

UCID- 19120

TECHNICAL EVALUATION OF THE ADEQUACY OF
STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES
FOR THE SAN ONOFRE NUCLEAR GENERATING STATION,
UNIT 1

SELECTED ISSUES PROGRAM

James C. Selan
(Docket No. 50-206)

January 14, 1982



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This work was supported by the United States Nuclear Regulatory Commission under a Memorandum of Understanding with the United States Department of Energy.

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ABSTRACT

This report documents the technical evaluation of the adequacy of the station electric distribution system voltages for the San Onofre Nuclear Generating Station, Unit. The evaluation is to determine if the onsite distribution system in conjunction with the offsite power sources has sufficient capacity to automatically start and operate all Class 1E loads within the equipment voltage ratings under certain conditions established by the Nuclear Regulatory Commission.

The analysis submitted demonstrates that acceptable voltages will be supplied to the Class 1E equipment under worst-case conditions.

FOREWORD

This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues Program being conducted for the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Operating Reactors, by Lawrence Livermore National Laboratory.

The U. S. Nuclear Regulatory Commission funded the work under the authorization entitled "Electrical, Instrumentation and Control System Support," B&R 20 19 04 031, FIN A-0250.

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1. INTRODUCTION

The Nuclear Regulatory Commission (NRC) by a letter dated August 8, 1979 [Ref. 1] expanded its generic review of the adequacy of the station electric distribution systems for all operating nuclear power facilities. This review is to determine if the onsite distribution system in conjunction with the offsite power sources has sufficient capacity and capability to automatically start and operate all required safety loads within the equipment voltage ratings. In addition, the NRC requested each licensee to follow suggested guidelines and to meet certain requirements in the analysis. These requirements are detailed in Section 5 of this report.

By letters dated May 1, 1980 [Ref. 2] and August 19, 1981 [Ref. 3], Southern California Edison Company (SCE), the licensee, submitted their analysis and conclusion regarding the adequacy of the electrical distribution system's voltages at the San Onofre Nuclear Generating Station, Unit 1 (SONGS 1).

The purpose of this report is to evaluate the licensee's submittal with respect to the NRC criteria and present the reviewer's conclusion on the adequacy of the station electric distribution systems to maintain the voltage within the design limits of the required Class 1E equipment for the worst case starting and load conditions.

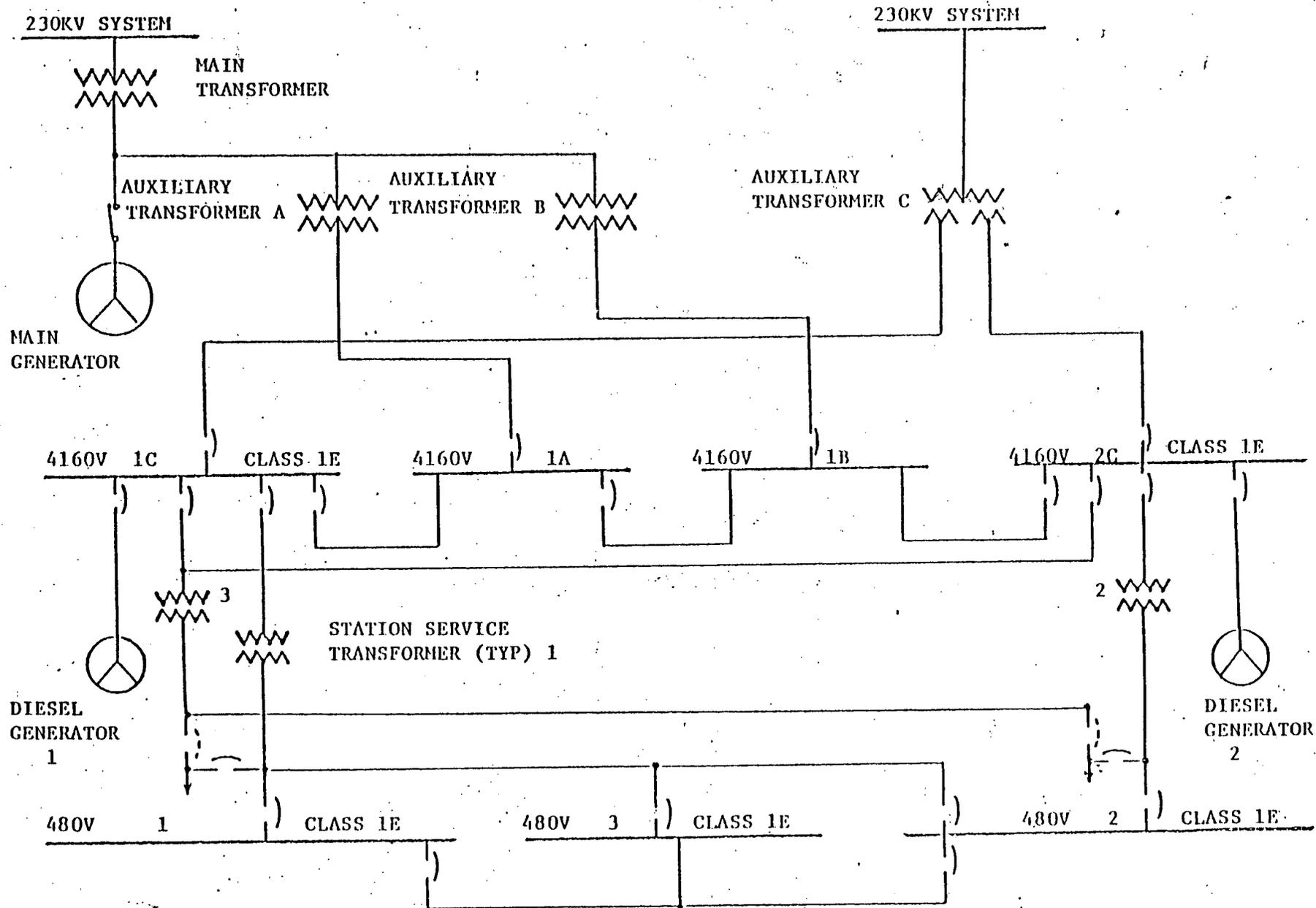


FIGURE 1. SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1 ELECTRICAL ONE-LINE DIAGRAM

voltages to determine the voltages at the terminals of the Class 1E equipment. The minimum and maximum grid voltages used in the analyses were 217.8 kV and 234.5 kV, respectively. The maximum voltage is based on all three units operating. However, until units 2 and 3 become operational, 224 kV is the maximum voltage with only unit 1 operational. All loads designed to automatically start and operate in a LOCA condition are assumed to occur. Normally, the Class 1E equipment is loaded through the sequencer. For conservatism, the Class 1E loads are assumed to start simultaneously including two 3500 hp feedwater pumps and two 700 hp safety injection pumps. The licensee analyzed two cases for voltage degradation, the worst postulated unit trip and accident condition.

4.2 ANALYSIS RESULTS

The worst case Class 1E equipment terminal voltages occur under the following conditions and the results summarized in Table 1.

4.2.1 Overvoltage

Minimum plant loading on transformer C, grid at 224 kV, with only unit 1 operational (234.5 kV with all 3 units operational), tap settings of 218.5/4.36 kV on transformer C and 4.16/.48 kV on station service transformers 1, 2 and 3.

4.2.2 Undervoltage

Unit auxiliary transformers A and B are out of operation. The reactor is in a hot shutdown mode, a LOCA occurs, grid at 217.8 kV, all Class 1E loads are started simultaneously including two 700 hp safety injection pumps and two 3500 hp feedwater pumps. For conservatism, both load groups are carrying 5,339 kVA load (normally, 5,339 kVA on Bus 1C and 2,799 kVA on Bus 2C).

4.3 ANALYSIS VERIFICATION

SCE submitted a detailed description of the test method which will be used to verify the analyses. The scope of the test is to determine that the auxiliary power system has the capability to start and operate the emergency loads required for the worst case LOCA event with the worst case grid voltage. Recording meters will be installed to record the steady state and transient voltages. The results will be compared to an acceptance criteria which consists of the following:

- (1) Voltage dip does not exceed 20% of the motor nameplate voltage
- (2) Class 1E loads start and operate normally
- (3) Steady state voltage shall be greater than or equal to 90% of motor nameplate voltage.

The test will be conducted during an outage planned for six effective full power months from plant startup on June 17, 1981.

5. EVALUATION

The NRC generic letter [Ref. 1] stated several requirements that the plant must meet in their voltage analysis. These requirements and an evaluation of the licensee's submittals are as follows:

- (1) With the minimum expected grid voltage and maximum load condition, each offsite source and distribution system connection must be capable of starting and continuously operating all Class 1E equipment within the equipment's voltage ratings.

The voltage analysis submitted by SCE has shown that each offsite source connection to the onsite distribution system has the capacity and capability to start and continuously operate the Class 1E equipment within the voltage ratings under worst case conditions.

- (2) With the maximum expected offsite grid voltage and minimum load condition, each offsite source and distribution system connection must be capable of continuously operating the required Class 1E equipment without exceeding the equipment's voltage ratings.

The voltage analysis submitted by SCE shows that the 440-volt Class 1E motor's upper voltage rating is exceeded by 2%. This 2% overvoltage is considered not to significantly affect the continued operation of the motors. The overvoltage condition can be eliminated by the adding of additional loads.

- (3) The analysis must show that there will be no spurious separation from the offsite power source to the Class 1E buses by the voltage protection relays when the grid is within the normal expected limits and the loading conditions established by the NRC are being met.

LLNL will verify in a separate report (TAC No. 10853) that the conditions of this position are met as the proposed design changes and modifications for a second-level of under-voltage protection has not been submitted.

- (4) Test results are required to verify the voltage analyses calculations submitted.

The test procedure has been reviewed and found acceptable. Upon the completion of the test, the test results when compared to the calculated values should be within 3% to verify the accuracy of the analyses.

REFERENCES

1. NRC letter (W. Gammill) to all power reactor licensees, dated August 8, 1979.
2. SCE letter (K. P. Baskin) to NRC (D. L. Ziemann), dated May 1, 1980.
3. SCE letter (W. C. Moody) to NRC (D. M. Crutchfield), dated August 19, 1981.
4. Code of Federal Regulations, Title 10, Part 50 (10 CFR 50), General Design Criterion 5, 13 and 17 of Appendix A for Nuclear Power Plants.
5. ANSI C84.1-1977, "Voltage Ratings for Electric Power Systems and Equipment."
6. IEEE Std. 308-1971, "Class 1E Power Systems for Nuclear Power Generating Stations."