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ACRONYMS

ALARA	As Low As Reasonably Achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
AWS	American Welding Society
BWR	Boiling Water Reactor
CNWRA	Center for Nuclear Waste Regulatory Analyses
COC	Certificate of Compliance
CTF	Cask Transfer Facility
DDE	Double Design Earthquake
DE	Design Earthquake
DCPP	Diablo Canyon Power Plant
DOE	U.S. Department of Energy
DSHA	Deterministic Seismic Hazard Analysis
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FHB/AB	Fuel-Handling Building and Auxiliary Building
FSAR	Final Safety Analysis Report
GSI	Geological Strength Index
HE	Hosgri Earthquake
ILP	ISFSI Long Period
ISFSI	Independent Spent Fuel Storage Installation
JCS	Joint Compressive Strength
JRC	Joint Roughness Coefficient
LTSP	Long-Term Seismic Program
M	Magnitude (Earthquake)
MPC	Multi-Purpose Canister
MSL	Mean Sea Level
MTU	Metric Tons of Uranium
NRC	U.S. Nuclear Regulatory Commission
NFPA	National Fire Protection Association
PGA	Peak Ground Acceleration
PG&E	Pacific Gas and Electric Company
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PSHA	Probabilistic Seismic Hazard Analysis
PWR	Pressurized Water Reactor
QA	Quality Assurance
RAI	Request for Additional Information
SAR	Safety Analysis Report
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SFPE	Society of Fire Protection Engineers
SSC	Structures, Systems, and Components
SSE	Safe Shutdown Earthquake
TEDE	Total Effective Dose Equivalent
TNT	Trinitrotoluene
ZPA	Zero Period Acceleration

EXECUTIVE SUMMARY

On December 21, 2001, the Pacific Gas and Electric (PG&E) Company submitted a license application in accordance with 10 CFR Part 72 to the U.S. Nuclear Regulatory Commission (NRC) to construct and operate an onsite independent spent fuel storage installation (ISFSI) on the site of the Diablo Canyon Power Plant . The application consists of the following documents:

- (1) A **License Application**, in which the applicant describes itself and provides general and financial information.
- (2) A **Safety Analysis Report**, in which the applicant describes its plans for building, operating, maintaining, and decommissioning the proposed ISFSI.
- (3) A revised **Emergency Plan** for the Diablo Canyon site, in which the applicant describes its plans for resolving any emergencies that may happen during the operation of the ISFSI.
- (4) A **Safeguards and Physical Security Plan** for the Diablo Canyon site (a separate safeguards document not releasable to the public), in which the applicant describes its plans for ensuring that the ISFSI and nuclear material are appropriately protected.
- (5) An **Environmental Report**, in which the applicant provides the information the NRC staff uses in performing its environmental assessment of the proposed ISFSI. This review is accomplished in parallel with the staff's safety evaluation and is documented in a separate Environmental Assessment by the staff.

The NRC staff has documented its review and conclusions on the safety-related aspects of PG&E's license application in this Safety Evaluation Report (SER). This SER provides the staff's evaluation concerning the first three documents of the Diablo Canyon ISFSI license application, as revised and supplemented. This executive summary provides a brief overview and summary of the SER.

The facility that PG&E proposes to build (called the Diablo Canyon ISFSI) would store spent nuclear fuel and associated radioactive materials used to generate power at the two units of the Diablo Canyon Power Plant (DCPP). The spent nuclear fuel is proposed to be stored in large metal and concrete containers called storage casks. This method of storing spent nuclear fuel is called dry cask storage technology and is distinct from wet storage, which is a method of storing the spent nuclear fuel in large pools of water. Based on the existing inventory of spent nuclear fuel in the pools and the expected generation of spent nuclear fuel, PG&E estimates that the current wet storage at the DCPP will reach capacity in approximately 2006.

The Nuclear Waste Policy Act of 1982 mandated that the U.S. Department of Energy (DOE) assume responsibility for the permanent disposal of spent nuclear fuel. The DOE has identified Yucca Mountain, Nevada, as its proposed site for disposal of high-level waste, including spent nuclear fuel. In accordance with the current DOE schedule, the proposed Yucca Mountain repository will not be able to accept high-level waste prior to 2010, pending approval of the

Yucca Mountain license application by the NRC. Thus, spent nuclear fuel will need to remain at the DCPD site until the proposed Yucca Mountain repository is operational or until another interim storage facility is in place to accept spent nuclear fuel. Therefore, PG&E proposed to use the onsite ISFSI dry storage technology to meet its needs for additional capacity to store spent nuclear fuel beyond 2006.

According to the PG&E license application, the ISFSI is to be located within the owner-controlled area on the same site as the DCPD. The Diablo Canyon site consists of 300 hectares [750 acres] of land located in San Luis Obispo County, California, near the Pacific Ocean. The site is approximately 19 km [12 mi] west-southwest of the city of San Luis Obispo, California. The proposed ISFSI includes four main categories of structures, systems, and components (SSCs). These categories are the (1) dry cask storage system, (2) storage pads, (3) onsite cask transporter, and (4) Cask Transfer Facility (CTF).

Description of the Proposed Diablo Canyon ISFSI

The dry cask storage system that PG&E proposes to use at the Diablo Canyon ISFSI is the Holtec International HI-STORM 100 System. The HI-STORM 100 System is a canister-based storage system that stores spent nuclear fuel in a vertical orientation (the cask, canister and the fuel rods inside are, in effect, standing up). The HI-STORM 100 System to be used at the Diablo Canyon ISFSI consists of three parts:

- (1) Multi-purpose canisters (MPCs), which contain the spent fuel
- (2) HI-STORM 100SA Overpacks, which contain the MPCs during storage
- (3) HI-TRAC 125 Transfer Cask, which contains the MPCs during loading, unloading, and transfer.

The MPCs provide the confinement system for the spent nuclear fuel. Each MPC is a welded, cylindrical canister in which the spent fuel is sealed. The HI-TRAC 125 Transfer Cask provides radiation shielding and structural protection of the MPC during transfer operations. The transfer cask is a multiwalled cylindrical vessel with a water jacket attached to the exterior. The HI-TRAC transfer cask will be used to move the MPCs from the fuel-handling building and auxiliary building at the DCPD to the CTF where they will be placed in the HI-STORM 100SA Overpacks (also referred to as casks). The storage overpacks provide radiation shielding and structural protection of the MPC during storage. The HI-STORM 100 System is a passive system that does not rely on any active cooling systems to remove spent nuclear fuel decay heat. At Diablo Canyon, the HI-STORM 100 overpacks will be anchored in a vertical position to the reinforced concrete storage pads.

The HI-STORM 100 System has been approved by the NRC for use under the general license provisions of 10 CFR Part 72, Subpart K (Certificate of Compliance No. 1014, Amendment 1, July 15, 2002, Docket No. 72-1014). Thus, the NRC staff has previously evaluated this cask system for general use for dry storage. That evaluation is documented in the NRC Holtec International HI-STORM 100 System Safety Evaluation Report, which was issued with the Certificate of Compliance, the regulatory document by which NRC allows general use of an approved storage cask system. However, PG&E has elected to apply for a site-specific license for the Diablo Canyon ISFSI, and in its application, makes frequent reference to the analyses previously submitted and approved for the HI-STORM 100 System, where applicable. As

discussed in this SER, the NRC staff finds that the HI-STORM 100 System to be used at the Diablo Canyon ISFSI is acceptable in accordance with the site-specific license provisions of 10 CFR Part 72.

The cask transporter is to be purchased as a commercial-grade item and qualified by testing prior to use to satisfy the single-failure-proof lift system criterion. The load-bearing components of the cask transporter are designed to prevent damage to the spent nuclear fuel and spent nuclear fuel storage cask during on-site transport, lifting, and MPC transfer operations under all normal, off-normal, and accident conditions. The cask transporter is designed to carry the MPC in the transfer cask from the DCPD to the CTF. At the CTF, the transporter will be used to lower each MPC into a storage overpack. The transporter will then be used to move the loaded overpack from the CTF to the storage pad.

The CTF is a below grade, cylindrical, steel-lined structure embedded in the rock close to the ISFSI storage pads. The CTF is designed to prevent damage to the spent nuclear fuel and cask system components during lifting and MPC transfer operations under normal, off-normal, and accident conditions. Operations in the CTF are performed as follows. The empty storage overpack is placed on the CTF lift platform and lowered into the CTF using three jack screws. The cask transporter, with MPC in the HI-TRAC 125 Transfer Cask, is driven over the CTF, and then secured in place using a lateral restraint system. The loaded transfer cask is positioned over the storage overpack and the two structures are connected by a mating flange. The cask transporter then lowers the MPC into the overpack. The transfer cask is removed, and the lid is then placed onto the overpack. The loaded overpack is lifted by the jack screws at the CTF and then secured to the transporter, which is then detached from the CTF and used to move the loaded overpack to its position on the storage pad.

Each HI-STORM 100 System storage overpack loaded with an MPC will be anchored to reinforced concrete storage pads that will be built on top of bedrock. The storage pads for the Diablo Canyon ISFSI provide the necessary embedment for the anchorage of the HI-STORM 100 System loaded overpacks (casks). The pads are designed to ensure a stable and level support surface for the storage cask during normal, off-normal, and accident conditions. Each of the seven pads at the ISFSI is designed to hold 20 casks.

Safety of the ISFSI

In its evaluation of the application, the NRC staff determined that PG&E showed that the proposed Diablo Canyon ISFSI and the HI-STORM 100 System cask design are structurally sound and will ensure that the spent fuel will remain safe within the canister during all phases of operation for normal, off-normal, and accident conditions. PG&E included analyses of all plausible natural and man-made phenomena, many of which had already been accepted by the NRC staff in its review of the HI-STORM 100 System, and in previous staff reviews of Diablo Canyon Power Plant licensing actions. The regulations at 10 CFR §72.40(c) indicate that a reevaluation of a site is not required if it is covered under previous licensing actions, except where new information is discovered that could alter the original site evaluation findings. In this review, the staff has not discovered new information that alters the applicability of the current DCPD licensing basis to the proposed ISFSI. In any cases where new information was found, PG&E provided additional analyses and discussion to demonstrate that the DCPD design basis remains unchanged. After reviewing the applicant's analyses, the NRC staff concluded that the

Diablo Canyon ISFSI and the HI-STORM 100 System design are structurally safe and will meet all applicable regulatory requirements.

The NRC staff also determined that PG&E has shown that the spent nuclear fuel within the storage casks will remain subcritical (that is, unable to sustain a nuclear chain reaction) during all phases of operation for both normal conditions and credible accident conditions. PG&E provided radiation dose estimates for the surrounding public and the workers at the ISFSI. The HI-STORM 100 System storage canister will be welded closed to prevent leakage of radioactive material. During storage, the canister (MPC) is surrounded by the overpack's thick wall of concrete and steel, which shields the area outside of the cask from direct radiation.

The amount of radiation to which a person is exposed is called a dose. PG&E has estimated that members of the public nearest the proposed ISFSI would receive doses below the NRC regulatory requirements, which for normal conditions of operation is 0.25 mSv/yr [25 mrem/yr] and for credible accidents is 0.05 Sv/yr [5 rem/yr]. PG&E also calculated radiation dose rates within the vicinity of individual casks to demonstrate that workers at the proposed ISFSI will not receive doses that exceed 0.05-Sv/yr [5 rem/yr], the NRC annual regulatory limit for workers at nuclear facilities. These radiation dose limits have been established by the NRC to prevent any undue risk and to ensure the safety of all members of the public and workers at a nuclear facility. PG&E also described its radiation protection program, which employs an "as low as reasonably achievable" (ALARA) radiation protection principle. PG&E will also monitor radiation doses received by the workers and dose rates within the vicinity of the storage pad to verify that radiation dose limits are not exceeded. The NRC staff reviewed PG&E's analyses and concluded that the Diablo Canyon ISFSI and HI-STORM 100 System design are radiologically safe and will meet regulatory requirements.

PG&E was required to demonstrate that all of the important parts of its proposed ISFSI would continue to perform their design functions during normal conditions and during any credible accidents that could be postulated to occur. The NRC staff concluded that, as required by 10 CFR Part 72, PG&E has provided acceptable analyses of the design and performance of these structures, systems, and components important to safety under credible off-normal and accident scenarios. Based on its evaluation of these events, the staff concluded that they do not pose a hazard to the ISFSI.

The staff further concluded that the PG&E analyses of off-normal and accident events demonstrate that the proposed ISFSI will be sited, designed, constructed, and operated so that during all credible off-normal and accident events, public health and safety will be adequately protected and the capability to retrieve spent fuel will be preserved.

PG&E evaluated the HI-STORM 100 System to be used at the Diablo Canyon ISFSI against the parameters and conditions specific to the site and the spent fuel to be stored. The NRC staff has reviewed PG&E's evaluation. As discussed in this SER, the staff finds that the use of the HI-STORM 100 System as proposed for the Diablo Canyon ISFSI is acceptable, in accordance with the site-specific license provisions of 10 CFR Part 72, subject to all conditions of the license.

Other Requirements

To demonstrate its financial qualifications, PG&E identified anticipated sources of funds for the ISFSI project. The NRC staff concludes in this SER that PG&E has provided reasonable assurance of its financial qualifications for construction, operation, and decommissioning of the proposed ISFSI.

The NRC staff also found PG&E's revisions to the DCPD emergency plan and safeguards and physical security plans to be acceptable. The emergency plan appropriately described PG&E's program for responding to onsite emergencies involving the ISFSI. It also described plans for seeking offsite assistance, if needed. The staff separately reviewed PG&E's proposed changes to the DCPD security program to incorporate ISFSI activities. These changes to the safeguards and physical protection plans were also found to meet NRC requirements.

SCOPE OF THE SAFETY EVALUATION REPORT

The NRC staff reviewed information submitted by PG&E in support of its application, including the following documents, which contain the information specified in 10 CFR Part 72, Subpart B, License Application, Form, and Contents:

- (1) The License Application, which contains
 - General and financial information required by 10 CFR §72.22
 - Proposed technical specifications required by 10 CFR §72.26
 - Applicant's technical qualifications required by 10 CFR §72.28
 - Preliminary decommissioning plan required by 10 CFR §72.30
 - A revised Emergency Plan for the DCPD as required by 10 CFR §72.32.
- (2) The Safety Analysis Report (SAR) for the Diablo Canyon ISFSI, required by 10 CFR §72.24.
- (3) The Environmental Report for the Diablo Canyon ISFSI, required by 10 CFR §72.34.
- (4) A revised Security Plan for the DCPD, which includes changes to the safeguards contingency plan to address the Diablo Canyon ISFSI, as required by 10 CFR §72.180 and §72.184.

Included in PG&E's license application is the Safety Analysis Report (SAR). Amendments 1 and 2 of the SAR (Pacific Gas and Electric Company, 2002, 2003) were submitted in October 2002 and October 2003 and incorporated PG&E's responses to the NRC staff's requests for additional information (U.S. Nuclear Regulatory Commission, 2002c). PG&E subsequently documented supplemental information related to the staff's requests for additional information. The staff's review of the SAR as documented in this Safety Evaluation Report (SER) is primarily based on the information provided in the SAR, as amended, and on supplemental information, as cited. Table 1 provides a summary list of the primary documents submitted by PG&E that the staff relied on in conducting its safety evaluation.

Table 1. Pacific Gas and Electric Licensing Submittals for the Diablo Canyon ISFSI

Date	Subject (PG&E Document Number)	NRC ADAMS Accession No(s).
12/21/2001	Diablo Canyon ISFSI License Application and Attachments A through F (PG&E DIL-01-002)	Package No. ML020180341
12/21/2001	Diablo Canyon ISFSI License Application - Environmental Report (PG&E DIL-01-002)	Package No. ML020180341
12/21/2001	Diablo Canyon ISFSI License Application - Safety Analysis Report, Volumes 1 and 2 (PG&E DIL-01-002)	Package No. ML020180341
12/21/2001	PG&E Calculation Packages (24) (PG&E DIL-01-004)	ML020280506
12/21/2001	Holtec Proprietary and Non-Proprietary Drawings (PG&E DIL-01-008)	ML020090680 ML020090655
12/21/2001	Seismic Hazards Review Board Final Report (PG&E DIL-01-006)	ML020090189
12/21/2001	Geologic Data Reports (11) (PG&E DIL-01-005)	ML020300398
04/18/2002	Submittal of Proposed Changes to DCPD Physical Security Program (Safeguards Information) (PG&E DCL-021-042)	ML021150090 (Cover letter only)
05/16/2002	Submittal of 16 Geosciences Calculations (PG&E DIL-02-005)	ML021490009
05/23/2002	Submittal of 4 Reference Documents (PG&E DIL-02-006)	ML021630191
06/07/2002	Supplemental of General and Financial Information - 10 CFR 72.22 (PG&E DIL-02-008)	ML021680332
10/15/2002	Response to NRC Request for Additional Information (PG&E DIL-02-009)	ML022950396
10/15/2002	Submittal of License Application Amendment 1 (PG&E DIL-02-010)	ML022950211

12/13/2002	Holtec Non-Proprietary Reports (PG&E DIL-02-012)	Package No. ML023570164
02/07/03	Submittal of Reference Documents (Slope stability and Transport Route) (PG&E DIL-03-001)	ML030430498
02/14/03	Supplemental Responses to NRC Request for Additional Information (Aircraft Hazards) (PG&E DIL-03-002)	ML030520090
03/27/03	Supplemental Responses to NRC Request for Additional Information (ISFSI Pad Design) (PG&E DIL-03-003)	ML031250421
03/27/03	Supplemental Responses to NRC Request for Additional Information (Slope Stability) (PG&E DIL-03-004)	Package No. ML031010455
03/27/03	Supplemental Responses to NRC Request for Additional Information (Explosion Hazards) (PG&E DIL-03-005)	Package No. ML030940393
03/27/03	Supplemental Responses to NRC Request for Additional Information (Explosion Hazards) Holtec Proprietary information (PG&E DIL-03-006)	ML030940565
05/06/2003	Supplemental Slope Stability Design Features Information PG&E DIL-03-007	ML031330459
06/13/2003	Supplemental Blasts and Explosions Responses (PG&E DIL-03-008)	ML031710082
07/28/2003	Supplemental Blasts and Explosions Responses (PG&E DIL-03-010)	ML032120173
10/03/03	Additional Information on Cask Transporter Lateral Restraints (PG&E DIL-03-011)	ML032830200
10/03/03	Amendment 2 to the Diablo Canyon ISFSI License Application (PG&E DIL-03-012)	ML032900121
10/10/03	Amendment 2 to Proposed Technical Specifications for the Diablo Canyon ISFSI (PG&E DIL-03-013)	ML032930133
12/04/03	Additional Information on Cask Transporter Lateral Restraints (PG&E DIL-03-015)	ML033450401
01/16/04	Additional Information Regarding ISG-11 (PG&E DIL-04-002)	ML040280533

This report documents the results of the safety evaluation review conducted by the NRC staff. The technical review was carried out according to the applicable NRC regulations in 10 CFR Part 20 and Part 72, and the guidance of NUREG-1567, Standard Review Plan for Spent Fuel Dry Storage Facilities (U.S. Nuclear Regulatory Commission, 2000); NUREG-1536, Standard Review Plan for Dry Cask Storage Systems (U.S. Nuclear Regulatory Commission, 1997); NUREG-0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (U.S. Nuclear Regulatory Commission, 1987); Regulatory Guide 3.61, Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask, Revision 1 (U.S. Nuclear Regulatory Commission, 1989a); and Regulatory Guide 3.62, Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Nuclear Fuel Storage Casks, Revision 0 (U.S. Nuclear Regulatory Commission, 1989b).

This SER documents the staff's review of the design, operation, and other safety aspects of the proposed Diablo Canyon ISFSI, as described in the above submittals, except for the Environmental Report. The Environmental Report is the subject of a separate Environmental Assessment issued by the NRC staff on October 24, 2003 (U.S. Nuclear Regulatory Commission, 2003).

The staff's assessment in this SER is based on the regulatory requirements of 10 CFR Part 72. In its review, the staff evaluated the (1) characteristics of the site, (2) facility operations and operating systems, (3) design and design criteria for the facility and its structures, systems, and components (SSCs) important to safety, (4) programs that support protection of public health and safety and worker health and safety, (5) impact of potential off-normal and accident events on SSCs important to safety, (6) financial qualifications of the applicant, and (7) proposed technical specifications.

The Diablo Canyon ISFSI will use the NRC approved HI-STORM 100 System through Amendment No. 1, effective July 15, 2002, with a modified cask anchoring system to be approved as part of this site-specific license. In evaluating the use of this cask at the Diablo Canyon ISFSI, the staff reviewed the HI-STORM 100 System Final Safety Analysis Report (Holtec International, 2002) and the related NRC SER (U.S. Nuclear Regulatory Commission, 2002a) and Certificate of Compliance (U.S. Nuclear Regulatory Commission, 2002b) to confirm that the ISFSI site parameters are enveloped by the cask design parameters considered in those reports and that the HI-STORM 100 System is acceptable for use at the Diablo Canyon ISFSI site. The staff also verified that the ISFSI cask storage pads and areas are designed to support the static load of the stored casks adequately and that the radiological limits of 10 CFR §72.104 will be met.

REFERENCES

- Holtec International. *Final Safety Analysis Report for the HI-STORM 100 Cask System*, Amendment No. 1. Docket No. 72-1014. Marlton, NJ: Holtec International. July, 2002.
- Pacific Gas and Electric Company. *Diablo Canyon ISFSI Safety Analysis Report*. Amendment 1. Docket No. 72-26. Avila Beach, CA: Pacific Gas and Electric Company. October 2002.

- Pacific Gas and Electric Company. *Diablo Canyon Independent Spent Fuel Storage Installation: Response to NRC Request for Additional Information for the Diablo Canyon Independent Spent Fuel Storage Installation (TAC No. L23399)*. Avila Beach, CA: Pacific Gas and Electric Company. October 15, 2002a.
- Pacific Gas and Electric Company. *Diablo Canyon ISFSI Safety Analysis Report*. Amendment 2. Docket No. 72-26. Avila Beach, CA: Pacific Gas and Electric Company. October 2003.
- U.S. Nuclear Regulatory Commission. *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*. NUREG-0800. Washington, DC: U.S. Nuclear Regulatory Commission. 1987.
- U.S. Nuclear Regulatory Commission. *Standard Format and Content for a Topical Safety Analysis Report for Spent Fuel Storage Casks*. Regulatory Guide 3.61. Washington, DC: U.S. Nuclear Regulatory Commission. 1989a.
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- U.S. Nuclear Regulatory Commission. *Standard Review Plan for Spent Fuel Dry Storage Facilities*. Final Report. NUREG-1567. Washington, DC: U.S. Nuclear Regulatory Commission. 2000.
- U.S. Nuclear Regulatory Commission. *Certificate of Compliance No. 1014, Amendment No. 0*. Docket No. 72-1014. Washington, DC: U.S. Nuclear Regulatory Commission. July 2002a.
- U.S. Nuclear Regulatory Commission. *Holtec International HI-STORM 100 Cask System Safety Evaluation Report*. Docket No. 72-1014. Washington, DC: U.S. Nuclear Regulatory Commission. July, 2002b.
- U.S. Nuclear Regulatory Commission. *Request for Additional Information for the Diablo Canyon Independent Spent Fuel Storage Installation Application*. Letter from J.R. Hall, to L.F. Womack, Diablo Canyon Power Plant. Washington, DC: U.S. Nuclear Regulatory Commission. August 29, 2002c.
- U.S. Nuclear Regulatory Commission. *Environmental Assessment and Finding of No Significant Impact Related to the Construction and Operation of the Diablo Canyon Independent Spent Fuel Storage Installation (TAC NO.L23399)*. ML032970337. Washington DC: U.S. Nuclear Regulatory Commission. October 24, 2003.