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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES, DRESDEN STATION - UNIT NOS. 2 AND 3, DOCKET NOS. 50-237 AND 50-249, TAC NOS. 12765 AND 12807

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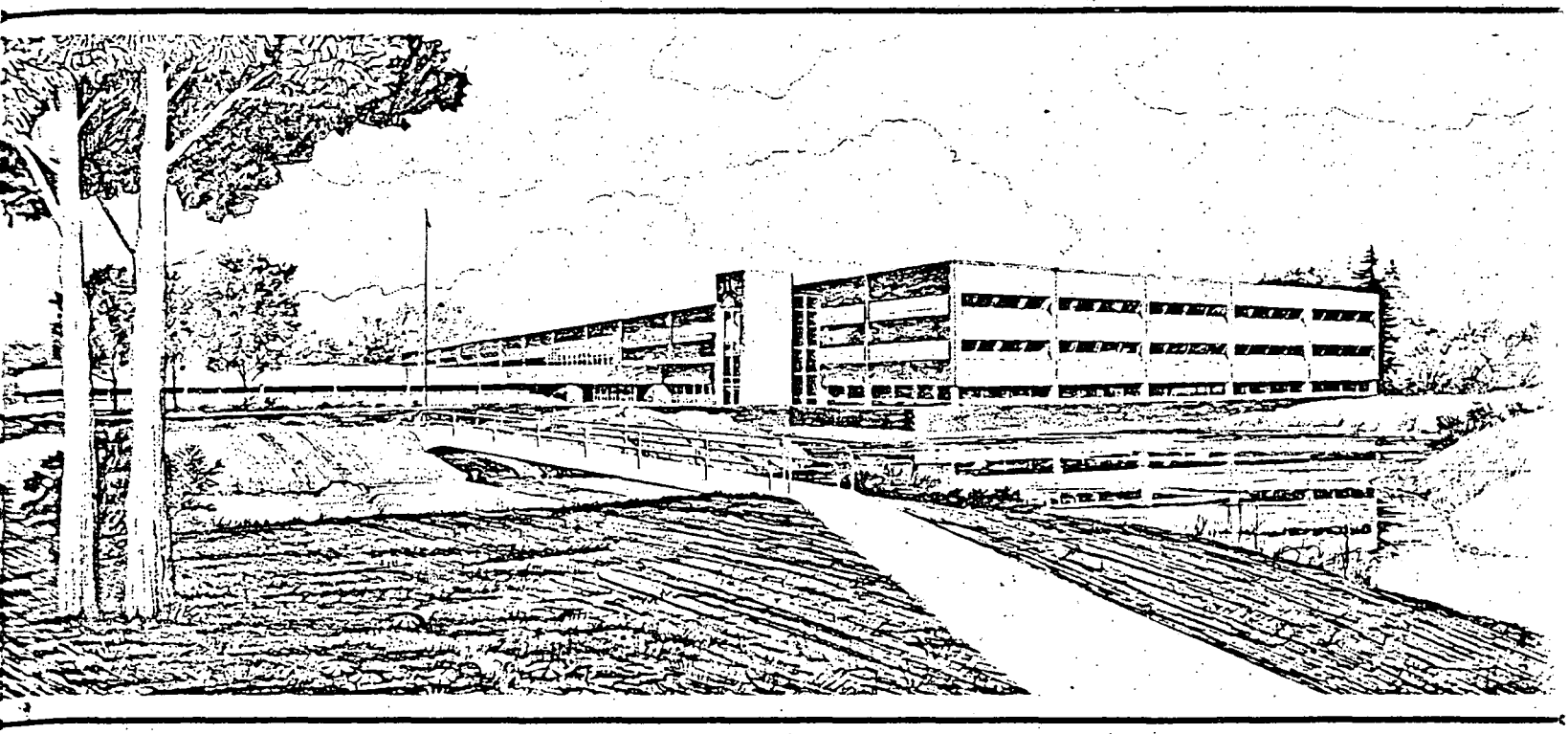

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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

DRESDEN STATION - UNIT NOS. 2 AND 3

Docket Nos. 50-237 and 50-249

August 1981

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TAC Nos. 12765 and 12807

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 (TER) reviews the submittals for the Dresden Station Units 2 and 3. A separate TER reviews the submittals for Unit 1.

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

DRESDEN STATION - UNIT NOS. 2 AND 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 supplied each class 1E load. The letter included 13 specific guidelines to be followed in determining if the voltage is adequate to start and continuously operate the class 1E loads.

Commonwealth Edison Company (CECo) responded to the NRC letter[1], for the Dresden Station, with letters of November 1, 1979[2] (which included a report on this subject, written by Sargent & Lundy) and December 14, 1979[3].

Based on the information supplied by CECo, this report addresses the capacity and capability of the onsite distribution system of Units 2 and 3 of the Dresden 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 steady-state load conditions. The Final Safety Analysis Report (FSAR), additional information submitted on June 30, 1980[4], June 26, 1980[5], and June 11, 1980[6], telephone calls in September 1980[7], and a letter of September 14, 1976[8], complete the information reviewed for this report. An analysis for use of the unit inter-tie between 4160V class 1E buses, provided on August 18, 1980,[9] as supplemented on March 18, 1981[10] and information on the use of unit 480V bus ties submitted on June 22, 1981,[11] were also reviewed for this report.

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. 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.

3.0 SYSTEM DESCRIPTION

The enclosures of references 2 and 4 discuss the onsite distribution system. Figure 1, page 3 of this report, is a simplified sketch of the class 1E electric distribution system taken from the Sargent & Lundy report of reference 2.

The Unit 2 class 1E 4160V buses 23-1 and 24-1 are normally supplied power from auxiliary buses 23 and 24, respectively. These buses are supplied power during emergency conditions by a 138/4.16kV station auxiliary transformer (SAT)[a] (Unit 3 uses a 345/4.16kV SAT). Bus 24-1 can be energized from the other unit[3] by a manual connection to bus 34-1 of Unit 3.[b] The unit technical specifications credit this as the second source of power required by GDC 17. This inter-tie can also be used to power bus 34-1 from bus 24-1 serving as the second source of offsite power for Unit 3. The Unit 2 distribution system is identified in the FSAR as being typical of Unit 3, except for bus and transformer numbers.

Each 4160V class 1E bus supplies power for one 480V class 1E bus via independent 4160/480V transformers. 120V vital buses are normally supplied power by motor-flywheel-generator sets[4]. These will soon be replaced by battery-powered inverters.

CECo supplied the equipment operating ranges identified in Table 1. Station 125V DC buses supply power for portions of the control circuits of the class 1E switchgear.

4.0 ANALYSIS DESCRIPTION

4.1 Analysis Conditions. CECo has used load-flow studies with contingencies in determining that the maximum and the minimum expected switchyard voltages are 142 and 132kV for Unit 2, respectively; 362 and 344kV for

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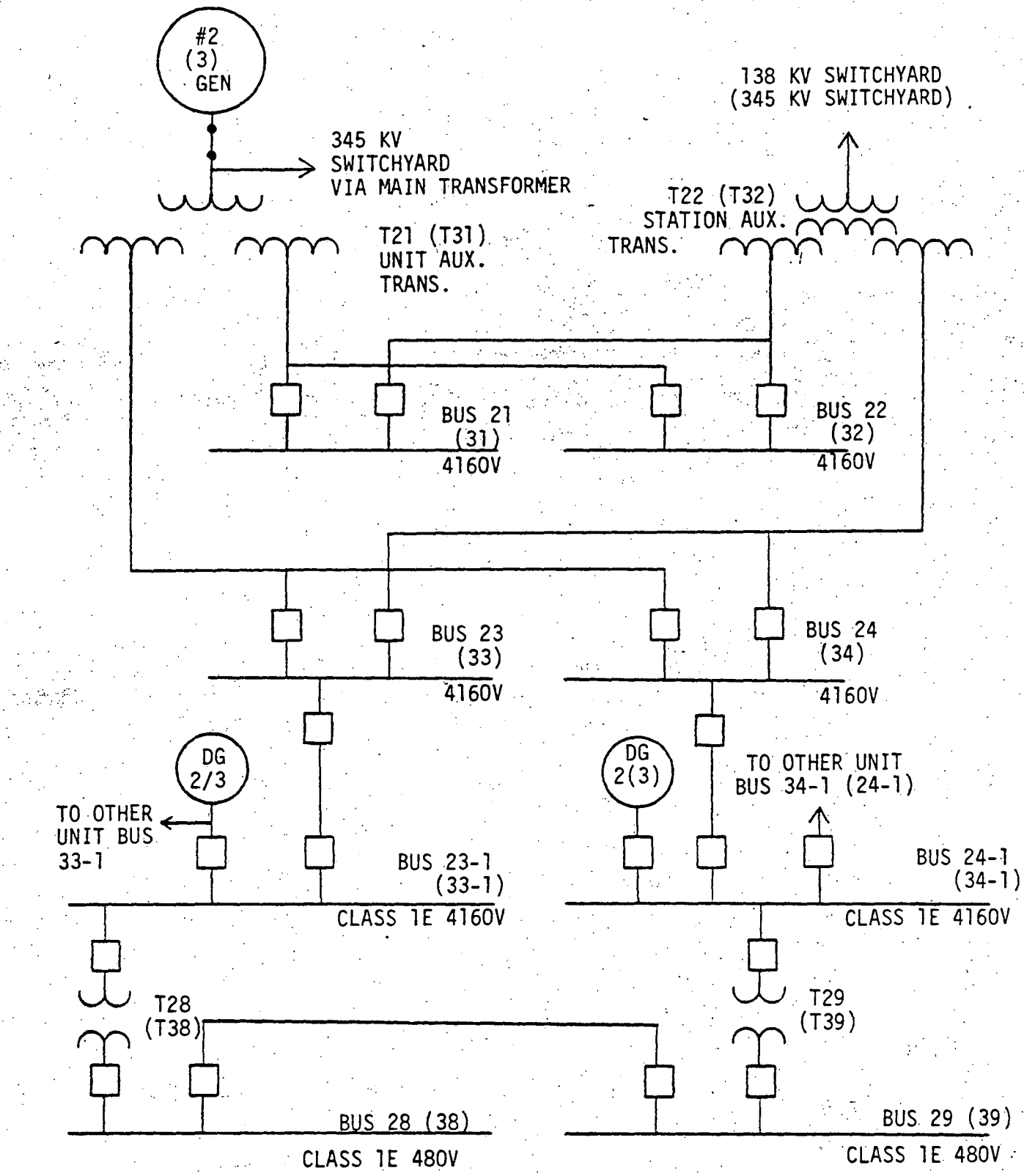
a. CECo also refers to this as a reserve auxiliary transformer (RAT)

b. This connection between Units 2 and 3 is referred to as an inter-tie in this report.



NOTE: UNIT 3 NOMENCLATURE SHOWN IN PARENTHESIS.

DRESDEN STATION

UNIT ONE LINE DIAGRAM
UNITS 2, 3
FIGURE 1

TABLE 1

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

Equipment	Condition	Maximum		Minimum		
					Analyzed	
		Rated	Analyzed	Rated	Steady State	Transient
UNIT 2						
4000V Motors	Start	--	--	75	--	88.5[a]
	Operate	110	109.7	90	94.1[b]	--
460V Motors	Start	--	--	75	--	81.8[a,c]
	Operate	110	108.3	90	90.1[b,c]	--
460V Motors[d]	Start	--	--	75	--	81.9[a]
	Operate	110	e	90	90.4[a,f]	--
480V Starters	Pickup	--	--	85	--	81.5
	Dropout	--	--	70	--	81.5
	Operate	110	103.8	85	88.0[d]	--
UNIT 3						
4000V Motors	Start	--	--	75	--	90.4[a]
	Operate	110	109.0	90	95.9[b]	--
460V Motors	Start	--	--	75	--	85.2[a]
	Operate	110	112.3	90	92.0[b]	--
460V Motors[d]	Start	--	--	75	--	81.7[a]
	Operate	110	e	90	90.3[a]	--
480V Starters	Pickup	--	--	85	--	84.7
	Dropout	--	--	70	--	84.7
	Operate	110	107.6	85	91.2	--
Other Equipment Units 2 and 3[g]						

a. Load terminal voltage supplied by CECo.
b. These values include the worst case (480V) or typical (4160V) feeder cable voltage drop (3.2%, 0.5%, respectively[2]).
c. Lowest voltage on Unit 2 480V buses when either Unit 2 SAT or Unit 3 SAT supplying power to Unit 2.
d. When SAT 2 is supplying the Unit 2 shutdown loads and the Unit 3 LOCA loads.
e. This information not supplied by CECo; however, the voltage is not expected to be higher than when the inter-tie is not in use.
f. The load terminal voltage, when in addition to this worst case analysis, the 480V bus tie is used, is 86.5.[11]
g. 120V vital buses are normally supplied power by motor-flywheel-generator sets[4]. These will soon be replaced by battery-powered inverters.

Unit 3, respectively. The reserve auxiliary transformer was used for the analysis described. CECo determined that:

1. The maximum expected load terminal voltages occur when the switchyard voltage is maximum and there are no unit loads.

2. The minimum expected continuous load terminal voltages, when not sharing an offsite power source, occur when the switchyard voltage is at a minimum and, except those loads automatically shed due to a unit trip, the auxiliary bus loads and the class 1E loads are maximum.

3. The minimum expected transient load terminal voltages occur under the conditions of 2, concurrent with the start of a large load.

4. The minimum continuous and transient load terminal voltages while sharing an offsite power source occurs with the unit SAT supplying the shutdown loads in the unit with offsite power and the accident loads in the unit being supplied by the inter-tie.

4.2 Analysis Results. Table 1 shows the worst case voltage levels identified in the CECo analyses.

The use of the 480V bus tie simultaneously with the unit intertie under the worst case conditions identified in Section 4.1 produce 480V load terminal voltages down to 86.5% of the equipment rated voltages. This will be discussed in a separate EG&G Idaho, Inc. report (TAC Nos. 10019 and 10021).

4.3 Analysis Verification. The computer analysis has not been verified at the Dresden station. CECo states[4] that the same computer program was verified for the Zion station[3] and Quad Cities Unit 2[6] by measuring the grid and bus voltages and the actual load of the buses and selected equipment while these units were shutdown. An analysis was done using the measured offsite source voltage, and the results compared with the measured bus voltages.

The comparison for each of the three units shows that the class 1E bus calculated voltages are within close correlation to the measured bus voltages. This verifies the adequacy of the submitted analyses for those units. Since the station-dependent data used (transformer taps and impedences) were field verified as correct,[4] the verification of the accuracy of the other units can be extended as verifying the analysis for Dresden Units 2 and 3.

5.0 EVALUATION

Six review positions have been established from the NRC analysis guidelines[1] and the documents listed in Section 2. 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 combiniation must be capable of starting and of continuously operating all class 1E equipment within the rated equipment voltages.

A brief condition exists, when starting a large non-class 1E load when all class 1E loads are operating, that would prevent class 1E contactor pickup if a 480V MCC load were stopped and then restarted concurrent with a large non-class 1E load, until the voltage recovers. It will not cause contactor dropout or spurious shedding of any loads.

CECo has shown that the minimum expected continuous and transient class 1E load terminal voltages are within the rated capability of the class 1E equipment.

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.

As Table 1 shows, the Unit 3 480V loads were analyzed to have a potential 112.3% for a no-load conditions. CECo concluded that these loads would not be subjected to unacceptable overvoltages because the analysis was done for a no-load condition and, when a load is added, voltage drops in the supply transformers and feeder cables reduces the voltage to "very close to 110%."[3]

CECo has shown that, with the grid voltage at the maximum expected value, the voltage ratings of the class 1E equipment, when connected, 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 Nos. 10019 and 10021).

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

CECo has tested, in similar nuclear units, the accuracy of the voltage analysis methods, and field verified for Dresden Unit nos. 2 and 3, the station dependent data. Thus, CECo has verified the accuracy of their voltage analysis for Dresden Unit nos. 2 and 3.

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).

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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.

CECo has analyzed the connections of the Dresden Station to the offsite power grid, and has determined that no potential exists for the simultaneous or consequential loss of both required circuits to the offsite power source.[2]

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.

The unit transformers are independently connected to the offsite power grid, but the station has the capability to interconnect certain class 1E buses between Units 2 and 3 (but not Dresden Unit 1). CECo has shown that the use of the inter-tie between Dresden Units 2 and 3 will supply adequate operating voltages to the class 1E buses when the buses are connected together.

6.0 CONCLUSIONS

The analyses submitted by CECo for this review were evaluated as stated in Section 5.0 of this report. It was found that:

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

2. CECo had determined that no potential for either a simultaneous or consequential loss of both offsite power sources exists.

3. The test used to verify the analysis shows the analysis to be an accurate representation of the worst case conditions analyzed.

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

7. 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. CECo letter, Robert F. Janecek to William Gammill, "Adequancy of Station Electric Distribution System Voltages", November 1, 1979.

3. CECo letter, Robert F. Janecek to William Gammill, "Adequacy of Station Electric Distribution System Voltages", December 14, 1979.

4. CECo letter, Robert F. Janecek to T. A. Ippolito, U. S. NRC, "Adequacy of Station Electric Distribution System Voltages," June 30, 1980.

5. CECo letter, Robert F. Janecek, to Darrell G. Eisenhut, U.S. NRC, "Second Level of Undervoltage Protection for 4kV Onsite Emergency Power Systems," June 26, 1980.

6. CECo letter, Robert F. Janecek, to William Gammill, NRC, "Adequacy of Station Electric Distribution System Voltages," June 11, 1980.

7. Telecon, Hal Stolt, CECo and other CECo personnel and Alan Udy, EG&G Idaho, Inc., September 11 and 22, 1980.

8. CECo letter, G. A. Abrell, to Karl R. Goller, NRC, "Information Concerning System Voltage Conditions," September 14, 1976.

9. CECo letter, Robert F. Janecek, to Darrell G. Eisenhut, NRC, "Additional Response concerning Adequacy of Station Electric Distribution System Voltages," August 18, 1980.

10. CECo letter, Robert F. Janecek to T. A. Ippolito, NRC, "Adequacy of Station Electrical Distribution System Voltages," March 18, 1981.

11. CECo letter, T. J. Rausch to T. A. Ippolito, NRC, "Response to Request for Additional Information Concerning Adequacy of Station Electric Distribution System Voltages," June 22, 1981.