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INTERIM REPORT

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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

CRYSTAL RIVER UNIT 3

Docket No. 50-302

March 1981

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TAC No. 12743

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 Crystal River Unit 3.

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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FIGURE

TABLE

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

CRYSTAL RIVER UNIT 3

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.

Florida Power Corporation (FPC) responded to the NRC letter[1] with a letter of April 3, 1980.[2] The Final Safety Analysis Report and the FPC response to questions regarding Reference 2, dated December 22, 1980,[3] were also reviewed for this report. A telephone call on January 5, 1981,[4] clarified portions of the Reference 3 response.

Based on the information supplied by FPC, this report addresses the capacity and capability of the onsite distribution system of Crystal River Unit 3, 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 is a simplified sketch of the Crystal River Unit 3 (CR3) one-line diagram taken from Ammendment 42 FSAR Figures 8-8 and 8-9. Units 1 and 2 are not nuclear units.

CR3 has three offsite supplies to the class 1E distribution system. They are:

1. Start-up transformer 3 (SUT 3), connected to the 230kV switchyard.

2. The unit auxiliary transformer (UAT), connected to the unit generator by disconnect links and the 500kV switchyard (via a step-up transformer). The removal of the generator-disconnect links allows use of the transformer as an offsite source.

3. Startup transformer 1/2 (SUT 1/2), connected to the 230kV switchyard and associated with fossil-fueled Units 1 and 2.

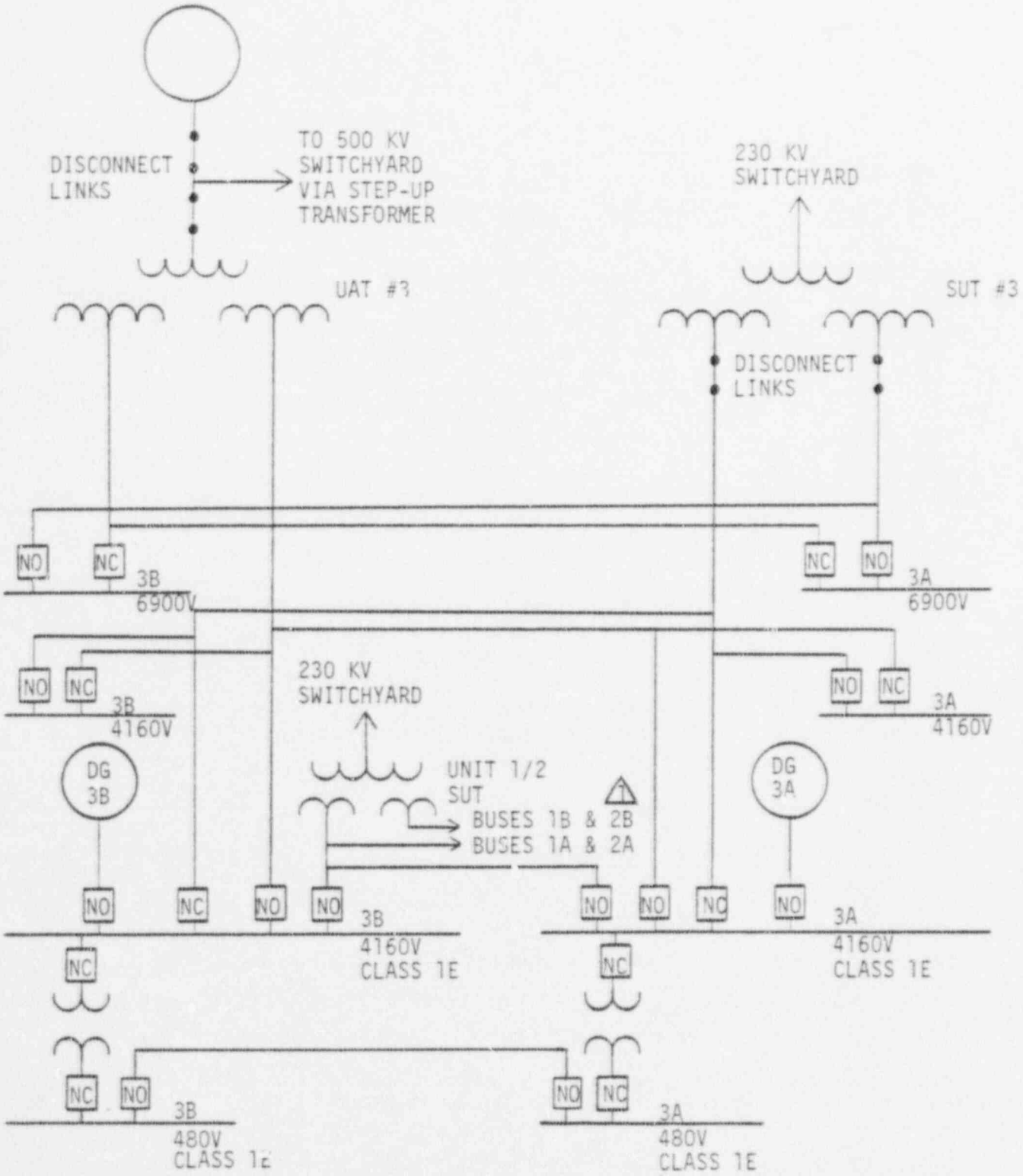
The 480V class 1E buses 3A and 3B are powered by 4160V class 1E buses 3A and 3B, respectively, by individual transformers. Technical Specification 3.8.2.1 prevents the use of the inter-tie between 480V buses 3A and 3B during nuclear operation. 480V class 1E motor-control centers (MCCs) use individual control transformers to power the associated control circuits.

Essential 120V AC power is supplied by non-interruptable power sources that are backed-up by station batteries. Should an inverter be shut down for maintenance, self-regulating transformers (over a ±15% input range) are used.

4.0 ANALYSIS DESCRIPTION

4.1 Design/Operation Changes. The voltages shown on Table 1 are based on the licensee changing the tap setting of the Unit 3 SUT to the 230,000V tap.[3]

4.2 Analysis Conditions. FPC has determined[3] by contingency planning that the maximum expected 230kV offsite grid voltage is 243.6kV and the minimum is 236.4kV. Similarly, the maximum expected 500kV offsite grid voltage is 540kV and the minimum is 475kV.



CRYSTAL RIVER
UNIT 3
ONE LINE DIAGRAM
FIGURE 1

1. THESE 4160V BUSES ARE IN FOSSIL FUELED UNITS 1 AND 2.
2. UNITS 1 AND 2 OUTPUT CONNECTED TO 230 KV SWITCHYARD.

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	--	--	85	--	90.6[a]
	Operate	110	109..	90	92.9[a]	--
460V Motors	Start	--	--	85	--	88.6[a]
	Operate	110	107.7	90	91.0[a]	--
480V Starters	ckup	--	--	80.5[b]	87.2	84.9
	Dropout	--	--	55	87.2	84.9
	Operate	110	103.2	85	87.2	--
Other Equipment[c]						

a. Bus voltage; feeder cable drop negligible.[2]

b. 80.5 is the average value when the coil is hot, 75 is the rated value when the coil is cold.[5]

c. Vital instrumentation and control loads are powered by non-interruptable power sources. The inverter automatically transfers to the DC battery source if the AC voltage is outside of ±10% of nominal. These loads are powered, during inverter maintenance, by self-regulating transformers (±1% regulation over ±15% input).

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

1. The maximum steady-state load terminal voltage occurs using the Unit 3 SUT with the unit refueling load.

2. The minimum steady-state load terminal voltage occurs with the UAT supplying the unit refueling load.

3. The minimum transient load terminal voltage occurs with the conditions of 2 above concurrent with the start of the largest class 1E motor.

4.3 Analysis Result. Table 1 shows the projected worst case class 1E equipment terminal voltages.

4.4 Analysis Verification. FPC has proposed to record bus voltages on the plant auxiliary and class 1E buses while Crystal River Unit 3 is operating.

These recorded voltages would be compared to calculated voltages.

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 the design 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.

FPC has shown, by analysis, that Crystal River Unit 3 has sufficient capability and capacity for starting and continuously operating the 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.

FPC 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. 10017).

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

FPC has proposed a test[3] to verify the accuracy of the submitted analysis. This proposed test is acceptable if the test values can be shown to accurately show feeder and transformer voltage drops. Further, this test should verify that the feeder cable voltage drops are negligible as assumed (see footnote a of Table 1).

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).

FPC has analyzed the connections of Crystal River Unit 3 to the offsite power grid, and has determined that no potential exists for simultaneous or consequential loss of more than one circuit from the offsite grid.

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.

Crystal River is the site of one nuclear unit and two operating fossil-fueled units. With no interconnected nuclear units, position 6 is not applicable to Crystal River Unit 3.

6.0 CONCLUSIONS

The voltage analyses submitted by FPC for Crystal River Unit 3 were evaluated in Section 5.0 of this report. Upon the completion of change described in Section 4.1, it was found that:

1. Voltages within the operating limits of the class 1E equipment are supplied for all projected combinations of plant load and offsite power grid conditions. However, FPC should verify, by test, that the feeder cable voltage drops are negligible.

2. The proposed test to verify the accuracy of the analysis is satisfactory if the test measurements are made with the class 1E buses and MCCs loaded to at least 30% of their full load. If this is not possible, FPC should define on what other basis their voltage measurements accurately account for feeder and transformer voltage drops.

3. FPC has determined that no potential for either a simultanous or a consequential loss of offsite power sources exists.

EG&G Idaho, Inc., is performing a separate review of the undervoltage relay protection at Crystal River Unit 3. 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 Voltage," August 8, 1979.

2. FPC letter, R. M. Bright, to W. Gammill, U.S. NRC, "Adequacy of Station Electric Distribution Systems Voltages," April 3, 1980.

3. FPC letter, P. Y. Baynard, to R. W. Reid, U.S. NRC, "Adequacy of Station Electric Distribution Systems Voltages," December 22, 1980.

4. Telecon, A. C. Udy, EG&G Idaho, Inc., and K. Baker, FPC, January 5, 1981.

5. Allen-Bradley letter, Van Smith & Co., Tampa District Office, to FPC, Att: Gary Castleberry. "Crystal River Unit #3," December 3, 1980.