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INTERIM REPORT

2174F

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

LA CROSSE BOILING WATER REACTOR

Docket No. 50-409

December 1980

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ABSTRACT

The Nuclear Regulatory Commission has required all licensees to analyze the electric power system at each nuclear station. 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. This Technical Evaluation Report reviews the submittals for the La Crosse Boiling Water Reactor.

The offsite power sources, in conjunction with the onsite distribution system, have been shown to have sufficient capacity and capability to automatically start as well as continuously operate, all required safety related loads within the equipment rated voltage limits in the event of either an anticipated transient or an accident condition.

FOREWORD

This report is supplied as part of the selected Electrical, Instrumentation, and Control Systems (EICS) issues program being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Operating Reactors, by EG&G Idaho, Inc., Reliability and Statistics Branch.

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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

LA CROSSE BOILING WATER REACTOR

1.0 INTRODUCTION

An event at the Arkansas Nuclear One station on September 16, 1978 is described in NRC IE Information Notice No. 79-04. As a result of this event, station conformance to General Design Criteria (GDC) 17 is being questioned at all nuclear power stations. The NRC, in the generic letter of August 8, 1979, "Adequacy of Station Electric Distribution Systems Voltages,"[1] required each licensee to confirm, by analysis, the adequacy of the voltage at the class 1E loads. This letter included 13 specific guidelines to be followed in determining if the load terminal voltage is adequate to start and continuously operate the class 1E loads.

Dairyland Power Cooperative (DPC) responded to the NRC letter[1] with letters of March 13, 1980,[2] and May 12, 1980.[3] The Safeguards Report (SR) and the DPC response to concerns about the earlier submittals, dated September 17, 1980,[4] and a telephone call in November 1980,[5] complete the information reviewed for this report.

Based on the information supplied by DPC, this report addresses the capacity and capability of the onsite distribution system of the La Crosse Boiling Water Reactor, in conjunction with the offsite power system, to maintain the voltage for the required class 1E equipment within acceptable limits for the worst-case starting and load conditions.

2.0 DESIGN BASIS CRITERIA

The positions applied in determining the acceptability of the offsite voltage conditions in supplying power to the class 1E equipment are derived from the following:

1. General Design Criterion 17 (GDC 17), "Electrical Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50.

2. General Design Criterion 5 (GDC 5), "Sharing of structures, Systems, and Components," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50.

3. General Design Criterion 13 (GDC 13), "Instrumentation and Control," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50.

4. IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations."

5. Staff positions as detailed in a letter sent to the licensee, dated August 8, 1979.[1]

6. ANSI C84.1-1977, "Voltage Ratings for Electric Power Systems and Equipment (60 Hz)."

Six review positions have been established from the NRC analysis guidelines[1] and the above-listed documents. These positions are stated in Section 5.0.

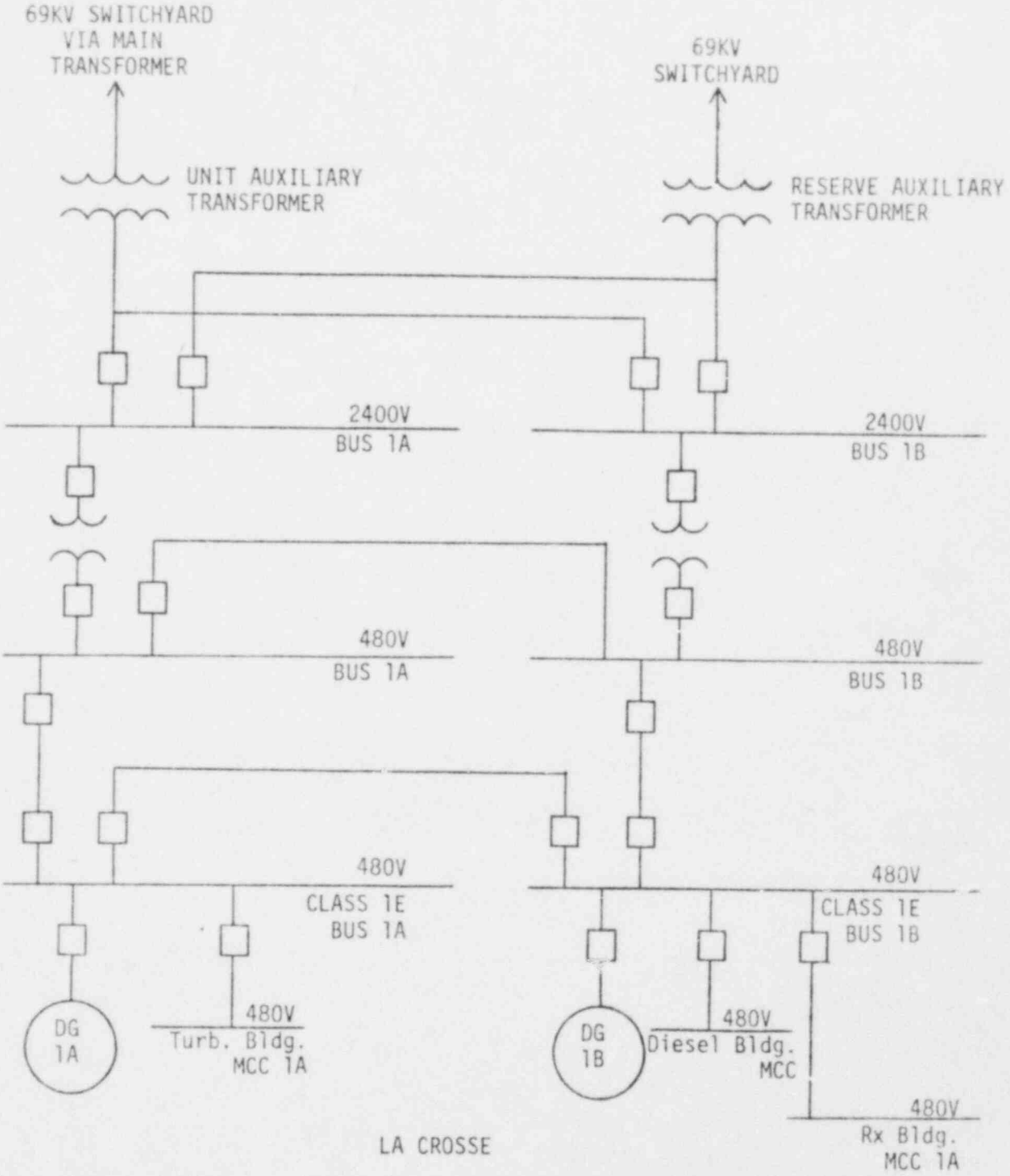
3.0 SYSTEM DESCRIPTION

Figure 1 of this report is a simplified sketch of the unit one-line diagram taken from the Sargent & Lundy report.[3] It shows that 480V class 1E buses 1A and 1B are supplied power by 480V auxiliary buses 1A and 1B, respectively, which, in turn, are powered by 2400V buses 1A and 1B by separate transformers.

There is only one reserve auxiliary transformer to supply offsite power for all buses. The unit auxiliary transformer cannot be used as a reserve source. There is automatic transfer from the unit auxiliary transformer to the reserve auxiliary transformer in the event of a unit trip.

Undervoltage relaying is provided on class 1E buses 1A and 1B[3] to separate the bus from offsite power should the voltage be degraded or lost.

DPC supplied the equipment operating ranges identified in Table 1.[3]



LA CROSSE

UNIT ONE LINE DIAGRAM
FIGURE 1

TABLE 1

CLASS 1E EQUIPMENT VOLTAGE RATINGS AND
ANALYZED WORST CASE TERMINAL VOLTAGES
(% of nominal voltage)

		Maximum		Minimum		
					Analyzed[a]	
Equipment	Condition	Rated	Analyzed	Rated	Steady State	Transient
440V Motors	Start	--	--	80	--	79.8
	Operate	110	107.5	90	92.3	--
460V Starters[b]	Pickup	--	--	60.9	--	76.3
	Dropout	--	--	71.3	--	76.3
	Operate	110	102.8	90	89.4	--
480V Battery Charger[c]		110	98.5	90	84.6	--
440V Battery Charger[d]		110	107.5	90	92.3	--
Other Equipment 120V[e]						

a. The analysis verification performed by DPC shows that the measured voltage is up to 1.1% lower than the corresponding analysis-derived voltage (see Section 4.4). The values here do not allow for this difference.

b. Ratings per telecon.[5]

c. Diesel Plant Battery Charger, ratings per telecon.[5]

d. Reactor Plant and Generator Plant Battery Chargers, ratings per telecon.[5]

e. This equipment is normally supplied by DC-powered inverters or alternate source regulating transformers (110% to 80%).[4]

4.0 ANALYSIS DESCRIPTION

4.1 Design Changes. The voltages shown on Table 1 are based on the following change. The tap setting of the reserve auxiliary transformer will be changed to the 70725V tap "as soon as operational conditions permit."[4]

4.2 Analysis Conditions. DPC has determined by previous steady state voltage measurements that the maximum expected offsite grid voltage is 73.2kV and the minimum is 70.8kV.

DPC has analyzed the offsite source to the onsite distribution system under extremes of load and offsite voltage conditions to determine the terminal voltages at the class 1E equipment. The worst case class 1E equipment terminal voltages occur under the following conditions:

1. The worst loading condition occurs when all loads that operate for power operation and the class 1E LOCA loads are carried by the reserve auxiliary transformer.

2. The worst transient voltage occurs on the class 1E system under the above condition combined with starting a 1500 hp feedwater pump on a 2400V bus.

3. The highest steady state voltage was determined to occur if no loads were operating.

The analyses provided did not account for use of the bus inter-ties between auxiliary 480V bus 1A and 1B or between class 1E 480V bus 1A or 1B.

4.3 Analysis Result. Table 1 shows the projected worst case class 1E equipment terminal voltages identified from the DPC analysis. It shows that, with the exception of the 460V starters and the 480V battery chargers, all class 1E loads are capable of starting and continuously operating for all conditions.

The worst analyzed steady state voltages are low by 0.6% for the 460V starter relays and by 5.4% for the diesel plant battery charger.

4.4 Analysis Verification. The computer analysis was verified[3,4] by measuring the grid and bus voltages, and the actual load of the buses and MCCs while using the reserve auxiliary transformer to supply power. The current in the feeder to each bus and MCC was equal to or greater than 72 ampere. An analysis was done using the measured offsite source voltage and measured loads, and the results compared with the measured bus voltages.

The comparison shows that the class 1E bus calculated voltages are up to 1.09% higher than the measured bus voltages. This verifies the adequacy of the submitted analysis; however, this difference must be accounted for in evaluating the voltage supplied to the class 1E equipment.

5.0 EVALUATION

Six review positions have been established from the NRC analysis guidelines[1] and the documents listed in Section 2.0 of this report. Each review position is stated below followed by an evaluation of the licensee submittals. The evaluations are based on completion of change described in Section 4.1.

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

DPC has shown, by analysis, that, with the exceptions listed in Section 4.3 of this report, the La Crosse Boiling Water Reactor has sufficient capability and capacity for starting and continuously operating the other class 1E loads within the equipment voltage ratings (Table 1).

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

DPC has shown, by analysis, that the voltage ratings of the class 1E equipment will not be exceeded.

Position 3--Loss of offsite power to either of the redundant class 1E distribution systems due to operation of voltage protection relays, must not occur when the offsite power source is within expected voltage limits.

EG&G Idaho, Inc., will verify, in a separate report, that the requirements of this position are satisfied (TAC NO. 10031).

Position 4--The NRC letter[1] requires that test results verify the accuracy of the voltage analyses supplied.

DPC has shown the calculations represent the class 1E buses and loads adequately. However, in correcting the voltage to the equipment noted in Section 4.3, the difference between the measured and the analyzed voltages must be accounted for.

Position 5--No event or condition should result in the simultaneous or consequential loss of both required circuits from the offsite power network to the onsite distribution system (GDC 17).

DPC has not analyzed the La Crosse connections to the offsite power grid. However, the DPC submittals show only one reserve auxiliary transformer with no other available connection to the offsite grid. This does not meet the GDC 17 requirement that two physically-independent circuits be available or that no potential exists for similtaneous or consequential loss of both circuits.

Position 6--As required by GDC 5, each offsite source shared between units in a multi-unit station must be capable of supplying adequate starting and operating voltage for all required class 1E loads with an accident in one unit and an orderly shutdown and cooldown in the remaining units.

This applies to multi-unit plants. It does not apply to the La Crosse single-unit station.

6.0 CONCLUSIONS

The voltage analyses submitted by DPC for the La Crosse Boiling Water Reactor were evaluated in Section 5.0 of this report. With the completion of the change described in Section 4.1:

1. Voltages within the operating limits of the class 1E equipment are not supplied for all projected combinations of plant load and offsite power grid conditions.

   To correct this, I recommend that:

   a. DPC should either provide voltages above the minimum rated continuous limits (90%) of the 460V class 1E starters or demonstrate that these starters and associated control circuits are capable of continuous operation at 88.3%[a] (of 460V).

   b. DPC should either provide voltages above the minimum rated continuous limits (90%) of the 480V diesel plant battery charger or demonstrate that the DC output of this charger is not impaired by continuous operation at 83.5%[a] (of 480V).

2. The test used to verify the analysis shows the analyses to be an accurate representation of the worst case conditions analyzed. However, the verification shows that the actual measured voltages are up to 1.09% lower than the analyzed values.

3. EG&G Idaho, Inc., is performing a separate review of the undervoltage relay protection at the La Crosse station. This will evaluate the relay setpoints and time delays to determine that spurious tripping of the class 1E buses will not occur with normal offsite source voltages.

4. The La Crosse station, built before GDC 17 was approved, does not have a second source of offsite power. This will be considered in the NRC Systematic Evaluation Program integrated assessment of the La Crosse Station

7.0 REFERENCES

1. NRC letter, William Gammill, to All Power Reactor Licensees (Except Humboldt Bay), "Adequacy of Station Electric Distribution Systems Voltage," August 8, 1979.

2. DPC letter, Frank Linder, to U.S. Nuclear Regulatory Commission, "Adequacy of Station Electric Distribution System Voltage for the La Crosse Boiling Water Reactor," LAC-6822, March 13, 1980.

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a. This voltage is the worst analyzed steady state voltage (Table 1) and the error between the analyzed voltage and the measured voltage.

3. DPC letter, Frank Linder, to U.S. Nuclear Regulatory Commission, "Adequacy of Station Electric Distribution System Voltage for the La Crosse Boiling Water Reactor," LAC-6912, May 12, 1980.

4. DPC letter, Frank Linder, to Director of Nuclear Reactor Regulation, U.S. NRC, "Adequacy of Station Electric Distribution System Voltages for the La Crosse Boiling Water Reactor," LAC-7160, September 17, 1980.

5. Telecon; J. Shea, NRC; A. Udy, EG&G Idaho, Inc.; R. Shimshak and W. Nowicki, DPC; November 5 and 6, 1980.