ENCLOSURE 1

SAFETY EVALUATION
SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1
DOCKET NO. 50-206
ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

INTRODUCTION AND SUMMARY

Southern California Edison Company was requested by NRC letter dated August 8, 1979 to review the electric power system at San Onofre Nuclear Generating Station Unit 1. The review was to consist of:

a) Determining analytically the capacity and capability of the offsite power system and onsite distribution system to automatically start as well as operate all required loads within their required voltage ratings in the event of 1) an anticipated transient, or 2) an accident (such as LOCA) without manual shedding of any electric loads.

b) Determining if there are any events or conditions which could result in the simultaneous or, consequential loss of both required circuits from the offsite network to the onsite electric distribution system and thus violating the requirements of General Design Criterion (GDC) 17.

The August 8, 1979 letter included staff guidelines for performing the required voltage analysis and the licensee was further required to perform a test in order to verify the validity of the analytical results. SCE responded by letters dated May 1, 1980 and August 19, 1981.

A detailed review and technical evaluation of the submittals was performed by Lawrence Livermore Laboratory (LLL) under contract to the NRC, with general supervision by NRC staff. This work is reported by LLL in Technical Evaluation Report (TER), "Adequacy of Station Electric Distribution System Voltages,

San Onofre Nuclear Generating Station, Unit 1," dated January 14, 1982. We have reviewed this report and concur in the conclusions that the offsite power system and the onsite distribution system are capable of providing acceptable voltages for worst case station electric load and grid voltages.

The licensee in a submittal dated July 15, 1982 provided the test results required to verify the assumption used in the voltage analysis. A detailed review and evaluation of this submittal was performed by LLL under general supervision of NRC staff. This work is reported by LLL in revised Technical Evaluation Report (TER), "Adequacy of Station Electric Distribution System Voltages, San Onofre Nuclear Generating Station, Unit 1, Revision 1," dated September 8, 1982 (attached). We have reviewed this report and the verification test results and find them acceptable.

EVALUATION CRITERIA

The criteria used by LLL in this technical evaluation of the analysis includes GDC 5 ("Sharing of Structures, Systems, and Components"), GDC 13 ("Instrumentation and Control"), GDC 17 ("Electric Power Systems") of Appendix A to 10 CFR Part 50; IEEE Standard 308-1974 ("Class 1E Power Systems for Nuclear Power Generating Stations"), ANSI C84.1-1977 (Voltage Ratings for Electric Power Systems and Equipment - 60 Hz"), and the NRC staff positions and guidelines in NRC letter to SCE dated August 8, 1979.

ANALYSIS AND TEST FEATURES

SCE analyzed each offsite power source to the onsite distribution system under maximum and minimum load conditions with the 230 kv grid at maximum and minimum anticipated grid voltages of 234.5 kv and 217.8 kv. The maximum voltage is based on all three units operating. With only Unit 1 operational,

224 kv is the maximum anticipated grid voltage. The Class 1E loads that are designed to automatically start and operate during a LOCA are normally loaded through a sequencer. For conservatism the analysis was based on bulk loading all the Class 1E LOCA loads, and two 3500 hp feedwater pumps onto the onsite distribution system. The results of the analysis indicate that the 4160 volt and 480 volt emergency loads will operate within allowable limits with single unit and three unit operation when supplied from the 230 kv grid.

The licensee, in a submittal dated July 15, 1982, provided a revised voltage analysis for the maximum grid voltage and minimum load condition. This new analysis covers the voltage conditions anticipated with single (Unit 1) and three (Units 1, 2, and 3) in operation. The revised analysis shows that the operation of Units 1, 2, and 3 with a generator terminal voltage at 105% (maximum) of rated voltage would result in a grid voltage of 240 kv. With the present auxiliary transformer tap settings of 218/4.36 kv and 4.16/0.48 kv this could result in overvoltages of 112% on the 4160 volt buses and 122% on 440 volt motors (most limiting equipment). With Unit 1 only in operation at 100% (normal) generator terminal voltage, the overvoltage condition would be reduced to 106% on the 4.16 kv buses and 115% on the 440 volt motors.

Because of this overvoltage condition, SCE has committed to monitor distribution system voltage during plant operation to verify the results of the revised voltage analysis and obtain data for optimization of the auxiliary transformer tap settings. The licensee has committed to provide the results of this monitoring program to NRC within 90 days after restart of Unit 1. The analysis shows that operation of Unit 1 only could result in exceeding

the design rating of the 440 volt Class 1E motors by 5% during the worst case overvoltage condition.

As a result of further discussions with the NRC staff, by letter dated December 14, 1982, the licensee committed to perform a study to determine the optimum transformer tap settings. The licensee has stated that this optimization will minimize overvoltages while ensuring sufficient voltage under minimum voltage conditions. Further, the licensee has committed to revise the tap settings based on this study prior to returning to power. SCE will perform the monitoring program and submit a report as discussed above. We, therefore, find this acceptable while conducting system voltage monitoring.

In addition to the above analysis, the licensee's submittal included the recent design changes that have been incorporated in the load sequencing of safety injection loads. The revised sequencing will trip the feedwater pumps upon receipt of a safety injection signal. They will be restarted at T = 11 seconds during sequencing of safety loads. In addition, a more realistic load condition was assumed for the 480 volt safety buses and the refueling water pump starting will be changed to start when containment pressure reaches 2 psi instead of starting at T = 0. These changes, as shown on Table 1 of the revised TER, show that under the minimum voltage maximum load conditions, acceptable voltage will still be provided to all Class 1E equipment under the worst case transient and minimum steady state voltage conditions.

The licensee has submitted a detailed description of the tests which will be performed to verify the voltage analysis. The proposed testing program conforms to staff requirements. The tests will be conducted during an outage scheduled to begin in March 1982 and the results of the tests will be provided to NRC upon completion.

The licensee, in the July 15, 1982 submittal also provided the results of tests performed to verify the assumptions used in the voltage analysis. The verification tests were conducted during a unit shutdown with the grid at 221 kv. Voltage measurements were taken on the 230 kv grid, 4.16 kv and 480 volt buses. Current measurements were made on the feeder cables to the 4.16 kv and 480 volt buses. The tests included measurements made during the sequencing of safety loads using the new sequence described in the above submittal. A comparison showed that the test results were within 1.2% of the values used in the analysis. This close correlation demonstrates that the analysis was accurate and acceptable.

CONCLUSIONS

We have reviewed the LLL Technical Evaluation Report and concur in the findings that:

1) SCE has provided voltage analysis to demonstrate that Class 1E equipment voltages will remain within acceptable operating limits for the postulated worst case grid voltage conditions.

2) The tests proposed by SCE will verify the voltage analysis accuracy. We have reviewed the test results and they show the analysis to be accurate and acceptable.

3) SCE's reaffirmation of compliance to GDC 17 requirements is acceptable.

4) The two percent overvoltage condition that could exist under minimum bus loading and maximum grid voltage is not considered significant since any loading of equipment on the Class 1E buses will reduce the voltage to acceptable levels.

The revised analysis shows that operation of Units 1, 2, and 3 with maximum generator terminal voltage of 105% of rated voltage could result in over-voltage of 112% on the 4160 volt buses and 122% on 440 volt motors. Subsequently, SCE has committed to perform a study to determine the optimized tap settings and to modify the settings accordingly prior to restart. SCE has additionally committed to initiate a voltage monitoring program to verify the results of the optimized tap settings. The licensee has committed to provide the results of this monitoring program to NRC within 90 days after Unit 1 restart. Operation of Unit 1 with the modified auxiliary transformer tap settings, while this monitoring program is being completed, is acceptable.