REPORT TO THE

NUCLEAR REGULATORY COMMISSION

FROM

PACIFIC GAS AND ELECTRIC COMPANY

ON

THE SEISMIC IMPLICATIONS

OF

THE TMI-2 ACCIDENT

TO

DIABLO CANYON

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1.0 INTRODUCTION/SUMMARY

In its report "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations" (NUREG-0578), the NRC Regulatory staff does not explicity address any implications of the TMI-2 accident with respect to seismic design. However, during its 232nd general meeting, the Advisory Committee on Reactor Safeguards (ACRS) indicated its interest in this subject in relation to the licensing of Diablo Canyon. Some specific ACRS concerns have been expressed in its letter of September 14, 1979. In this report, PG&E has responded to the ACRS concerns and addressed the overall issue of seismic design implications of the TMI-2 accident.

Section 2.0 includes PG&E's response to the 13 ACRS agenda items.

Section 3.0 of this document assesses the significance of the seismic qualification of the potentially mitigating systems used during each phase of the accident which effectively began at T=0 with a trip of the main feedwater pumps:

Phase 1:	Loss of Feedwater	T=0 to T=60 sec.
Phase 2:	Small LOCA	T=60 sec to T=2 hrs/21 min.
Phase 3:	Fuel Damage	T=2 hr/21 min. to T=16 hrs.
Phase 4:	Long-Term Recovery	T=16 hours and onward

For each phase, this evaluation identifies the equipment utilized during the TMI-2 accident, describes the equivalent equipment available to provide the same function at Diablo Canyon, and assesses this equipment in terms of its seismic design.

The evaluation included in Section 3.0 concludes that a seismic event would not significantly contribute to the likelihood of any of the above phase's occurrence or increase its severity. In addition, although each phase could be mitigated without reliance on offsite power, this evaluation also concludes that the availability of offsite power, following an accident, is probably no more jeopardized by a seismic event than by any other natural phenomenon affecting sites of low seismicity.

2.0 QUESTIONS FROM THE AD HOC ACRS SUBCOMMITTEE ON THE TMI-2 ACCIDENT IMPLICATIONS FOR THE OCTOBER 3, 1979 MEETING

The subsequent paragraphs of this section include PGandE's response to each of the 13 questions from the Ad Hoc ACRS Subcommittee on TMI-2 Accident Implications for the October 3, 1979 meeting.

2.1 SEISMIC DESIGN CONSIDERATIONS

What if anything does the NRC Staff think may warrant a special look because of seismic considerations?

The seismic design of Diablo Canyon has received an extraordinary amount of attention during the review of PGandE's operating license application. The Regulatory staff's review was unprecedented in its thoroughness, the ACRS devoted a great deal of time to this subject, and 32 days of public hearing before an ASLB were concerned solely with the subject of seismic safety at Diablo Canyon. Prior to the TMI-2 accident, both the Regulatory staff and the ACRS concluded that the Diablo Canyon design provided protection for the public health and safety adequate to support issuance of an operating license. It is PGandE's position that the only areas where it is necessary to further review the Diablo Canyon seismic design are those specifically identified in the NUREG-0578 short-term recommendations.

The NUREG-0578 document does not, in general, directly address seismic design. The term "safety grade" is used in connection with some of the NUREG-0578 recommendations. It is PGandE's interpretation that any items required to be safety grade generically for all plants should also incorporate Seismic Category I requirements.

When seeking to apply Seismic Category I requirements to the TMI-2 Lessons Learned, there are levels of priority that the Staff has not addressed. First priority items are those which serve to reduce the possibility of occurrence of an accident similar to that at TMI-2. These first priority items include operator training, PORV position indication, and auxiliary feedwater system improvements. Second priority items are those which, given an accident similar to that at TMI-2, better mitigate accident consequences or facilitate post-accident recovery. These second priority items include emergency planning, off-site communications, and technical support. These items are of second priority because they are only necessary if an accident is assumed to have occurred.

2.1 SEISMIC DESIGN CONSIDERATIONS (Cont'd)

Finally, third priority items are those which might be desirable but which would have no direct effect on the probability of an accident, accident releases, and the resultant risk to public health and safety.

Prior to the issurance of the recommendations in NUREG-0578, PGandE developed its own plan for identifying and incorporating these three priority-level "lessons learned" into its plans, procedures and designs. This plan was augmented to cover commitments made by PGandE in responding to NUREG-0578. Modifications to the plant design, improvements to operating and emergency procedures, development of a corporate response plant, and other actions based on the lessons learned at TMI-2 have already been initiated.

In response to the ACRS's concern that there may be other seismic design implications of the TMI-2 accident, PGandE has also utilized the operational and radiological event sequences included in NUREG-0600 to review the systems playing a role in the TMI-2 accident. This phase-by-phase review, included in Section 3.0 of this report, was performed to identify any areas where Diablo Canyon's seismic environment would have

1) contributed to the accident's initiation probability,
2) contributed to its severity,
3) increased the potential for fuel damage and/or
4) hampered long-term recovery.

Other than items discussed by PGandE in this and previous reports to the NRC, the TMI-2 accident has no seismic design implications to Diablo Canyon.

2.2 EMERGENCY PROCEDURES

Has the staff and applicant looked at procedures for a severe earthquake? How is a decision reached regarding its adequacy?

Diablo Canyon has "in-place" an emergency procedure for an earthquake (Emergency Procedure M-4). The procedure has been prepared, reviewed, and approved in accordance with plant Administrative Procedures. Operating personnel have been trained in its use.

The emergency procedure for an earthquake establishes four earthquake classifications, based on maximum accelerations measured on the containment base slab.

Maximum Acceleration (g's)	Classification
Less than 0.01	Unmeasured
0.01 to 0.1	Minor
0.1 to 0.2	Moderate
Greater than 0.2	Major

For each earthquake classification, the emergency procedure lists symptoms and expected automatic actions and provides requirements for immediate and subsequent operator action and for subsequent Power Production Engineer action.

Included in the procedure are requirements for notification of plant personnel and the Nuclear Regulatory Commission. Also provided are instructions concerning seismic instrumentation, collection of seismic data, criteria, forms, and check lists for post-earthquake inspection and evaluation. Drawings are included as an attachment to the procedure which identify post-earthquake inspection areas.

PG&E believes this emergency procedure is adequate to assure that necessary actions are taken in the event of an earthquake. Criteria for use in determining the steps to be taken before the plant can be returned to power following an earthquake more severe than the Design Basis Earthquake (Operating Basis Earthquake) would be based on an evaluation of the seismic data and post-earthquake inspections and would be established in conjunction with the Nuclear Regulatory Commission.

2.3 OPERATOR TRAINING

What anomalies in system behavior during an earthquake should operators be trained to handle? An example would be the failure of non-seismically qualified equipment.

Operators at Diablo Canyon are trained to follow plant operating procedures and emergency operating procedures which cover a broad range of operating conditions, transients, and accidents, including anomalies in system behavior and situations involving equipment failures. These equipment failures can occur for a number of reasons, including a seismic event. It is neither practical nor necessary to identify equipment failures or anomalies in system behavior as being caused specifically by a seismic event.

For example, an earthquake may include an equipment failure in the condensate system which could cause a loss of feedwater flow. The operators are trained to follow the emergency operating procedure for loss of feedwater flow which provides the operator with a list of symptoms and automatic actions and with immediate and subsequent operator actions. These operator actions take into consideration possible equipment failures by specifying operator actions to compensate for such failures. For instance, in the event of a loss of feedwater flow, auxiliary feedwater should have been automatically initiated. The operator verifies this by looking at valve position indication, flow indication, and pump instrumentation. If the auxiliary feedwater pumps have not been automatically started, the operator starts the pumps manually. The procedure leads the operator through a series of steps that assume that failures can occur. It is not necessary that these failures be explicitly identified as seismic failures.

2.4 NON-SEISMIC CATEGORY I PIPING

What are the assumptions concerning failure of non-seismic Class I piping? To what extent can the failure of such piping be tolerated? Is the design based on a single (failure) criterion?

Piping systems at Diablo Canyon which are important to safety are designated Design Class I (equivalent to the current Category I classification), and are designed to remain functional for the Safe Shutdown Earthquake. Design Class I piping systems are those necessary to:

1) Maintain the integrity of the reactor coolant system pressure boundary,

2) Safely shut down the reactor, or

3) Mitigate the consequences of accidents having offsite dose consequences comparable to the guidelines in 10 CFR 100.

By definition, these functions must be maintained without relying on any non-design Class I piping systems, since these systems are assumed to be unavailable following a seismic event. The effect of the assumed failure of such piping systems on Design Class I equipment was considered by postulating breaks in piping in accordance with criteria set forth by the Regulatory Staff and assuring that the effects of such breaks (pipe whip, jet forces, jet impingement, flooding, and environmental effects) would not adversely affect Design Class I equipment.

With respect to the assumed failure of non-design Class I piping, no single failure criterion is applicable, since any or all such systems must be assumed to be unavailable. The criteria employed for postulating breaks in these piping systems did contain assumptions similar to the single failure criterion, since simultaneous breaks in more than one pipe were not required to be postulated unless the effects of a break in one pipe could result in causing a second break.

It is important to note that a number of piping systems not designed to seismic Class I criteria at other plants have been modified at Diablo Canyon to meet Design Class I seismic criteria. This was a requirement of the Regulatory staff in order to assure the capability to achieve cold shutdown following an earthquake.

2.5 RWST RELIABLILTY

Has the applicant examined the reliability of connections to the Refueling Water Storage Tank for the earthquake situation? What criteria do the connections meet?

The piping connections to the RWST have been analyzed for Hosgri loads both on the tank itself and on the connecting piping. These connections, the RWST itself, and the connected piping all meet the acceptance criteria outlined in the Hosgri Evaluation Report.

2.6 BORATED WATER SYSTEM PIPE CRACKING

What significance is attached (if any) to recent cases of pipe cracking in stagnant borated water line as it applies to earthquakes?

The cause of this cracking is currently under investigation by a number of organizations, including the NRC Regulatory staff, reactor vendors, and the Electric Power Research Institute. When the mechanisms involved are identified, steps can be taken to minimize or eliminate the problem.

This problem is generic in nature and is not unique to Diablo Canyon. Diablo Canyon is not yet operating and this phenomena has not been observed there.

The extent to which this pipe cracking could lead to failures when subjected to operating or seismically induced stresses depends on a number of factors. If it is determined that cracking of this nature could propagate as a result of operating or seismic stresses, it is evident that such pipe cracking in safety related piping is not acceptable. This is true for other plants, as well as for Diablo Canyon, since seismic stress is often only a small fraction of total stress, even at Diablo Canyon and since stresses induced by normal operation and by transients are far more likely to contribute to crack propation than an infrequently-experienced seismic event. The contribution of seismic stress to total stress in Diablo Canyon piping systems was discussed by PGandE and the Regulatory Staff in past ACRS meetings.

PGandE will follow closely the work being done in this area and will make any changes or modifications found necessary to assure that this problem does not adversely affect the safety of Diablo Canyon.

2.7 INSERVICE INSPECTION

What considerations does the staff believe appropriate for system degradations, such as the recent feedwater nozzle cracking experience, as it applies to inservice inspection programs for plants in areas of high seismic activity?

PG&E does not believe that the seismic enviornment makes this problem a significantly greater concern at Diablo Canyon than for other plants. Seismic stress is often only a small fraction of total stress, and stress induced by normal operation and by transients is far more likely to contribute to crack propogation than an infrequently experienced seismic event. We believe this conclusion is valid not only for the feedwater nozzle cracking experience but for undetected flaws, cracks, and other types of system degradation. The inservice inspection requirements of Section XI of the ASME Code are designed to detect such problems and are equally appropriate for plants in low seismic areas and high seismic areas. Specific problems such as the feedwater nozzle cracking experience may well make it desirable to perform more frequent inspections, but this decision should have no dependence on the seismic environment. It should be noted that PGandE metallurgical engineers who are responsible for inservice inspection programs at Diablo Canyon are actively involved in ASME Section XI Code Committe work.

At Diable Canyon, cracking has been experienced in the weld area between steam generator feedwater nozzles and feedwater piping. The cracking at Diablo Canyon occurred after the post-weld examination but before experiencing any significant cycling of the piping and nozzles. (Diablo Canyon is not yet operating - cracks were discovered during and following hot functional testing). The mechanism of the cracking at Diablo Canyon was carefully evaluated and the problem is attributable to the procedures used for preheating and post-weld heat treatment. Extensive non-destructive inspection was performed on all nozzle welds. In order to provide maximum assurance that no future cracking will develop, the affected sections were removed from the pipe nozzle areas and new spool pieces were welded in, giving close attention to welding

procedure, preheating, and post-weld heat treatment. Post-weld non-destructive examination was very thorough and there exists an extremely high level of confidence that the present condition of the nozzle pipe weld area is satisfactory.

PGandE understands that the cracking at other plants apparently developed after some period of plant operation. The cause of the cracking has been attributed by some to be a stress-assisted corrosion mechanism but study of this problem is continuing. Based on the results of these studies and continuing experience at other plants, the necessity of performing inservice inspection of the feedwater nozzle area after some period of operation will be evaluated. Additionally more frequent inspections than required by the current code will be evaluated. Some time is available before such a decision is required.

2.8 SEISMIC DESIGN OF PORV'S, BLOCK VALVES

What are the seismic classes of:

a. PORV

b. Block Valve

c. Equipment related to the operability of these devices

a) The PORV's are Seismic Category I.

b) The block valves are Seismic Category I.

c) The equipment needed to operate them is either presently Seismic Category I or is being upgraded to Seismic Category I.

2.9 AUXILIARY FEEDWATER SYSTEM

What are the specific recommendations for the Auxiliary Feedwater System at Diablo Canyon? (Plant Specific Report)

Although PG&E understands that the Regulatory Staff has not yet completed a plant specific report for the Diablo Canyon auxiliary feedwater system, PG&E has evaluated this system, using the best information available with respect to possible Regulatory Staff recommendations and requirements. This information includes the short-term recommendations contained in NUREG-0578 and material presented to the ACRS by the NRC Regulatory Staff.

NUREG-0578 contains two short-term recommendations for PWR auxiliary feedwater systems. PG&E has addressed these recommendations in detail in its report to the NRC dated August 27, 1979. The first of the NUREG-0578 recommendations is for automatic initiation of the auxiliary feedwater system. The existing Diablo Canyon design meets all Regulatory Staff positions related to this recommendation. The second NUREG-0578 recommendation is for auxiliary feedwater flow indication to steam generators. Diablo Canyon presently has such flow indication which is being modified to meet all Regulatory Staff positions.

At various times in the past few months, the Regulatory Staff has discussed with the ACRS possible longer-term requirements for PWR auxiliary feedwater systems. Based on material presented by the Regulatory Staff to the ACRS, that possible longer-term requirements include the following:

1. Provision of an alternate water source for auxiliary feedwater if a single suction valve is employed between the primary water source and the auxiliary feedwater pumps.

2. A low-level alarm for the primary water source (condensate storage tank).

3. Endurance tests for auxiliary feedwater pumps.

4. Confirmation of correct valve position on loss of air or loss of power.

5. A diverse means of powering at least one auxiliary feedwater pump, actuated and operable assuming loss of all AC power.

6. Modification of technical specifications.

7. Plant specific requirements for auxiliary feedwater pump test criteria, possible modification of valve lineups, review of common mode electrical failures, and possible modification of surveillance test procedures.

PG&E has examined the Diablo Canyon auxiliary feedwater system, attempting to evaluate it against the limited information available concerning possible longer-term requirements. PG&E has concluded that the system, as presently installed, meets these requirements. Although the Diablo Canyon auxiliary feedwater pumps have been operated for long periods of time during functional testing, an additional endurance test of at least 72-hours duration will be conducted for the auxiliary feedwater pumps if required by the Regulatory staff. A determination of whether modifications are required for auxiliary feedwater pump test criteria, valve lineups, and surveillance test procedures must await the results of the staff evaluation. PG&E will take whatever steps are necessary to meet future staff requirements.

2.10 CONTROL ROOM SEISMIC EFFECTS

Are there seismic effects in the control room which require attention? Has special consideration been given to structures, equipment, and instrumentation in the control room for an earthquake situation? For example:

- Has the ceiling been analyzed?
- Will lighting be adequate?
- Will lighting fixtures remain in place?

The control room at Diablo Canyon is located in a Category I structure. Explicit provisions have been made for its continued use following a seismic event. Safely-related equipment in the control room meets Category I seismic requirements. This equipment includes the control room ventilation and air conditioning systems, the main control boards, the operator's consoles, and all safely-related instrumentation and controls. Control room equipment, fixtures and accessories which are not safely related have been designed to preclude damage to safety-related equipment and injury to or interference with operators as a result of a seismic event. A study was made of the human factors involved in control room operations during and following a seismic event. As a result of this study, some modifications were made to methods of operation and some hardware changes were made to make certain that, in the event of an earthquake, operators would not be adversely affected by furniture, bookshelves, and other control room accessories. This study also resulted in the installation of "grab-rails" to provide operators with the capability for support during an earthquake while minimizing the possibility of inadvertent actuation of panel mounted controls.

The luminous ceiling in the control room consists of a steel framing grid restrained by the control room's walls and roof. The grid supports the lighting fixtures, with their fluorescent tubes, and the plastic light diffuser ceiling panels.

The steel framing grid has been analytically qualified for the seismic inputs associated with the Hosgri seismic event. The analysis shows

that the grid will remain in place and continue to support the lighting fixtures and ceiling panels.

The plastic light diffusing ceiling panels are 2 ft. by 4 ft. in size and are made of 15 mil thick vinyl sheet material. They are the double panel type made of two vinyl sheets with about an inch space between them for better light diffusion. It is extremely unlikely that they could cause damage or injury if they fell. However, to prevent the panels falling from the grid, "hold-down" clips have been added to the panels.

Each fluorescent tube is 4 ft. long and has double mounting pins on each end of the tube. The tube is mounted to fixture sockets that require the two pins on each end to be channeled into a slot on the sockets and then rotated ninety degrees. The rotation prevents the tube from dropping out of the fixture without first being "back" rotated, making it unlikely that a lamp would drop out of a fixture.

Usually, a properly mounted fluorescent tube would not drop out unless it had first been broken in two so that the mounting pins could pull back out of the socket slot. The tubes would not drop out under other circumstances unless the lighting fixture became deformed. This is not possible as long as the steel framing grid remains in place. If a tube or parts of a tube should drop out, it would be retained by the plastic diffuser ceiling panels below the lighting fixture and would not fall to the floor. Tests have been conducted simulating fluorescent tubes dropping out of the lighting fixtures and onto the plastic diffuser ceiling panels. These tests have shown that the panels will remain intact and retain the fluorescent tubes, preventing any damage to control room equipment or injury to operators.

As stated above, it is not expected that fluorescent tubes would fall out of the lighting fixtures. However, even if one half of all the lamps dropped, there would still be about 70 ft. candles of light in the room. (Only 3 ft. candles is required by IES Handbook for emergency lighting in control rooms.)

2.10 CONTROL ROOM SEISMIC EFFECTS (Cont'd)

Lighting in the control room is provided by four independent means. These are 1) normal ac lighting, 2) emergency ac lighting, 3) emergency dc lighting powered by the station batteries and 4) seismically qualified 8 hour battery pack operated sealed beam lights.

If normal ac power is lost as the result of a seismic event, the normal ac lighting would be lost. The emergency dc lighting and battery pack lighting would immediately come on. The emergency dc lighting consists of seven 200 watt incandescent fixtures. When the on-site emergency diesel-generators come up to speed (10 seconds), emergency ac lighting will replace the dc lighting. Eighteen single tube 40 watt fluorescent fixtures are powered by the emergency ac.

The 8 hour battery pack operated sealed beam lights are designed to provide a minimum lighting level in the event a fire causes loss of all other lighting power. They have been seismically qualified by shake table test.

In summary, assurance has been provided that the control room lighting and luminous ceiling will not adversely affect the safe operation of the plant in the event of an earthquake. Adequate lighting levels will be maintained under all circumstances.

2.11 CONTROL ROOM INSTRUMENTATION DISPLAYS

What is the status of control room instrumentation displays, how rapid is the plant process computer (delay between printing and real time). What effect would an earthquake have?

All required control room instrumentation displays are Seismic Category I.

The plant process computer would probably fall behind the course of the accident as it did at TMI-2. The rotating memory would probably be destroyed during a severe earthquake, but all of the information needed to safely shut the plant down is displayed on seismically qualified devices on the main control board.

The subject of instrumentation needed to bring the plant to a safe shutdown was very thoroughly covered in our Hosgri analysis and is discussed in the Hosgri Evaluation Report. No credit for the computer has been taken in that analysis.

2.12 OFF-SITE/ON-SITE POWER SYSTEM RELIABILITY

How comprehensive are tests for electrical transients during an earthquake and effect on equipment? Reliability of both offsite and onsite power.

The electrical transients generated from an earthquake are no different than transients resulting from other causes. The combined potential for forced outages due to all natural phenomena, including tornadoes, electrical storms, floods, fires, ice, snow, and earthquakes probably does not vary considerably from plant to plant. In fact, the combined forced outage potential may be lower at Diablo Canyon because of the low combined probability of all severe natural phenomena including earthquakes.

The equipment would not be affected by electrical transients resulting from earthquakes any more than by other electrical transients. All equipment has been adequately rated to perform any intended function under fault conditions.

Protective equipment such as relays are periodically tested to verify proper operation. Company standards are established for such testing and have been utilized for many years throughout the PGandE system.

Equipment within the plant which is required to initiate bus transfers, diesel starts and bus loading is tested in accordance with the Technical Specifications. Such testing is designed to improve the reliability of offsite power and demonstrate the reliability of the onsite emergency power system.

2.13 TECHNICAL SUPPORT CAPABILITIES

Staff conclusion regarding technical support capabilities for Diablo Canyon.

PGandE has responded to the NRC Staff letter dated June 29, 1979 with the data requested in Section II.A of the enclosure to the letter titled, "Information Required to Review Corporate Capabilities". This initial response included the on-site technical resources available at both Diablo Canyon and Humboldt Bay and was submitted on July 30, 1979. The use of off-site management and technical resources during an unusual event like the TMI-2 accident has been provided for in the Diablo Canyon and Humboldt Bay Site Emergency Plans, but these supplemental roles have not yet been formalized at the corporate level.

On July 5, 1979, PGandE submitted to the NRC Staff a document titled "Report to Nuclear Regulatory Commission from Pacific Gas and Electric Company Describing Response Programs Following the Accident at Three Mile Island".

Section III.B of this report includes a commitment to complete a Corporate Emergency Response Plan prior to power operation at Diablo Canyon. The information requested in Sections I and II.B of the enclosure to the June 29, 1979, letter will be developed as part of the Corporate Emergency Response Plan and will be transmitted to the NRC Staff as soon as it is completed.

3.0 SYSTEM AVAILABILITY EVALUATION

Seismic Impact on Accident Initiation

Most of the components of the Diablo Canyon condensate and feedwater systems are located in the turbine building. This building meets Category I seismic requirements. The kind of seismic structural failure that might lead to a loss of main feedwater should be less of a concern at Diablo Canyon than at a plant where this equipment is located in a non-seismically qualified building. Over the life of the plant, the seismic contribution to loss of main feedwater initiated transients is certainly negligible in terms of all the other possible contributors; however, certainly a number of instances of loss of main feedwater will occur. The seismic contribution to these instances will be insignificant. From the standpoint of the initiating event, Diablo Canyon is not significantly different from other plants. The probability that the initiating loss of feedwater event would take place is no greater.

Seismic Impact on Accident Sequence

Phase I of the TMI-2 accident sequence is no more likely at Diablo Canyon than at any plant located in an area of low seismicity.

As discussed in subsequent paragraphs of this section, Diablo Canyon's relatively high site seismicity does not increase the potential for encountering any other phase of the TMI-2 accident sequence, nor does it decrease the plant's ability to respond to any of these phases.

In addition, although not subsequently discussed, the Diablo Canyon reactor would be tripped immediately following any earthquake subjecting the containment base slab to an acceleration higher than approximately .35g. This anticipatory trip helps to ensure that the reactor would be safely shut down before any non-Seismic Category I equipment failures could have even an indirect impact on reactor core heat removal.

3.1 PHASE I - LOSS OF FEEDWATER

Assume an event initiates a transient, that begins like TMI, with a loss of main feedwater.

Auxiliary Feedwater System

This requires that auxiliary feedwater be initiated and available. At Diablo Canyon, all components of the auxiliary feedwater system that are necessary for its initiation and operation are seismically qualified for the postulated Hosgri event. This includes all the auxiliary supporting systems for the auxiliary feedwater system including power supply, control, and monitoring.

Water Supply

As a part of the review of the plant for the Hosgri earthquake, PGandE has met a requirement which provides a significantly greater amount of auxiliary feedwater than exists at other plants. The primary supply of auxiliary feedwater is the condensate storage tank which is a Seismic Category I tank. The water stored in the Seismic Category I firewater tank is also available. The minimum volume of water in the condensate storage tank is 170,000 gallons. The normal volume is at least 300,000 gallons. The firewater tank's minimum volume is 300,000 gallons.

In addition to the seismically qualified supply to the auxiliary feedwater system that provides between 32 - 40 hours of hot shutdown capacity, at least 2 million gallons is maintained in a raw water storage reservoir. It is PGandE's position that this reservoir would be available to supply a source of auxiliary feedwater following any postulated seismic event up to and including the Hosgri. The reservoir will provide 8 to 10 days of supply for the auxiliary feedwater system. This is significantly greater storage of auxiliary feedwater than is provided at most other plants. With respect to the water supply for the auxiliary feedwater system at Diablo Canyon, any problems due to high site seismicity are compensated for by the fact that a significantly greater amount of water is available for auxiliary feedwater

3.1 PHASE I - LOSS OF FEEDWATER (Cont'd)

Water Supply (Cont'd)

than at other plants. The water supply for auxiliary feedwater is discussed in the attached Pages 5-5, 5-6, and 5-6B of the Hosgri report.

For a loss of feedwater accident, the auxiliary feedwater system at Diablo Canyon is required to be operable to mitigate the accident. Because the auxiliary feedwater system at Diablo Canyon and everything necessary for its initiation and operation is seismically qualified, and because there is a large amount of water available from diverse water sources, it can be concluded that even with the seismic environment at Diablo Canyon, the availability of the auxiliary feedwater system will be no lower than for a plant in a less severe seismic environment.

Reactor Coolant System Pressure Control

The design of the Diablo Canyon plant (and of Westinghouse plants in general) is such that for a loss of normal feedwater one would not expect a power operated relief valve or a safety valve to open. However, for the purposes of this report, it has been assumed that a TMI-2 sequence is initiated for some unidentified reason. If, following the initiating event, the reactor coolant system pressure increases significantly the pressurizer's power operated relief valves (PORV) and/or the safety valves would be required to open. Therefore, this and other pressure control functions have been evaluated. Those plant features necessary for this postulated post-accident pressure control include:

Safety valves (including positive position indication)
Power operated relief valves (including positive position indication)
Pressurizer heaters
Pressurizer spray
Pressurizer level and pressure instrumentation (to provide for both protection system actuation and control room indication)

3.1 PHASE I - LOSS OF FEEDWATER (Cont'd)

Safety Valves and Relief Valves

Pressurizer safety valves and power-operated relief valves at Diablo Canyon, including power supply and all necessary actuating devices, are seismically qualified. The power-operated relief valves are provided with positive position indication which is seismically qualified. The safety valves will be provided with such indication. This is in accordance with the recommendations set down in NUREG-0578 which PGandE responded to in its report to the Nuclear Regulatory Commission dated August 27, 1979.

Pressurizer Heaters

Also in accordance with the NUREG-0578 recommendations, redundant seismically qualified power supplies are being provided to each of the pressurizer heater groups necessary for this particular transient. The heater elements themselves are qualified seismically as is discussed in Section 6.9 of the Hosgri evaluation report.

Pressurizer Spray

The pressurizer auxiliary spray system is seismically qualified. The air operated valve in the system has been provided with a seismically qualified backup motive power supply and a manual bypass valve. This ensures the operability of the auxiliary spray system following a seismic event. As a result of the present system-by-system review of the TMI-2 events, the bypass valve is being provided with a seismically qualified motor operator.

Pressurizer Level and Pressure Indication

Both the level and pressure instrumentation are seismically qualified from the transmitters to the control room parameter readouts.

Reactor Coolant Pumps

For a seismically initiated accident at Diablo Canyon, it has been assumed that the reactor coolant pumps would not be available because of

Reactor Coolant Pumps (Cont'd)

the assumption that offsite power would be lost. As discussed in Section 5.1 of the Hosgri evaluation report, the plant is capable of reaching cold shutdown using natural circulation in the event the pumps cannot be restarted due to a loss of offsite power.

Margin to Saturation Indication

Additional instrumentation has been provided as a result of the NUREG-0578 recommendation for explicit indication of margin to saturation in the control room. This indication is seismically qualified. Additional instrumentation (i.e., pressure and temperature in the reactor coolant system) is available which is also seismically qualified and allows the operator to make a determination of margin to saturation independent of additional instrumentation.

RCS Inventory Control System Required for Safe Shutdown

The plant water inventory control systems needed following various postulated events (including a loss of feedwater accident) have been analyzed in the course of the Hosgri evaluation, and modifications have been made to the plant in order to maintain hot shutdown and proceed to cold shutdown using only seismically qualified equipment, even assuming a single active failure.

Main Steam System (Category I Portion)

All components of the main steam system that are required for purposes of heat removal (either maintaining hot shutdown or going to cold shutdown) are Seismic Category I. This includes the steam generators themselves, the piping to and including the main steam isolation valves and the steam generator power operated relief valves, their controls and air systems. The system is designed to take the plant to cold shutdown or maintain hot shutdown using only Seismic Category I equipment.

3.1 PHASE I - LOSS OF FEEDWATER (Cont'd)

Main Steam System (non-Category I) and Main Feedwater and Condensate System

During the course of the TMI-2 accident and the subsequent recovery period, components of the main steam, feedwater, and condensate systems were used that were not safety grade systems. While these systems are also not seismically qualified at Diablo Canyon, in the course of satisfying the pipe break criteria, the supporting systems were substantially strengthened over conventional power plant design and would not be expected to fail even during a Hosgri seismic event. Certain other steps taken at Diablo Canyon increase the reliability and probability that these systems would be available and would function satisfactorily. However, at TMI-2, as well as at Diablo Canyon, alternate means exist to accomplish accident mitigation and long-term cooldown. These include the use of atmospheric dump.

Reluctance at TMI-2 to use the atmospheric relief to remove heat from the primary system was prompted primarily by concern about leakage in one of the two steam generators. The fact that the Diablo Canyon design employs four steam generators makes it less probable that steam generator tube leakage would preclude atmospheric relief.

As noted earlier, components of the Diablo Canyon feedwater and condensate systems, while not Seismic Category I, are housed in a building that meets Seismic Category I requirements. Consequently, their failure due to a seismically induced structural failure of the building is highly unlikely. In addition to the protection afforded by their structure, these components and systems have been reviewed against seismic considerations and employ features beyond those normally found in a non-Category I system. These features, including seismic supports to hold down the equipment, were considered necessary at Diablo Canyon to preclude damage to the structure from equipment that might break loose during a seismic event. This additional care utilized in seismic support and restraints for non-Category I equipment appreciably reduces the probability of damage during a seismic event.

3.1 PHASE I - LOSS OF FEEDWATER (Cont'd)

Control Room

The control room at Diablo Canyon is located in a Category I structure. Explicit provisions have been made in a number of areas for its continued use following a seismic event. This includes the ventilation and air conditioning systems. These systems are themselves Category I as are their power supplies, and the control boards and panels. The non-seismically designed accessories in the control room - such as lighting - are designed to preclude damage to safety related equipment or interfere with the operators during a seismic event. This also includes work that was done and studies that were conducted relative to the human factors involved in operating the control room following a seismic event. As a result of the studies, some modifications were made to methods of operation and some hardware changes were made in the control room to make certain that the operator wouldn't adversely be affected by furniture, bookshelves, etc., and that he was provided with the capability to support himself during the earthquake in a manner that would minimize the possibility of inadvert actuation of panel mounted controls. Although no operator actions would be required during this first phase of the accident, the operator supports have been designed to facilitate operator action during a seismic event.

Before the reactor coolant system (RCS) temperature has decreased to 200°F, the pressurizer is filled solid and pressure is controlled with the low-pressure letdown valve. When the RCS temperature reaches 160°F, the last reactor coolant pump is tripped.

Finally, auxiliary spray is supplied from the charging system to cool the water volume in the pressurizer to the cold shutdown conditions of the balance of the reactor coolant system. The low-pressure letdown valve is used to depressurize the plant to atmospheric.

If as a result of the earthquake, offsite power is not available, the procedure is as above, except that essential equipment is energized by the standby diesel generators, the reactor coolant pumps are not used, auxiliary pressurizer spray is used, and steam dump is to atmosphere instead of to 60
the condenser. The steam turbine driven auxiliary feed pump may be used. If in addition normal shutdown systems are not available, other equipment and procedures which have been evaluated for the Hosgri earthquake are available both to maintain the plant in a safe hot standby condition and to take it to cold shutdown conditions. A description of shutdown using the minimum of equipment follows:

After the reactor is tripped, the operator maintains hot standby conditions by supplying water to the steam generators. The motor-driven auxiliary feedwater pumps are desirable but the turbine driven pump is sufficient. Steam dump from the steam generators is through the steam generator 10% atmospheric relief valves. The primary source of auxiliary feedwater is the condensate storage tank. At its minimum allowable level it provides 170,000 gallons of auxiliary feedwater. Under severely conservative assumptions (including 102% reactor power and 10% below low-low water level in all four steam generators) this quantity will allow one hour at hot standby and a normal four hour cooldown period. If it is reasonably assumed not to be necessary to raise the steam generator water level, this same quantity of water will allow four or five hours at hot standby and a normal four hour cooldown. The normal level in the condensate storage tank would

allow approximately twelve hours of hot standby operation under the most conservative assumptions. The water in the fire water storage tank would allow additional hot standby operation for about twenty-eight hours (for one unit) and the water in the raw water storage reservoir would allow hot standby operation for about eight days (for one unit). 70

To borate the reactor coolant system to compensate for xenon decay or prior to initiating cooldown, the operators use the normal boration path but may bypass the blendor. An alternate boration path from the centrifugal charging pumps to the reactor coolant system by the reactor coolant pump seal injection flow path also is available.

To accomplish the initial stage of cooldown the operators use the steam generator 10% atmospheric relief valves to regulate the cooldown rate. Natural circulation flow in the RCS provides the heat transfer from the core to the steam generators.

To make up for reactor coolant system volume contraction during cooldown, the operators align the centrifugal charging pumps to take suction from the refueling water storage tank and to discharge to the RCS through the normal charging path. Depressurization of the RCS is accomplished by using pressurizer auxiliary spray.

When the RCS pressure and temperature are decreased to approximately 400 psig and 350°F respectively, the operators initiate RHR system operation to continue the cooldown to 200°F. The RHR system heat sink is through the component cooling water system and the auxiliary salt water system to the Pacific Ocean.

Evaluation of the required fluid systems and mechanical equipment for Hosgri are described in Chapters 6, 7, 8. Their functions are summarized in Figure 5-1.

2. The primary source of auxiliary feedwater is from the condensate storage tank. For longer periods at hot standby, 2,000,000 gallons in the raw water reservoir may be used as auxiliary feedwater. This quantity of water will permit one unit to remain at hot standby for 200 hours or both units for 100 hours, following full power operation. In addition, 300,000 gallons in the fire water tank may be used. This will permit about 28 hours hot standby for one unit or 13 hours for both units. Finally, temporary connections allow sea water from the auxiliary salt water piping at the component cooling water heat exchangers to be pumped through hoses by a portable pump and used as auxiliary feedwater makeup. Any hoses intended to be used in any temporary auxiliary feedwater connections will be given the same regular inspection and maintenance as are plant fire hoses, which will meet the requirements of the National Fire Protection Codes. 70

3. The first active components in the auxiliary feedwater flow path from the condensate storage tank to the steam generators are the auxiliary feedwater pumps. One turbine driven pump and two motor driven pumps are provided, any one of which can provide sufficient auxiliary feedwater flow. The two motor driven pumps are powered from different emergency power trains, and the turbine driven pump can receive motive steam from either of two steam generators. This system can withstand the single failure of any one pump, valve, or power supply and still supply water to all four steam generators.

   The turbine driven pump is normally aligned to provide flow to all four steam generators via four normally open motor operated valves (LCV-106, 107, 108, 109). If any one of these valves spuriously failed closed, flow could still be provided from the turbine driven auxiliary feedwater pump to the remaining three steam generators. Each motor driven pump is normally aligned to provide flow to two of the four steam generators through normally closed electro-hydraulic valves (LCV-110, 111 and LCV-113, 115) which are powered from emergency power trains. Normally closed manual cross-connect valves (in line K16/4292/4) can be opened to allow either motor driven pump to feed all four steam generators.

3.2 PHASE II - SMALL LOSS OF COOLANT ACCIDENT (LOCA)

Phase II of the TMI accident marked the departure from a normal loss of feedwater accident and the progression to a small loss of coolant accident. This Phase begins at the approximate time when the pressurizer power operated relief valve should have reset (about one minute after the start of the accident) and ends approximately two hours and twenty-one minutes into the accident when fuel damage was first observed. Many of the same systems described in Phase I were utilized in Phase II. Therefore, in addition to discussing the new systems utilized, consideration will also be given to any new aspects of systems discussed in Phase I.

Reactor Coolant System/Pressurizer Relief Tank

During Phase II of the accident, the power operated pressurizer relief valve discharged into the quench tank (at Diablo Canyon the Pressurizer Relief Tank). In the event of a seismic occurrence, this non-Category I tank may not be available at Diablo Canyon. With or without a seismic event, the sustained blowdown of the PORV would burst the relief diaphragm in the Pressurizer Relief Tank and, therefore, it is not clear that there is any benefit of having a Seismic Category I Pressurizer Relief Tank.

Containment System

In the event of the small break LOCA, there are several systems provided to contain the discharge from the reactor coolant system and also to monitor any resultant radiation. Among these, the containment pressure and the containment hydrogen concentration indicators are currently Seismic Category I or will be purchased and installed to Seismic Category I requirements. The containment spray system, the hydrogen recombiners and the containment isolation provisions are all Seismic Category I. The containment temperature indication and radiation monitoring equipment are not Seismic Category I.

Containment Fan Coolers

An additional containment system available to mitigate the consequences of a small LOCA is the reactor building fan cooling system. The system is designed to provide containment atmospheric cooling and is Seismic Category I.

3.2 PHASE II - SMALL LOSS OF COOLANT ACCIDENT (LOCA) (Cont'd)

Uncontrolled Release Paths

Two other features that figured prominently in the TMI accident were the reactor building sump pump control system and the waste gas vent header. The major release path at Three Mile Island was ultimately via the waste gas vent header. At Diablo Canyon, this header is provided with Seismic Category I isolation valves so that in the event of emergency core cooling system (ECCS) actuation, the line would be isolated and leakage from the header would remain inside the containment.

With respect to the waste gas vent header during this phase of the accident (prior to the time when significant fuel damage has occurred) the important consideration is whether pressurization of the header due to pressurizer relief tank pressurization could create leak paths that would be of concern during later phases of the accident (i.e., when there would be significant activity in the waste gas vent header). For the reactor building sump pumps, while they did provide a leak path, the amount of the activity released prior to the time of significant fuel damage through this pathway was not a significant contributor to the accident's severity. Consequently, the major concern is whether these systems isolate on a containment isolation signal and whether that containment isolation signal would be generated prior to fuel damage. At Diablo Canyon, the containment is isolated upon ECCS actuation, thereby eliminating these release paths.

Radiation Monitoring

The existing radiation monitoring system at Diablo Canyon has no seismic qualifications. The new instruments being added for post-accident monitoring will be seismically qualified for the Hosgri event.

Reactor Coolant System Pressure Control

Phase I requirements of the pressurizer pressure control systems generally remain unchanged in Phase II. The only additional items required during Phase II were the block valves associated with the pressure relief valves (PORV). At Diablo Canyon, these block valves and their motor operators are seismically qualified and are powered from the plant vital power system.

3.2 PHASE II - SMALL LOSS OF COOLANT ACCIDENT (LOCA) (Cont'd)

In-core Thermocouples

During the TMI-2 accident, the in-core thermocouples provided a valuable indication of the lack of core cooling and the potential for fuel damage. Neither at TMI-2 nor at Diablo Canyon do the in-core thermocouples have explicit seismic qualification. However, the devices used would not necessarily fail in the event of a seismic event. The thermocouple design is simple, and is similar to designs used elsewhere in systems that have received seismic qualification. At Diablo Canyon, there are a total of 65 in-core thermocouples in each unit. Therefore, one would expect that following a seismic event at Diablo Canyon, a sufficient number of these in-core thermocouples would remain functional for use in determining in-core conditions. These thermocouples are housed in a seismically qualified reactor vessel that precludes damage from vessel or containment structural failure that would affect their function. In addition, the forces due to hydraulic induced vibrations, to which these thermocouples are subjected during normal operation, are probably comparable to seismic inputs.

Control Room

In addition to the control room habitability considerations discussed previously, the provision of sufficient information to enable the operator to follow the course of the accident and take the necessary actions to mitigate the accident is extremely important during this and all subsequent phases of the accident. Although at other plants, a great deal of information is conveniently available only through the use of the non-Category I plant computer, a sufficient subset of the information necessary for accident mitigation is available in the control room at Diablo Canyon and is provided by indicators and recorders that are seismically qualified.

Long-term recommendations that are expected to come from various groups, including the NRC, may well identify requirements for more extensive historical or diagnostic information beyond what is currently available at Diablo Canyon and at other plants. However, until such recommendations

3.2 PHASE II - SMALL LOSS OF COOLANT ACCIDENT (LOCA) (Cont'd)

Control Room (Cont'd)

are made on an industry-wide basis, the Category I information available to the operator at Diablo Canyon is deemed sufficient to enable the operator to follow the course of the accident, take necessary actions to mitigate the accident's consequences, and place the plant in a safe shutdown condition.

Other Phase II Systems

The remaining systems utilized during Phase II were also described under Phase I. There are no additional sets of those systems that were utilized during Phase II. Therefore, there are no additional seismic implications of the accident relative to these systems.

3.3 PHASE III - FUEL DAMAGE

During the next phase of the TMI accident, the fuel underwent significant damage. This phase began approximately two hours, 21 minutes into the accident and lasted until approximately 16 hours. Several of the systems used during Phase III were used much the same way as in the two previous phases and need not be discussed further here. These include the pressurizer relief tank, containment, auxiliary feedwater system, reactor coolant system, main steam system, reactivity control systems, and condensate and feedwater systems.

Area Radiation Monitoring

Among the additional systems used during Phase III was the area radiation monitoring system used to detect and measure levels of radiation resulting from the failure of the cladding and the breach of the RCS pressure boundary. The areas where monitoring was necessary included the containment, the auxiliary building, the control room, the fuel handling building, and the offsite environment. Much of the area radiation monitoring equipment was not originally purchased to Seismic Category I requirements. Monitors used to isolate the control room from potential sources of radiation following an accident are Seismic Category I.

Sampling Systems

During the course of the TMI-2 accident and especially following the occurrence of significant fuel damage, a number of the sampling systems were important in assessing the severity of the accident and providing guidance to the plant operators for the post-accident recovery. In accordance with the recommendations contained in the NUREG-0578 on short-term lessons learned, PG&E in its August 27, 1979 report to the NRC, has committed to follow the short-term recommendations by reviewing the design of important sampling systems to assure that in the event of an accident like TMI-2, these sampling systems would be available and samples obtainable, if necessary, without unexceptable dose consequences to plant personnel.

3.3 PHASE III - FUEL DAMAGE (Cont'd)

As part of that review, PGandE is reviewing the seismic design of those sampling systems to assure that those sample lines necessary to perform an important function following an accident like TMI-2 would continue to be available following a seismic event. This review may well lead to some modifications being made to bring those important sampling systems up to Category I standards.

Much of the laboratory equipment necessary to perform sample analyses has not been procured to seismic criteria because Seismic Category I equipment is not generally commercially available. Also, in many cases, this equipment is portable. In the event that the laboratory equipment needed for this kind of analysis has been damaged by a seismic event, other equipment is available in other PGandE facilities. The nature of the equipment is such that it can be brought to the plant site in a time frame that does not compromise the ability to perform sample analyses.

Process Radiation Monitoring Equipment

Following the advent of serious fuel damage at TMI-2, process radioactivity monitoring equipment in a number of systems bounding the reactor coolant system was important to ascertain whether leakage was occurring in any of these systems and/or whether they were themselves becoming radioactive. At Diablo Canyon, as at other plants, this process activity monitoring instrumentation has not been procured in accordance with any seismic criteria. However, radioactivity monitoring in these systems is not

3.3 PHASE III - FUEL DAMAGE (Cont'd)

Process Radiation Monitoring Equipment (Cont'd)

important until some time after an accident has occurred. Alternate methods are available if leakage has taken place in a secondary system. For example, samples can be taken and analyzed in the laboratory. The capability to take samples of this nature is being reviewed in accordance with PGandE's response to the NUREG-0578 recommendations regarding sampling systems.

Control Room

In addition to the information necessary for safe shutdown, the emergency plan requires actions to be taken based on the information available to the operator. This necessary information would be available following a seismic event.

Communications Equipment

Critical to the Phase III effort was the activation of the emergency plan and intraplant communications following the activation of the emergency plan. Within Diablo Canyon, several communication systems exist. Although they have not been rigidly qualified to Seismic Category I requirements, they have high reliability and are expected to incur at most isolated random failures due to the seismic event. Relative to communications with offsite emergency coordinating organizations, the communication problems expected to be encountered will be no different than those which would be encountered at sites with low seismicity but with higher risk of meteorological damage due to hurricanes, tornados, and other events that are of relatively low probability at Diablo Canyon.

Residual Heat Removal System

One additional system required in the long-term following the accident at TMI-2 was the residual heat removal system. At TMI-2, for a number of reasons, it was decided not to employ this system.

3.3 PHASE III - FUEL DAMAGE (Cont'd)

Residual Heat Removal System (Cont'd)

However, at Diablo Canyon, all equipment necessary for residual heat removal is Seismic Category I. In addition, as discussed previously, the systems and components needed to bring the plant to a cold shutdown condition have been seismically qualified to assure that a cold shutdown condition can be achieved using only seismically qualified equipment and components. This is unique among all other plants in the operating and near-term operating license category. Because of the very rigorous program conducted to assure seismic qualification of the systems, the probability of these systems becoming damaged or unavailable because of the seismic event at Diablo Canyon should be essentially the same as at another site with lower seismicity. In other words, as reiterated throughout this report, the steps taken to assure adequate seismic design at Diablo Canyon significantly adds to the assurance that all systems, including the RHR system, needed for a TMI-2 type of accident are capable of withstanding the Hosgri seismic event.

The capability to provide decay heat removal in the long-term requires that a number of systems be available. At Diablo Canyon, this includes the residual heat removal system, the component cooling water system, the auxiliary saltwater system, and the ultimate heat sink--the Pacific Ocean. Also required is the electrical power to operate the components associated with these systems. In all cases, these systems are powered from the emergency on-site power system. These systems' safety functions can be performed without reliance on off-site power.

All devices associated with these systems are either powered from the emergency power system or have seismically qualified backup air systems to assure that they function properly.

3.4 PHASE IV - LONG TERM RECOVERY

Several systems which have been used in one or more of the previous three phases are utilized during the long-term recovery mode, Phase IV. These include the pressurizer relief tank, containment, area radiation monitoring, sampling systems, process monitoring equipment, auxiliary feedwater system, various parts of the reactor coolant system - including ECCS, main steam system, control room, reactivity control systems, and the feedwater and condensate systems.

Offsite Power

Some of the systems, components, and structures used at TMI-2 during Phase IV and each of the other phases of the accident were powered from the non-Seismic Category I offsite power system. Although previous sections of this report have discussed the Category I, Class 1E powered equipment available at Diablo Canyon to acceptably perform required functions, this section of the report addresses the concern that a seismic event could significantly contribute to i) the likelihood of a TMI-2 type accident at Diablo Canyon while ii) causing damage to the local transmission equipment to the extent that offsite power would not be available for a considerable time following the accident.

The continued availability of offsite power depends upon the seismic resistance of system transmission lines, generating plant switchyards, and system substations to seismic activity that could conceivably cause a concurrent Diablo Canyon outage.

The attached FSAR Figure 8.2-2 shows the location of the substations and power plants available to supply power to Diablo Canyon following a forced outage.

PGandE has decades of experience in the design and installation of electrical generation, transmission, and distribution equipment for use in high seismic areas. As discussed below, this will help assure that in the event of a severe earthquake, the coincident loss of power to the non-Class 1E station auxiliaries is highly unlikely. This is due to the high seismic resistance of the Diablo Canyon and Morro Bay generating stations, the Mesa, Gates and Midway substations, the 500 and 230kV lines connecting them, and the extensive physical separation between the facilities listed above.

3.4 PHASE IV - LONG TERM RECOVERY (Cont'd)

Diablo Canyon Forced Outage Potential

The TMI-2 accident resulted from equipment malfunctions, design deficiencies and operator errors following a plant upset. The Diablo Canyon plant is designed to remain operational following earthquakes in the site vicinity resulting in site ground acceleration levels up to .2g.

The potential for earthquakes of this magnitude causing a forced outage is no greater at Diablo Canyon than for forced plant outages at nuclear plant sites in tornado and/or hurricane-prone areas, especially since Diablo Canyon is designed to remain operational following the most common cause of forced outages during extreme natural phenomenon, i.e., the loss of net electrical load following distribution system damage.

As discussed in a May 1979 paper, "Seismic Capability of Nuclear Piping" by Robert L. Cloud, which has been submitted to the ACRS by the Stone & Webster Engineering Corporation on another matter, earthquakes above the levels discussed above would most likely cause only minor plant switchyard damage.

In the unlikely event that an earthquake does create extensive switchyard damage at Diablo Canyon, mobile transformers would be the only remotely located equipment needed to power the station auxiliaries from the 230kV transmission system (switching could be performed at the remote substations). These trailer-mounted transformers could be quickly dispatched to the site to power the unit auxiliaries within eighteen hours after the accident.

Morro Bay Forced Outage Potential

The seismic resistance of non-nuclear thermal power plants is extremely high. Observations of the effects of earthquakes on thermal generating stations, included in the above referenced paper, indicate that many have operated through or been only briefly shut down following ground accelerations of up to .25g.

3.4 PHASE IV - LONG TERM RECOVERY (Cont'd)

Switchyard/Substation Damage Potential

Switchyard damage, specifically breakage of porcelain bushings and dislocation of improperly anchoraged components, is the primary cause of seismically induced forced outages. PGandE has incorporated many of the lessons learned from observed earthquake switchyard damage (particularly from the 1971 San Fernando earthquake) to improving the reliability of its switchyards and substations. For example, it was observed that track-mounted transformers which had been welded to the track were not dislodged and that large porcelain bushings could be made earthquake resistant by modifying their restraints to allow free movement. As a result of these lessons learned, which have been incorporated throughout the system, the resistance of the switchyard and substation components to seismic events is such that effective ground acceleration levels of at least .2g could be withstood with, at most, minor random damage which could be repaired or bypassed to provide power to the site within eight hours.

Transmission Tower Damage Potential

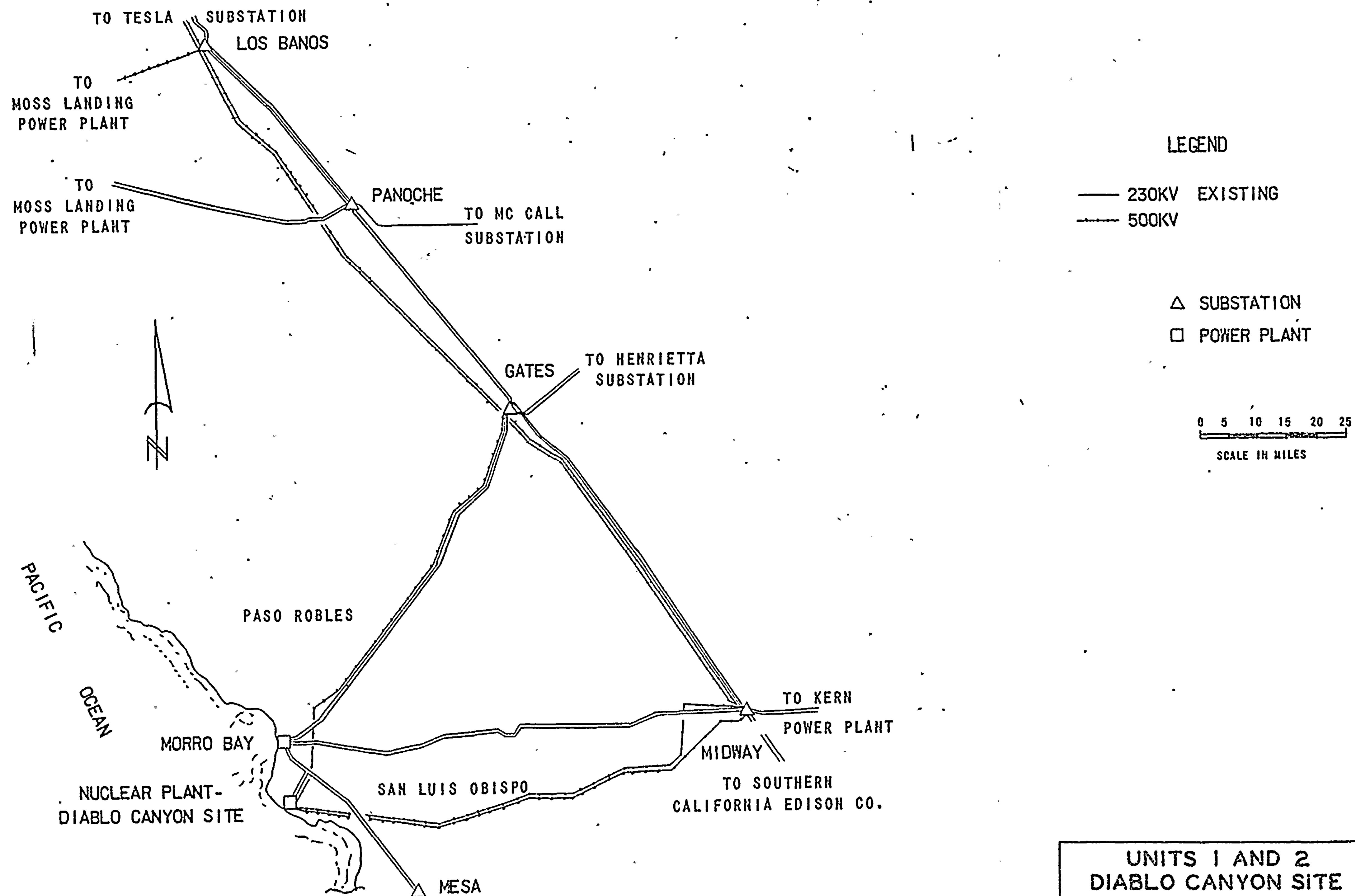
The design of transmission towers includes an inherently high resistance to seismic inputs. This is because their high wind loadings are usually design limiting. For example, transmission towers in the PG&E service area are designed for 58 mph wind loading; the design developed for this loading can withstand an effective ground acceleration level of up to .9g.

In addition, extensive preconstruction field reconnaissance activities are performed to assure the adequate foundation stability of individual towers. These activities include tower site screenings performed by Company field engineers experienced in recognizing potentially unstable sites, and follow-up examinations of questionable sites by engineering geologists. This work has resulted in the shifting, reorientation or otherwise adjusting of field staked tower leg locations, and/or the spanning or skirting of potential landslide, erosion-prone, or otherwise potentially unstable areas.

3.4 PHASE IV - LONG TERM RECOVERY (Cont'd)

Combined Seismic Damage Potential

As indicated in FSAR Figure 8.2-2, there are potential sources of backup power far removed from the Diablo Canyon site. It is, therefore, unlikely that any earthquake could result in a loss of such power to the Diablo Canyon station auxiliaries. Any interruption which did take place would not be expected to last beyond the time necessary for switchyard repair. However, in the extremely unlikely event of major switchyard damage at Diablo Canyon, power restoration would depend on the deployment of mobile substations. It is expected that this could be accomplished within eighteen hours. As discussed in previous sections of this report, onsite Category I equipment is available to mitigate any postulated event during this time.



UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.2-2

OFF-SITE INTERCONNECTION DIAGRAM