Consumers Power

POWERING MICHIGAN'S PROGRESS

Palisades Nuclear Plant: 27780 Blue Star Memorial Highway, Covert, MI 49043

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Nuclear Regulatory Commission
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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT - REPLY TO OPEN ITEMS; NRC INSPECTION REPORT No. 91019

NRC Inspection Report No. 91019 provided the results of the special electrical distribution system functional inspection (EDSFI) of the Palisades Plant. The inspection report identified apparent violations and deviations from NRC requirements. Consumers Power Company responded to the violations and deviations in a letter dated March 2, 1992. The inspection report also identified a number of open items and requested a reply to those items as well. As was discussed between Mr. Bruce Jorgensen of Region III staff and Mr. Pat Donnelly of our staff, on February 12, 1992, a reply to the open items was to be provided by March 31, 1992. Attached to this letter are the responses to the open items identified in the inspection report.

Gerald B Slade
General Manager

CC Administrator, Region III, USNRC
NRC Resident Inspector - Palisades

Attachment

IE01 1/1

ATTACHMENT

Consumers Power Company
Palisades Plant
Docket 50-255

REPLY TO OPEN ITEMS

INSPECTION REPORT No. 91019

March 31, 1992

24 Pages

REPLY TO OPEN ITEMS

Open Item 91019-01

3.1.1 *Electrical Load Study*

The team evaluated the licensee's study conducted in 1988 and 1989 of the adequacy of station power systems to supply adequate voltage under worst-case loading conditions and identified the following concerns:

- *The study assumed a temperature of 75°C for all cables No. 8 and smaller and 65°C for all cables No. 6 and larger. However, the cables in the plant are rated for a maximum conductor temperature of 90°C. The cable resistance at this temperature will be greater than the resistance at the assumed temperature.*
- *The resistance and reactance values used were based on Westinghouse T&D Handbook, Table 6. The reactance values shown in this table are for a grounded neutral system and paper Insulated cables. These values are not applicable to the type of cable used in this plant.*
- *The impedance of circuit breaker contacts and fuses were not considered.*
- *The loads considered were not the "worst-case loads," (i.e., all motors running).*
- *The licensee identified in Audit Report QA-91-06 that the impedance of the buried cables from the switchyard to safeguards transformer was incorrectly specified in the calculations. Audit results indicated that the actual impedance was approximately 30 times greater than the impedance values used in the calculations.*

In response to the team's concern, the licensee submitted new data which demonstrate that the effect of higher resistance on system voltage was negligible, agreed to update the study in 1992. This item remains open pending NRC review of the updated study (255/91019-01(DRS)).

Open Item

"The study assumed a temperature of 75°C for all cables No. 8 and smaller and 65°C for all cables No. 6 and larger. However, the cables in the plant are rated for a maximum conductor temperature of 90°C. The cable resistance at this temperature will be greater than the resistance at the assumed temperature."

CPCo Response

Power System Simulation/Electrical (PSS/E) loadflow simulations with cables assumed at 65°C and 75°C (original model) versus simulations with cables assumed at 90°C (added conservatism) were run for comparison purposes. The simulations indicated that correcting the cable resistances for 90°C resulted in voltage changes of only 0.01% difference on 2400V buses, 0.02% difference on 480V buses, 0.01% worst case on Class 1E 2300 volt motors, and 0.2% worst case on 460V Class 1E motor terminal voltages. Thus, the impact of changing the cable resistances to 90°C has minimal impact on the loadflow simulations.

The use of 65°C and 75°C for cable resistances for the loadflow model was based on initial data available for model development. It is agreed that, for conservatism, the cable resistances should be corrected for 90°C for loadflow modeling in all future studies. The corrections, as was shown, will have minimal impact on the overall results of the loadflow studies currently available.

Presently, there are 182 power cables modeled in the PSS/E loadflow model. Final correction of the resistances of these cables due to temperature will require an engineering analysis and model update.

Corrective Action

By the end of 1993, correct the cable resistances to 90°C in the PSS/E loadflow model for the station auxiliary system.

Open Item

"The resistance and reactance values used are based on Westinghouse T&D Handbook, Table 6. The reactance values shown in this table are for grounded neutral system and paper insulated cables. These values are not applicable to the type of cables used in this Plant."

CPCO Response

Table 6 of the Westinghouse T&D Handbook was chosen for typical cable constants. The use of this table or similar tables from other references only provides typical cable constants. The use of typical cable reactance is standard industry practice when developing loadflow and short circuit models of station power systems.

The Palisades loadflow model for the worst case start-up transformer (SUT) 1-2 supply during block loading of the Emergency Core Cooling System (ECCS) motor loads was field verified using steady state and transient voltage measurements. The model assumed cable resistances at 65°C and used the cable resistance and reactance constants from Table 6 of the Westinghouse T&D Handbook. Field verification of the model indicated that voltages measured on the 2400V and 480V buses were within 1.07% of the simulated values and meet

the NRC recommended accuracy of 3% as outlined in of Branch Technical Position PSB-1, "Adequacy of Station Electric Distribution System Voltages." In fact, the model predicted lower voltages on both 2400V and 480V buses than the actual field measurements. This field verification documents the validity of using the cable resistance (at 65°C) and reactance values in the model from Table 6 of the Westinghouse T&D Handbook.

Although the reactance values in Table 6 of the Westinghouse T&D Book are for a grounded neutral system, balanced three phase conditions are assumed in the loadflow and short circuit models. A balanced three phase system will have zero neutral/ground current. Therefore, the effects of neutral currents on cable reactance are not required and Table 6 is applicable for determining typical cable reactance for balanced three phase loadflow and short circuit models. We agree that the determination of positive, negative, and zero sequence cable reactance for unbalanced conditions would require additional calculations, and the use of Table 6 would apply only for systems using a grounded neutral system. With respect to Table 6 applying to paper insulated cables, it was used for determining typical resistances and reactance for copper cable. It was not used for determining ampacity requirements for power cables.

Corrective Action

No further corrective action is required.

Open Item

"The impedance of circuit breaker contacts and fuses were not considered."

CPCO Response

It is not standard industry practice to include the impedance of circuit breaker contacts and fuses in plant auxiliary loadflow or short circuit models. They are considered to be negligible when compared to station power transformer or power cable impedances. However, we agree that the effects of the impedances of circuit breakers and fuses should be documented in the loadflow and short circuit analyses.

Corrective Action

By the end of the second quarter of 1994, document the effects of circuit breakers and fuse impedances on the overall circuit impedance in the loadflow and short circuit models of the station auxiliary system.

Open Item

"The loads were not the "worst-case loads," (i.e., all motor running).

CPCO Response

The response to the loadflow analyses not considering "all motors running" as stated in the FSAR has been evaluated in a corrective action document, D-PAL-91-104. The evaluation concluded that the loadflow analyses assumed realistic loads with required system load configurations for the given operating condition. The FSAR statement can be interpreted to imply that all motors connected to a given bus were assumed to be running, regardless of the plant operating condition. The corrective action from D-PAL-91-104 is to align the FSAR with the present analyses and submit a request to change the wording in the FSAR, Section 8.3.2.

In addition, a review of Chapter 8 of the FSAR will be performed to ensure that current loadflow analyses align with FSAR statements and commitments.

Corrective Action

By the end of 1992, (1) submit a request to change the wording in the FSAR, Section 8.3.2 and (2) review Chapter 8 of the FSAR to ensure that current loadflow analyses align with FSAR statements and commitments.

Open Item

"The licensee identified in audit report QA-91-06 that the impedance of the buried cables from the switchyard to safeguards transformer was incorrectly specified in the calculations. Audit results indicated that the actual impedance was approximately 30 times greater than the impedance values used in the calculations."

CPCO Response

Corrective action documents D-PAL-90-122 and D-QG-91-12 were issued concerning the incorrect safeguards cable impedance. Field testing and analyses to determine the correct impedance have been completed as a part of the corrective actions. Additional corrective actions included: (1) performing and documenting the results of technical specifications surveillance test (TSSP) Q01, "Safety Injection System," documented in EA-D-PAL-90-122-01, (2) determining the safeguards cable impedance using TSSP Q01 test results documented in EA-D-PAL-QG-91-12, (3) validating the Power System Simulation/Electrical (PSS/E) Dynamic Model of Safeguards supply during TSSP Q01 testing documented in EA-D-PAL-90-122B, and (4) developing recommended second level undervoltage relay transient time delay during TSSP Q01 testing to avoid diesel generator starts, documented in EA-D-PAL-90-122A.

Corrective Action

By the end of 1993, update the loadflow and short circuit models with the updated safeguards cable impedance. This will be coordinated with the overall update of cable resistances to 90°C (loadflow modeling) or 25°C (short circuit modeling).

Open Item 91019-02

3.1.3 Overvoltage on Class 1E Equipment

The team was concerned that plant operating procedures did not adequately direct corrective actions to be taken in the event of higher than 2400V on the Class 1E buses caused by a stuck safeguards or start-up transformer tap changer. This condition could result in Class 1E motors being exposed to voltages higher than their rating. The team also noted that no formal calculations were in place identifying the expected voltages on Class 1E motor terminals during conditions of a stuck tap changer concurrent with high system voltages.

In response to the team's concern, the licensee determined that the voltage on the 2400V Class 1E buses should be maintained at less than 2530V to prevent exceeding the voltage limitations of the 2300V and 460V motors. The licensee also agreed to revise the appropriate procedures to identify operator actions to be taken to maintain voltages below 2530V during stuck tap changer conditions. This item remains open pending NRC review of the revised procedures (255/91019-02(DRS)).

CPCo Response

Maximum station power voltages have been documented in engineering analysis EA-E-ELEC-VOLT-10/91-01, "Palisades Maximum and Minimum Station Power Voltages" during a maximum historical 345 kV system voltage of 369 kV with the unit offline. The loadflow simulations assumed plant cold shutdown loads fed by Safeguards Transformer (SGT) 1-1 (normal automatic tap changes) or Start-up Transformer (SUT) 1-2. No overvoltages were identified on Class 1E equipment in EA-E-ELEC-VOLT-10/91-01 for the worst case 345 kV system voltage of 369 kV. CPCo maintains historical records of its 345 kV switchyard voltages and periodically reviews worst case voltage profiles using loadflow models of the plant station power system. Based on current analyses, the addition of overvoltage protection or alarms is not required.

We agree that expected voltages on Class 1E motor terminals during conditions of a stuck tap changer should be identified through additional calculations. Furthermore, we agree that voltages on the 2400V Class 1E buses should be maintained less than 2530V to prevent exceeding voltage limitations on the 2300V and 460V motors. To assure these voltages are maintained, appropriate operating procedures will be revised.

Corrective Action

Perform computer analyses to document expected voltages on Class 1E equipment due to a stuck tap changer. Procedures will be revised to include: (a) a stuck tap changer on SGT 1-1, or b) operation via SUT 1 2. The procedures will identify necessary operator actions to maintain voltages below 2530V during these conditions. Completion of these items is scheduled for the end of the second quarter of 1994.

Open Item 91019-03

3.1.5 Overloading of Buses 1C and 1D Feeder Cables from Start-Up Transformer

During review of the "Steady State and Transient Cable Ampacities for Buses 1C, 1D & 1E, Palisades Plant," dated December 1988 the team noted that the 500 MCM cables from start-up transformer 1-2 to buses 1C and 1D were heavily overloaded during small LOCA transients. An operator action was required to reduce the load within 11 hours to avoid damage to the cables. Based on this study, the licensee instituted administrative loading limits pending replacement of the cables. A subsequent special ampacity study, "SUT 1-2 500 MCM, Buses 1C and 1D via SUT 1-2," Revision 0, dated September 21, 1991, was performed utilizing a 105°C emergency overload temperature. This study resulted in the cancellation of the cable replacement and removal of the administrative loading limits.

The team was concerned that the analysis had not quantified the cable rating in terms of total allowable time at cable temperatures beyond 90°C. The team pointed out that the cable could be operated at 105°C for up to 100 hours only and not indefinitely as assumed by the analysis. The licensee agreed that additional studies were required to quantify the time for operating beyond the 90°C rating of the cable and agreed to incorporate these limits into appropriate operating procedures. This item remains open pending NRC review of the additional studies and procedure revisions (255/91019-03(DRS)).

CPCo Response

The plant's normal operating configuration is via Safeguards Transformer (SGT) 1-1 supplying 2400V Buses 1C, 1D and 1E simultaneously. The original 500 MCM cables feeding Buses 1C and 1D from this supply were replaced with 1000 MCM cables as a part of facility change FC-800, "Addition of 2400V Offsite Power." The 2400V source from Start-up Transformer (SUT) 1-2 is provided as a backup to the normal power source from SGT 1-1. Engineering analysis EA-SC-88-019-003 was performed to determine the necessity of replacing the 500 MCM cables from SUT 1-2 to Buses 1C and 1D and concluded that this was unnecessary. This conclusion was based on worst case accident loadings and the 105°C emergency overload temperature rating of the cable. The analysis showed that the cable would exceed its 90°C continuous rating, but would remain below its 105°C emergency rating for the assumed accident loadings.

Subsequent review of loading the cable to its emergency rating of 105°C indicated the overload must be limited to 100 hours per year not to exceed a total of 5 occurrences (reference IEEE S-135, IPCEA P-46-426). Even though the accident load resulted in temperatures above 90°C, but below 105°C, further investigation of the allowable time above continuous rating is needed. We agree that a re-evaluation of post-LOCA loading and the effects on management of the post-LOCA response is required. Furthermore, we agree that both the maximum time and maximum ampere cable limits should be determined and incorporated as appropriate in operating procedures.

Corrective Action

By the end of the second quarter of 1994, update the post-LOCA loading analyses on SUT 1-2 and determine maximum time and ampere cable limits for the 500 MCM cable feeding buses 1C and 1D from SUT 1-2. Incorporate these limits into appropriate operating procedures as required.

Open Item 91019-04

3.1.6 Switchyard Station Power Transformer Cable

The team questioned the ability of the feeder cable to switchyard station power transformer No. 2 to withstand postulated fault currents. Switchyard station power transformer No. 2 is fed from 2400V bus 1C through three single conductor cables. The maximum fault current at the load terminals of the circuit breaker is 30,900 Amps (5 cycle value). The team performed an informal calculation which questioned the cable's ability to withstand the fault current caused by a fault located at the breaker's terminal. The calculations submitted by the licensee in response to the team's concern confirmed that for the postulated fault, the cable would exceed its damage temperature threshold in approximately 2.8 hertz. The licensee immediately issued Deviation Report D-PAL-91-196 to further analyze the concern. This item remains open pending resolution of D-PAL-91-196 (255/91019-04(DRS)).

CPCo Response

There are two No. 1/0 cables reviewed as a result of corrective action document D-PAL-91-196. Cable No. 1 runs from 2400 volt Bus 1C in its own conduit to the underground duct and out to the switchyard. Cable No. 2 runs from 2400 volt Bus 1E through a conduit to a tray, through the turbine building to 1C switchgear where it enters a conduit to the underground duct and out to the switchyard. A detailed review of the routing of the two cables in question indicated they are not routed with any class 1E cables. Therefore, no operability concerns were identified.

The root cause of the No. 1/0 cable being undersized for short circuit conditions is attributed to a design error. This is evidenced by the fact that the current FSAR, as well as the original FSAR, states "*The design prevents the conductor temperature from exceeding 200°C for rubber insulated cables for the fault current available from the source.*"

An industry recognized cable expert was contacted to provide possible failure modes of the cable in question. The expert evaluation concluded:

- The cable would have to replaced after the (highly unlikely) short circuit took place.
- The insulation will self-destruct and cease to function.
- No explosion is expected, and only sporadic smoking is possible.
- Minor, sporadic flame, if any, in the conduit and duct bank will die out for lack of oxygen.
- While the temperature involved is high, the times involved are extremely short. It is this short duration of time that helps to alleviate the situation.
- The other cables in the tray will continue to be operable. The jackets of the cables in the tray that are in contact with this cable may experience some jacket damage.
- The cables should be examined after such an occurrence.

Cable No. 1 from 2400V Bus 1C is in its own conduit to the underground duct and out to the switchyard. No other cables are exposed to potential damage in the event of a short circuit. This cable, however, needs to be addressed as it does not meet the requirements of the FSAR. Cable No. 2 needs to be addressed since it does not meet the requirements of the FSAR and is in the turbine building cable tray with other non-1E cables for approximately 300 feet.

The recommended corrective action is to revise the FSAR to reflect the exception to the 200°C requirement for both cables and accept the small risk that if a short circuit occurs the No. 1/0 cable will need to be replaced and, if the short circuit occurs on cable No. 2, the other cables in the tray will need to be inspected for possible jacket damage.

<u>Corrective Actions:</u>

1. Initiate a change to the FSAR to make an exception to the 200°C requirement for the two cables feeding switchyard power. This action is scheduled for completion by June 1992.

2. The CPCo System Protection Department will review the 480V system for similar situations. This review is scheduled for completion by September 1992.

Open Item 91019-05

3.1.7 Short Circuit Study

The team was concerned that non-conservative values for system voltage and cable temperature were used in calculation EA-E-ELECT-FLT-10/91-1, dated October 28, 1991, which was prepared to determine fault duties on the 4160V, 2400V, and 480V AC systems. In response to the team's concern, the licensee provided an analysis that demonstrated that the voltage assumed in the calculation was conservative in relation to the maximum historical switchyard voltage. In addition, the licensee provided an analysis that demonstrated that the non-conservative high cable temperatures would not have a significant effect on the overall results of the calculation. The licensee committed to revise the calculation to provide a clarification of voltage criteria and to reflect conservative cable temperatures. Pending further NRC review, these issues are considered an open Item (255/91019-05(DRS)).

CPCo Response

We agree that the voltage criteria assumed in the short circuit calculation should be clarified. In addition, we agree that for conservatism, the cables should be corrected for 25°C for short circuit modeling in all future studies. The corrections, however, will have minimal impact on the overall results of the short circuit studies currently available. No station power system problems due to these changes are expected. Presently, there are 182 power cables modeled in the Auxiliary System Design Optimization Program (ASDOP) short circuit computer model and Power System Simulation/Electrical (PSS/E) loadflow model.

Corrective Action

By the end of 1993, update the cable resistance in the short circuit model to 25°C and clarify the voltage criteria used in the short circuit analyses.

Open Item 91019-06

3.1.8 Operator Response to Ground Fault Indication

The team determined that existing plant procedures do not provide adequate guidance on how to identify the location of a faulted bus and do not alert operators of the dangers of operating two safety buses from the same source when a ground fault exists on the ungrounded 2400V system. In case of a solid single line to ground fault on an ungrounded system, the location of the fault cannot be immediately determined by observing system instruments. Also,

although continued operation is possible, an overvoltage of 73% will occur on the unfaulted phases and a second fault on the system could cause the simultaneous loss of redundant loads.

In response to this concern, the licensee agreed to revise their procedures to direct operators to transfer the 2400V buses one at a time to the alternate offsite source while observing the status of the ground fault relays and to supply the faulted bus from a separate supply until the fault is located. The licensee has committed to complete these actions in the first quarter of 1992. Pending further NRC review, this is an open item (255/91019-06(DRS)).

CPCo Response

Palisades 2400v bus design is such that electrical separation of 2400V buses is not possible without transfer of an affected bus to a separate off-site power supply. The procedure of concern, Alarm Response Procedure (ARP) 3, "Electrical Auxiliaries And Diesel Generator Scheme EK-05," was inadequate in that it failed to provide direction to operators to electrically separate 2400V buses during efforts to locate the source of the ground fault.

ARP 3 has been revised to direct operators to transfer 2400V buses one at a time from the normal to the standby off-site power supply in conjunction with using ground fault indication to determine the affected bus. This revision also provides direction that the grounded bus, once identified, is to remain on the standby power supply until the fault is cleared to eliminate the possibility of simultaneous loss of redundant loads.

Corrective Action

The corrective action for this open item has been completed.

Open Item 91019-07

3.1.9 Overvoltage on Ungrounded 2400V System

The team was concerned that the 2400V electrical system, which was designed to be ungrounded, was susceptible to high voltage transients caused by intermittent ground faults. The 2400V electrical distribution system, including safety buses 1C and 1D, is designed as an ungrounded system in order to permit continued operation with a single ground fault on the system. However, ungrounded systems are susceptible to severe overvoltages caused by repetitive intermittent ground faults such as can be produced in a piece of vibrating equipment. This phenomenon can rapidly produce voltages five or six times normal and may cause failures in motors connected to the system before operators can intervene. Also, since the safety buses are interconnected through cables or buses when being supplied from the primary or alternate offsite source, an overvoltage originating anywhere in the 2400V system will appear on both safety buses. Although the condition described here is considered to be of low probability, it is of concern because it represents a

potential common mode failure mechanism. Pending further NRC review, this matter is considered an open item (255/91019-07(DRS)).

CPCo Response

The ungrounded 2400V system design used at Palisades is a standard industry design and is used at other nuclear power plants. The main advantage of an ungrounded 2400V system is that it allows continued operation of critical Class 1E Emergency Power Supply (EPS) loads during a LOCA, coincident with a single-line-to-ground fault. The present overvoltage relays will sense the ground-fault and alert operators who will isolate the ground fault through manual breaker operations.

We disagree with the concern that the 2400V ungrounded system is susceptible to severe overvoltages due to repetitive intermittent ground faults. The phenomenon of intermittent arcing faults is generally confined to systems of 15 kV or higher employing overhead lines or cable runs with high capacitive reactance. Theoretically, voltages can rise to 5 to 6 per unit peak-to-peak. However, this will occur only if sufficient capacitive reactance is present during the ground fault to provide energy for restrike. "Protective Relaying - Principles and Applications," by J. Lewis Blackburn, provides some guidance related to the susceptibility of a power system to an intermittent ground fault due to the system capacitive reactance. Although it represents a wye grounded primary source, it does provide insight into the amount of capacitive reactance required in a low voltage power system to sustain high voltages to ground due to an open conductor;

$$\frac{Xc}{Xe} > K$$

where

Xc = the equivalent capacitive reactance per phase

Xe = the equivalent exciting reactance per phase

K > 40 for limiting voltage on an open phase to 1.25

The above ratio was checked for conditions at the 2400V Bus 1C when fed from the Safeguards Transformer 1-1 which includes the worst case cable run of 2500 feet. The ratio of Xc/Xe was estimated to be 26,247 which is well above 40 for limiting voltage on an open phase to 1.25 per unit. This indicates that the present 2400V system has very low capacitance to ground to sustain transient voltages and an intermittent arcing ground fault as proposed in the stated concern.

The application of the ground fault detector schemes on the 2400V buses provides a high impedance ground path. The resistors are used to reduce the shift of the neutral for either unbalanced excitation paths of the voltage transformers or from ferro-resonance between the inductive reactance of the voltage transformers and relays in the capacitive system. Circuit resistance will introduce dampening of the transient, reducing the peak value of the voltage. The resistance of the relays and associated resistors also helps to limit the transient overvoltages.

Corrective Action

No corrective action is required.

Open Item 91019-08

3.1.11 Retransfer of Bus to Preferred Source

The team determined that operating procedures provide insufficient guidance regarding the potential adverse effects, during a LOCA concurrent with a loss of offsite power, of retransferring from onsite power (EDGs) to restored offsite power. When loads are being supplied from the EDGs during a concurrent LOCA and loss of offsite power, operating procedures require retransfer to the preferred source, should it become available again. However, when LOCA loads are applied to the offsite source, a voltage drop slightly larger than 2% can occur on the safety bus. If the bus voltage is too low, this additional drop could cause the second level undervoltage relays to drop out causing the loads to be transferred back to the onsite source. (A rough calculation performed by the team indicated that an initial voltage greater than .94 pu would be required to maintain loads, using startup transformer 1-2 as the offsite source.) In this case, it would be preferable to leave the bus connected to the onsite source. In response to this concern, the licensee agreed to perform analyses to establish minimum required voltages to enable successful retransfer, and to revise procedures accordingly. Pending further NRC review of the revised procedures, this matter is considered an open item (255/91019-08(DRS)).

CPCo Response

Current Palisades operating procedures provide guidance to operators as to the minimum voltage required on the offsite source to maintain loads. This guidance has been incorporated into a revision to System Operating Procedure (SOP) 30, "Station Power." The graph summarizing Startup Transformer 1-2 load limits assures a minimum operating voltage of 0.94 per unit (2256 volts) is maintained on the 2400V buses. The synchronization of the diesel generator to the 2400V bus is accomplished by adjusting the automatic voltage regulator to the operating bus voltage prior to paralleling. The transfer of the diesel generator loads back to the offsite source is expected to be a smooth transition. A pre-transfer voltage of 0.94 per unit is expected to be adequate to avoid actuation of the undervoltage relays at 0.91883 per unit.

However, analyses will be completed to determine recommended 2400V voltages prior to transferring diesel generator loads back to an available offsite power supply.

Corrective Action

By the end of the third quarter of 1994, perform analyses which identifies minimum required 2400V voltages prior to transferring diesel generate loads back to an available offsite supply and incorporate voltage limits into appropriate operating procedures.

Open Item 91019-09

3.1.12 Diesel Generator Steady State Loading Calculation

The team was concerned that the magnitude, start time, and duration of manually started loads identified in EDG steady state loading calculation DRS-010990-1 may not reflect worst case conditions. This could result in the application of heavier loadings on the EDGs than were reflected in the calculation. The loads evaluated were based on manual operator actions listed in the EOPs, and the timing criteria used was based on expected plant conditions and the author's experience. The licensee agreed to perform additional studies to assess worst case contingencies and to revise operating procedures as appropriate.

In addition, the licensee could not provide evidence that calculation EA-P-SA-8602 which was used as an input to the EDG loading calculation, was prepared in accordance with accepted design control procedures. Pending further NRC review of the revised procedures and studies, this issue remain open (255 91019-09(DRS)).

CPCo Response

Engineering analysis EA-E-PAL-89-011-01, "Evaluate EDG Load Profile for Seven Days After an Accident (Large Break LOCA)," was used as an input to Calculation No. DRS-010990-1, "Diesel Generator Load Analysis." In order to provide a realistic (but also conservative) diesel generator load profile, DRS-010990-1 used the magnitude and timing of manually-actuated Emergency Power System (EPS) loads from EA-E-PAL-89-011-01, which in turn was based upon Emergency Operating Procedures (EOPs) and Off-Normal Operating Procedures (ONPs). A worst case load profile was performed for each diesel generator. This occurs when the opposite diesel generator was not available.

Since the EOPs and ONPs specify manual equipment actuations based upon plant or equipment conditions rather than time criteria, it was necessary to assume the timing of those manual equipment actuations as defined in EA-E-PAL-89-011-01. These assumptions were based on the judgment of an experienced individual.

There was no attempt to quantify variations in diesel generator electrical loads which may result from an operator failing to follow the load profile defined in DRS-010990-1, since it was intended to represent a conservative load profile. However, the load profile was not intended to constrain or limit the operator in emergency or off-normal conditions.

We agree that additional studies of potential post-LOCA operating contingencies should be performed with the Operations Department to assure all possible manual addition or removal of post-LOCA loads are considered in the diesel generator steady state loading limits. Results of these studies will provide maximum flexibility within diesel generator limits. Changes to appropriate operating procedures will be incorporated as required.

Corrective Action

By the end of 1993, complete additional analyses of post-LOCA operating contingencies and incorporate diesel generator loading limits into appropriate operating procedures as required.

Open Item 91019-10

3.1.13 Diesel Generator Trip Logic

The team noted that the EDG control scheme employs the following automatic trip mechanisms that do not require two or more independent measurements of the trip parameter:

- *Generator trip on underspeed (<600 RPM) through the Field Shutdown Timer.*
- *Engine and generator trip on engine underspeed (<120 RPM).*
- *Engine and generator trip on jacket water low pressure, start circuit B only.*
- *Engine and generator trip on generator overcurrent.*

Since these trips do not employ coincident logic, they increase the potential for spurious EDG trips, which could cause loss of a division during an emergency.

In addition, the non-coincident jacket water low pressure signal provides an unintended DG trip mechanism and can result in the engagement of the air start motors while the engine is running. This could cause equipment damage and deplete the starting air supply. The licensee had previously identified these conditions and has committed to correct them by the fourth quarter of 1992. Pending further NRC preview of the licensee's corrective action, these issues remain open (255/91019-10(DRS)).

CPCo Response

During the development of Design Basis Document DBD-5.06, "Diesel Generator Controls," a Discrepancy Report No. (DRN) F-CG-91-106, entitled "Emergency Non-Coincident/Non-Bypassed Trips," was issued to identify and evaluate the diesel generator automatic shutdown logic. As many as four process or system conditions can cause automatic diesel generator shutdown under circumstances which are unacceptable according to the NRC's technical criteria (i.e., Branch Technical Position No. ICSB-17; superseded by Regulatory Guide (RG) 1.9). Because this aspect of the diesel generator control circuit design represented a potential conflict in the plant's licensing bases, a corrective action document, D-PAL-91-160, was initiated to evaluate the issue. The corrective action which resulted from D-PAL-91-160 was to modify the diesel generator control circuits to meet RG 1.9.

Also, during the development of DBD-5.06, DRN F-CG-91-107 was issued to identify and provide a basis for the process or equipment conditions which can cause automatic shutdown (i.e., low jacket water pressure and engine underspeed [<120 rpm]). These items were never intended as shutdown signals. Rather, an apparent (original design) oversight, wherein the diesel generator "engine started" signal was not designed to seal-in, makes the unit susceptible to automatic shutdown from these process signals. This occurs if the "engine started" permissive conditions fall below the sensing instrument settings at any time during operation, following a legitimate start. Additionally, a related condition was identified where the lack of the seal-in feature can cause the re-engagement of the air start motor, with the engine running, for the duration of the overcrank trip timer setting. As a result, the potential for air start motor damage or needless starting air depletion, or both, is introduced.

The occurrence of a diesel generator unit trip on "low jacket water pressure" or "engine underspeed" can occur due to non-coincident signals during emergency operation. These trip are not in conformance with the NRC's technical criteria. Modifications to the control circuit described in Deviation Report No. D-PAL-91-160 will resolve this issue.

Corrective Action

A modification to correct these diesel generator control circuit deficiencies will be completed during the 1993 refueling outage.

Open Item 91019-11

3.1.14 Engineered Safeguards Testing

The team identified that Surveillance Procedure RT-8C&D requires that less than 50% of the equipment required to be load shed during a Safety Injection System (SIS) actuation, coincident with loss of offsite power (LOOP), be verified to have properly shed. Additionally, during the load sequencing portion of the test, only a few selected loads were verified to auto start. In the event of a SIS actuation coincident with a LOOP, failure of one or more

major loads to shed could effect the EDGs' ability to maintain voltage levels during load sequencing. Also, there is a potential of a generator overload trip, as the DG overcurrent relay trip signal is not bypassed during an ESF actuation.

The licensee's response to the team's concern was that surveillance procedure RT-8C&D meets the TS objective to demonstrate overall automatic operation of the emergency power system based on initial construction testing which verified that each relay contact operated properly.

The TS wording allows for the automatic starting of only "Selected Motors and Equipment" (apparently original TS wording) is not consistent with emergency diesel testing as stated in the Combustion Engineering Standard TS.

Palisades has committed to implement a restructured TS that contains a more conservative EDG testing requirement. This item is unresolved pending NRC review of Palisades implementation of the restructured TS (255/91019-11(DR5)).

CPCo Response

The first part of the open item states that technical specifications surveillance procedures (TSSPs) RT-8C and RT-8D require less than 50% of the equipment required to be load shed be verified to have properly shed. However, Technical Specification 4.7.1.b states, "A test shall be conducted during each refueling outage to demonstrate the overall automatic operation of the emergency power system."

RT-8C and RT-8D verify that at least one load controlled by each load shed relay is properly shed. Using this method, the logic of the scheme is verified and the overall automatic operation of the emergency power system is demonstrated.

The second part of the open item states that during the load sequencing portion of TSSPs RT-8C and RT-8D only a few selected loads were verified to automatically start. This is an incorrect statement. Both procedures verify automatic start for every Safety Injection System (SIS) actuated load and also verify timing for every Design Basis Accident (DBA) sequencer actuated load.

Corrective Action

Prior to the 1993 refueling outage, TSSPs RT-8C and RT-8D will be reviewed and revised to demonstrate, to the maximum extent possible, load shedding of the emergency loads.

Open Item 91019-17

3.2.1 Engineering Drawings

The team noted various minor discrepancies between single line diagram E-8, Sheets 1 and 2, and other relevant engineering documents. Examples of observed discrepancies included:

- *Circuit breakers 72-18 and 72-28 were shown on diagram E-8, Sheet 1 as having thermal and magnetic trips whereas FSAR and coordination curves correctly indicated that there were only thermal trips in these breakers.*

- *The feeders to panels D11-1, D11-2, D21-1 and D21-2 were shown on diagram E-8, Sheet 1 as 2#4/0 (1c/pole) whereas calculations D11/SC and D21/SC correctly indicated 2x2#4/0 (2c/pole).*

- *Main single line diagram E-1, Sheet 1 did not show the 1200 A fuses in series with the 500 A breakers on the feeders to dc distribution panels D10 and D20, whereas diagram E-8, Sheet 1 correctly showed the 1200 A fuses.*

The licensee agreed to revise and update all relevant drawings. This item remains open pending NRC review of the licensee's corrective action (255/91019-17(DRS)).

CPCo Response

In response to the above open item, a document change request (DCR) 950-91-1194 was initiated to correct plant electrical drawing E-8, Sheets 1 and 2. Electrical Drawing E-1, Sheet 1, will also be reviewed and corrected as necessary.

Corrective Action

In addition to the above action, a review of plant electrical single line drawings and single line meter and relay drawings will be performed to ensure they contain the proper level of detail and consistency. This corrective action is scheduled for completion by the end of 1993. The review of electrical drawing E-1 will be completed by April 30, 1992.

Open Item 91019-18

3.2.2 Cable Selection and Sizing Criteria

The team was concerned that the licensee's voltage drop and short circuit calculations developed for sizing 125Vdc and 125Vac cables did not consider worst case temperature conditions. Existing design documentation did not identify important cable data such as cable resistance and temperature

ratings. The licensee stated that for cables larger than 8 AWG, the temperature used in the voltage drop calculations was 65°C and for cables 8 AWG and smaller the temperature used was 75°C. The team determined that for the XLPE and EPR cables, a non-conservative value of 90°C was used. In addition, the team noted that the licensee used a value of 30°C in short circuit calculations instead of a more conservative value of 25°C. Finally, the team noted that AC resistance values were used in the short circuit calculations for DC circuits resulting in lower than actual calculated short circuit currents. The licensee is currently updating calculations and agreed to use cable resistances at 25°C for short circuit calculations and cable resistances at rated temperature for voltage drop calculations. This item remains open pending NRC review of the updated calculations (255/91019-18(DRS)).

CPCo Response

We agree that the voltage drop and short circuit calculations for sizing 125Vdc cables should consider worst case temperature conditions. Calculations for the dc system will be updated using cable resistances at 25°C for short circuit and cable resistances at rated temperature for voltage drop calculations.

Corrective Action

By the end of the second quarter of 1994, update the dc voltage drop and short circuit calculations with cable resistances at rated cable temperature (voltage drop) and at 25°C (short circuit).

Open Item 91019-19

3.2.3 Battery Charger Input and Output Cables

The team was concerned that the battery charger's input and output cables were inadequately sized. The input and output rating of the chargers were 90 A and 200 A respectively, and the cables used were 2 AWG and 4/0 rated 120 A and 253 A respectively. Applying the derating factor of 0.7 used by the licensee in their calculations, the cables should not have been used for currents more than 84 A and 177 A respectively. The licensee re-evaluated the sizing of the battery charger on September 11, 1989, (Deviation Reports D-PAL-89-148 and -149) and concluded that the existing cables were acceptable. However, the team's informal calculations indicated that the cables were undersized for the battery charger's rating. However, since the battery chargers are not operating at their full rated capacity, the team had no immediate operability concerns for the cable. The licensee's response to the team's concern was that these cables would be included in their cable tray ampacity study plan, a program in progress to be completed during the fourth quarter of 1993. This issue remains open pending NRC of the results of the ampacity study for the battery chargers (255/91019-19(DRS)).

CPCo Response

Work continues on the cable tray ampacity study.

Corrective Action

The cable tray ampacity study is scheduled for completion during the fourth quarter of 1993.

Open Item 91019-22

3.3.1 Diesel Engine Support Systems

3.3.1.1 Fuel Oil Supply System

The team identified the following discrepancies in the design documentation associated with the EDG fuel oil storage tanks:

- *Fuel consumption tests were not documented.*
- *The calculations regarding the capacities of the EDG day tanks and belly tanks were inconsistent.*
- *The low level day tank alarm setpoint did not provide an accurate tank inventory.*
- *The UFSAR, TS and various engineering analyses stated different EDG running time capabilities.*

The team noted that the day tank emergency supply lines and their external valves DE-115 and 116, were not included in a maintenance and testing program to assure their availability at all times. The supply lines provide compensation for the fact that storage tank T-10 and its appurtenances are not seismically or tornado qualified. The team was also concerned that the TS required minimum 16,000 gallons of fuel in storage tank T-10 would not assure 7 days of dedicated EDG fuel supply. The licensee currently maintains tank levels above the TS minimum to satisfy calculated 7 day fuel supply requirements. The licensee's responses to the team's concerns committed to evaluate and provide necessary corrective action by the fourth quarter of 1992. This item remains open pending NRC review of the licensee's corrective action (255/91019-22(DRS)).

CPCo Response

During the inspection, the NRC noted a number of discrepancies in the calculations and documentation (i.e., FSAR and the technical specifications) associated with the diesel fuel oil storage analyses.

The issue regarding the current Technical Specification 3.7.1i limit on diesel generator fuel oil supply was addressed by CPCo in 1989 as a result of the Configuration Control Project. We determined that the technical specification limit of 16,000 gallons of diesel fuel oil in T-10 would not support 7 days of diesel generator operation. This is documented in LER 89-005, dated March 3, 1989. Corrective action for that event included performing a calculation to determine the actual diesel fuel oil storage capacity. As result, a technical specifications change request was submitted on November 11, 1989 to increase the diesel fuel oil storage capacity requirement. We are currently awaiting NRC approval of this technical specification change request. In the interim, the more restrictive diesel fuel oil storage requirements are being administratively controlled via Standing Order 54, Section 3.7.1i and will serve to insure an adequate supply of diesel fuel oil is maintained. The remaining issues concerning diesel fuel oil storage analysis are currently being evaluated.

The NRC also identified a weakness in the calculations for the diesel fuel oil storage capacity in that fuel oil consumption rates utilized in the calculations had not been verified by testing. CPCo had utilized the original diesel generator fuel consumption rate (obtained by test at the factory) in our calculations. Data obtained during the performance of technical specification surveillance test (TSSP) MO-7A, "Emergency Diesel Generators," indicated the existing fuel consumption rates were nearly equal the factory test data. A more formal test needs to be performed.

The NRC team also identified a weakness concerning the emergency fill lines to the diesel generator day tanks in that they are not included in the maintenance and testing programs. CPCo will develop a maintenance and testing program commensurate with the significance and probability of the failure of the emergency fill lines.

Corrective Action

The remaining issues concerning diesel fuel oil storage analysis are currently being evaluated and will be completed by the end of 1992. Recommended corrective actions resulting from this evaluation will be documented and appropriate completion dates will be assigned. The formal test to determine the diesel generator fuel oil consumption rate as well as the maintenance and testing program for the emergency fill lines to the diesel generator day tanks will be developed by the end of 1992.

Open Item 91019-23

3.3.1.2 Diesel Generator Room Heating, Ventilation, and Air Conditioning

The team questioned the ability of each EDG room heating, ventilation and air conditioning (HVAC) system to maintain the ambient air temperature below 104°F with only one of two fans fed by Class 1E power, considering all heat sources in the room, and the design maximum intake air temperature of 95°F. The information provided by the licensee did not provide confidence that fans

V-24A (K-6A) or V-24C (K-6B) would be able to provide adequate ventilation. Most of the team's concerns had been previously identified by the licensee who retained the services of Bechtel Corporation for the preparation of an analysis demonstrating the capacity of the existing system. After the completion of this analysis, appropriate corrective actions to resolve the concern will be performed by the licensee. This issue remains open pending NRC review of the analysis and corrective action (255/91019-23(DRS)).

CPCo Response

As indicated in the NRC discussion of this open item, CPCo had identified this issue prior to the EDSFI inspection and had initiated corrective action to address diesel generator room HVAC capacity.

Corrective Action

CPCo has received the results of Bechtel's analysis and is currently in the process of reviewing those results. Our initial review indicates that the existing configuration is not adequate to maintain room temperature below 104°F when the outdoor temperature is greater than or equal to 95°F. As a result, we are developing corrective actions to ensure that the diesel generator room HVAC capacity is adequate prior to periods of high summer temperature. This work will be completed by the summer of 1992.

Open Item 91019-24

3.3.1.3 Emergency Diesel Generator Air Intake and Exhaust

During system walkdowns, the team found the EDG exhaust mufflers unbolted from their pedestals. The nuts had been removed and the ends of the bolts flame cut to prevent the reinstallation of the nuts. This raised a concern regarding the ability of the exhaust system to function after an earthquake. The licensee explained that the mufflers were left unbolted during preparations testing in order to accommodate thermal expansion of the exhaust piping. No formal modifications documentation was available for review. The licensee committed to include the EDG exhaust system in its Seismic Verification Project under the auspices of the Seismic Qualification Utility Group (SQUG), and to formally document the anchoring design of the mufflers for both seismic loadings and thermal expansion during the first quarter of 1992. This item remains open pending NRC review of the design documentation (255/91019-24(DRS)).

CPCo Response

We agree that a concern exists regarding the ability of the exhaust system to function after an earthquake. Engineering analyses EA-SP-07003-01, EA-SP-07003-02, and EA-IO-SP-07003-01 were performed on the diesel generator

exhaust mufflers to address seismic and anchorage concerns and take into account thermal expansion. The engineering analyses concluded that the piping meets the Interim Operability Criteria of CPCo Specification M-195(Q), Rev 2, but does not meet CPCo FSAR Design Class II requirements. This issue is documented in a corrective action document, D-PAL-92-096.

Corrective Action

We are currently developing modifications to the diesel generator exhaust piping to meet the requirements of CPCO Design Class II. These modifications are scheduled for completion prior to the end of the 1992 refueling outage.

Open Item 91019-25

3.3.1.4 Emergency Diesel Generator Starting

The team noted that the EDGs have never been tested to demonstrate their ability to start at minimum hot standby conditions as specified by the manufacturer (i.e., 90°F lube oil and jacket water temperature and 65°F room temperature). EDG monthly testing does not verify these parameters prior to startup. The licensee committed to test start the EDGs under these temperature conditions by the end of the next refueling outage.

The possibility that jacket water and room temperatures could fall below the minimum hot standby conditions was considered significant since these parameters are not under automatic alarm surveillance. The licensee's response to the team's concern committed to evaluate methods to assure that these temperatures do not fall below design temperatures, including modification or procedure revisions, as required. This item remains open pending NRC review of the licensee's corrective action (255/91019-25(DRS)).

CPCo Response

The diesel generator vendor has supplied information which indicates that the minimum ambient temperature which a diesel generator can be expected to start without starting aids (eg warmed lube oil and jacket water) is 50°F. However, it is not clear that this criteria applies to nuclear plant standby service (critically timed 10 second start).

The system operating procedure for the diesel generators, SOP-22, "Emergency Diesel Generators," states that the lube oil and jacket water temperatures must be maintained above 90°F to insure diesel generator operability. The original purchase specification for the diesel generator states that the minimum expected ambient room temperature would be 60°F. As indicated in the inspection report, and in our responses to concerns of the EDSFI inspection team, CPCo has not performed a documented test to qualify or validate diesel generator performance at these minimum temperature limits. Also, as indicated in the inspection report, low jacket water temperature and low room temperature are not alarmed parameters.

CPCo believes that frequent testing at the minimum temperatures is not necessary nor prudert in that frequent cold-fast starts have been demonstrated to result in premature diesel generator wear and failure. This issue has been well documented in the industry and specifically in NRC Generic Letter 84-15 "Proposed Staff Actions to Improve and Maintain Diesel Generator Reliability." However, we will perform a test at the minimum hot standby conditions on a one time basis as a "qualification" test for the diesel generators.

Corrective Action

The following actions will be completed to resolve this issue.

1. Perform a one time "qualification" test to demonstrate that an EDG is capable of adequately starting at or below the following conditions:

   Cold lube oil temperature ≤ 90°F

   Cold jacket water temperature ≤ 90°F

   Room ambient temperature ≤ 60°F

CPCo originally committed (in our responses to concerns during the EDSFI inspection) to perform this test by the end of the 1992 refueling outage; however, due to work priorities we were not able to develop and schedule an adequate test to support performance during the 1992 refueling outage. This testing will now be completed by the end of the 1993 refueling outage.

2. The operator rounds sheet will be revised to include recording of the diesel generator jacket water temperature and the diesel generator room temperature. Action limits and recommended corrective actions will be specified. These revisions will be completed by May 1, 1992.

3. An evaluation will be performed to determine the need to provide an automatic alarm on low jacket water and low room temperature conditions. This evaluation will be completed by December 31, 1992 and any recommended modifications will be scheduled through the plant planning process.

Open Item 91019-26

3.3.2 Limiting Conditions of Operation and Maintenance for Emergency Diesel Generators

The team was concerned that plant procedures or policies neither prohibit nor control work in the switchyard or on redundant systems when one EDG is inoperable because of maintenance or testing. Unnecessary risk of loss of offsite power should be clearly eliminated by procedures when only one EDG is operable. An incident of this nature is described in NRC Information Notice 91-34. The licensee agreed to incorporate into plant administrative procedures the guidance to assure that testing or maintenance is avoided which

has reasonable potential to affect redundant equipment. This issue remains open pending NRC review of the procedure and policy revisions (255/91019-26(DRS)).

<u>CPCo Response</u>

We agree that additional guidance regarding limiting conditions of operation and maintenance for emergency diesel generators is desirable. We will incorporate this additional guidance into plant administrative procedures. The revised procedures will serve to assure that testing or maintenance, which has reasonable potential to affect redundant equipment, is avoided.

<u>Corrective Action</u>

Administrative procedures will be revised in accordance with our procedure biennial review process. This action will be completed by the third quarter of 1993.