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# TECHNICAL EVALUATION OF THE ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES FOR THE ARKANSAS NUCLEAR ONE, UNIT 2

James C. Selan

SELECTED ISSUES PROGRAM

(Docket No. 50-368)



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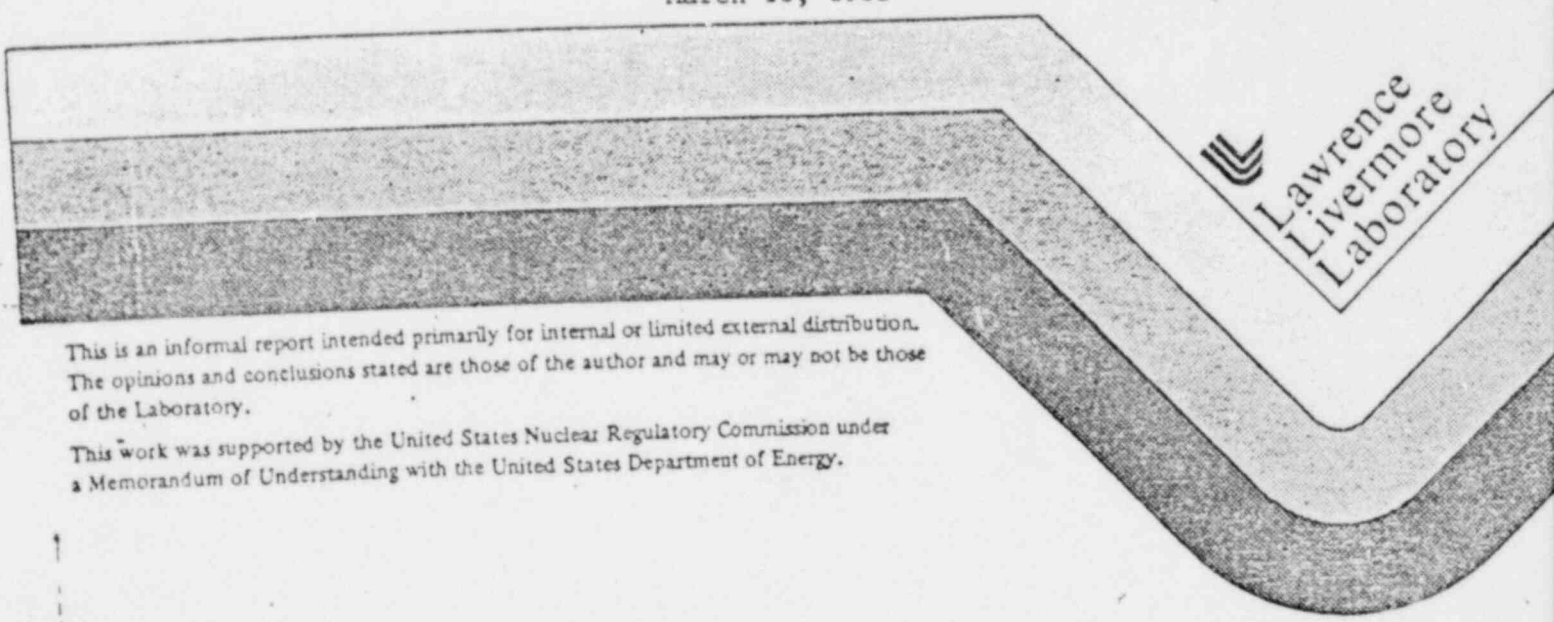




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## ABSTRACT

This report documents the technical evaluation of the adequacy of the station electric distribution system voltages for the Arkansas Nuclear One, Unit 2. 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 analyses submitted demonstrate that the station's electric distribution system supplies adequate voltage to the Class 1E equipment under the worst case conditions analyzed.


## 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 Licensing, by Lawrence Livermore National Laboratory.


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# TECHNICAL EVALUATION OF THE ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES FOR THE ARKANSAS NUCLEAR ONE, UNIT 2

(Docket No. 50-368)

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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 March 30, 1978 [Ref. 2], and March 13, 1979 [Ref. 3], Arkansas Power and Light Company (AP&L), the licensee, submitted their analysis and conclusion regarding the adequacy of the electrical distribution system's voltages at Arkansas Nuclear One, Unit 2.

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.

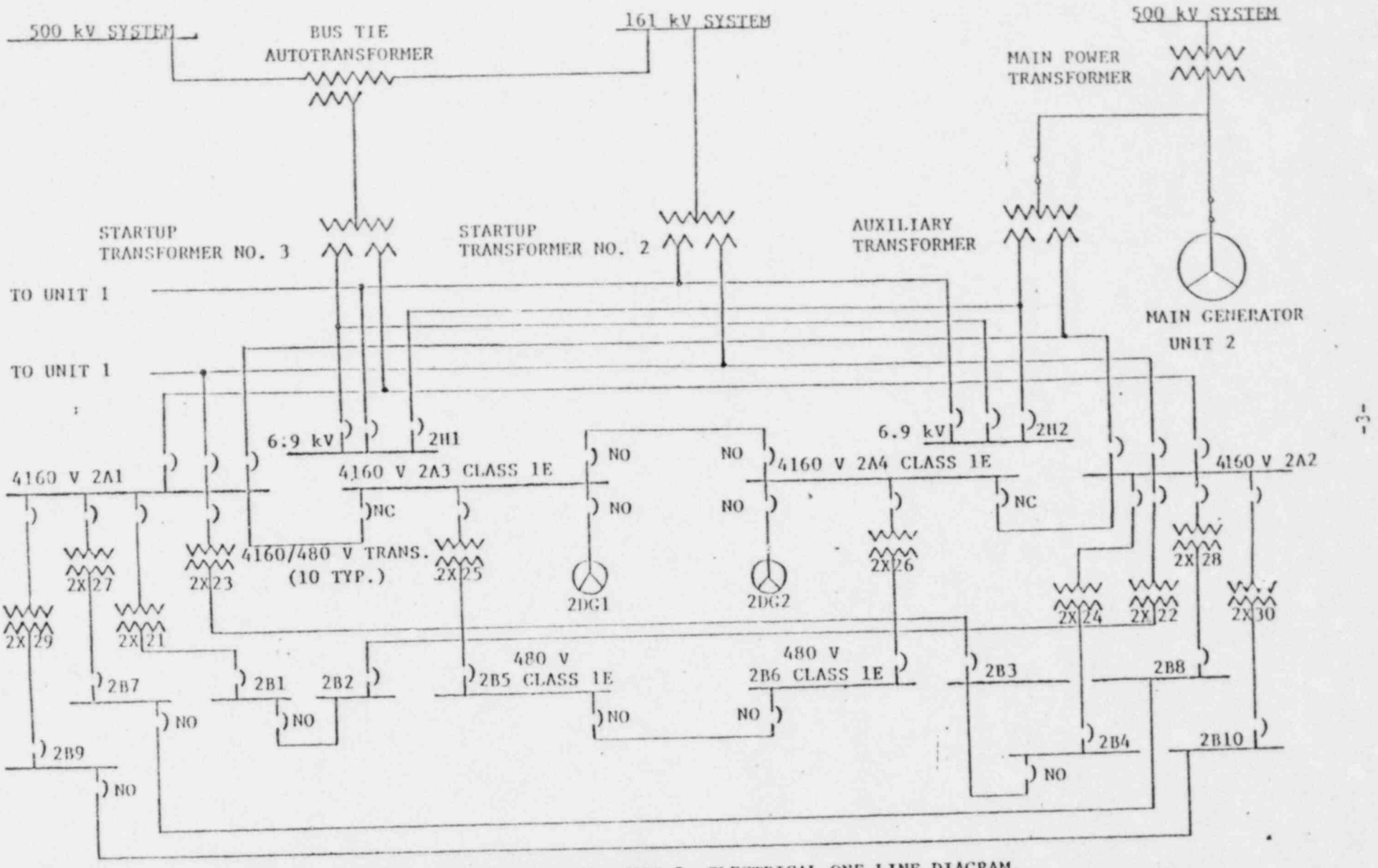


FIGURE 1 - ARKANSAS NUCLEAR ONE, UNIT 2, ELECTRICAL ONE-LINE DIAGRAM

(2) Should the automatic fast transfer fail (with offsite source available) all Class 1E and non-Class 1E loads are then shed with subsequent Class 1E load sequencing with delayed starting of certain Class 1E loads.

(3) Interlocks to be provided to prevent the simultaneous, automatic transfer of unit 1 and unit 2 loads to SUT-2.

(4) Delete automatic slow transfer from the UAT to SUT-3 which will prevent simultaneous starting of station auxiliary loads.

(5) Manually block the operation of the second-level undervoltage protection scheme during the starting of a reactor coolant pump or a circulating water pump.

(6) Install a second-level undervoltage protection scheme on each 480-volt Class 1E bus. The scheme will include a 2-out-of-2 coincident logic with a voltage setpoint of 92% of 460 volts (423 volts $\pm$ 4 volts) with a time delay of 8 seconds $\pm$ 0.8 seconds.

(7) Increase size of control transformers (89 for size 1 starters) to 150 VA as required to insure adequate voltage for contactor pickup.

(8) Add interposing relays to eleven starters (4 for size 1, 1 for size 2, 2 for size 3, and 4 for size 4). These relays are of a lower voltage rating which will ensure adequate operation of the main motor control relays.

(9) Increase cable size to two 480-volt loads.

(10) Replaced existing 92% undervoltage relays with solid state type.

Based on the above modifications, the worst case Class 1E equipment voltages occur under the following conditions:

4.2.1 Overvoltage

Minimum station load (2 MVa on main 4160-volt buses, one service water pump on each 4160-volt Class 1E bus and 0.0 load on one 480-volt Class 1E bus), maximum grid voltage of 1.05 per unit on the 161 kV system, SUT-2 is supplying power to the Class 1E buses.

4.2.2 Undervoltage

LOCA with fast transfer to the SUT-2, (SUT-3 is not available) grid voltage at 1.0 per unit of the 161 kV system, the bus tie autotransformer is out and the 161 kV lines are intact.

These worst case Class 1E equipment voltages are shown in Table 1.

4.3 ANALYSIS VERIFICATION

By telecon dated February 5, 1982 [Ref. 7], the licensee committed to perform a verification test during the 1983 refueling outage (Unit 1).

## 5. EVALUATION

The NRC generic letter [Ref. 1] stated several requirements that the plant must meet in the 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 AP&L shows that the offsite sources in conjunction with the onsite distribution system, have the capacity and capability to automatically start and continue to operate the Class 1E equipment within their design voltage ratings.

(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 shows that the Class 1E equipment's voltage rating is not exceeded for minimum plant load and maximum expected offsite grid voltages.

(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.

The licensee has installed a Class 1E blocking circuit to the second-level of undervoltage protection scheme to prevent spurious tripping caused by the starting of a reactor coolant pump (RCP) or a circulating water pump (CWP). The contacts from the RCP and CWP control switches are connected to energize two Class 1E timers (one on each 480-volt Class 1E bus) upon operation of any of these switches to the closed position.

By making the hardware and circuitry changes outlined in Section 4.2, the offsite sources, in conjunction with the onsite distribution system, have the capacity and capability to automatically start and continuously operate the Class 1E equipment within their design voltage ratings.

(2) Spurious separation from the offsite sources will not occur as the second-level of undervoltage protection system is manually blocked during the starting of a RCP or a CWP.

(3) The electric power system is in conformance with GDC 17 requirements.

(4) The requirement of GDC 5 for multi-unit stations was met by installing an interlock to prevent the simultaneous automatic transfer of both station loads to SUT-2.

(5) Upon receipt of the results from the test verification made during the 1983 refueling outage, a review will be made to determine the acceptance of the analysis results submitted.

Accordingly, I recommend the NRC approve the analyses submitted by Arkansas Power and Light Company for Arkansas Nuclear One, Unit 2, which demonstrates that the station electric distribution system is adequate to supply acceptable voltages to the Class 1E equipment for the worst case conditions analyzed.

## REFERENCES


1. NRC letter (W. Gammill) to all power reactor licensees, dated August 8, 1979.
2. AP&L letter (D. H. Williams) to NRC (J. F. Stolz), dated March 30, 1978.
3. NRC letter (Guy Vissing) summary of meeting with AP&L, dated March 13, 1979.
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."
7. Telecon, L. Young (AP&L) and Guy Vissing (NRC), dated February 5, 1982.
8. Telecon, L. Parscale (AP&L) and J. Selan (LLNL), dated February 19, 1982.