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December 4, 2003

PG&E Letter DIL-03-015

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 72-26
Diablo Canyon Independent Spent Fuel Storage Installation
Response to NRC Request for Additional Information Regarding Cask Transporter Lateral Restraints for the Diablo Canyon ISFSI (TAC No. L23399)

Dear Commissioners and Staff:

By Pacific Gas and Electric Company (PG&E) Letter DIL-01-002, dated December 21, 2001, PG&E submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for a 10 CFR 72 site-specific license to build and operate an independent spent fuel storage installation (ISFSI) at the Diablo Canyon Power Plant site. The application included a Safety Analysis Report (SAR), Environmental Report, and other required documents in accordance with 10 CFR 72.

By letter dated August 29, 2002, the NRC staff requested additional information needed to complete their review of the Diablo Canyon ISFSI License Application. PG&E submitted its response to the NRC staff by PG&E Letter DIL-02-009, dated October 15, 2002. PG&E submitted an additional response regarding cask transporter lateral restraint to the NRC staff by PG&E Letter DIL-02-011, dated October 3, 2003.

This response provides additional information to facilitate completion of your review of our application.

Enclosure 1 contains a mark-up draft of the Amendment 2 Diablo Canyon ISFSI SAR sections to depict integration of the cask transporter lateral restraint system description into the applicable sections. In addition, corrections were made to references to correlate the loading applied to the cask transfer facility (CTF) main shell and the cask transporter restraints to source documents Holtec International Document HI-2012626 and PG&E Calculation M-1058, respectively. The mark-up draft changes will be incorporated into the Diablo Canyon ISFSI Final Safety Analysis Report upon receipt of the ISFSI license.

NMSS01

Enclosure 2 provides a study of the cask transporter lateral restraint system that demonstrates the feasibility of reducing the large upper bound restraint load through frictional resistance of the cask transporter to CTF surface interface, and by transmitting the restraint loads to more than one anchor point using connecting links capable of tension and compression. The resulting reduced loads are shown to be accommodated by strut-type components common to the process and power production industry.

As reflected in the additional information provided, PG&E will implement a cask transporter lateral restraint system consisting of steel struts or similar equipment suitably sized to restrain the transporter at the CTF during MPC transfer operations.

If you have any questions regarding this letter, please contact Mr. Terence Grebel at (805) 545-4160.

Sincerely,

Lawrence F. Womack
Vice President – Nuclear Services

rlj/4160
Enclosures

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY Diablo Canyon Independent Spent Fuel Storage Installation	Docket No. 72-26

AFFIDAVIT

Lawrence F. Womack, of lawful age, first being duly sworn upon oath says that he is Vice President – Nuclear Services of Pacific Gas and Electric Company, that he is familiar with the content thereof; that he has executed this response to an NRC request for additional information regarding cask transporter lateral restraints for the Diablo Canyon Independent Spent Fuel Storage Installation license application on behalf of said company with full power and authority to do so; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

Lawrence F. Womack
Vice President – Nuclear Services

Subscribed and sworn to before me this 4th day of December 2003.

Notary Public
State of California
County of San Luis Obispo

CHUCK MACKEY
Commission # 1397547
Notary Public - California
San Luis Obispo County
My Comm. Expires Feb 1, 2007

Mark-up Draft
Diablo Canyon ISFSI SAR Amendment 2
Affected Pages

SAR CHANGE SUMMARY
CASK TRANSPORTER LATERAL RESTRAINTS

Change Description	Reason for Change
Section 3.3.3.2.10: Added to provide criteria for cask transporter restraint structural connection.	Clarification. October 27, 2003 NRC request for additional detail in DC ISFSI SAR to consolidate cask transporter lateral restraint system design criteria and description.
Section 3.3.5: Added Reference 15 to refer to Holtec Document HI-2012626.	Omission. Reference was missing from the Chapter. This calculation derives the loading that the cask system creates while situated in the CTF structure.
Section 3.3.4.2.6: Corrected incorrect reference to new Reference 15.	Reference 15 is the proper source document for loads to be resisted near the surface of the CTF by the top shell seismic restraint.
Section 3.3.5: Added Reference 16 for additional lateral restraint system clarification.	Reference presents feasibility of reducing upper bound lateral restraint loads of Reference 14.
Section 3.3.4.2.8: Added to provide criteria for cask transporter restraint structural connection to ground.	Clarification. October 27, 2003 NRC request for additional detail in DC ISFSI SAR to consolidate cask transporter lateral restraint system design criteria and description.
Section 3.3.4.2.7: Changed blocks to anchors and clarified descriptions of References 8 and 9.	Clarification. Blocks implies an above-ground scheme. Anchors more accurately conveys an in-ground, embedded configuration.
Section 4.2.1.2: Corrected incorrect reference from 21 to 25.	Reference 25 is the proper source document for loads to be resisted near the surface of the CTF by the top shell seismic restraint.
Section 4.2.1.2: Separated tie-down description and added reference to Reference 21.	Clarification. October 27, 2003 NRC request for additional detail in DC ISFSI SAR to consolidate cask transporter lateral restraint system design criteria and description.
Section 4.2.6: Corrected to Holtec Document Number.	Proper reference is Holtec Document HI-2012626.
Section 4.3.2.1.2: Added closing paragraph to describe the ability of the cask transporter structure to accommodate the external restraint loading.	Clarification: Adds descriptive content about cask transporter attributes capable of enduring forces from the lateral restraint system.
Section 4.3.5: Added Reference 7.	Reference presents feasibility of reducing upper bound lateral restraint loads.
Section 5.1.4: Removed Reference 6.	Text previously referring to Reference 6 was changed in Amendment 2 and this reference was not removed.

SAR CHANGE SUMMARY CASK TRANSPORTER LATERAL RESTRAINTS	
Change Description	**Reason for Change**
Section 8.2.1.2.2.1: Corrected incorrect reference from 47 to 32.	Reference 32 is the proper source document for loads to be resisted near the surface of the CTF by the top shell seismic restraint.
Section 8.2.1.2.2.1: Added paragraph describing cask transporter restraint system.	Clarification. October 27, 2003 NRC request for additional detail in DC ISFSI SAR to consolidate cask transporter lateral restraint system design criteria and description.
Section 8.2.18: Corrected to Holtec Document Number.	Proper reference is Holtec Document HI-2012626.
Section 8.2.18: Added Reference 52.	Reference presents feasibility of reducing upper bound lateral restraint loads.

3.3.3.2.10 Lateral Restraint Design Criteria

The cask transporter structure is designed to accommodate external loading from a lateral restraint system at the CTF to preclude seismic interaction with the cask system during MPC transfer operations in the cask transfer facility. The structural components of the transporter resisting the restraint loads are designed to the applicable limits of ASME Section III, Subsection NF including Appendix F (Reference 7).

3.3.4 CASK TRANSFER FACILITY

3.3.4.1 General

The ISFSI CTF is used in conjunction with the cask transporter to accommodate MPC transfers between the transfer cask and the overpack. The CTF is designed to position an overpack sufficiently below grade where the transfer cask can be mated to the overpack using the cask transporter. The CTF lifting platform acts as an elevator to raise and lower the overpack. In the full-up position, the overpack base is approximately 40 inches below grade. The surface of the CTF contains an approach pad that supports the loaded transporter and provides a laydown area for the transfer cask, cask transport frame, mating device, seismic restraint, and other load handling equipment.

3.3.4.2 Design Criteria

The rated load of the CTF lifting system is the bounding weight of a loaded overpack (360,000 lb). The design criteria for the specific subcomponents are discussed below. The CTF is designed to withstand a design-basis seismic event without an uncontrolled lowering of the lifted load. The design life of the CTF is 40 years. Design criteria for the CTF are summarized in Table 3.4-5 and presented in Reference 13.

3.3.4.2.1 Main Shell Design Criteria

A cylindrical steel shell forms the opening in the ground into which the overpack is lowered, provides the support for the lifting jacks, and provides a setdown location for the lifting platform when it is fully lowered. The main shell forms a cylindrical opening of approximately 150 inches in diameter and approximately 200 inches deep. Three extensions run the length of the cylinder and form the locations for the jacks. The shell is also equipped with a sump for collecting and disposing of incidental water from the CTF. The surrounding area is reinforced concrete. The resulting structure is a flat-surfaced pad with a steel-lined hole. The main shell is designed in accordance with applicable portions of ASME Section III, Subsection NF.

3.3.4.2.2 Lifting Jacks

Three lifting jacks provide the lifting force for the lifting platform. The jacks are located on the circumference of the main shell in the extensions. The jacks are supported at the top end and suspend the lifting platform by bearing on a traveling nut on each jack screw. All jacks operate in unison to keep the platform level through the entire travel range (approximately 160 inches). The jacks are interconnected with an electronic position monitoring and control system. The maximum lift speed of the jacks is 12 inches/minute and will not unwind on loss of the driver.

3.3.4.2.3 Drive and Control System

A drive and control system provides the power and control for the lifting jacks. Electrical power is supplied to each jack drive motor. The speed is reduced via one or more gearboxes. The relative position of each jack is monitoring by the drive and control system to stop all jacking if a mismatch is detected. Position switches limit the travel beyond established points. The control system is designed in accordance with applicable guidelines of NUREG-0612, Section 5.1.6 (2). The lifting jack design ensures the load will stop in position on a loss of electrical power to the drive and control system.

3.3.4.2.4 Lifting Platform

A lifting platform provides the support of the overpack and transmits the lifting jack force to the cask. Multiple beams or a single torsion box-type beam forms the lifting platform. The platform provides a level base on which the overpack rests. To interface with the lifting jacks, the platform has extensions that enter into each main shell extension. Uniform loading of the lifting platform is afforded by the location and controlled movement of the jacks. Radial stability of the lifting platform is provided by the main shell.

Wheeled or low-friction pad-type vertical guides or runners are provided to prevent damage to the main shell and lifting platform at the interface locations. The guides (or runners) are capable of restraining the lift platform under the maximum horizontal loading due to a design basis seismic event.

3.3.4.2.5 HI-STORM Mating Device

A mating device provides structural support and shielding at the interface between the top of the open overpack and the bottom of the transfer cask during MPC transfer operations. The mating device also facilitates the removal of the pool lid from the transfer cask prior to MPC transfer operations.

3.3.4.2.6 Top Shell Seismic Restraint

A removable top shell seismic restraint provides lateral structural support in the gap between the overpack and the CTF main shell (Reference 15).

3.3.4.2.7 Reinforced Concrete Support Structure

The reinforced concrete surrounding the shell is capable of supporting a loaded transporter and handling any seismic loads applied through the shell. The reinforced concrete base pad supports the CTF shell and a steel pedestal base that supports the lifting platform when it is in the full-down position. The approach pad is designed for the weight of the transporter with a loaded overpack. Independent, tie-down anchors at the surface level of the CTF will be provided to hold the transporter in place during the MPC transfer operation. The reinforced concrete structure is designed in accordance with ACI 349-97 (Reference 8), including draft Appendix B, as clarified by NRC draft Regulatory Guide DG-1098 (Reference 9).

3.3.4.2.7.1 Design Load Combinations

Factored load combinations for the CTF concrete structure design are provided in the ACI 349-97 and supplemented by the factored load combinations from NUREG-1536 (Reference 5), Table 3.1, and NRC draft Regulatory Guide DG-1098 (Reference 9), as applicable.

3.3.4.2.8 Cask Transporter Lateral Restraints

The cask transporter lateral restraint system is designed to apply external restraint loading to the cask transporter structure. As discussed in References 16 and 14, the restraints will be steel struts or similar equipment suitably sized to restrain the transporter by transferring the restraint loading to the ground adjacent to the CTF foundation. The restraints are designed to meet the stress limits of ASME Section III, Subsection NF including Appendix F (Reference 7). The surface-level, in-ground portion of the restraints are designed in accordance with ACI 349-97 (Reference 8), including draft Appendix B, as clarified by NRC draft Regulatory Guide DG-1098 (Reference 9).

3.3.5 REFERENCES

15. Holtec International Document No. HI-2012626, "Structural Evaluation of Diablo Canyon Cask Transfer Facility."

16. PG&E Letter DIL-03-015} to the NRC, Additional Information on Cask Transfer Facility Cask Transporter Lateral Restraint System, December 4, 2003.

4.2.1.2 CTF Support Structure

The CTF concrete support structure is a cylindrical, steel-lined structure, embedded in the rock, underground; made-up of steel-reinforced slabs and walls (Figure 4.2-4). This concrete structure houses the CTF steel shell structure consisting of a lift platform and associated mechanical equipment. The facility is designed with a sump for incidental water collection. An associated standpipe will accommodate a temporary, drop-in sump pump for water removal. When not in use, the facility will be enclosed with a cover for personnel safety and protection of the structure from the environment.

The cask transporter lateral restraint system is designed to apply external restraint loading to the cask transporter structure. As discussed in References 21 and 29 the restraints will be steel struts or similar equipment suitably sized to restrain the transporter by transferring the restraint loading to the ground adjacent to the CTF support structure. The transporter tie down locations immediately adjacent to the CTF support structure are shown on Figure 4.2-4. The tie-downs will be supported by rock anchor installations into the ground. Holtec Drawing 3770, showing the CTF shell structure, is provided in Figure 4.4-3.

The CTF structure is fully and permanently embedded in the ground. The top of the structure is at grade and the bottom of the concrete base slab is approximately 20 ft below the surface of the adjacent competent rock (see Figure 4.2-4). Once the base slab is poured, the main shell steel structure is placed, plumbed and anchored to the base slab. Concrete is placed between the exterior surface of the main shell and the surrounding competent rock. Following concrete placement, the main shell remains embedded in the concrete.

The concrete portion of the facility is designed to transfer all loads to the rock in direct bearing of the concrete on the rock. The analysis demonstrates that all stresses in the concrete and the rock remain less than the allowable limits under all design conditions. Therefore, it is not necessary to anchor the concrete structure to the rock.

The design of the CTF is described in References 24 and 25. This calculation demonstrates that the concrete structure is capable of resisting all applied loads and adequately transferring these loads to the surrounding rock. This includes all applicable loads from the transporter, the CTF structure and the fully loaded cask. This calculation considers all operating loads in addition to other applicable loads including seismic. A removable seismic restraint provides lateral support in the gap between the overpack and the CTF main shell (Reference 25).

4.2.6 REFERENCES

29. PG&E Letter DIL-03-015 to the NRC, Additional Information on Cask Transfer Facility Cask Transporter Lateral Restraint System, December 4, 2003.

4.3.2.1.2 Design

The cask transporter is custom-designed for conditions at the Diablo Canyon ISFSI site, including the transport route with its maximum grade of approximately 8.5 percent. It will remain stable and will not overturn, experience structural failure, or leave the transport route should a design-basis seismic event occur while the loaded transfer cask is being moved to the CTF; while transferring an MPC at the CTF; or while moving a loaded overpack from the CTF to the storage pad. In addition, the cask transporter is designed to withstand DCPP design-basis tornado winds and tornado-generated missiles without overturning, dropping the load, or leaving the transport route. Other natural phenomena, such as lightning strikes, floods and fires have been evaluated and accounted for in the cask transporter design. All design criteria for natural phenomena used to design the cask transporter are specific to the Diablo Canyon ISFSI site (see Sections 3.2 and 3.4 for detailed information).

A lightning strike on the cask transporter would not structurally affect the transporter's ability to hold the load. Due to the massive amount of steel in the structure, the current would be transmitted to the ground without significantly damaging the transporter. However, the driver may be affected by a lightning strike. Therefore, the transporter design includes fail-safe features to automatically shutdown the vehicle if the operator is injured or incapacitated for any reason.

Flooding is not a concern on the transport route for reasons discussed in Section 3.2.2. Sources of fires and explosions have been identified in Sections 2.2 and 3.3.1.6 and in Table 3.4-1, and have been evaluated with respect to cask integrity in Sections 8.2.5 and 8.2.6. Fixed sources of fire and explosion are sufficiently far from the transport route to be of no concern. Mobile sources of fire and explosion, such as fuel tanker trucks, will be kept at a safe distance away from the transporter during loaded cask movement through the use of administrative controls.

The cask transporter is capable of forward and reverse movement as well as turning and stopping. It includes an on-board engine that is capable of supplying enough power to perform its design functions. The cask transporter includes fail-safe service brakes (that is, setting brakes that automatically engage in any loss of power) and an independent parking brake. The brake system is capable of stopping and holding a fully loaded cask transporter on the maximum design grade. The cask transporter is also equipped with an automatic drive brake system that applies the brakes if there is a loss of hydraulic pressure or the drive controls are released. Additionally, the fully loaded cask transporter is not capable of coasting on a 10 percent downward grade with the brakes disengaged, due to the resistance in the drive system.

The cask transporter is equipped with a control panel that is suitably positioned on the transporter frame to allow the operator easy access to the controls located on the control panel and, at the same time, allow an unobstructed view of the cask handling operations. The control panel provides for all-weather operation or will be enclosed in the cab. The control panel includes controls for all cask transporter operations including speed control, steering, braking, load raising and lowering, cask restraining, engine control and "dead-man" and emergency stop switches. Additional emergency stop switches are located at ground level both in the front and rear of the transporter.

Figures 4.3-1 through 4.3-3 show the cask transporter (and associated components) performing its required functions. The cask transporter works with certain other ancillary components to facilitate the lifting and movement of the transfer cask and the overpack. Each ancillary component is described in Sections 4.3.2.2 through 4.3.2.8. Lifting of the loaded transfer cask and cask transport frame is accomplished using the transfer cask horizontal lift rig and the transfer cask lift slings. Transfer cask vertical handling, using the cask transporter, is performed using the transfer cask lift links. Likewise, overpack handling is performed only with the overpack in the vertical orientation using the HI-STORM lifting brackets.

The cask transporter and associated lifting components are classified important to safety, purchased commercial grade, and qualified for MPC and overpack transfer operations at the CTF by testing prior to service. These lifting components are defined as those components in the load path of the supported load. Special lifting devices, defined as any suspended load-bearing component below the integral load links, are designed in accordance with ANSI N14.6 (Reference 2) per the applicable guidance of NUREG-0612 (Reference 3). Table 4.3-1 provides a summary of the design code(s) applicable to each of the lifting and handling components.

On top of the main structure of the transporter is a lifting beam supported by two lifting towers that use hydraulic cylinders to provide the lifting force. Mechanical design features and administrative controls provide a defense-in-depth approach to preventing load drops during lifting and handling. The primary load-retaining devices of the cask transporter are the hydraulic cylinders. In combination, the hydraulic system is designed to carry twice the rated load, including a 15 percent hoist load factor, or 2.3 times the rated load (828,000 lb).

Once the cask is raised to its travel height by the cylinders, a redundant load support system is used. This may take the form of either locking pins and/or wedge brakes. Wedge brakes, by their shape, limit tower movement to the lift (up) direction only. Any failure of the lifting hydraulics will not result in an uncontrolled lowering of the load. Locking pins are inserted into each gantry leg to independently support the load when no vertical movement is needed. The wedge brakes are operable at all times when a load is being lifted or lowered. To remove the pins or wedge locks, the cylinder must first be extended slightly to take the load off the pin or wedge. The load may then be lowered using the lifting cylinders. Requiring the cylinders to take the load ensures that they are operational before lowering the load. Any failure of the hydraulic system at this time will be mitigated by the cylinder safety systems as described below.

The cask transporter hydraulic system wedge brake design prevents uncontrolled lowering of the load upon a loss of hydraulic fluid. A minimum amount of hydraulic fluid system pressure is required to disengage the wedge brakes to allow movement of the load. A loss of hydraulic fluid would drop the pressure in the system and engage the wedge brakes, preventing further movement of the load until corrective actions can be implemented.

The cask transporter is used to lift and place the loaded transfer cask atop the overpack for MPC transfer. During the MPC transfer process, the transfer cask trunnion connections to the cask transporter (that is, lift links) must be disconnected to provide access for the MPC downloader. Prior to disconnecting the lift links, the transporter is restrained. The restraint limits movement of the cask transporter during the time the cask transporter is disengaged from the transfer cask trunnions. Section 5.1 of this SAR provides additional detail on storage system operations.

The design of the cask transporter includes a lateral cask restraining system to secure the load during transport operations. The restraint system is designed to prevent lateral and transverse swinging of the load.

The cask transporter structure is designed to accommodate external loading from a lateral restraint system at the CTF to preclude seismic interaction with the cask system during MPC transfer operations in the cask transfer facility. As discussed in Reference 7, the restraints will be steel struts or similar equipment suitably sized to restrain the transporter by transfering the restraint loading to the ground adjacent to the CTF support structure.

4.3.5 REFERENCES

7. PG&E Letter DIL-03-015 to the NRC, Additional Information on Cask Transfer Facility Cask Transporter Lateral Restraint System, December 4, 2003.

5.1.4 REFERENCES

6. Deleted

8.2.1.2.2 Seismic Analysis of Cask Transfer Facility Seismic Configuration 3

8.2.1.2.2.1 CTF STEEL STRUCTURE

The CTF at the Diablo Canyon ISFSI is used in conjunction with the cask transporter to perform MPC transfers between the HI-TRAC transfer cask and the HI-STORM 100SA overpack. Prior to the transfer operation, the empty HI-STORM 100SA overpack is placed in the CTF. The overpack is lowered to the full down position in the CTF and a mating device is installed on the top of the overpack. This mating device serves as a structural connection and an alignment device between the top of the overpack and the bottom of the HI-TRAC transfer cask. The transfer cask is positioned over the overpack by the cask transporter, which remains in position during the transfer operation. Restraints are used to secure the cask transporter to ground during the MPC transfer operation.

The cask transfer facility is shown in Figure 4.4-3 and includes the following main structural components:

Main Shell – A cylindrical shell is positioned into a larger vertical hole in the rock with concrete backfill providing an interface connection with the rock walls of the hole. The bottom of the shell is anchored to a reinforced concrete base. This cylindrical shell serves as the cavity liner into which the overpack is lowered and provides the support for the lifting jacks and a set down location for the lifting platform when the lifting platform is fully lowered. Three vertical stiffening extensions (U-shaped) run the length of the cylinder shell and act as the main structural members that transfer the loads from the lifting jacks to the shell and down to the base. Restraints are installed at the top of the shell, which serve to restrain the cask under lateral loads from seismic events (Reference 32).

Lifting Jacks – Three lifting jacks are used to raise or lower the lifting platform. They are located in the three vertical stiffening extensions on the circumference of the main shell. The lifting jacks are supported at the top end and have traveling nuts that operate in unison to keep the platform level.

Jack Supports – Jack platform plates and gussets are welded to the top of the shell extensions to provide support for the lifting jacks.

Lifting Platform – A lifting platform of built-up plates provides vertical support of the HI-STORM 100SA overpack and transmits the load to the lifting jacks. During the lifting operation, a uniform loading of the lifting platform is afforded by the location and controlled movement of the lifting jacks. Support plates together with the top and bottom platform plates form the lifting platform structural frame. A cover plate covers the lifting platform plate and provides a base on which the overpack rests. The lifting platform has extensions that reach into each main shell stiffening extension to interface with the lifting jacks. Gussets are welded to the platform outer plates to provide a stiff structural member in the vicinity of the lifting jacks.

Reinforced Concrete Support Structure -The CTF steel structure is placed on a steel reinforced concrete foundation slab and surrounded by heavily reinforced concrete up to the surface. The concrete structure will carry all the compressive loadings on the base and the side-walls (cylindrical in shape) to the ground rock. The structure will have an adjoining gravity fed sump for drainage.

Cask Transporter Lateral Restraint System - The cask transporter lateral restraint system is designed to apply external restraint loading to the cask transporter structure. The structural components of the transporter resisting the restraint loads are designed to the applicable limits of ASME Section III, Subsection NF including Appendix F. As discussed in References 47 and 52, the restraints will be steel struts or similar equipment suitably sized to restrain the transporter by transferring the restraint loading to the ground adjacent to the CTF support structure. The restraints are designed to meet the stress limits of ASME Section III, Subsection NF including Appendix F. The surface-level, in-ground portion of the restraints are designed in accordance with ACI 349-97 (Reference 10), including draft Appendix B, as clarified by NRC draft Regulatory Guide DG-1098 (Reference 11). The transporter tie down locations immediately adjacent to the CTF support structure are shown on Figure 4.2-4. The tie-downs will be supported by rock anchor installations into the ground. Holtec Drawing 3770, showing the CTF shell structure, is provided in Figure 4.4-3.

8.2.18 REFERENCES

32. Holtec International Document No. HI-2012626, "Structural Evaluation of Diablo Canyon Cask Transfer Facility."

52. PG&E Letter DIL-03-015 to the NRC, Additional Information on Cask Transfer Facility Cask Transporter Lateral Restraint System, December 4, 2003.

Cask Transporter Lateral Restraint Load Reduction Study

BACKGROUND

Reference 2 documents that for unrestrained conditions, the transporter carrying a cask is susceptible to slide up to 8.9 inches along transverse or longitudinal directions. 'This sliding is to be avoided by introduction of the restraint system, when the transporter is stationary on top of the CTF. Calculation M-1058 (Reference 1) calculates the max. seismic load in cable restraints, as 241 Kips. These cables are at an angle of 34.32 degrees from horizontal, and are spaced out along 45 degree quadrants being 87 inches along horizontal X and Y from the attachment points. The height of the attachment point is 84 inches above ground.

DISCUSSION

The seismic load can be resisted completely by the seismic restraints or by a combination of friction at the transporter base and the seismic restraints. Actual load in the lateral restraints is a function of axial stiffness of the lateral restraint, the frequency of the combined transporter being supported by the restraints, as well as considerations of how much load is resisted by friction at the base of the transporter. A non-linear analysis of the transporter (when designed) including seismic restraints would accurately predict these forces, correctly allowing for all of the above variables. This analysis will be performed at final design stage. Below is discussion regarding design feasibility for this solution.

DESIGN FEASIBILITY

Calculation M-1058 has calculated these loads conservatively ignoring the following:

1. Some of the lateral seismic load is taken by friction

2. Peak seismic loads in 3 orthogonal directions do not occur simultaneously

Assuming that the transporter being supported by the restraint system has a fundamental frequency in the rigid range, the applicable accelerations are site PGA values consistent with the assumption made in Reference 1. Actual frequencies are dependent on the final selection of the restraint system and will be properly accounted for in detailed design.

Ignoring friction resistance for now, and referring to Figure 1 attached, the upper bound force (F_{UB}) in 2 restraints marked as "A" and "B" as a result of X component of earthquake is:

$$2F_{UB} \text{ Cos } 45° \text{ Cos } 34.32° = 170 \times 0.83g$$

Where 170 Kips is the weight of empty transporter and 0.83g is the site horizontal PGA for design basis seismic event, thus:

F_{UB} = 121 Kips

The stability analysis of transporter (Reference 2) used a range of 0.4 to 0.8 for coefficient of friction (COF). Using the lower end of this COF range to maximize sliding, and 40 percent of max. vertical EQ at 0.7g, the friction resistance is:

$F_{friction}$ = 0.4 x 170 (1g-0.4x0.7g) = 49 Kips

Therefore lower bound force in the cables (F_{LB}) is given as:

$2F_{LB}$ Cos 45° Cos 34.32° = 170 x 0.83g – 49, Thus:

F_{LB} = 79 Kips

Therefore the range of force developed in each cable as a result of X earthquake alone is F, where

79 < F < 121 Kips

The same force is developed for the Y earthquake in restraints "A" and "C" (see attached Figure 1), however the two peaks do not occur simultaneously, thus using the 100 percent–40 percent–40 percent combination rule, the peak force in any one restraint as a result of both X and Y components of earthquakes are as follows:

F_{UB} = 1.4 x 121 = 169 Kips
F_{LB} = 1.4 x 79 = 110 Kips

Thus the range of actual load in each seismic restraint is:

110 < F < 169 Kips (vs. 241 Kips calculated in Reference 1).
The vertical component of earthquake will not impose any load on the seismic restraints since the PGA of vertical component is 0.7g, which is less than 1g dead load. Also, Reference 2 demonstrated that for unrestrained conditions, there is hardly any rocking of transporter. Thus, there will be no additional loads imposed on the seismic restraints associated with rocking of the transporter.

The above force range is calculated assuming tension-only cables are used. If struts are used which can take the load in compression as well as tension, the values of the peak seismic load in each strut would be one-half of the value calculated above, since all 4 struts will be engaged. Therefore, if struts are used, each strut will be subject to the following load:

$55 < F < 85$ Kips

The length of each strut is:

$L = [84^2 + 87^2 + 87^2]^{0.5} = 149$ inches from ground to transporter attachment point

This maximum load and the Center-to-Center (C-C) distance can be accommodated by a strut. For example, using NPS struts, size 36 (Reference 3) is rated for a level D axial load (tension/compression) of 181 Kips at 160 inches C-C dimension (See Figure 2 attached).

Check frequency of system with strut size 36:

$A = 10.7\ in^2$ for 6 inches schedule 120 pipe for this strut size
$E = 29.2$ E3 Ksi
$L = 149"$

$K_{strut} = EA/L = 2.1E3$ K/in

Stiffness contribution from 4 struts along X or Y:

$K_x = K_y = 4K_{strut} \cos 45° \cos 34.32° = 4.9E3$ K/in

$F = 1/2\pi[K/M]^{0.5}$

$F = 1/2\pi[4.9E3 \times 386.4/170]^{0.5} = 16.8$ Hz.

This frequency is not in the rigid range ignoring friction contribution to lateral stiffness. Conservatively work with 5 percent damped spectral ordinate at this frequency:

Spectral ordinate $\approx$ 1.25g

Thus peak loading in absence of friction is calculated as follows:

$F_{UB} = 85 \times 1.25g/0.83g = 128$ Kips < 181 Kips allowable, thus O.K.

Therefore design is feasible using struts.

CONCLUSION

Depending on how much of the load is resisted by friction, proper seismic restraint can be designed and accommodated. The seismic restraint can be reduced in size if resistance due to friction is properly accounted.

Assuming that all seismic loads are to be resisted by the seismic restraints, this calculation demonstrates that it can be accommodated by NPS strut size 36. The final design will allow for proper distribution of load between friction and the seismic restraint allowing for proper flexibilities present in the system by performing a non-linear dynamic analysis. The design of the restraint system will be finalized based on these results.

REFERENCES

1. PG&E Calculation M-1058, Rev. 2, dated 12/11/01, titled "Cask Transfer Facility Seismic Restraint Configuration"

2. "Transporter Stability on Diablo Canyon Dry Storage Travel Paths", Holtec Document No. HI-2012768, Rev. 0, dated 10/26/01

3. NPS Catalog for Struts

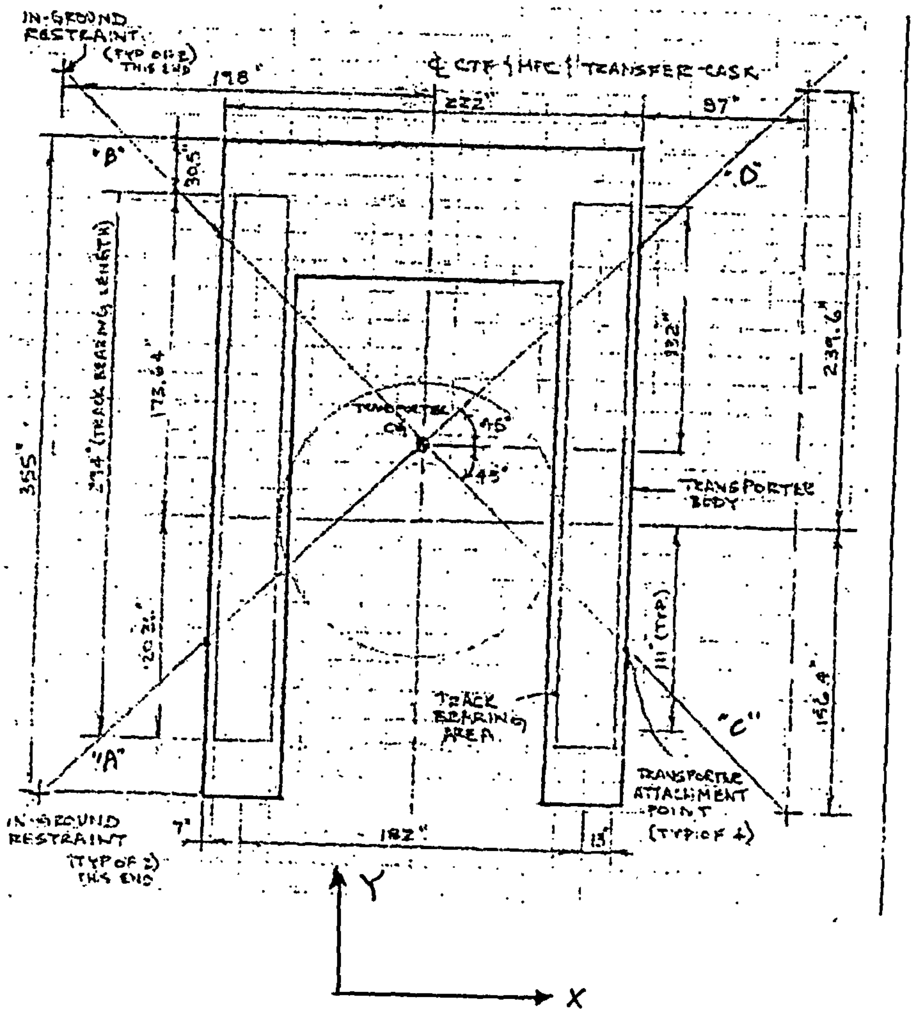

Figure 1: Plan View of Seismic Restraints for Transporter on top of CTF

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Products covered by this Certified Design Report Summary are included in __5__ Section of NPS Products Catalog	NPS PRODUCTS COMPONENT SUPPORT CERTIFIED DESIGN REPORT SUMMARY	CDRS No.: SRX Page 3 of 3 Rev. 7 Date 02/23/94

Product Name / Part Code: Sway Strut / SRS Fixed Length Sway Strut / SRF Mixed Sway Strut / SRM

SWAY STRUT SIZE NO. - LEVEL C/D LOAD - KIPS AT [illegible]°F

SIZE NO.		06	08	10	12	14	20	24	36
Min.	SRF	6	5	9	8	8	12	18	24
c-c	SRX	12 1/2	12 1/2	14 3/4	17 1/4	17 1/4	24 1/2	29 1/2	30 1/4
(in.)	SRS	15 7/8	18	22 3/4	24 3/4	24 3/4	34 1/2	37 3/4	51
C-C (in.)									
10		3.6/ 5.4	6.6/ 10	10.6/ 14.4	15.4/ 20.5	21.0/ 27.8			
20		3.6/ 5.4	6.6/ 10	10.6/ 14.4	15.4/ 20.5	21.0/ 27.8	44.5/ 57.3	67.5/ 85.3	
30		3.6/ 5.4	6.6/ 10	10.6/ 13.9	15.4/ 20.0	21.0/ 27.2	44.5/ 57.3	67.5/ 85.3	163/ 210
40		3.6/ 5.4	6.6/ 10	10.6/ 13.7	15.4/ 19.3	21.0/ 26.7	44.5/ 56.6	67.5/ 84.7	163/ 210
50		3.6/ 4.3	6.6/ 8.9	10.6/ 12.1	15.4/ 18.5	21.0/ 25.1	44.5/ 55.1	67.5/ 84.1	163/ 210
60		3.3	6.6/ 7.6	10.6/ 10.9	15.4/ 17.3	21.0/ 23.5	44.5/ 54.2	67.5/ 82.9	163/ 208
70		2.6	5.9	9.4	15.4/ 15.9	21.0/ 22.8	44.5/ 52.7	67.5/ 82.7	163/ 207
80		2.1	4.7	7.3	15.3	19.6	44.5/ 50.6	67.5/ 80.1	163/ 205
90			3.8	6.1	12.5	17.0	44.5/ 48.3	67.5/ 78.9	163/ 202
100			3.1	5.0	10.4	14.3	44.5/ 45.9	67.5/ 76.3	163/ 200
110				4.2	8.7	12.3	43.1	67.5/ 73.5	163/ 198
120				3.5	7.3	10.0	40.7	67.5/ 70.7	163/ 195
140						7.4	33.0	65.3	163/ 188
160						5.7	25.5	58.0	163/ 182
180							20.4	50.2	163/ 172
200							16.4	40.9	161
220							13.8	34.2	150
240								28.1	137
Max. C-C (in)		78	100	120	120	144	220	240	240

* Do not exceed Max c-c
** SRS and SRM Min c-c dimensions are with no adjustment.

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TOTAL P.07

Figure 2: NPS Load Rating Sheet for Struts