July 21, 1989

Docket Nos. 50-275 and 50-323

MEMORANDUM FOR: George W. Knighton, Director
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects

FROM: Harry Rood, Senior Project Manager
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects

SUBJECT: FORTHCOMING MEETING WITH PACIFIC GAS AND ELECTRIC COMPANY (LONG TERM SEISMIC PROGRAM, TAC NOS. 55305 AND 68049)

DATE & TIME: August 8, 9, and 10, 1989 - 8:30 a.m. to 5:00 p.m.

LOCATION: Room 6-B-11
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

PURPOSE: DISCUSS EARTHQUAKE SOURCE CHARACTERIZATION, DIABLO CANYON LONG TERM SEISMIC PROGRAM

*PARTICIPANTS:

NRC	PG&E
G. Bagchi	L. S. Cluff
R. McMullen	F. W. Brady
L. Reiter	K. Coppersmith
H. Rood	et. al.
R. Rothman	
et. al.	

original signed by

Harry Rood, Senior Project Manager
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects

cc: See next page

Contact: H. Rood (301) 492-1352

*Meetings between NRC technical staff and applicants or licensees are open for interested members of the public, petitioners, intervenors, or other parties to attend as observers pursuant to "Open Meeting Statement of NRC Staff Policy," 43 Federal Register 28058, 6/28/78.

DRSP/PD5 HR
HRood
07/21/89

DRSP/D:PD5
GWKnighton
07/21/89

Memo 4
cc

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

July 21, 1989

Docket Nos. 50-275
and 50-323

MEMORANDUM FOR: George W. Knighton, Director
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects

FROM: Harry Rood, Senior Project Manager
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects

SUBJECT: FORTHCOMING MEETING WITH PACIFIC GAS AND ELECTRIC COMPANY (LONG TERM SEISMIC PROGRAM, TAC NOS. 55305 AND 68049)

DATE & TIME: August 8, 9, and 10, 1989 - 8:30 a.m. to 5:00 p.m.

LOCATION: Room 6-B-11
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

PURPOSE: DISCUSS EARTHQUAKE SOURCE CHARACTERIZATION, DIABLO CANYON LONG TERM SEISMIC PROGRAM

*PARTICIPANTS:

NRC	PG&E
G. Bagchi	L. S. Cluff
R. McMullen	F. W. Brady
L. Reiter	K. Coppersmith
H. Rood	et. al.
R. Rothman	
et. al.	

Harry Rood

Harry Rood, Senior Project Manager
Project Directorate V
Division of Reactor Projects - III,
IV, V and Special Projects

cc: See next page

Contact: H. Rood (301) 492-1352

*Meetings between NRC technical staff and applicants or licensees are open for interested members of the public, petitioners, intervenors, or other parties to attend as observers pursuant to "Open Meeting Statement of NRC Staff Policy," 43 Federal Register 28058, 6/28/78.

Mr. J. D. Shiffer
Pacific Gas and Electric Company

Diablo Canyon

cc:
Richard F. Locke, Esq.
Pacific Gas & Electric Company
Post Office Box 7442
San Francisco, California 94120

Ms. Sandra A. Silver
660 Granite Creek Road
Santa Cruz, California 95065

Mr. Peter H. Kaufman
Deputy Attorney General
State of California
110 West A Street, Suite 700
San Diego, California 92101

Managing Editor
The County Telegram Tribune
P. O. Box 112 Chairman
San Luis Obispo, California 93406

Ms. Nancy Culver
192 Luneta Street
San Luis Obispo, California 93401

Regional Administrator, Region V
U.S. Nuclear Regulatory Commission
1450 Maria Lane
Suite 210
Walnut Creek, California 94596

Dr. Gerard C. Wong, Chief
Radiological Materials Control Section
State Department of Health Services
714 P Street, Office Building #8
Sacramento, California 95814

NRC Resident Inspector
Diablo Canyon Nuclear Power Plant
c/o U.S. Nuclear Regulatory Commission
P. O. Box 369
Avila Beach, California 93424

Bruce Norton, Esq.
c/o Richard F. Locke, Esq.
Pacific Gas and Electric Company
Post Office Box 7442
San Francisco, California 94120

Dr. R. B. Ferguson
Sierra Club - Santa Lucia Chapter
Rocky Canyon Star Route
Creston, California 93432

San Luis Obispo County Board of Supervisors
Room 270
County Government Center
San Luis Obispo, California 93408

Michael M. Strumwasser, Esq.
Special Assistant Attorney General
State of California
Department of Justice
3580 Wilshire Boulevard, Room 800
Los Angeles, California 90010

cc:

Dr. Keiiti Aki
Department of Geological Sciences
University Park
University of Southern California
Los Angeles, California 90089-0741

Dr. Ralph J. Archuleta
Department of Geological Sciences
University of California Santa Barbara
Santa Barbara, California 93106

Dr. Robert D. Brown, Jr.
U.S. Geological Survey
Mail Stop 977
345 Middlefield Road
Menlo Park, California 94025

Dr. David B. Slemmons
Center for Neotectonic Studies
MacKay School of Mines
University of Nevada-Reno
Reno, Nevada 89557-0047

Dr. Robert Fitzpatrick
Building 130
Brookhaven National Laboratory
Upton, New York 11973

Dr. C. J. Costantino
Building 129
Brookhaven National Laboratory
Upton, New York 11973

Dr. Michael Bohn
Sandia Lab. - Organization 6412
Post Office Box 5800
Albuquerque, New Mexico 87185

Dr. Steven M. Day
Department of Geological Science
San Diego State University
San Diego, California 92182

Dr. George Gazetas
Dept. of Civil Engineering
212 Ketter Hall
SUNY-Buffalo
Buffalo, New York 14260

Dr. Jean Savy
Mail Code L-196
Lawrence Livermore National Laboratory
P. O. Box 808
Livermore, California 94550

Dr. Anestis S. Veletsos
5211 Paisley Avenue
Houston, Texas 77096

Dr. Ken Campbell
U.S. Geological Survey
P.O. Box 25046, Mail Stop 966
Denver Federal Center
Denver, Colorado 80225

Dr. M. K. Ravindra
EQE
3150 Bristol Street, Suite 350
Costa Mesa, California 92626

Dr. J. Johnson
EQE
595 Market Street - 18th Floor
San Francisco, California 94105

DISTRIBUTION
Docket File
NRC & LPDR
PDV Reading File
T. Murley/J. Sniezek
J. Partlow
G. Holahan
M. Virgilio
H. Rood
W. Lanning
OGC
E. Jordan
B. Grimes
Receptionist, White Flint
G. Bagchi
R. McMullen
L. Reiter
R. Rothman
ACRS (10)
GPA/PA
V. Wilson
L. Thomas
H. B. Clayton
G. Cook, RV
M. Mendonca, RV
P. Narbut, RV
J. Lee

DF01
1/1

016

2 JUL 21 1989

MEMORANDUM FOR: Goutam Bagchi, Chief
Structural & Geosciences Branch
Division of Engineering, NRR

THRU: Andrew J. Murphy, Chief
Structural & Seismic Engineering Branch
Division of Engineering, RES

Daniel Guzy, Section Leader
Structural & Seismic Engineering Branch
Division of Engineering, RES

FROM: Richard McMullen, Geologist
Structural & Seismic Engineering Branch
Division of Engineering, RES

SUBJECT: DIABLO CANYON LONG TERM SEISMIC PROGRAM (LTSP)

Enclosed for your use is a draft summary of meetings held at the Pacific Gas & Electric Company's (PG&E) office in San Francisco concerning the subjects of geology, seismology, and geophysics. Attendees included representatives from PG&E and its consultants, the NRC and its advisors, the U.S. Geological Survey (USGS) and the University of Nevada, Reno (UNR), the ACRS consultants, the California Division of Mines and Geology, and the public.

The purpose of the meeting was for PG&E to respond to USGS, UNR, and NRC requests for additional information and to update reviewers on findings since publication of the LTSP final report.

Original Signed by
Richard McMullen

Richard McMullen, Geologist
Structural & Seismic Engineering Branch
Division of Engineering, RES

Enclosure: As stated

cc e/encl: L. Reiter
R. Rothman
H. Rood

DISTRIBUTION: RESReading DCS R-2411 RMcMullen DGuzy AMurphy RBosnak LShao

DF03
11

SSEB/DE/RES	SSEB/DE/RES	SSEB/DE/RES
RMcMullen:fkm	DGuzy	AMurphy
RBM	RBM for	AJM
7/21/89	7/21/89	7/21/89

8907250100 890721
RES SUBJ
2411 CDC

Memo 4
cc

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

DIABLO CANYON LONG TERM SEISMIC PROGRAM

A meeting was held at the Pacific Gas and Electric office in San Francisco on June 12 through June 16, 1989 among the Pacific Gas and Electric Company (PG&E) and its geological and geophysical consultants, the Nuclear Regulatory Commission (NRC) and its advisors, the U.S. Geological Survey (USGS) and the University of Nevada, Reno (UNR), the Advisory Committee on Reactor Safeguards (ACRS) geological and geophysical consultants, and the California Division of Mines and Geology (CDMG). The purpose of the meeting was for PG&E to respond to requests for additional information by the USGS, UNR and NRC transmitted to PG&E in April, 1989, and to update the reviewers on data and analyses acquired since publication of the Long Term Seismic Program Final Report.

GENERAL TOPICS OF THE MEETING SUMMARY

12 June, 1989

I. SUMMARY OF MAJOR CONCLUSIONS

PG&E presented a summary of the general findings of the Long Term Seismic Program (LTSP) as described in detail in the Final Report, an overview of plate interaction, and regional and site area tectonics. The following are conclusions derived by PG&E as a result of the LTSP:

(1) The Hosgri Fault Zone is predominantly a right lateral strike slip, high angle dipping fault.

(2) Slip rate on the Hosgri ranges from 1 to 3 mm/yr of strike slip displacement.

(3) Vertical slip rate varies along the fault but is estimated to be 0.1 to 0.2 mm/yr.

(4) The Los Osos Fault, a reverse fault, forms the northwest boundary of the San Luis-Pismo structural block.

(5) The Casmalia-Orcutt Fault Zone bounds the southern margin of the San Luis-Pismo block.

(6) A zone of discontinuous faulting that includes the Pecho, Wilmar Avenue, San Luis Bay, Olson, Oceano, and Santa Maria River Faults comprise the southwest margin of the block.

(7) The Hosgri Fault Zone is the northeastern boundary of the San Luis-Pismo block, where the block is impinged against it.

(8) Strike slip displacement is transferred between the Hosgri and San Simeon Faults by means of a right en echelon step, late Quaternary pull-apart basin.

(9) A slip rate along the Hosgri and San Simeon fault zones of 1 to 3 mm/yr is consistent with the observed Late Quaternary deformation in the pull-apart basin.

(10) The rate of vertical slip along the southwest boundary of the San Luis-Pismo block is estimated to range from .02 to 0.1 mm/yr.

(11) The vertical rate of slip on the Los Osos Fault is 0.2 to 0.5 mm/yr.

(12) The San Luis Pismo block, bounded on the northeast by the Los Osos Fault, is a domain of northeast crustal shortening.

(13) Crustal shortening is accommodated on the Hosgri Fault.

(14) The Santa Maria domain to the south is experiencing more westerly directed shortening.

II. UNIVERSITY OF NEVADA RENO

The University of Nevada Reno (UNR) presented the status of its independent investigations and of its review of the LTSP. As far as the UNR is concerned there are 3 unresolved major issues: (1) the character and location of the southwestern boundary of the Pismo block; (2) the possibility of upward partitioning of oblique strain at depths on the Hosgri Fault Zone and (3) segmentation.

1. Southwestern boundary: The deficit in vertical displacement between that of the Los Osos Fault and the total amount estimated on mapped faults of the southwest boundary systems appears to require another fault similar to the one postulated by Nitchman in his thesis. The southwest boundary zone is similar to the Los Osos in that the three cross cutting structures affect both, particularly from Point Buchon to Morro Bay. A bathymetric linear on the wave cut platform shown in the PG&E data, the straight coastline, the narrowness of the wave cut platform along that portion of the coast, and the erosion characteristics of ocean waves acting on the headlands with varying resistant rock types versus uplift rates were also described as bases for postulating an additional fault along the southwest boundary.

2. Strain partitioning along the Hosgri Fault Zone: The presence of both low angle thrust and high angle strike slip splays may be explained by oblique slip at depth being partitioned into vertical displacement on the thrust

strand and horizontal displacement on the high angle strand. Analogies of this phenomenon from other parts of the world were presented.

It was pointed out that strain partitioning would require that both fault components of the Hosgri would have to be currently active. However, evidence indicates that the thrust splay is not active.

3. Segmentation: the segments proposed by PG&E for the Hosgri Fault Zone, the Los Osos Fault, and the southwest boundary lack the consistency observed in other segmented faults such as the San Andreas, Wasatch, etc. Additionally, with respect to known segmented faults, segmentation points are important in the early stages of the fault, but are less important as the fault becomes more established.

III. U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey (USGS) presented outstanding issues that it recognized concerning the dip, subsurface geometry, sense of slip, and segmentation of the Hosgri and the Los Osos Fault Zones; the analysis of the 1927 earthquake; the logic tree method as used by PG&E; and the possibility of alternate models to explain tectonic conditions in the region, such as the Namson model.

1. Dip of the Hosgri Fault Zone: evidence that the Hosgri has a flatter dip than PG&E interprets include: (a) although the vertical component shows a dip of 80-90 degrees near the surface, seismic records show a dip of 65 degrees at 3 to 4 km depth, (b) below, where west verging thrust faults merge with the Hosgri, the dip of the Hosgri becomes flatter, (c) focal mechanisms of earthquakes occurring along or near the Hosgri indicate reverse or oblique motion, (d) focal mechanisms for earthquakes near the San Simeon Fault indicate rupture on north-northwest striking faults that dip 55 degrees east, and (e) the diffuse pattern of earthquakes on planview and profile plots along the Hosgri Fault Zone suggest a northeast dip of 55 to 60 degrees.

2. Subsurface geometry: the subsurface geometry may be different from that proposed by PG&E. (a) Southwest verging reverse faults are responsible

for tilting of Quaternary strata and offset of the sea floor (i.e., Purisima structure); (b) between Pt. Buchon and Point Sal the east strand of the Hosgri is imaged on seismic reflection lines as a low angled, or gently dipping fault. The presence and orientation of structures appear to be determined by irregularities of basement surface. There is a major structural break at 6 seconds. Seismicity (the 1969 swarm of earthquakes southwest of San Luis Banks and the Queenie structure) indicates distributive seismicity above the 6 second reflector; and (c) contrary to PG&E interpretation, proprietary lines (GSI, Jebco) between Morro Bay and Piedras Blancas indicate that the Hosgri has a strong low angle thrust component.

3. Sense of slip: The USGS opinion concerning vertical versus horizontal slip varies between individual reviewers, but they all recognize significantly greater vertical displacement than PG&E (range is from 50 percent vertical to 50 percent horizontal to 100 percent thrust). (a) The presence of both east facing and west facing ocean floor scarps along the Hosgri is used by PG&E as a basis for strike slip offset. Most of the west facing scarps north of Pt. Sal are on the eastern strand of the Hosgri, but the east facing scarps are east of the Hosgri Fault Zone on other structures. (b) South of Pt. Sal, surface deformation is transferred to the Purisima structure and the scarps are indicative of compressional, thrust faulting. The western-most reverse fault effects younger sediment. (c) Along the trace of the Hosgri there is a spatial association between the Hosgri Fault Zone and the following features: the Wisconsinan shelf break, the boundaries between erosional and depositional regimes, a flexure in the Foxen reflector, a 30 to 35 m, west facing scarp that extends for 14 km north of the latitude of Morro Bay, steeply sloping topography at many locations all along the Hosgri Fault, and truncated bathymetry with shelf break. (d) At locations where the Hosgri crosses the oceanward slope there should be east facing scarps, but none are observed. (e) Focal solutions of earthquakes along the Hosgri trend have equal components of vertical and strike-slip displacement. (f) From Pt. Estero to Pt. Piedras Blancas the east side of the Hosgri Fault Zone is characterized by many Quaternary basins on the seaward sloping shelf. These depressions appear to be features that typically develop on the hanging walls of active thrust faults. If this is true the Hosgri and San Simeon Fault Zones have seismically active compressional components partly controlled by old basement surface. This

currently active compressional regime has been superimposed on an older, fundamental boundary strike slip regime as indicated by substantial changes in gravity and magnetics from one side of the fault zone to the other. The Hosgri-San Simeon fault zone, attains the characteristics of a strike slip fault from Cape San Martin north. South of Cape San Martin the fault zone can generate either a large compressive event or a large strike slip event.

4. Alternative models: PG&E's deep penetration seismic reflection data indicate a prominent reflector at 5 seconds (about 14km depth). Such a surface is consistent with the decolliment postulated by Namson's model. According to the model only ramps extending upward from this decolliment or other detachment surfaces are seismogenic. Depths and locations of recent earthquakes relative to known and postulated structures seem to support that model. According to that model, earthquakes occur on blind thrust faults associated with fault propagation and fault bend folds.

5. Segmentation: The most credible points of segmentation on the Hosgri Fault Zone are considered to be the location of a change of strike of the Hosgri south of its intersection with the Los Osos Fault, change in structural style at the intersection with the Casmalia Fault, change of structural style in the Piedras Blancas area, and the apparent termination near Perdinales Point. The following unresolved issues with respect to segmentation were stated: (a) there is little or no support in the geological and geophysical data for a fault rupture pattern, (b) the largest credible earthquake is unknown, (c) based on segmentation studies of the southern San Andreas Fault, the largest earthquakes break through segment boundaries, and (d) segmentation points are likely to be different depending on whether the earthquake is generated by strike slip motion or thrust motion.

The Los Osos Fault is believed to have a flatter dip than PG&E indicates (less than 45 degrees southwest). The subsurface geometry of the Los Osos Fault is unknown. There is no geological or geometrical evidence that supports PG&E's segmentation of the Los Osos Fault other than its intersection with the West Juasna Fault. The largest credible event is expected to rupture through them. The sense of slip would be reverse displacement normal to the mapped trace of the fault.

The location of the 1927 Lompoc earthquake is still highly uncertain. The distribution of aftershocks was such that events of estimated magnitude 4 or less were felt at Point Arguello, Buelton and San Luis Obispo. Intensity modelling by Everndon favored a location near Point Arguello, 60 km north of the PG&E location.

Most of the USGS comments on the logic tree will be provided at the August meeting. The USGS regards the logic tree method as useful but gives an example of one of its flaws. PG&E gives a high weighting factor to strike slip displacement on the Hosgri Fault. That sense of displacement requires that the fault dip at a relatively steep angle. A more appropriate way to begin would be to determine the angle of dip and let that result drive the predominant sense of slip model. Many of the logic tree branches are considered to be unrealistic.

IV REGIONAL SEISMICITY

PG&E presented the following seisologic information:

There is coherence between focal mechanisms and structures. North of its intersection with the Oceanic Fault, the San Simeon Fault Zone shows considerable topographic evidence of both strike slip motion in offset stream channels and vertical offset in the range front of the Santa Lucia Mountains. South of this intersection the predominant strike slip offset follows the San Simeon and Hosgri trend while the predominant vertical slip continues along the Oceanic Fault at the front of the Santa Lucia Mountains. The hypocenters of the 1980 magnitude 5.1 and two later events near Point Sal were at a depth of 9 km on a southwest dipping thrust fault consistent with the Casmalia Fault. This data is not consistent with an occurrence on a thrust Hosgri, which is much more shallow, and if projected to the east at a dip of 60 degrees or less, it would cut off the Casmalia fault far above the earthquake hypocenter.

A. Recent Instrumental Seismicity

An update was given of seismicity from October, 1987 to May 1989. 291 microearthquakes have been recorded on the 19 station, including 5 three

component instruments, network during that time period. The San Simeon is characterized by diffused seismicity, microearthquakes align along the Hosgri Fault, there is a clustering of seismicity at the Hosgri-Casmalia intersection, and a clustering off Point Arguello.

The Hosgri Fault Zone, as observed over the last 20 years, is a seismic boundary with seismicity to the east and relatively little seismicity to the west.

Focal mechanisms along the San Simeon-Hosgri Fault Zone are both strike-slip and reverse. To the north off Cape San Martin they are strike-slip and also strike-slip along the Nacimiento Fault. The Hosgri changes from strike-slip to more reverse to the south. Los Osos Fault earthquakes are reverse motion and the Transverse Ranges indicate a variety of mechanisms.

A cross section showing hypocenters is drawn through the DCNPP perpendicular to the Hosgri and Rinconada Fault Zones. The Hosgri is interpreted as a steeply dipping fault because of the strike slip events occurring on it. The epicenters of two events are spatially associated with the Los Osos Fault, but plotting their hypocenters on profile would place them far below it. An earthquake occurring beneath Point San Luis would fall on the Los Osos Fault assuming a dip of 60 degrees to the west.

B. 1927 Earthquake

Three new analyses of the 1927 earthquake were presented: (1) tsunami data, (2) teleseismic waves to determine location, and (3) regional seismic waves to determine seismic moment and mechanisms.

1. Tsunami Data

Tsunami arrival times at La Jolla near San Diego to the south and Fort Point near San Francisco to the north were analyzed to verify the location of the earthquake. Three epicentral locations were used: the Honda, Gawthrop and the LTSP locations. Models of the waves from the three locations were shown in which, because of refraction due to

shallow water, waves from the LTSP location arrived at both locations prior to the other two. On comparing the model with actual time and tide gage records at both sites, the modelling of the tsunami from the LTSP epicenter best fit the actual records, indicating that the 1927 earthquake did not occur close to shore on the Hosgri Fault.

2. <u>Teleseismic Data</u>

PG&E did not use conventional teleseismic analysis methods because absolute time records and global travel time tables were uncertain in 1927. The PG&E method used records from the Debilt Netherlands seismograph, which has been in operation since 1927, to analyze relative times of PS and SSS waves, compared the 1927 record with the recent Santa Lucia Banks and Coalinga earthquakes, and used the correlative of wave forms.

3. <u>Regional Waves</u>

Records used in this analysis were from Berkley, Lick Observatory on Mt. Hammilton, and Tucson. Modelling of regional body waves using good crustal structure data, long period body waves, and surface waves was accomplished.

PG&E conclusions about the 1927 earthquake from these analyses are:

(1) the 1927 earthquake occurred far offshore, tens of kilometers west or southwest of Point Arguello;

(2) its could not have occurred close to shore;

(3) its seismic moment was 1 to 4 x 10^{26} dyne cm;

(4) surface wave magnitude was 7.0; and

(5) its source mechanism was pure reverse on a fault plane striking north-northwest.

13, June, Tuesday

V. TECTONIC HISTORY OF THE SAN GREGORIO - SAN SIMEON-HOSGRI FAULT SYSTEM

A review of the tectonic history of this fault system was given beginning with a general discussion of Quaternary faulting within the plate boundary zone between the Wasatch Fault and the Continental slope and then focussing on the San Gregorio-Hosgri fault system. Profound structural contrast as revealed by gravity and magnetic data can be seen across the southern part of fault system. Pure right lateral strike slip typifies the system from Año Nuevo to Point Piedras Blancas. The fault system is the boundary between uplift onshore and down-dropped basins offshore. From Monterey Bay to the Point Sal area compressional structures intersect the fault system at an angle, but the faults of the San Gregorio-Hosgri system cut them in a strike slip manner. Components of the fault system do not exhibit appreciable vertical displacement. The San Gregorio Fault extends from its intersection with the San Andreas near Bolinas Bay to southwest Monterey Bay, then splays into several faults, the most significant of which is the Sur Fault. Based on similar offset crystalline rocks, one at Point Reyes west of the fault to the north, and the other east of the fault at Lopez Point to the south, about 190 km right lateral strike slip displacement is estimated along the northern reach of the fault system. The Sur Fault extends to Lopez Point where it steps over to the San Simeon Fault. Both faults partly bound the activity subsiding Sur Basin offshore. The northern part of the San Simeon Fault has 2 km of topographic relief across it with Franciscan formation to the east and Franciscan and ophiolite to the west. It also exhibits a classic strike slip, rift valley form in the area north of Cape San Martin. An offshore canyon is offset 2 km right laterally. Onshore to the south the San Simeon Fault leaves the mountain front, ~~s~~tr~~a~~ends down Arroyo Laguna Creek to the offshore south of Point San Simeon. The west side of the fault is up along Arroyo Laguna Creek and in the offshore. The San Simeon Fault steps over to the Hosgri Fault at Cabria, and the Hosgri Fault extends southward to point Perdinales.

The large scale strike slip history of the fault system took place in the early Cenozoic and was followed by a transtensional enviroment between late Miocene and early Pliocene during which time the faults served as basin boundaries with the onset of the change in the direction of plate motion in the

Plicene. About 5 million years ago the principle motion along the fault system became right lateral strike slip. This predominent sense of slip continues at the present time.

Logic Tree Elements:

A brief summary of the logic tree method and how it was applied was presented. During the subsequent discussions of the Hosgri fault zone and other significant faults an explanation was given as to how the various parameters were used in the logic tree analysis.

V. HOSGRI FAULT ZONE

During the LTSP, PG&E investigated the seismicity, paleoseismicity, the deformational history, the sense of slip including slip rate and down dip geometry, segmentation and length of the Hosgri fault zone, and world-wide analogies of strike slip, dip slip, reverse slip, and oblique slip faults.

It is postulated by PG&E that the compressional slip that characterizes this region is the result of the clockwise rotation of the western Transverse Ranges causing it to press against the Salina Block. Strike slip motion along the Hosgri fault zone is considered to be necessary to accommodate that crustal shortening.

The late Quaternary behavior of the San Simeon-Hosgri Fault Zone was investigated on shore near Point San Simeon by field mapping, mapping by borings of the buried marine platforms, mapping terrace strand lines (strain gage) relative to the fault (up on southwest side), studying the linearity of the fault, attitude of slickensides, development of soil profiles, thermoluminescense radiometric dating, and geomorphic effects of the fault. A detailed discussion was presented of the findings in the four areas that were investigated by trenching, and the slip rates used based on studies of marine terraces, trench logs, and geomorphology. These studies and their results are thoroughly described in the LTSP final report. The parameters used in the logic tree based on these studies are: (1) sense of slip-right lateral; (2) rate of slip-1 to 3 mm/yr; and (3) ratio of lateral slip to vertical slip ranges from 5:1 to 50:1. The only parameter that directly translates to hazards is slip rate.

The PG&E interpretation of strike-slip sense of slip was questioned by the USGS on the basis of the number of thrust and oblique slip earthquakes that have been recorded along the fault zone. It was pointed out that along the segment of the 1857 Fort Tejon rupture of the San Andreas, all small earthquakes that have been recently recorded have had thrust mechanisms, yet that rupture and all pre-historic ruptures have been shown by paleoseismic data to be strike-slip. The paleoseismic data is considered to be more diagnostic of predominent activity on the San Andreas and also the Hosgri fault zone.

A. <u>San Simeon-Hosgri Stepover</u>

PG&E presented evidence for the presence of the Cambria pullapart basin, through which strike slip displacement is transferred between the Hosgri and San Simeon Faults, and its structural implications which include:

1. Three seismic reflection profiles were presented: one showing that the San Simeon is a high angle fault offshore south of Point San Simeon; the second showing the presence of normal faults between the San Simeon and Hosgri Faults off the coast of Cambria; and the third one showing no southern extension of the San Simeon Fault into Estero Bay.

2. Seismic reflection lines CM-86-45 and CM-86-47 were displayed to show the characteristics of post-Wisconsin features within the pull-apart basin. On 45 the seafloor escarpment formed by the 18,000 year sea still stand is underlain by unfaulted strata, and on 47, the apparent northern extent of the basin is indicated by the dying out of the normal faults. In this profile the sea floor escarpment appears to be controlled by the western low angle component of the Hosgri and associated folding.

3. Longitudal line GS1-19 which extended north-south through the length of the basin, and crosslines CM-86-49, and CM-86-41 were shown, all of which illustrated evidence of tension in this area.

4. World-wide data on pull-apart stepover basins and their relationships to major strikeslip faults was illustrated: (a) the Hope Fault in

New Zealand, which also has local areas of compression; (b) the Niksar pull-apart between segments of the Northern Anatolian Fault in Turkey; (c) the Dead Sea Fault Zone (this left lateral fault was shown to have a relatively flat dip similar to the fault associated with the North Palm Springs earthquake, which had a pure strikeslip focal mechanism and a 45 degree dip).

PG&E concludes that the Cambria pull-apart basin is:

1. Three to 5 km wide and 10 km long;

2. Is predominantly a Quaternary half graben, including and bordered to the west by normal faults;

3. The basin is in the area of the southern termination of the San Simeon Fault and the northern termination of the Hosgri Fault;

4. Right lateral strike slip displacement of 1 to 3 mm/yr is transferred across the basin between the San Simeon and Hosgri Faults;

5. Theoretical kinetic models of this region support the presence of the Cambria stepover.

B. Components of Slip

PG&E's evidence of lateral slip is well documented in the LTSP Final Report and was discussed throughout this meeting and will not be described here. However, new information with respect to vertical slip on the Hosgri was also presented. Two longitudal profiles along the entire length of the Hosgri: one 1 km seaward and the other 1 km shoreward of Hosgri deformation. The profiles are based mainly on seismic reflection data and illustrate the relative uplift (and/or subsidence) of the 3 marker unconformities - basement, middle Miocene, and Pliocene-Pleistocene. PG&E interprets the data to show that much of the vertical displacement was inherited from the pre Tertiary transtensional environment. A viewgraph of a table showing relative rates of vertical uplift on each seismic line from basement to Quaternary sediments was presented. PG&E's thesis is that

if vertical uplift had been substantial along the Hosgri, there would be a mountain front east of the fault. Additionally, the presence of thick post Wisconsinan sediments on the east side of the Hosgri (upthrown block) would have been eroded away if there had been significant uplift during the later Quaternary.

Based on its investigations, PG&E concludes that the horizontal slip rate which is 1 to 3 mm/yr along the northern reach of the Hosgri Fault decays to the south as it is absorbed by intersecting compressional faults to 0.5 to 0.2 mm/yr at its southern extremity. The ratio of lateral slip to vertical slip is assumed to be 2:1 mm/yr even through PG&E considers it to be much less.

14 June, Wednesday

C. Downdip Geometry

Representative seismic reflection profiles to demonstrate downdip characteristics of the Hosgri Fault were presented as follows:

1. CM-86-47 shows pullapart basin features, the weakness of the Hosgri signature at its northern extremity, folding in Miocene strata above the Hosgri and lack of folding in the Pliocene stratigraphic section.

2. CM-86-47 shows post middle Pliocene strata deformed by the Hosgri Fault.

3. JEBCO-113 - the Hosgri Fault displaces the middle Pliocene unconformity at about 120 m depth and the low angel thrust component is shown to be truncated by the vertical fault component of the Hosgri Fault. Some of the reflectors bow up above the faults and other reflectors bow downward. PG&E interprets these characteristics as indicative of strike slip displacement.

4. PG&E-1, which is located in Estero Bay just south of the Los Osos-Hosgri Faults intersection, shows that the Hosgri Fault is vertical to a depth of 4 km, and shows no evidence of a low angle component. PG&E stated that the low angle component is more discontinuous along the

trace of the fault zone, and the high angle component is continuous as illustrated on Plate 6 in the LSTP final report.

5. GS1-86 shows all three components of the Hosgri Fault Zone: the high angle dipping east and west traces, and the low angle thrust fault. The pre-middle Pliocene strata is upwarped west of the low angle component, but the middle-Pliocene unconformity is flat lying above it. PG&E pointed out that the middle-Pliocene unconformity is never seen to be faulted and rarely folded.

6. JEBCO-126 crosses the middle of San Luis Obispo Bay. The low angle component is shown, by PG&E's interpretation, to be cut by the high angle component, which continues downward at a high angle to at least 4 km. The basement is up to the east, but the Miocene and Pliocene rocks are down dropped on the east side of the fault. This observation is considered by PG&E to be evidence for strike slip offset and against thrusting. There is a difference of opinion regarding this profile in that the USGS interprets there to be indications of bulging in the strata overlying the low angle component.

7. GS1-114 was presented to show the high angle northeast dip of the Hosgri and down dropped strata to the east.

8. GSI-123 shows no basement offset but the middle Pliocene unconformity is down dropped to the northeast. A small graben is present within the fault zone.

D. <u>Geomorphic Expression</u>

The high angle traces of the Hosgri Fault Zone form a continuous trace over its entire 110 km length. There is little or no relief on the ocean floor on either side of the fault zone. Folds in rocks west of the Hosgri are subparallel to the Hosgri Fault Zone, and folds to the east are at an angle of 45 degrees to 60 degrees to the Hosgri.

These observations suggest that there are two different crustal domains across the Hosgri Fault Zone, an east-west oriented domain west of the Hosgri,

and a northeast-southwest oriented domain on the east side. The oblique folds on the east side are causing relief on the sea floor in spite of erosion of the wave cut platform.

Examples of geomorphic expressions of strike slip and thrust faults worldwide were presented. Strike slip faults that have a linear, continuous surface trace include: the North Anatolian, New Port Englewood, San Clemente, Hayward, and San Jacinto Faults. Examples·of thrust faults which have sinuous surfaces traces, horizontal to vertical slips of ration 2:1, and are producing mountain ranges include the Pleito Fault and the San Fernando Fault of south-central California.

E. Seismicity

The evidence for the location of the 1927 earthquake and its potential seismogenic sources were restated here. It was pointed out that in the latitude of the site area, all seismicity lies between the Hosgri Fault Zone and the Riconada Fault and there is no seismicity west of the Hosgri. In the Point Sal area seismicity is concentrated south of the Hosgri-Casmalia Faults intersection east of the Hosgri at a depth of about 10 km. This seismicity is interpreted to be related to the near vertical Hosgri and to be occurring within the San Luis-Pismo structural block.

F. Strike Slip Characteristics Typical of Faults World-Wide

Seismic reflection profiles of several large strike slip faults were shown, including the West Andaman Fault and faults in the Bering Sea, and compared to the Hosgri Fault Zone as interpreted from line PG&E-3. The strike slip features illustrated in these profiles that characterize these faults include: vertical separations on both sides of the fault, reversals of dip, surficial tension structures, flower structures, the presence of low angle components, basement offset, and upwarped Tertiary strata above fault.

G. Logic Tree

A summary of the logic tree slip parameters and weights was given for the Hosgri as follows: for strike slip = 0.65; oblique slip with horizontal to vertical ratio ranging from 2:1 to 1:2 = 0.3; and for thrust = 0.05.

The method used to acquire parameters for the logic tree was to first gain a consensus of opinion of 16 experts on the definitions such as of strike slip, thrust, oblique, etc., and then gather their opinions. The weighting of parameters was based on these expert opinions. Results of the weighting were reviewed by the 16 experts and revised according to their comments.

In like manner the dip, maximum depth, average displacement per event, total length, and rupture length parameters and respective weighting used in the logic tree were summarized.

H. Segmentation

Rupture segment is defined as that part of a fault that ruptures per event. A fault segment is the geologically coherent part of a fault that makes it unique from other segments. The concept of segmentation is used by PG&E to estimate the length of the potential rupture during a large earthquake. Another method that has been used in the past is the fractional fault length method.

Examples of rupture on fault segments around the world were given and a summary of the history of the development of the concept were presented. Based on the percentage of times that potential segmentation points have ruptured through compared to those that have terminated rupture, the segmentation technique cannot be used carte blanche. However, it appears that the greater number of segmentation point characteristics that typify a specific segmentation point, the greater the possibility that it will terminate rupture.

The segmentation points proposed by PG&E for the southern San Simeon-Hosgri Fault Zone are: intersection with the Oceanic Fault, Cambria stepover, the Los Osos Fault, Pecho Fault, Casmalia Fault, Lions Head Fault and the Santa Ynez River Fault.

PG&E conducted analyses of four different segment length versus earthquake assumptions: 20 km, 45 km, 70 km and 110 km rupture lengths. An apparent inconsistency was pointed out, in that a 2 m single event displacement determined by paleoseismicity studies along the 20 km segment of the San Simeon Fault from the Oceanic Fault to the Cambria Stepover is not consistent with other documented single event offset versus rupture length data. The 2 meter offset most likely represents a long rupture, possibly more than 100 km.

<u>15 June, Thursday</u>

VII. LOS OSOS FAULT

The Los Osos Fault is 57 km long from its intersection with the Hosgri in Estero Bay to its intersection with the West Juasna Fault in the Santa Lucia Mountains. The Los Osos Fault is divided into 4 segments by PG&E: Estero Bay, Irish Hills, Newsome Ridge, and Lopez Reservoir ~~S~~segments. According to PG&E, each segment defines the northeast boundary of sub blocks within the San Luis-Pismo structural block. Each segment displays individual degrees of activity. Based on active subsidence of the Morro Bay area, the accumulation of ponded alluvium behind the fault, and the elevation of a flight of Pleistocene terraces near Montano de Oro State Park, the Irish Hills segment is the most active segment and is being uplifted at the rate of 0.22 to 0.24 mm per year. The other sub blocks are being uplifted at lesser rates. PG&E stated that the differing amounts of uplift of the sub blocks does not require the presence of faults between them.

The Los Osos Fault, which is the northeast boundary of the San Luis-Pismo block, is interpreted to steepen with depth, based on well log data which indicate that the Pismo syncline is not truncated by the fault above seismogenic depths. The Los Osos, like the Miguelito fault, is thought to have originated as a high angle strike-slip fault and the current reverse Los Osos is utilizing that original fault. Other surficial low angle thrust faults, such as the Casmalia, Oceanic and West Juasna Faults steepen to dips of 50 to 60 degrees at depth. A boring in the northeastern part of the Irish Hills block suggests that the Los Osos Fault dips at least 70 degrees below a depth of 500 meters.

PG&E briefly summarized the trenching data, mapping of the marine terraces, and mapping of the fluvial terraces, the data which formed the basis for the slip rate used in the logic tree.

The parameters used in the logic tree were: dip = 30 degrees to 60 degrees, total length = 57 km, rupture length = 19 and 35 km, maximum displacement per event = 2 m, and slip rate = 2 mm/year.

The USGS commented that the Estero Bay and Irish Hills segments should be considered as one segment, and that 2 m displacement is too large for the size of the fault. Two meters thrust offset is comparable to El Asnam which was related to a magnitude 7 earthquake.

VIII. SOUTHWEST BOUNDARY OF THE SAN LUIS-PISMO BLOCK

The southwest boundary is described as an 8 kilometer wide, diffuse zone of high angle, northeast dipping reverse faults, with an overall slip rate of 0.1 to 0.2 mm/yr. It is comprised of the San Luis Bay, Wilmar Avenue, Olson, Pecho, Oceano, and Santa Maria River Faults. The faults are 2 to 5 km apart, have distinct end points, and probably don't converge to form a single fault at 7 to 8 km depth.

The San Luis-Pismo Block is similar to the Casmalia Block where a strong fault, the Orcutt Casmalia, forms the northern boundary and a wide zone of weak faults, including the Lions Head Fault, comprise the southern boundary.

Based on virbraseis data, the Santa Maria Valley sub block, which lies between the San Luis Pismo and Casmalia blocks, is relatively undeformed by faulting. The southwest boundary zone divides the San Luis-Pismo block, which is a zone of uplift, from the Santa Maria Valley block, which is a zone of subsidence.

The characteristics of the six faults were presented and their parameters used in the logic tree were given. These faults are described in detail in the LSTP Final Report. A significant point made about the San Luis Bay, which sup-

ports PG&E's thesis that the southwest boundary faults steepen with depth, is that within the outcrop the dip of this fault steepens from 19 degrees to 46 degrees.

To illustrate the similarity of the faults forming the west boundary, and their relatively low slip rate, PG&E pointed out that the mountain range fronts had been backwasted to the east from these faults.

A major concern of the University of Nevada, Reno, has been the possible presence of an undetected fault near shore between the Pecho Fault and the coastline. This concern is based on variable erosion rates that were obviously not controlled by lithology, a linear northwest striking anomally on the wave cut platform, the straight coastline, and a deficit in uplift on the southwest boundary.

PG&E attempted to show that no such structure with significant vertical offset existed. High resolution seismic refraction lines extend shoreward to the sea stacks and show no evidence of faulting in the shallow sub seafloor. Correlation of rocks comprising the sea stacks with similar rocks onshore indicate continuity, and therefore no offset. Mapping of the terraces onshore show that the straightness of the coastline is a temporary feature, ~~and~~ that it has not been straight through the late Quaternary. Point Buchon and the site area are underlain by highly resistant Obispo volcanic rock, while the areas northeast of Point Buchon and south from the site area to Point San Luis are underlain by softer rock. This is indicated by the fanning out of the marine terraces in these areas, and their narrowing between the site area and Point Buchon. CM-86-23 crosses a projection of the proposed coastline fault and the platform lineament and shows no evidence of a fault.

The faults of the southwest boundary zone are interpreted to not intersect above the seismogenic zone or above 7 to 8 km depth.

Regional Tectonics

Viewgraphs were shown to illustrate PG&E's positions regarding the tectonic setting, the specifics of the Los Osos-Santa Maria Domain, and the way in which local structures fit into the regional tectonic kinematics.

IX. ALTERNATIVE HYPOTHESES

A. J. Crouch

On June 15 the NRC requested of PG&E that J. Crouch be permitted to present his position regarding the style of faulting associated with the Hosgri Fault Zone. Dr. Crouch stated that although he was employed by the State's Attorney's office the views presented were his and not of that office. He cautioned that PG&E should not be locked into a single position (that Hosgri is mainly a strike slip fault) in the event that that concept does not hold up in the future. The following are the main points presented by Dr. Crouch.

1. The Hosgri Fault Zone is analogous to the Orcutt/Casmalia fold-fault system. This system onshore has been explored by oil companies using remote sensing, surface mapping, seismic reflection, well boring data, etc., and if the Hosgri Fault Zone had been investigated in comparable detail, it would resemble the Orcutt-Casmalia structure, but dipping in the opposite direction. The Orcutt-Casmalia fold-fault system is a fault propagated fold system and the Hosgri is that type of system also. To illustrate this point he showed his interpretation of lines Nekton 229 and GSI 103, located 1/2 km and 3 km from PG&E-3 respectively. These profiles are controlled by nearby deep well 397. (PG&E-3 was used by PG&E to support a steep dip for the Hosgri Fault). He also showed GSI-86 near Point Buchon and Line 106. He interprets these lines to show that basement (at 3 km) and other more shallow reflectors are unbroken beneath the Hosgri vertical component, the vertical component is cut by the flat lying thrust fault reflector, and the vertical component rolls over and merges with the horizontal component.

2. The linearity of the seafloor trace of the Hosgri Fault Zone, cited by PG&E as evidence of strike-slip motion, is the result of mapping the vertical component. If the trace of low angle thrust component were mapped, it would not be linear.

3. The apparent truncation of the low angle thrust by the Miocene-Pliocene unconformity may be misleading because the sediments overlying it are

time-transgressive. The sediments onlapping the fold were deposited rapidly and ages vary considerably from west to east. A profile through the Kettlemen Hills oil field, where there is considerable subsurface information available, containing a conformity overlain by time transgressive sediment, was presented as an analogy.

4. The young, apparently undisturbed sediments overlying the low angle thrust component are soft and don't readily reflect folding.

5. The Piedras Blancas antiform is interpreted to be an active anticline underlain by a blind thrust fault.

6. Vertical rates of uplift across the Hosgri Fault Zone are much greater than those estimated by PG&E. Within the past 5 million years the basement east of the Hosgri has been uplifted several kilometers estimated to average 0.5 to 0.75 km/year.

7. The Hosgri Fault Zone does not conform to the standard wrench fault system model as proposed by PG&E. To do this there should be evidence of en echelon folding (anticlines) adjacent to and at an angle to the trace of the Hosgri. The Newport Englewood Fault was presented as an example of the development of en echelon folding during the early stages of development of a strike slip fault. The Hosgri Fault Zone shows no evidence of such features.

8. The features along the Hosgri in the shallow subsurface, which are interpreted to be flower structures, are not flower structures. They are features that are typically found within all narrow fault-fold zones.

9. The entire California coast from San Diego to Point Arena is being subjected to northeast directed horizontal compression.

10. The Transverse Ranges block is not being rotated as proposed by PG&E. Rotation of the Transverse Ranges ceased when the triple juncture passed through the region.

B. J. Namson

Jay Namson, who just completed a research project for the USGS in the region of the DCNPP site was invited to present his findings. The project was to construct balanced and retrodeformable cross sections through the Coast Ranges and Santa Maria Basin.

The hypothesis is that the plate motion between the Pacific and North American plates in this region is being accomodated primarily by the San Andreas Fault and horizontal thrust faults rooted in the ductile zone of the earth's crust. Earthquakes are being generated along ramps that splay upward from these horizontal detachment surfaces. The known geometry of folds in the upper crust is used to predict the geometry of underlying unmapped faults. These folds are classed as fault bend or fault propagating folds, depending on the nature of the fault that is activating them. Namson presented four examples that support the validity of the technique: (1) a transect across the Guyama Valley, Southern Caliente Mountains and Carrizo Plain where a nearby seismic line and deep well indicate that the San Andreas Fault dips to the east at 65 degrees, (2) the Transverse Ranges where moderate earthquakes occur between folds, which is interpreted to indicate that they are being generated on fault ramps at depth related to the near surface folding, (3) the 1988 Whittier Narrows earthquake, interpreted to have been generated on a ramp beneath the Santa Monica Mountains, was predicted by this method, and (4) the 1983 Coalinga Earthquake was generated on a blind thrust fault ramp beneath an active fault propagation fold.

The transact of interest at this meeting consisted of balanced and retrodeformable cross sections of structures affecting Miocene and younger rocks across the Santa Lucia Mountains extending southwest through the Purisima-Lompoc structure beyond the coastline. The region is underlain by a main detachment surface at a depth of 12 or 13 km. A system of ramp faults and lesser detachment surfaces are postulated to extend upward from the sole detachment causing folding nearer to ground surface. Three major anticlines are postulated along the profile from northeast to southwest: the Point San Luis, the Orcutt, and the Purisima-Lompoc anticlines. Normal faulting began in the region in early Miocene and accelerated through late Miocene and early Pliocene. The Hosgri Fault was a major normal fault at this time. Compressional tectonics began to dominate

about 4 million years ago and the Pismo (PG&E's San Luis-Pismo syncline) and Juasna synclines began to form. The Hosgri fault was rotated to an east dipping fault, and is not an important feature in this model.

The Hosgri fault is considered to be analogous to the Casmalia-Orcutt Fault, which originated as a normal fault, but began to be rotated 4 million years ago with the growth of the Orcutt anticline as a fault propagation fold along a blind thrust ramp fault. An important facet of the interpretation is the thickness of the Sisquoc formation on the down thrown side of the fold-thrust fault, which demonstrates the presence of a rapidly growing anticline. The Orcutt Fault is not considered to be large enough or have sufficient offset to account for the size of the Orcutt anticline. The Purisima-Soloman thrust fault, a blind thrust, is postulated as the ramp fault responsible for the geometry and size of the Orcutt-Casmalia fold.

The site area is located on the hypothesized east flank of the Point San Luis anticline, which is estimated to be growing at the rate of 2.3 to 2.5 mm/yr. Uplift of the San Luis Pismo syncline measured by PG&E is explained by Namson to be due to the location of the shallow rooted syncline above an east dipping ramp. The block above the ramp containing the San Luis Pismo syncline is moving up ramp. The relative lack of uplift found in San Luis Bay is caused by the location of that area on the crest or southwest flank of the Point San Luis anticline where movement is horizontal. No consideration was given to surface mapping by PG&E such as that which indicates that uplift is taking place along the Los Osos Fault. Namson, in response to a question, estimated that the ramp surface beneath the San Luis Pismo syncline is 80 km long by 10 km wide, and that a 2 m displacement resulting in a magnitude 7.0 earthquake is possible.

The main criticisms of the Namson hypothesis are that Quaternary information obtained during the LTSP investigations conflicts with the broad interpretations made of the tectonic occurrences at depth; and the insignificance in the model of the Hosgri-San Simeon Fault Zone to current tectonics.

15 June, Friday

X. PG&E SUMMARY

PG&E presented its summary, which in general is: (1) The broad site region is in an environment of a transpressional plate margin; (2) the site is within the Los Osos-Santa Maria structural domain which is bounded by the Oceanic, West Huasna, Foxen Canyon, and Little Pine Faults on the east, the Santa Ynez River Fault on the south, and the Hosgri Fault Zone on the west; (3) the Hosgri Fault Zone is principally a right lateral strike slip fault slipping at the rate of 1 to 3 mm/yr., transferred from the San Simeon Fault by way of a pull-apart basin, and which decays to .05 to .2 mm/year at its southern end by means of intersecting thrust faults; (4) the Hosgri Fault Zone is a fundamental boundary between the Los Osos-Santa Maria domain and the structurally different offshore Santa Maria Basin domain; and the DCNPP site is located on a crustal block within the Los Osos-Santa Maria domain: the San Luis-Pismo block, which is being uplifted without internal deformation, and is bounded on the northeast by the Los Osos Fault, on the south by the Orcutt-Casmalia Fault, on the southwest by the southwest boundary zone of faulting, and on the west by the Hosgri Fault Zone.

The analysis of the 1927 tsunami data was reviewed, which provided an independent basis for the location of that earthquake, mechanism, and moment magnitude.

The seismic source characterization of the Hosgri Fault Zone was reviewed. (1) The slip rate is the dominant drive in the probabilistic risk assessment. (2) There is contradictory information regarding the nature of the Hosgri Fault Zone at depth. For that reason it is necessary to examine the total data set to reach a conclusion. In rebuttal to J. Crouch's presentation, several examples were given where seismic reflection data indicated that horizontal reflectors interpreted to be low angle listric faults may be the dominant structural style, yet when earthquakes occurred hypocenters were well below these features on high angle faults. Such examples included: the 1983 Borah Peak earthquake, where the low angle faults were at depths of 3 km and the earthquakes occurred on the basin border fault at 16 km; the Wasatch Fault where the mountain front is

bounded by a major high angle fault system, but low angle reflectors are common in the basin; the Mears Fault which is mapped as a vertical fault near ground surface, but seismic reflection data indicate a 25 degree dipping reflector at depth, but no high angle fault; and the Walker Lane fault system which has physical evidence of strike slip motion, but seismic reflection data show low angle faulting at depth. (3) Studies indicate that listric faults that dip less than 30 degrees don't generate large earthquakes. (4) A preliminary transect by T. Davis using the balanced and retrodeformable cross sections method utilized the interpretation of offshore data by J. Crouch in his analysis of the foreland dips of sediment over the thrust component of the Hosgri Fault. In this interpretation, the structure has to be a fault bend fold, but since there was no way to project the deformation into the sediment structure above the fault he concluded the Hosgri Fault was inactive. (5) PG&E prioritized the data in the following order: first priority - seismicity, second priority - the Quaternary record, and third priority - deeper structure as defined by the seismic reflection data.

Preliminary information on an earthquake that had just been recorded on the PG&E network was described: magnitude = 4, thrust mechanism within the Queeny Structure offshore at a depth of 7 km.

XI. USGS, UNR, CDMG AND NRC COMMENTS

A caucus was held on Friday June 16 among the NRC and its advisors, the U.S. Geological Survey and the University of Nevada, Reno, and the California Division of Mines and Geology. The items listed below are comments and issues raised during this caucus and later presented to PG&E.

1. New information was presented on uplift rates across the Hosgri Fault Zone in the form of a summary longitudinal profile along the Hosgri Fault Zone. The data supporting these uplift rates such as seismic sections constrained by well log control should be provided.

2. PG&E should construct balanced cross section through the site area similar to the Namson cross section, taking into account the surface and near surface data gathered by PG&E.

3. The dip of the Hosgri is uncertain. PG&E should provide an explanation and bases as to the reasons that horizontal reflectors on some high resolution seismic reflection appear to be continuous without disruption beneath the near surface high angle Hosgri Fault. PG&E projects the high angle fault downward through these reflectors without supporting data at depth.

4. PG&E should address the possibility that reverse or strike slip displacement may be transferred to the Hosgri by structures west of the Point Piedras Blancas High.

5. Consideration of the concept of partitioning of strain within the Hosgri Fault Zone should be made. Partitioning may explain the diversity of opinions concerning the sense of slip on the Hosgri.

6. The new data presented at this meeting regarding the southwest boundary fault zone of the San Luis/Pismo syncline should be provided for review. This information includes the coastal erosion analysis.

7. Whether or not there is deformation in the San Luis/Pismo block is still not clear and the characteristics of the southwest boundary faults at depth haven't been resolved.

8. There is wide diversity of opinion on the degree of activity on the low angle component of the Hosgri. PG&E should consider activity on this surface and how that could be or not be reflected in the overlying Pliocene-Quaternary sediments.

9. The northern termination of the Hosgri Fault Zone is not strongly supported in the data.

10. The evidence for Wisconsinan low stands and the data supporting the offsets calculated along the Hosgri at the basement, top of Miocene, base of the Foxen (mid-Pliocene) should be provided.

11. PG&E should furnish for review the tsunami analysis presented at this meeting and the supporting data.

12. The source structure for the 1927 earthquake should be identified and as required by Appendix A, 10 CFR 100, the nearest that structure approaches the site should be determined. If no structure can be identified determine the closest distance from the site a similar event must be assumed to occur according to the requirements of Appendix A.

13. Comparing intensity data between the 1927 and 1980 earthquakes may not be valid as they occurred on different structures. Differences in the strikes of the fault planes would cause there to be differences in the seismic wave radiation patterns and the aftershock patterns.

14. Instrumental data on the 1927 earthquake from the Wood-Anderson seismograph at Santa Barabara should be evaluated for azimuth information.

15. A critique of the work of Namson should be provided by PG&E.

16. PG&E should provide a summary discussion of the Cambria stepover basin and its rates of formation.

17. A logic tree should be constructed with respect to the San Luis/Pismo syncline considering the presence of blind thrust faults.