SAFETY EVALUATION REPORT

DOCKET NO. 72-27

HUMBOLDT BAY INDEPENDENT SPENT FUEL STORAGE INSTALLATION

Materials License No. SNM-2513

August 2005

Enclosure 2

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

TABLES

HUMBOLDT BAY ISFSI SER ACRONYMS

American Welding Society	AWS
as low as is reasonably achievable	ALARA
boiling water reactor	BWR
California Public Utilities Commission	CPUC
Certificate of Compliance	CoC
cyclic stress ratio	CSR
damaged fuel container	DFC
design basis earthquake	DBE
design earthquake	DE
deterministic seismic hazard analysis	DSHA
Final Safety Analysis Report	FSAR
finite element model	FEM
Greater than Class C	GTCC
Humboldt Bay Power Plant	HBPP
Independent Spent Fuel Storage Installation	ISFSI
Limiting Condition for Operation	LCO
mean higher high water	MHHW
mean lower low water	MLLW
mean sea level	MSL
megawatt-electric	MWe
multi-purpose canister	MPC
Pacific Gas and Electric Company	PG&E
peak ground accelerations	PGA
probabilistic seismic hazard analyses	PSHA
probable maximum flood	PMF
quality assurance	QA
Refueling Building	RFB
Safety Analysis Report	SAR
Safety Evaluation Report	SER
Senior Seismic Hazard Analysis Committee	SSHAC
soil-structure-interaction	SSI
spent fuel pool	SFP
spent nuclear fuel	SNF
standard penetration test	SPT
square root of the sum of squares	SRSS
structures, systems, and components	SSCs
surveillance requirement	SR
Thermoluminescent Dosimeter	TLD
U.S. Nuclear Regulatory Commission	NRC

EXECUTIVE SUMMARY

On December 15, 2003, 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 independent spent fuel storage installation (ISFSI) on the site of the Humboldt Bay Power Plant (HBPP). The application consists of the following documents:

(1) A **License Application** - the applicant describes itself and provides (i) general and financial information, as required by 10 CFR §72.22; (ii) an Emergency Plan as required by 10 CFR §72.32; (iii) Proposed Technical Specifications, as required by 10 CFR §72.26; (iv) a Training Program, as required by 10 CFR §72.192; (v) a Quality Assurance Program, as required by 10 CFR §72.24; and (vi) a Preliminary Decommissioning Plan, as required by 10 CFR §72.30.

(2) A **Safety Analysis Report (SAR)** - the applicant describes its plans for designing, constructing, operating, maintaining, and decommissioning the proposed ISFSI, as required by 10 CFR §72.24.

(3) An **Environmental Report** - the applicant provides the information the staff uses in performing its environmental assessment of the proposed ISFSI, as required by 10 CFR §72.34. This review is accomplished in parallel with the staff's safety evaluation and is documented in a separate environmental assessment by the NRC staff.

(4) A **Physical Security Plan** - the applicant describes its plans for ensuring that the ISFSI and nuclear material are appropriately protected. This is a separate safeguards document not releasable to the public. It includes the Security Training and Qualification Plan and Safeguards Contingency Plan, as required by 10 CFR §72.180 and §72.184. This review is accomplished in parallel with the staff's safety evaluation and is documented in a separate security evaluation by the NRC staff.

The staff has documented its review and conclusions on the safety-related aspects of the license application in this Safety Evaluation Report (SER). The technical review was carried out according to the applicable NRC regulations in 10 CFR Part 20 and Part 72. Review of the SAR was conducted following guidance in NUREG-1567 (U.S. Nuclear Regulatory Commission, 2000) and other applicable regulatory guides and interim staff guidance. This SER documents the NRC staff's review of the design, operation, and other safety aspects of the proposed Humboldt Bay ISFSI, as described in the above submittals, except for the Environmental Report and Physical Security Plan. The Environmental Report is the subject of a separate Environmental Assessment, and the Physical Security Plan is the subject of a separate security evaluation, to be issued by the NRC staff. This executive summary provides a brief overview and summary of this SER.

Amendment 1 of the SAR (Pacific Gas and Electric Company, 2004a) was submitted in October 2004 and incorporated the applicant's responses to the staff's request for additional information (Pacific Gas and Electric, 2004b). Supplemental information related to the staff's request for additional information is documented in subsequent letters from the applicant (Pacific Gas and Electric, 2005). As documented in this SER, the staff's review of the SAR is primarily based on the amended information provided in the SAR and on the cited supplemental information.

The HBPP consists of five generating units. Unit 3, the only nuclear unit, is a boiling water reactor (BWR) that was operated for approximately 13 years before being shut down in July 1976. The reactor has remained inactive since that time. In 1983, PG&E concluded that the seismic and other plant modifications required, in part, as a result of the Three Mile Island accident in 1979, were not economical and opted to decommission the plant. The remaining spent nuclear fuel (SNF) from reactor operation is currently stored in the spent fuel pool (SFP) in Unit 3. The other electrical generating units are conventional units capable of operating on fuel oil or natural gas (Units 1 and 2) and gas turbines (Units 4 and 5).

The proposed Humboldt Bay ISFSI will store SNF and associated radioactive material from Unit 3. Spent fuel assemblies will be relocated from wet storage in the Unit 3 SFP to dry storage containers at the proposed ISFSI. The Humboldt Bay ISFSI will facilitate dismantling the existing Unit 3 structures and provide for earlier termination of the 10 CFR Part 50 license for Unit 3. A 10 CFR Part 50 license amendment request to permit cask handling activities in the HBPP refueling building (RFB) has been submitted to NRC. The SNF that will be stored in the proposed ISFSI will need to remain there until a U.S. Department of Energy or other facility is available for further interim storage or permanent disposal.

The Humboldt Bay ISFSI consists of a below-grade storage vault, onsite cask transporter, and dry cask storage system. The applicant will use a modified version of the Holtec International HI-STAR 100 dry cask storage system for the HBPP SNF, referred to as the HI-STAR HB dry cask storage system. The HI-STAR HB system incorporates a cask design that is suitable for both storage and transportation; however, the scope of this licensing action is limited to onsite SNF storage under 10 CFR Part 72. The HI-STAR HB cask provides structural protection and radiation shielding for the multi-purpose canister (MPC-HB) containing the SNF. The onsite handling of the HI-STAR HB cask will be accomplished using a tracked transporter. The transporter developed for the Diablo Canyon ISFSI will be used for the Humboldt Bay ISFSI.

Description of Humboldt Bay Independent Spent Fuel Storage Installation Site

According to the license application, the Humboldt Bay ISFSI will be co-located with the HBPP on PG&E-owned property, which is located on the northern California coast approximately 5 km [3 mi] south of Eureka, California. The applicant owns approximately 0.57 km^2 [143 acres] of land on the shore of Humboldt Bay opposite the bay entrance, with water areas extending approximately 150 m [500 ft] into Humboldt Bay from the land area. The owner-controlled area is not traversed by public highways or railroads. A public trail to access a breakwater for fishing traverses the owner-controlled area. However, 10 CFR §72.106(c) allows the controlled area to be traversed as long as appropriate and effective arrangements are made to control traffic and protect public health and safety. The public trail crossing the PG&E property to the north of the ISFSI will be controlled by fences and gates. The gates will be open to allow access to the

public trail during normal ISFSI storage operation. During cask transfer and handling operations, the gates will be locked to prevent public access within the controlled area until the cask transfer activities and any corrective actions are completed. If an accident should occur within the controlled area during normal ISFSI storage operation, the applicant will assess radiological conditions. If radiation levels exceed the allowable levels for public health and safety, the gates will be closed and locked to prevent public access within the controlled area until radiological conditions return to allowable levels. The applicant has full authority to control all activities within the ISFSI site and owner-controlled area.

Description of the Humboldt Bay Independent Spent Fuel Storage Installation Storage System

The Humboldt Bay ISFSI consists of a below-grade storage vault, onsite cask transporter, and dry cask storage system. The ISFSI is designed to store up to 400 SNF assemblies from HBPP Unit 3 in five casks, with a sixth cask to store Greater than Class C (GTCC) waste.

The dry cask storage system selected by the applicant is the Holtec International HI-STAR HB system. This is a variation of the HI-STAR 100 system, which has been certified by NRC (U.S. Nuclear Regulatory Commission, 2001a,b) for use by 10 CFR Part 50 licensees under the general license provisions of 10 CFR §72.210. The HI-STAR HB system is comprised of the MPC-HB, which is a seal-welded canister containing 80 SNF assemblies; damaged fuel containers (DFC), which can be inserted into an MPC-HB and can hold an intact fuel assembly or damaged fuel; and the HI-STAR HB storage overpack (or cask). The design and operation of these components are described in detail in the HI-STAR 100 System Final Safety Analysis Report (Holtec International, 2002). Holtec developed the modified (shorter) HI-STAR HB cask system for use at Humboldt Bay because of the smaller HBPP fuel assembly dimensions (length and width). It should be noted that the issuance of a 10 CFR Part 72 site-specific license to PG&E only authorizes the applicant to use the HI-STAR HB storage system at the Humboldt Bay ISFSI; this licensing action is not a revision or amendment to the existing NRC approval for the HI-STAR 100 system.

The MPC-HB provides the confinement boundary for the SNF and associated nonfuel hardware. An integrally welded pressure vessel holds up to 80 HBPP SNF assemblies. The MPC-HBs are welded cylindrical structures consisting of a honeycomb fuel basket, a baseplate, a canister shell, a lid, and a closure ring. The honeycomb fuel basket uses geometric spacing and fixed neutron absorbers for criticality control. The MPC-HB is made entirely of stainless steel, except for the neutron absorbers and aluminum seal washers in the vent and drain ports. The HI-STAR HB storage cask provides an internal, cylindrical cavity of sufficient size to house the MPC-HB during loading, unloading, transfer and storage activities. The storage cask is a rugged, heavy-walled cylindrical container constructed of carbon steel. The overpack provides gamma and neutron shielding and protects the MPC-HB from missiles and natural phenomena during onsite transfer and storage.

The cask storage vault is comprised of six below-grade, cylindrical storage cells that are structural units constructed of steel-reinforced concrete with a carbon steel liner. The vault provides additional shielding and defense-in-depth of the casks from missiles and natural phenomena. The vault is sized to hold five HI-STAR HB casks with SNF and one GTCC certified cask. The storage vault is located at about 183 m [600 ft] from the RFB inside a

security area that has applicable barriers, access, and surveillance controls that meet 10 CFR §73.51 requirements.

A transporter is used to move the HI-STAR HB cask from outside the RFB to the ISFSI. The transporter developed for the Diablo Canyon ISFSI will be used for the Humboldt Bay ISFSI. The transporter is a U-shaped tracked vehicle consisting of the vehicle main frame, hydraulic lifting towers, an overhead beam system that connects between the lifting towers, a cask restraint system, the drive and control systems, and a series of cask lifting attachments. The transporter design permits the HI-STAR HB cask to be handled vertically. The transporter also is used to lower the HI-STAR HB cask into the storage vault.

Safety of the Humboldt Bay Independent Spent Fuel Storage Installation

The staff has determined that the proposed Humboldt Bay ISFSI and the HI-STAR HB cask design are structurally sound and that the SNF will remain safe within the canister during all phases of operation for normal, off-normal, and accident conditions. The analyses included all plausible natural and human-made phenomena, many of which had already been accepted by the staff in its review of the HI-STAR 100 dry cask storage system (U.S. Nuclear Regulatory Commission, 2001a) and in previous staff reviews of HBPP licensing actions. After reviewing the applicant's analyses, the staff concluded that the Humboldt Bay ISFSI and the HI-STAR HB system design are structurally safe and will meet all applicable regulatory requirements.

The staff has also determined that the applicant has shown that the SNF within the storage casks will remain subcritical (i.e., unable to sustain a nuclear chain reaction) during all phases of operation for both normal conditions and credible accident conditions. The applicant has provided radiation dose estimates for the surrounding public and the workers at the ISFSI. The MPC-HB will be welded closed to prevent leakage of radioactive material. Additional shielding is provided by the overpack and the below-grade reinforced concrete vault.

The amount of radiation to which a person is exposed is called a dose. The applicant has estimated that members of the public nearest to the proposed ISFSI would receive doses below 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]. Radiation dose rates will be calculated 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 NRC to prevent any undue risk and to ensure the safety of all members of the public and workers at a nuclear facility. The applicant has described its radiation protection program, which employs an as low as is reasonably achievable (ALARA) radiation protection principle. Radiation doses received by the workers and dose rates within the vicinity of the storage pad will be monitored to verify that radiation dose limits are not exceeded. The staff reviewed the analyses provided by the applicant and concluded that the Humboldt Bay ISFSI and HI-STAR HB system designs are radiologically safe and will meet regulatory requirements.

As required by 10 CFR Part 72, the applicant demonstrated that all components of its proposed ISFSI that are important to safety would continue to perform their design functions during normal, and off-normal conditions and during any credible accidents that could be postulated to occur. Based on its review and evaluation of the information provided, the staff concluded that

the applicant has provided acceptable analyses of the design and performance of these structures, systems, and components important to safety under normal, off-normal, and accident conditions.

The staff further concluded that the applicant's analyses related to 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.

The HI-STAR HB system was evaluated against the parameters and conditions specific to the site and the SNF to be stored. Based on its review, the staff finds that the use of the HI-STAR HB system as proposed for the Humboldt Bay 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, the applicant identified anticipated sources of funds for the ISFSI project. The staff concludes in Chapter 13 of this SER that the applicant has provided reasonable assurance of its financial qualifications for construction, operation, and decommissioning of the proposed ISFSI.

The staff also found the revisions to the HBPP Physical Security Plan to incorporate the ISFSI to be acceptable. The staff's security evaluation of the revised plan was transmitted as a separate safeguards document that is not available to the public.

REFERENCES

Holtec International. *Final Safety Analysis Report for the Holtec International Storage, Transport, and Repository Cask System* (*HI-STAR 100 System*). Rev. 1. HI-2012610. Docket No. 72-1008. Marlton, NJ: Holtec International. 2002.

Pacific Gas and Electric Company. *Humboldt Bay ISFSI Safety Analysis Report*. Amendment 1. Docket No. 72-27. Avila Beach, CA: Pacific Gas and Electric Company. 2004a.

Pacific Gas and Electric Company. *Response to NRC Request for Additional Information for the Humboldt Bay Independent Spent Fuel Storage Installation Application* (*TAC No. L23683*). Letter (October 1). HIL-04-007. Avila Beach, CA: Pacific Gas and Electric Company. 2004b.

Pacific Gas and Electric Company. *Response to NRC Request for Additional Information for the Humboldt Bay Independent Spent Fuel Storage Installation Application.* Letter (April 8). HIL-05-003. April 5, 2005. Avila Beach, CA: Pacific Gas and Electric Company. 2005.

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

U.S. Nuclear Regulatory Commission. *Holtec International HI-STAR 100 Cask System Safety Evaluation Report*. Amendment 2. Docket No. 72-1008. Washington, DC: U.S. Nuclear Regulatory Commission. 2001a.

U.S. Nuclear Regulatory Commission. *10 CFR Part 72 Certificate of Compliance No.1008, Amendment 2, for the HI-STAR 100 System Dry Cask Storage System*. Docket No. 72-1008. Washington, DC: U.S. Nuclear Regulatory Commission. 2001b.