**IPRP Report No. 4**

**Comments on PG&E’s Enhanced Seismic Study Progress Presentation for Diablo Canyon Power Plant**

**Background**

In 2006, the California Legislature enacted Assembly Bill (AB) 1632, which was codified as Public Resources Code Section 25303. AB 1632 directed the California Energy Commission (CEC) to assess the potential vulnerability of California’s largest baseload power plants, which includes Diablo Canyon Power Plant (DCPP), to a major disruption due to a major seismic event and other issues. In response to AB 1632, in November 2008 the CEC issued its findings and recommendations in its AB 1632 Report, which was part of its 2008 Integrated Energy Policy Report Update.

In Pacific Gas and Electric Company’s (PG&E) 2007 General Rate Case decision D.07-03-044, the California Public Utilities Commission (CPUC) directed PG&E to address and incorporate the recommendations from the AB 1632 Report into its feasibility study to extend the operating licenses of its Diablo Canyon Units 1 and 2 for an additional 20 years.

In November 2009, PG&E submitted its formal application with the Nuclear Regulatory Commission (NRC) to extend the licenses of DCPP Units 1 and 2. On January 15, 2010, PG&E filed A.10-01-014 with the CPUC for cost recovery of $16.73 million associated with the enhanced seismic studies recommended by the CEC’s AB 1632 Report. On September 23, 2011, PG&E filed a Motion to re-open A.10-01-014 to request additional funding for a total of $64.25 million for increased costs of the enhanced seismic studies at DCPP. The Motion was subsequently approved at a Pre-Hearing Conference on November 30, 2011.

The comprehensiveness, completeness, and timeliness of these studies will be critical to the CPUC’s ability to assess the cost-effectiveness of Diablo Canyon’s proposed license renewal. As noted in the CEC’s AB 1632 Report, a major disruption because of an earthquake or plant aging could result in a shutdown of several months or even cause the retirement of one or more of the plants’ reactors. A long-term plant shutdown would have economic, environmental and reliability implications for California ratepayers.

In response to the CPUC, CEC’s and California Coastal Commission’s direction to complete the AB 1632 Report- recommended seismic studies as part of license renewal reviews, PG&E is planning 2-D and 3-D seismic studies and analyses at its Diablo Canyon Power Plant. PG&E plans to perform these studies for on-shore and off-shore areas by using enhanced 2-D and 3-D seismic reflection mapping and other advanced geophysical techniques to explore fault zones in the vicinity of DCPP, as recommended by the CEC AB 1632 Report.

PG&E **Seismic Study Progress Presentation**

As anticipated in IPRP Report No.3 dated April 6, 2012, PG&E and the IPRP met on June 29, 2012 to participate in a quarterly meeting/briefing to review the status of PG&E’s seismic studies, changes in the study plans, and preliminary study findings.

These quarterly briefings/meetings allow PG&E to report on its progress and help facilitate a productive informal exchange of scientific viewpoints.

In the following, we summarize the presentations from the June 29, 2012 meeting. The presentations covered three components of the ongoing seismic study. These components consist of:

* Off-shore low energy seismic reflection profiling in 2-D and 3-D;
* On-shore seismic reflection profiling, new and legacy data;
* Off-shore high energy 3-D seismic reflection profiling plans and capabilities of the Central Coastal California Seismic Imaging Project (CCCSIP).

Summaries of the presentations of recent progress in these investigations and IPRP comments on the investigations are given below following the order of presentation in the meeting on June 29, 2012.

The investigations focus on “targets” that may provide observations relevant to determining the seismic hazards at DCPP. Specifically, these targets can be categorized as fault geometry and fault activity. Fault geometry issues have the greatest impact on ground motion estimates when they affect distance from a fault plane to the site. Fault geometry, specifically how “connected” different strands of the fault are, also affects the maximum magnitude of earthquake that can occur on a fault.

Fault activity is best expressed as the fault slip rate, which is proportional to the recurrence rate of earthquakes. In general, high slip rate fault have shorter recurrence rates. Fault slip rates are determined by measuring the offset of a marker feature across a fault and using its age to calculate the slip rate. The uncertainties involved are related to correctly identifying the feature, the offset measurement, the feature age determination, and lastly the context of the age determination as it relates to the feature displacement history. Offsets of geologically recent markers result in slip rate values most relevant for seismic hazards. These features are found in the near surface, so they are best characterized by methods that focus on the surface and near surface such as low energy seismic reflection methods, multibeam bathymetry, LiDAR, and surface mapping.

The recurrence rate is also controlled by the amount of displacement per event (earthquake) and this in turn is influenced by the degree of connection among faults. For this reason, it is important to characterize fault junctures. Current research has shown that sub-parallel strike-slip faults that are separated by less than 5 km often rupture together during single events. When this distance is less than 3 km then fault to fault rupture jumps are more common than not, and the faults can be considered connected. The distance is based on surface-trace mapping from earthquakes that were studied in detail.

**Agenda title presentation 1: 2010/2011 Point Buchon 2-D/3-D Low Energy Seismic Survey Results (*Gary* *Greene*)**

**Presentation title: PG&E DCPP 3-D/2-D Seismic Reflection Survey Offshore Pt. Buchon, Results and Interpretations of Low Energy Data**

Dr. Gary Greene presented preliminary results and interpretations from this low energy (2 kilojoules) seismic reflection survey focused on the Point Buchon area; specifically on the intersection of the Shoreline and Hosgri faults. The survey imaged an area extending from 1.5 km south of DCPP along the Shoreline fault, northward beyond the projected intersection with the Hosgri fault. The survey area extends westward to cover about half of the Hosgri fault zone’s width, a total area of about 48 square km. Within the northward-narrowing box which defines the 2-D seismic survey, a less extensive 3-D survey was nested, covering approximately 16 square km (Fig. 2 and Plate 1 of presentation). The seismic-reflection profile spacing of the 2-D survey is 100m, and for the 3-D survey is 12.5 m. The data collection methodology consists of towing a set of seismic streamers behind a boat and covering the survey area with parallel paths or track lines.

The following data plots were presented:

- 3-D seismic reflection profiles (vertical planes) and time slices (horizontal planes) showing reflector amplitudes, and annotated with interpretations: faults, structures, marker horizons.

- Multibeam-bathymetry overlaid upon 3-D seismic time slice.

- Various plots illustrating methods to visualize the unconsolidated sand cover, including isopach maps.

- User-selected seismic reflection strike lines and associated time slices. These are examples of the 3-D capability that clearly result in greater confidence in characterizing fault zones.

Dr. Greene presented preliminary examples of 3-D/2-D seismic reflection data. These data image the shallow structure over the northern Shoreline-Hosgri fault intersection in unprecedented detail to depths of 300 m. Based on these data, Dr. Greene presented the interpretation that the northernmost Shoreline fault transitions into a fold that trends towards the Hosgri fault, the Point Buchon fault dies out in a graben and the East Point Buchon fault continues north out of the survey area.

Previously, in IPRP Reports 2 and 3, this investigation target was referred to as Item 2.2 Hosgri-Shoreline Intersection. The reason for characterizing this intersection in great detail is to improve estimates of the probability of earthquake ruptures propagating across the Hosgri-Shoreline fault juncture. Given the established limited spatial separation of 2 km between the northern end of the mapped Shoreline fault and the Hosgri fault, the connectivity in terms of through-going ruptures cannot be eliminated. Additionally, an active fold trends from this northern imaged fault portion towards the Hosgri fault, which is evidence that strain is being transferred between these two faults.

IPRP comments: These low energy surveys image the faults in the upper crust, above the depths that earthquakes nucleate. Imaging by the proposed high energy seismic survey should provide additional information on the connection between these faults below the depth that can be imaged by the low energy survey, including seismogenic depths.

**Agenda title presentation 2: Irish Hills 2-D/3-D Seismic Reflection Survey Update 2011/ 2012 Survey (*Daniel* *O’Connell*)**

**Presentation title: Irish Hills 2-D/3-D Seismic Reflection Survey Update: 2011 Program**

Daniel O’Connell introduced this onshore survey as guided by the NRC Regulatory Guide 1.208 (2007) “A performance-based approach to define the site-specific earthquake ground motion,” which defines areas for detailed and very detailed investigations:

“Within a Radius of 8 Kilometers (5 mi) of the Site (Site Area) detailed*geological, seismological, geophysical, and geotechnical engineering investigations* should be conducted to evaluate the potential for tectonic deformation at or near the ground surface and to assess the transmission characteristics of soils and rocks in the site vicinity.”

“Within a Radius of Approximately 1 Kilometer (0.6 mi) of the Site (Site Location), very detailed*geological, geophysical, and geotechnical engineering investigations* should be conducted to assess specific soil and rock. The areas of investigation may need to be expanded beyond those specified above in regions that include capable tectonic sources, relatively high seismicity, or complex geology, or in regions that have experienced a large, geologically recent earthquake identified in historical records or by paleoseismic data.”

The pre-existing on-shore seismic reflection in the Irish Hills appears to be limited to a single profile within the 8-km radius “detailed” investigation area. Five additional profiles exist along the southeast portion of the Irish Hills (Fig. 2 presentation). These data were collected prior to 1985.

The current survey employed two systems:

- Shallow 2-D high-resolution, depth range ~ 2300m or 2 sec. two-way-travel time (TWT) Source: accelerated weight drop.

- Vibroseis and Zland 3-D nodal system, depth range with consistent good signal to noise ratio: 4-12 km, or 5-8 sec TWT. Deployment of seismometers in 7220 locations in a grid, and the recording of micro earthquakes in addition to the active source allow the refinement of a velocity model. The improved velocity model allows more precise earthquake relocations and ground motion estimates.

The coverage within the investigation areas is quite variable due mainly to access (Fig. 3). A nested approach using these different systems is planned to achieve greater coverage.

O’Connell concludes, “ There is strong and persistent reflectivity from the near surface to the base of the seismogenic crust thorough most of the Irish Hills making it feasible to image faults with 3-D seismic imaging.”

Future plans include additional surveys in both the near plant “very” detailed and the 8 km radius “detailed” investigation areas. A mini Vibroseis system may be added to the survey methods employed for these investigations. This system may be used to image bedrock terrace surfaces.

IPRP comments: This onshore investigation may provide observations relevant for issues identified in IPRP Reports 2 and 3 as 2.8: Los Osos Dip, 2.9: Los Osos Sense of Slip and 2.10: Los Osos Slip Rate. The presented on-shore seismic reflection data suggest that this project will probably provide an improved characterization of the Los Osos fault geometry; particularly the dip (2.8). For the remaining issues, namely the sense of slip and the slip rate, we expect the contribution to be indirect, by providing a framework that may allow a strategic targeting of specific sites for field geologic investigations.

Overall, the broad objective of developing a tectonic model of the Irish Hills will be greatly improved by this work, and the presented preliminary results are promising, especially because it appears that imaging within the Franciscan Complex, formerly thought to be devoid of seismic reflection imagable horizons, can be successful. The IPRP is looking forward to presentations on the implications of this survey to the geometry of faults beneath the Irish Hills.

**Agenda title presentation 3: 2011 San Luis Bay 3-D Low Energy Seismic Reflection Survey Update (*Phil Hogan*)**

Phil Hogan presented low energy seismic reflection survey results from data collected in 2010/2011. The survey areas are was located near Point Buchon and San Luis Bay. These are nested surveys, with larger 2-D survey area containing nested highest-resolution 3-D surveys.

The northern area is the area presented by Gary Greene at Point Buchon, from 1.5 km south of DCPP along the Shoreline fault, northward beyond the projected intersection with the Hosgri fault. Hogan’s presentation focused on the southern survey in San Luis Bay. That survey covered an irregular pentagon-shaped area about 5 km across. This survey focused on the southern extent of the Shoreline fault as it trends towards the Pecho fault zone, with the more detailed nested 3-D survey focused on potential offset of channels that probably were eroded during the last glacial maximum approximately 20,000 years ago.

Two data collection methods were employed:

* 4-streamer low energy seismic reflection system.
* 12-14 streamer low-energy P-cable seismic reflection system. Streamers spaced at 6.25 m, 8 channels per streamer.

A 19-step data processing workflow chart was presented. Both methods entailed towing a set of seismic streamers behind a boat and covering the survey area with a set of adjacent equally-spaced parallel paths or track lines. Each track is numbered for reference. Several examples of preliminary data visualizations were shown:

* 3-D block diagram SW Point Buchon (from an article published in “SeaTech” by Nishenko et al. 2012)
* Brute stack seismic reflection plot.
* Post stack migration 3-D volume-IHS Kingdom VuPak, cut-out oblique block diagram illustrating the area in San Luis Bay where the Shoreline fault cuts submerged remnant channels.
* Seismic reflection profile showing submerged channels and indicating a horizontal time slice.
* Several plan-view time slice seismic reflection amplitude plots in San Luis Bay where the Shoreline fault cuts submerged remnant channels.
* Associated time slice “coherency” plots of submerged remnant channels. These plots present a powerful visualization that is based on edge detection methods, and is particularly sensitive in detecting faults.

Future survey areas presented as data gaps were suggested by Greene / Hogan.

- Estero Bay

- San Luis Bay

- Hosgri fault strip surveys focusing on potential slip rate targets. The Hosgri Slip rate target was identified as target 2.3 in IPRP Reports 2 and 3.

- Releasing Hosgri fault bend identified as target 2.1 Hosgri-San Simeon fault step-over in IPRP Reports 2 and 3.

- Shoreline faults’ northern and southern extents identified as targets 2.2 and 2.7 in IPRP Reports 2 and 3.

IPRP comments: The survey approach combining larger 2-D survey areas and nested highest-resolution 3-D surveys promises the most success in obtaining a slip rate, the most critical seismic hazard parameter on the Shoreline fault. The 3-D method, in particular the “coherency” plots, may provide one of the most objective fault characterizations so far. These plots are unusually clear in locating the fault with very high confidence. Although the southern end of the Shoreline fault has yet to be determined, this method promises to be successful. We anticipate that this method will be used to characterize the fault linkages of the southern end of the Shoreline fault as recommended in IPRP Report 2.

Agenda title **presentation** 4: 2012 Low Energy 2-D Marine Seismic Reflection Survey, *(Gary Greene*)

This brief presentation reiterated the future 3-D targets outlined in the previous presentations. The focus was on the future survey areas presented as data gaps in the previous presentation. An example of the 3-D fault imaging capability was presented with a coherency time slice plot of the southern mapped extent of the Shoreline fault with two fault branches cutting submerged remnant channel.

Agenda title **presentation** 5: Overview 2012 High Energy Seismic Survey (*Nishenko, Vardas)*

The various configurations of the high energy seismic survey track lines were discussed with associated maps (Presentation 6). The initial “Draft EIR” configuration consists of 4 areas:

* Southern coastline-parallel survey from San Luis Bay to Point Buchon, Zone 1
* Southern west survey along the Hosgri fault zone to Estero Bay, Zone 2
* Northern survey along Hosgri fault zone from Estero Bay to Cambria, Zone 3
* Central survey Estero Bay, Zone 4

Maps showing these zones with additional areas including “Marine protected areas” (MPAs) and the “Monterey Bay National Marine Sanctuary” (NMS) were presented. The survey track lines are designated as run-ins, run-outs, survey tracks and line changes.

The proposed alternative configuration III (b) in the Draft EIR is the same as the original described above with the northern Zone 3 eliminated. An alternative labeled: ”Box 2/Box 4 overlap” was presented, in which the original Zone 2 was lengthened and Zone 4 was extended and rotated counter clockwise to be perpendicular to the shoreline. The reasoning for this alternative is to collect more relevant data in the Hosgri- Los Osos-Shoreline fault intersection region.

IPRP comments: On August 20, 2012, the State Lands Commission approved surveys “generally consistent” with those shown as Alternate III (b) (which eliminates the northernmost Zone 3). It is not known whether the “Box 2/Box 4 overlap variant is now formally part of the proposed survey configuration.

Agenda title presentation 6: Marine Survey (*Kent, Driscoll*)

Dr. Kent reviewed the evolution of marine high energy seismic reflection technology with a focus on the capabilities of the proposed vessel, the R/V Marcus Langseth. Additionally, he presented examples of state of the art seismic reflection projects as they may relate to the proposed DCPP survey. As there have been discussions in previous IPRP meetings as to whether the National Science Foundation owned R/V Marcus Langseth was sufficient to accomplish the proposed high energy survey comparable to current “industry standard” oil company platforms, Kent contrasted these methods.

His presentation emphasized that while “state of the art” oil company seismic reflection platforms are impressive, they have evolved for a very specific and narrow geological target that includes deep water salt dome related structures. In contrast, the R/V Marcus Langseth, a former “industry” ship, has been upgraded to provide the best capability to image a wider array of structures, including faults.

Additionally, the R/V Marcus Langseth, because it tows 4 streamers instead of the 10-14 streamers common in the industry, has the ability to image in much shallower water, where several proposed DCPP survey targets are located. In his opinion, Dr. Kent emphasized that a 10-14 streamer platform will have great difficulty and will risk streamer loss in water less than 75 m deep. Dr. Kent concluded that the 10-14 streamer array common in the industry would yield lesser quality imaging because the wide-swath could lead to unaccounted for anisotropic effects in the shallow crust. Due to these factors, Dr. Kent contends that optimal streamer configuration for shallow water is closer to the 4-streamer configuration found on the R/V Marcus Langseth.

In summary, Dr. Kent presented the concept that the “industry” seismic reflection platforms are optimized for deep water surveying, whereas the R/V Marcus Langseth has advantages in shallow water and that an industry deep water platform would present a mismatch of platform to geological target.

Previously, the IPRP had requested details about the CCCSIP regarding the data acquisition and data processing flow and their integration. The IPRP’s main concern is how these tasks are optimized to characterize the geologic targets most valuable for input to the seismic hazard evaluation of DCPP. In particular, IPRP Report No. 3 noted that,

*“Imaging the detailed geometry and continuity of the Shoreline fault will be especially sensitive to the quality of data acquisition and processing techniques in the shallow water overlying its trace. Surveys of such ‘transition zones’ are more challenging than purely on-shore or deeper-water off-shore surveys. The IPRP is particularly interested in acquiring expert review of the data acquisition geometry and data processing sequence proposed in this area.”*

Dr. Kent’s presentation responded to these requests, without going into detail. Dr. Kent stated that the proposed data processing procedure is essentially identical to industry standards and would be performed by industry leaders such as GeoTrace or Fugro. The data processing flows presented were marked as “typical”. This processing would include all industry level QA/QC procedures.

IPRP comments: The IPRP has discussed the types of details that would allow us to verify that the survey design and processing are optimized for the targets of the survey. For instance, industry standard is to optimize a specific processing approach through modeling the seismic response of the expected target. The presentation by Dr. Kent responded to many of these earlier requests and provided much useful information.

In addition, IPRP member Dr. Bruce Gibson (acting in his role as San Luis Obispo County Supervisor) has written a letter to PG&E asking some of the same questions as have been raised in previous IPRP meetings. Although Dr. Gibson’s letter was not a formal communication from the IPRP, PG&E sent their response to the IPRP as well as to Dr. Gibson, and it is discussed in a separate section below.

Agenda title presentation 8: Onshore Survey (*O’Connell*)

Presentation title: Irish Hills 2-D/3-D Seismic Reflection Survey: 2012 Program

This presentation was a continuation of O’Connell’s first presentation focused on future targets in the “detailed” and “very detailed” perimeter survey areas centered on DCPP.

A summary of desired survey attributes as presented is given below:

Very Detailed Imaging is Required Within 0.6 Miles of DCPP

–Strike and dip vary rapidly with depth and position in the top 1-2 km

–3-D imaging requires regular surface

–Mini-Vibroseis with 30 ft Iseis Sigma node spacing (1000 nodes)

–Large Vibroseis with 100 ft Fairfield node spacing (2500 nodes)

–Determine optimal sweeps

–Determine source infill to compensate for missing source receiver stations.

Detailed Imaging is Required within 5 Miles of DCPP

–Large Vibroseis with 300 ft Fairfield node spacing (3000 nodes)

–Mini-Vibroseis infill for areas where large Vibroseis cannot access

–Fairfield node continuous recording to capture earthquake ground motions.

–Mini-Vibroseis 5-10 ft Iseis Sigma node spacing (1000 nodes) high-resolution 3-D imaging of age-dated uplifted marine terraces to map bedrock surface, soil stratigraphy, and piercing points in the terraces.

IPRP comments: As discussed above, this on-shore investigation may provide observations relevant for issues 2.8: Los Osos Dip, 2.9: Los Osos Sense of Slip and 2.10: Los Osos Slip Rate. Overall, the broad objective of developing a tectonic model of the Irish Hills will be greatly improved by this work. Presentations to date have focused on the methods of conducting these surveys The IPRP is looking forward to presentations on the implications of this survey on the geometry of faults beneath the Irish Hills. The quarterly briefings/meetings such as the one described in this summary allow PG&E to report on its progress and help facilitate a productive informal exchange of scientific viewpoints. The IPRP would like to schedule the next briefing in the near future.

**Further discussion of survey design parameters**

As noted above, Dr. Bruce Gibson (in his role as San Luis Obispo County Supervisor) requested that PG&E provide information regarding CCCSIP survey design details and approach (letter dated June 20, 2012). PG&E responded with a letter dated July 13, 2012 (DCL-2012-637). We refer to the above mentioned documents for a more comprehensive discussion of specific CCCSIP design concerns.

Because the PG&E response generally covers material similar to presentation 6 above, we generally note these clarifications with brief summaries as follows.

1. Request:- Descriptions of the overall design approach for the offshore, onshore and transition zone seismic reflection surveys. This should include a summary of seismic hazard relevant targets and the geophysical methods used for their characterization.

PG&E Response: “The overall design approach for both LESS and HESS studies is dictated by the technical goals to be addressed as well geographic setting of the site (e.g. water depth, navigation obstacles), the capabilities of the survey vessel(s) and equipment, as well as environmental and permitting constraints. “ A table was provided which summarizes the target region, technical issue and method used; whether low or high energy, and 2-D and/or 3-D. An important result which bears directly on the planned HESS survey and the feasibility of useful imaging in the highly chaotic Franciscan Complex, which underlies the region, was obtained from the 2011 pilot test onshore 3-D seismic reflection surveys. Preliminary results indicate that the 3-D surveys have the ability to image many structures within the Franciscan Complex that are not recognizable with 2-D surveys.

1. Request:- Description of the data processing flow. Validation of the acquisition parameters and processing flow using conducted surveys and wave-equation modeling. This should include a discussion of the data processing contractors’ qualifications.

PG&E Response: The typical data processing flow, acquisition parameters, and receiver configurations were described in detail and presented in four summary tables.

As a validation, the following major findings from the 2011 onshore seismic reflection survey in the Irish Hills were presented:

(1) Successful imaging of reflectors within the Franciscan basement can be accomplished, contrary to previous expectations.

(2) The identification of swept frequency and geophone spacing parameters

necessary to capture both shallow and deep imaging.

(3) There is a higher expectation of success in imaging the Transition Zone through the use of on-shore and off-shore seismic sources.

The contractors’ experience was discussed in greater detail and the following contractors were listed:

**Marine Navigation Processing**: NCS SubSea (Houston, TX; http://www.ncssubsea.com/).

**Marine Seismic Data Acquisition and Processing:** Contractors from well-established firms such as Fugro Geoteam (Houston, TX; http://www.fugro-geoteam.com/) and/or GeoTrace (Houston, TX; <http://www.geotrace.com/>).

**On-shore Seismic Data Acquisition and Processing**: Onshore, Nodal Seismic

(Signal Hill, CA; http://www.nodalseismic.com/) and Bird Seismic Services (Globe, AZ; http://www.birdseismic.com/).

**Transition Zone Data Collection and Processing**: FairfieldNodal (Sugar Land, TX; http://www.fairfieldnodal.com/) will be responsible for the Transition Zone data

collection using up to 600 Z700 marine nodes.

In its response to Dr. Gibson, PG&E states that, “PG&E is currently working with industry seismic processing companies to update the 2011 Illumination study, based on improved velocity models from 2011 onshore survey, to optimize marine node placement as well as onshore and offshore imaging capabilities. Recognition of environmental restrictions, including placement of nodes on hard (rocky) bottom, avoidance of protected species, etc. need to be addressed before the final node configuration is established.”

“A number of industry contractors have been identified to conduct both the onshore and offshore seismic data acquisition and processing for the CCCSIP. All of the work performed will be in compliance with Nuclear Quality Assurance (NQA-1) requirements as stated in 10 CFR 50, Appendix B and10 CFR 21. The proposed processing flow for the 3D Diablo Canyon project will embody the latest, cutting-edge seafloor multiple removal and seismic imaging techniques (among a myriad of recent advancements) that are currently available within industry processing shops.”

1. Request:- Discussion of the proposed 4-streamer narrow-azimuth survey in contrast to “industry” standard wide-azimuth 10-14 streamer arrays. In particular, image quality and survey acquisition efficiency should be addressed.

PG&E Response: The response consists of a detailed comparison of the larger “industry standard” 10 plus streamer vessels versus the proposed R/V Langseth 4-streamer vessel. The relevant issues that lead to the R/V Langseth choice are summarized:

- R/V Langseth can survey in water depth as shallow as 25 meters versus “industry standard” vessels limit is 75 meters. Many critical targets for the CCCSIP are located in water depths shallower than 75 meters.

- The narrower-swath 4-streamer configuration proposed for the CCCSIP 3-D survey should provide crisper less noisy images, because anisotropic effects are less than those encountered during wide-swath geometry surveys.

- There may be no efficiency gains from using a larger vessel due to difficulties in navigation.

**Summary**

In general, the IPRP finds that PG&E has responded effectively to the stated concerns and has shown that the proposed high energy survey appears to be designed to efficiently acquire the data most relevant to seismic hazards at DCPP. While IPRP is reassured that the data acquisition will be conducted using industry-level QA/QC and is expected to be processed with techniques typically employed in current industry surveys, some questions remain unresolved regarding important components of the CCCSIP. The IPRP anticipates that further discussion with PG&E will be needed to fully address the remaining issues that Dr. Gibson has raised in separate communications with PG&E.

On August 20, 2012, the California State Lands Commission (SLC) approved a permit for survey alternative III (b) allowing PG&E to conduct its off-shore seismic survey between the time period October 15 through December 31, 2012, provided that air guns cannot be used until November 1, 2012 to minimize the impact on marine mammals. If not completed during this time period, PG&E may complete its surveys during the same time window in 2013 without having to seek another permit from the SLC. We note that Alternative III (b) is consistent with the IPRP’s recommendation to eliminate the northernmost survey area Zone 3 as stated in IPRP Report No. 3. Additionally, SLC has directed that independent third-party review by qualified experts be conducted. The IPRP anticipates that it will contribute to the selection of contractors and summary of the results of this third-party review.

As noted in IPRP Report No.3, peer review of details of the seismic survey design and data processing are beyond the current expertise of the IPRP, whose members’ expertise is in hazard analysis. Additionally, peer review of such seismic survey design details as vessel selection, data acquisition, collection, data processing, analysis and interpretation are beyond the original scope of the IPRP. The State of California has no known standards regarding the technical capabilities of seismic survey designs, the vessel used, or the individuals who process the data. For this reason, the IPRP has previously suggested outside expert review of data acquisition and data processing techniques. The IPRP is working with the CPUC to develop an arrangement to retain the services of necessary outside technical experts to assist the IPRP with seismic data acquisition and data processing techniques. Such independent review of survey details would alleviate the IPRP’s remaining concerns about the high energy off-shore survey.

**IPRP membership**:

California Geological Survey

California Coastal Commission

California Emergency Management Agency

California Energy Commission

California Seismic Safety Commission

California Public Utilities Commission

County of San Luis Obispo