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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

EDWIN I. HATCH NUCLEAR POWER STATION - UNIT NOS. 1 AND 2

Docket Nos. 50-321 and 50-366

April 1981

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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 Edwin I. Hatch Nuclear Power Station.

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 Operating Reactor Issues Program (III)," being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by EG&G Idaho, Inc., Reliability and Statistics Branch.

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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

EDWIN I. HATCH NUCLEAR POWER STATION - UNIT NOS. 1 AND 2

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 voltage is adequate to start and continuously operate the class 1E loads.

Georgia Power Company (GPC) responded with an analysis on December 7, 1979[2]. Besides the original analysis, a letter of July 22, 1977[3], the Final Safety Analysis Report (FSAR), and additional analyses submitted on April 28, 1980[4], complete the information reviewed for this report. Telephone conversations in June 1980[5] clarified portions of the April 28, 1980, submittal. These conversations resulted in additional material submitted on October 9, 1980[6]. MCC contactor ratings were supplied in February 1981.[7]

Based on the information supplied by GPC, this report addresses the capacity and capability of the onsite distribution system of the Edwin I. Hatch Nuclear Power Station, 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.

The following description and evaluation of the Unit 1 design also applies to the onsite distribution system of Unit 2.

2.0 DESIGN BASIS CRITERIA

The positions applied in determining the acceptability of the offsite voltage conditions in supplying power to 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. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"

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]

Six review positions have been established from the NRC analysis guidelines[1] and the above-listed documents. These positions are given in Section 5 of this report.

3.0 SYSTEM DESCRIPTION

Figure 1 is a simplified sketch of the unit one-line diagram taken from Sheets 5-60 and 5-61 of the Reference 2 attachments. The distribution systems for Unit 1 and Unit 2 are identical. The Unit 1 class 1E 4160V buses can be supplied offsite power from the 230kV switchyard by startup transformers 1C or 1D. These buses cannot be connected to the unit auxiliary transformers 1A or 1B.

The two class 1E 600V buses 1C and 1D are each normally connected by 4160/600V transformers to class 1E 4160V buses 1E and 1G, respectively. An identical 4160/600V transformer, connected to class 1E 4160V bus 1F can be connected to either 600V bus 1C or 1D by disconnect links. The FSAR indicates that procedures prevent both 600V buses being connected to the same transformer or being operated in parallel. Class 1E buses 1C and 1D supply essential power to the 120/208V AC instrument power system by two separate transformers. While the instrument power system supplies both essential and non-essential loads, Section 8.3.1.1.4a of the FSAR indicates that failure of a nonessential load will not affect the ability of the system to supply the essential (class 1E) loads.

GPC supplied the equipment operating ranges identified in Table 1 of this report.[4]

4.0 ANALYSIS DESCRIPTION

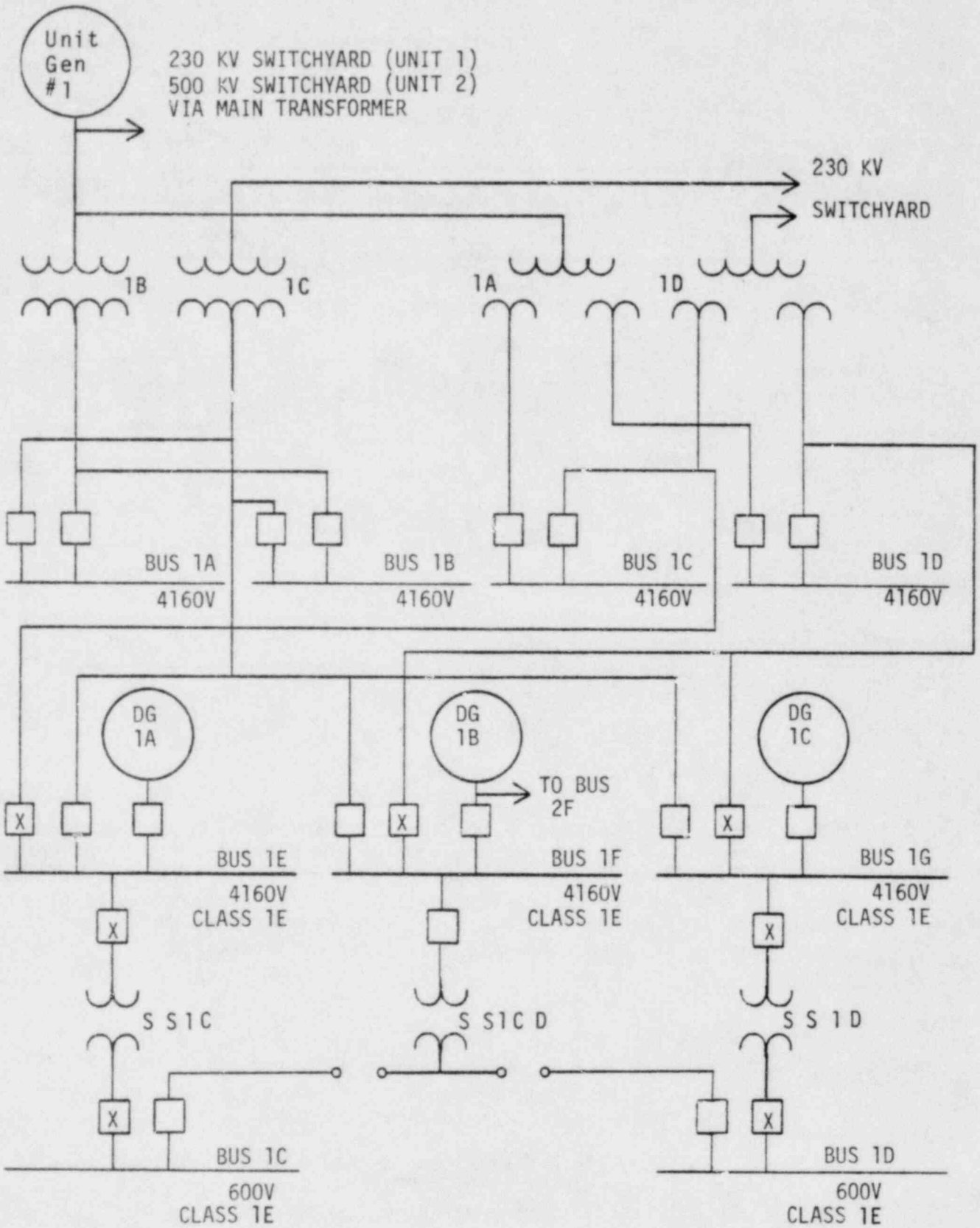
4.1 Design Changes. GPC has changed the tap settings to 0.925 (instead of 1.00)[4,5] on all of the Hatch Station transformers that supply voltages of less than 600V.

4.2 Analysis Conditions. GPC has determined by load-flow and grid contingency studies that the maximum expected offsite grid voltage is 239.2kV (104%) and the minimum is 225.4kV (98%).

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

1. Start-up transformer 1D supplying power to the Unit 1 class 1E buses is the worst-case condition[5] (transformer 2D for Unit 2).

2. With one unit operating and one unit shut down, GPC determined the maximum expected bus and load voltages using the maximum expected grid voltage.



1. UNIT 2 IDENTICAL EXCEPT FOR SHARED D-G SET 1B
2. BREAKERS SHOWN ALIGNED FOR PREFERRED OFFSITE SOURCE TO CLASS 1E BUSES

HATCH STATION
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	
Equipment	Condition	Rated	Analyzed	Rated	Steady State	Transient
4000V Motors	Start	--	--	75/70[a]	--	75.6
	Operate	110	107.8	90	91.4	--
550V Motors	Start	--	--	75/70[a]	--	75.1
	Operate	110	110.0	90	92.0	--
600V MCC contactors (115V coil)	Pickup	--	--	74.8	--	68.9
	Dropout	--	--	54.8	--	68.9
	Operate	108.7	100.8	N/A	85.4	--
208V Motors	Start	--	--	75/70[a]	--	71.2
	Operate	110	108.8	90	90.4	--
208V MCC contactors (115V coil)	Pickup	--	--	74.8	--	72.6
	Dropout	--	--	54.8	--	72.6
	Operate	108.7	108.8	N/A	91.4	--
Low voltage instruments and control circuits[b]						

a. 30-second stall rating.

b. GPC states[4], "The buses may supply instruments and control circuits as required by GDC 13. We do not know of any connected equipment which is not capable of withstanding the analyzed voltages. However, not all manufacturers' responses are yet available. If any equipment is discovered which does not meet the functional requirements in the expected conditions, it will be the subject of a report to the NRC."

3. With one unit in normal shutdown and one unit in a LOCA condition and all buses in service, GPC determined the minimum expected continuous bus and load voltages using the minimum expected grid voltages.

4. With an automatic and simultaneous start of the class 1E loads and a condensate pump, GPC determined the minimum expected transient bus and load voltages with the minimum expected grid voltage.

To make the analyses more conservative, the measured bus loadings were increased by 5% for some of the maximum load analyses. Separate analyses were supplied for both units.

These conditions are the worst of those supplied by the GPC submittals. The voltage levels supplied for analyses using transformer 1C assumed that buses 1A and 1B are not transferred from onsite power (transformer 1B) to transformer 1C on a unit trip.

4.3 Analysis Results. Table 1 shows the projected worst case class 1E equipment terminal voltages. It shows that, in all steady-state cases, the class 1E loads have voltages that are within the equipment rated limits.

The worst case transient voltage condition will last less than 12 seconds before normal operating voltages are restored.[4] At these minimum voltages, no contactors will drop out to cause spurious tripping of loads. Only the 208V motors are not capable of accelerating at the analyzed voltage level; however, they will start as the voltage recovers above 75%. Their operation is at a voltage above the 70% stall voltage (i.e., operation at 70% and full load is acceptable for 30 seconds).

As stated in footnote b of Table 1 of this report, GPC has determined that the 120V AC instruments and control circuits are capable of withstanding the analyzed voltages.

GPC has not supplied a minimum continuous duty rating for their AC powered contactors. As shown in Table 1, this rating needs to be at least 85%. The contactors are shown to have an analyzed voltage of 0.1% higher than the contactor rating for maximum coninuous duty. The rating is lower than NEMA standards call for. The analyzed voltage is not significantly higher than the rating to cause concern.

4.4 Analysis Verification. The load flow analysis was verified[4] by measuring the grid, generator and bus voltages, and the actual load of the buses and selected equipment while Unit 1 was operating and Unit 2 was in a normal shutdown. The analysis model was developed from this measured loading. The model was then used for the GPC analysis. An analysis was done using the measured generator and offsite source voltages, and the results compared with the measured bus voltages. The voltages analyzed for the measured load are within $\pm$0.58% of the duplicate measured bus voltages.

While GPC did not directly verify the analysis for buses at voltages less than 4160V, they did include the load measurements and system impedences in developing the model of the distribution system. In lumping the lower voltage bus loads on the 4160V bus base, the analysis verification does account for the low voltage buses.

5.0 EVALUATION

Six review positions have been established from the NRC analysis guidelines[1] and the documents listed in Section 2 of this report. Each review position is stated below, followed by the evaluation of the licensee submittals.

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 rated equipment voltages.

GPC has shown, by analysis, that except for the AC powered contactors, the Hatch Station has sufficient capability and capacity for starting and continuously operating all class 1E equipment within the equipment voltage ratings.

GPC should determine the ability of the AC contactors to operate continuously, without damage, down to 85% (of 600V).

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 all class 1E equipment without exceeding the rated equipment voltage.

GPC has shown, by analysis, that the voltage ratings of the class 1E equipment are not exceeded.

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

EG&G Idaho, Inc., will verify in a separate report, that the requirements of this position are satisfied (TAC No. 10025).

Position 4--Test results should verify the accuracy of the voltage analyses supplied.

GPC has has supplied the required information[2] which shows the analysis to be an accurate representation of the worst case voltage conditions for the class 1E buses and loads.

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

GPC has analyzed the connections of the Hatch Station to the offsite power grid and has determined[2] that no potential exosts for either a simultaneous or a consequential loss of both circuits from the offsite grid.

Position 6--As required by GDC 5, each offsite source[a] 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.

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a. Section 8.1.1 of IEEE Standard 308 permits the use of a single source of offsite power to be shared between units of a multi-unit station.

Each unit is independently connected to offsite power and no common electrical connection exists between units; therefore, this position does not apply to the Hatch Station.

6.0 CONCLUSIONS

The analyses submitted by GPC for the Edwin I. Hatch Nuclear Power Station were evaluated in Section 5.0 of this report. It was found that:

1. With one exception, voltages within the operating limits of the class 1E equipment are supplied for all projected combinations of plant load and normal offsite power grid conditions; including an accident in one unit and the safe shutdown of the other unit.

   GPC should be required to document, by suitable qualification tests, that their AC contactors can operate continuously down to 85% (of 600V).

2. The test used to verify the analysis shows that the analysis is an accurate representation of the worst case conditions analyzed.

3. GPC has determined that no potential for either a simultaneous or consequential loss of both offsite power sources exists.

EG&G Idaho, Inc., is performing a separate review of the undervoltage relay protection at the Edwin I. Hatch 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.

7.0 REFERENCES

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

2. GPC letter, R. J. Kelly, to U.S. Nuclear Regulatory Commission, "Adequacy of Station Electric Distribution System Voltages," dated December 7, 1979.

3. GPC letter, Chas. F. Whitmer, to U.S. Nuclear Regulatory Commission, "Emergency Power Systems," dated July 22, 1977.

4. GPC letter, W. A. Widner, to U.S. Nuclear Regulatory Commission, "Adequacy of Station Electric Distribution System Voltages," dated April 28, 1980.

5. Telecons, D. Verelli, NRC, R. Baker, GPC, A. Udy, EG&G Idaho, Inc., June 11, 1980, June 13, 1980, June 23, 1980, and June 25, 1980.

6. GPC letter, W. A. Widner, to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information--System Voltage Study," dated October 9, 1980.

7. Telecons, R. Baker, GPC, A. Udy, EG&G Idaho, Inc., December 17 and 23, 1980, January 7 and 26, 1981, and February 13, 1981.