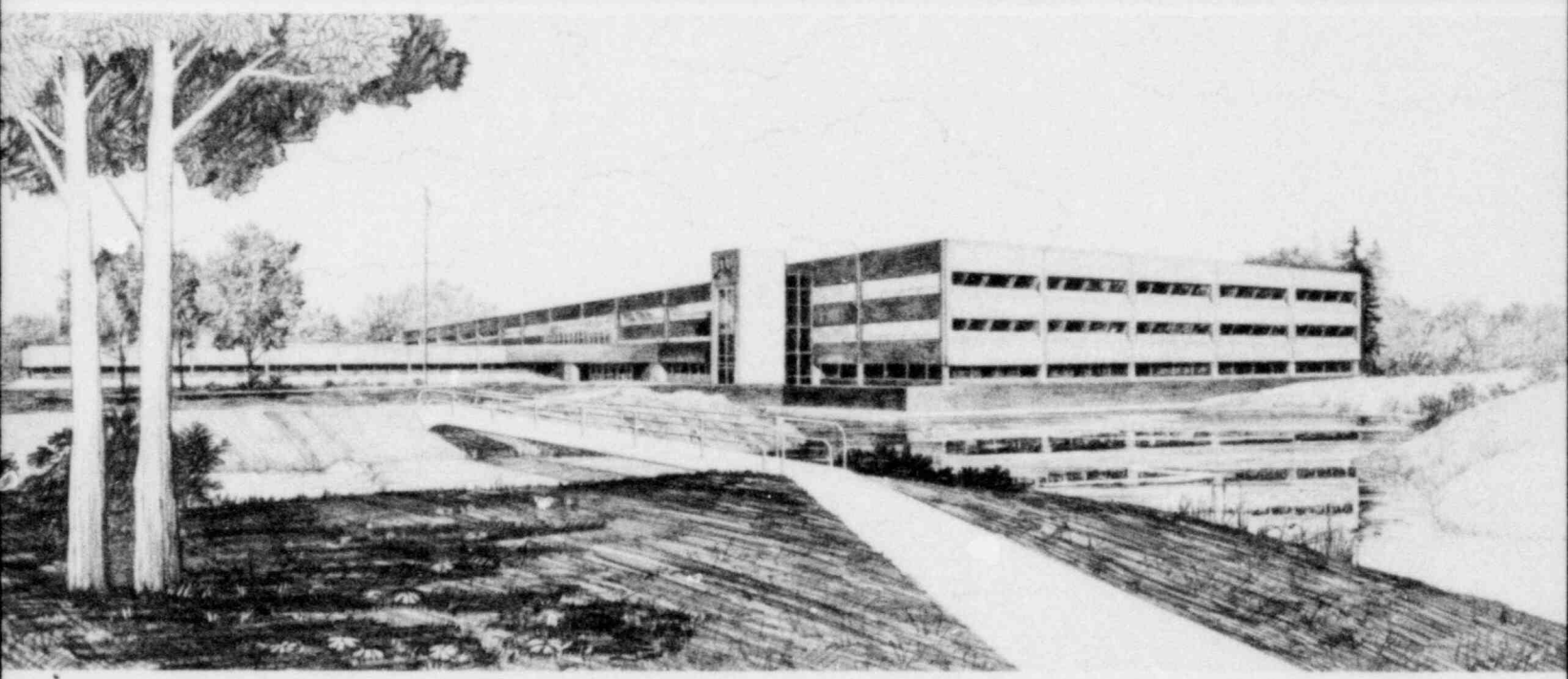
EGG-EA-5305

December 1980

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES, ZION STATION, UNIT 1, DOCKET NO. 50-295, TAC NO. 13007

A. C. Udy

U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory



This is an informal report intended for use as a preliminary or working document

Prepared for the
U.S. Nuclear Regulatory Commission
Under DOE Contract No. DE-AC07-76ID01570
FIN No. A6256

EG&G Idaho

EG&G Idaho, Inc.

FORM EG&G 398
(Rev. 11-79)

INTERIM REPORT

Accession No. _____

Report No. EGG-EA-5305

Contract Program or Project Title:

Electrical, Instrumentation and Control System Support

Subject of this Document:

Adequacy of Station Electric Distribution System Voltages, Zion Station, Unit 1, Docket No. 50-295, TAC No. 13007

Type of Document:

Informal Report

Author(s):

A. C. Udy

Date of Document:

December 1980

Responsible NRC Individual and NRC Office or Division:

Paul C. Shemanski, Division of Licensing

This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U.S. Nuclear Regulatory Commission
Washington, D.C.
Under DOE Contract No. DE-AC07-76ID01570
NRC FIN No. A6256

INTERIM REPORT

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

ZION STATION - UNIT NO. 1

Docket Nos. 50-295

December 1980

A. C. Udy
Reliability and Statistics Branch
Engineering Analysis Division
EG&G Idaho, Inc.

TAC No. 13007

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 Zion Station.

With one exception, 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.

The U.S. Nuclear Regulatory Commission funded the work under the authorization entitled, "Electrical, Instrumentation, and Control System Support," B&R 20 19 01 03, FIN A6256.

CONTENTS

FIGURE

TABLE

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

ZION STATION - UNIT NO. 1

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 Zion 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 the Zion 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 conditions. The Final Safety Analysis Report (FSAR), additional analyses submitted on June 23, 1980,[4] and August 18, 1980,[5] telephone calls in July and August 1980,[6] and a letter of September 14, 1976,[7] complete the information 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

Section 8 of the Zion Station FSAR and the enclosures of references 2, 3, and 4 discuss the onsite distribution system. Figure 1, page 3 of this report, is a simplified sketch of the unit one-line diagram taken from the Sargent & Lundy report of reference 2.

Figure 1 shows that, for Unit 1, the class 1E 4160V buses 147, 148, and 149 are normally supplied power from auxiliary buses 142, 143, and 144, respectively. These three buses are connected via two station auxiliary transformer (SAT) secondary windings (a single transformer) to the 345kV switchyard. The Unit 2 distribution system is identical except for bus and transformer numbers.

The CECo analysis shows that one of the three class 1E 4160V buses can be energized from the other unit SAT Z winding via an inter-tie connection that serves as a reserve source. The various breakers feeding each bus are interlocked so that no two sources can be connected together.[5] However, no interlocks exist to prevent two or three class 1E 4160V buses from being energized at the same time by the inter-tie connection.

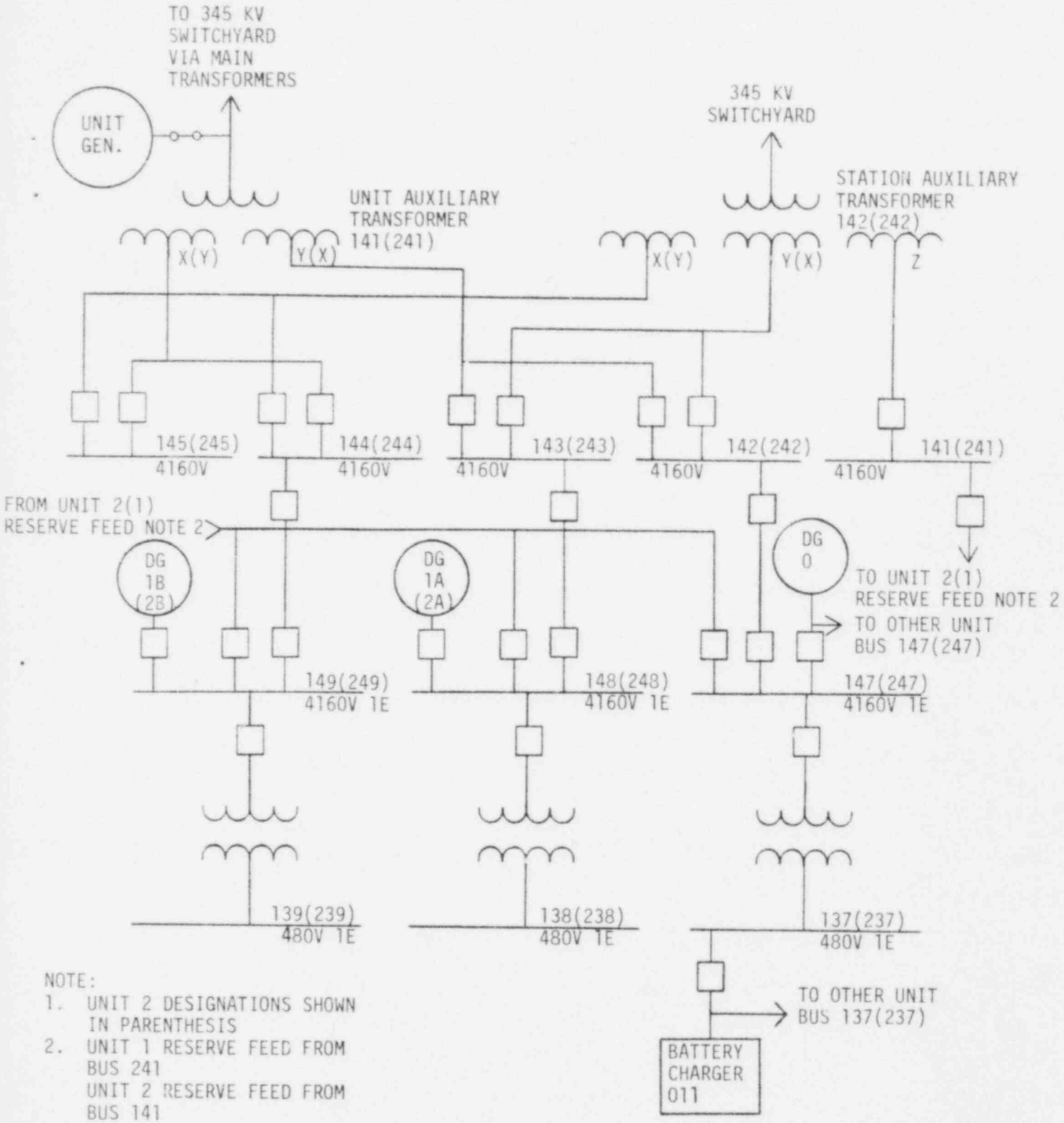
Each 4160V class 1E bus supplies power for one 480V class 1E bus via independent 4160/480V transformers. 120V vital buses are normally supplied power by four DC powered inverters[4]. Technical Specifications limit reactor operation to 14 days should one inverter be out of service. Should a second inverter become inoperable during this 14-day period, immediate shutdown is required.

CECo supplied the equipment operating ranges identified in Table 1. Station 125V DC buses supply power for all class 1E switchgear, except for 480V MCC circuits which use individual control power transformers and contactors.

4.0 ANALYSIS DESCRIPTION

4.1 Design Changes. CECo submitted analysis[3,4,5] based on the following proposed change. CECo will install automatic load shedding when both low voltage (440V) and a unit trip exist concurrently. The loads to be shed are two condensate booster pumps and one circulating water pump. The discussion in this report and the values in Table 1 are on the basis that this change has been done.

4.2 Analysis Conditions. CECo has used load-flow studies in determining that the maximum 345kV switchyard voltage is 354kV and the minimum voltage is 343kV. The station auxiliary transformer was used for the analyses described. CECo determined that:



NOTE:
1. UNIT 2 DESIGNATIONS SHOWN IN PARENTHESIS
2. UNIT 1 RESERVE FEED FROM BUS 241
   UNIT 2 RESERVE FEED FROM BUS 141

ZION STATION
UNIT ONE LINE DIAGRAM
FIGURE 1

TABLE 1

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

Equipment	Nominal Voltage (100%)	Maximum		Minimum		
		Rated	Analyzed	Rated	Analyzed[a]	
					Steady state	Transient[b]
Motors	4000V					
Start		--	--	75	--	80.6[c]
Operate		110	109.5	90	97.4[d]	--
	460V					
Start		--	--	75	--	69.1[c]
Operate		110	112.6	90	91.3[d]	--
Starters	480V					
Pickup		--	--	85[7]	--	69.1
Dropout		--	--	70[7]	--	69.1
Operate		110	107.9	85	87.5	--
Other Equipment[e]						

a. Includes analysis for unit inter-tie.

b. This is the worst case transient condition identified by CECo that administrative procedures do not prohibit.

c. Load terminal voltage supplied by CECo.

d. These values include the worst case (480V) or typical (4160V) feeder cable voltage drop (3.0% and 0.5%, respectively[2]).

e. 120V vital buses are normally powered by DC inverters.[4]

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

2. The minimum expected continuous load terminal voltage occurs when the switchyard voltage is minimum and all buses are in service (except for loads shed due to unit trip).

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

4. The minimum continuous and transient voltages while using the unit inter-tie occur with a shutdown in the unit with offsite power and an accident in the unit being supplied by the inter-tie.

4.3 Analysis Results. Table 1 shows the worst case voltage levels identified in the CECo analyses. As can be seen from Table 1, the 4kV loads are operated within allowable voltage limits.

Table 1 also shows that CECo has analyzed a potential voltage dip that could drop out those 460V loads that are operated by AC contactors. CECo has not taken corrective measures.

4.4 Analysis Verification. The computer analysis was verified[3] by measuring, at both units, the grid and bus voltages, and the actual load of the buses and selected load terminal voltages while both units were shut down. Since the bus loads were light, a digital voltmeter (±0.01% accuracy) was used to be sure that voltage drops could be measured. Analyses were done using the measured offsite source voltage, and the results compared with the measured bus voltages.

The comparison shows that the class 1E bus calculated voltages are within +0.54 and -0.65% of the measured bus voltages for both units. This close correlation verifies the adequacy of the analysis submitted.

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.

CECo has shown that the minimum expected continuous class 1E bus voltages are within the rated capability of the class 1E equipment. CECo has not demonstrated the capability of the safety related loads to operate

under all postulated transient voltage conditions; however, the loads shed when the contactor drops out would start again as the voltage recovers.[6]

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.

CECo has shown, by analysis, that the voltage ratings of the class 1E equipment, when connected, will not be 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. 10061 and 10062).

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

CECo has shown the calculations to be an accurate representation of the class 1E buses and loads.

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).

CECo has analyzed the connections of the Zion Station to the offsite power grid, and has determined that no potential exists for the simultaneous or 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.

The unit transformers are connected independently to the offsite power grid. CECo has shown that the Z winding of one SAT supplies adequate starting and operating voltages to one of the three 4160V class 1E buses of the other unit if the administrative procedure prohibiting the start of the electric steam generator feedwater pump is followed. CECo has not shown that more than one bus can be powered by this inter-tie.

---

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.

6.0 CONCLUSIONS

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

1. CECo has not provided voltage analysis for the Z winding of one unit SAT supplying power to more than one class 1E power system of the other unit, CECo should put limiting conditions of operation in the Zion Technical Specifications to prevent the inter-tie from powering more than a single 600V class 1E bus. Alternatively, CECo could provide appropriate interlocking.

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

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

3. CECo 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 Zion Station. This will evaluate the relay setpoints and time delays to determine that spurious tripping of the safety related loads 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. 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, William F. Naughton to Harold R. Denton, U. S. NRC, "Response to Questions on Adequacy of Station Electric Distribution System Voltages," June 23, 1980.

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

6. Telecon, Hal Stolt, CECo and other CECo personnel and Alan Udy, EG&G Idaho, Inc., July 28, 30, and 31, August 8 and 11, 13, and September 25, 1980.

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

8. 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.