4 STRUCTURES, SYSTEMS, AND COMPONENTS AND DESIGN CRITERIA EVALUATION

4.1 Conduct of Review

This section describes the staff's review of the principal design criteria and classification of structures, systems, and components (SSCs) provided by the applicant in Chapters 3, "Principal Design Criteria" and 4, "ISFSI Design," of the Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR) (Pacific Gas and Electric Company, 2004a). The review focused on the spent nuclear fuel (SNF) that will be stored at the Humboldt Bay ISFSI site; the identification of SSCs important to safety; the design bases and criteria associated with structural design, mechanical design, shielding, confinement, criticality, and retrieval assessments; and the load combinations used for the design.

Section 3.1 of the SAR identifies the materials that will be stored in the Humboldt Bay ISFSI. The materials to be stored include intact and damaged SNF assemblies and Greater than Class C (GTCC) waste.

Section 4.5 of the SAR identifies the SSCs classified as important to safety. The SSCs important to safety are designed to maintain conditions required to safely store the SNF; prevent damage to the SNF or container during handling and storage; and provide reasonable assurance that the SNF can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

Chapter 3 of the SAR identifies the design criteria and appropriate load combinations for the Humboldt Bay ISFSI. The design criteria are derived from the requirements of 10 CFR Part 72, relevant U.S. Nuclear Regulatory Commission (NRC) regulatory guidance documents, and applicable industry codes and standards. Section 3.4 of the SAR provides a summary of the principal design criteria for the SSCs important to safety for the Humboldt Bay ISFSI.

The objective of the review was to ensure that the applicant acceptably defines (I) the limiting characteristics of the SNF or other high-level radioactive waste materials to be stored; (ii) the classification of SSCs according to their importance to safety; and (iii) the design criteria and design bases, including the external conditions during normal and off-normal operations, accident conditions, and natural phenomena events (U.S. Nuclear Regulatory Commission, 2000). The review was conducted in accordance with NUREG-1567 (U.S. Nuclear Regulatory Commission, 2000). In addition, the review was closely coordinated with the review of Chapter 2 of the SAR.

The review considered how the SAR and related documents address the regulatory requirements of 10 CFR §72.2(a)(1), §72.24(c), §72.24(n), §72.103(f)(2)(iii), §72.106(a), §72.106(c), §72.120(a), §72.120(b)(1), §72.120(b)(2), §72.122(a), §72.122(b)(1), §72.122(b)(2), §72.122(c–e), §72.122(h)(5), §72.122(k)(1), §72.122(l), §72.124(a–c), §72.126(a–b), §72.126(d), §72.128(a), §72.144(a), and §72.144(c). Complete citations of these regulations are provided in the Appendix of this Safety Evaluation Report (SER).

4.1.1 Materials to be Stored

As identified in Section 3.1 of the SAR, the materials to be stored at the Humboldt Bay ISFSI are intact and damaged fuel assemblies, and GTCC waste. The fuel assemblies consist of General Electric Types II and III and Exxon Types III and IV assemblies. The General Electric Type II assemblies contain a 7 × 7 array of fuel rods, while the other types are made of 6 × 6 arrays of fuel rods. The applicant currently has 390 SNF assemblies and loose debris equivalent to one assembly stored at the Humboldt Bay Power Plant (HBPP) site. Among the 390 SNF assemblies, 11 were classified as damaged, and 16 were classified as SNF debris. Each fuel assembly contains approximately 87 kg [192 lb] of uranium dioxide. The cladding material for all assemblies is Zircaloy-2. The SNF is coated with a crud layer of undetermined thickness because of oxidation of the carbon steel piping system. Table 3.1-2 of the SAR provides a summary of the physical characteristics of the SNF that will be stored at the Humboldt Bay ISFSI. The SNF assemblies will be placed in five custom-designed multi-purpose canisters (MPC-HB). Each MPC-HB has the capacity of housing 80 SNF assemblies. Damaged assemblies and loose debris, including unclad fuel pellets, Zircaloy cladding, and stainless steel cladding remnants from fuel previously shipped offsite, will be placed in a damaged fuel container (DFC). Each DFC will occupy the same space as an intact assembly in the MPC-HB.

Several limiting values for storing SNF assemblies at the Humboldt Bay ISFSI are provided in Section 3.1.1.2 of the SAR and Table 2.1-1 of the proposed Technical Specifications (Pacific Gas and Electric Company, 2004b, Attachment C). These limiting values include (I) a maximum total heat load of 2 kW [6,824 Btu/hour] for a single cask, (ii) a maximum heat load of 50 W [171 Btu/hour] for each assembly, (iii) a maximum of 23,000 MWd/MTU average burnup per assembly, (iv) a minimum cooling time of 29 years, and (v) a planar-average enrichment of no more than 2.60 and no less than 2.09 wt% of Uranium 235.

The potential amount and content of the GTCC waste is provided in Table 3.1-3 of the SAR. The SAR states that the actual waste quantity will be less than the amount provided in the table, and an accurate classification of the waste will be conducted before the waste is loaded into an MPC-HB. All GTCC waste will be stored in one cask. In addition, as required, and as stated in the SAR, the GTCC waste and the SNF will not be stored in the same cask.

The staff finds that the applicant has provided sufficient information in describing the materials to be stored to satisfy the regulatory requirements of 10 CFR §72.22(a)(1). The staff also finds the fact that GTCC waste will not be stored in a cask that also contains SNF is in compliance with the regulatory requirements of 10 CFR §70.120(b)(1). No liquid GTCC waste is planned to be stored in the Humboldt Bay ISFSI, as the ISFSI is a dry storage facility. Consequently, the regulatory requirements of 10 CFR §72.120(b)(2) have been satisfied.

4.1.2 Classification of Structures, Systems, and Components

The staff reviewed Section 4.5 of the SAR, which identifies safety protection systems and provides a brief description of the important characteristics of each system. SSCs important to safety are defined in 10 CFR §72.3 as items whose functions are to

- Maintain the conditions required to store SNF safely
- Prevent damage to the SNF container during handling and storage

- Provide reasonable assurance that SNF can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public

4.1.2.1 Classification of Structures, Systems, and Components - Items Important to Safety

According to the SAR, the SSCs are classified as important to safety if at least one subcomponent of the major component is classified as important to safety. In addition, the applicant divided the SSCs important to safety into three quality assurance (QA) categories: Classification Categories A, B, and C. This categorization is developed following the guidance provided in NUREG/CR-6407 (McConnell, et al., 1996). Classification Category A is defined for the SSCs important to safety that are critical to safe operation. Classification Category B is defined for the SSCs important to safety that may have major impacts on safety. Classification Category C is defined for the SSCs important to safety that may have minor impacts on safety.

The classification of the SSCs for the storage system is provided in Table 4.5-1 of the SAR. The SSCs important to safety include the (i) MPC-HB, (ii) fuel basket and basket spacer, (iii) DFC, (iv) HI-STAR HB overpack, (v) cask transporter, (vi) transporter lift link, (vii) ISFSI storage vault (the storage vault lid and lid bolts are considered not important to safety for certain beyond design basis seismic events), (viii) fuel spacers, (ix) transporter connector pins, (x) helium fill gas, and (xi) lid retention device. The first six items were determined to be in Classification Category A, and the remainder were determined to be in Classification Category B. The primary functions for the SSCs important to safety in Classification Category A are to provide confinement or shielding, or to prevent criticality. The function of Classification Category B SSCs important to safety is to prevent an unsafe condition. No Classification Category C SSCs important to safety were identified.

The staff reviewed the information concerning the classification of SSCs important to safety and finds that the SSCs listed in Table 4.5-1 of the SAR have been properly classified as important to safety items. The staff concludes that the SSCs important to safety identified and listed in the SAR are acceptable and are in compliance with the regulatory requirements of 10 CFR §72.24(n) and §72.144(a). In addition, the staff finds that the use of Classification Categories is consistent with the regulatory requirements of 10 CFR §72.122(a), which requires that the SSCs important to safety must be designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed.

4.1.2.2 Classification of Structures, Systems, and Components - Items Not Important to Safety

SSCs not important to safety do not involve a safety-related function and are not subject to special quality requirements or NRC-imposed regulatory requirements. SSCs not important to safety relevant to the proposed Humboldt Bay ISFSI are listed in Table 4.5-1 of the SAR. The staff reviewed Table 4.5-1 and agrees with the applicant's classification of SSCs. The classification is based on the function of the SSC and its potential to ensure that radiation dose rates remain within acceptable and analyzed limits, and that there are no uncontrolled releases, so that there is no undue risk to the health and safety of the public.

The staff concludes that the applicant has appropriately identified the components listed in Table 4.5-1 of the SAR as not important to safety.

4.1.2.3 Classification of Structures, Systems, and Components - Conclusion

The staff evaluated the classification of SSCs important to safety by reviewing Section 4.5 of the SAR. The staff determined that the classification of the SSCs important to safety and their associated categories meets the regulatory requirements of 10 CFR §72.122(a) and §72.144(a) and that the associated technical information is in compliance with 10 CFR §72.24(n). The staff's evaluation of the applicant's QA program is contained in Chapter 12 of this SER.

4.1.3 Design Criteria for Structures, Systems, and Components Important to Safety

The principal design criteria identified for SSCs important to safety at the Humboldt Bay ISFSI are described in Chapters 3 and 4 of the SAR. Section 3.2 of the SAR discusses the design criteria for environmental conditions and natural phenomena. Section 3.3 of the SAR discusses the design criteria for safety protection systems. Section 3.4 of the SAR provides a summary of design criteria. More detailed discussions of the design criteria are presented in Sections 4.1.3.1 and 4.1.3.7 of this SER.

4.1.3.1 General

As discussed in Section 4.1.1 of this SER, the SNF assemblies to be stored in the Humboldt Bay ISFSI consist of General Electric Types II and III and Exxon Types III and IV assemblies. There are 390 SNF assemblies and loose debris equivalent to one assembly to be stored at the HBPP site. These SNF assemblies will be loaded into five MPC-HBs, and the associated GTCC waste will be placed in one additional MPC-HB.

As indicated in Section 4.2 of the SAR, the major components for the Humboldt Bay ISFSI include a reinforced concrete storage vault and the HI-STAR HB casks. The reinforced concrete storage vault has six cells to accommodate five HI-STAR HB casks and one GTCC waste certified cask. A HI-STAR HB cask consists of a HI-STAR HB transportation and storage overpack and an MPC-HB. The HI-STAR HB cask system, including an overpack and an MPC-HB is a modified version of the HI-STAR 100 system. A cask transporter will be used to transfer the loaded HI-STAR HB cask from the HBPP Refueling Building (RFB) to the Humboldt Bay ISFSI. The Humboldt Bay ISFSI is located within the HBPP controlled area.

Normal, off-normal, and accident loads for the Humboldt Bay ISFSI are given in Sections 3.3.2.3.1, 3.3.2.3.2, and 4.2.3.3 of the SAR. The quality standards for the design bases of SSCs important to safety are provided in Chapters 3, 4, and 11 of the SAR.

The HI-STAR HB system is approximately 193 cm [76 in] shorter than the generic HI-STAR 100 system, but has a relatively larger capacity (80 Humboldt Bay spent fuel assemblies versus 68 standard BWR assemblies). Other modifications include a different upper fuel spacer, fuel basket, and overpack neutron shield enclosure design and the use of METAMIC® neutron absorbers instead of BORAL®. Because the HI-STAR HB system is shorter, it has a lower center of gravity. According to the SAR, the HI-STAR HB system is designed to withstand all design-basis loads related to Humboldt Bay site-specific environmental conditions and natural phenomena. The design criteria for the generic HI-STAR 100 system are used for the design of the HI-STAR HB system if these design criteria bound the Humboldt Bay site-specific conditions; otherwise, site-specific design criteria will be used. This approach provides additional safety to the performance of the HI-STAR HB system at the Humboldt Bay ISFSI site.

Detailed design criteria and load combinations can be found in the HI-STAR 100 system Final Safety Analysis Report (FSAR) (Holtec International, 2002).

The design life for the reinforced concrete storage vault and the HI-STAR HB system is 40 years and is 20 years for the cask transporter. The design life of the SSCs important to safety is based on their ability to withstand the applied loads. The applied loads are defined using an annual probability of exceeding the design load. Analysis procedures are used to demonstrate the ability of the SSCs to withstand the applied loads with additional factors applied to the loads and material allowables as identified by the referenced codes and standards. The design life for the cask transporter is determined based on the industry experience on this type of vehicle with normal maintenance.

The staff finds that the design criteria discussed in the SAR satisfy the regulatory requirements of 10 CFR §72.24(c), §72.120(a), and §72.122(h)(5) because the design criteria are identified properly. The staff also finds that the SSCs important to safety will be designed to quality standards commensurate with their importance to safety functions to be performed, thereby satisfying the requirements of 10 CFR §72.122(a) and §72.144(c). The staff finds that the Humboldt Bay ISFSI has a controlled area that meets the regulatory requirements of 10 CFR §72.106(a) and §72.106(c).

The staff reviewed the information provided in the SAR and determined that (i) no SSCs important to safety have been identified to be shared between the Humboldt Bay ISFSI and other facilities, (ii) no control room has been identified as necessary to provide safe control of the Humboldt Bay ISFSI during off-normal or accident conditions, and (iii) no utility services or distribution systems have been identified to be important to safety. Based on this review, the staff finds that the regulatory requirements of 10 CFR §72.122(d) and §72.122(k)(1) have been met.

Structural design criteria and radiological protection and confinement criteria are identified in the SAR. A review of the structural criteria is presented in this chapter of the SER. The staff assessment of the adequacy of the site-specific environmental conditions and natural phenomena-related design criteria is contained in Chapter 2 of this SER. Review of the radiological protection and confinement criteria is presented in Chapters 7, 8, 9, and 11 of this SER.

4.1.3.2 Structural

The staff reviewed the discussion on structural design criteria of SSCs presented in Sections 3.2, 3.3, 3.4, 4.2, 4.3, and 4.4 of the SAR.

The design of the reinforced concrete vault of the Humboldt Bay ISFSI is based on American Concrete Institute (ACI) 349-01 (American Concrete Institute, 2001) and, as applicable, the factored load combinations from Table 3-1 of NUREG-1536 (U.S. Nuclear Regulatory Commission, 1997) will be used. ACI 349-01 specifies the acceptable design and construction of concrete structures that form part of a nuclear power plant and have nuclear safety-related functions. Structures included in the ACI code are concrete structures inside and outside the containment system. According to the SAR, the critical sections of the vault are the sections between two adjacent storage cells, and the structural analyses of these sections indicate that the stresses are within the allowable limits specified in ACI 349-01 (American Concrete Institute, 2001).

The design loads, operating temperature ranges, and strength at 28 days for the reinforced concrete vault are listed in Table 3.4-3 of the SAR. The minimum dry densities for the reinforced concrete for both storage vault and storage cell lids are 2,339 kg/m^3 [146 lb/ft^3]. The steel reinforcing bars for the storage vault will be designed to meet American Society of Testing Materials (ASTM) A615, Grade 60 specifications. The steel liner and seismic restraints for storage cells, and the steel plates for storage cell lids will be constructed using SA36 or SA516 Grade 70 carbon steel. The storage cell lid closure bolts will be made of SA193 B7 material.

The design of the HI-STAR HB system, including the MPC-HB, DFC, and overpack, conforms to standard engineering practice, as identified in relevant subsections of Section III of the 1995 Edition ASME Boiler and Pressure Vessel Code with 1996 and 1997 addenda (ASME International, 1996). A detailed list of the subdivisions of the ASME Boiler and Pressure Vessel Code for design of the SSCs of the HI-STAR HB system is provided in Section 4.2.3.3 of the SAR. The ASME Boiler and Pressure Vessel Code establishes rules governing design, fabrication, and inspection during the construction of boilers and pressure vessels. This code contains mandatory requirements, specific prohibitions, and nonmandatory guidance for selection of materials, design, fabrication, examination, inspection, testing, certification, and pressure relief. Table 3.4-5 of the SAR lists the exceptions and alternatives to the ASME code for some systems or components.

The staff reviewed the information provided regarding codes and standards for the SSCs important to safety and the proposed exceptions and alternatives to the ASME code and finds the information acceptable.

In addition, ANSI N14.6 (American National Standards Institute, 1993), as referenced in NUREG-0612 (U.S. Nuclear Regulatory Commission, 1980), is identified for the design criteria of the (I) cask transporter lift points, overhead beam, vehicle body, and seismic restraints; (ii) overpack lifting trunnions and trunnion blocks; and (iii) lifting bolts of a DFC for compliance with a single-failure-proof system or component. NUREG-0612 (U.S. Nuclear Regulatory Commission, 1980) identifies controls for handling heavy loads at nuclear power plants. The staff finds that using a single-failure-proof design satisfies the regulatory requirements of 10 CFR §72.120(a) and §72.122(h)(5).

The off-normal and accident design-basis internal pressures for the MPC-HB are 0.76 and 1.38 MPa gauge [110 and 200 psig]. The off-normal conditions correspond to a 10-percent SNF rod rupture and the nonmechanistic rupture of 100 percent of the SNF rods for the accident conditions. The off-normal and accident analysis results for the MPC-HB presented in Sections 8.1.1 and 8.2.11 of the SAR indicate that the off-normal and accident internal pressure limits are not exceeded.

As identified earlier, the SSCs important to safety are designed to withstand the effects of environmental conditions and natural phenomena for normal, off-normal, and accident conditions. The structural design loads for SSCs important to safety are provided in Section 3.2 of the SAR. Information on the derivation of site-specific design criteria for the meteorology, hydrology, and seismology is contained in Chapter 2 of the SAR.

Wind

Information provided in Section 2.3.1.3 of the SAR identifies a maximum recorded wind gust speed of 111 kmph [69 mph] at the Humboldt Bay ISFSI site. Section 2.3.1.3 of the SAR further indicates that the 1-minute average wind speed for the 50-year return period is 93 kmph [58 mph] with a peak gust of 114 kmph [71 mph]. The wind speed of 137 kmph [85 mph] with a gust factor of 1.1 is used as the design basis wind for the Humboldt Bay ISFSI.

The staff reviewed the design basis wind for the Humboldt Bay ISFSI and finds that it is consistent with that identified in ASCE 7-98 (American Society of Civil Engineers, 2000) for this location. The staff also finds that the requirements of 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2) have been satisfied, in that the effects of wind are considered in the design of the Humboldt Bay ISFSI.

Tornado

The design basis tornado wind loads for the Humboldt Bay ISFSI site are discussed in Section 3.2.1.1 of the SAR. In determining the design basis tornado, Regulatory Guide 1.76 (U.S. Atomic Energy Commission, 1974) was followed. The Humboldt Bay ISFSI site is located in tornado intensity Region II. According to Regulatory Guide 1.76 (U.S. Atomic Energy Commission, 1974), the design basis tornado characteristics associated with tornado intensity Region II are

- 483 kmph [300 mph], maximum speed
- 386 kmph [240 mph], rotational speed
- 97 kmph [60 mph], translational speed
- 15.5 kPa [2.25 psi], pressure drop
- 8.3 kPa/s [1.2 psi/s], rate of pressure drop

The parameters for the tornado identified have been reviewed, and the staff finds that the use of design basis tornado characteristics for tornado intensity Region II provided in Regulatory Guide 1.76 (U.S. Atomic Energy Commission, 1974) is acceptable.

In addition, the design basis tornado for the HI-STAR HB system is the same as that for the HI-STAR 100 system. The design basis tornado for the HI-STAR 100 system is defined for tornado intensity Region I given in Regulatory Guide 1.76 (U.S. Atomic Energy Commission, 1974). Because tornado intensity for Region I is stronger than that for Region II, the design basis tornado for the HI-STAR 100 system bounds the site-specific design basis and is, therefore, conservative. Specific design basis tornado characteristics for the HI-STAR HB system are given in Table 3.2-1 of the SAR.

The staff reviewed the information regarding design basis tornados and finds that the requirements of 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2) have been satisfied, in that the effects of site conditions and environmental conditions are considered in the design of the Humboldt Bay ISFSI and the HI-STAR HB system.

Tornado Missiles

The postulated tornado missiles for the Humboldt Bay ISFSI, the HI-STAR HB system, and the cask transporter are identified in Section 3.2.1.3 and Table 3.2-2 of the SAR. The postulated tornado missiles include three objects consistent with those specified as Spectrum I missiles in Section 3.5.1.4 of NUREG-0800 (U.S. Nuclear Regulatory Commission, 1981). The use of Spectrum I is considered acceptable by NRC. The mass and associated impact velocity for the three objects are provided in Table 3.2-2 of the SAR.

According to the SAR, tornado missiles may cause spalling on the storage cell lid and apron of the reinforced concrete storage vault. The reinforced concrete storage vault is below grade and, therefore, is shielded from the horizontal missile impacts. A HI-STAR HB system may be affected by tornado-generated missiles when the loaded HI-STAR HB system is transferred from the RFB to the ISFSI site and during the storage operations (lowering the HI-STAR HB system into the vault and installing seismic constraints) at the ISFSI site. The SAR indicates that the cask transporter will have redundant drop protection to prevent a drop of the loaded HI-STAR HB system caused by direct impacts of tornado missiles.

The staff reviewed the design-basis tornado missiles for the Humboldt Bay ISFSI, the HI-STAR HB system, and the cask transporter and finds that they are able to withstand tornadoes, consistent with the design criteria specified in Section 3.5.1.4 of NUREG-0800 (U.S. Nuclear Regulatory Commission, 1981), and in accordance with the regulatory requirements of 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2).

Flood

Based on the elevation of the Humboldt Bay ISFSI and the site surface hydrology, the applicant concluded in Section 2.4 of the SAR that flooding is not a concern at the Humboldt Bay ISFSI site. Although flooding is not a concern, Section 3.2.2 of the SAR indicates that the HI-STAR HB system is designed "to withstand pressure and water forces associated with floods, based on the similarity in design to the HI-STAR 100 system." The design basis water pressure and horizontal load for the HI-STAR 100 system are 200 m [656 ft] of water head and 4 m/s [13 ft/s] of flow velocity. Also, the vault structure is designed to withstand 1.8 m [6 ft] of water head.

The staff reviewed the flood design criteria and concludes that the design of the Humboldt Bay ISFSI and the HI-STAR HB system is acceptable to withstand floods in accordance with the regulatory requirements of 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2).

Seismicity

The staff reviewed the data presented in the SAR associated with seismic design criteria for the Humboldt Bay ISFSI. Section 3.2.4 of the SAR gives the seismic design criteria based on deterministic and probabilistic ground motion studies for the Humboldt Bay ISFSI site as summarized in Section 2.6.6 of the SAR. The staff's assessment of the adequacy of the site-specific seismic design criteria is contained in Chapter 2 of this SER. The applicant's analysis of the SSCs important to safety during the site-specific design basis seismic ground motion is evaluated in Chapters 5 and 15 of this SER.

The applicant has used both the deterministic (10 CFR Part 100, Appendix A) and probabilistic (U.S. Nuclear Regulatory Commission, 2003a) methods to develop the design earthquake ground motion (DE) spectra. Since the deterministic spectra exceed the probabilistic uniform hazard spectra for a 2000-year return period at all spectral periods (SAR Figure 2.6-72), the applicant has used the deterministic spectra for the design of SSCs. Reviews of the development of the deterministic and probabilistic uniform hazard spectra are discussed in Chapter 2 of this SER. The use of the uniform hazard spectra with a 2,000-year return period as the seismic design basis is consistent with the staff position in Regulatory Guide 3.73 (U.S. Nuclear Regulatory Commission, 2003a).

For the limited duration transient activities, including transferring the HI-STAR HB system to the ISFSI storage vault and cask handling operations at the storage vault, the applicant has used a risk-informed approach by considering the total exposure times (durations) associated with these activities and has used design earthquake ground motions lower than the DE. According to the SAR, the estimated exposure time for transferring five HI-STAR HB systems to the ISFSI storage vault and completing the storage operations is 2.5 days. Based on the exposure time, the applicant determined that the ground motion corresponding to a 14-year return period earthquake is appropriate for the transient activities. The applicant used the ground motion associated with a 50-year return period earthquake as the design basis for the transfer activities, and the ground motion associated with a 25-year return period earthquake as the design basis for the storage vault cask handling operations. The ground motions for these return periods (SAR Figures 2.6-69–2.6-71) are evaluated in Section 2.1.6.2 of this SER.

The staff finds the applicant's risk-informed approach acceptable for establishing a level of design earthquake ground motion for transient activities commensurate with the risk posed by these activities to the public health and safety. This approach is consistent with the NRC Strategic Plan FY 2004–FY 2009 (U.S. Nuclear Regulatory Commission, 2004) Effectiveness Strategy, "Use state-of-the-art methods and risk insights to improve the effectiveness and realism of NRC actions," and with the Commission's Staff Requirements Memorandum (SECY-98-144, U.S. Nuclear Regulatory Commission, 1999) that was specifically focused on enhanced use of risk-informed, performance-based regulatory approaches for nuclear materials and radioactive waste disposal.

The staff performed an independent analysis based on the assumption that any two structural systems or activities with different lifetimes have the same risk significance if both have the same probability of exceedance. The probability of the exceedance of a certain ground motion intensity is the likelihood that at least one earthquake of certain ground motion intensity will occur during the service lifetime or the activity duration. The staff determined that the probability of exceedance for the reinforced concrete storage vault with a seismic design basis of a 2,000-year return period earthquake and a service life of 20 years [10 CFR §72.42(a)] is approximately 1 percent. Using this information and considering the transient activities durations as proposed by the applicant, the staff concluded that the 25- and 50-year return period earthquakes proposed by the applicant are sufficient to assure a probability of exceedance significantly less than 1 percent during the transient activities.

Additionally, the applicant has shown that the transporter could withstand the DE without any adverse effects to the transporter and the cask, except during the time when the transporter is going over a short segment {30.5 m [100 ft] length, which will take no more than 3 minutes to traverse} of the road next to the discharge canal. An occurrence of the DE during this very short time may cause the transporter and the cask to slide into the discharge canal. However, even in this extremely unlikely event, the cask is not likely to be damaged to the extent that any radioactivity may be released. Therefore, there is no risk to the health and safety of the public resulting from the use of the design earthquake ground motions for transient activities lower than the DE as discussed above.

Based on the review of the applicant's seismic design criteria for the SSCs important to safety at the Humboldt Bay ISFSI as described above, the staff finds that the applicant's consideration of seismic design criteria is appropriate, as required by 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2).

Tsunami

The tsunami hazards for the Humboldt Bay ISFSI site are described in Section 2.6.9 of the SAR, and the design considerations of tsunami hazards are discussed in Sections 3.2.3 and 4.2.3.3.2.7 of the SAR. The potential tsunami is estimated to be 9.1 to 12.2 m [30 to 40 ft] above the mean lower low water (MLLW)[1] at the bay entrance. Considering an attenuation factor of 0.7 to 0.9, the inundation height will be approximately 6.4 to 11 m [21 to 36 ft] above the MLLW at low tide and 8.5 to 13.1 m [28 to 43 ft] at high tide. The surface of the reinforced concrete storage vault is at an elevation of 13.4 m [44 ft] above the MLLW. The estimated maximum inundation height, therefore, remains below the elevation of the top of the reinforced concrete storage vault. Although the surface of the reinforced concrete storage vault will be above the projected tsunami runup elevation, the vault structure will be designed to withstand 1.8 m [6 ft] of water head and protect itself from flowing water. In addition, the HI-STAR HB system is designed to withstand 200 m [656 ft] of water head and 4 m/s [13 ft/s] of flow velocity.

As discussed previously, the seismic design basis for the transfer activities corresponds to a 50-year return period earthquake. According to the SAR, the 50-year return period earthquake does not have sufficient energy to create a tsunami that will cause flooding of the transfer route. The applicant indicated that a tsunami induced by a 2,000-year return period earthquake, if it occurred, could inundate the transporter with a maximum 8.5 to 13.1 m [28 to 43 ft] of sea water at high tide. As stated earlier, the HI-STAR HB system is designed to withstand 200 m [656 ft] of water head and 4 m/s [13 ft/s] of flow velocity. Consequently, inundation of the transporter along with the HI-STAR HB system with a tsunami induced by a 2,000-year return period earthquake will not compromise the confinement function of the HI-STAR HB system (Pacific Gas and Electric Company, 2004c). The SAR indicated that the fact that the confinement function of the HI-STAR HB system may not be compromised because of the potential inundation of the HI-STAR HB system with a tsunami induced by a 2,000-year return period earthquake provides further assurance of acceptable performance in the event of a tsunami exceeding the proposed 50-year period design basis tsunami.

The staff reviewed the tsunami considerations for the Humboldt Bay ISFSI and finds that the applicant's consideration of tsunami effects is appropriate and meets the regulatory requirements of 10 CFR §72.120(a), §72.122(b)(1), §72.122(b)(2), and §72.103(f)(2)(iii). The staff's evaluation of compliance with 10 CFR §72.103(f)(2)(iii) is discussed in Chapter 2 of this SER.

Snow and Ice

As indicated in Section 2.3.1.2 of the SAR, snowfalls are rare at the Humboldt Bay ISFSI site, with an annual trace amount of 0.76 cm [0.3 in]. Section 3.2.5 of the SAR states that designing for ground snow is not necessary for the Humboldt Bay ISFSI. Figure 7-1 of ASCE 7-98

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[1] Tidal patterns along the western United States coast are mixed semidiurnal, such that there are two high and two low tides each day. The semidiurnal tidal pattern is considered "mixed" because the two daily high tides and two daily low tides are of different magnitudes. Elevations in the SAR reference three tidal elevations: (i) mean lower low water (MLLW), which is the average of the lower of the two daily low tides; (ii) MHHW, which is the average of the higher of the two daily high tides; and (iii) mean sea level (MSL), which is the overall average water elevation. In the SAR, the applicant provides analyses relative to MLLW. The applicant reports that, at the Humboldt Bay ISFSI site, the difference between MLLW and MHHW is 2.1 m [6.9 ft], and the difference between MLLW and MSL is 1.13 m [3.7 ft].

(American Society of Civil Engineers, 2000) suggests that the snow load for the region is approximately zero, consistent with the regional monitoring data.

The staff reviewed the snow and ice loading criteria for the Humboldt Bay ISFSI and finds that there is no need to design for ground snow at the Humboldt Bay ISFSI site. The staff further determined that the applicant's consideration of snow and ice loads is appropriate and in accordance with the regulatory requirements of 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2).

<u>Temperature Loads</u>

The normal thermal loads for the Humboldt Bay reinforced concrete storage vault and the HI-STAR HB system include loads associated with normal condition temperatures, temperature distributions, thermal gradients within the structure, and the effects of expansion and contraction of structural elements. As identified in Table 3.4-1 of the SAR, the annual average site ambient temperature is approximately 11.1 EC [52 EF]. The normal site maximum and minimum ambient temperatures are 30.6 EC [87 EF] and !6.7 EC [20 EF], respectively. The off-normal site ambient temperature is 15.6 EC [60 EF]. The extreme site minimum and maximum temperatures are !9.4 and 32.2 EC [15 and 90 EF], respectively.

The design basis normal temperature for the HI-STAR 100 system is 32 EC [80 EF], as identified in Section 3.2.7 of the SAR. The off-normal minimum and maximum ambient temperatures for the HI-STAR 100 system are !40.0 EC [!40 EF] and 37.8 EC [100 EF], as identified in Sections 3.2.7 and 8.1.2.3 of the SAR. The accident (extreme) minimum and maximum ambient temperatures for the HI-STAR system are !40.0 EC [!40 EF] and 51.7 EC [125 EF] as identified in Section 3.2.7 of the SAR. Because the materials and design features of the HI-STAR HB system are consistent with those for the HI-STAR 100 system, the design temperatures for the HI-STAR 100 are applicable to the HI-STAR HB. These design temperatures bound the site-specific design temperature requirements for normal, off-normal, and extreme conditions.

The staff reviewed the thermal loading criteria established for the Humboldt Bay ISFSI and finds that they are appropriate and in accordance with the regulatory requirements of 10 CFR §72.120(a), §72.122(b)(1), and §72.122(b)(2).

<u>Fire</u>

The staff reviewed Sections 3.3.1.6, 4.2.3.3.3, and 8.2.5 of the SAR. Potential fire hazard sources are identified in Section 2.2.2.2.1 of the SAR. Fires are categorized as engulfing and nonengulfing fires.

The bounding case for the reinforced concrete storage vault structure is an engulfing fire postulated by burning a fuel source in a pool of fuel surrounding a HI-STAR HB cask. As a result of this fire, the short-term temperature limit for the reinforced concrete may be exceeded. To recover from this fire event, the applicant will conduct an inspection and a technical assessment to determine if the ability of the reinforced concrete storage vault structure to perform its intended function is maintained. As indicated in the SAR, appropriate compensatory and corrective actions will be taken as necessary.

The HI-STAR HB system is designed to withstand an engulfing transportation fire accident with a flame temperature of 802 EC [1,475 EF] for 30 minutes. The SAR indicates the short-term design temperature limits for the SNF cladding, and all steel components of the HI-STAR HB system will not be exceeded because of this fire. The short-term design temperature limit for the Holtite-A neutron shielding material, however, will be exceeded. The dose calculation performed by the applicant, assuming a complete loss of neutron shielding, has shown that the dose rates associated with this fire accident are within regulatory limits.

According to the SAR, administrative controls will be implemented as described in Section 10.2 of the SAR to (I) avoid concurrent oil, diesel, and propane deliveries and onsite cask transfer and storage operations and (ii) isolate and depressurize gas distribution lines during onsite cask transfer and storage operations. These administrative controls are expected to further reduce the effects of credible fire scenarios.

The staff reviewed the fire considerations in the SAR and finds that the design and location of the SSCs important to safety and the operational restraints are in compliance with the regulatory requirements of 10 CFR §72.122(c). The design criteria for the HI-STAR HB system are sufficient to ensure that the relevant SSCs important to safety will be designed to perform their safety functions effectively during credible fire conditions. Also, the staff finds that the applicant's proposed actions in response to an engulfing fire accident are acceptable. The proposed actions include performing inspection and technical assessment of the vault structure to determine whether compensatory and corrective action are needed.

<u>Explosion</u>

The staff reviewed Sections 3.3.1.6, 4.2.3.3.2.9, and 8.2.6 of the SAR. Potential explosion sources that may affect the onsite transfer and storage operations and interim storage in the reinforced concrete vault are identified in Section 2.2.2.2.2 of the SAR.

Accidents involving explosive materials may cause overpressure on the SSCs important to safety. The magnitude of overpressure is controlled by the quantity and type of the explosive material. As indicated in Section 4.2.3.3.2.9 of the SAR, the MPC-HB is designed for an external pressure of 0.41 MPa gauge [60 psig]. The HI-STAR HB overpack is designed to withstand a 2-MPa gauge [300 psig] external pressure. Section 8.2.6 of the SAR states that these design basis overpressures are sufficient for the credible explosion scenarios postulated at the Humboldt Bay ISFSI site. In addition, the potential detonation-induced missile impacts are bounded by the impacts from the design basis tornado-generated Spectrum I missiles. As indicated in Section 4.2.3.3.2.2 of the SAR, the internal and external pressure-induced stresses are within the code allowables.

Several postulated explosion scenarios are identified to be credible to produce overpressure on the reinforced concrete storage vault and the vault cell lid. The assessment presented in Section 8.2.6 of the SAR indicates that this overpressure will have minimal adverse structural effects given the massive size of the reinforced concrete storage vault and the thickness of the vault cell lids. The damage from detonation-induced missiles may involve only local spalling on the vault cell lid and vault apron.

Administrative controls will be implemented as described in Section 10.2 of the SAR to (i) avoid concurrent oil, diesel, and propane deliveries and onsite cask transfer and storage operations and (ii) isolate and depressurize gas distribution lines during onsite cask transfer and storage operations. These administrative controls are expected to further reduce the effects of credible explosion scenarios.

The staff reviewed the explosion considerations in the SAR and finds that these considerations are in accordance with Regulatory Guide 1.91 (U.S. Nuclear Regulatory Commission, 1978) and in compliance with the regulatory requirements of 10 CFR §72.122(c).

Lightning

The staff reviewed Sections 3.2.6 and 8.2.12 of the SAR. Section 8.2.12 of the SAR postulates that a lightning strike may be possible even though lightning events may be rare at the Humboldt Bay ISFSI site. The lightning strike to the HI-STAR HB system may occur during the transfer or storage operations. The loaded HI-STAR HB cask, however, will be protected from lightning strike by the reinforced concrete vault, and the vault cell lid will be protected while it is in interim storage in the reinforced concrete vault.

During onsite transfer, the gantry and rigging metal above the cask transporter may be sufficient to protect the HI-STAR HB system from direct lightning strikes. A lightning strike to the cask transporter will not cause much damage because the current will be transmitted to the ground. In addition, the HI-STAR HB overpack is made of conductive material. If the HI-STAR HB overpack were to be struck by lightning, the current will flow from the overpack outer shell into the cask transporter and eventually into the ground. Furthermore, the cask transporter will be designed to shut down in a fail-safe condition. A lightning strike that disables the operator, therefore, will not cause an instability problem for the cask transporter. The staff reviewed the lightning design criteria as discussed in the SAR and determined that the lightning design criteria are acceptable for the design of SSCs important to safety, in compliance with the regulatory requirements of 10 CFR §72.122(b)(1) and §72.122(b)(2).

Load Combinations

The load combinations presented in Sections 3.3.2.3.1 and 3.3.2.3.2 of the SAR are used in the analyses of the concrete vault storage system SSCs important to safety. The loads considered in the load combinations for the reinforced concrete storage vault include:

- Dead loads, including piping and equipment (D)
- Live load (L)
- Lateral soil and hydrostatic pressures (H)
- Internal moments and forces due to normal, off-normal, and extreme thermal loads (T_o)
- Design-basis earthquake loads, including earthquake-induced equipment reactions (E_{ss})
- Tornado loads (W_t)

- Accident loads (A)

The loads considered in the load combinations for the cask alignment plate in the reinforced concrete storage vault include:

- Dead weight (D)
- Normal temperature loads (T_n)
- Design-basis earthquake loads (DBE)
- Tornado loads (W_t)
- Accident pressure (P_a)
- Accident loads (A)

The specific load combinations identified for the reinforced concrete storage vault and cask alignment plates are, in general, consistent with those suggested in Section 9.2.1 of ACI 349-01 (American Concrete Institute, 2001), except for the load factor for T_o. For bounding purposes, the load factor for T_o is 1.275, as suggested in Table 3-1 of NUREG-1536 (U.S. Nuclear Regulatory Commission, 1997), instead of the 1.05 value suggested by ACI 349-01 (American Concrete Institute, 2001).

According to Section 3.2.8 of the SAR, the load combinations for the HI-STAR HB system are consistent with those for the HI-STAR 100 system and the load combinations given in the HI-STAR 100 FSAR (Holtec International, 2002).

The staff reviewed the information presented in the SAR concerning load combinations and determined that the load combination design criteria are appropriately considered for the design of SSCs important to safety, as required by 10 CFR §72.122(b)(1) and §72.122(b)(2). Appropriate combinations of the effects of normal and accident conditions and the effects of natural phenomena are considered.

<u>Structural Design Criteria Conclusion</u>

The structural design criteria discussed in the previous sections represent the structural loads that may be present at the site. The SSCs important to safety for the Humboldt Bay ISFSI must be designed to withstand these structural loads, as applicable. The ability of the SSCs to perform their intended safety functions under the applicable structural design loads is evaluated in Chapters 5 and 15 of this SER.

The Humboldt Bay ISFSI is located close to the HBPP. The HBPP consists of five electric generation units. Unit 3 is a boiling water reactor (BWR) that was permanently shut down in July 1976. Units 1 and 2 are conventional fossil units, and the remaining two units are gas turbines. There are no other nuclear facilities in the vicinity of the Humboldt Bay ISFSI. Unit 3 is undergoing decommissioning, and once the SNF is transferred from Unit 3 to the ISFSI, there will not be any effect from Unit 3 decommissioning operations to members of the public. There are, therefore, no potential cumulative effects on the combined operations of the ISFSI or any nearby nuclear facilities. Consequently, the regulatory requirements of 10 CFR §72.122(e) have been satisfied.

4.1.3.3 Thermal

The staff reviewed the discussion on thermal design criteria for SSCs important to safety for normal site maximum and minimum ambient temperatures. These thermal design criteria are presented in Section 3.2.7 of the SAR. The staff's assessment of the adequacy of the site-specific temperature design criteria is contained in Chapter 2 of this SER.

The staff reviewed the ambient condition loading design criteria and determined that these criteria are acceptable because they are based on site-specific information. Consequently, the ambient condition loading design criteria satisfy the regulatory requirements of 10 CFR §72.122(b)(1) and §72.122(b)(2) and are discussed in Chapter 6 of this SER.

Off-normal and accident thermal loads for the reinforced concrete storage vault are defined in Section 3.3.2.3.1 of the SAR. The off-normal and accident ambient temperatures for the reinforced concrete storage vault and the HI-STAR HB system are given in Section 3.2.7 of the SAR. In addition, the environmental design basis temperatures for the Humboldt Bay ISFSI site are listed in Tables 3.2-3 and 3.4-1 of the SAR. These design bases are discussed briefly in Section 4.1.3.2 of this SER. The off-normal and extreme maximum ambient temperatures are 72-hour averages. The minimum and maximum operating temperatures defined for the reinforced concrete storage vault and cask transporter are !9.4 and 32.2 EC [15 and 90 EF], which are consistent with the extreme temperature conditions estimated for the Humboldt Bay ISFSI site. Consequently, the loading design criteria for the off-normal and accident thermal load conditions satisfy the regulatory requirements of 10 CFR §72.122(b)(1) and §72.122(b)(2), as discussed in Chapter 6 of this SER.

Allowable fuel cladding temperatures for short-term operation, interim storage in the reinforced concrete vault, and off-normal and accident conditions are based on Interim Staff Guidance (ISG)-11 (U.S. Nuclear Regulatory Commission, 2003b). The limit is 400 EC [752 EF] for short-term operation and interim storage and 570 EC [1,058 EF] for off-normal and accident conditions. Stress allowable values for a range of temperatures for the SSCs of the HI-STAR HB system are provided in the ASME Boiler and Pressure Vessel Code (ASME International, 1996). The performance requirements of 10 CFR §72.120(a) have been met for all materials as demonstrated by the acceptable temperatures identified in conformance with the accepted standards.

As stated in Section 4.1.1 of this SER, the maximum total heat load of a single cask is 2 kW [6,824 Btu/hr] with the maximum for each assembly equal to 50 W [171 Btu/hr]. The maximum insolation values for the Humboldt Bay ISFSI site are 2,518 g-J/cm^2 [602 g-cal/cm^2] per day for a 24-hour period and 2,481 g-J/cm^2 [593 g-cal/cm^2] for a 12-hour period. The helium supply used in the backfill process for all MPC-HBs will have a purity no less than 99.995 percent. In addition, the helium backfill pressure will be verified during loading for all MPCs-HBs to ensure that it is greater than or equal to 312 kPa gauge [45.2 psig] and less than or equal to 336 kPa gauge [48.8 psig]. The HI-STAR HB system overpack annulus will be backfilled with helium of 99.995-percent purity and a pressure between 68.9 and 96.5 kPa gauge [10.0 and 14.0 psig] once it is vacuum dried.

Thermal design criteria are based on environmental conditions specific to the Humboldt Bay ISFSI site and heat generated by the materials stored. The storage systems are passive and incorporate passive heat removal. The staff reviewed the thermal design criteria for the SSCs important to safety for the Humboldt Bay ISFSI and determined that they are appropriately identified, as required by 10 CFR §72.120(a), §72.122(b)(1), §72.122(b)(2), and §72.122(c). The staff's review of the thermal evaluation of the Humboldt Bay ISFSI is provided in Chapter 6 of this SER.

4.1.3.4 Shielding and Confinement

The staff reviewed the discussion on shielding and confinement design criteria for the SSCs important to safety for the Humboldt Bay ISFSI presented in Sections 3.3.1.2, 3.3.1.5, 4.2.3.3.6, 4.2.3.3.8, and 4.4.3.5 of the SAR.

A security fence will be constructed to surround the concrete storage vault to control access. A controlled area is identified in accordance with the regulatory requirements of 10 CFR §72.106(a). No highway, railroad, or waterway traverses the controlled area; however, a public trail does pass through the controlled area boundary. According to the SAR, the public trail has been used occasionally. During cask transfer and storage operations, the public trail will be controlled using locked gates to keep members of the public out of the controlled area. The staff review of the applicant's measures to control public access within the controlled area, as required by 10 CFR §72.106(c), is discussed in Chapter 11 of this SER.

Criteria used for radiological protection features and confinement design bases for the HI-STAR HB system are provided in the SAR. The basic concept for shielding the HI-STAR HB system is protection by multiple barriers and using a combination of steel and Holtite-A neutron shielding material to meet the regulatory requirements of 10 CFR §72.126(a) and §72.128(a). The multiple barriers include the MPC-HB, HI-STAR HB overpack, and the reinforced concrete storage vault. The MPC-HB provides the necessary confinement for the HI-STAR HB system. The MPC-HB is seal-welded in accordance with ISG–18 (U.S. Nuclear Regulatory Commission, 2003c). The use of the HI-STAR HB system, which is a sealed canister and overpack-based system, satisfies the regulatory requirements of 10 CFR §72.122(h)(5). The reinforced concrete storage vault is designed to be below grade. The concrete material and the surrounding soil backfill provide shielding during interim storage in the reinforced concrete vault. Operating procedures, shielding design, and access controls provide the necessary radiological protection to ensure radiological exposures to Humboldt Bay ISFSI personnel and the public are as low as is reasonably achievable (ALARA), as required by 10 CFR §72.126(d). Chapter 11 of this SER provides further details and procedural considerations for radiation protection to limit public and occupational doses from Humboldt Bay ISFSI operations.

As indicated in Section 3.3.1.5.3 of the SAR, airborne or area radiological alarm systems are not necessary at the Humboldt Bay ISFSI storage vault because the storage system is passive. Portable, hand-held radiation protection instruments and self-reading dosimeters will be used during cask transfer operations and routine maintenance at the ISFSI storage area. The staff concurs with the applicant's assessment and finds that the regulatory requirements of 10 CFR §72.126(b) have been satisfied.

The offsite dose collective exposures estimated for members of the public at the public trail and the nearest resident are given in Section 7.5 of the SAR. The estimated occupational dose exposures are given in Section 7.4 of the SAR. The estimates for the off-normal and accident conditions are discussed in Chapter 8 of the SAR. The staff's review of the dose estimates is discussed in Chapter 11 of this SER. The HBPP radiation protection program, shielding design, and access controls provide the necessary radiological protection to ensure that radiological exposures to facility personnel and the public are ALARA, as required by 10 CFR §72.126(d).

The staff reviewed the design criteria for the HI-STAR HB system, and cask transfer and storage operations and determined that they are appropriately identified as required by 10 CFR §72.128(a). Detailed evaluations on shielding, confinement, and radiation protection are provided in Chapters 7, 9, and 11 of this SER.

4.1.3.5 Criticality

The staff reviewed the discussion on criticality design criteria for the SSCs important to safety for the Humboldt Bay ISFSI in Sections 3.3.1.4, 4.2.3.3.7, and 4.4.3.6 of the SAR. Standard design and criticality control methods are used for the Humboldt Bay ISFSI to maintain a subcritical condition of the stored SNF with a multiplication factor (k_{eff}) below 0.95 for all normal, off-normal, and accident conditions. Principal design features and control methods include (I) identification of maximum allowable SNF assembly enrichment and physical properties (e.g., the summary of fuel physical characteristics presented in Table 3.1-2 of the SAR), (ii) favorable geometry design for the fuel basket of the MPC-HB, (iii) permanent neutron-absorbing material in the fuel basket structure, and (iv) use of the DFC to store damaged SNF.

Criticality safety analyses have demonstrated that there are adequate safety margins for handling and storage operations at the Humboldt Bay ISFSI, as discussed in the staff's evaluation in Chapter 8 of this SER. According to the SAR, the limiting reactivity condition involves loading SNF in the spent fuel pool. Both installed and portable radiation monitoring instruments are used during cask loading and unloading activities in the RFB. During the transfer operation at the Humboldt Bay ISFSI and interim storage in the reinforced concrete storage vault, the SNF is in a helium-filled and seal-welded MPC-HB; therefore, the reactivity is low.

The staff finds that the design criteria for criticality are identified appropriately in the SAR, as required by 10 CFR §72.124(a–c). The staff's criticality evaluation is discussed in Chapter 8 of this SER.

4.1.3.6 Decommissioning

The staff's review of Section 4.7 of the SAR is presented in Chapter 13 of this SER.

4.1.3.7 Retrieval

The staff reviewed the discussion on retrieval design criteria of the SSCs important to safety for the Humboldt Bay ISFSI in Sections 3.3.1.1.1, 3.3.1.7.1, 4.2.3.2.2, 4.2.3.3.2, 4.5.1.2, and 8.2.2.3 of the SAR. The SNF will be stored in a MPC-HB, which will be placed in the HI-STAR HB overpack. Both the overpack and MPC-HB provide structural protection to prevent damage to SNF and ensure retrievability. As discussed in Section 4.1.1 of this SER, damaged fuel will be placed in DFCs before being inserted in the MPC-HB. A DFC provides a safe geometry for and ensures retrievability of the damaged SNF. The SAR further indicates that the Humboldt Bay HI-STAR HB system is designed to ensure adequate safety and to protect fuel integrity and retrievability under design basis loads. Retrievability also is discussed for tornado-generated missile accident events.

Based on the foregoing discussion, the staff finds that the HI-STAR HB system will provide adequate safety and maintain SNF retrievability for the Humboldt Bay ISFSI site-specific conditions. The staff, therefore, finds that the consideration of the retrievability of the SNF in the Humboldt Bay ISFSI design meets the regulatory requirements of 10 CFR §72.122(l) and §72.128(a).

4.1.4 Design Criteria for Other Structures, Systems, and Components

No specific requirements are identified in 10 CFR Part 72 for other SSCs not important to safety. The staff's review of the information provided in the SAR is discussed in this section, but no evaluation findings are made. The SSCs not important to safety for the Humboldt Bay ISFSI include security systems, a fence, lighting, electric power, communication systems, an automated welding system, a forced helium dehydration system, a vacuum drying system, and a cask transfer rail dolly in the RFB.

The design criteria for SSCs classified as not important to safety, but which have security or operational importance, are addressed in Chapter 4 of the SAR. Normal and emergency power needs for security equipment are discussed in Section 9.6 of the SAR. These SSCs classified as not important to safety will be designed to comply with appropriate commercial standards and codes to ensure compatibility with the SSCs classified as important to safety.

The staff finds that the use of commercial standards and codes for design of the SSCs not important to safety is acceptable.

4.2 Evaluation Findings

Based on its review of the information presented in the SAR, the staff makes the following evaluation findings regarding the proposed Humboldt Bay ISFSI:

- The staff finds that the SNF that will be stored in the Humboldt Bay ISFSI has been appropriately identified and is in compliance with 10 CFR §72.2(a)(1).

- The staff finds that the GTCC waste and the SNF will not be stored in the same MPC-HB. This approach is in accordance with the regulatory requirements of 10 CFR §70.120(b)(1).

- The staff finds that no liquid GTCC waste will be stored in the Humboldt Bay ISFSI, as the Humboldt Bay ISFSI is a dry storage facility. The regulatory requirements of 10 CFR §72.120(b)(2), therefore, have been satisfied.

- The staff finds that (I) the SSCs important to safety have been properly classified, (ii) the associated Classification Categories are consistent with the regulatory requirements of 10 CFR §72.144(a), and (iii) the supporting technical information presented in the SAR is in accordance with 10 CFR §72.24(n). This list of SSCs is based on the definition of SSCs important to safety in 10 CFR §72.3. The use of classification categories to divide the SSCs important to safety into three QA categories is consistent with the regulatory requirements of 10 CFR §72.122(a).

- The staff finds that the SAR appropriately specifies the design criteria for the SSCs important to safety in accordance with the regulatory requirements of 10 CFR §72.24(c), §72.120(a), and §72.122(h)(5). The staff also finds that the

SSCs important to safety will be designed as per the quality standards commensurate with the important to safety functions to be performed in accordance with the regulatory requirements of 10 CFR §72.144(c).

- The staff finds that the design criteria are described in sufficient detail to satisfy the regulatory requirements of 10 CFR §72.24(c).

- The staff finds that the structural design criteria given in the SAR for the SSCs important to safety have been developed from site characteristics and used in the determination of structural loads. Appropriate consideration of the natural phenomena-related design bases has been demonstrated, in compliance with the regulatory requirements of 10 CFR §72.120(a) , §72.122(b)(1), §72.122(b)(2), and §72.103(f)(2)(iii); and consideration of environmental conditions in the design has been demonstrated, in compliance with the regulatory requirements of 10 CFR §72.122(c). The values for these parameters form the basis for the structural design, mechanical design, shielding, confinement, and criticality assessments of the Humboldt Bay ISFSI.

- The staff finds that the load combination design criteria have been adequately considered for the design of SSCs important to safety, as required by 10 CFR §72.122(b)(1) and §72.122(b)(2). Appropriate combinations of the effects of normal and accident conditions and the effects of natural phenomena have been considered.

- The staff finds that the cumulative effects of the combined operations of the Humboldt Bay ISFSI and the HBPP are not a concern because the BWR unit of the HBPP (Unit 3) is no longer in operation. The staff finds that the regulatory requirements of 10 CFR §72.122(e) have been satisfied.

- The staff finds that (I) no SSCs important to safety have been identified to be shared between the Humboldt Bay ISFSI and other facilities, (ii) no control room has been identified as necessary to provide safe control of the Humboldt Bay ISFSI during off-normal or accident conditions, and (iii) no utility services or distribution systems have been identified to be important to safety. The staff finds that the regulatory requirements of 10 CFR §72.122(d) and §72.122(k)(1) have been satisfied.

- The staff finds that a controlled area has been identified, in accordance with the requirements of 10 CFR §72.106(a). As a public trail traverses the controlled area, the staff finds that the applicant will implement appropriate measures to control traffic and protect the public health and safety, as required by 10 CFR §72.106(c).

- The staff finds that radiological protection features and confinement design bases for the HI-STAR HB system satisfy the regulatory requirements of 10 CFR §72.126(a). The use of the sealed canister and overpack-based HI-STAR HB system allows handling and retrievability without the release of radioactive materials to the environment or radiation exposures in excess of 10 CFR Part 20 limits; thus, the design satisfies the regulatory requirements of 10 CFR §72.122(h)(5).

- The staff finds that the use of portable, hand-held radiation protection instruments and self-reading dosimeters during cask transfer operation and routine maintenance at the ISFSI storage area satisfies the regulatory requirements of 10 CFR §72.126(b).

- The staff finds that the use of operating procedures, shielding design, and access controls provides necessary radiological protection to satisfy the ALARA requirements of 10 CFR §72.126(d).

- The staff finds that design criteria for the storage and handling of SNF have been properly specified, as required by the regulatory requirements of 10 CFR §72.128(a).

- The staff finds that the design criteria for criticality have been identified in the SAR as required by 10 CFR §72.124(a–c).

- The staff finds that the Humboldt Bay ISFSI design, which includes the use of the HI-STAR HB system, allows for retrieval of SNF, in accordance with 10 CFR §72.122(l).

- The staff finds that the applicant has defined the design criteria for the cask transporter, trunnions, and lifting bolts to conform with the single-failure-proof systems in accordance with NUREG-0612 (U.S. Nuclear Regulatory Commission, 1980), and that these design criteria are in compliance with the regulatory requirements of 10 CFR §72.120(a) and §72.122(h)(5).

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