9 CONFINEMENT EVALUATION

9.1 Conduct of Review

The staff reviewed the confinement evaluation presented in the Diablo Canyon Independent Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR) (Pacific Gas and Electric Company, 2002) and the HI-STORM 100 System Final Safety Analysis Report (FSAR), Revision 1 (Holtec International, 2002).

The Diablo Canyon ISFSI will use the HI-STORM 100 System, which has been approved by U.S. Nuclear Regulatory Commission for use under the general license provisions of 10 CFR Part 72. The design criteria for the confinement function of the HI-STORM 100 System are addressed in Chapter 7 of the amended HI-STORM 100 System FSAR, Revision 1.

The applicant conducted a confinement analysis of a hypothetical radiological release, based on information in the HI-STORM 100 System FSAR, Revision 1. The confinement evaluation submitted by the applicant relies on the analyses performed by Holtec International to demonstrate compliance with 10 CFR Part 72 and includes a discussion of radiological release calculations and an evaluation of stored material degradation. Information about chemical composition and mechanical properties of materials for construction of critical cask components is provided in the HI-STORM 100 System FSAR, Revision 1.

This review was conducted in accordance with the guidance presented in Chapter 9 of NUREG–1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities” (U.S. Nuclear Regulatory Commission, 2000), with the exception that no independent confirmatory calculations were performed for this review. This review focused on analyses and results presented and referenced by the applicant in the Diablo Canyon ISFSI SAR. The referenced analyses include those performed by Holtec International for the HI-STORM 100 System proposed for use at the Diablo Canyon ISFSI.

9.1.1 Radionuclide Confinement Analysis

The application was reviewed for identification of the quantity of radionuclides that hypothetically could be released during normal, off-normal, and accident conditions, including design-basis accidents. The staff reviewed Sections 3.3.1.2, 3.3.1.5, 3.3.1.7, 4.2.3.2, 6.1, 8.1.3, and 8.2.7 and Chapter 7 of the Diablo Canyon ISFSI SAR, and Section 1.5 and chapters 4 and 7 of the HI-STORM 100 System FSAR, Revision 1. The information presented has been reviewed for conformance with the following regulatory requirements:

- 10 CFR §72.24(l)(1) requires a description of the equipment to be installed to maintain control over radioactive materials in gaseous and liquid effluents produced during normal operations and expected operational occurrences. The description must identify the design objectives and the means to be used for keeping levels of radioactive material in effluents to the environment as low as is reasonably achievable and within the exposure limits stated in §72.104. The description must include an estimate of the quantity of each of the principal radionuclides expected to be released annually to the environment in liquid and gaseous effluents produced during normal ISFSI operations.

- 10 CFR §72.44(c)(1)(i) requires that each license issued under this part include technical specifications for functional and operating limits and monitoring instruments and limiting control settings. The functional and operating limits for an ISFSI are limits on fuel or waste handling and storage conditions that are found to be necessary to protect the integrity of the stored fuel or waste container, to protect employees against occupational exposures and to guard against the uncontrolled release of radioactive materials.

- 10 CFR §72.106(b) requires that any individual located on or beyond the nearest boundary of the controlled area may not receive from any design basis accident the more limiting of a total effective dose equivalent 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 dose equivalent may not exceed 0.15 Sv [15 rem] and the shallow dose equivalent to skin or any extremity may not exceed 0.5 Sv [50 rem]. The minimum distance from the spent fuel, high-level radioactive waste, or reactor-related GTCC waste handling and storage facilities to the nearest boundary of the controlled area must be at least 100 meters [300 ft].

- 10 CFR §72.122(b)(4) requires that if the ISFSI is located over an aquifer which is a major water resource, measures must be taken to preclude the transport of radioactive materials to the environment through this potential pathway.

- 10 CFR §72.122(h)(3) requires that ventilation systems and off-gas systems must be provided where necessary to ensure the confinement of airborne radioactive particulate materials during normal or off-normal conditions.

- 10 CFR §72.126(d) requires that the ISFSI be designed to provide means to limit to levels as low as is reasonably achievable the release of radioactive materials in effluents during normal operations; and control the release of radioactive materials under accident conditions. Analyses must be made to show that releases to the general environment during normal operations and anticipated occurrences will be within the exposure limit given in §72.104. Analyses of design basis accidents must be made to show that releases to the general environment will be within the exposure limits given in §72.106. Systems designed to monitor the release of radioactive materials must have means for calibration and testing their operability.

- 10 CFR §72.128(a)(3) requires that spent fuel storage systems be designed with confinement structures and systems.

The HI-STORM 100 System is designed for long-term confinement and dry storage of pressurized water reactor or boiling water reactor spent nuclear fuel. The design of the HI-STORM 100 System is discussed in detail in Section 4.2.3 of the Diablo Canyon ISFSI SAR. In Section 4.2.3.3.6, the applicant states that all components of the confinement system are classified as important to safety. The major components of the HI-STORM 100 System that are classified as important to safety include the sealed multi-purpose canister (MPC) and the storage cask. The MPC is designed to maintain a confinement barrier during all normal, off-normal, and accident conditions.

The confinement boundary for the Holtec HI-STORM 100 System includes the MPC shell, the bottom baseplate, the MPC lid (including the vent and drain port cover plates), the MPC closure ring, and the associated welds. The welds forming the confinement boundary are described in detail in Section 7.1.3 of the HI-STORM 100 System FSAR. The MPC is designed, fabricated, and tested in accordance with the applicable requirements of ASME Code, Section III, Subsection NB, to the maximum extent practicable (ASME International, 1998). The MPC lid weld is designed to maintain confinement during normal and design-basis accident conditions. The closure ring weld provides a redundant welded boundary.

In Section 6.1 of the SAR, the applicant states that no releases of any type of radioactive material will occur during normal operations. This statement is in agreement with the statements in Section 7.2.3 of the HI-STORM 100 System FSAR, Revision 1, which were previously reviewed and found acceptable by the staff (U.S. Nuclear Regulatory Commission, 2002). Thus, leakage of the MPCs during normal conditions was not reevaluated for this safety evaluation.

In Section 8.2.7 of the SAR, leakage from the HI-STORM 100 System during hypothetical accident conditions was evaluated. Following the methodology in the HI-STORM 100 System FSAR and in accordance with Interim Staff Guidance document 5 (ISG-5, U.S. Nuclear Regulatory Commission, 1999), the applicant calculated the dose to an individual continuously present at the controlled-area boundary for 30 days at the location nearest to the Diablo Canyon ISFSI. This hypothetical, worst-case calculation, using methodology from Regulatory Guide 1.145 (U.S. Nuclear Regulatory Commission, 1983), yielded a total effective dose equivalent of 8.3 µSv [0.83 mrem] from a single leaking MPC. This value is lower than that reported by Holtec International; the primary contributor to the decrease is the increased distance to the receptor from 100 m [330 ft] for the generic HI-STORM 100 System analyses to approximately 430 m [1,400 ft] for the Diablo Canyon ISFSI (Pacific Gas and Electric Company, 2002). The accident dose rates (caused by direct and scattered radiation and a hypothetical release) for the HI-STORM 100 System do not exceed limits specified in 10 CFR §72.106(b).

While a hypothetical accident condition leakage calculation was performed for the HI-STORM 100 System, the applicant expects that there will be no release of radioactive materials in effluents during normal and all credible accident conditions. This is supported by the applicant's analyses, which demonstrate that the MPC would maintain its confinement integrity under the design-basis normal, off-normal, and accident conditions (including earthquake, tornado, flood, drops and tip-over, fire, explosions, leakage, electrical accident, loading of an unauthorized assembly, loss of neutron shielding, adiabatic heat-up, blockage of vents and inlets, fuel rod rupture, transmission tower collapse, and lift jack failure). Based on the results of the applicant's analyses, the staff agrees that the MPC confinement integrity would be maintained under the design-basis normal, off-normal, and accident conditions.

The staff, therefore, has reasonable assurance that the risk of release of radioactive effluents to the general public from storing as many as 140 HI-STORM 100 System casks at the Diablo Canyon ISFSI is insignificant and meets the requirements of 10 CFR §72.106(b). The staff concludes that the stainless steel welded canisters (with redundant welds in the lid enclosure of the canister) manufactured and inspected according to the ASME Code, as approved by the staff, are not expected to release radioactive effluents, and thereby meet the requirements of 10 CFR §72.122(b), §72.126(d), and §72.128(a)(3).

The staff reviewed the applicable chapters of the SAR and found that the conclusions that were made by the applicant were in agreement with the Holtec HI-STORM 100 System FSAR, previously approved by the NRC staff. The staff also reviewed the site technical specifications proposed by the applicant and found those portions related to the confinement integrity of the HI-STORM 100 System to be acceptable, thereby meeting the requirements of 10 CFR §72.44(c)(1), §72.122(h), §72.126(d), and §72.128(a)(3).

9.1.2 Confinement Monitoring

The staff review of this section focused on two areas: the continuous monitoring of closure seal effectiveness and the measure of radionuclides released to the environment during normal and accident conditions. The staff reviewed Sections 3.3.1.3, 3.3.1.5, 3.3.1.7, 4.2.3.3, and Chapter 6 of the Diablo Canyon ISFSI SAR (Pacific Gas and Electric Company, 2002). The information presented has been reviewed for conformance with the following regulatory requirements:

- 10 CFR §72.24(l) requires a description of the equipment to be installed to maintain control over radioactive materials in gaseous and liquid effluents produced during normal operations and expected operational occurrences. The description must identify the design objectives and the means to be used for keeping levels of radioactive material in effluents to the environment as low as is reasonably achievable and within the exposure limits stated in §72.104. The description must include: (1) an estimate of the quantity of each of the principal radionuclides expected to be released annually to the environment in liquid and gaseous effluents produced during normal ISFSI operations.

- 10 CFR §72.44(c)(3)(iv) requires confirmation that the limiting conditions required for safe storage are met.

- 10 CFR §72.122(h)(4) requires that storage confinement systems 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 §72.126(c)(1) requires as appropriate for the handling and storage system, that effluent systems be provided. Means for measuring the amount of radionuclides in effluents during normal operations and under accident conditions must be provided for these systems. A means of measuring the flow of the diluting medium, either air or water, must also be provided.

- 10 CFR §72.128(a)(1) requires that spent fuel storage systems be designed with a capability to test and monitor components important to safety.

Based on the staff's assessment of welded cask enclosures, consistent with NUREG–1536, "Standard Review Plan for Dry Cask Storage Systems;" Chapter 7, Section V.2 (U.S. Nuclear

Regulatory Commission, 1997), the MPC, which is the confinement system for the HI-STORM 100 System, provides reasonable assurance that no effluents will be released and, therefore, requires no monitoring of the MPC for leakage. The seal weld will be inspected and tested in accordance with the requirements in Section 8.1.5 of the HI-STORM 100 System FSAR. These requirements were reviewed during the certification of the HI-STORM 100 System and were found to be acceptable by the staff (U.S. Nuclear Regulatory Commission, 2002).

The staff finds the proposal to provide no monitoring of the confinement barrier for the HI-STORM 100 System to be used at the Diablo Canyon ISFSI acceptable because the casks will be loaded, welded, inspected, and tested in accordance with appropriate cask design requirements, meeting the requirements of 10 CFR §72.122(h)(4) and §72.126(c)(1).

9.1.3 Protection of Stored Materials from Degradation

The application was reviewed to establish that the fuel cladding would not experience significant degradation during the requested 20-year storage period. The staff reviewed Sections 3.3.1.1, 3.3.1.2, 3.3.1.1.7.2, 4.4.1.2, and 5.1.1.2 and Table 3.4-2 of the Diablo Canyon ISFSI SAR. The information presented has been reviewed for conformance with the following regulatory requirements:

- 10 CFR §72.122(h)(1) requires that the spent fuel cladding be protected during storage against degradation that leads to gross ruptures or be otherwise confined such that degradation of the fuel during storage does not pose operational safety problems with respect to its removal from storage.

- 10 CFR 72.122(l) and 72.236(m) require that the storage system be designed to allow ready retrieval of the spent fuel from the storage system for further processing or disposal.

Following the loading of the MPC, the main lid is welded and a helium leak test is performed on the seal weld. The MPC cavity is then dried and filled with helium fill gas. The vent and drain ports are then welded into place and a helium leak test is conducted on the vent and drain port covers. These steps are described in detail in the HI-STORM 100 System FSAR, Section 7.1. The helium back-fill procedure ensures that the presence of oxidizing gasses in the MPC cavity will be minimized.

The thermal analysis of the HI-STORM 100 System indicates that the fuel cladding temperature will not exceed the limits established to prevent fuel clad degradation during storage. The fuel cladding performance and limitations on the spent fuel to be stored at the Diablo Canyon ISFSI are discussed in more detail in Section 6.1.2 of this SER.

The staff verified that the ISFSI SAR was consistent with the information provided in the HI-STORM 100 System FSAR, Revision 1. The staff reviewed the proposed Diablo Canyon ISFSI Technical Specifications and found the conditions to ensure the protection of stored materials from degradation in the HI-STORM 100 System to be acceptable, thereby meeting the requirements of 10 CFR §72.122(h)(1).

9.2 Evaluation Findings

During the evaluation of confinement of the spent nuclear fuel stored at the Diablo Canyon ISFSI, the staff assumed that only the HI-STORM 100 System, as approved through Amendment 1, will be used. Based on the staff's review of the applicant's submittal and the applicable technical specifications, the staff made the following findings:

- The radionuclide confinement analysis for the Holtec HI-STORM 100 System and the Diablo Canyon ISFSI has met the requirements of 10 CFR 72.24(l) by providing a description of how radioactive materials in gaseous and liquid effluents will be controlled such that they are as low as is reasonably achievable. The requirements of 10 CFR §72.44(c) have been met, based on the staff's review of the Technical Specifications that have been submitted by the applicant. The MPC is welded and tested in accordance with acceptable methods, as described in the SAR, and is not expected to leak under normal, off-normal, and accident conditions. Therefore, the staff finds that the requirements of 10 CFR §72.122(h)(3), §72.126(d), §72.128(a)(3), and §72.122(a) have been met.

- The staff concludes that the HI-STORM 100 System, which uses an entirely redundant closure system, is not expected to leak and therefore does not require confinement monitoring. Based on this finding, the requirements of 10 CFR §72.44(c), §72.122(h)(4), §72.126(c)(1), and §72.128(a)(3) are met.

- The staff concludes that the proposed Technical Specifications are sufficient to protect the stored materials from degradation in accordance with 10 CFR §72.24(l). The staff also finds that the proposed methods to protect the stored materials from degradation are acceptable to protect the spent fuel cladding from gross ruptures in accordance with 10 CFR §72.122(h)(1).

9.3 References

ASME International. *ASME Boiler and Pressure Vessel Code, Section III*. New York City, NY: American Society of Mechanical Engineers. 1998.

Holtec International. *Final Safety Analysis Report for the Holtec International Storage and Transfer Operation Reinforced Module Cask System (HI-STORM 100 Cask System), Revision 1. Vols I and II*. HI–5014464. Docket 72-1014. Marlton, NJ: Holtec International. 2002.

Pacific Gas and Electric Company. *Diablo Canyon Independent Spent Fuel Storage Installation Safety Analysis Report, Amendment 1*. San Luis Obispo County, CA: Pacific Gas and Electric Company. 2002.

U.S. Nuclear Regulatory Commission. *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*. Regulatory Guide 1.145. Rev. 1. Washington, DC: U.S. Nuclear Regulatory Commission. 1983.

U.S. Nuclear Regulatory Commission. *Standard Review Plan for Dry Cask Storage Systems.* NUREG–1536. Washington, DC: U.S. Nuclear Regulatory Commission. 1997.

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U.S. Nuclear Regulatory Commission. *Standard Review Plan for Spent Fuel Dry Storage Facilities.* NUREG–1567. Washington, DC: U.S. Nuclear Regulatory Commission. 2000.

U.S. Nuclear Regulatory Commission. *Holtec International HI-STORM 100 Cask System Amendment No. 1 Safety Evaluation Report*. Docket 72-1014. Washington, DC: U.S. Nuclear Regulatory Commission. 2002.