

SAFETY EVALUATION
YANKEE ROWE NUCLEAR POWER STATION
DOCKET NO. 50-29
ADEQUACY OF STATION ELECTRIC DISTRIBUTION
SYSTEM VOLTAGES

INTRODUCTION AND SUMMARY

Yankee Atomic Electric Company (YAECO) was requested by NRC letter dated August 8, 1979 to review the electric power system at Yankee Row Nuclear Power Station. The review was to consist of:

- a) Determining analytically the capacity and capability of the offsite power system and the 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 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. YAECO responded by letters dated February 27, 1980 and January 21, 1981. A detailed review and technical evaluation of the submittal was performed by Lawrence Livermore Laboratory (LLL) under contract to NRC, and with general supervision by NRC staff. This work was reported in LLL Technical Evaluation Report (TER), Adequacy of Station Electric Distribution System Voltages, Yankee Rowe Nuclear Power Station, dated May 29, 1980 (attached). We have reviewed this

report and concur in the conclusions that the offsite power system and onsite distribution system are capable of providing acceptable voltages for worst case station electric load and grid voltages.

EVALUATION CRITERIA

The criteria used by LLL in this technical evaluation of the analysis includes GDC 13 ("Instrumentation and Control"), GDC 17 ("Electric Power Systems") of Appendix A to 10 CFR 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-60HZ"); and the staff positions and guidelines in NRC letter to YAECO dated August 8, 1979.

ANALYSIS AND TEST FEATURES

YAECO analyzed each offsite power source to the onsite distribution system under maximum and minimum load conditions with the offsite power sources at maximum and minimum voltage, 117Kv and 109 Kv respectively. The analysis included the effects on the Class 1E equipment when starting and running a large non-Class 1E motor under conditions with maximum load and minimum grid voltage. It has been established that the emergency 480 volt loads would operate within allowable limits for the worst case conditions noted above. During the minimum voltage transient experienced on the 120 vac system, two valve monitoring systems (PORV and SV) may falsely indicate that a normally closed valve has opened. The licensee states that this false indication can be verified by other system parameters and is, therefore, considered acceptable and of no safety significance.

The voltage analysis was verified by comparing actual bus voltages to voltages predicted by the computer program. Two verification tests were made for actual plant operating conditions. The comparison showed the calculated voltages for the Class 1E buses are within - 0.85 and + 1.70 percent of the measured bus voltages. This close correlation verifies the adequacy of the analysis submitted.

CONCLUSIONS

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

1. YAECO has provided verified voltage analyses to demonstrate that the Class 1E equipment terminal voltages remain within acceptable operating limits for the postulated worst case conditions.
2. The tests to verify the analysis was valid and showed the analysis to be accurate.
3. YAECO's reaffirmation of compliance with GDC 17 requirements is acceptable.
4. Upon the review and approval of the degraded grid protection modifications proposed by YAECO and currently being reviewed by LLL, there will be acceptable assurance that spurious tripping of offsite power to Class 1E equipment will not take place upon starting a large non-Class 1E load.

TECHNICAL EVALUATION OF THE
ADEQUACY OF STATION ELECTRIC
DISTRIBUTION SYSTEM VOLTAGES
FOR THE YANKEE ROWE NUCLEAR POWER STATION

(Docket No. 50-29)

Lawrence Livermore National Laboratory, Nevada

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 February 27, 1980 [Ref. 2] and January 21, 1981 [Ref. 3], Yankee Atomic Electric Company (YAECO), the licensee, submitted their analysis and conclusion regarding the adequacy of the electrical distribution system's voltages at the Yankee Rowe Nuclear Power Station.

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.

2. DESIGN BASIS CRITERIA

The design basis criteria that were applied in determining the adequacy of station electric distribution system voltages to start and operate all required safety loads within their required voltage ratings are as follows:

- (1) General Design Criterion 17 (GDC 17), "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," in the Code of Federal Regulations, Title 10, Part 50 (10 CFR 50) [Ref. 4].

HARRIMAN LINE
Z-126

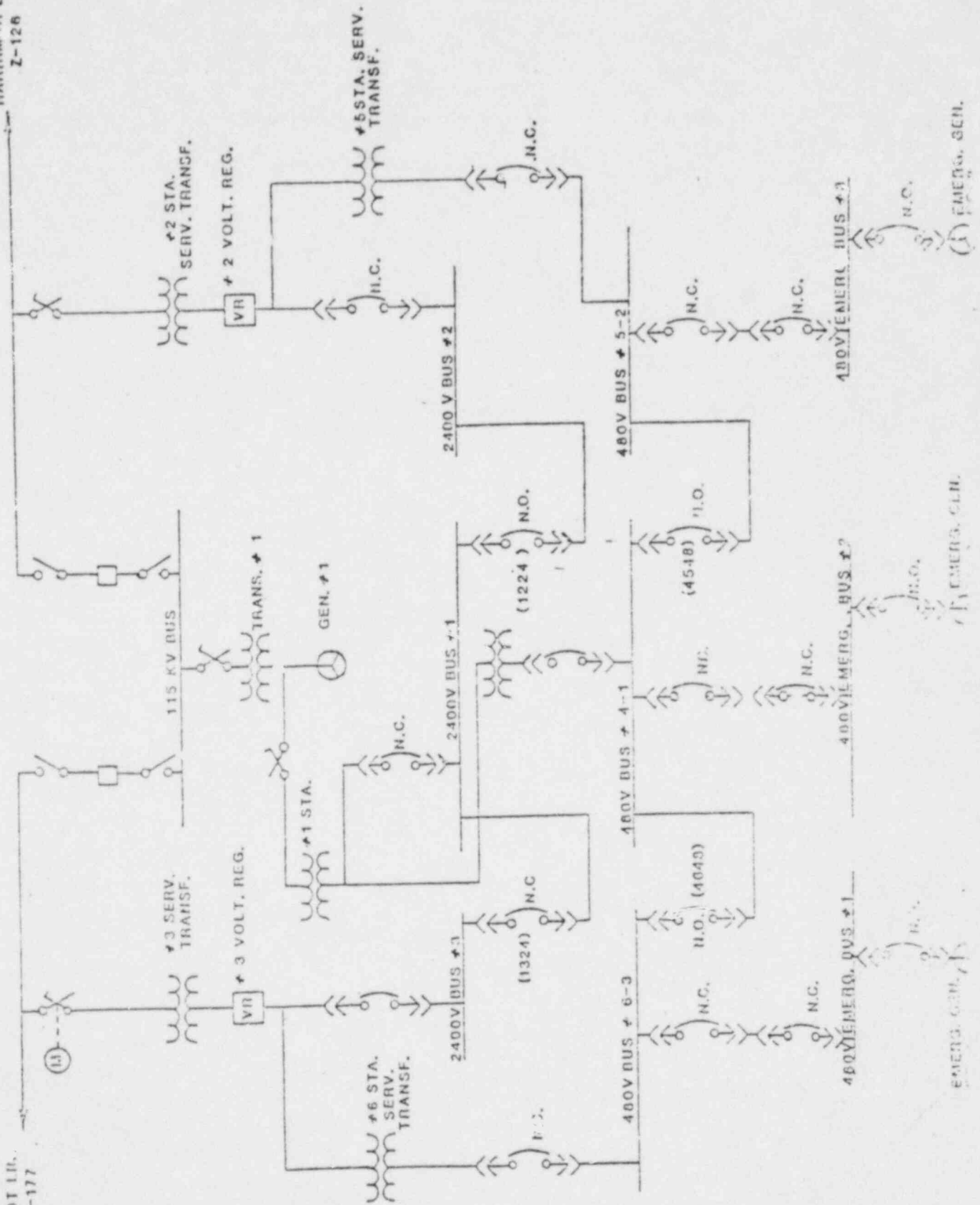


FIGURE 1 - YANKEE ROWE ELECTRICAL ONE - LINE DIAGRAM

4.2 ANALYSIS RESULTS

During the voltage analysis under the above conditions, a potential problem was discovered and reported as Licensee Event Report 50-29/79-26 [Ref. 7]. With the generator off line, the center buses tied to the outer buses, and the grid at the minimum expected value, the auxiliary power system might not have the capacity to operate all Class 1E loads upon a SIAS. As a solution to this problem, voltage regulators were installed on the secondary side of the 115KV/2400-volt station service transformers. The regulators maintain a regulated secondary voltage of ± 20 volts with a variation in the primary voltage of $\pm 15\%$.

The worst case Class 1E equipment terminal voltages shown in Table 1 occur under the following conditions:

4.2.1 Overvoltage

Plant at cold shutdown, minimum plant load and grid at maximum expected voltage of 117KV.

4.2.2 Undervoltage

Worst case loading exists when an accident occurs without loss of offsite power and with the generator off line, grid at minimum expected voltage of 109 KV, 2400-volt bus No. 1 not tied to 2400-volt bus No. 2 (breaker 1224 open), 480-volt bus 4-1 tied to 480-volt bus No. 5-2 (breaker 4548 closed), offsite source is the 115KV Harriman line.

4.3 ANALYSIS VERIFICATION

YAECO verified their computerized voltage analysis calculations by comparing actual measured bus voltages to voltages predicted by the computer program. Rather than performing the test with an actual degraded grid condition, actual plant operating conditions were selected. The computer program was used to predict bus voltages for the operating condition and then compared to actual measured bus voltages for the same plant condition. Two verification tests were made. The first verification test produced percent deviation errors of -0.85 to + 0.42 and the second test of -0.64 to + 1.70. A plus percent deviation error indicates predicted values to be higher than measured values.

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 YAECO shows that after installation of voltage regulators, each offsite source, in conjunction with the onsite distribution, has the capability and capacity to automatically start and continue to operate all Class 1E equipment within their design ratings with one exception. During the minimum voltage transient experienced on the 120VAC system, two valve monitoring systems (PORV and SV) may falsely indicate that a normally closed valve has opened. The licensee states that this false indication can be verified by other system parameters and is, therefore, considered acceptable and of no safety significance.

- (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 YAECO shows that after installation of voltage regulators, each offsite source at the maximum expected grid voltage with minimum plant operating loads will supply adequate voltage to the Class 1E equipment without exceeding their design ratings.

- (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 #10060) that the requirements of this position are met, as final designs and Technical Specifications have not been submitted.

REFERENCES

1. NRC letter (W. Gammill) to all Power Reactor Licensees, dated August 8, 1979.
2. YAECO letter (J. A. Kay) to NRC (D. L. Ziemann), dated February 27, 1980.
3. YAECO letter (J. A. Kay) to NRC (D. L. Ziemann), dated March 11, 1980.
4. Code of Federal Regulations, Title 10, Part 50 (10 CFR 50), General Design Criterion 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."
7. YAECO letter to NRC, Licensee Evert Report 50-29/79-26, dated October 27, 1979.