CATEGORY 1

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9902160215 DOC.DATE: 99/02/05 NOTARIZED: YES DOCKET #
FACIL:50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
50-323 Diablo Canyon Nuclear Power Plant, Unit 2, Pacific Ga 05000323
AUTH.NAME AUTHOR AFFILIATION
OATLEY,D.H. Pacific Gas & Electric Co.
RECIP.NAME RECIPIENT AFFILIATION
Records Management Branch (Document Control Desk)

SUBJECT: Forwards response to NRC questions discussed during conferences calls on 981016&23,1104,12&20 & 990108,revised response to question 1 of RAI dtd 980316 & proposed revised FSAR pages discussing improvements to offsite power sys.

DISTRIBUTION CODE: A001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 22
TITLE: OR Submittal: General Distribution

NOTES:

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD4-2 LA	1	1	PD4-2 PD	1	1
	BLOOM,S	1	1			
INTERNAL:	ACRS	1	1	FILE CENTER 01	1	1
	NRR/DE/ECGB/A	1	1	NRR/DE/EMCB	1	1
	NRR/DRCH/HICB	1	1	NRR/DSSA/SPLB	1	1
	NRR/DSSA/SRXB	1	1	NRR/SPSB JUNG,I	1	1
	NUDOCS-ABSTRACT	1	1	OGC/HDS3	1	0
EXTERNAL:	NOAC	1	1	NRC PDR	1	1

C A T E G O R Y 1 D O C U M E N T

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE. TO HAVE YOUR NAME OR ORGANIZATION REMOVED FROM DISTRIBUTION LISTS OR REDUCE THE NUMBER OF COPIES RECEIVED BY YOU OR YOUR ORGANIZATION, CONTACT THE DOCUMENT CONTROL DESK (DCD) ON EXTENSION 415-2083

TOTAL NUMBER OF COPIES REQUIRED: LTTR 15 ENCL 14

Pacific Gas and Electric Company

David H. Oatley
Vice President–Diablo Canyon
Operations and Plant Manager

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

805.545.6000

February 5, 1999

PG&E Letter DCL-99-013

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

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Additional Information Regarding License Amendment Request (LAR) 98-01, Implementation of 230 kV System Improvements

Dear Commissioners and Staff:

In conference calls on October 16, 1998; October 23, 1998; November 4, 1998; November 12, 1998; November 20, 1998; and January 8, 1999; PG&E and the NRC staff discussed additional technical information required in order for them to complete their evaluation associated with improvements to the Diablo Canyon Power Plant, Units 1 and 2, offsite power system. PG&E's response to the NRC questions discussed during those calls is documented in Attachment B. Attachment C includes a revised response to Question 1 of the NRC request for additional information dated March 16, 1998. This response supersedes the response included in PG&E letter DCL-98-076, "Response to NRC Request for Additional Information Regarding License Amendment Request (LAR) 98-01, Implementation of 230 kV System Improvements," dated May 19, 1998.

Attachment D includes proposed revised Final Safety Analysis Report pages discussing the improvements to the offsite power system, and the licensing basis for the offsite power system.

This additional information does not affect the results of the safety evaluation performed for LAR 98-01.

Sincerely,

D. H. Oatley

David H. Oatley

A001

cc: Edgar Bailey, DHS
Steven D. Bloom
Ellis W. Merschoff
David L. Proulx
Linda J. Smith
Diablo Distribution

Attachments

[illegible]

Attachment A
PG&E Letter DCL-99-013

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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

AFFIDAVIT

David H. Oatley, of lawful age, first being duly sworn upon oath says that he is Vice President - Diablo Canyon Operations and Plant Manager of Pacific Gas and Electric Company; that he is familiar with the content thereof; that he has executed the Additional Information Regarding License Amendment Request 98-01, "Implementation of 230 kV System Improvements," dated February 5, 1999, on behalf of said company with full power and authority to do so; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

D H Oatley

David H. Oatley
Vice President - Diablo Canyon Operations
and Plant Manager

Subscribed and sworn to before me this 5th day of February, 1999.
County of San Luis Obispo
State of California

Amy J Calloway

Notary Public

AMY J. CALLOWAY
COMM. #1096602
NOTARY PUBLIC CALIFORNIA
SAN LUIS OBISPO COUNTY
My Comm. Expires April 28, 2000

Additional Information Regarding Offsite Electrical System Improvements

Question 1:

Safety Analysis Report (SAR) description and commitment to process / plan for establishing operability.

PG&E Response to Question 1:

The Diablo Canyon Power Plant (DCPP) Final Safety Analysis Report (FSAR) Update, Revision 12, submitted to the NRC dated September 28, 1998, discusses the load tap changer (LTC) startup transformers (SUTs), the capacitor banks, and the Independent System Operator (ISO). Procedure O-23, "Operating Instructions for Reliable Transmission Service for DCPP," for system operation is not directly referenced in the FSAR but the FSAR states that operability is procedurally controlled. Procedure O-23 establishes the operability constraints for the 230 kV system, with the LTCs and without automatic LTCs, and with and without the capacitor banks. A copy of Procedure O-23 was provided as an attachment to PG&E letter DCL 98-076, "Response to NRC Request for Additional Information Regarding License Amendment Request (LAR) 98-01, Implementation of 230 kV System Improvements," dated May 19, 1998.

A proposed FSAR Update revision is attached. This revision includes the operability requirements for the offsite power system.

Question 2:

SAR description and analysis for meeting current Licensing Basis (LB).

PG&E Response to Question 2:

A proposed FSAR Update revision is attached. This revision describes the current licensing basis and the analysis assumptions.

Question 3:

Independent System Operator (ISO) contractual requirements do not accurately reflect LB or Technical Specifications, Limiting Conditions of Operation (LCO).

PG&E Response to Question 3:

Attachment 4 to PG&E letter DCL-98-076 contained a copy of a letter from the ISO dated January 27, 1998, committing to the use of Procedure O-23.

The ISO is contractually required to maintain the transmission system within the allowed voltage range and minimum pretransfer voltage at the DCPP switchyards, in order to accommodate a design basis accident in one unit and a safe shutdown of the other unit. The ISO is committed to follow procedure O-23 which details allowed voltages for various line configurations and compensatory actions required by DCPP for various offsite power configurations. These voltage levels assure that the voltages at the 4 kV and 480V vital buses will be adequate to support the operability of required safety-related equipment.

Should there be a line outage that affects system voltages, SUT taps will be automatically adjusted to compensate for this condition. PG&E's Transmission Operations Center will immediately attempt to restore 230 kV voltages to the normal voltage schedule. Should there be a disturbance on the 230 kV system, vital loads are protected and would be transferred to the emergency diesel generators (EDGs).

Question 4.a:

Technical Specifications

a. *TS for short duration of off-normal offsite configurations or SAR description and commitment to process / plan for operating or limiting operation in an off-normal configuration.*

PG&E Response to Question 4.a:

The FSAR Update, Section 8.2.2, lists potential off-normal offsite configurations and the potential need for compensatory measures. In addition, the FSAR Update references a procedurally controlled basis for off-normal operation. This procedure is O-23. The purpose of Procedure O-23 is to determine the allowed voltage and compensatory measures to ensure operability of the 230 kV system for each of the contingency configurations listed in Procedure O-23. Once the 230 kV system is determined to be inoperable, the plant is in a Technical Specification (TS) limiting condition for operation (LCO) action.

LCO actions for the loss of one, or more than one, offsite power sources are included in the DCPP TS. The DCPP TS Bases document for Section 3/4.8 references Regulatory Guide (RG) 1.93 as the bases for the A.C. and D.C.

allowable out of service times. The TS Bases do not commit to conform to the entire content of RG 1.93 and it was never PG&E's intent to imply that all of the specifics of the RG were applicable to DCPP. The DCPP LCOs for offsite power are also consistent with the guidance in NUREG 1431.

The offsite power systems for DCPP are classified as non-Class 1E, nonsafety-related. There are no safety limits, or limiting safety system settings that would fall under the requirements of 10 CFR 50.36. Further, the determination of offsite power operability is a complex analysis based on offsite power system grid conditions and onsite power loading sequences. The operability conditions established in Procedure O-23 are reviewed annually, and revised as grid conditions change. The guidance for operability is discussed in the FSAR Update. The application of the guidance changes with time and would not meet the requirements of 10 CFR 50.36 for TS.

Procedure O-23 contains restrictions for continuous operation with compensatory measures. There are two compensatory measure actions. Action 1 has the effect of preventing the Units 1 and 2 standby condensate/booster pump set from starting on transfer to 230 kV power. Action 2 prevents the transfer and restarting of two of the four operating reactor coolant pumps on a unit trip and transfer to the 230 kV source. Also, Procedure O-23 limits certain configurations to short durations and cautions that other configurations should be evaluated by engineering. In practice, for any abnormal occurrence in the transmission system affecting DCPP, DCPP Operations is immediately notified. Operations assesses the situation and determines if management needs to be informed, and if further evaluation is warranted, on what urgency. Offsite power off-normal configurations are given high priority for resolution. When off-normal configurations could be extended, the risks to the plant are assessed and the NRC onsite resident inspector is typically informed. The DCPP probabilistic risk assessment (PRA) does not identify any risk changes associated with continuous plant operation while compensatory measures are in place. The PRA does not assign any additional risk because the 230 kV system is restored to operability prior to the postulated accident. Other affected systems are not in a condition that affects the PRA results. With compensatory measures in place, the 230 kV system and the reactor coolant system will meet their LCOs listed in TS 3.8.1.1 and TS 3.8.1.2, and TS 3.4.1.1, TS 3.4.1.2, and TS 3.4.1.3, respectively; there are no TS requirements related to operation of the standby condensate/condensate booster pump set.

The planned maintenance and repairs or modifications to the offsite power facilities are controlled through interface procedures. Maintenance is preferably scheduled during off-peak system loading when no compensatory measures are required, or during DCPP outages, to limit the impact on 230 kV system

availability. However, maintenance may be performed at times when compensatory measures are required. The actual experience during the last three years, since Procedure O-23 has been in effect, has demonstrated a significantly improved availability for the 230 kV system. The only forced outage of any extended duration was to repair a broken conductor. The repair was completed and the 230 kV system was restored to operability within 27 hours.

Question 4.b:

b. *24 hour LCO for inoperability of 230 kV System vs. 72 hours.*

PG&E Response to Question 4.b:

The DCPP TS 3.8.1.1, LCO for plant Modes 1, 2, 3, or 4, include a 72-hour allowed outage time (AOT)for the loss of one offsite source of power, and a 24-hour AOT for the loss of both offsite sources of power. Note that during normal plant operation the unit auxiliary loads and vital loads are supplied power from the main generator, not from the offsite power system.

Significant improvements have been implemented for the 230 kV system: (1) the two - 230/12kV SUTs have been replaced with new transformers with LTCs; (2) 50 MVAR capacitor banks have been installed at the Diablo and Mesa 230 kV switchyards; (3) two additional 25 MVAR banks are proposed for the year 2002; (4) procedure O-23 is implemented and documents the controls to ensure 230 kV system operability; and (5) DCPP performs an annual review of the offsite power system to confirm that there is sufficient capacity and capability for each procedure O-23 scenario.

As a result of the above improvements, the 230 kV system is more reliable and better controlled and fully complies with the licensing basis for either 230 kV transmission line to DCPP to be capable of supplying the design basis loads. Complete loss of 230 kV is unlikely. The vital auxiliary loads are normally supplied from the main generator. The 500kV system provides a delayed alternate source of offsite power for shutting down the plant. The EDGs are fully capable of meeting the immediate backup requirements, if the 230 kV system is lost. Loss recovery measures are formalized to rapidly recover from a loss of 230 kV transmission. Based on these considerable improvements in the 230 kV system and on a risk assessment, we believe that the existing LCOs are appropriate for DCPP.

Question 4.c:

c. *TS for reset of undervoltage protective relaying*

PG&E Response to Question 4.c:

FSAR Update, Revision 12, Section 8.3.1.1.9, "Operation of Emergency Power System," describes the timing sequences for the transfer to offsite power and to the EDGs. These discussions relate the starting and loading of the EDGs to the recovery (reset) of the second level undervoltage relays (SLURS) and the first level undervoltage relays (FLURS). The reset of these relays will block actuation of the auto-transfer interlock relay; thereby, preventing transfer to the diesel generators.

The trip (dropout) setpoint for the SLURs is included in DCPP TS Table 3.3-4. The reset voltage for the SLUR relays is a direct relationship to the dropout setpoint. By specifying one, the other is known. The reset voltage is not included in the Standard TS nor the Improved TS. Further, this level of detail is not consistent with the requirements of 10 CFR 50.36, and we are not aware of other nuclear plants that include SLUR reset voltage in their TS.

A proposed draft FSAR Update revision is attached. This revision includes the operability requirements for the offsite power system and relates operability to ensuring that the EDGs do not load.

Question 5:

Testability and surveillance - SAR description and commitments.

PG&E Response to Question 5:

RG 1.70 has no specific requirements for testability and surveillance details to be included in the FSAR Update. The DCPP FSAR Update does not specifically address the testability and surveillance for the SUTs. The SUTs, LTCs, controls and relays underwent extensive postmodification and initial startup tests during installation. The periodic testing and surveillance of the SUTs are part of the normal DCPP program for oil-filled transformers: 1) oil is sampled every six months; 2) protective relays are calibrated every other outage; and 3) circuit switchers and tap changer - diverters are inspected every six years. The maintenance procedure for calibration of the LTC voltage control relays and the backup voltage control relays is performed every outage.

The capacitor banks are part of the PG&E utility switchyard. The capacitor banks are among the other major switchyard equipment that DCPP credits for offsite power. These capacitor banks were installed to ensure the 230 kV system would continue to meet the PG&E Transmission Operation Center and the California ISO requirements for reliable service. The maintenance of the switchyard, including the capacitor banks, is included in the substation maintenance program.

DCPP does retain responsible oversight for offsite power activities. Although DCPP is not directly responsible for maintenance of the offsite facilities, DCPP generates work orders from the plant work control system for major components within the scope of the Maintenance Rule. Scheduled maintenance is performed by utility personnel. Surveillance Test Procedure I-1C, "Modes 1, 2, and 3 Weekly Checklist," confirms the availability of the offsite transmission network by verifying the correct breaker alignments and operability of the SUTs, and also requires verification that the 230 kV system operability requirements of procedure O-23 are satisfied. That verification is obtained from the Diablo Canyon switching center (DCSC). The DCSC monitors 230 kV system voltages and the availability of the Diablo and Mesa switchyard capacitor banks.

A proposed draft FSAR Update revision, is attached. This revision discusses monitoring of the LTCs and offsite power

Question 6:

What is the reliability of the load tap changers? Also, describe the operation of the load tap changers and their capability to move two steps in sixteen seconds.

PG&E Response to Question 6:

The reliability of the LTCs was discussed in LAR 98-01 (PG&E letter DCL-98-008, dated January 14, 1998) as follows: "LTCs are extremely reliable. The type of LTC (Reinhausen Type M) selected for DCPP application is considered the best in the industry in performance and reliability, with a failure rate of 1 in 1667 years. In comparison, a large power transformer has a failure rate of 1 in 300 years."

The LTC adjusts voltage on the 12 kV bus to provide adequate power to loads to ensure that the onsite EDGs can remain in a standby status. The LTC operates as follows when the voltage control relay senses a voltage difference greater than 2.25 percent of setpoint:

1. After 5 seconds of voltage difference greater than 2.25 percent, the LTC motor receives a signal to make a change.

2. The step change is made in 2.5 seconds (cumulative time is approximately 7.5 seconds).

3. If the voltage difference is still greater than 2.25 percent, there is a 0.8 second time delay before the next tap position change (cumulative time is 8.3 seconds).

4. The next step change is made in 2.5 seconds (cumulative time is 10.8 seconds).

5. Subsequent times for tap changes would be in increments of 3.3 seconds (i.e. 14.1, 17.4 seconds).

This process would continue until the voltage is within 2.25 percent of the setpoint.

Revised Response to Question 1 of NRC Request for Additional Information dated March 16, 1998

Question 1:

The Diablo Canyon licensing basis requires the offsite system to have sufficient capacity and capability to supply the necessary voltage to safety system loads following the occurrence of two transmission network contingencies [1 and 2]. Confirm this.

[1]The first transmission network contingency is defined as the loss of the worst case (most heavily loaded) transmission line, switchyard bus, capacitor bank, or generating unit connected to (or associated with) the transmission network, assuming the worst case summer and/or winter expected loading or operating configuration of the transmission network. Five exceptions to this contingency are explicitly defined on page 8.2-3 of Section 8.2.2 of Revision 11 of the FSAR.

[2]The second contingency is defined as the trip of one of the two Diablo Canyon units following a loss of coolant accident and trip of the second unit 30 seconds following trip of the accident unit or, if more limiting, assuming one unit operating at 100 percent power with a loss of coolant accident trip.

PG&E Revised Response to Question 1:

During a phone call in November 1998, the NRC requested that PG&E further clarify the licensing basis requirements for the offsite power system. This response supersedes the response to Question 1 included in PG&E letter DCL-98-076, "Response to NRC Request for Additional Information Regarding License Amendment Request (LAR) 98-01, Implementation of 230 kV System Improvements," dated May 19, 1998. In determining operability of the offsite power system, various offsite and onsite contingencies are considered, as discussed below. A trip of a second unit 30 seconds after a design basis accident (DBA) or trip of the first unit is not part of the licensing basis. A DBA on one unit with the other unit operating at 100 percent power is addressed.

The licensing basis for the Diablo Canyon Power Plant (DCPP) offsite power system regarding the capacity and capability of the offsite power system, and the stability of the transmission grid is summarized in the Safety Evaluation Report (SER), issued by the Directorate of Licensing, U. S. Atomic Energy Commission, for DCPP on October 16, 1974.

The licensing basis for the DCPP offsite power system requires the offsite power system to have sufficient capacity and capability to operate the engineered

safety features for a DBA (or unit trip) on one unit, and those systems required for an orderly shutdown of the second unit. A trip of the second unit 30 seconds following the DBA, is not a licensing or design basis requirement.

To ensure that this requirement is met, load flow and dynamic loading analyses are performed for anticipated operating configurations of the transmission system (e.g., a generating unit out of service, transmission line(s) out of service, or voltage control devices out of service), assuming the worst case summer and/or winter expected loading conditions. Analyses are also done to examine the affect of one 230/12 kV standby startup transformer (SUT) being unavailable, and for manual 230/12 kV standby SUT load tap changer (LTC) operation. Operability is based on the ability to transfer to the 230 kV system following a DBA or unit trip without loading the emergency diesel generators, and provide adequate voltage to the safety-related loads. Compensatory measures, including blocking the transfer of nonessential loads, may be necessary for certain transmission system configurations to ensure adequate voltage to the vital buses.

Also, the licensing basis requires the transmission system must remain stable and able to provide power to DCPP following the loss of a generator, the loss of a large load block, or a fault on the most critical transmission line. Grid stability analyses are performed periodically whenever there is a significant change in generation, load, or transmission capability to ensure that this criterion is met. These analyses also consider the worst case summer and/or winter expected loading conditions.

These analyses, and the load flow and dynamic loading analyses discussed above, are done to demonstrate compliance with General Design Criterion (GDC) 17, GDC 17 has a requirement that provisions be included to minimize the probability of losing electrical power from any of the remaining sources as a result of, or coincident with, the loss of power generated by the nuclear unit, the loss of power from the transmission network, or the loss of power from the onsite electrical power sources. These analyses are also consistent with Branch Technical Position ICSB-11 (PSB), "Stability of Offsite Power Systems," and Standard Review Plan 8.2, "Offsite Power System," Section III.1.(f), regarding grid stability.

Any condition affecting the transmission system is assumed to occur in sufficient time prior to the transfer to the 230 kV system such that the voltage on the 230/12 kV LTC has adjusted to the transient, or PG&E's Transmission Operations Center has restored 230 kV voltages to the normal voltage schedule.

In addition, the SER concluded that a combination of one 230 kV circuit and one 500 kV circuit provides sufficient assurance that redundant and independent sources of offsite power are provided, as required by GDC 17. The 230 kV system provides an immediate source of offsite power. The 500kV system provides a delayed access source of offsite power. This design meets GDC 17, as modified by Regulatory Guide 1.32, which states that an acceptable design would substitute a delayed access circuit for one of the immediate access circuits provided that availability of the delayed access circuit conforms to GDC 17. The additional 230 kV and 500 kV circuits provide additional capability, beyond that required to meet the minimum NRC regulatory requirements, to ensure reliability of the offsite power systems. PG&E's policy is to maintain a high degree of availability of the offsite power systems to ensure reliability, and to minimize the duration and extent of any outage due to maintenance or failures. This is discussed further in PG&E's response to additional Question 4.a, included in Enclosure 1 of this submittal.

PROPOSED FINAL SAFETY ANALYSIS REPORT (FSAR)
SECTION 8.2, OFFSITE POWER SYSTEM

(Changes are to FSAR Update Revision 12)

8.2 OFFSITE POWER SYSTEM

PG&E has transmission systems operating at several voltage levels. DCPP is interconnected to PG&E's electric grid system via two 230-kV and three 500-kV lines emanating from their respective switchyards; these switchyards are physically and electrically separated and independent of each other. The 230-kV system provides startup and standby power, and is immediately available following a loss-of-coolant accident to assure that core cooling, containment integrity, and other vital safety functions are maintained. The 500-kV system provides for transmission of the plant's power output. The 500-kV connection also provides a delayed access source of offsite power after the main generator is disconnected. A combination of either 230-kV circuit and one of the 500-kV circuits provides independent sources of offsite power, as required by GDC 17. The other 230-kV and 500-kV circuits provide capability beyond that required to meet minimum NRC regulatory requirements to ensure reliability of the offsite power systems.

8.2.1 DESCRIPTION

8.2.1.1 230-kV System

Offsite power for startup and standby service is provided from the 230-kV transmission system. The two incoming 230-kV transmission lines, one from the Morro Bay switchyard, about 10 miles away, and the other from the Mesa Substation, feed a 230-kV switchyard having three 230-kV circuit breakers, one for each line and one for the 230/12-kV standby startup transformers. A single tie-line from the 230 kV switchyard supplies the standby startup transformer (230-kV/12-kV) for each unit. Shunt capacitors at DCPP and Mesa Substations are utilized to provide support when required by the 230-kV grid conditions. The shunt capacitors, along with automatic load tap changers (LTCs) on the 230/12-kV standby startup transformers, enable the 230-kV transmission system to be independent of Morro Bay generation. The single line diagram of the 230-kV system to Units 1 and 2 is shown in Figure 8.2-1. Figure 8.2-2 shows the offsite interconnections. Figure 8.2-3 shows the general arrangements of the 230-kV and 500-kV switchyards. Figure 8.2-4 shows the arrangement of the 230-kV switch, bus, and circuit breaker structures. Figure 8.2-6 shows the arrangement of the standby 230/12-kV startup transformers.

The tap position on each 230/12-kV standby startup transformer LTC is monitored in the DCPP Main Control Room. Loss of the LTC voltage control relays or of the LTC backup voltage control relays is alarmed in the Main Control Room. Periodic testing and surveillance of the standby startup transformers are part of the normal DCPP program for oil-filled transformers. A single standby startup transformer may be taken out of service for maintenance. Both units are designed to be supplied from a single startup transformer, with the startup bus Unit 1-Unit 2 cross-tie breaker closed.

Continued operation of the plant is procedurally controlled while in this configuration. The DCPP surveillance program confirms the availability of the offsite transmission network by verifying the correct breaker alignments, voltage levels, capacitor bank status, and any compensatory measures.

Each of the two 230-kV transmission lines feeding the 230-kV switchyard is provided with relay protection consisting of a carrier distance relaying terminal, including carrier distance and directional ground relays, with backup directional ground and fault detector relays, and automatic reclosing.

The 230-kV startup and standby service power line from the 230-kV switchyard to the plant is provided with relay protection consisting of a differential pilot wire relay system with overcurrent and fault detector relays for backup.

The 230-kV switchyard dc control power is provided by a lead-acid battery and two battery chargers. Each charger is capable of supplying the normal dc load of the 230-kV switchyard and maintaining the battery in a fully charged condition. Normally, one charger is operating with the second charger available on standby. Both chargers may be operated in parallel if desired. Each charger is equipped with an ac failure alarm that operates on loss of ac to the charger. The battery and chargers feed a 125-Vdc distribution panel that is equipped with a dc undervoltage relay that initiates an alarm if the dc voltage drops below a preset value. Separate dc control circuits are provided from the dc distribution panel for each 230-kV power circuit breaker.

Occurrences that could result in the loss of the 230/12-kV standby startup auxiliary power sources are:

(1) Loss of Morro Bay switchyard or loss of both circuits of the 230-kV transmission line in the sections between the Morro Bay switchyard and Diablo Canyon site. It is noted that an outage of any one of the three 230-kV circuits (Morro Bay-Diablo Canyon, Diablo Canyon-Mesa, or Morro Bay-Mesa) would not result in interruption of the transmission supply to Diablo Canyon. However, procedurally controlled compensatory measures may be required for certain line outages.

(2) Loss of the 230-kV bus structure at the Diablo Canyon site. This 230-kV structure has a double bus arranged so that a permanently faulted bus section can be isolated and replaced by the unfaulted bus section by means of manual switching operations. These structures are suitably spaced from one another. Only an event of great physical extent would cause the loss of both buses.

(3) Loss of the 230-kV line from the Diablo Canyon switchyard to the 230/12-kV standby startup transformers, or loss of its associated 230-kV oil circuit

breaker. If the power loss is due to mechanical or electrical failure of the oil circuit breaker, the circuit breaker can be isolated and bypassed by means of manual switching operations. A physical disruption of the short section of 230-kV line from the switchyard to the plant is considered highly unlikely.

(4) Loss of either 230/12-kV standby startup transformer 11 or (21)[a] or the associated 12-kV breakers or buses. Standby startup transformers 11 and (21) are normally separated on the 12-kV side, with transformer 11 feeding Unit 1 and transformer (21) feeding Unit 2. In case of a failure of either transformer, the faulted transformer can be manually switched out of service, its bus can then be transferred to the other transformer by closing the 12-kV bus tie air circuit breaker. This circuit breaker is common to the 12-kV standby startup buses of Units 1 and 2, and is normally kept open.

(5) Failure of 4.16-kV standby startup transformer 12 (22). By means of manual switching after a failure, the buses served from this transformer can be supplied from the 230-kV system by unit auxiliary transformer 12 (22) through unit auxiliary transformer 11 (21), fed from the 12-kV standby startup bus. This requires removal of links in the generator bus at the main transformer as well as opening of the disconnecting switch to the generator. This is an unusual configuration and is used only when better methods are not available.

While the above failure mechanisms are possibilities, the 230-kV transmission system and 230/12-kV standby startup power system are designed in a manner intended to obtain a high degree of service reliability and to minimize the time and extent of outages if failures do occur.

8.2.1.2 500-kV System

The 500-kV system provides for transmission of the plant's power output, and provides a delayed access source of offsite power to the plant auxiliary systems and ESF buses when the main generator is not in operation. The 500-kV system is available in sufficient time to safely shutdown the plant during non-accident conditions. Power is backfed via the main transformer and the unit auxiliary transformers. A dc motor-operated disconnecting switch in the generator's main leads is opened to use this source. This switch is a telescoping type that is an integral part of the generator isolated phase bus. This switch is operated under manual control from the control room and is interlocked to prevent opening under load. Upon actuation, the motor-operated disconnect takes approximately 30 seconds to isolate the main generator from the main and the unit auxiliary transformers. In the event of a loss of main generator output, the 500-kV backup source of auxiliary power could be placed in service after

[a] Parentheses indicate Unit 2.

about 30 minutes. After the two 500-kV breakers are tripped, operations personnel coordinate with PG&E's Transmission Operations Center, realign protective relaying, and manually open the switch. The position of the motor-operated switch is verified prior to backfeeding from the 500-kV line. Figure 8.1-1 (Plant Single Line Diagram) shows the three 500-kV line terminals and the interconnections to the plant auxiliaries. Figure 8.2-5 shows the arrangement of the 500-kV switch, bus, and circuit breaker structures.

Each 500-kV transmission line to the 500-kV transmission system is provided with relay protection terminal equipment consisting of two line relay sets (directional comparison), each operating over physically separate channels, microwave and power line carrier, and each provided with a separate dc power circuit. High-speed automatic reclosing is provided. Backup protection (provided by a distance relaying terminal, including distance and directional ground relays) is normally cut-out, and cut-in when either primary relay set is not operable. Each 500-kV line between the 500-kV switchyard and a generator step-up transformer bank is provided with relay protection, consisting of a differential pilot wire relay system with directional and ground overcurrent relays for backup.

The 500-kV switchyard dc control power is provided by a lead-acid battery and two battery chargers. Each charger is capable of supplying the normal dc load of the 500-kV switchyard and maintaining the battery in a fully charged condition. Normally, one charger is operating with the second charger available on standby. Both chargers may be operated in parallel, if desired. Each charger is equipped with an ac failure alarm that operates on loss of ac to the charger. The battery and chargers feed two 125-Vdc distribution panels, one of which is equipped with a dc undervoltage relay that initiates an alarm if the dc voltage should drop below a preset value. Separate dc control circuits are provided for each 500-kV power circuit breaker.

8.2.2 ANALYSIS

8.2.2.1 Load Flow and Dynamic Loading Analyses

The 230-kV System is the immediate source of offsite power following a design basis accident or unit trip. Operability is based on the ability to transfer to the 230-kV System following a design basis accident or unit trip without loading the emergency diesel generators, and provide adequate voltages to the safety related loads. Load flow and dynamic loading analyses are performed for anticipated configurations of the transmission network (e.g., generating units out of service, transmission line(s) out of service, or voltage control devices out of service) to ensure that the 230-kV system has sufficient capacity and capability to operate the engineered safety features for a design basis accident (or unit trip) on one unit, and those systems required for an orderly

shutdown of the second unit. A dual-unit trip is not a licensing or design basis requirement.

Any condition affecting the transmission network is assumed to occur in sufficient time prior to the transfer to the 230-kV System such that the voltage on the 230/12-kV LTC has adjusted to the transient, or PG&E's Transmission Operations Center has restored 230-kV voltages to the normal voltage schedule.

Depending upon system load and available generation, a degraded grid voltage condition can result. Compensatory measures, including blocking the transfer of non-essential loads, may be necessary for certain transmission network configurations to ensure adequate voltage to the vital buses and to return the 230-kV System to operable status. PG&E operating procedures provide compensatory actions and minimum voltages required at the Diablo Canyon 230-kV switchyard to ensure adequate voltages to the ESF loads. These operating procedures are used by the California Independent System Operator (ISO), PG&E's Transmission Operations Center, the Diablo Canyon Switching Center, and DCPP. Continued operation of the DCPP units under this condition is procedurally controlled to ensure the offsite power system meets DCPP operability requirements.

Compensatory measures and the voltages required to maintain operability are reviewed annually. The purpose of the review is to examine major changes in system load projections, generating capacity and transmission grid connections. PG&E's Transmission Operations Center engineering support staff develops load projections for the PG&E system and updates their analytical model of the entire Western Systems Coordinating Council (WSCC). If necessary, load flow studies are then conducted, using the updated WSCC model, for each anticipated configuration of the transmission network. The initial conditions for the studies include the peak system loading, and only one DCPP unit generating. The configurations modeled include all lines in service; one line out of service; two parallel lines out of service; capacitor banks available; and capacitor banks unavailable. The results of the studies are calculated system equivalents and voltages with and without DCPP loading for each configuration. The results of the system load flow studies ensure transmission voltages are adequate to support DCPP transfer. Plant dynamic loading analyses are then performed, using the results of the system load flow studies as input. The plant analyses determine if the calculated voltages are adequate for the bus transfer to the 230 kV system following a design basis accident or single unit trip, and starting of required plant loads. If the voltages and existing compensatory measures are not adequate, the analysis is rerun with additional compensatory measures. Analyses are also done to examine the affect of one 230/12-kV standby startup transformer being unavailable, and for manual 230/12-kV standby startup transformer LTC operation. PG&E procedures which provide compensatory measures for offsite power system operability are then modified to reflect the results of the analyses.

8.2.2.2 Offsite Electrical System Stability

The California transmission system (control area under ISO) is operated in such a way that the loss of any generator, the loss of a large load block, or a fault on the most critical transmission line will not cause the system to become unstable. Grid stability analyses are performed periodically whenever there is a significant change in generation, load, or transmission capability to ensure that this criterion is met.

The program used in these studies permits the representation of the PG&E system and the interconnected western systems in sufficient detail so that they properly represent the electromechanical reaction of the combined systems to the cases studied. The scenarios modeled included both a single-unit trip and a dual-unit trip of DCPP.

The simulated events begin with a stable system condition, then a fault at the Diablo Canyon 500-kV bus. In approximately 4 cycles, the fault has been cleared from the 500-kV bus and the station loads transferred to the 230-kV system. Both worst case summer and winter loadings were simulated, since the total load and available generation varies with the season.

The first case simulated the loss of a unit at full load with the other unit in service. Under both summer and winter loadings, the offsite power system was very stable and no adverse effects on the system were found.

The second case simulated a dual-unit trip from full load, although the electrical design of Units 1 and 2 minimizes the possibility of simultaneous trip of both units, and a dual-unit trip is not a licensing or design basis requirement. Again, the offsite power system was very stable and no adverse effects were found on the rest of the system. The Transmission System Operator may be required to take action to raise the 230-kV voltage to meet the voltage schedule.

It is concluded that the loss of a generating unit at the Diablo Canyon site has little effect on the offsite electric power supply feeding the DCPP switchyard 230-kV buses. Both voltage and frequency will stabilize within several seconds. For a single-unit trip, the availability of offsite power to the ESFs at Diablo Canyon will not be affected. For a dual-unit trip, the 230-kV switchyard will remain energized, but Transmission System Operator action may be required to restore voltage.

In the event of a dual-unit trip, the 230-kV switchyard will remain energized and stable, an accident is not postulated, and loading of the emergency diesel generators is acceptable. However, during the dual-unit trips of December 14, 1994, and August 10, 1996, the emergency diesel generators were not loaded.

8.2.2.3 Operation During Severe System Disturbances

The ISO schedules the generation and operates the transmission system to minimize cascading during severe system disturbances. The ISO exercises centralized control over generation and transmission facilities within California. The ISO also coordinates the scheduled outage of the production and transmission facilities for preventive maintenance and repair, thereby ensuring a nearly constant level of system reliability.

System disturbances can be initiated by trouble either within the ISO control area or external to it. The 500-kV ac Pacific Intertie, running the length of PG&E's system, provides a strong internal backbone transmission system and strong ties to neighboring utilities. If the system is subjected to a severe disturbance caused by trouble external to the PG&E system, underfrequency protective relaying has been provided that will activate. This relaying automatically separates the PG&E system from its neighbors should frequency drop to 58.2 Hz, provided these ties have not been previously opened by the action of other protective relaying.

System disturbances of July 2, 1996, and August 10, 1996, were reviewed by PG&E and members of the Western Systems Coordinating Council (WSCC). WSCC-prescribed reliability improvement criteria (i.e., revised ac and dc intertie limits), along with other compensatory measures, have been put in place to prevent widespread impacts throughout WSCC.

It is the ISO's responsibility to carry at all times operating reserve to satisfy the WSCC Reliability Criteria and meet the requirements of the North American Electric Reliability Council.

To preserve the integrity of generating units during extreme system disturbances, nuclear power plants, including DCPP, will be given the highest priority for restoration of power to the DCPP switchyards. PG&E and the ISO have emergency restoration plans in place to utilize combustion turbine units, hydroelectric units, and the transmission grid to provide startup power to its major thermal electric generating plants. PG&E has approximately 3.9 million kW of its own hydrogeneration and another million kW of hydrogeneration within its control area that also greatly assists the system in riding through disturbances.

The WSCC has prepared a coordinated response to underfrequency events. A coordinated response by all utilities and generation owners under WSCC jurisdiction maximizes the integrity of the system. PG&E has implemented a multi-step load shed scheme within WSCC guidelines to maintain a balance between load and generation. These guidelines include the separation of generation based on underfrequency setpoints that have been coordinated within the WSCC areas of control. All setpoints for load shedding and generation tripping have been selected to minimize equipment

damage and provide long term system reliability. To minimize the possibility of a cascading failure and the possibility of severe overloading of generating units, underfrequency load shedding is used to automatically relieve load during an extreme emergency. This load is removed automatically in increments between 59.75 and 58.2 Hz. Should even these measures fail to arrest a system frequency decay, provision has been made to automatically separate any thermal unit from the transmission system should any of the following conditions develop: frequency remains at 58 Hz for 3 minutes, at 57 Hz for 1 minute, or drops to 55 Hz for 0.5 seconds. Additional manual load shedding may be required to stabilize the system. Hydroelectric units connected to the transmission system have a broad capability to operate during underfrequency conditions. The hydroelectric units underfrequency setpoints are lower than the thermal plants, although most hydroelectric units do not have underfrequency control and would remain connected and continue to provide power to the transmission system.

The measures outlined above, together with others, provide the basis for PG&E's confidence that the offsite power sources to the Diablo Canyon site are extremely reliable. The interconnection of Diablo Canyon to the 500-kV system by way of Midway and Gates, and to the 230-kV system by way of Morro Bay switchyard and Mesa substation, ensures access to the very heart of PG&E's transmission systems.