Pacific Gas and Electric Company®

Donna Jacobs
Vice President
Nuclear Services

Diablo Canyon Power Plant
P. O. Box 56
Avila Beach, CA 93424

805.545.4600
Fax: 805.545.4234

June 23, 2005

PG&E Letter DCL-05-073

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

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
<u>Response to NRC Request for Additional Information Regarding License Amendment Request 04-07, "Revision to Technical Specifications 3.7.17 and 4.3 for Cycles 14-16 for a Cask Pit Spent Fuel Storage Rack"</u>

Dear Commissioners and Staff:

Pursuant to 10 CFR 50.90, Pacific Gas and Electric Company (PG&E) submitted an application for amendment to Facility Operating License Nos. DPR-80 and DPR-82 by PG&E Letter DCL-04-149, dated November 3, 2004. License Amendment Request (LAR) 04-07, submitted for Nuclear Regulatory Commission (NRC) review and approval, proposed Technical Specification changes to allow installation and use of a temporary cask pit spent fuel storage rack for Units 1 and 2. The cask pit rack would allow the storage of an additional 154 spent fuel assemblies. The total spent fuel pool storage capacity for each unit would be increased to 1478 fuel assemblies for Cycles 14-16.

The NRC staff has identified additional information required to complete their evaluation of the structural and heavy load drop analyses associated with LAR 04-07. Enclosed is PG&E's response to the request for additional information (RAI).

The enclosed RAI response does not affect the results of the safety evaluation and no significant hazards determination previously transmitted in PG&E Letter DCL-04-149.

A001

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

Sincerely,

Donna Jacobs
Vice President Nuclear Services

tlg/4160
Enclosure
cc: Edgar Bailey, DHS
Terry W, Jackson
Bruce S. Mallett
Diablo Distribution
cc/enc: Girija S. Shukla

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY	)	Docket No. 50-275 Facility Operating License No. DPR-80
Diablo Canyon Power Plant Units 1 and 2	)	Docket No. 50-323 Facility Operating License No. DPR-82

AFFIDAVIT

Donna Jacobs, of lawful age, first being duly sworn upon oath states that she is Vice President Nuclear Services of Pacific Gas and Electric Company; that she is familiar with the content thereof; that she has executed this supplemental response to additional NRC questions regarding License Amendment Request 04-07, "Revision to Technical Specifications 3.7.17 and 4.3 for Cycles 14-16 for a Cask Pit Spent Fuel Storage Rack" 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 her knowledge, information, and belief.

Donna Jacobs
Vice President Nuclear Services

Subscribed and sworn to before me this 23rd day of June 2005, by Donna Jacobs, personally known to me or proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

Sandra Eatherly
Notary Public
State of California
County of San Luis Obispo

SANDRA EATHERLY
Commission # 1425568
Notary Public - California
San Luis Obispo County
My Comm. Expires Jul 18, 2007

PG&E Response to Request for Additional Information Regarding License Amendment Request 04-07, "Revision to Technical Specifications 3.7.17 and 4.3 for Cycles 14-16 for a Cask Pit Spent Fuel Storage Rack"

Structural Analysis (SA) RAIs – 03/23/05

<u>NRC Question SA-1</u>

With respect to Section 6.0, "Rack Structural Integrity Considerations" of Enclosure 5 to the Holtec Report HI-2043162 Revision 1, provide additional information relating to the following items:

a. *Since the rack/platform structure inside the recessed cask pit of the spent fuel pool is different in its structural configuration from the familiar freely standing single rack structure on a spent fuel pool floor, we expect that modeling differences in the Holtec's DYNARACK code may involve significant approximations. Discuss any unique modeling features employed for the rack/platform structure seismic analysis that reflect on the validity of the seismic responses reported in Tables 6.8.1 and 6.8.2 of the Holtec report.*

b. *Considering that the cask pit rack/platform model analysis methodology used in Section 6.0 of the Holtec report is based on many engineering assumptions (see Section 6.5.2) in its theoretical development, provide a summary discussion of the potential variabilities of the specific analysis results reported in Tables 6.8.1 and 6.8.2, and the DCPP's basis for judging that these variabilities are adequately accounted for in the design of the cask pit rack and the platform structures.*

c. *Referring to Figure 6.5.3, "Schematic of the Dynamic Model of Cask Pit Rack Platform Used in DYNARACK," describe the approach used in developing the stiffness matrices for: (a) the platform/cask pit floor gap and friction elements, (b) the platform/cask pit wall gap and vertical friction elements, (c) the rack pedestal to platform gap/impact element, and (d) the tension-only elements representing the connector links.*

d. *Explain how the in-structure seismic responses in the vicinity of the spent fuel pool structure (per the DCPP UFSAR) for the DE, DDE, HE and LTSP earthquakes were utilized in developing the time-history accelerograms shown in Figures 6.4.1 through 6.4.12.*

<u>PG&E Response to Question SA-1</u>

a. While the cask pit rack/platform structure seismic analysis does employ some unique modeling features as compared to the typical spent fuel rack seismic analyses, all modeling has been performed within the framework of the existing

DYNARACK code (i.e., no modifications have been made to the program that would affect the validity of the seismic response). DYNARACK is a general purpose dynamics program, which has been validated by Holtec under their 10 CFR 50, Appendix B Quality Assurance (QA) Program, that allows the user to build models using a combination of lumped mass and spring elements in any configuration. What makes the cask pit rack/platform structure model different from the familiar single rack model is that additional mass and spring elements have been added to incorporate the platform structure.

The platform structure is modeled in DYNARACK as a six degrees-of-freedom (i.e., three translation degrees of freedom and three rotation degrees of freedom) rigid body with the proper overall dimensions and mass properties. Consequently, the total number of degrees of freedom in the cask pit rack/platform structure model is 28 versus only 22 in the typical single rack model. The contact interfaces between the platform and the cask pit rack and the platform and the cask pit walls are modeled using gap elements and friction elements in a manner very similar to how the spent fuel rack support pedestals and the cask pit rack-to-wall gaps are modeled (see Figure 6.5.3 of the Holtec Licensing Report HI-2043162, Spent Fuel Storage at Diablo Canyon Power Plant for Pacific Gas and Electric Company, Revision 1, previously submitted to the NRC in PG&E Letter DCL-04-149 dated November 3, 2004, for schematic of interface springs). Further discussion on the determination of the spring constants for each of the platform interface springs is provided in PG&E Response to NRC Question SA-1c below. Since the platform is an open frame structure that is firmly wedged in the cask pit when installed, there are no fluid coupling effects associated with the platform.

The seismic analyses of the cask pit rack/platform structure using DYNARACK are not intended to resolve the stresses in the platform structure. The purpose rather is to: (a) show that the cask pit rack/platform model does not impact the spent fuel pool (SFP) walls at top of rack, (b) compute the stress factors in the cask pit rack cell structure, and (c) determine the maximum interface forces acting on the platform during a seismic event. The maximum interface forces are then used to calculate the stresses and safety factors in the platform using ANSYS and basic strength of materials formulas. Thus, only the results in Holtec Licensing Report HI-2043162, Revision 1, Table 6.8.1 are directly obtainable from DYNARACK. The results in Holtec Licensing Report HI-2043162, Revision 1, Table 6.8.2 are derived from a three-dimensional, linear elastic finite element model of the platform structure using the maximum interface forces from DYNARACK as input. Therefore, the modeling of the platform in DYNARACK as a six degrees-of-freedom rigid body with appropriate interface springs is sufficient for the intended purposes and well within the proven capabilities of the DYNARACK code.

b. The analysis for the spent fuel rack has been developed by Holtec International over a period of many years and is used for determination of global displacements of spent fuel racks, rack-to-rack, and rack-to-floor reaction forces. Over the years, the methodology has been continually improved to minimize the effect of engineering variabilities. Section 6.5 of the Holtec Licensing Report HI-2043162, Revision 1, provides a brief description of the theoretical concepts and conservative assumptions used in the development of the cask pit rack/platform model. The building block for the simulation is the structural model of a single spent fuel rack. Each rack is modeled as a beam-like structure having 12 degrees of freedom. The formulation is set up so that classical beam theory (including shear deformation) static solutions are reproduced when the rack model is subject to end loadings. Therefore, to the extent that the "beam properties" of the spent fuel rack are modeled accurately, the predicted results are consistent with the accuracy of beam theory applied to any structure. Fortunately, the spent fuel rack is a rugged, nearly rigid honeycomb structure whose beam properties (area and moments of inertia) can be developed with minimal assumptions. In terms of its global response, it can be characterized as a "nearly rigid" structure. Therefore, the results that are obtained from any simulation will differ from the results obtained by considering the racks as rigid (with known mass and inertia properties) only to the extent of the "improvements" included in the characterization of the beam-like deformations. If the behavior of spent fuel racks in a dry pool were being studied, it would be concluded that the results have minimal variability as they are founded in the well known precepts of multi-body rigid body dynamics. Any variabilities would, in that case, come only from the numerical solution procedure and the step size of integration. Based on numerous convergence studies that have been performed over the years, the results obtained reflect the reality of the scenarios under study.

Since the real scenarios of interest involve racks under water, it is recognized that the responses obtained are very dependent upon the approach used to simulate the hydrodynamic coupling between rack and (SFP) walls, and between individual fuel assemblies and rack cell walls. The basis of the simulation of fluid coupling effects is a classical analytical solution of a moving fluid filled cylinder that contains a smaller moving solid cylinder; coupling between the bodies is provided by the fluid filled annulus (See Reference 6.5.7 of Holtec Licensing Report HI-2043162, Revision 1, which is Fritz, "The Effects of Liquids on the Dynamic Motions of Immersed Solids"). Holtec has extended this solution to the case of rectangular bodies and then further extended the solution to cover multiple rectangular bodies. Recognizing the extent to which the theory was extended, multiple test cases were solved to ensure that the formulation could be supported by both existing and new experimental results. At the request of the Nuclear Regulatory Commission (NRC) staff, Holtec demonstrated that the methodology gave results in full agreement with the experimental results performed at Carnegie Mellon. This comparison was submitted under the Waterford 3 docket. Holtec also performed its set of experiments involving multiple rectangular bodies submerged in a fluid and subject to dynamic motion. This data was also submitted under the Waterford 3 docket (contained in Reference 6.5.6 of Holtec Licensing Report HI-2043162, Revision 1, which is B. Paul's "Fluid Coupling in Fuel Racks: Correlation of Theory and Experiment"). The excellent agreement of Holtec's fluid coupling methodology with all of the available experimental work provided the necessary confidence to utilize it in all of Holtec's spent fuel rerack projects and expect that it would provide results suitable to make engineering assessments of the viability of a proposed rerack scheme.

Holtec recognizes that no analytical approach can exactly predict what will happen to an assemblage of real structures submerged in a seismically excited SFP. Therefore, to the extent possible, all engineering assumptions are made in a manner that ensures that the results will overpredict displacements, forces, etc., and therefore will produce conservative estimates of safety factors. In addition, to minimize the effects of variability, adequate safety factors are maintained. The results for the Diablo Canyon Power Plant (DCPP) cask pit rack and platform structure have at least a 15 percent margin to the design basis limit.

Based on the theoretical development, experimental verification, and numerous independent reviews of Holtec methodology (Franklin Institute Research Laboratories, Brookhaven National Laboratories), the results are within what would be accepted as good engineering accuracy, and any variation is likely to be on the conservative side (i.e., overpredictions). To further ensure that variabilities in the results would not inadvertently lead to an adverse conclusion, structural margins are maintained that are well below the design limit.

c. *The development of the stiffness matrices for the various gap and friction* elements mentioned in NRC Question SA-1c is based on finite element analysis and classical strength of materials and elasticity formulas. More specifically, the stiffness value assigned to the platform/cask pit floor gap element is based on the solution for a semi-infinite solid loaded over a rectangular area found in Timoshenko's Theory of Elasticity (Third Edition). The semi-infinite solid has the mechanical properties of concrete, and the load is applied over a 120 square inch area. For the platform/cask pit wall gap element, the local concrete stiffness is combined in series with the local stiffness of the platform as determined using ANSYS. The local concrete stiffness is once again calculated using the same formula from Timoshenko. Due to the design of the platform, the net stiffness value is different at the top and bottom shim locations. The rack pedestal to platform lateral impact stiffness is determined from Roark's Formulas for Stress & Strain, Table 33, case no. 2c. The stiffness of the tension-only elements representing the connector links is based on the free length of the shaft considered as a bar (i.e., $k = EA/L$). Finally, the stiffness value assigned to the friction elements is at least 1000 times greater than the stiffness of the coincident gap element. The use of a very high stiffness value minimizes the amount of extension/compression in the friction element as the friction force ramps up to its threshold limit, which leads to a more accurate prediction of the overall displacement.

d. The time-history accelerograms used as input to the seismic analyses of the cask pit rack were developed using synthetic time-history generation software to fit the target floor acceleration response spectra at the location of the SFP in the fuel handling area of the auxiliary building. The following methodologies were used.

The design earthquake, double design earthquake, and Hosgri earthquake synthetic time-history accelerograms were developed in 1985 in support of the installation of the high density spent fuel racks in the DCPP SFPs (reference PG&E Calculation 52.15.58, Revision 0). These time-history accelerograms form part of DCPP's licensing basis and their use is described in DCPP Final Safety Analysis Report (FSAR) Update, Section 3.8.8.4, "Design and Analysis of Racks".

For the long term seismic program earthquake (LTSP), three orthogonal spectrum-compatible time-history accelerograms were developed to match the LTSP response spectra in the SFP. The NRC Standard Review Plan spectral matching criteria (Section 3.7.1 of NUREG-0800) were followed. These criteria recommend that 75 frequencies be used for comparison of the response spectrum associated with the time-history accelerogram to the target response spectrum and that the computed spectral acceleration at no more than 5 of the 75 frequency points fall below the target spectrum, and that no point falls below 0.9 times the target spectrum. The time-history accelerograms satisfy these requirements.

<u>NRC Question SA-2</u>

With respect to the footnote provided on page 6-12 of Holtec report discussing the selection of the bounding values of coefficient of friction for the interface between the cask pit rack pedestal supports and the platform structure, indicate if the results of the 199 tests referred to in the footnote discussion are identical to those used in defining the coefficient of friction values used in the Holtec Proprietary Report HI-961465, "WPMR Analysis User Manual for Pre & Post Processors & Solver," August, 1997. Discuss the basis for judging the applicability of the test data to the DCPP specific interface between the cask pit rack pedestal supports and the platform structure supports.

<u>PG&E Response to Question SA-2</u>

The 199 tests referred to in the footnote on page 6-12 of Holtec Licensing Report HI-2043162, Revision 1, are identical to those used in defining the coefficient of friction values in the Holtec Proprietary Report HI-961465 and numerous spent fuel rack licensing applications. The subject tests, which were performed by E. Rabinowicz in 1976 and documented in the report titled "Friction Coefficients for Water Lubricated Stainless Steels for a Spent Fuel Rack Facility," are applicable to the interface between the cask pit rack pedestal supports and the platform structure supports at DCPP because of the aqueous SFP environment and the fact that both components are made from stainless steel. The cask pit rack pedestal supports are made from the same stainless steel material (i.e., SA564-630) that has been used to machine hundreds of Holtec-designed spent fuel rack pedestal supports. The platform structure supports are made from SA240-304 stainless steel, which is the material commonly used by Holtec and others for spent fuel rack bearing pads. Thus, the friction interface between the cask pit rack pedestal supports and the platform structure supports is very similar to the typical spent fuel rack support pedestal to bearing pad interface. This is the basis for concluding that the test data are applicable to the DCPP specific interface between the cask pit rack pedestal supports and the platform structure supports.

NRC Question SA-3

As applicable, discuss DCPP's spent fuel racks/pool structure's operating experience including any loss of functions or structural damage during past earthquakes of meaningful magnitude at the DCPP site since the plant operation.

PG&E Response to Question SA-3

Inspections of the plant facilities are performed by operations, maintenance, and engineering after the occurrence of an earthquake of meaningful magnitude in accordance with Casualty Procedure M-4, "Earthquake." The results of post-earthquake inspections to date have not identified any observed structural damage to the SFP or spent fuel racks. Additionally the handling of new and spent fuel in the SFP subsequent to an earthquake has not identified any misalignment or deformations of the spent fuel racks that would indicate earthquake induced damage.

The SFP leak monitoring system has also been checked after an earthquake to determine if there is any change in the collection rate of SFP water. The collection rate observed after an earthquake has not increased, indicating that there has been no effect on the integrity of the SFP liner.

NRC Question SA-4

Provide a summary discussion of past DCPP's operating and maintenance experience with respect to its spent fuel racks and pool structural elements including potential pool structural deformation or leakage and damages of racks, fuel assemblies, cask pit floor/walls and spent fuel pool liner. Also, discuss aging related degradation of the spent fuel pool structural concrete.

PG&E Response to Question SA-4

The structural condition of the SFPs and spent fuel racks are visually monitored by the civil engineering group in accordance with Procedure MA1.NE1, "Maintenance Rule Monitoring Program - Civil Implementation." Degradation of these items has not been identified during these inspections. In addition, no significant misalignment or deformation has been identified by operations during fuel handling activities in the SFP.

The DCPP SFPs are concrete structures with a stainless steel liner. Each SFP includes an integral leakage detection and collection system consisting of a network of monitoring trenches that drain to a collection system of six individual collection pipes, terminating in a valve and quick disconnect at the monitoring location. Each collection pipe is individually sampled at the quick disconnect for fluids on a weekly basis. Once per quarter, samples from each collection pipe are analyzed for iron content.

In 1988, SFP liner leaks were identified in Unit 1 and were repaired by welding stainless plates over the leaks. No significant leakage has been observed since this repair. Unit 2 has experienced 200-300 ml leakage per week from one of the sample points. The other sample points have exhibited no appreciable leakage. The leakage detection system on both units appears to be free-flowing with no blockage. There has been no evidence of leakage from the SFP through the concrete structure. No chemical compounds have been detected that would indicate degradation of the SFP concrete or reinforcing steel. Additionally, material degradation of the concrete due to any leakage would be negligible since the chemical reaction between the concrete and effluent (boric acid) would cause negligible degradation of the concrete as reported in American Concrete Institute (ACI) 515.1, Table 2.5.2, A Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete.

NRC Question SA-5

Provide a discussion of any needed modification to existing DCPP spent fuel pool operation related administrative controls in order to implement the proposed revision to technical specifications 3.7.17 and 4.3 for cycles 14-16 for a cask pit spent fuel storage rack.

PG&E Response to Question SA-5

A specific procedure will be developed and approved in accordance with the DCPP QA Program (FSAR Update Section 17.5 "Instructions, Procedures, and Drawings") for controlling the fuel that will be placed in the cask pit storage rack. This procedure will ensure that only fuel with an initial enrichment of less than or equal to 4.1 weight-percent U-235, a minimum 10-year decay time, and a discharge burnup in the acceptable region of Technical Specification (TS) Figure 3.7.17-4 is stored in this rack. This procedure will fully implement all applicable requirements of TS 3.7.17 and 4.3 for the cask pit storage rack.

Once the cask pit racks have been installed, the rack on each unit will be fully loaded with spent fuel assemblies from the existing inventory of fuel in the SFPs prior to the 14th refueling outage on each unit. It is not PG&E's intent to utilize the cask pit racks in the management of the spent fuel during subsequent refueling outages. Thus, it is intended that the procedure that controls which fuel assemblies may be stored in the cask pit racks will only be implemented once on each unit, shortly after the installation of the racks. This approach allows fuel handling operations during the 14th and 15th refueling outages on each unit to be performed using the existing storage racks with the procedures and controls currently in place.

NRC Question SA-6

Discuss DCPP's plant specific quality assurance and inspection programs to be implemented in order to preclude installation of an irregular or distorted cask pit rack/platform structure, and how DCPP confirms that the actual installed cask pit rack gap configurations are consistent with those gaps assumed in the cask pit rack/platform dynamic analysis and design.

PG&E Response to Question SA-6

- Quality Assurance and Inspection Programs

  The procurement specification for the cask pit rack/platform structure contains quality verification requirements in accordance with the DCPP QA Program FSAR Update, Section 17.7, "Control of Purchased Material, Equipment, and Services". The quality verification requirements include source inspection to assure that the structure is manufactured in accordance with the requirements and tolerances specified in Holtec's design and fabrication drawings. Receipt inspections will be performed in accordance with DCPP's QA Program requirements for quality-related components (FSAR Update Sections 17.7 and 17.10, "Inspection"). Specified attributes will be verified for conformance with the design and fabrication drawings to assure that the structure has not been damaged during shipping and handling. All PG&E inspections will be performed in accordance with DCPP's QA Program as specified by FSAR Update Section 17.10.

  In addition to the above, the cask pit racks and platform structures will be fabricated by U.S. Tool & Die, Inc., Holtec's designated manufacturer, under a 10 CFR 50, Appendix B, QA Program. The fabrication process will be controlled and monitored via the use of an approved set of procedures and shop travelers. After fabrication is complete, each cask pit rack and platform structure will undergo a final inspection to verify all critical dimensions and characteristics. Furthermore, Holtec's installation team will perform its own receipt inspections, independent of any PG&E inspections, of the fabricated components when they arrive on site.

- Confirmation of Installed Gap Configurations

  The cask pit rack/platform dynamic analysis considers two sets of gap dimensions, used simultaneously as input in order to establish an acceptable range of gap dimensions while at the same time ensuring conservative results. To be more specific, the cask pit rack/platform dynamic model has the capability to differentiate between the fluid coupling gap and the impact gap. This allows the use of an upper bound gap for fluid coupling effects, thereby minimizing the resistance to rack motion, and a lower bound gap for impact tracking. This analytical approach has been used at DCPP to establish an acceptable range of gap dimensions in each direction.

  Installation of the cask pit rack/platform structure will be implemented in accordance with plant-specific installation procedures, developed by Holtec. Prior to use, these procedures will be reviewed and approved by PG&E in accordance with the DCPP QA Program (FSAR Update, Section 17.5). Specifically, acceptability of the actual installed cask pit rack gap configuration will be confirmed during installation, by taking a series of gap measurements using a long-handled measuring tool and an underwater camera and comparing them to the gaps sizes, including tolerances, specified on the design and fabrication drawings. Platform-to-wall gap measurements will be taken immediately following the installation of the platform, and rack-to-wall (or cask restraint) gap measurements will be taken after the cask pit rack is lowered into position. At each stage, measurements will be taken prior to disconnecting the lifting device so that, in the event that the gaps are unacceptable, the rack and/or platform can be lifted and repositioned as needed until the configuration is acceptable. PG&E will establish holdpoints, in accordance with the DCPP QA Program (FSAR Update, Section 17.10) to verify that actual installed cask pit rack gap configurations are consistent with those gaps assumed in the cask pit rack/platform dynamic analysis and design. These holdpoints must be signed off by PG&E quality control (QC) personnel as required by FSAR Update, Section 17.10. The installation procedures will also require independent verification of the installed gap configuration and rack levelness by Holtec's own QC person through a holdpoint inspection

<u>*NRC Question SA-7*</u>

Section 7.2 of the Holtec report discusses DCPP's analyses performed to evaluate the damage to the new cask pit rack, the pool liner, and the concrete slab in the cask pit area subsequent to the impact of a fuel assembly, a rack or a rack platform under various drop scenarios. Results of the analyses covering shallow drop, deep drop, rack drop and platform drop events are presented in Section 7.5 of the Holtec report. Discuss DCPP's basis for judging that the results obtained from these analyses are

directly applicable and reasonable for use in the cask pit rack and platform design, cask pit rack and platform structures.

PG&E Response to Question SA-7

All aspects of the drop accident models and evaluations were performed by Holtec using DCPP-specific data based on Holtec's design of the rack and platform and the configuration of DCPP's SFP liner and concrete. The evaluations of the liner and concrete considered the as-built configuration of these items, including material strengths, weld seam locations, liner thickness, leak detection channel locations, and concrete thickness. Bounding weights and material properties have been used to provide conservative results. For example, the cask pit rack is modeled as weighing 27,200 lb as compared to its actual design weight of 26,000 lb. The use of a higher weight conservatively increases the kinetic energy at impact and maximizes the damage to the cask pit liner and concrete slab.

The computer code LS-DYNA, which is a commercial code developed by Livermore Software Technology Corporation, has been validated under Holtec's 10 CFR 50, Appendix B, QA program through comparisons with documented test cases. This program is ideally suited for the solution of impact problems. In addition LS-DYNA has been widely used for many years in the automobile and aerospace industries to simulate dynamic impact problems, and numerous examples exist in published literature demonstrating the program's accuracy when compared with actual test results. The analysis methodology, described in Section 7.4 of Holtec Licensing Report HI-2043162, Revision 1, has been applied to drop analyses for numerous SFP reracking projects and has been previously accepted by the USNRC.

The PG&E review of the Holtec load drop analyses included review of the modeling analyses methodology and assumptions to verify that the analyses were appropriate for use at DCPP and the input assumptions were consistent with plant-specific data.

To conclude, the results are applicable and reasonable for use in the cask pit rack and platform design because they are derived from DCPP-specific data using a well-established computer code and methodology.

Heavy Load Drop Analysis (HL) 05/02/05 RAIs

NRC Question HL-1

Holtec Licensing Report HI-2043162 Revision 1 states that:

"The third and fourth classes of drop events assume that a lifted empty rack and a rack platform fall from the top of the SFP water level and impact the floor of the cask pit, respectively."

However, it appears that while maneuvering the empty rack and the rack platform into the cask pit area, both components will be positioned at a higher elevation than the one assumed in the Holtec report.

a. *Provide the basis for this assumption and elaborate as to why it is conservative to use a lower elevation on the analysis opposed to the highest elevation at which the components are maneuvered.*

b. *Explain how the results of the analysis are impacted if the components fall from the highest elevation at which they are maneuvered.*

PG&E Response to Question HL-1

The results presented in Holtec Licensing Report HI-2043162, Revision 1, assume that the rack and platform are dropped from the SFP maximum water level (elevation 139 feet) and fall a distance of 44 feet 3 inches through water before impacting the top of the cask pit liner (elevation 94 feet 9 inches). While the empty rack and platform are being manipulated above the SFP water during installation, the maximum lift height of either component will be limited by procedures to the 141-foot elevation. The basis for assuming the rack and platform drop from the lower 139-foot elevation, and not the 141-foot elevation, is that the additional velocity associated with the 2-foot drop in air will be negated by the energy that is dissipated when the rack/platform impacts the surface of the water.

However, in order to demonstrate that a potential drop from the 141-foot elevation has no significant impact on the results presented in Holtec Licensing Report HI-2043162, Revision 1, the final velocities of the rack and platform, just prior to impact, have been computed for different combinations of drop elevation and SFP water level in Holtec Report HI-2043219 (Analysis of Postulated Mechanical Accidents at the Diablo Canyon Spent Fuel Pool Cask Pit), Revision 4. The following table summarizes the various drop cases and their final impact velocities. Cases 1 and 4 correspond to the drops of the rack and platform, respectively, postulated in Holtec Licensing Report HI-2043162, Revision 1, (SFP maximum water level and no drop in air); Cases 2 and 5 correspond to the drops of the rack and platform, respectively, from 3.67 feet above the minimum

SFP water level; and Cases 3 and 6 correspond to drops of the rack and platform, respectively, from 2 feet above the maximum SFP water level.

Case No.	Component	Drop Elevation (ft)	SFP Water Level (ft)	Drop Height (ft)		Final Impact Velocity (in/sec)
				In Air	In Water	
1	Empty Rack	139.00	139.00	0.00	44.25	217.6
2	Empty Rack	141.00	137.33	3.67	42.58	217.6
3	Empty Rack	141.00	139.00	2.00	44.25	217.6
4	Platform	139.00	139.00	0.00	44.25	372.1†
5	Platform	141.00	137.33	3.67	42.58	376.5
6	Platform	141.00	139.00	2.00	44.25	375.5

† Results presented in Holtec Licensing Report HI-2043162, Revision 1, for the rack platform drop are conservatively based on a final impact velocity of 373.0 inches per second.

From the above table, the final impact velocity is the same for all three rack drop cases, indicating that the rack reaches its terminal velocity in water (provided that it falls less than 3.67 feet in air before entering the water). Therefore, a rack drop from the highest elevation (i.e., 141 feet) has no impact on the results presented in the Holtec Licensing Report HI-2043162, Revision 1.

The rack platform exhibits only a slight increase in impact velocity with increasing drop height in air. The percentage increase between cases 5 and 4 is less than 1 percent (based on 373.0 inches per second velocity for case 4), which is not enough to develop through-thickness cracks in the concrete slab and/or punch through the liner considering the large margins of safety reported in Holtec Licensing Report HI-2043162, Revision 1, for the lower drop elevation (i.e., 139 feet). Note that the calculated results for cases 5 and 6 conservatively assume no velocity loss as the platform transitions from air to water. Finally, the LS-DYNA model used in the Holtec Licensing Report HI-2043162, Revision 1, to predict concrete cracking in the cask pit slab does not take any credit for steel reinforcement; this conservatism offsets the slight increase in the platform's final impact velocity.

In conclusion, the potential drop of either the rack or platform from the highest elevation has no impact on the results presented in Holtec Licensing Report HI-2043162, Revision 1.

<u>*NRC Question HL-2*</u>

What controls or measures will be taken to assure the capability to unload and remove the cask pit storage racks?

<u>PG&E Response to Question HL-2</u>

Once the cask pit racks have been installed during the 14th operating cycle, the final acceptance test will be a full drag test of all 154 cell locations using a dummy fuel assembly. Any cell locations not meeting the drag test limits will be reworked prior to being loaded with spent fuel assemblies, thus ensuring the capability to successfully load and unload the racks. The cask pit racks on each unit will then be fully loaded with spent fuel assemblies from the existing inventory of fuel in the SFPs utilizing the same fuel handling equipment and procedures currently in use for the existing fuel storage racks.

With the current fuel inventories in the SFPs and the number of new fuel assemblies that will be discharged to the SFPs during the 14th and 15th refueling outages, there will be adequate free space in the existing fuel racks to fully offload the cask pit racks during either the 15th or 16th operating cycles. Depending on the timing for initial operation of the dry cask storage facility at DCPP, the cask pit racks will be offloaded and removed during one of these operating cycles on each unit.

Once offloaded, the cask pit storage rack is designed to be disconnected from the platform and removed from the pool using remote underwater tools. The steps required to remove the cask pit rack are as follows. A specially designed long-handle tool will be lowered into the empty storage cells above the connector links so that the connector links can be rotated to their unlocked position and lifted out of the SFP. This is the same tool that is used to install the links during rack installation. After the connector links are removed, the rack lift rig will be lowered into the pool and inserted into lifting holes in the rack baseplate. The rack will then be lifted vertically out of the pool using the fuel handling building crane. The rack platform will remain in the cask pit to serve as a support base for dry cask loading operations.