Table 7-1). Therefore, 1-hour fire-rated walls and ceiling will ensure adequate fire protection. Fire detection equipment and a sprinkler system are provided in this area (Foster Wheeler Environmental Corporation, 2003a).

ISF Facility Yard Area

The yard contains the diesel generator area, storage warehouse, guardhouse, visitor center, and administrative center. A supply of approximately 3,875 L [1,000 gal] of diesel fuel is stored in a double-walled Underwriters Laboratory listed storage tank in accordance with NFPA 30 (1996a) in the diesel generator area. The distance to the transfer area is more than 6 m [20 ft] (Foster Wheeler Environmental Corporation, 2003a). Sufficient separation distance and the design of the diesel storage tank will ensure that a fire hazard does not exist from this source (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003).

The storage warehouse, guardhouse, visitor center, and administrative center are support facilities and do not contain any safety-related items. A fire at any of these facilities, however, may pose a potential fire hazard to the structures, systems, and components important to safety at the proposed ISF Facility. A potential fire hazard at these facilities is assessed using the guidance in NFPA 80A (1996b) in terms of separation distance from safety-related items at the proposed ISF Facility. The storage warehouse is more than 15 m [50 ft] from the proposed ISF Facility. The guardhouse will contain various amounts of office-related Class A combustibles. It is more than 60 m [200 ft] from the proposed ISF Facility. The visitor center will have display areas and will contain various amounts of Class A combustibles. It is more than 60 m [200 ft] from the proposed ISF Facility. The administrative center will contain office spaces with moderately high Class A combustible materials and it is more than 15 m [50 ft] from the proposed ISF Facility. Based on NFPA 80A (1996b), the facilities are adequately separated from the proposed ISF Facility (Foster Wheeler Environmental Corporation, 2003a; Utility Engineering, 2003). Therefore, there is no postulated hazard to the proposed ISF Facility from fire at these facilities, and, consequently, none of these buildings have any fire-rated barriers (Foster Wheeler Environmental Corporation, 2003a).

A transformer is located in the switchyard northwest of the operating gallery. The transformer contains approximately 2,271 L [600 gal] of oil, categorized as “less flammable” per Factory Mutual Insurance Company Data Sheet 5–4 (Factory Mutual Insurance Company, 2001). Located approximately 7.5 m [25 ft] from the proposed ISF Facility, the transformer meets the separation distance requirement of Factory Mutual Insurance Company Data Sheet 5-4 for unapproved fluids. The distance requirement is smaller for approved fluids. A seismic cutoff switch for power supplies, the only safety-related item, is also located in the switchyard, approximately 6 m [20 ft] from the transfer area. A fire within this area could disable the seismic switch. The seismic switch activates during an earthquake only. For the scenario where an earthquake results in a fire in this area, the seismic switch would have already executed its intended safety function before exposure to the fire (Foster Wheeler Environmental Corporation, 2003a). Therefore, no fire protection is necessary for the seismic switch.

Vehicle fires are postulated for the trucks that deliver ISF components, such as new canisters, provide other support services, or remove waste or other materials. Delivery access paths used

by these trucks are generally at least 6.6 m [20 ft] from the transfer area. Locations at which these vehicles will routinely enter the proposed ISF Facility have been discussed and their potential hazards have been previously evaluated. Additionally, any potential hazards from a fire at these vehicles have been evaluated for the CRA and new canister receipt area. The truck for liquid waste would be located south of the liquid waste storage area to empty the tanks (Utility Engineering, 2003). Although the corresponding wall of the liquid waste storage area building is rated for a 1-hour fire, under certain circumstances, a fire involving 1,134 L [300 gal] of diesel may burn longer. Therefore, a fire spreading into the liquid waste storage area is a possibility. Administrative procedures, based on the fire protection program, will ensure at least 3.3 m [10 ft] of separation between the 1-hour fire-rated wall of the liquid waste storage area and the truck (Foster Wheeler Environmental Corporation, 2003a). This distance has been determined to be sufficient to prevent flame impingement on the building. Other vehicles also will maintain this minimum separation distance (Utility Engineering, 2003). Additionally, Foster Wheeler Environmental Corporation (2003a) will place a berm around the liquid waste truck processing location to contain any potential flammable liquid spill and to maintain a 3.3-m [10-ft] separation distance. The 1-hour fire-rated wall and a 3.3-m [10-ft] separation distance will provide adequate protection against fire damage to this radiologically controlled area.

Fires—Conclusion

The staff reviewed the information provided by the applicant regarding potential wildfires and onsite fires at the proposed ISF Facility. The staff found the applicant’s analysis acceptable because:

- Adequate design details have been provided regarding the fire detection, alarm, and suppression systems to be installed at the proposed ISF Facility. These systems will be designed in accordance with acceptable codes and standards. Moreover, these systems have sufficient capacity and capability to minimize the adverse effects of a postulated fire on structures, systems, and components important to safety. The suppression systems and fire-fighting brigade are discussed in Chapter 6 of this SER.

- Noncombustible and heat-resistant materials will be used to protect important to safety structures, systems, and components, wherever practical.

- Walls, ceilings, and floors of different areas of the proposed ISF Facility, where applicable, have been designed with adequate fire-rated materials and construction to prevent any spread of a postulated fire and to provide protection against fire damage to all safety-related structures, systems, and components.

- Through design and administrative procedures, sources of ignition will be kept to a minimum at all areas of the proposed ISF Facility where a postulated fire may affect any safety-related structures, systems, and components.

- A restricted area with designed fire barriers to prevent wildfires from affecting the ISF Facility has been adequately described.

The applicant has assessed the site conditions, such as ground topography and the frequency of wildfires. Additionally, the applicant has appropriately designed the systems, structures, and

components important to safety and will locate them within the ISF Facility so that they can continue to perform their safety functions during credible fire scenarios.

Based on the foregoing evaluation, there is reasonable assurance that onsite fires and wildfires will not create a significant hazard to the proposed ISF Facility. The staff finds the proposed ISF Facility is sited, designed, and will be operated to minimize the potential for fires, and any onsite fires or wildfires will not impair the ability of the structures, systems and components to maintain subcriticality, confinement, sufficient shielding, and retrievability of the stored fuel. The applicant's description of its means and equipment to fight onsite fires provides a defense-in-depth approach and is adequate to assure the health and safety of its workers, the public, and the environment.

Explosion

The staff has reviewed the information presented in Sections 8.2.4.4, "Fire and Explosion," and 3.3.6, "Fire and Explosion Protection," of the SAR. Potentially combustible materials within the ISF Facility can be found in waste processing or delivery vehicles. These materials include:

- Diesel fuel in cask transporters;
- Gasoline and diesel fuels in waste processing or delivery vehicles; and
- Diesel fuel in diesel generator tank in the switchyard.

Important to safety structures, systems, and components are required to function after an explosion event. Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978) sets 6.9 kPa [1 psi] as the peak positive incident overpressure below which no significant damage to the structures would be expected to result from an explosion. Blast-induced ground motions are bounded by the earthquake criteria, and blast-generated missiles are bounded by the tornado missile criteria established for the ISF Facility. For explosion sources in the proposed ISF Facility, air overpressure from an explosion presents the most critical consideration.

A diesel fuel oil storage tank will be located within the restricted area fence for the diesel generator. The capacity of the diesel storage tank will be approximately 3,875 L [1,000 gal]. This tank has double walls to satisfy the primary and secondary spill containment requirements of NFPA 30 (1996a). This diesel storage tank may rupture, resulting in spillage of diesel fuel. Spilled diesel fuel, however, does not create the potential for an explosion because of its low volatility and high flash point. The flash point of diesel fuel is 51.7 EC [125 EF]. Based on NFPA Handbook (1997), the flash point of a liquid must be less than 37.8 EC [100 EF] to be classified as a flammable liquid. Therefore, diesel in the storage tank does not pose a credible explosion hazard. Similarly, diesel in the transporter will not pose a credible explosion hazard.

Tanks of any gasoline-powered vehicles potentially may explode when the vehicles are inside the proposed ISF Facility boundaries; however, without a credible initiating mechanism, the annual frequency of such explosions does not make this hazard credible.

The staff reviewed the information provided by the applicant regarding potential hazards from accidental onsite explosions at the ISF Facility. The staff finds the analysis acceptable because adequate design details of the diesel storage tanks have been provided.

The applicant has appropriately designed the structures, systems, and components important to safety and will locate them within the ISF Facility so they can continue to perform their safety functions during potential onsite explosion scenarios. Based on the foregoing evaluation, the staff finds that potential onsite explosions would not impair the ability of the structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.14 Maximum Hypothetical Dose Accidents

The staff reviewed the information presented in Section 8.2.4.5, "Maximum Hypothetical Dose Accidents," of the SAR. These accidents involve two hypothetical, beyond design basis, nonmechanistic events: (i) failure of the ISF canister confinement boundary and (ii) failure of the ISF transfer area confinement boundary. As indicated in the SAR, these events were selected as the worst-case scenarios with bounding radiological consequences.

As discussed in Section 8.2.4.5 of the SAR, the canister leakage in the first nonmechanistic event assumes that the canister is contaminated internally from the failed fuel and that the particulate contamination is considered to be released to the environment. Also, the ISF canister is assumed to leak at the maximum rate permitted by the helium leak rate test for a period of 30 days, and the fuel cladding/coating is considered to be 100 percent ruptured. The resulting dose from this postulated hypothetical event at the controlled area boundary located at 13.7 km [8.5 mi] is 3×10^{-5} mSv [3×10^{-3} mrem] TEDE. As discussed in Section 8.2.4.5 of the SAR, the second nonmechanistic event concerns hypothetical deflagration of HEPA filters in the FPA in the ISF transfer area. Radioactive contamination from the fuel handled in the FPA is assumed to collect onto one of the five FPA HEPA exhaust filters up to an exposure rate limit allowable by administrative procedures before replacement of HEPA filters. A loaded HEPA filter is assumed to deflagrate, causing offsite radiological consequences. The resulting dose from this postulated hypothetical event at the controlled area boundary located at 13.7 km [8.5 mi] is 2×10^{-4} mSv [2×10^{-2} mrem] TEDE.

The calculated doses from both nonmechanistic accidents are well below the 10 CFR §72.106 accident dose limit of 0.05 Sv [5 rem]. The estimated dose rate to the workers at nearby facilities for bounding HEPA filter release is also below the regulatory limits.

Based on the previous discussion, the staff agrees that the radiological consequences at the controlled area boundary resulting from the maximum hypothetical dose accidents have been acceptably calculated for these hypothetical events, and the applicant has demonstrated that the dose limits for accidents defined in 10 CFR §72.106 are not exceeded.

15.1.2.15 Loss of External Power for an Extended Period

The staff reviewed the information presented in Section 8.2.5.1 of the SAR, "Loss of External Power for an Extended Interval." This accident event involves loss of power from external sources for an indefinite period. The event is caused by a major utility power failure resulting from several potential causes, such as offsite accident, breakdown or malfunction of equipment, or natural phenomena.

As discussed in Section 8.2.5.1 of the SAR, the ISF Facility is designed to shut down in a safe mode following power loss. Standby and uninterruptible power supply power are available for a

period of 24 hours to continue interim operations. Power from these sources, however, is not required to safely secure the SNF, nor to maintain confinement or heat transfer. Although not required for the safety of the SNF, transfer equipment is provided with manual capability.

The HVAC system is designed to maintain neutral pressure in the FPA, in the event of a power loss. For neutral conditions, a negligible volume of air flows into or out of the area. In addition, HEPA filters provided in the inlet and exhaust ducts maintain confinement in the event of a power loss. Thermal calculations with the bounding fuel at the fuel operation and monitoring station in the FPA demonstrated that the steady-state fuel and ISF Facility structure concrete temperatures would not exceed the lowest allowable temperature limits. The steady-state temperature for the bounding TRIGA fuel is 151.7 EC [305 EF], and concrete temperature using the bounding Peach Bottom fuel is 77.78 EC [172 EF]; whereas, the limiting temperatures are 204.4 EC [400 EF] and 93.33 EC [200 EF], respectively.

Loss of HVAC has minimal effect on the transfer cask in the CRA. In addition, the maximum and minimum temperatures in the CRA would not exceed the design limits. The storage area does not require electrical power to ventilate the storage tubes and is not affected by extended power loss.

Based on the review of the information provided, the staff finds that the ability of structures, systems, and components to maintain subcriticality, confinement, and shielding will not be impaired as a result of loss of external power to the ISF Facility for an extended period.

15.1.2.16 Earthquake

The staff reviewed the information presented in SAR Sections 8.2.5.2, “Earthquake;” 2.6, “Geology and Seismology;” 3.2.3, “Seismic Design;” 4.2.3.3, “Design Bases and Safety Assurance” (for storage tube structures); and 4.7.3.3, “Design Bases and Safety Assurance” (for the ISF Facility structures).

The proposed ISF Facility design earthquake (DE) is based on a design response spectrum that envelops the 2,500-year return period rock uniform hazard spectra. The original 2,000-year return period uniform hazard spectra have been increased by 8 percent to develop the 2,500-year return period uniform hazard spectra. The peak horizontal ground acceleration at the rock outcrop is estimated to be 0.123g for the DE with a return period of 2,500 years. Sections 2.1 and 2.1.6 of this SER provide additional information on the seismic ground motion hazard at the proposed ISF Facility.

A seismic event can occur at any time during any stage of a transfer or storage operation involving a cask or a canister. Section 3.4 of the SAR classifies the structures, systems, and components into two categories: important to safety and not important to safety. All structures, systems, and components important to safety should be able to function during a seismic event. These important to safety features at the proposed ISF Facility are in the CRA, transfer area, and storage area.

In the CRA, structures, systems, and components important to safety are designed to function during and after a design basis seismic event without any radiological consequences. The important to safety structures, systems, and components are the transfer cask and cask receipt

crane. The staff reviewed information provided in the SAR and other related documents for each item. Details of the review are in Chapters 4 and 5 of this SER.

The transfer casks will deliver SNF from the adjacent Idaho Nuclear Technology and Engineering Center (INTEC) area to the proposed ISF Facility. These casks would also be used to transport the SNF from the CRA to the FPA. In the CRA, the transfer casks will be handled by the cask receipt crane. The cask will be lifted to a maximum height of 3.3 m [10 ft]. As stated in the SAR, these casks are designed for a drop of 10 m [30 ft] onto a hard and unyielding surface. Additionally, this crane is designed to be single-failure-proof in accordance with the requirements of NUREG–0554 (U.S. Nuclear Regulatory Commission, 1979). Therefore, the handling of the transfer cask in the ISF Facility will not result in any radiological consequences from a DE event.

The CRA consists of a steel-framed building surrounding a central steel tower. This tower supports the cask receipt crane. Primary structural steel members in the CRA are designed to withstand the loads resulting from a DE. In addition, the primary structural steel members of items not important to safety in the CRA also are designed for the DE loads. The worst-case scenario happens when the crane is lifting the maximum load. Therefore, the seismic analysis of the crane includes the vertically lifted mass of the transfer cask. The cask receipt crane will lift the transfer cask, weighing 31.75 tonnes [35 tons] from the transporter and lower it onto the cask trolley. The rated capacity of the crane is 141 tonnes [155 tons]. The crane is designed in accordance with NUREG–0612 (U.S. Nuclear Regulatory Commission, 1980) and is also designed to be single-failure-proof in accordance with NUREG–0554 (U.S. Nuclear Regulatory Commission, 1979). NUREG–0612 identifies controls for handling heavy loads at nuclear power plants. NUREG–0554 identifies the design features, fabrication, installation, inspection, testing, and operation of the hoisting system. Because of the single-failure-proof design, any potential failure of a single component will not result in the crane losing its capability to stop and hold the load. The crane is provided with suitable restraints to prevent any uplift during an earthquake. The crane design will not allow any part to become detached and fall in a DE. Additionally, the crane will not lower the load in an uncontrolled manner during or as a result of a DE. Based on the analysis provided in Section 4.7.3.3.4, “Cask Receipt Crane,” of the SAR, the crane will be able to withstand the DE loads without any unacceptable consequences and release of radioactive materials.

In the transfer area, the important to safety structures, systems, and components designed to withstand the loads from a DE are the FPA building structure, Transfer Tunnel, CCA building structure, cask and canister trolleys, FHM, portions of duct work and HEPA filters of the HVAC, manipulators, and personnel shielded access door. The staff reviewed information provided in the SAR and other related documents for each structure, system, or component important to safety. Details of the review are in Chapters 4 and 5 of this SER.

The FPA building is a reinforced concrete structure located inside the transfer area. This structure provides a confinement barrier, able to withstand the DE loads, for remote and safe handling of SNF. The SNF from the transfer cask will be repackaged into new ISF canisters in the ISF Facility. In addition, primary structural members of the transfer area classified as not important to safety are designed to withstand loads resulting from the DE. Therefore, a DE will not cause a release of any radioactive materials from the FPA.

The Transfer Tunnel is a reinforced concrete structure that provides a shielded corridor among the CRA, storage area, FPA, and CCA. A seismic isolation joint has been provided between the north and south sections to allow differential movement during a DE. The CCA is made of reinforced concrete. It is structurally a part of the FPA. The Transfer Tunnel runs below a part of the CCA.

The cask trolley will be used to transport a loaded transfer cask between the CRA and the cask port beneath the FPA in the Transfer Tunnel. The cask trolley also will be used to return an empty transfer cask to the CRA. The trolley is designed to be single-failure-proof in accordance with the requirements in NUREG–0554 (U.S. Nuclear Regulatory Commission, 1979). The cask trolley design prevents derailment during an earthquake. A locking pin extends from the base platform into an engineered cavity in the floor to lock the trolley at the cask port beneath the FPA. This pin is designed to fail as-is and, therefore, the trolley will be in a locked position if an earthquake occurs during loading of the transfer cask and transfer of SNF.

The canister trolley will be used to transfer ISF canisters loaded with SNF from the FPA to the CCA and also sealed canisters to the storage area loading and unloading port. The trolley is designed to be single-failure-proof in accordance with the requirements in NUREG–0554. The canister trolley design prevents derailment during an earthquake. A locking pin extends from the base platform into an engineered cavity in the floor for locking the trolley to prevent movement during an earthquake. This pin is designed to fail as-is and, therefore, the trolley will be in a locked position if an earthquake occurs during canister closure operations and transfer of SNF.

The FHM is an overhead electric crane to be operated in the FPA and has a top running bridge and cross travel trolley. The crane is designed to be a single-failure-proof crane in accordance with the requirements of NUREG–0554 and mounted on rails. The FHM is designed to withstand the DE without dropping or damaging the SNF container and disengaging from the rails. As discussed previously, the FPA concrete structure is also designed to withstand the DE. Therefore, the FHM will be able to withstand the loads associated with the DE with no radiological consequences.

The HVAC system is not required to operate during or after a seismic event to mitigate the effects of a DE. A seismic switch will stop the electrical power supply to the proposed ISF Facility including the fans at the transfer area, CRA, and storage area. Part of the ductwork will perform as confinement barriers. They include the supply HEPA filters, the internal exhaust HEPA filters, and the connecting ductwork with components from the filters to the enclosure walls. According to the SAR, these ductwork components are designed to withstand the effects of the DE.

A series of through-wall MSMs are mounted in the walls of the FPA. These manipulators serve to steady and align items suspended from the FHM hoist. These manipulators are classified as items important to safety because they form part of the FPA confinement barrier.

The personnel shielded access door allows personnel access to perform maintenance of the FHM. This door forms a part of the FPA confinement barrier and is designed to withstand the DE without any radiological consequences.

In the storage area, the important to safety structures, systems, and components designed to withstand the loads from a DE are storage vaults, storage tube assembly, ISF canister, and CHM. The staff reviewed information provided in the SAR and other related documents for each structure, system, or component. Details of the review are in Chapters 4 and 5 of this SER.

The storage vaults are composed of reinforced concrete. Thick concrete walls provide the radiation shielding to the SNF. The vaults are designed to withstand the DE without any radiological consequences. A storage tube assembly consists of the storage tube body, storage tube lid and seals, and the internal plug. The assemblies are designed to withstand the DE without any radiological consequences.

The canisters consist of the canister body assemblies and the lids. The canisters are designed to withstand the DE without any radiological consequences.

The CHM is a shielded machine that lifts loaded canister assemblies from the canister trolley and places them in the storage tubes in the storage area. The machine is designed to be single-failure-proof in accordance with the requirements of NUREG–0554 (U.S. Nuclear Regulatory Commission, 1979). The CHM also is designed to withstand the loads from the DE without damaging or dropping the canisters loaded with SNF and, therefore, without any radiological consequences.

The staff reviewed the information and analyses provided by the applicant for potential hazards from earthquake ground motion at the proposed ISF Facility. As discussed in Section 2.1.6.2 of this SER, the staff finds acceptable the probabilistic seismic hazard analysis methodology with a 2,500-year return period value used by the applicant to determine the DE for accident analyses (details are provided in Section 2.1.6 of this SER).

The staff also reviewed the information presented by the applicant on stability analyses of structures, systems, and components important to safety. The staff's evaluation is discussed in Chapter 5 of this SER. The staff finds the applicant's stability analyses acceptable because:

- Single-failure-proof lifting devices, designed to withstand the site-specific ground motion without toppling or dropping the load, will be used in the proposed ISF Facility; and
- All structures, systems, and components important to safety are designed to withstand the DE without any radiological consequences.

Based on the foregoing evaluation, the staff finds that a DE at the ISF Facility would not impair the capabilities of the structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.17 Flood

The applicant has considered flooding a credible accident at the ISF Facility area. The limiting flood conditions assumed for the ISF Facility are the result of the probable maximum flood. The probable maximum flood may be a result of the failure of Mackay Dam. As discussed in Chapters 2 and 4 of this SER, the flood waters within the ISF Facility would reach up to

1,499.83 m [4,921 ft] above mean sea level, and the surface elevation at the ISF Facility site is 1,498.7 m [4,917 ft].

Based on Section 3.2.2, “Water Level (Flood) Design,” of the SAR, the design of the ISF Facility for flood protection includes: (i) considering flooding loads in the design basis for structures, systems, and components, and (ii) sealing construction joints of the FPA and the storage vault below the probable maximum flood elevation to ensure water tightness. Therefore, in the event of a flood, the SNF or structural configuration will not be changed.

The SAR states that, if the probable maximum flood does occur, transporting of potential contamination could be possible via flood water from the CRA, Transfer Tunnel, solid waste storage area, SWPA, liquid waste storage tank area, and HVAC exhaust system to the offsite boundary.

Also, the SAR states that the CRA, cask trolley, and transfer cask delivery and removal transport will be maintained free of loose radioactive contamination. Furthermore, the transfer cask will remain sealed while in the CRA, so the flood water, if any, will not affect the SNF inside the cask.

Normal radiological controls will be implemented by the applicant to monitor and remove loose radioactive contamination from cask and canister trolleys while in the Transfer Tunnel for SNF unloading and loading, Transfer Tunnel floor and walls, and liquid waste storage tank area and SWPA during processing of waste. These normal radiological controls will limit the loose contamination potentially present during flood conditions.

A canister cask in the trolley is below the flood level when in the lowered position. To prevent flood water contact with the potentially contaminated interior surfaces or the ISF canister, the canister cask will be designed to include a water-tight seal for side and bottom joints. In the event the transfer cask is contaminated during unloading SNF, decontamination will be performed before releasing the transfer cask to the CRA.

Waste containers in the solid waste storage area and SWPA will be sealed and smeared for loose radioactive contamination. No loose contamination will be available to act as a source term for release during a flood event. The solid waste storage area and SWPA will be surveyed periodically and decontaminated as necessary. The tanks, pipes, pumps, and valves in the liquid waste storage tank area will be leak tight to prevent the spread of contamination.

The HEPA filters inside the ductwork of the HVAC exhaust system may become contaminated during normal operations. Ducting, however, around the HEPA filters is a leak-tight system. Consequently, the contamination present will not act as a source term for release from exposure to flood waters.

As indicated in the SAR, should the probable maximum flood occur, its flood wave will travel more than 13.5 hours before reaching the ISF Facility. Sufficient time is available to implement preplanned flood control measures (e.g., securing any ongoing processing sequences and waste containers in the SWPA).

Based on the preceding discussion, the staff agrees with the applicant that: (i) the structures, systems, and components important to safety are designed for flood protection to prevent

changes in SNF or structural configuration, (ii) the potential sources of radiological contamination available for exposure to flood waters in the ISF Facility are limited, and (iii) the response time is sufficient upon warning of an impending flood to permit actions to secure operations and prevent local flooding of potentially contaminated areas to prevent or further reduce the potential for radiological releases. Therefore, the staff concludes that no adverse radiological consequences at the offsite boundary will result from the flood event, nor will the flood event impair the ability of ISF Facility structures, systems, and components to maintain subcriticality, confinement, shielding, or retrievability of SNF.

15.1.2.18 Extreme Wind

The staff reviewed the information presented in Sections 2.3.1.3.3, “Tornadoes;” 3.2.1, “Tornado and Wind Loadings;” and 8.2.5.4, “Extreme Wind,” of the SAR. This review was conducted by assuming site personnel would not have any prior warning before the ISF Facility structures, systems, and components are impacted by a potential design basis tornado and a tornado missile.

The proposed ISF Facility is to be constructed at the INEEL site, at approximately 43E north latitude and 113E west longitude. The geographic region encompassing the INEEL site is one of the areas in the United States with very low tornado hazard (Ramsdell and Andrews, 1986). The SAR has assumed the design basis tornado for the proposed ISF Facility has a maximum wind speed of 322 km/h [200 mph], a rotational speed of 257 km/h [160 mph], and a translational speed of 64 km/h [40 mph] with a pressure drop of 10.3 kPa [1.5 psi], citing U.S. Nuclear Regulatory Commission guidance (1993). Additionally, the applicant considered Spectrum II missiles, as defined in Section 3.5.1.4, “Missiles Generated by Natural Phenomena,” in NUREG–0800 (U.S. Nuclear Regulatory Commission, 1981), as representative tornado-generated missiles for the proposed site. These missiles include:

- 52-kg [115-lb] wooden plank traveling at 58 m/s [190 ft/s];
- 130-kg [287-lb] 15.24-cm [6-in]-diameter Schedule 40 steel pipe traveling at 10 m/s [33 ft/s];
- 4-kg [9-lb] 2.54-cm [1-in]-diameter steel rod traveling at 8 m/s [26 ft/s];
- 510-kg [1,124-lb] utility pole traveling at 26 m/s [85 ft/s];
- 340-kg [750-lb] 0.3-m [12-in]-diameter Schedule 40 steel pipe traveling at 7 m/s [23 ft/s]; and
- 1,810-kg [4,000-lb] automobile traveling at 41 m/s [134 ft/s].

The applicant has concluded that the utility pole and 0.3-m [12-in]-diameter steel pipe are not credible missiles, citing U.S. Department of Energy Standard DOE–STD–1020–1994 (1994), because heavier missiles will not be generated by wind speeds less than or equal to 322 km/h [200 mph]. Similarly, the applicant has excluded the automobile as a potential tornado-generated missile for the proposed IFS Facility, citing Coats and Murray (1985), because automobiles will not be picked up or sustained by tornado events with wind speeds less than or equal to 322 km/h [200 mph].

Characteristics of the design basis tornado and tornado missile are given in Section 3.2.1 of the SAR. The proposed site is located in the Region III zone, as defined in Regulatory Guide 1.76 (U.S. Nuclear Regulatory Commission, 1974). The characteristic of the design basis

tornado for Region III is defined as a tornado with a maximum wind speed of 386 km/h [240 mph], a rotational speed of 306 km/h [190 mph], a translational speed of 80 km/h [50 mph], a radius of maximum rotational speed of 45.7 m [150 ft], and a 10.3-kPa [1.5-psi] pressure drop at a rate of 4.1 kPa/s [0.6 psi/s].

Ramsdell and Andrews (1986), based on historical tornadoes, estimated the potential for and characteristics of tornadoes in the contiguous United States for each 5E latitude and longitude box and in each state. The State of Idaho experienced six F0 {wind speed between 64 and 116 km/h [40 and 72 mph]}, 22 F1 {wind speed between 117 and 180 km/h [73 and 112 mph]}, and four F2 {wind speed between 181 and 253 km/h [113 and 157 mph]} tornadoes between 1954 and 1983. Expected tornado strike probability of the State of Idaho is 1.07×10^{-6}/year with an average (arithmetic average of observed tornadoes) strike probability of 6.62×10^{-7}/year. The 5E box encompassing the proposed site has experienced a total of 53 tornadoes between 1954 and 1983. Of the 53 tornadoes, 34 were classified using the Fujita scale: 8 F0, 20 F1, and 6 F2 tornadoes. Expected tornado strike probability is 1.07×10^{-6}/year with an average strike probability of any tornado (category F2 or less) striking in the 5E box encompassing the proposed ISF Facility is approximately 6.01×10^{-7}/year. The probability of a tornado larger than F2 striking the region is small. Ramsdell and Andrews (1986) estimated the probability of a tornado of category F2 or higher {wind speed higher than 181 km/h [113 mph]} is approximately 1.69×10^{-7}/year.

Ramsdell and Andrews (1986) also estimated the wind speed at each 5E box for a tornado with a probability of occurrence of 10^{-7}/year. The estimated wind speed in the 5E box encompassing the proposed site is 275 km/h [171 mph], and there is a 90-percent chance the true strike probability will be less than this. The applicant has assumed the maximum wind speed of the design basis tornado to be 322 km/h [200 mph], which is larger than that estimated by Ramsdell and Andrews (1986).

The current position of the U.S. Nuclear Regulatory Commission on the appropriate wind speed for the design basis tornado in SECY–93–087 (1993) is 322 km/h [200 mph] for states west of The Rocky Mountains. Therefore, the maximum wind speed assumed by the applicant is consistent with position given in SECY–93–087. Additionally, the nearby Three Mile Island Unit 2 Independent Spent Fuel Storage Installation is also designed for a maximum tornado wind speed of 322 km/h [200 mph]. Therefore, the staff concludes that the applicant has considered appropriate characteristics of the design basis tornado for the proposed ISF Facility, based on site-specific hazard information.

The applicant has excluded three of the Spectrum II missiles from further consideration because these heavy missiles would not be generated by tornadoes with wind speed less than or equal to 322 km/h [200 mph]. These missiles are: (i) 510-kg [1,124-lb] utility pole; (ii) 340-kg [750-lb] 0.3-m [12-in]-diameter Schedule 40 steel pipe; and (iii) 1,810-kg [4,000-lb] automobile. Because the design basis maximum tornado wind speed at the proposed ISF Facility is estimated to be 322 km/h [200 mph], with the expected wind speed of 275 km/h [171 mph] at an annual probability of occurrence of 10^{-7}, the staff concludes that the applicant’s assumption that these three heavy missiles need not be evaluated is acceptable. The applicant has considered the remaining three tornado missiles of Spectrum II. These objects are postulated to be picked up and transported by the winds of a design basis tornado.

Structures, systems, and components important to safety should be able to continue performing their safety functions during and following a design basis tornado to maintain confinement of the SNF, prevent criticality, and provide adequate shielding. The applicant has estimated that the minimum thickness of steel necessary to prevent local perforation is 0.2 cm [0.08 in] (Foster Wheeler Environmental Corporation, 2003a). Local scabbing would be prevented if there is 17.8-cm- [7-in]-thick concrete. The applicant proposed a 30-cm- [12-in]-thick reinforced concrete wall for protection against design basis tornado missiles. Therefore, the staff concludes, in accordance with NUREG–0800, Section 3.5.3—Barrier Design Procedures (U.S. Nuclear Regulatory Commission, 1981), that the proposed thickness of reinforced concrete would be adequate to protect against design basis tornado missiles.

The important to safety structures, systems, and components that may be affected by design basis tornado missiles are located: (i) outside the receipt area, (ii) inside the receipt area while the transfer cask is on the transporter, (iii) inside the receipt area while the transfer cask is suspended by the crane, (iv) inside the receipt area while the transfer cask is in the cask trolley, (v) inside the Transfer Tunnel while the transfer cask is in the cask trolley, (vi) inside the Transfer Tunnel while SNF is in the canister trolley, (vii) in the FPA, (viii) in the CCA, (ix) in the storage area (including the CHM), and (x) in the solid and liquid waste area. The applicant has analyzed the potential for tornado and tornado missiles hazard at each of these areas and concluded that important to safety structures, systems, and components will continue to perform their safety functions in the event of a tornado missile strike. The staff reviewed the applicant's analysis, as summarized below.

<u>Outside Receipt Area</u>

In this area, the protection against design basis tornado missiles to the SNF will be provided by the transfer cask. Appendix A of the SAR indicated that the transfer cask has been analyzed to survive drops up to a height of 8.2 m [27 ft] without loss of the cask confinement barrier. The SAR further pointed out this analysis is considered to bound the cases of overturning the cask or trailer by the design basis tornado winds and the tornado-generated missile loadings. The staff finds that the transfer cask will provide the necessary protection against design basis tornado missiles at the proposed ISF Facility.

<u>Inside Receipt Area while the Transfer Cask is on the Transporter</u>

The SNF will still be inside the transfer cask inside the CRA. The transfer cask will be on the transporter with cask hold-downs removed). In this configuration, the transfer cask will provide the necessary protection against design basis tornado missiles at the proposed ISF Facility.

<u>Inside Receipt Area while the Transfer Cask is Suspended by the Crane</u>

The SNF will still be inside the transfer cask. The transfer cask will be suspended by the cask receipt crane after removing the impact limiters. The crane is not designed to withstand the impact of a tornado missile strike. The applicant estimated each shipment of fuel would take less than 1 day to process at the proposed ISF Facility, which translates to approximately 15 percent of calendar days of the operating (fuel handling) phase of the ISF Facility. The probability a tornado will strike while the proposed ISF Facility is handling SNF is approximately $0.15 \times 6.62 \times 10^{-7}$, or 0.99×10^{-7}/year. Therefore, a tornado or missile impacting the cask receipt crane is not considered a credible hazard. Additionally, the applicant will use

administrative controls to restrict handling of SNF when tornado watches or warnings are in effect. Moreover, the supporting structure for the crane has been designed for appropriate Spectrum II missiles. Therefore, the hoist will not collapse on the cask below as a result of a tornado missile strike.

Inside Receipt Area with Transfer Cask in Cask Trolley

The SNF processing time of 24 hours includes time spent here. Therefore, the previous analysis also addresses this case, and a tornado missile is not a credible hazard at this part of the proposed ISF Facility.

Inside Transfer Tunnel with Transfer Cask in Cask Trolley

The Transfer Tunnel will be constructed with a minimum 0.91-m [3-ft]-thick reinforced concrete, which provides adequate protection against any design basis tornado missile. The outer door at the Transfer Tunnel entrance in the CRA and the maintenance hatch are designed to withstand any design basis tornado missile impact. Therefore, the SNF inside the transfer cask would be protected from tornado missiles for this case.

Inside Transfer Tunnel with SNF in Canister Trolley

Similar to the previous case, the reinforced concrete walls of the Transfer Tunnel and its outer door adequately protect the SNF loaded into the ISF storage canister from any design basis tornado missiles.

Fuel Packaging Area

This area is enclosed by reinforced concrete walls 1.22 m [4 ft] thick. The HEPA filters within this area and the tornado dampers outside this area provide the confinement boundary during a design basis tornado event. The HEPA filters are designed to withstand the wind and pressure differential of a tornado by the action of the tornado differential pressure dampers, which are protected from design basis tornado missiles. The ventilation ductwork is offset through the walls to limit the dose and to protect the tornado dampers inside the FPA from design basis tornado missiles. Electrical penetrations into the walls will be similarly offset to provide necessary shielding.

Canister Closure Area

This area is enclosed by 0.91-m [3-ft]-thick reinforced concrete walls. This area contains the upper part of the ISF canister during closure welding. A single viewing window is the only credible path for a tornado missile to reach the ISF canister. Possible paths to this window are protected by a labyrinth of barrier walls. Additionally, potentially exposed parts of the canister are well above the protected fuel part of the canister, which is protected within the 27.94-cm [11-in]-thick canister cask.

Canister Handling Machine

The CHM is designed to withstand the effects of tornado winds and associated pressure drop; however, it is not designed to withstand the direct impact of a tornado missile. The CHM will be

used to insert as many as 246 canisters into the storage tubes over 39 months of operation. Each SNF canister storage operation will be completed within 1 day. Therefore, the CHM will be handling SNF for approximately 21 percent of the operating period. The probability of a tornado strike with sufficient strength (Category F2 or higher) during fuel handling operations is $0.21 \times 1.69 \times 10^{-7}$, or 3.6×10^{-8}/year, as estimated in the SAR. Using the tornado strike characteristics data of the State of Idaho, the probability of a tornado strike with sufficient strength during fuel handling operations is $0.21 \times 1.92 \times 10^{-7}$, or 4.0×10^{-8}/year, Therefore, for either calculation, a tornado missile is not a credible hazard for the canister handling machine. As an added safety measure, the applicant will use administrative controls to restrict the fuel handing operations when tornado watches or warnings are in effect.

Storage Area

The storage area is enclosed by reinforced concrete walls 0.91-m [3-ft] thick around the perimeter. The storage tube cover plates are composed of approximately 5.72-cm [2.25-in]-thick steel and, therefore, will be able to withstand the design basis tornado missiles.

Solid and Liquid Waste Areas

The solid waste storage area is protected on two sides by tornado missile-resistant walls. Similarly, the SWPA will be protected from all sides and the roof by tornado missile-resistant walls. The liquid waste storage tank area is protected on two sides by tornado missile-resistant walls. In the proposed ISF Facility, the solid waste will be packaged into steel drums or boxes. A tornado-generated missile may puncture these sealed waste drums or boxes and release radioactive materials, causing localized contamination. The applicant assessed the amount of radioactive contamination that may be released and concluded that it would not be sufficient to exceed the offsite dose limit.

Summary of Review of Extreme Wind

The staff reviewed the information provided by the applicant and evaluated the analyses of potential hazards from design basis tornadoes and tornado missiles at the ISF Facility. The staff finds the analyses acceptable because:

- The frequency and characteristics of tornadoes and tornado missiles for the proposed site have been adequately assessed.

- Acceptable methodologies have been used to characterize the design basis tornadoes and tornado missiles for the proposed site.
- Structures, systems, and components important to safety that may be affected by the design basis tornados and tornado missiles have been identified.
- Structures, systems, and components important to safety that may be affected are adequately designed to withstand postulated tornado wind loads and loads imparted by the postulated tornado missiles, or the annual probability of being affected by a tornado missile strike is low enough to consider this potential hazard to the proposed facility to be a non-credible event.

Based on the foregoing evaluation, the staff finds that a tornado or tornado-generated missile will not impair the capability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.19 Lightning

The staff reviewed the information presented in Section 8.2.5.5, "Lightning," of the SAR as an accident event. The lightning risk to the ISF Facility is estimated as moderate to severe. A lightning protection system is provided to reduce the risk, as discussed in Section 4.3.8.1.4, "Design Code Compliance," of the SAR. The ventilation system and other equipment are not relied on for removal of heat from the stored SNF. Hence, failure of these systems as a result of lightning strikes would not affect the integrity of the fuel. There will be no radiological consequences or breach of confinement resulting from lightning strikes.

As indicated in Appendix A of the SAR, during the brief period the transfer cask is located outside the ISF Facility when it is first received, the rubber tires of the transporter will serve as an insulator to protect the cask from a significant surge of electrical current in event of a lightning strike.

Based on the review of the information provided, the staff finds that lightning strikes would not impair the capability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.20 Accidents at Nearby Sites—Offsite Explosion Hazards

The staff reviewed the information presented in Sections 2.2, "Nearby Industrial, Transportation, and Military Facilities," and 8.2.5.6, "Accidents at Nearby Sites," of the SAR. Supplemental information presented by Foster Wheeler Environmental Corporation (2003b,c) was also reviewed. This accident event involves an offsite explosion that may damage the structures, systems, and components important to safety of the proposed ISF Facility. The effects produced by an explosion may be an incident or reflected overpressure, blast-induced ground motion, or blast-generated missiles. The onsite explosion hazard has been evaluated in Section 15.1.2.13, "Fire and Explosion," of this SER.

The potential scenarios at the ISF Facility that can result in an offsite explosion include:

- An accident at nearby storage tanks of flammable and combustible materials; or
- An accident involving a tanker truck transporting flammable or combustible materials.

<u>Accidental Explosion at Storage Tank</u>

Foster Wheeler Environmental Corporation (2003c) has identified propane storage tanks as the largest stationary source of flammable and combustible materials that may affect the proposed ISF Facility in an accidental explosion. The applicant identified the propane tanks in the vicinity of the proposed ISF Facility site. All known propane sources are less than 3,785 L [1,000 gal] capacity, and are located more than 450 m [1,475 ft] from the proposed ISF Facility site.

To provide flexibility in storing propane at INTEC in the future, Foster Wheeler Environmental Corporation (2003c) determined the minimum setoff distances required for any explosion of these sources to result in an air overpressure less than or equal to 6.9 kPa [1 psi] at the proposed ISF Facility. Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978) establishes an air overpressure limit of 6.9 kPa [1 psi], below which significant damage to structures, systems, and components is not expected to occur. The U.S. Department of Energy–Idaho Operations Office has committed to ensure that these minimum setoff distances for any propane storage installations will be maintained (Foster Wheeler Environmental Corporation, 2003c).

Foster Wheeler Environmental Corporation estimated the necessary setoff distances so the air overpressure from accidental detonation of 3,785- and 7,571-L [1,000- and 2,000-gal] propane tanks would be less than or equal to 6.9 kPa [1 psi], using the methodology given in Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978). Several assumptions were made for the estimation: (i) no other structures are between the tanks and the proposed ISF Facility, (ii) the tank structure does not provide any blast-dampening effects, and (iii) the tanks are completely filled with propane. These assumptions are conservative, because NFPA 58 (1998b) does not permit completely full propane storage tanks at any time. The applicant assumed that the entire propane contents are released from the storage tank instantaneously as vapor and are involved in the explosion. This assumption is conservative. The explosion yield is assumed to be 10 percent. Using the equation provided in Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978), the applicant estimated that, at a distance of 229 and 287 m [750 and 940 ft] from the storage tanks of capacity 3,785 and 7571 L [1,000 and 2,000 gal], the peak air overpressure would be 6.9 kPa [1 psi]. These setoff distances are estimated without any wind dispersion effects. Because wind dispersion reduces the setoff distances, these distances are conservative.

Because all propane tanks in the vicinity of the proposed facility have capacity less than 3,785 L [1,000 gal] and are at greater distances than the minimum setoff distance estimated to be 229 m [750 ft], any accidental explosion of these tanks would not pose a credible hazard to the proposed ISF Facility. Additionally, as discussed previously, DOE-ID has committed to maintain these setoff distances for any future propane storage tank installations. Any accidental explosion of these tanks would not pose a credible hazard to the proposed ISF Facility.

The applicant also identified significant quantities of diesel and kerosene stored in underground and above-ground tanks in the vicinity of the proposed ISF Facility site. Diesel and kerosene are not flammable liquids and have low volatility. They are classified as Class II combustible liquids using NFPA 30 (1996a) criteria. The flash points of these fuels are between 38 and 60 EC [100 and 140 EF]. Therefore, a potential explosion of the storage tanks containing either diesel or kerosene is not considered credible.

Additionally, Foster Wheeler Environmental Corporation identified an underground gasoline tank more than 600 m [1,967 ft] from the proposed ISF Facility. The applicant performed a bounding calculation to determine that an air overpressure of 6.9 kPa [1 psi] would be generated from an explosion of 45,425 L [12,000 gal] of gasoline stored above ground at a distance of 583 m [1,912 ft]. In comparison, a potential accidental explosion of a significantly lesser quantity of gasoline in the underground storage tank at a distance more than 600 m [1,967 ft] from the ISF Facility would generate an air overpressure below 6.9 kPa [1 psi] at the

proposed facility. Therefore, the explosion of a nearby underground gasoline tank would not pose a credible hazard for the ISF Facility.

Accidental Explosion of a Tanker Truck

Foster Wheeler Environmental Corporation (2003c) used the methodology given in Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978) to estimate the annual frequency of potential transportation-related explosions at the proposed ISF Facility. Potential sources of explosion include fuel deliveries to the proposed ISF Facility.

The applicant identified propane, gasoline, diesel fuel, and kerosene as the primary flammable and combustible materials transported to INTEC (Foster Wheeler Environmental Corporation, 2003c). Other flammable materials, such as carbon monoxide, ethyl acetate, hydrogen sulfide, and isobutane, are transported in much smaller quantities {less than 43 kg [100 lb]} and are not of concern. The maximum amount of propane that can be transported is based on the Idaho Department of Transportation limit on gross vehicle weight and is equal to 47,318 L [12,500 gal] (Foster Wheeler Environmental Corporation, 2003a). The maximum amounts of gasoline, diesel fuel, and kerosene that can be transported are 45,425 L [12,000 gal] for gasoline, 37,854 L [10,000 gal] for diesel fuel, and 37,854 L [10,000 gal] for kerosene.

Using the trinitrotoluene-equivalence methodology given in Regulatory Guide 1.91, with a 10-percent explosion yield, the applicant estimated the distance at which the peak incident air overpressure would be 6.9 kPa [1 psi] for explosion of trucks transporting propane, gasoline, diesel, and kerosene in quantities described previously. Estimation was conducted for a wind-affected scenario, along with a scenario in which wind does not affect the fuel dispersion. In no-wind conditions, it was assumed the entire mass of the material is released instantaneously as vapor and is available for explosion. Additionally, it has been assumed no structures interfere with the propagation of the blast wave before impinging on the proposed facility. Both of these assumptions are conservative.

The worst-case release assumptions used are consistent with the U.S. Environmental Protection Agency (2002) recommendations given in 40 CFR §68.25 and are acceptable to the staff. It has been assumed the proposed ISF Facility is always directly downwind of the explosion location. This assumption is generally conservative because the transportation routes are predominantly northwest of the proposed site; and the predominant wind at the proposed site is from the southwest or northwest.

The applicant performed bounding calculations to determine conservative setoff distances for consideration of tanker truck explosions. Similar to the previous calculation for a gasoline storage tank of equal volume, the estimated setoff distance is 583 m [1,912 ft] for a tanker truck carrying 45,425 L [12,000 gal] of gasoline, assuming no wind dispersion, which is conservative because wind dispersion would quickly reduce the flammable mass. A setoff distance of 674 m [2,211 ft] is estimated for the explosion of a tanker truck carrying 47,318 L [12,500 gal] of propane. The estimated setoff distances were 551 m [1,809 ft] and 557 m [1,829 ft] for diesel and kerosene with no wind-assisted dispersion. The lower explosive limit of the flammable mass was never exceeded for diesel and kerosene when wind-affected dispersion was assumed.

The flash points of diesel fuel and kerosene are 51.7 EC [125 EF] and 43.3 EC [110 EF]. Based on the NFPA handbook (1997), the flash point of a liquid must be less than 37.8 EC [100 EF] to be classified as a flammable liquid. Diesel and kerosene are classified as Class II combustible liquids. Therefore, while being transported, diesel and kerosene do not pose credible explosion hazards to the proposed ISF Facility. However, to be very conservative, Foster Wheeler Environmental Corporation (2003c) included both diesel and kerosene in its analyses.

Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978) provides a methodology to estimate the exposure rate *r* per year:

$$r = n \cdot f \cdot s \tag{15-1}$$

where,

n	—	explosion rate (per mile)
f	—	frequency of shipment (per year)
s	—	exposure distance (mile)

Foster Wheeler Environmental Corporation used information from the U.S. Department of Transportation, U.S. Department of Commerce, Federal Emergency Management Agency, and U.S. Environmental Protection Agency to estimate the explosion rate, *n*, of the flammable and combustible liquids while being transported in tanker trucks in the vicinity of the proposed ISF Facility. The latest information available from the U.S. Department of Transportation and U.S. Department of Commerce (2000) is for the year 1997.

Based on U.S. Department of Transportation and U.S. Department of Commerce (2000) information, 7.89×10^8 tonne [8.69796×10^8 ton] of hazardous cargo were shipped in 1997. These cargos traveled 1.088×10^{11} tonne-km [7.4939×10^{10} ton-mi]. The U.S. Department of Transportation and U.S. Department of Commerce provided the estimated travel distance per shipment of hazardous materials by truck in 1997 to be 117.4 km [73 mi] (2000, Table 1). The staff used this information in its review.

There were an average of 7.68907×10^5 hazardous cargo shipments in a day (U.S. Department of Transportation, 2000). Therefore, on average, approximately 2.80651×10^8 shipments of hazardous cargo occur in a year. Consequently, the hazardous cargo will travel approximately $2.80651 \times 10^8 \times 117.4$, or 3.2948×10^{10} km [$2.80651 \times 10^8 \times 73$, or 2.0488×10^{10} mi]. Based on Federal Emergency Management Agency, U.S. Department of Transportation, and U.S. Environmental Protection Agency information (1988), 80 percent of hazardous materials transported by truck contain flammable and combustible materials. Therefore, distance traversed by flammable and combustible cargo while transported in trucks would be 2.636×10^{10} km [1.639×10^{10} mi] annually.

Based on 1997–2001 information from the U.S. Department of Transportation, Foster Wheeler Environmental Corporation estimated that, on average, 11.4 explosions involving flammable and combustible materials take place each year while being transported in trucks on highways. For comparison, 11 explosions occurred in 1997. Therefore, the number of explosions of flammable and combustible materials that take place annually is approximately $11.4/2.636 \times 10^{10}$, or $4.32 \times 10^{!10}$/km [$11.4/1.639 \times 10^{10}$, or $6.96 \times 10^{!10}$/mi] of travel.

Therefore, the explosion rate, *n*, of flammable and combustible liquid would be 4.32×10^{-10}/km [6.96×10^{-10}/mi].

The applicant and the U.S. Department of Energy–Idaho Operations Office indicated that, although there will be many shipments of flammable and combustible liquids to the INTEC facilities, only a few would travel inside the risk zones delineated by the minimum setoff distances discussed previously. In addition, each shipment would consist of smaller quantities of flammable or combustible liquids than was assumed for determining the setoff distances. The applicant assumed conservative values for the annual frequency of shipments for propane, gasoline, diesel and kerosene. For these flammable and combustible liquids, Foster Wheeler Environmental Corporation used twice the calculated setoff distance as the exposure distance in its analyses. Using these distances for these liquids, the applicant conservatively estimated the annual exposure rate from these explosion events to be 3.73×10^{-8}. Therefore, the staff concludes that such explosion events will not impact the ISF Facility safety-related structures, systems, and components, and they would be able to perform their intended function.

Other gasoline-powered vehicles will use the east perimeter road. Gasoline tanks in these vehicles potentially may explode following a collision or a crash. The speed on this road is low and the traffic volume is low. Therefore, the possibility of a collision between two vehicles or a single vehicle crash also is low, and the annual frequency of such crashes resulting in an explosion of the fuel tank(s) is extremely low. Assuming the capacity of the gasoline fuel tanks of these vehicles to be a maximum of 95 L [25 gal], the peak air overpressure from an explosion will be less than 6.9 kPa [1 psi] at the ISF Facility transfer area. Moreover, other structures in the propagation path of the blast wave will dampen the air overpressure further, so that potential damage to ISF Facility safety-related structures, systems, and components is not credible for this event.

Summary of Review of Offsite Explosion Hazards

The staff reviewed the information provided by the applicant and evaluated the applicant's analyses of potential hazards from offsite explosions at the proposed ISF Facility site. The staff finds these analyses acceptable because:

- The applicant has assumed that there are no structures between the storage tanks and the proposed ISF Facility. This assumption is conservative because dampening of the blast wave by the existing structures has been neglected in the analysis.
- The applicant has assumed that the entire fuel mass from the storage tanks is released instantaneously, forms a vapor cloud, and is available for explosion. This assumption is conservative.
- The applicant has assumed that diesel and kerosene would form a vapor cloud and potentially explode. This assumption is conservative given the environmental conditions and fuel characteristics.
- The accident rate of trucks hauling flammable and combustible liquids inside INTEC is assumed to be the same as the national average. This assumption is conservative, given the lower average speed and traffic in this area.
- The applicant has assumed that the proposed ISF Facility is directly downwind of the source of a vapor cloud explosion. This assumption is conservative, given the prevailing wind directions in this area.

- The estimated annual exposure rate of structures, systems, and components important to safety at the proposed ISF Facility is well below 10^{-6} from potential explosions at nearby facilities.

The applicant has examined, collected, and evaluated information on potential offsite explosions near the proposed ISF Facility. The applicant used acceptable methods to evaluate the potential explosion events for transport vehicles and nearby facilities. Evaluation of the potential effects shows that offsite explosions will not pose a hazard to the ISF Facility.

Based on the foregoing evaluation, the staff finds that potential offsite explosions would not impair the ability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.21 Accidents at Nearby Sites–Offsite Toxic Gas Release Hazards

The staff reviewed the information presented in Sections 2.2, “Nearby Industrial, Transportation, and Military Facilities,” and 8.2.5.6, “Accidents at Nearby Sites,” of the SAR. Supplemental information presented by Foster Wheeler Environmental Corporation was also used in this review. This accident event involves the potential release of toxic chemicals from nearby facilities that may impact the proposed ISF Facility or its workers.

Foster Wheeler Environmental Corporation identified two toxic chemicals, if released from nearby facilities, with the potential to exceed the recommended distances in Emergency Response Planning Guide 3 (American Industrial Hygiene Association, 2001). These recommended distances ensure that the maximum airborne concentration is below what all individuals can be exposed to for up to 1 hour without experiencing life-threatening health effects. These two toxic chemicals are hydrofluoric acid and nitric acid. Nitric acid was determined to be the more limiting chemical for analysis purposes, since hydrofluoric acid within the area of concern is only in the form of a complexed chemical aluminum fluoride that cannot be released as a vapor.

Foster Wheeler Environmental Corporation (2003b) analyzed the potential release of nitric acid and its resulting impact on concentration levels inside and outside the proposed ISF Facility. Analysis was conducted using three different meteorological scenarios: (i) U.S. Environmental Protection Agency worst-case scenario based on 40 CFR Part 68, (ii) a worst-case scenario, assuming a simultaneous release from all tanks, and (iii) a typical scenario. The U.S. Environmental Protection Agency requires evaluation of release from single tank only unless the tanks are directly connected.

Results using the typical case did not show any significant concentration at the proposed ISF Facility. Using the U.S. Environmental Protection Agency worst-case scenario, maximum concentrations of nitric acid outside and inside the proposed ISF Facility were from a single tank. The estimated concentrations were 32 and 20 ppm of nitric acid outside and inside the proposed ISF Facility. These values are significantly below the maximum airborne concentration for nitric acid of 78 ppm (American Industrial Hygiene Association, 2001).

The applicant determined that a hypothetical coincident release of nitric acid from multiple nearby tanks could result in an airborne concentration at the proposed ISF Facility that might

impact the health of exposed personnel. For this worst-case scenario, the prevailing wind direction was directly from the source toward the proposed ISF Facility. For this case, the concentration of airborne nitric acid will rise slowly inside the proposed ISF Facility to 422 ppm. The outside concentration is estimated to be 1,490 ppm. The atmospheric level of nitric acid concentration would return to normal after the source has been depleted.

In the case of a catastrophic release from multiple tank failures, prevailing winds during typical meteorological conditions, as shown in Figures 2.3-13 through 2.3-16 of the SAR, would dilute the quantity of toxic gas reaching the ISF Facility and, therefore, the airborne concentration of nitric acid would be less than estimated in the applicant's worst-case scenario. This scenario is not credible, based on the U.S. Environmental Protection Agency guidelines for worst-case modeling in 40 CFR Part 68 (U.S. Environmental Protection Agency, 2002). In addition, nearby facilities were designed in accordance with applicable codes and the requirements of U.S. Department of Energy to withstand maximum credible natural phenomena, such as earthquakes and tornadoes. All below ground structures and above ground structures necessary for process control and confinement are hardened to mitigate consequences from earthquakes and tornadoes. The building grade level has been constructed to be above the maximum credible flood level.

The postulated nitric acid plume concentration in air could require the evacuation of personnel from the proposed ISF Facility, as directed by the ISF Facility Emergency Plan (Foster Wheeler Environmental Corporation, 2003c). Procedures or actions in response to a toxic gas release may require or recommend sheltering of personnel for 1 to 2 hours within nearby normally occupied facilities. The proposed ISF Facility is designed in such a way that emergency actions by personnel would not be required to ensure safe operation of the ISF Facility prior to evacuation (Foster Wheeler Environmental Corporation, 2003b,c). Therefore, release of toxic chemicals at nearby facilities would not pose a credible hazard to the proposed ISF Facility.

Summary of Review of Offsite Toxic Gas Release Hazards

The staff reviewed the information provided by the applicant and evaluated the applicant's analyses of potential hazards from offsite release of toxic gases on the proposed ISF Facility. The staff finds the analyses acceptable because:

- The use of the American Industrial Hygiene Association Emergency Response Planning Guide level is acceptable because the risk from toxic gas release is to the personnel, not to the public.

- An acceptable methodology was used to estimate the maximum airborne concentration of toxic gases at the proposed ISF Facility.

- Three different meteorological assumptions were used based on U.S. Environmental Protection Agency worst-case conditions, worst-case conditions, and typical conditions.

- Although the estimated airborne concentration level using multiple tank failure worst-case scenarios, which are unlikely events, could require evacuation of personnel at the proposed ISF Facility, the ISF Facility is designed to maintain the SNF in a safe condition without reliance on any emergency actions by personnel prior to evacuation.

The applicant has examined, collected, and evaluated information on the potential release of toxic gases from offsite sources near the proposed ISF Facility. The applicant used acceptable methods to evaluate the potential release of toxic gases at these nearby facilities. Evaluation of the potential effects shows that offsite release of toxic gases will not pose a hazard to the ISF Facility.

Based on the foregoing evaluation, the staff finds that potential release of toxic gases from nearby facilities would not impair the ability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.22 Accidents at Nearby Sites—Radiological Hazards

The staff reviewed the information presented in SAR Sections 2.2, "Nearby Industrial, Transportation, and Military Facilities," and 8.2.5.6, "Accidents at Nearby Sites." Supplemental information presented by Foster Wheeler Environmental Corporation (2003c). This postulated accident involves a radioactive release at nearby facilities that may impact the ISF Facility or its workers.

Foster Wheeler Environmental Corporation (2003c) identified a radiological release at the nearby INTEC facilities as the primary radiological risk to the proposed ISF Facility. The radiological criterion, Threshold of Early Lethality, used at INTEC is the TEDE of 1 Sv [100 rem]. Foster Wheeler Environmental Corporation (2003c) determined that a radiological release at several nearby facilities could impact the proposed ISF Facility and needed closer scrutiny.

Nearby facilities for the storage and processing of irradiated and unirradiated fuel are designed and operated so as to minimize the potential for accidental release of radioactive materials. The estimated doses at the proposed ISF Facility resulting from hypothetical accidents at these facilities could be greater than 0.01 Sv [1 rem]; however, the doses would not exceed the Threshold of Early Lethality of 1 Sv [100 rem] (Foster Wheeler Environmental Corporation, 2003b).

Other nearby facilities include radioactive material storage facilities and a test reactor. The applicant evaluated the radiological consequences of hypothetical accidents at these facilities and concluded that the doses at the proposed ISF Facility could exceed the Threshold of Early Lethality of 1 Sv [100 rem].

The major contributor to the dose from an accident at the materials storage facility is via inhalation. Direct radiation shine doses are less than 2 mSv [200 mrem] for this event, which would not impact the components and operation of the proposed ISF Facility (Foster Wheeler Environmental Corporation, 2003c). For an accident at the test reactor, the released radioactivity for worst-case meteorological conditions could force evacuation of an area that includes the proposed ISF Facility.

The emergency action manager, at his or her discretion, will be notified about radiological accidents at any nearby facilities. Some postulated radiological accidents at the nearby facilities may require evacuation of personnel from the proposed ISF Facility, as dictated by the emergency plan. The proposed ISF Facility is designed in such a way that emergency actions

by personnel would not be required prior to evacuation in order to maintain the spent fuel in a safe configuration (Foster Wheeler Environmental Corporation, 2003b,c). Therefore, the release of radioactive materials from accidents at nearby facilities would not impact the proposed ISF Facility or its functions and would not initiate an accident or an event sequence at the proposed ISF Facility.

<u>Summary of Review of Offsite Radiological Hazards</u>

The staff reviewed the information provided by the applicant and evaluated the applicant's analyses of potential hazards from offsite radiological release at the proposed ISF Facility. The staff finds these analyses acceptable because:

- Systematic analyses were used to identify potential sources of radiological release at the nearby facilities that could exceed the allowable dose limit.

- Although the estimated dose at the proposed ISF Facility from unlikely accidents postulated at some nearby facilities could exceed the radiological dose criterion and require evacuation of personnel, the ISF Facility is designed to maintain the spent fuel in a safe condition without reliance on any emergency actions by workers prior to evacuation.

The applicant has examined, collected, and evaluated information of potential offsite radiological releases near the proposed ISF Facility. The applicant used acceptable methods to evaluate the potential radiological releases from these nearby facilities. Evaluation of the potential effects shows that offsite radiological releases will not pose a hazard to the ISF Facility.

Based on the previous evaluation, the staff finds that potential offsite radiological releases from nearby facilities would not impair the ability of the ISF Facility structures, systems, and components to maintain subcriticality, confinement, and sufficient shielding of the SNF.

15.1.2.23 Aircraft Crash Hazards

The staff reviewed the information presented in Section 2.2 of the SAR, "Nearby Industrial, Transportation, and Military Facilities." In addition, the staff reviewed information presented in the applicant's response to the staff's request for additional information (Foster Wheeler Environmental Corporation, 2003b). This review ensures that the risk to the proposed ISF Facility as a result of aircraft hazards has been appropriately estimated and is acceptable.

The staff reviewed the aircraft crash hazard analysis in accordance with NUREG–0800, Section 3.5.1.6, "Aircraft Hazards" (U.S. Nuclear Regulatory Commission, 1981). The staff accepts the methodology in NUREG–0800, as applicable, for reviewing the aircraft crash probability for the proposed ISF Facility site. Section 3.5.1.6 of NUREG–0800 provides three screening criteria that must be satisfied to conclude, by inspection, that the aircraft hazards at a nuclear power plant are less than 1×10^{-7}/year for accidents that could result in radiological consequences greater than 10 CFR Part 100 exposure guidelines. The screening criteria are as follows:

- The plant-to-airport distance, D, is between 8 and 16 km [5 and 10 statute mi], and the projected annual number of operations is less than $500D^2$ or the plant-to-airport distance D is greater than 16 km [10 statute mi], and the projected annual number of operations is less than $1{,}000D^2$.

- The plant is at least 8 km [5 statute mi] from the edge of the military training routes, including low-level training routes, except for those routes associated with a usage greater than 1,000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.

- The plant is at least 3.2 km [2 statute mi] beyond the nearest edge of a Federal airway, holding pattern, or approach pattern.

Estimating the total probability of an aircraft crash onto the proposed ISF Facility site requires an evaluation of crash probabilities from several sources:

- Aircraft taking off and landing at nearby airports
- Commercial aviation flying nearby
- General aviation flying nearby
- Military aircraft flying training routes VR1300, IR302, and IR305
- Helicopter flights
- INEEL–Federal Aviation Administration (FAA) aircraft tests.

Aircraft Taking Off and Landing at Nearby Airports

Commercial airports near the INEEL site include: (i) Idaho Falls Regional Airport, approximately 70 km [43 mi] away; (ii) Pocatello Regional Airport, approximately 79 km [49 mi] away; (iii) Burley Municipal Airport, approximately 134 km [83 mi] away; and (iv) Joslin Field–Magic Valley Regional Airport, near Twin Falls, approximately 176 km [109 mi] away. Twelve single-engine aircraft are based at Arco–Butte County Airport, approximately 32 km [20 mi] west of the proposed ISF Facility site. Howe Airport is located approximately 32 km [20 mi] north of the proposed site, and four single-engine aircraft are based there.

Idaho Falls Regional Airport had 44,040 operations (takeoffs and landings) in 2001, out of which 14,421 and 15,270 were by local and itinerant general aviation aircraft (Foster Wheeler Environmental Corporation, 2003b). In 2001, 909 and 13,168 operations at this airport were by air carriers and air taxis; the rest were by military aircraft. Pocatello Regional Airport had 43,562 operations in 2001, out of which 1,159 were by air carriers, 14,144 are by air taxis, and 27,563 were by general aviation aircraft; the rest were by military aircraft. Burley Municipal Airport had 32,264 operations in 2001. This airport had 400 operations by air taxis and 100 operations by military aircraft. The remaining 31,764 operations were by general aviation aircraft. Joslin Field–Magic Valley Regional Airport had 38,715 operations in 2001. Air carriers and air taxis accounted for 121 and 11,199 operations. There were 848 operations by military aircraft. The remaining 25,699 operations were by general aviation aircraft. Arco–Butte County Airport had 8,900 operations in 2001, with air taxis and military aircraft accounting for 100 operations each. The remaining 8,700 operations were by general aviation aircraft. Howe Airport had 7,250 operations in 2001, all of which were conducted by general aviation aircraft.

All these airports are at significant distances from the INEEL facilities. Therefore, any flights near the INEEL facilities would be in a cruise mode. Based on NUREG–0800 (U.S. Nuclear Regulatory Commission, 1981), any landing and departure operations at these airports would have a negligible crash hazard to the proposed ISF Facility.

Two small airports near the proposed site, Midway and Big Southern Butte, are used by private and crop-dusting aircraft primarily for recreational and emergency purposes. Midway and Big Southern Butte Airports are approximately 16 km [10 mi] south-southeast and 20 km [12 mi] south-southwest of the proposed site. Midway Airport has a dirt and gravel runway, while Big Southern Butte Airport is served by two grassy runways. Foster Wheeler Environmental Corporation (2003b), based on the information from the Airport Maintenance Manager for Idaho State Airports, estimated approximately 20 takeoffs and landings occur annually at these airports. Based on the criteria provided in NUREG–0800, any landing and departure operations at these airports would have a negligible crash hazard to the proposed ISF Facility.

Commercial Aviation

For national security purposes, the FAA has placed an advisory prohibiting flights at altitudes below 1,800 m [6,000 ft] above mean sea level over the INEEL facilities. The proposed ISF Facility is at an elevation approximately 1,500 m [4,900 ft] above mean sea level. Aircraft usually fly around the INEEL boundary (Foster Wheeler Environmental Corporation, 2003b).

An average of 2 to 3 air taxi flights are flown between Idaho Falls and Boise each day, with 1,000 flights annually (Lee, at al., 1994). These flights come within approximately 5 km [3 mi] of the proposed site. Air taxi flights from Idaho Falls Regional Airport use FAA-approved vector 269 while flying to Pocatello, Burley, and Twin Falls. Approximately 6 flights take place in a day, with an annual total of 2,000 flights. These flights approach within approximately 30 km [19 mi] of the proposed ISF Facility (Lee, et al., 1994) and use the Federal Airway vector 269. The edge of this airway nearest the proposed ISF Facility site is approximately 15 km [9 mi] (Foster Wheeler Environmental Corporation, 2003b). No jet ways, holding patterns, or approach patterns are near the proposed site (Foster Wheeler Environmental Corporation, 2003b).

Based on NUREG–0800, any flights by commercial aircraft, as described, would have a negligible crash hazard to the proposed ISF Facility because the ISF Facility will be located at least 3.2 km [2 mi] beyond the nearest edge of a flight path.

General Aviation

Approximately 98 percent of the traffic at Arco–Butte County airport is general aviation aircraft composed of private and crop-duster aircraft. All the traffic, or 100 percent, at Howe Airport is by general aviation aircraft, mostly used for crop dusting (Foster Wheeler Environmental Corporation, 2003b). Most aircraft used in crop dusting around the INEEL facilities do not cross the INEEL boundary; they use the boundary for turning the aircraft. Aircraft need to be moved across the INEEL a few times a year, however. Approximately 60–100 annual overflights by crop dusting and other similar aircraft traditionally have been permitted by the INEEL Flight Department (Lee, et al., 1994). General aviation aircraft flying from Pocatello to Salmon use the Federal Airway vector 269 and fly within approximately 15 km [9 mi] of the proposed ISF Facility. Only a small number of flights travel this route annually (Lee, et al., 1994). Aircraft

flying from Pocatello to Boise also use Federal Airway vector 269. Approximately 2,000 flights take place annually between these cities (Foster Wheeler Environmental Corporation, 2003b).

Based on NUREG–0800 (U.S. Nuclear Regulatory Commission, 1981), any flights by the general aviation aircraft, as described, would have a negligible crash hazard to the proposed ISF Facility because the ISF Facility will be located at least 3.2 km [2 mi] beyond the nearest edge of a flight path. Additionally, the INEEL is approximately 59.5 km [37 mi] in north-south and east-west directions (along the longest dimension). Approximately 60–100 annual overflights by crop dusting and other similar aircraft for transferring the aircraft to the other side of INEEL pose an insignificant hazard to the proposed ISF Facility.

Military Aviation

Military training routes near the proposed ISF Facility (VR1300, IR302, and IR305) are used by the Idaho Air National Guard for terrain masking (Foster Wheeler Environmental Corporation, 2003b). Hazardous activities such as practice bombing or laser firing are not conducted in these routes. Approximately 435 annual sorties are flown on these routes. These training routes are located not less than 40 km [25 mi] from the proposed ISF Facility.

Based on NUREG–0800, any flights by military aircraft in these training routes, as described, would have a negligible crash hazard to the proposed ISF Facility because the ISF Facility will be located at least 8 km [5 mi] beyond the nearest edge of a flight path.

Helicopter Flights and INEEL—FAA Aircraft Tests

The U.S. Department of Energy discontinued flights of security helicopters at the INEEL since 1998. No helicopters are stationed at the site (Foster Wheeler Environmental Corporation, 2003b). Therefore, flying helicopters within the INEEL boundaries is no longer a credible hazard to the proposed ISF Facility.

The FAA conducted tests on new commercial aircraft at the National Oceanic and Atmospheric Administration tower located approximately 2.4 km [1.5 mi] north of the proposed site. These tests have been discontinued since 1990. The FAA has no plans to resume these tests at the ISF Facility (Foster Wheeler Environmental Corporation, 2003b). Therefore, testing of aircraft by the FAA is no longer a credible hazard to the proposed ISF Facility.

Summary of Review and Discussion

The Foster Wheeler Environmental Corporation (2003b) has examined past and present activities in connection with potential hazards from the crash of civilian and military aircraft flying in the vicinity of the proposed ISF Facility. The activities examined include aircraft taking off and landing at nearby airports, aircraft flying Federal Airway vector 269, and military aircraft flying in training routes. The applicant provided sufficient information and used acceptable methods to evaluate the potential hazard to the proposed ISF Facility from an aircraft crash. The staff reviewed the scenarios, data, information, and analyses presented by the applicant in connection with the proposed Facility. The staff finds the estimated hazard acceptable because:

- Adequate information has been presented to describe the potential hazard;

- An acceptable methodology has been used to screen the potential hazard; and
- Appropriate bases have been provided for the assumed number of flights of each type of aircraft in the vicinity of the proposed ISF Facility.

Based on the previous information, the staff concludes that the probability of crash for civilian, general aviation, and military aircraft at the proposed site is acceptably low. Therefore, the staff concludes that flying activities in the site vicinity by commercial, general aviation, and military aircraft would not pose any undue hazard to the proposed ISF Facility.

Future Developments

Foster Wheeler Environmental Corporation (2003b) estimated the projected growth of civilian flights based on the FAA long-range forecast (FAA website, 2004). Based on the FAA forecasts for the nearby airports, the commercial and general aviation aircraft operations are projected to increase; however, the total number of operations forecast for 2020 is still below the threshold level recommended in NUREG–0800 (U.S. Nuclear Regulatory Commission, 1981).

Foster Wheeler Environmental Corporation (2003b) has discussed the long-term trend of military aviation using training routes VR1300, IR302, and IR305. Currently, there are no plans to increase the number of flights in these training routes. If the number of flights using these routes increased substantially, all affected parties would be notified, and the hazard re-evaluated, as appropriate.

Based on the estimated annual frequencies and the projected increase of commercial and general aviation traffic projected by the FAA, the annual frequency of aircraft crashing onto the ISF Facility will still be below 10^{-7}. Therefore, no detailed analysis is necessary for the aircraft crash hazard.

Summary of Aircraft Crash Hazard

Based on the information and analyses provided by Foster Wheeler Environmental Corporation (2003b), the staff concludes the cumulative probability of a civilian and military aircraft crashing at or affecting the proposed ISF Facility is below the threshold probability criterion of 10^{-6}/year. Therefore, there is reasonable assurance that civilian or military air crashes will not pose a hazard to the proposed ISF Facility.

15.1.2.24 Volcanism

The staff reviewed information provided in Section 8.2.5.7 of the SAR, "Volcanism," the relevant literature cited, and other literature cited herein to provide an independent evaluation of potential mitigation strategies for volcanic accident scenarios. Credible volcanic accidents (U.S. Nuclear Regulatory Commission, 2001) for the ISF Facility are potential inundation by basaltic lava flows and deposition of ash falls.

Volcanic Lava Flows

The staff independently determined that the proposed ISF Facility has a 10^{-6}–10^{-5}/year probability of a basaltic lava flow reaching the site. Basaltic lava flows consist of hot {1,100 °C [2,000 °F]}, heavy {2.6 g/cm^3 [162 pcf]} masses of molten rock that can travel down slopes at several miles per hour. Based on these physical conditions, the staff concludes encroachment of lava flows into the proposed ISF Facility site would likely degrade the performance of structures, systems, and components important to safety. Rather than include a potential lava flow hazard as a design basis accident, the applicant proposes a mitigation strategy to divert potential lava flows away from the site.

Based on the behavior of volcanoes similar to those in the INEEL area, molten rock rising from a source region deep in the Earth's crust would likely generate a large number of small earthquakes. As discussed in the SAR, the INEEL maintains a seismic monitoring network that reasonably would detect a rapid increase in the number of earthquakes. Although there is relatively little information available on how fast molten rock rises beneath volcanoes like those in the INEEL area, the staff agrees that at least several days to perhaps several weeks of small earthquakes likely would occur before molten rock reached the surface and erupted (e.g., Foster Wheeler Environmental Corporation, 2003a).

Using information from volcanoes similar to those in the INEEL, the staff agrees that potential lava flows are likely to move down gentle topographic slopes at velocities of approximately 80 m/hr [260 ft/hr] (Foster Wheeler Environmental Corporation, 2003a). Similar types of lava flows in, for example, Hawaii, have flow velocities that range from approximately 1 m/hr [3 ft/hr] to approximately 100 m/hr [330 ft/hr] (Rowland and Walker, 1990). The staff concludes that the general flow velocity of 80 m/hr [260 ft/hr] used in the SAR appears reasonable for a potential lava flow down topographic slopes toward the proposed ISF Facility. At this speed, a lava flow would likely take at least 5 days to travel to the proposed ISF Facility site from a potential volcanic source zone at least 10 km [6.2 mi] away (Foster Wheeler Environmental Corporation, 2003a).

Berms of locally derived sediment, rock, and soil can be constructed rapidly and are demonstrably effective barriers against basaltic lava flows like those found in the INEEL area (e.g., Barberi, et al., 2003). In the event that precursory volcanic activity began in the Axial Volcanic Zone or Arco Volcanic Rift Zone, the applicant (Foster Wheeler Environmental Corporation, 2003a) proposes to construct 6.1-m [20-ft] earthen berms around the ISF Facility as part of a lava-flow mitigation strategy. Because the average thickness of lava flows in the INEEL area is approximately 3.7 m [12 ft], this berm height appears sufficient to mitigate the effects of all but the most voluminous of potential lava flows. The berms would be constructed 103,980 m^3 [136,000 yd^3] of locally derived soils and sediments, using standard cut-and-fill techniques to form an approximately 610-m [2,000-ft] barrier. Information presented in the SAR details how this berm could be constructed in 8–10 days. The staff concludes sufficient time will likely exist for construction of the described earthen berm, considering the interval between the average onset of volcanic unrest in a potential lava-source zone and the average arrival time of a lava flow at the proposed ISF Facility. The gentle topographic characteristics of the proposed site also appear amenable to the diversion of lava flows by construction of earthen berms (e.g., Barberi, et al., 2003), increasing the likelihood that the proposed mitigation strategy would be successful.

The applicant also proposes using pumped water to cool the front of a potential lava flow and thus slow or redirect its advance downslope. The staff agrees this approach has been successful in delaying or diverting several lava flows that are reasonably analogous to those likely in the INEEL area (i.e., Barberi, et al., 2003). Analyses presented in the SAR demonstrate sufficient water volume is available to potentially cool a 1,220-m [4,000-ft] section of the flow front each day, provided adequate piping is emplaced. The time to construct the needed piping network, however, is estimated at 18–20 days. This amount of preparatory time may not be available for pipeline construction unless at least several weeks of precursory earthquake activity occur before a potential eruption, or unless lava flow rates are relatively slow. The staff concludes efficacy of the proposed earthen barrier system, however, is not dependent on the implementation of a water pumping system. Construction of a lava-cooling system thus provides an additional margin of safety in support of the reasonably effective earthen berm system (Foster Wheeler Environmental Corporation, 2003a).

The staff concludes that the applicant has examined adequately the likely hazards from volcanic lava flows not mitigated by facility design. The staff finds that ISF Facility structures, systems, and components important to safety will be protected adequately from the adverse impacts of potential lava flow hazards through the emergency construction of diversionary structures, in the unlikely event a lava-flow eruption appears possible in relevant volcanic source zones. An additional margin of safety from lava flow hazards is likely available by cooling the lava flow with pumped water.

Volcanic Ash Falls

Volcanic ash is a hard, abrasive substance that can obstruct openings and degrade performance of mechanical and electrical systems. Deposits of volcanic ash are relatively heavy and have approximately half the weight of nearby soils. For example, ash from Mount St. Helens (a Cascade Range volcano) has a dry density of approximately 0.5 g/cm^3 [30 pcf] (Sarna-Wojcicki, et al., 1981), which increases to approximately 1.3 g/cm^3 [80 pcf] when wet. Relatively thick deposits of volcanic ash potentially can exceed the maximum structural load limits of engineered systems.

The applicant indicates in the SAR that an 8-cm [3.1-in] thick ash deposit represents the credible upper bound for this volcanic hazard. The staff independently determined, however, the proposed ISF Facility has a 10^{-6}–10^{-5}/year probability of receiving a 10-cm- [4-in]-thick ash-fall deposit. Volcanoes in the distant Cascade Range are estimated to have a 1×10^{-6}/year probability of producing a 10-cm- [4-in]-thick deposit at the INEEL area (Hoblitt, et al., 1987). The Yellowstone volcanic center has produced ash-fall deposits during the last 2 million years that indicate a less than 4×10^{-6}/year probability of future ash fall on the INEEL site (i.e., Christiansen, 2001). Formation of a new silicic dome volcano, located in the Axial volcanic zone at least 10 km [6.2 mi] from the ISF Facility site, has an estimated probability of less than 5×10^{-6}/year (Foster Wheeler Environmental Corporation, 2003a). Deposits from silicic dome volcanoes generally do not exceed thicknesses of 10 cm [4 in] more than 10 km [6.2 mi] from the vent (Scott, 1987), and ash-fall deposits from older silicic dome volcanoes have not been observed in the ISF Facility area (Hackett and Smith, 1994). Based on the available information, the staff concludes 10 cm [4 in] represents the credible upper bound to the thickness of a potential ash-fall deposit at the proposed ISF Facility.

The proposed ISF Facility is designed for a roof snow load of 0.5 g/cm^3 [30 pcf]. The applicant used an ash-fall deposit dry density of 0.8 g/cm^3 [50 pcf] to calculate that an 8-cm [3-in]-thick deposit would not exceed the designed load capabilities of the ISF Facility roofs. Using this deposit density, the staff confirmed that a 10-cm- [4-in]-thick ash-fall deposit also would not exceed the design load capabilities of the ISF Facility roofs. Wetting an ash deposit increases the deposit density but also reduces the deposit thickness by compaction. Using a wet deposit density of 1.3 g/cm^3 [80 pcf] (Sarna-Wojcicki, et al., 1981), the staff determines a 10-cm- [4-in]-thick deposit of wet ash creates a load of 1.44 kPa [27 psf]. Although this load appears close to, but still below, the design basis roof snow load, compaction during rainfall would necessarily decrease the resulting deposit thickness to less than 10 cm [4 in]. The staff concludes the design basis roof snow load of 1.44 kPa [30 psf] appears adequate to mitigate the potential effects of structural collapse during a possible volcanic ash-fall event.

Ash deposits less than 10 cm [4 in] thick have probabilities of occurrence greater than 10^{-6}–10^{-5}/year at INEEL. These relatively thin ash deposits have the potential to affect the performance of ventilation systems by plugging filters or abrading components. Ash-fall deposits likely will occur at the ISF Facility site with a minimum of several hours warning following the onset of a potential eruption. The staff reviewed information in the SAR relevant to potential ash-fall effects on ventilation systems and agrees with the applicant most of the ventilation systems in the proposed ISF Facility are not important to safety. Sections of the ventilation system important to safety can be isolated from outside ash contamination by closing dampers and by use of upstream filtration systems. The staff agrees with the applicant that adequate time likely will exist to isolate the ventilation system prior to the arrival of potential ash deposits.

The ISF Facility decay heat removal system uses air circulation to remove heat from stored SNF canisters. A small annular gap exists between the SNF canisters and the canister support system. This gap could potentially be plugged by airborne ash during a possible ash-fall eruption. The staff reviewed the analyses in Sections 8.1, "Off-Normal Events," of the SAR relevant to the potential 50-percent reductions in airflow through the heat-removal system. The staff considers this analysis an appropriate representation of a potential blockage by ash in the decay heat removal system, because airborne particle concentrations in enclosed buildings are generally 100 to 300 times lower in buildings than in disturbed outdoor conditions (e.g., Bernstein, et al., 1986). Assuming 50-percent annular blockage by ash particles, the applicant concludes at least 9 days would elapse before storage area temperatures exceeded off-normal temperature limits. The staff agrees with the applicant that 9 days provide more than adequate time to mitigate potential blockages of the heat-removal system through routine maintenance procedures. Therefore, the staff concludes that the potentially adverse effects of ash fall deposits on the ISF Facility decay heat removal system can reasonably be mitigated by implementing routine maintenance procedures during and immediately after a potential ash fall eruption, and that the applicant has demonstrated compliance with 10 CFR §72.90, §72.92, §72.98, §72.122(h)(1), and §72.122(h)(4) for these events.

15.2 Evaluation Findings

The applicant has provided acceptable analyses of the design and performance of ISF Facility structures, systems, and components important to safety for credible off-normal events and

accident scenarios. The following summarizes the findings of the staff that pertain to the off-normal event and accident review.

Off-Normal Events

The staff evaluated the information provided in Section 8.1 of the SAR on off-normal events. Table 15-1 provides a summary of the off-normal events addressing Design Event II. The table provides descriptions of the events evaluated in the SAR, effects and consequences, estimated dose, and corrective actions if the event occurs, including the SER sections where these accidents have been evaluated.

The potential events analyzed relate to the transfer cask events, fuel packaging events, fuel storage events, waste handling events, and other events. The off-normal events primarily result from operator error or failure of equipment. Design features of structures, systems, and components or operational controls and interlocks preclude radiological consequences from the drop events for transfer casks in the CCA, impact and binding of U.S. Department of Energy containers and baskets and ISF baskets in the FPA, and impact and binding of ISF canisters in the storage area. The FPA provides confinement to the radiological consequences resulting from potential drop events associated with handling of SNF in the FPA. Radiological consequences were evaluated for misventing of transfer casks in the CRA, loss of confinement barriers from the FPA, ISF canister external contamination in the CCA, and breach of waste packages in the solid waste area. The potential doses to the public and personnel were within the requirements of 10 CFR §72.106(b).

The staff finds that the ISF Facility SAR adequately considered off-normal events that may result from facility operations. The proposed facility will use dry storage technology, and there will be no pool at the proposed facility. Therefore, events associated with pool facilities are not applicable. The information provided about the facility operations and design features of structures, systems, and components is sufficient to conclude that the ISF Facility operations can be conducted without endangering the health and safety of the public during potential off-normal events.

In summary, the analyses in the ISF Facility SAR for off-normal events demonstrate that the proposed facility will be designed, constructed, and operated so that during all credible off-normal events, public health and safety will be adequately protected. Based on analyses submitted by the applicant and independent confirmatory analyses performed by the staff, the staff finds that the proposed facility will maintain subcriticality, confinement, and sufficient shielding for all credible off-normal events, consistent with the requirements of 10 CFR §72.106(b), §72.122(b), §72.122(c), §72.122(h)(1), §72.122(h)(4), §72.122(h)(5), §72.122(i), §72.122(l), §72.124(a), and §72.128(a)(2).

Accidents

The staff evaluated the information provided in Section 8.2 of the SAR regarding potential accidents. Table 15-2 provides a summary of the accidents addressing Design Events III and IV. The table shows descriptions of the accidents evaluated in the SAR, effects and consequences, estimated doses, and corrective actions if the event occurs, including the SER sections where these accidents have been evaluated.

The potential events analyzed that relate to the operations at the ISF Facility include transporter vehicle collision and transfer cask drop and tipover at the CCA; drop events of the fuel container and fuel basket in the FPA; drop and impact of SNF canisters at the storage area; cask trolley collision and movement of trolley in a raised position in the Transfer Tunnel; adiabatic heatup caused by blockage of inlet and outlet vents of the storage area; fire and explosion; loss of radiation shielding in FPA, CCA, and storage area; and building structural failure. These events are considered unlikely, because the SAR adequately demonstrated that these accident events are precluded based on the design features of structures, systems, and components; operational controls and interlocks; and detection through instrumentation. Hence, no radiological releases, nor significant radiation dose is expected from these events. The SAR also evaluated the bounding radiological consequence for worst-case hypothetical scenarios and demonstrated that the radiological doses would not exceed regulatory limits. The staff finds that the SAR adequately considered accident events that may occur during facility operations.

The SAR evaluated the impact of external events on the ISF Facility. The external events evaluated are loss of external power for an extended period and earthquake, flood, extreme wind, lightning, accidents at nearby sites, volcanism, and aircraft impact. The ISF Facility SAR adequately demonstrated that the proposed facility is adequately designed for design basis flood, earthquake, and tornado loading. Lightning strikes would be reduced by adequate lightning protection. The staff finds that the structures, systems, and components important to safety would be protected adequately from adverse impacts of lava flow hazards, and routine maintenance during and immediately after potential volcanic ash fall would be sufficient for decay heat removal. The SAR analysis provides reasonable assurance that the annual frequency of civilian and military aircraft crash is less than 10^{-6}/year.

Based on the information provided, the analyses of accident events provided in the SAR demonstrate that the proposed ISF Facility will be designed, constructed, and operated so that during all credible accident events, public health and safety will be adequately protected. Based on the analyses submitted by the applicant and independent confirmatory analyses performed by the staff, the staff finds that the proposed ISF Facility will maintain subcriticality, confinement, and sufficient shielding for all credible accident scenarios, consistent with the requirements of 10 CFR §72.90, §72.92, §72.94, §72.98(a), §72.98(c), §72.106(b), §72.122(b), §72.122(c), §72.122(h)(1), §72.122(h)(4), §72.122(h)(5), §72.122(i), §72.122(l), §72.124(a), and §72.128(a)(2).

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Table 15-1. Off-normal events evaluated

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.1.1	Misventing of Transfer Cask at Transfer Tunnel	Increased dose inside Transfer Tunnel	Less than 0.1 mSv [10 mrem] to operator; negligible at controlled area boundary	Decontaminate area, determine cause, and implement corrective action
15.1.1.2	Cask Drop Less Than Design Allowable Height at CRA	Maintain closure due to nonmechanistic drop scenarios	No radiological consequences	NA
15.1.1.3	Attempt to Lower Fuel Container into Occupied Fuel Station at FPA	No adverse consequences and criticality potential	No radiological consequences	Determine cause and implement corrective action
15.1.1.4	Attempt to Load Fuel Element into Full ISF Basket at FPA	No adverse consequences and criticality potential	No radiological consequences	Determine cause and implement corrective action
15.1.1.5	Failure of Fuel Element During Handling at FPA	Delay in operations while fuel recovery is performed	No radiological consequences outside FPA area	Cease operations, recovery actions, determine cause, and implement corrective action
15.1.1.6	Drop of Fuel Element During Handling at FPA	Delay in operations while fuel recovery is performed	No radiological consequences outside FPA area	Cease operations, recovery actions, determine cause, and implement corrective action
15.1.1.7	Fuel Container Binding or Impact During Handling at FPA	Delay in operations to replace ISF storage container	No radiological consequences	Cease operations, recovery actions, determine cause, and implement corrective actions
15.1.1.8	Malfunction of ISF Canister Heating System at CCA	Increase in fuel temperature, no adverse consequences	No radiological consequence	Repair heater
15.1.1.9	Malfunction of ISF Canister Vacuum Drying/ Helium Fill System at CCA	Delay in operations, possible increase in fuel temperatures, no adverse consequences	No radiological consequences	Repair equipment, determine cause, and implement corrective action

Table 15-1. Off-normal events evaluated (continued)

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.1.10	Loss of Confinement Barrier at FPA	Increased radiation dose to onsite workers because of decontamination efforts	Potential spread of particulate into adjacent areas of FPA; nonmechanistic dose at the controlled area boundary is 0.0002 mSv [0.02 mrem]	Repair equipment, determine cause, and implement corrective action
15.1.1.11	Binding or Impact of ISF Canister During Hoisting/Lowering Operations at Storage Area	No adverse consequences	No radiological consequences	Determine cause and implement corrective action
15.1.1.12	ISF Canister External Contamination	Increased radiation dose to onsite workers because of decontamination efforts	Minimal dose consequences from decontamination efforts: 0.1 DAC	Decontaminate, determine cause, and implement corrective action
15.1.1.13	Extended Operation with ISF Canister in CHM at Storage Area	Increase in fuel temperature	No radiological consequences	Repair equipment, determine cause, and implement corrective action
15.1.1.14	Malfunction of Storage Area Vacuum Drying/Helium Fill System at Storage Area	Increase in fuel temperature	No radiological consequences	Repair equipment, determine cause, and implement corrective action
15.1.1.15	Partial Air Inlet/Outlet Vent Blockage at Storage Area	Increase in fuel temperature	No radiological consequences	Clear obstructions from inlet/outlet
15.1.1.16	Breach of Waste Package in the Solid Waste Area	Increased radiation dose to onsite workers because of decontamination efforts	Minimal dose consequences from decontamination efforts: 0.1 DAC	Repair equipment, determine cause, and implement corrective action
15.1.1.17	High Dose Rate to Solid Waste Area	Increased radiation level in unoccupied waste enclosure, negligible worker exposure	Negligible worker exposure, no offsite consequences	Return material to FPA, determine cause, and implement corrective action

Table 15-1. Off-normal events evaluated (continued)

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.1.18	Ventilation System Failures	Increased fuel temperatures, no significant release, negligible worker exposure, no offsite exposure	No significant release or exposure, no offsite radiological consequences	Repair equipment or determine cause, implement corrective action
15.1.1.19	Loss of External Power Supply for a Limited Duration	Increased fuel temperatures	No radiological consequences	Restore power source; manual and backup power available but not required
15.1.1.20	Off-Normal Ambient Temperatures	No adverse consequences	No radiological consequences	None required; HVAC designed for extremes
CHM—canister handling machine DAC—derived air concentration-hour HVAC—heating, ventilation, and air conditioning CCA—canister closure area CRA—cask receipt area FPA—fuel packaging area ISF—Idaho Spent Fuel NA—not applicable NRC—U.S. Nuclear Regulatory Commission				

Table 15-2. Accident analysis for the proposed ISF Facility

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.2.1	Vehicular Collision with Transporter at CRA	No adverse consequence	No radiological consequences	Event is bounded by transportation evaluation of Peach Bottom cask
15.1.2.2	Transfer Cask Drop During Hoisting Operations at CRA	Needs to evaluate drop onto transport trailer	No radiological consequences	Not a credible event. Transfer cask drop is prevented by single-failure-proof system.
15.1.2.3	Transfer Cask Tipover at CRA	No adverse consequence	No radiological consequences	Not a credible event; system designed to prevent the event
15.1.2.4	Cask Trolley Collision Events at Transfer Tunnel	No adverse consequence	No radiological consequences	Collision prevented by limit switches and cask designed to withstand impact
15.1.2.5	Drop of DOE Fuel Container During Handling at FPA	Delay in operations while fuel recovery is performed	No radiological consequences outside FPA	Cease operations, perform recovery actions, determine cause, and implement corrective action
15.1.2.6	Drop of ISF Basket During Handling at FPA	No adverse consequence	No radiological consequences	Not a credible event; spent fuel basket will be handled by FHM designed to the requirements of single-failure-proof system
15.1.2.7	Canister Trolley Movement in Raised Position in Transfer Tunnel	No adverse consequence	No radiological consequences	Not a credible event; trolley movement before lowering of canister cask prevented by interlock
15.1.3.8	ISF Canister Drop at Storage Area	No adverse consequence	No radiological consequences	Not a credible event; drop events prevented by single-failure-proof design of CHM and interlocks
15.1.2.9	Transverse Movement of the CHM with an ISF Canister Partially Inserted at Storage Area	No adverse consequence	No radiological consequences	Not a credible event; CHM movement prevented by interlock and seismic design

Table 15-2. Accident analysis for the proposed ISF Facility (continued)

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.2.10	Adiabatic Heatup	No adverse consequence	No radiological consequences	Periodically inspected to keep inlet and outlet vents free from blockages Applicant conducted nonmechanistic analysis considering 100-percent blockage and established the allowable recovery time.
15.1.2.11	Loss of Shielding	No increase in exposure rate expected	No radiological consequences	No significant shielding concern; prevented by administrative control, design, and radiation monitoring
15.1.2.12	Building Structural Failure onto Structures, Systems, or Components	No adverse consequence	No radiological consequences	Not considered credible Building structures would be designed using regulatory guidance and codes Lifting devices would be designed as single-failure-proof devices or with added design margins
15.1.2.13	Fire and Explosion	No adverse consequence	No radiological consequences	Radiologically controlled areas are enveloped by fire-rated barriers to minimize potential for offsite release Impact of INTEC facility, storage yards, fuel storage tanks, and access roads to independent SNF facility was evaluated

Table 15-2. Accident analysis for the proposed ISF Facility (continued)

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.2.14	Maximum Hypothetical Dose Accident	Dose well below the 50 mSv [5,000 mrem] limit	Nonmechanistic dose at the controlled area boundary: 3×10^{-5} mSv [0.003 mrem] TEDE storage area container leakage release 2×10^{-4} mSv [0.02 mrem] TEDE FPA HEPA filter release	Evaluated hypothetical events that result in nonmechanistic offsite dose for the purposes of demonstrating compliance with 10 CFR 72.106(b)
15.1.2.15	Loss of External Power for an Extended Period	Increased fuel temperatures	No radiological consequences	Safe shutdown Minimal effect on CRA and Storage Area Increased temperature in FPA within limits
15.1.2.16	Earthquake	No adverse consequence	No radiological consequences	Facility designed to withstand design basis earthquake
15.1.2.17	Flood	No adverse consequence	No radiological consequences	Facility designed for flood protection
15.1.2.18	Extreme Wind	No adverse consequence	No radiological consequences	Facility designed to withstand design basis wind load
15.1.2.19	Lightning	No adverse consequence	No radiological consequences	Facility designed for lightning protection
15.1.2.20	Accidents at Nearby Sites–Offsite Explosion Hazards	No adverse consequence	No radiological consequences	No hazards to ISF Facility from offsite explosion
15.1.2.21	Accidents at Nearby Sites–Offsite Toxic Gas Release Hazards	Nitric acid plume concentration in air, Personnel evacuation	No radiological consequences	ISF Facility designed to operate in safe conditions without any emergency actions by workers prior to evacuation

Table 15-2. Accident analysis for the proposed ISF Facility (continued)

SER Section No.	Description	Effects and Consequences	Estimated Dose	Corrective Action
15.1.2.22	Accidents at Nearby Sites–Radiological Hazards	Worst-case release could result in TEDE at the ISF Facility exceeding the Threshold of Early Lethality of 1.0 Sv [100 rem]	Greater than 1.0 Sv [100 rem]-Inhalation Less than 2 mSv [200 mrem]-Direct Radiation Shine Dose	Emergency evacuation Would not initiate an accident at the proposed ISF Facility ISF Facility designed to operate in safe conditions without any emergency actions by workers prior to evacuation
15.1.2.23	Aircraft Impact	No adverse consequence	No radiological consequences	Not a credible event
15.1.2.24	Volcanism	No adverse consequence	No radiological consequences	Take measures to divert lava flow if necessary Maintenance plan for decay heat removal from ash fall eruption

CHM—canister handling machine
CRA—cask receipt area
DOE—U.S. Department of Energy
FHM—fuel handling machine
FPA—fuel packaging area
HEPA—high-efficiency particulate air
INTEC—Idaho Nuclear Technology and Engineering Center
ISF—Idaho Spent Fuel
SNF—spent nuclear fuel
TEDE—total effective dose equivalent