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Barbara Byron
California Energy Commission
1516 Ninth Street, MS-36
Sacramento, CA 95814

RE: PG&E's Comments on the Draft Consultant Report, "AB 1632 Assessment of California's Operating Nuclear Power Plants," dated September 2008

Dear Ms. Byron:

Attached are Pacific Gas and Electric Company's (PG&E) Comments on the Draft Consultant Report, entitled "AB 1632 Assessment of California's Operating Nuclear Power Plants," dated September 2008. PG&E appreciates that the Commission's consultants incorporated much of the information submitted in our data responses, and believes that, in many areas, the report accurately describes the operation of the Diablo Canyon Power Plant.

However, there are some errors, and some instances where the report fails to recognize the substantial benefits that Diablo Canyon provides, including GHG-free, affordable generation that ensures grid reliability and resource adequacy for PG&E customers. Our detailed comments are attached to this letter, and we respectfully urge that the consultant report be edited to reflect them in its final version. In addition, we have attached written responses to the questions you submitted to us after the report was released.

PG&E appreciates the opportunity to participate in the report process, and continues to look forward to working with the Committee in the development of its recommendations.

Sincerely,

Mark Krausse

EXECUTIVE SUMMARY

In the report's focus on the technical aspects of vulnerability and potential risks and issues that need to be addressed the report loses sight that Diablo Canyon is:

- The largest source of emission free generation in the State
- Among the least cost sources of generation in the State and the lowest cost power within PG&E's portfolio; and
- The most reliable power in the state.

PG&E believes that the report should clearly state these important assets of the Diablo Canyon facility in the Executive Summary. Such acknowledgement is factually accurate and compliments the thorough review conducted by the report authors.

General Comments

The discussion of the seismic hazard conclusions for DCPP highlight extreme interpretations (Hosgri is 100% reverse) that are not supported by the data and within the professional community. These conclusions do not follow from the discussion in the text and should not be part of the executive summary.

The issue of a reverse fault occurring under DCPP is presented as something new that was developed based on the San Simeon earthquake and that had not been considered in the previous evaluations. This case has been previously addressed by PG&E as part of the LTSP. As noted in the Chapter 2, a magnitude 6.8 earthquake was considered on the Los Osos fault which dips westward under the plant. Magnitude 6.1-6.5 earthquakes were considered for the Southwest Boundary faults. The conclusion that this is a new key issue for DCPP does not follow from the material presented in Chapter 2.

Detailed Comments

Page 11, bottom paragraph

Text should read "San Luis-Pismo structural block", not geologic block.

Page 12: Item 4:

What is the reference for the consensus fault model? This discussion in Chapter 2 regarding the UCERF model does not address the dip angles of the bounding faults.

Page 14, Paragraph 3:

The closest distance from DCPP to the Hosgri is 4.5 km, not 6-8 km as stated in the text.

Page 16, Paragraph 3:

The tsunami hazard maps being developed at USC were originally to be used for evacuation planning and not hazard assessment. Their usefulness for hazard assessment was not intended by the USC researchers.

Page 18, Vulnerability of Spent Fuel Storage Facilities:

The statement "PG&E is investigating the water-tightness of conduits in its reactor buildings" (page 18) is incorrect. The spent fuel pools are in the Auxiliary Building at DCPP (since we are a pressurized water reactor), not the Reactor Building (KKNPS is a boiling water reactor).

Pages 23, 25 and 223

The report states that the spent fuel pool can be decommissioned when the current license expires without additional dry storage being required. PG&E would like to clarify that that the dry cask storage was sized to accommodate spent fuel storage thru 2021/2025 which was the original Units 1 and 2 operating license periods. When PG&E recaptured 3 additional years for Unit 1 to extend its life to 2024, the balance between storage capacity and fuel use was slightly modified. With this change the Diablo Canyon facility does not currently have enough combined storage capacity to completely offload the Unit 1 pool. As we approach the end of our license, PG&E will seek additional ISFISI storage.

Pages 24 and 29

The report states that more study is required to assess the impact of a dry cask storage facility on local property values, business, and tourism, as current academic research into this issue is very limited. PG&E disagrees with this assertion as studies have not found negative correlation and in fact the experience in San Luis Obispo County indicates that the property values are among the highest in the nation.

Pages 28 and 29

PG&E disagrees with the assertion that additional modeling is needed to fully understand the economic and environmental tradeoffs, as well as the implications on the California power grid, of permanently retiring Diablo Canyon. Contrary to the assertion that license renewal would commit the company and the state for 20 years to operate, plant license renewal in reality provides the option and flexibility for the plant to continue to operate.

CHAPTER 1: INTRODUCTION

Page 33, Paragraph 4:

The dates for the public workshop and written comments should be corrected to reflect the new schedule.

CHAPTER 2: SEISMIC VULNERABILITY OF THE DIABLO CANYON AND SONGS SITES

General Comments

Overall, the report provides a good description of the seismic sources that impact the seismic hazard at the DCPP site.

The focus of the chapter is currently on rare design basis events that may impact safety at the plants. Since a key objective of the report is to address the reliability of DCPP and SONGS, we recommend that this chapter focus on more likely earthquakes that are lower than the design basis, but which could damage non-safety related systems and impact reliability and restart times. Seismic hazard curves should be shown and earthquakes with a reasonable chance of occurring during the plant life (e.g.10% chance in the next 20 years) should be identified. For example, for DCPP this could be a magnitude 6 1/4 earthquake at a distance of 15 km with a PGA of 0.2g. While this event will not impact safety related SSCs, its impact on the non-safety related SSC that are required for DCPP to operate should be considered in Chapter 3.

The report identifies a M6.5 earthquake on the Southwest boundary zone under DCPP as potential source that should be considered. This type of earthquake was considered by PG&E in the LTSP. As noted in the report, a magnitude 6.8 earthquake on the Los Osos fault was included in the LTSP source models. The hazard analysis considered dips of 60 degrees (weight of 0.7) and 30 degrees (weight of 0.3). This range encompasses the 45 degree dip used by the Study Team. The report should note that the postulated M6.5 earthquake under DCPP falls within the range of sources considered by PG&E.

The landslide hazard discussion (page 70) notes that landslides could temporarily block the access road. It should be noted that DCPP has an alternative access route (the north access road to Montana del Oro State Park) which could be used in an emergency. There is also an annual slope stability and shoreline erosion monitoring program to identify potential landslide hazards.

Detailed Comments

The chapter 2 title should be changed to "Seismic Hazards at the Diablo Canyon and SONGS plants". The vulnerability is addressed in chapter 3.

There are a number of minor comments listed below that address errors in the text. None have a significant impact on the conclusions, but they should be corrected.

Page 36, Paragraph 2:

The text states that the movement on dip-slip faults is "vertical". This is not correct for most dip-slip faults. The movement has both horizontal and vertical components for any fault dip other than 90 degrees. Revise the text as follows" "Movement on these types of faults during earthquake rupture is perpendicular to the strike and includes both vertical and horizontal components of movement.

Page 36, Paragraph 2:

The description of oblique faulting is not correct. It should be modified as follows: "Movement both along strike and down dip can occur in an earthquake. The combination of strike-slip and dip-slip movement is referred to as oblique faulting"

Page 37, Paragraph 1:

The ground motion is not "directly proportional to the distance" as stated in the text. Almost all ground motion models scale as (Dist + C)^N so at short distances that are of most concern, the ground motion is not directly proportional to distance. The text should be changed to "the ground motion from earthquakes decreases with increasing distance from the site to the fault rupture".

Page 38, Paragraph 3:

Smaller magnitude earthquakes do not always produce lower ground motions than larger magnitude earthquakes due to the large variability of the ground motion. Change the first sentence as follows: "... linked to the earthquake magnitude: on average smaller earthquake magnitudes produce smaller ground motions, and larger earthquake magnitudes produce larger ground motions; however, due to the large variability of ground motion, for any single earthquake, the ground motion from a smaller magnitude earthquake will in some cases be larger than the ground motion from some larger magnitude earthquake"

Page 39, Paragraph 4:

The ongoing work of the LTSP is reviewed by the NRC staff, but not by the USGS and UNR.

Page 40, Paragraph 1:

The LTSP research has been peer reviewed. This should be indicated. Change the text to read: "because of the volume of peer-reviewed research available ..."

Page 41, Table 1:

The slip-rate for the Los Osos fault listed in Table 1 is not consistent with the values listed in the reference (Slemmons and Clark, appendix D of SSER-34). Slemmons gives two ranges: 0.13 – 0.33 (for the Ingley trench) and 0.25-0.80 (for the Marine terraces). The full range should be 0.13-0.80 not 0.07-0.80 as listed in Table 1.

The slip rates for the Southwest Boundary faults listed in Table 1 are also not consistent with the values in the reference (Slemmons and Clark). It is not clear how the values in Table 1 (0.16-0.30 mm/yr) were computed. What faults are included in this slip rate?

The maximum magnitudes listed in Table 1 are not in a consistent format (ranges vs mean and standard deviation). The values given in the text (page 45) for the Southwest Boundary faults (5.8 to 6.6 with a mean of 6.1) are not consistent with the values listed in Table 1 (6.15-6.5). Based on the LTSP, the maximum magnitude for the Southwest Boundary faults is 6.15 +- 0.22. For the Hosgri fault, the maximum magnitude is 6.96 +- 0.27

Page 43, Paragraph 1:
The LTSP divided the Los Osos fault into 4 segments between 8 and 19 km, not 8 – 21 km as stated in the text.

Page 43, Paragraph 2:
The recent slip along the Los Osos fault has been dip-slip, but not "nearly vertical along the fault plane". Delete the words "that is, nearly vertical along the fault plane". (This is related to the comments on page 36 about types of faults)

Page 43, Paragraph 2:
PG&E used dips of 30 degrees (0.3 weight) and 60 degrees (0.7 weight). This gives the 51 degree weighted average, but it would be helpful to list the range of dips in addition to the average. This shows that the 45 degree dip scenario postulated by the study team is within the range considered in the PG&E model.

Page 43, Paragraph 3:
The range of slip rates given in the text for the shallow trench evaluation is 0.07-0.33 but this should be 0.13 – 0.33.

Page 48, Paragraph 1:
The text states that PG&E modeled fault rupture scenarios for the Hosgri using segment lengths between 22 and 110 km with lengths of 45 and 70 km carrying the majority of the weight. The range of the lengths should be 20 (not 22) – 110 km. The weights depended on the mechanism and are as follows:

SS: 20 (0.25), 45 (0.4), 70 (0.25), 110 (0.1)
OBL: 20 (0.5), 45 (0.3), 70 (0.1), 110 (0.1)
RV: 20 (0.5), 45 (0.3), 70 (0.2)

The majority of the weights are on 20 km and 45 km, not 45 and 70 km.

Page 51, Paragraph 2:
It is not just the LTSP geologists and seismologists that believe the Hosgri is strike-slip, but most who have worked on the Hosgri support a strike-slip characterization. Change the text to read "Most geologists and seismologists that have evaluated the Hosgri fault believe that it is a strike-slip fault; however, ..."

Page 52, Paragraph 2:
The NRC did not require PG&E to use 1/3 reverse and 2/3 strike-slip for the Hosgri. Rather, as part of its own evaluation, the NRC used 1/3 Rev and 2/3 SS with the Campbell ground motion model to compare to the PG&E spectra based on 0.05 Rev, 0.3 oblique/reverse and 0.65 strike-slip. In Campbell's ground motion model, reverse and reveres/oblique were combined together (they give the same ground motion) so the separation of the weights into reverse and reverse/oblique was not considered in the NRC model.

The use of 1/3 Rev and 2/3 SS is not the cause for the increased long periods. The increased long periods result from the Campbell ground motion model. This model excludes hard-rock data and includes both soil and soft-rock sites. Since soil sites have larger long periods than rock sites, the Campbell model lead to larger long period ground motions as compared to the PGE spectra that were based on data from rock sites (combined hard-rock and soft-rock).

Change the text to read: "The NRC subsequently conducted its own evaluation of the ground motion from the Hosgri fault using 67 percent strike-slip and 33 percent thrust faulting with the Campbell ground motion model. Using the Campbell model, they found an increased long period content as compared to the PG&E model. The NRC required PG&E to consider the envelop of the PG&E spectrum and the Campbell spectrum for defining the LTSP spectrum.

Page 52, Paragraph 3:
The interpretation for the LTSP studies did not conclude that the Oceanic fault was a pure strike-slip fault, but rather modeled the Oceanic-West Huasna system as a right oblique reverse fault.

Page 54, Paragraph 2:
The difference in the dips interpreted for the Los Osos fault (30-60) by PG&E and those associated with the San Simeon rupture is not large as indicated in the text. The report does not list the dip assumed for the San Simeon rupture. Most models show the rupture as occurring on a 50-60 degree dipping fault.

What is the basis for the report indicating that there is a large difference?

Page 71, Paragraph 3:
The 1927 Point Arguello earthquake should be called the 1927 Lompoc Earthquake to be consistent with the earlier section in the Chapter.

The tsunami height for the 1927 Lompac earthquake is listed a 7 ft in the report. There is no reference for this value. The largest wave height that NOAA gives for this earthquake is 6 ft.

Page 75, para 2

The text states that ground motions in the strike-normal direction are always larger than in the strike-parallel direction. This is not correct. There is a large variability of ground motions. On average, the strike-normal is larger, but not always.

Change the text as follows: " ... ground motions in the strike-normal direction are, on average, larger than in the strike-parallel direction"

Page 75, Paragraph 4

The text states that the variability in near-fault motions observed in the Parkfield earthquake was larger than previously expected. The referenced paper by Shakal et al states this, but it is folklore and is not correct.

The key issue here is that ground motion is modeled using a lognormal distribution. That means that the range of ground motions is a scale factor from the average (not an arithmetic sum). When we see ground motions are larger distances, then seeing a factor of 10 range (e.g. 0.01 to 0.1g) does not seem large, but when we see the same range of a factor of 10 for close in data (e.g. 0.2 to 2g) earth scientists that were not experienced with ground motion data were surprised.

Using the Parkfield data recorded within 20 km of the fault, the standard deviation of the PGA is 0.53 natural log units. The standard deviations for the ground motion models commonly used at the time (Abrahamson and Silva, 1997; Sadigh et al, 1997, Campbell, 2003) give standard deviations for PGA from a magnitude 6 earthquake of 0.47 – 0.55. The latest NGA models (which do not include the Parkfield earthquake in the data sets) give slightly higher values of about 0.6 natural log units.

The key conclusion from the variability observed in the Parkfield earthquake is that the variability from a log normal distribution seen in data from larger distances is applicable to the near-fault region. This has been the standard assumption used in ground motion models for seismic hazard studies. In recent years, there have been paper published objecting to the extrapolation of the variability to short distances and claiming that the log normal distribution is not applicable. But the Parkfield data show that this is appropriate.

Change the text to read: "ground motion recordings for the magnitude 6.0 earthquake that struck Parkfield, California in September 2004 indicate the importance of inclusion of the variability of the ground motion and that the large variability from empirical ground motion models is applicable to the near-fault region for a single earthquake."

CHAPTER 3: SEISMIC VULNERABILITY OF THE DIABLO CANYON AND SONGS PLANTS

General Comments

The multiple sets of seismic criteria for DCPP can cause confusion. The terms SSE and OBE were not defined when DCPP received its original license and so it was based on the DE and DDE. The DE and DDE are still part of the license, but the NRC considers the Hosgri Earthquake spectrum to be the SSE for DCPP. The plant meets all of the requirements using the Hosgri Earthquake as the SSE. It would be easier to follow the discussion in this chapter if the report said that the Hosgri Earthquake is being used as the SSE for the purpose of this evaluation. There is really no need to compare with the DE or the DDE in this report.

Detailed Comments

Page 101, Paragraph 3:
The 2003 San Simeon earthquake did not occur on the San Simeon Fault as stated in the text.

Page 101, Paragraph 4:
The text lists the magnitude for the 1975 earthquake near Humboldt as 5.5. The local magnitude for this earthquake is 5.3.

Page 109, Table 3:
There are several inaccuracies with regard to DCPP's design

- "Fuel Building" (actually part of Auxiliary Building at DCPP) is safety-related, not "partially safety-related"
- The turbine building is "partially safety-related," not "not safety related" (since it contains the diesel generators, vital electrical power system switchgear, and vital cooling water heat exchangers)
- Footnote 234 is misleading - the area of the turbine building housing the diesel generators is not "self-contained" - the diesel generator rooms are integral with the overall turbine building structure. In addition, the vital cooling water heat exchangers are located in the central region of the building, not specifically separated from the turbine generator area

Page 111, Impact of an OBE:

- Statement "Balance of plant support systems will become inoperable until emergency diesel generators power emergency load busses" is incorrect. Since the BOP support systems are not powered from the emergency load busses (aka "vital" busses), they do not receive power from the EDGs and will remain inoperable until off-site power is restored.

- Statement "A reactor could likely return to service immediately following inspections, with repairs continuing in areas that are separate from those supporting nuclear power generation" is incorrect. Even if undamaged, the reactor cannot be restarted until the BOP equipment is restored (e.g., operation of the condensers and turbines is required before the reactor can restart).

Page 111, Impact of an SSE:

- Statement "As with an OBE, an SSE is not expected to cause any damage within buildings.... and balance of plant support systems" is not correct. (a) there are lots of non-safety related components inside the safety related buildings that would likely be damaged, and (b) balance of plant support systems would likely be damaged

Page 113, Impact of an Earthquake Twice as Intense as an SSE:

- It is not clear what is meant here by twice the SSE. This report defines the PGA for the SSE as 0.4 g (page 102), not 0.75 g (the Hosgri Earthquake). Does this refer to a 0.8g PGA or 1.5g PGA? If it is supposed to be 0.8g, then it would be clearer to talk about the impact of a Hosgri Earthquake. As noted in the general comments, it would help to just use the Hosgri as the SSE for this report.

- Statement "Turbine Building roof could collapse" is misleading. The weakest links for the turbine building are the east-west concrete shear walls (non-ductile failure mode), while the roof may deform significantly, but is ductile and unlikely to collapse.

Page 116: Switchyards:

The output from DCPP is through the 500 kv switchyard, which is located on very deep fill. This switchyard is extremely vulnerable to earthquake damage (local amplification, subsidence, etc.). The normal source of off-site power is through the 230 kv switchyard, which is much more robust, and, as a result of the LTSP review, has had certain upgrades, and available spare parts for quick post-earthquake restoration, however, this would not help with the ability to distribute power out to the grid, since there is not output path through the 230 kv switchyard.

Page 118: Turbine Building:

The weak links for the turbine building are the concrete shear walls. What is the basis for the conclusion that the roof could collapse as postulated in the report?

Page 119: Tank Areas:

The listed outdoor tanks (CST, RWST, FWTT) are safety related, and were significantly reinforced for the Hosgri Earthquake. They are reinforced concrete encased steel tanks with foundations that are supported by concrete fill extending down to bedrock, so damage is very unlikely.

Page 119: Tsunami Damage

The "ground level" buildings (turbine, auxiliary, and containment) are all located on a terrace at elev. 85'. This is well above the predicted maximum tsunami run-up, splash, and spray levels. Therefore, flooding of these buildings should not be a concern.

The only safety-related equipment located within the maximum tsunami elevation are the auxiliary saltwater pumps (in the intake structure). These are located inside water tight compartments, with "submarine-type" doors. These doors are normally closed, but the casualty procedure for tsunami requires that these doors be secured if a tsunami warning is received. The only vulnerability is if the tsunami height exceeds the "snorkels" which provide ventilation to the pump rooms

The current tsunami evaluation for the auxiliary saltwater system accounts for the potential drawdown of water in the intake cove. The bottom of the suction pipes are well below sea level, and, due to an undersea 'bench", a certain volume of water is impounded in front of the intake structure, even if there is a significant drawdown event.

DCPP has performed an evaluation of the potential for the loss of auxiliary saltwater flow. Credit is taken for other water sources (vital water tanks, reservoirs, etc.) for emergency core cooling.

Page 132. Conclusions:

The statement "magnitude 7.2 on the Hosgri fault" is incorrect. The postulated Hosgri Earthquake is magnitude 7.5. Though the LTSP reduced the value, all deterministic design basis evaluations for the Hosgri Earthquake are based on M7.5.

CHAPTER 4: SEISMIC AND OTHER VULNERABILITIES OF SPENT FUEL STORAGE FACILITIES, TRANSMISSION SYSTEMS, AND ACCESS ROADWAYS

Page 147, Vulnerability to Seismic or Terrorist Events:

The statement "water tightness of conduits in its reactor building" is incorrect. The spent fuel pools are in the Auxiliary Building at DCPP (since we are a pressurized water reactor), not the Reactor Building (unlike KKNPS, which is a boiling water reactor).

Page 151: Reference 331

PG&E has applied for a license amendment that provides for changes that will be implemented after the first loading campaign scheduled for the summer of 2009. All regulatory approval required to start NRC dry-runs have been received.

Page 153

The report states that temporary track systems in the refueling building have not been evaluated. It also states that fuel transfer operations over a bearing wall may imply the building floor is vulnerable to heavy load drops. PG&E is in the process of installation of a single-failure proof crane which precludes heavy load drops. PG&E has evaluated these activities in accordance with 10 CFR 50.59 and found them to be safe. The NRC will evaluate these activities to ensure that they are safe and meet all applicable NRC criteria.

Page 153, Paragraph 3

The platforms currently in the spent fuel storage pool cask pits were specifically design to accommodate the installation of a seismic restraint. The platform currently supports the temporary spent fuel rack that will be removed to facilitate installation of the seismic restraint and movement of spent fuel into dry storage.

Page 153, Second Bullet

" Fuel transfer operations must occur over a load bearing wall." This is no longer the case. In the original design we assumed that the cask was dropped from over 25 feet due to the fact that we did not have a single failure proof crane. To accommodate the drop, energy absorbers were required and the lowering operation had to occur over a load-bearing wall. We have now installed a single failure proof crane and relocated the seismic restraint/work platform. This is no longer an issue.

Page 153, Third Bullet

This needs to be rewritten. It is a requirement in our NRC license that a process be in place for opening a sealed fuel container. All requirements for performing the cutting and monitoring environmental effects are specified in the license. As part of the NRC reviewed dry-run operations, the NRC reviews the procedures and verifies that the utility has the ability to reopen a container.

There are no unanalyzed explosive force design conditions.

Page 153, Setting and Design of Diablo Canyon ISFSI:

The statement "To further strengthen the pad, rock anchors are installed...." is incorrect. The rock anchors do not strengthen the pad, they are used for stabilizing the cut-slope uphill from the pad and have no direct connection to the pad.

The statement "At times the spent fuel pool work platform..." (page 153) is incorrect. DCPP will employ a new seismic restraint, mounted in a recess in the floor of the spent fuel pool, to support the canister while it is in the pool. This seismic restraint has been specifically designed for seismic loading from the canister.

Page 154

The report states that administrative controls are used to maintain a set back distance (1200 ft) and recommends that these controls should be verified to be effective, especially for truck drivers not directly involved in ISFSI operations. The NRC which has jurisdiction of the public health and safety for ISFSI operations, has specifically reviewed the use of administrative controls and found them to be acceptable in the Safety Evaluation Report issued for ISFSI operations. The NRC will review the adequacy of these controls prior to ISFSI initial operations and periodically during the lifetime of the ISFSI.

Page 159

The report recommends that the availability of roadway materials and equipment to make necessary repairs to roadways following a seismic event be considered in the mitigation solutions of any emergency planning. PG&E maintains such equipment onsite and the County also maintains such equipment and has proven their capability during recent events such as the cliff collapse on Avila Drive.

Page 222 and 223, First Paragraph

"PG&E is currently awaiting..." See page 224 for the facts: "The NRC has not announced a date for final decision. Until a decision is made, the Diablo Canyon ISFSI license remains valid, and PG&E retains full authority to begin operating the facility as planned."

Page 226, Cost Table

The cost through 2007 for DCPP are $81 million. Storage Cask Procurement and Loading cost, in 2007 dollars, for the next 138 cask is expected to be $179 million. Construction and loading cost per assembly is $59,000.

Page 223

With the license recapture for unit 1, PG&E will be 3 casks short of being able to empty the unit 1 spent fuel pool. PG&E would have to amend our license or use a general license to expand the ISFSI beyond the current 138. This would also require a Coastal Development Permit revision to go beyond 138 storage cask.

CHAPTER 5: PLANT AGING VULNERABILITY ASSESSMENT

The report did a good job on identifying that PG&E has developed criteria and programs to identify, manage and address systems and components susceptible to aging vulnerabilities.

The report recognizes that Diablo Canyon has an excellent safety culture

The report does recognize that Diablo Canyon's workers are aging and that PG&E is actively engaged collaboration with community colleges, community base organizations, workforce investment boards and labor unions in order to recruit new employees.

CHAPTER 6: IMPACTS OF A MAJOR DISRUPTION AT DIABLO CANYON AND SONGS

The executive summary at p. 19 says that "no electricity supply shortages would occur as the result of either Diablo Canyon or SONGS being unexpectedly shut down for an extended period in the near term." PG&E does not agree with this finding.

The analysis described in Chapter 6 assumes California has available reserves of 26% with Diablo and SONGS in 2012, the year for which the analysis was done.

Peak demand	60,780 mw
Total resources	76,841
Reserve Margin	26%

PG&E believes this overstates the electric supply outlook for 2012. It assumes that sufficient capacity will come on line to hold Planning Reserve Margins (PRM) at high levels. However, among various challenges, new generation faces permitting uncertainties and rapidly escalating costs. A significant number of new generation projects that were expected to come on-line in the near future have recently been terminated or are at risk of being terminated by developers who have found many of the development challenges insurmountable.

> There currently is 913 MW of new planned generation from PG&E's 2004 LTRFO that is at risk of not coming on line as anticipated. If this occurs, PG&E's

2012 PRM would be reduced by 4.3 percent, or from 20.6 percent[1] to 16.3 percent. Similarly, PG&E's 2013 PRM would be reduced from 18.0 percent to 13.7 percent, which is below the minimum of 15 percent currently established by the CPUC. In addition, the City and County of San Francisco's (CCSF) 180 MW San Francisco Reliability Project (SFRP) is experiencing development uncertainties. Without the SFRP, the 2012 and 2013 PRM would be further reduced to 15 percent and 13 percent, respectively. If Diablo is not available, the 2012 and 2013 PRM would fall to 5% and 3%, respectively.

PG&E believes that the assumption that counting wind as 22 percent, as mentioned in the footnote on p. 208 that says that resources available include wind resources counted at 22 percent of nameplate capacity overstates the dependable capacity of wind.

CHAPTER 7: NUCLEAR WASTE ACCUMULATION AT DIABLO CANYON AND SONGS

Page 238

The report claims Class A disposal costs will be much larger than the D&D estimates of $250/ft3. The report does not grasp that Class A resin disposal is about $500/ft3 while trash and debris is about $150/ft3. Since most of the waste is trash and debris a "blended" cost of about $250/ft3 is probably a good estimate.

CHAPTER 8: LAND USE AND ECONOMIC IMPLICATIONS OF THE ON-SITE WASTE STORAGE

The report provides no justification that reuse of the Diablo Canyon site for open space and recreation would bring any economic revenues to the state or San Luis Obispo County and certainly and not to the level of the hundreds of millions of dollars annually provided by Diablo Canyon.

In addition reliance on solar thermal development to provide the same tax revenues is misplaced as the California Constitution exempts solar thermal owned by independent generators from the type of tax revenues that account for the large amount of revenue currently provided to the state and San Luis Obispo County from Diablo Canyon.

The report fails to acknowledge the breadth of the positive economic activity on the government especially the local school districts and local business economy that would be lost if the plant is shutdown.

[1] D.07-12-052 at p. 116

- 600 million dollars in annual economic benefit to the County
    - 24 million dollars in property tax
    - Head of household salaries are 60 percent higher than the County average
    - Payroll of 100 million dollars annually

CHAPTER 9: POWER GENERATION OPTIONS

PG&E agrees with the preliminary conclusion that replacing the nuclear plants with the selection of renewable technologies would come at a non-trivial cost to California.

Based on technical potential estimates of various resource alternatives presented in Table 22, the draft report says that "It is evident ... that potential cost-effective renewable energy resources are abundant in California." The draft, however, fails to explain the basis it uses to conclude that abundant cost-effective renewable resources are available. At a minimum, the report should compare the cost of the renewable resources with alternative conventional resource cost to determine which renewable resources are cost-effective. The cost-effectiveness metric should reflect not only the renewable resource cost, but also the additional transmission needed to access those resources and any integration costs needed to meet incremental operating requirements associated with intermittent resources, if applicable.

The low end of the alternative resources costs shown in Table 23 seems unrealistic.

PG&E is also concerned with the conclusions presented in Table 25 – Summary of Life Cycles and Environmental Impacts of Generation Technologies. Specifically, the life cycle environmental impacts of intermittent generation technologies do not address the fact that conventional resources need to be added to meet the incremental regulation, load following, ramping and back-up their intermittent generation.

The analysis comparing nuclear and other technologies, which is presented in Table 30, should be done on a $/MWh basis rather than on a $/kW basis, and the comparison should account for the differences in reliability contribution that each technology provides. For example, comparing 2,000 MW of dependable nuclear capacity against 2,000 MW of dependable wind capacity makes no sense because wind's dependable capacity is less than 10% of the installed capacity, so rather than 6,000 MW of installed wind capacity as the draft assumes is needed to provide 2,000 MW of dependable capacity, the system will need close to 20,000 MW of wind installed capacity. However, 20,000 MW of wind installed capacity will produce more energy than the 2,000 MW of nuclear generation. Therefore, the study should compare the technologies on a $/MWh basis but recognizing the reliability, and other differences in the type and quality of the generation that they produce.

Page 262, First Paragraph

AB 32 mandates that the state's greenhouse gas emissions be reduced to 1990 levels by 2020. This equates to a reduction of 169 million tonnes of CO2 equivalent emissions. If reductions are assigned on a proportionate level, the electric sector would be expected to reduce emissions by approximately 42 million tonnes. In this context, the shut-down of Diablo Canyon and SONGS would add an additional 14-18 million tonnes of CO2, effectively pushing the goal line out to 56-60 million tonnes per year. Since renewables would require considerable fossil backup and firming, under the best scenarios, shut-down of these plants would mean considerable additional CO2 tonnage.

Page 275 -- Once Through Cooling Section
Second and Fourth paragraphs

The report states that larger marine animals are sometimes entrained and notes that Diablo Canyon entrains 1 large marine animal annually. This is incorrect. Diablo Canyon does not entrain large marine animals. During 23 years of plant operation, no large marine animals have been lost due to the once-through cooling system. A total of 8 sea turtles have been rescued from the area between the curtain wall and bar racks and released unharmed.

The report states that Diablo Canyon entrains over 1.8 billion fish per year. PG&E requests that this statement be revised to state that fish eggs and larvae are entrained, not fish. It is important to note that over 99% of these eggs and larvae would not survive to adulthood, regardless of entrainment in the once-through cooling system.

Page 276

The report states that Diablo Canyon's thermal discharge has "greatly altered" 1.4 miles of coastline. PG&E requests that the report clarify that the area affected is the intertidal and shallow subtidal area within Diablo Cove and that the effect is primarily a shift to indigenous species that are more tolerant of warmer water. Additionally, the measurement of coastline uses a 1:9.000 scale, which is much more detailed than commercially available maps, measuring not only major coastal features but smaller features such as boulders, rocks, and surge channels. This finer scale mapping technique results in a coastline estimate that is roughly 20% greater than a standard mapping technique.

Page 277

Table 28 states that Diablo Canyon impinges roughly 400 fish per year, entrains 1.8 billion fish, and impacts 1.4 miles of shoreline. As noted above, PG&E requests that this table be revised to reflect that 1.8 billion fish eggs and larvae (not fish) are entrained, that roughly 800 pounds of fish per year are impinged, and that the altered habitat is limited to Diablo Cove. [BRYAN]

Page 278
Paragraph 1 (from prior page)
The report states that "intakes in deep waters located near rock outcrops (Diablo Canyon) . . .could also have significant impingement and entrainment impacts." PG&E would like to clarify that Diablo Canyon's intake is a shoreline intake, not a deep water intake.

Paragraph three
The report states that "Entrainment losses can be partially mitigated by placing mesh screens over the intakes." PG&E disagrees with this statement as the efficacy of fine mesh screens is site specific. PG&E has evaluated the possibility of fine mesh screens on several occasions and determined that this technology will not work in the open ocean environment at Diablo Canyon. The screens are too susceptible to clogging from marine debris -- and appear likely to turn "entrainment" into "impingement" -- survivability is not at all proven. No agency has found that this technology would be workable at Diablo Canyon.

CHAPTER 10: STATE CONSIDERATIONS FOR LICENSE RENEWAL

Once-Through Cooling Retrofit Costs

Page 303
First paragraph
The report states that "Diablo Canyon and SONGS currently use once-through cooling to cool their reactors." This statement is incorrect. Once-through flow is used to remove heat from and condense steam that has passed through the turbine generators. The steam used to spin the turbines is generated within a separate closed loop system. The once-through flow does not come in contact with or cool equipment directly related to the reactors. [BRYAN]

Page 303 – Proposed Regulations
Second paragraph
The report's discussion of the proposed regulations for once-through cooling does not include any reference to or discussion of the Supreme Court's review of the Second Circuit decision. Certiorari was granted in April 2008 and review will address only the validity of using cost-benefit analysis to establish the standard or grant a variance from it. Oral arguments are scheduled for December 2, 2008 and a decision is expected in the first half of 2009.

Third paragraph
The report states that CSLC "passed a draft resolution requiring existing power plants to fully comply (or work toward full compliance) with federal and states water regulations, PG&E requests that this sentence be revised to indicate that the resolution dealt specifically with Clean Water Act Section 316(b) compliance - not water regulations generally. Also, footnote 831 notes that PG&E was among the petitioners challenging the CSLC's April 2006 resolution. PG&E would like to clarify that it did not directly

challenge the resolution. A petition was filed by the California Council for Environmental and Economic Balance (CCEEB) and PG&E is a member of CCEEB.

Page 305 - Retrofit Feasibility and Cost
First paragraph
The report states that "With regard to nuclear power plants, converting to wet cycle closed-cooling has received the most study, because dry cooling is not considered a commercially viable option." PG&E asks that this sentence be revised to indicate that dry cooling is not feasible at Diablo Canyon due to space constraints.

Page 306 – California Ocean Protection Council
The report includes a summarized discussion of the findings in the Tetra Tech Report. PG&E disagrees with many of the statements and findings of the Tetra Tech Report and believes it to be a wholly inadequate basis on which to make a determination of the feasibility of cooling tower retrofit. Given the inadequacy of the Tetra Tech Report, PG&E has continued to evaluate the feasibility of a cooling tower retrofit and a new assessment prepared by Enercon, Inc. will be completed during October 2008. This new and more thorough evaluation provides the following findings in four key areas:

Engineering and Construction Challenges
- four twenty-cell tower arrays required (347,000 SF footprint)
- Relocation of major buildings (likely offsite) and rerouting of ISFSI road
- Excavation of over 2 million cubic yards of rock and soil
- Major modifications to existing systems including condensers, service cooling heat exchangers and electrical system
- Extremely difficult tie-in process to existing underground facilities
- Downtime of at least 18 months

Nuclear Safety Challenges
- Increased flood risk to safety-related systems from cooling tower water
- Increased risk of interruption to auxiliary salt water system and fire systems during construction
- Accelerated aging of plant equipment and possible plant trips from salt deposition

Adverse Environmental Impacts
- Salt deposition of 7 million pounds per year
  arcing concerns and impact on agricultural and terrestrial habitat
- PM10 emissions likely cannot be permitted by SLOAPCD
- Plume would be over 2,460 feet high 35% of the year, often as long as 5 miles
  visible from Avila Beach 80 days a year and from SLO 70 days a year
- Fossil-fueled replacement power for the 18 month downtime will emit 8-10 million tons of GHG per year.
- Permanent loss of an average of 55 MW would also have negative impact on GHG emissions.
- Remaining discharge of approximately 100 MGD would require offshore diffuser

- Permitting, in addition to air quality mentioned above, would be extremely difficult.

Economic Challenges

- Capital costs would exceed $2.6 billion
- Replacement power costs estimated at $1.8 billion total = $4.4 billion
- Costs are conservative, as they assume that the plant will maintain current capacity levels (other than the average 55 MW derating) – and this is highly unlikely given the extremely complex nature of a retrofit.

Page 307 Paragraph two

The report states that the "change in quantity and characteristics of effluent discharge could require amended NPDES permits (if required at all)" PG&E would like this statement revised to reflect that fact that the remaining discharge would include cooling tower blowdown of 72 million gallons of a day and another 25 million gallons a day from systems remaining on a separate once through cooling system. This discharge would clearly require an NPDES permit and due to its high salinity content, installation of an offshore diffuser system would be required. Conceptually, the diffuser would be approximately 1600 feet long, would include 600 individual discharge dispersion nozzles, and would require a 36 inch diameter pipe.

Page 308 - Others

The report states that PG&E "commissioned a study of the economic benefits of reductions in entrainment losses from installing cooling towers at Diablo Canyon" and then goes on to cite findings from the study. While PG&E commissioned a benefits valuation study performed by Triangle Economic Research in 2005 and had it peer-reviewed by two resource economists, the cites in the paragraph are to a 2003 study of cooling tower feasibility prepared by Burns Engineering.

ADDITIONAL DATA RESPONSES

Request:

1. Please describe the field work and seismic investigations (including geologic, seismologic, tsunami, and ground motion studies) that PG&E is conducting or has conducted in the vicinity of Diablo Canyon or along the central coast of California over the past three years.

2. Please provide copies of completed studies and estimated dates of completion for studies currently underway.

3. Please also describe field work and seismic investigations that PG&E plans to complete over the next five years.

Response:

These three questions overlap and we have prepared one integrated response. We first describe PG&E's approach to earthquake research through public-private partnerships. Next we describe the ongoing program to update the seismic hazard in central coastal California. Finally, we describe the nearly completed updated tsunami hazard study for DCPP. The overall schedule for this work is shown in Table 1.

Table 1. Schedule for Completion of Ongoing Work

	Seismic Hazard Tasks
2007	Evaluation of existing data, planning of field work
2008-2009	Field work, data collection
2009-2010	New tectonic models for central coastal California
2007 - 2010	Ground motion models
2011	Hazard evaluation
2012	Final report
	Tsunami Hazard Tasks
2008	Complete final report

Public-Private Partnerships Earthquake Research

In 1992 the Pacific Gas and Electric Company (PG&E) established a Public-Private Partnership, as part of a Cooperative Research and Development Agreement (CRADA) with the US Geological Survey (USGS). The initial partnership focused on characterizing earthquake hazards in the San Francisco Bay Area. In 1996, PG&E worked with the California Seismic Safety Commission to establish the Pacific Earthquake Engineering Research Center (PEER), Lifelines Program. Caltrans joined the Public-Private Partnership in 1998 providing additional leveraged funding for earthquake engineering research. In 1999, the California Energy Commission PIER program provided funding during the period of 1999-2004 for the PEER Lifelines program to support earthquake research on the performance on key components of the electric transmission system. Studies of system reliability during earthquakes, such as those

needed to address the central theme of reliability given in AB1632, were proposed through the PIER program, but were not selected by the CEC for funding.

In 2003 the PG&E/USGS CRADA was modified to include evaluations of the 2002 Denali, Alaska earthquake. In 2003, Alyeska Pipeline Service Company joined the CRADA. The PG&E/USGS/Alyeska CRADA was completed in 2006. The Denali earthquake is relevant to the seismic hazard at DCPP as it impacts evaluations of fault segmentation and near fault ground motions.

In 2005, in part due to the occurrence of the 2003 San Simeon and the 2004 Parkfield earthquakes, the PG&E/USGS CRADA was modified to include the central coastal California region. The CRADA's central coastal California program now is into the second year of a five-year (2007-2011) seismic hazards update effort for this region. The status of the central coastal California program is described below.

Central Coastal California Seismic Hazard Update

PG&E is currently supporting a major update of the seismic hazard in the central coastal California region including development of new source characterization models and the ground motion models. The source characterization work includes collecting new geophysical and geological data (under the PG&E/USGS CRADA) that will be used to develop an improved tectonic model for the central coast region. The ground motion work includes developing new empirical ground motion models and improved numerical simulation methods for near-fault ground motions. PG&E will use the updated models to update the probabilistic seismic hazard analysis for DCPP, scheduled to be completed in 2012. Some details about the ongoing work are given below.

Geographic Positioning System (GPS)

As part of the PG&E/USGS CRADA for the central coastal California region, the USGS is in the process of compiling all of the existing Geographic Positioning System (GPS) data for coastal central California. Many GPS sites where data has been collected in the past will be reoccupied to increase the length of the observation period at those sites to obtain better velocity measurements. New GPS station locations are also being established to fill gaps in coverage along the coastal region and develop an appropriately dense and evenly distributed network. The plan is to establish up to 20 new GPS sites within the next few years. Figure 1 shows the locations with previous GPS measures (mostly campaign deployments). The planned new GPS profiles are shown by the black lines. The number next to the lines indicate the priority for installation of the new GPS network.

Potential new station locations are first being identified and permitted in the vicinity of San Luis Obispo, and will extend northwest and southeast from there in the following years. A new GPS station was established near DCPP in May 2008. Approximately 3 to 5 years of observations will be necessary to obtain high-precision rate estimates due to the relatively low levels of tectonic motion in the region. Therefore, these new data may not provide important constraints for the current hazard update, but the collection of this type of data needs to get started so that it will be available for use in future updates.

SAR Immagery

As part of the PG&E/USGS CRADA, the USGS is also using satellite Synthetic Aperture Radar (SAR) imagery collected between 1992 and 2007 to characterize the spatial extent and temporal variability of surface deformation. An example of SAR imagery is shown in Figure 2. While the SAR data does not have the accuracy of GPS, it provides observations over a large region. The SAR data can be used together with the GPS data to constrain the spatial extrapolation of the GPS point measurements.

In addition to complimenting the point GPS measurements, these data will also be used to guide the deployment of new GPS stations to minimize the deformational influence of ground water pumping and hydrocarbon production. The initial area of emphasis for this analysis is the San Simeon- Irish Hills region and will systematically expand to cover the entire central coast region during the next 2 years

Aero-Magnetic Surveys

The USGS previously collected high resolution areo-magnetic data along the San Andreas fault, but not along the central coastal California region. As part of the PG&E/USGS CRADA, high resolution aero-magnetic data were collected by the U S Geologic Survey along the central California coast in the summer of 2008. Figure 2 shows the area for which the high-resolution areo-magnetic data were collected. This data fills in the missing gaps in the areo-magnetic data and provide an improved framework for the identification and interpretation of subsurface geologic structures. Plans for data reduction and analysis are presently scheduled during the 2009.

Bathematric and Marine Magnetic Surveys

The USGS is currently collecting high-resolution bathemetric data only the California Coast, out to a distance of 3 miles. As part of the CRADA, the study area was extended further off-shore in the central coastal region to capture the Hosgri fault (Figure). The scope of the study was also expanded to include the collection of marine magnetic data in the central coastal region. The new bathmetric and marine magnetic data were collected by the USG in the summer of 2008. The data reduction will be completed in 2009. These data will help to constrain the locations of off-shore faults and will be incorporated into the new tectonic model.

Seismic Reflection Studies

As part of the CRADA, the USGS is reprocessing seismic line J-6 (Figure 5). This reprocessed data will be used to help constrain the 3-D tectonic model.

Geologic Studies

As part of the CRADA, the USGS is compiling the current geologic information for the central coastal California region. To date, no field studies have been conducted as part of the PG&E/USGS CRADA. Starting in 2009, there are plans to develop improved mapping of the marine terraces with the objective of using the warping of the terraces to constrain thrust faulting in the region. The warping of the marine terraces is considered one of the most promising constraints for testing the thin-skin and thick-skin models.

Balanced Cross-Sections

The primary tool used for developing the thin-skin tectonic model has been balanced cross-sections. Current research is addressing the uncertainties in balanced cross-sections (Conners, 2008). PG&E is supporting work to develop uncertainty estimates for balanced cross-sections that can be applied to the central coastal region. This work is planned to be implemented in 2009.

Seismic Networks

PG&E continues to operate a seismic network in the central coast region that was first installed in 1986. The network is currently being upgraded from short period seismometers to broadband seismometers. Figure 5 shows the configuration of the network. Six broadband stations have been installed so far with 14 additional broadband stations to be installed in the coming years. The data from this network are provided to the USGS and are used by the USGS for locating earthquakes in the region. The data from this network leads to more accurate locations and focal mechanisms, particularly along the Hosgri fault, which are important for constraining the tectonic model for the region

The data from this network were recently used to study the San Simeon earthquake and area summarized in a paper by McLaren et al (2008). This network data is being used to develop improved 3-D velocity models for the central coast region and to develop an updated earthquake catalog for the central coast region.

Updated Tectonic Model for Central Coastal California

Using the newly collected geophysical data, geological data, earthquake locations, and other available data for the region, the USGS will develop an updated tectonic model for the central coastal region. Both the thick skin and thin skin models will be evaluated and a set of alternative credible models will be selected that will then be used in the hazard analysis. This work is scheduled to be completed in 2010.

Empirical Ground Motion Studies

PG&E is one of the sponsoring organizations for the Pacific Earthquake Engineering Research (PEER) Center's Next Generation Attenuation (NGA) project. This project began in 2002 to take advantage of the large increase in the number of strong motion recordings close to large earthquakes (Figure 7). New empirical ground motion models for the horizontal component response spectral values and new models for directivity effects developed in the NGA project were published in Earthquake Spectra in 2008. The key changes from previous ground motion models are (1) smaller median ground motions for large strike-slip earthquakes, (2) larger median ground motions for sites over the hanging wall of buried thrust earthquakes, and (3) increased standard deviation of high frequency ground motions for large magnitude earthquakes.

The ongoing NGA work at PEER is focused on developing empirical ground motion models for vertical component, fault normal and fault parallel scale factors, and fling effects. The ongoing work is scheduled to be completed by December 2009.

Numerical Simulation Ground Motion Studies

PG&E is supporting the development of improved numerical simulations of ground motion at the USGS and at SCEC. SCEC is being supported to develop a standard numerical simulation platform for conducting finite-fault simulations. This platform is based on the kinematic approach, shown schematically in Figure 8. The key issue for use of kinematic models is the specification of the inputs (the timing, amount and direction of slip) at each of the grid points on the fault as shown in Figure 8. Previous studies have used marginal distributions for the inputs without regard to their correlation, often resulting in unrealistic simulated ground motions. Through the PG&E/DOE cooperative agreement, numerical simulation methods based on dynamic rupture models are being developed through SCEC and the USGS. The dynamic rupture models are based on simple physical models of the rupture process and incorporate the correlations of the source parameters. These models are used to constrain the kinematic model inputs. The standard kinematic platform is scheduled to be completed in 2009.

Once the platform is completed and the constraints on the input source parameters are developed, suites of numerically simulated ground motions will be generated for DCPP. The resulting ground motions based on the improved numerical simulation methods will supplement the empirical models developed as part of the NGA project. The site-specific numerical simulations for DCPP will be completed in 2010.

Soil/Structure Interaction Research

PG&E is conducting a study on spatial coherency of ground motion over short distances that is used as part of the input to soil/structure interaction analyses for DCPP structures. This was originally called the "newmark tau-effect" during the licensing of DCPP. It was used to estimate the reduction in the motion of a large foundation as compared to free-field ground motions from the attenuation relations. New empirical data from dense arrays as well as numerical simulations of scattering in 2-D and 3-D structures are being used to develop the new coherency models. This will be an update to the recently developed EPRI (2005) models which was based on a very limited empirical data set. This work is scheduled to be completed by December 2009.

Tsunami Hazard Update

PG&E is currently completing a report for an updated tsunami hazard at DCPP. PG&E conducted a probabilistic tsunami hazard analysis for DCPP including tsunamis triggered by local and distant earthquakes, as well as local submarine landslides. Numerical simulations of the tsunami run-up from all relevant sources were computed for the DCPP intake and discharge structures. Wave heights from both tsunami and storms were considered in the hazard analysis. Full probabilistic models including both the aleatory variability and the epistemic uncertainty were included. The results of this study found that the hazard from tsunami is dominated by the distant earthquakes and that the frequency of submarine landslides were very low so that they did not contribute significantly to the hazard. For DCPP, the hazard from storms without tsunamis is by far the dominant source for large waves. The report for this study is scheduled to be completed by December 2008.

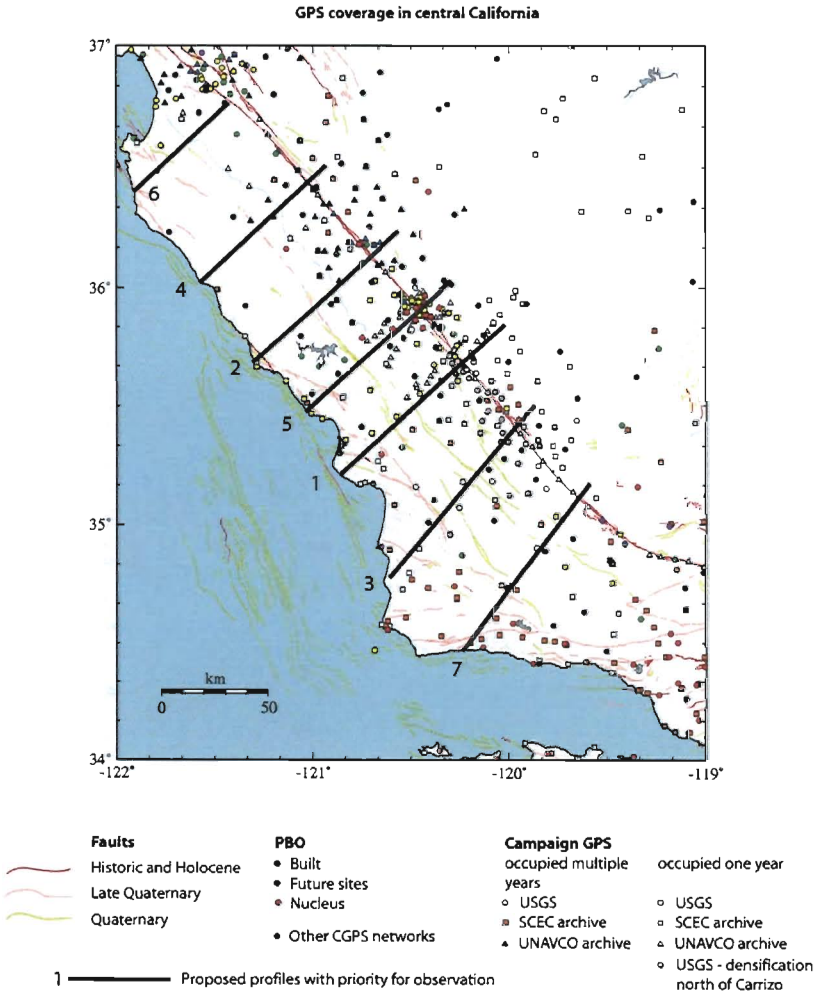

Figure 1. Previous GPS sites (dots) and the planned GSP surveys (lines). The numbers next to the lines indicate the priority of the lines.

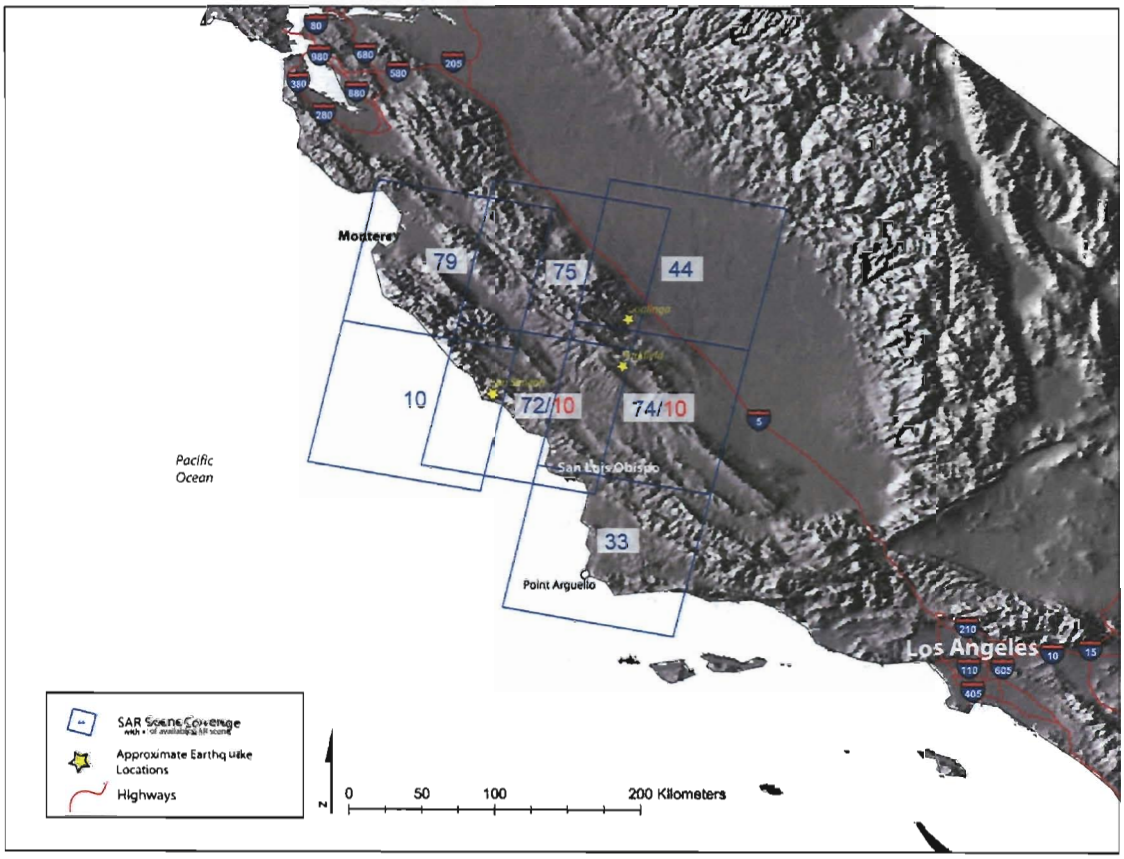

Figure 2. SAR imagery coverage the is currently available.

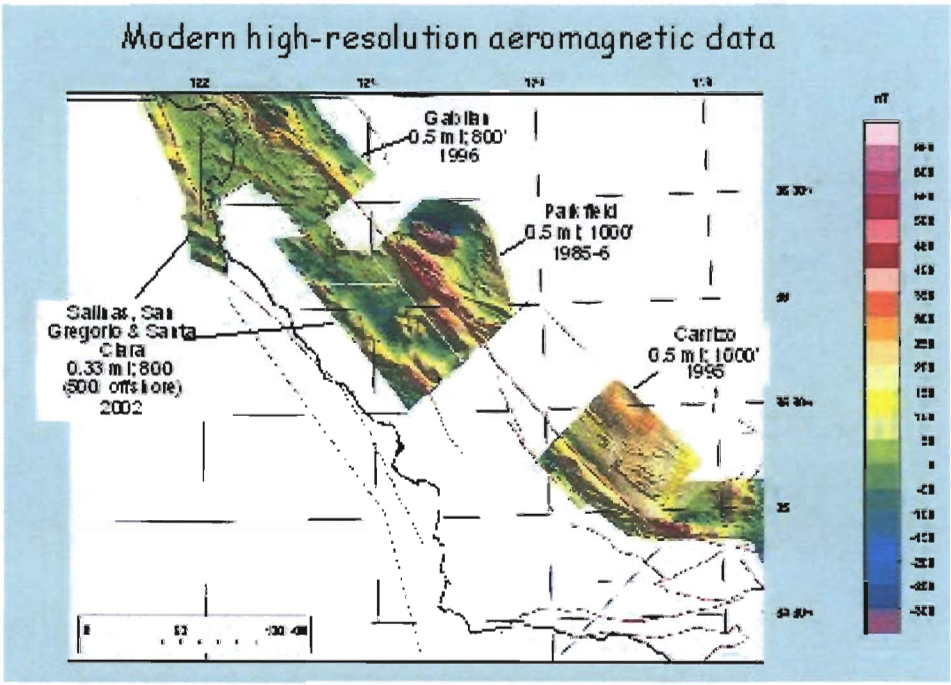

Figure 3. High resolution areo-magnetic data previously collected by the USGS.

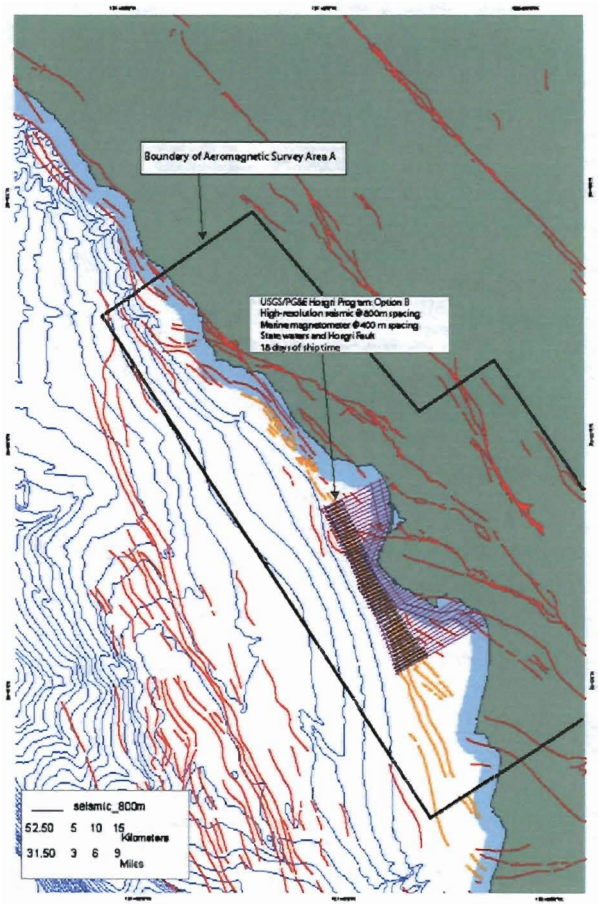

Figure 4. The region for collection of new high-resolution bathemetric data and marine magnetic data is shown by the hatched zone. The light blue band is the 3-mile region that the USGS is addressing as part of other studies. The black box shows the extent of the new areo-magnetic data (see Figure 3).

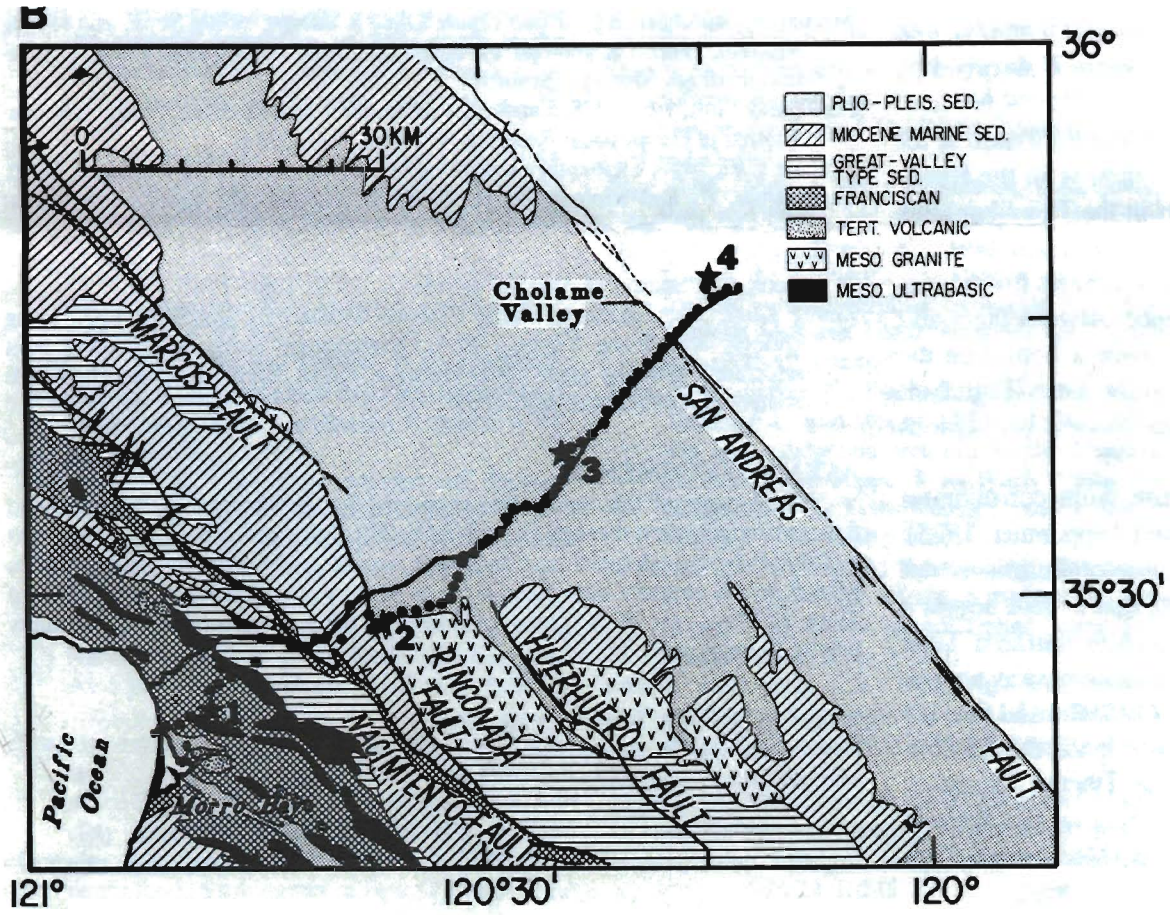

Figure 5. Seismic reflection line J-6 that is being reprocessed.

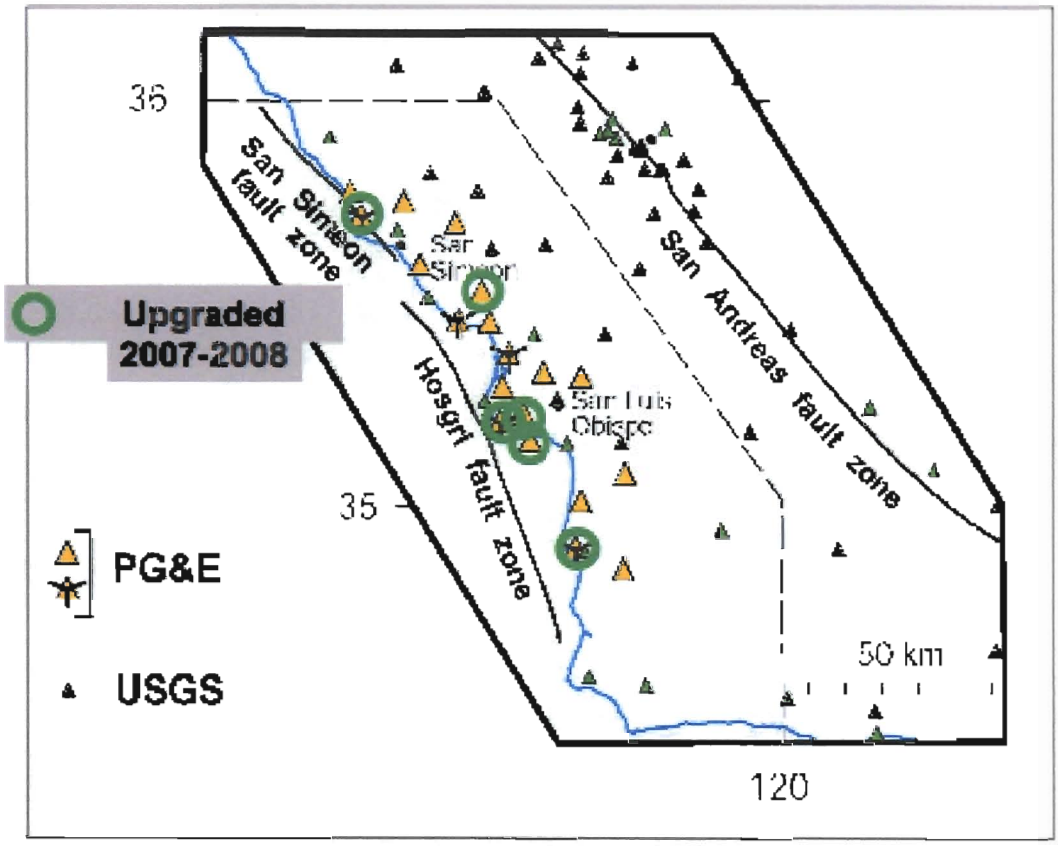

Figure 6. Configuration of the PG&E DCPP seismic network. The stations that have been upgraded to broadband sensors are shown by the green circles.

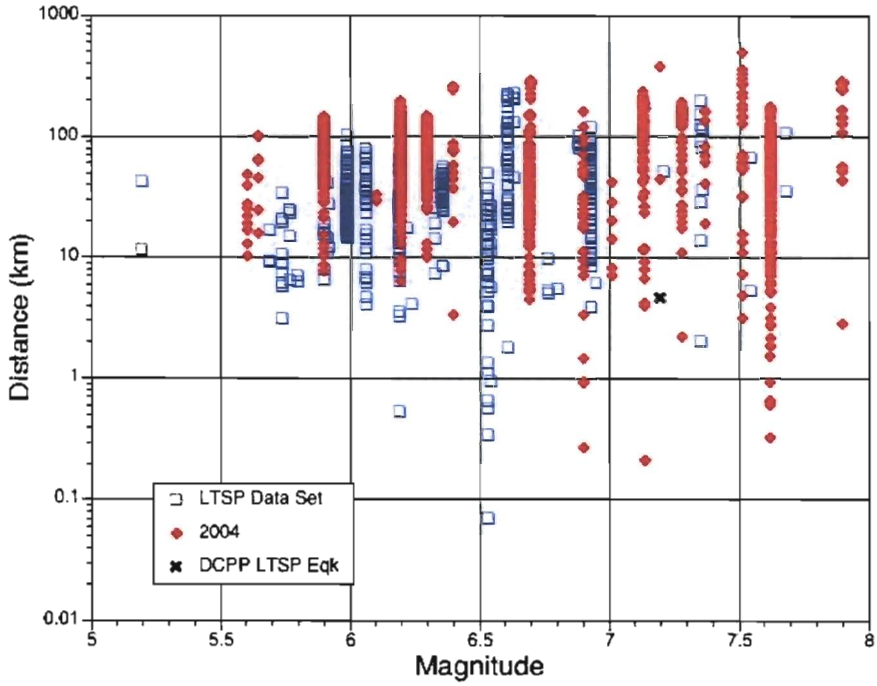

Figure 7. Comparison of the strong motion data that were available during the LTSP and the data used during the NGA project. The LTSP earthquake (M7.2, distance of 4.5 km) is shown by the black x.

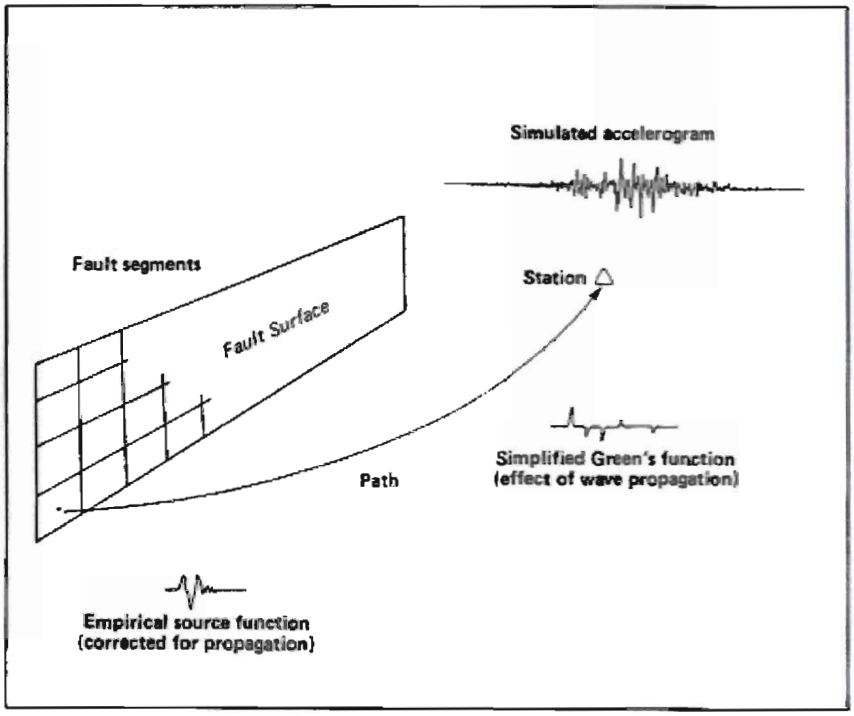

Figure 8. General approach to numerical simulations of strong ground motions.