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EGG-EA-5307

December 1980

TECHNICAL EVALUATION REPORT, ADEQUACY OF STATION ELECTRICAL DISTRIBUTION SYSTEMS VOLTAGES, INDIAN POINT NUCLEAR STATION, UNIT 2, DOCKET NO. 50-247

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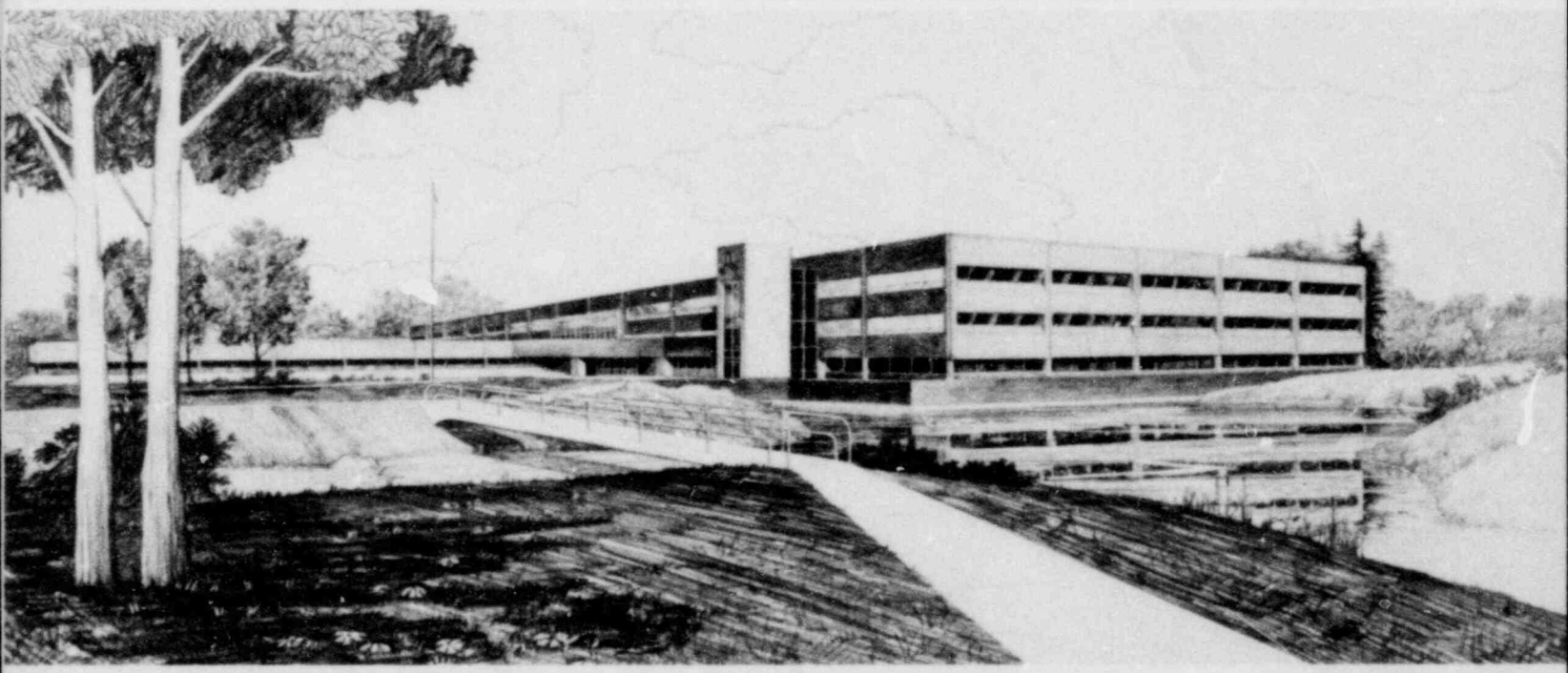
PRELIMINARY

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



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Assistance Report

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

EG&G Idaho

8101190711

EG&G Idaho, Inc.

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

INTERIM REPORT

Accession No. _____

Report No. EGG-EA-5307

Contract Program or Project Title:

Electrical, Instrumentation and Control System Support

Subject of this Document:

Adequacy of Station Electrical Distribution System Voltages, Indian Point Nuclear Station, Unit 2

Type of Document:

Technical Evaluation Report

Author(s):

D. A. Weber

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.

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

INTERIM REPORT

2235F

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

INDIAN POINT NUCLEAR POWER STATION--UNIT NO. 2

Docket No. 50-247

December 1980

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Draft 12-8-80
TAC Nos. 12992

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 Indian Point 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 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 No. A6256.

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FIGURE

TABLE

ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

INDIAN POINT NUCLEAR STATION--UNIT NO. 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 load terminal voltage is adequate to start and continuously operate the class 1F loads.

In response to the NRC generic letter, Consolidated Edison Company of New York (Con Ed) submitted a voltage analysis on April 28, 1980.[3] This review is based on this submittal, Con Ed's submittals of October 16, 1979,[2] August 1, 1980,[4], and the Final Safety Analysis Reports (FSARs) for Units 2 and 3.

Based on the information supplied by Con Ed, this report addresses the capacity and capability of the onsite distribution system of the Indian Point Nuclear Power Station Unit 2, 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

A single-line diagram of the AC electrical system at Indian Point 2 is shown in Figure 1.

During normal operation, the 6.9 kV buses 1, 2, 3, and 4 and the 480V IE buses 2A and 3A are supplied from the 22kV Unit Auxiliary Transformer (UAT). The 6.9kV buses 5 and 6 and the 480V buses 5A and 6A are supplied from the 138kV normal offsite source via the Station Auxiliary Transformer (SAT). The 6.9kV and 480V buses normally supplied from the UAT will automatically fast transfer to the SAT should the reactor or turbine trip.

In addition to the 138kV normal offsite source, the loads on the 6.9kV buses 5 and 6 and IE buses 5A and 6A can be supplied from the 138/13.8kV Buchanan tie via the 13.8/6.9kV transformer. These buses can also be supplied from a 13.8kV gas turbine generator via the 13.8/6.9kV transformer. This transformer can also supply the Unit 3 loads via a Unit 2/Unit 3 tie breaker. This also holds true for the Unit 3 13.8/6.9kV transformer.

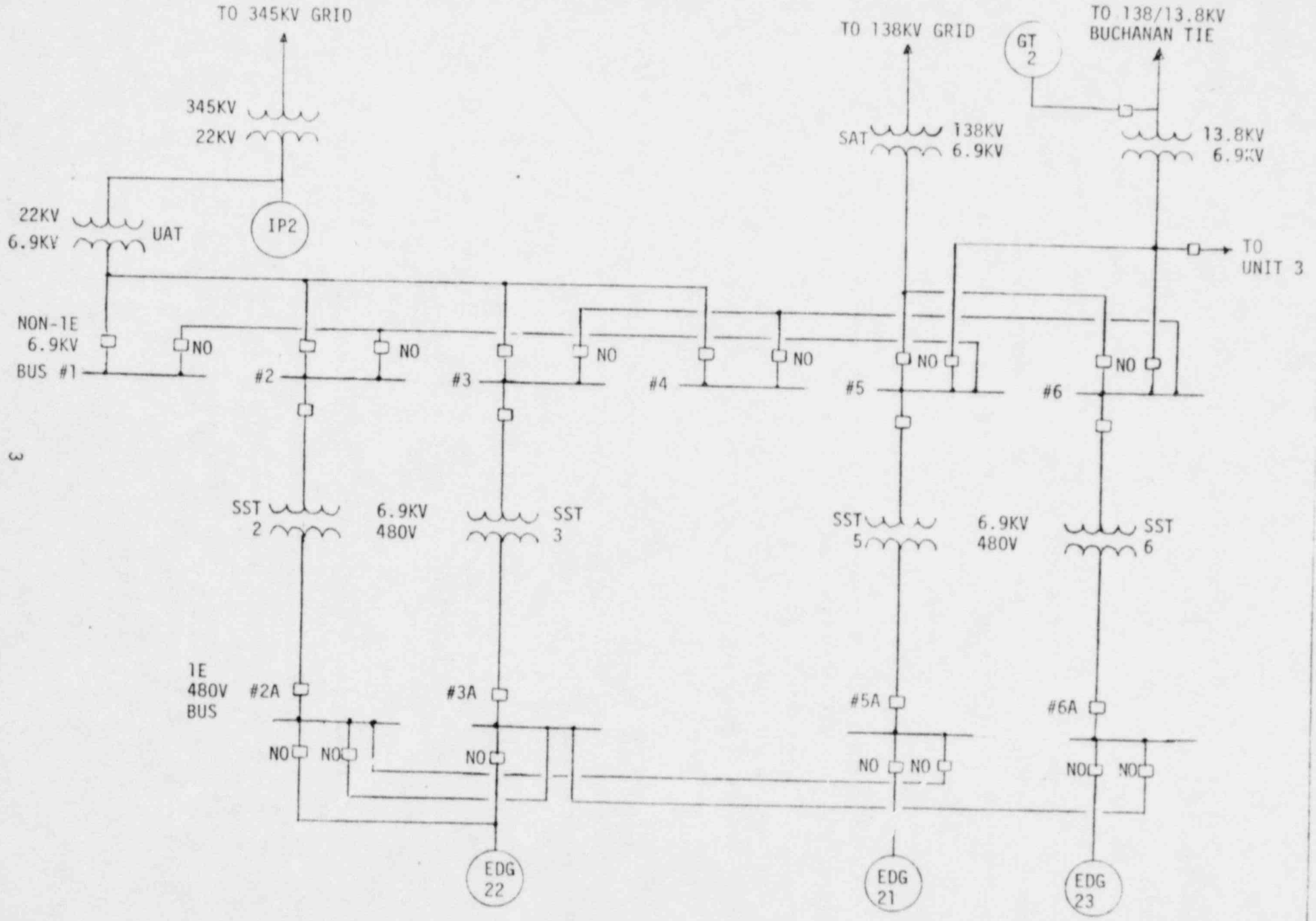

FIGURE 1. INDIAN POINT UNIT 2 ONE-LINE

The Technical Specifications require that the IE 480V bus inter-ties must be open when Unit 2 is operating.

The IE 480V buses supply two 120V AC battery chargers and four instrumentation buses in addition to their normal load. The two battery chargers maintain voltage on the two 125V DC battery systems in addition to supplying the normal DC loads. Two of the instrumentation buses are energized through constant voltage transformers and the other through station inter-ties.

4.0 ANALYSIS DESCRIPTION

4.1 Design/Operation Changes. The voltages shown in Table 1 are based on the following licensee proposed changes:

When the 13.8/6.9kV transformer is supplying the 6.9kV buses 5 and 6, the fast transfer of buses 1, 2, 3, and 4 will be prevented by interlocks. The modification will be completed during the 1980-81 refueling outage.[4]

4.2 Analysis Conditions. Con Ed has determined by load flow analysis that the maximum expected offsite grid voltage is 145.7kV for the 138kV system and the minimum 13.7kV for the 13.8kV system.

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

1. The maximum voltage occurs when the offsite 138kV grid is at its maximum expected value of 145.7kV and no load on the station buses.

2. The minimum voltage occurs when the offsite 13.8kV system is at its minimum expected value of 13.7kV; the 13.8/6.9kV transformer is supplying 6.9kV buses 2, 3, 5, and 6, and 480V buses 2A, 3A, 5A, and 6A; and all IE loads are in operation.

TABLE 1

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

		Maximum[a]		Minimum[b]		
					Analyzed	
Equipment	Condition	Rated	Analyzed	Rated	Steady State	Transient[c]
440V Motors	Start	--	--	80	80.45	--
	Operate	110	112[d]	90	92.7	--
460V Motors	Start	--	--	80	87.3	--
	Operate	110	107	90	94.1	--
480V Starters	Pickup	--	--	80	--	--
	Dropout	--	--	70	--	--
	Operate	110	103	90	90.2	--
Other Equipment[e]						

a. 138kV source: maximum analyzed = 1.056%.

b. 13.8kV source: minimum analyzed = 0.9927%.

c. Licensee did not provide transient values but stated that they analyzed the start of the 900 hp Circulating Water Pumps and indicated that "the voltages at all equipment would remain above the minimum required voltage" for the duration of the start.[4]

d. As load is applied, the voltage will decay to acceptable levels.

e. Equipment at the 480V level and below is "unaffected by any offsite occurrences."[4]

3. The worst case transient voltages occur when starting the 900 hp Circulating Water Pump and the 13.8kV system is at its minimum value and supplying maximum loads.

4.3 Analysis Result. Table 1 shows the projected worst case class 1E equipment terminal voltages based on the modification in Section 4.1.

4.4 Analysis Verification. Con Ed has indicated that test equipment will be installed on all class 1E 480V load center buses and MCC 26A and B

during the 1980-1981 refueling outage to measure current and voltage when the plant is in operation. The values obtained will be used to calculate voltages by the same technique as used in the analysis and the results would be compared with the actual voltages. Review of the test results, when submitted, will determine the validity of the analysis.[4]

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 changes 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.

Con Ed has shown, by analysis, that the 138kV and 13.8kV systems have sufficient capability and capacity for starting and continuously operating the class 1E loads within the equipment voltage ratings (Table 1).

However, Con Ed has not provided analysis showing the capability and capacity of the 13.8kV system to supply all Unit 2 and Unit 3 loads through a Unit 2/Unit 3 tie breaker. There are no interlocks or limiting conditions of operation included in the plant Technical Specifications that prevent the use of the tie during operation of either plant.

Additionally, the Technical Specifications contain no limiting conditions to prevent the use of one or more gas turbine generators (GTs) from supplying all required IE 480V loads via the 13.8/6.9kV transformer. Con Ed has not provided an analysis to demonstrate that the GTs are capable of starting and of continuously operating all required IE equipment within the equipment voltage rating to either Unit 2 or both units via the Unit 2/ Unit 3 tie breaker.

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.

Con Ed has shown, by analysis, that the voltage ratings of the 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. 10028 and 10029).

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

Con Ed indicates that test results will be available in August 1981. The proposed test is acceptable if the test values used are obtained when the 1E buses are loaded to at least 30%.

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).

Con Ed has analyzed the 138kV and 13.8kV connections to the offsite power grid, and determined that no potential exists for simultaneous or consequential loss of both circuits 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.

Indian Point is the site of two operating nuclear units. The preferred (138kV) and alternate (13.8kV) offsite sources are independently connected to the onsite distribution system of each unit. However, the alternate offsite source of each unit can simultaneously supply IE loads of the other unit through a tie breaker. Con Ed has not provided an analysis for the connection. Additionally, the Indian Point Station has three gas turbine generators that could supply power to class IE loads individually or in combination to one unit or both units through the tie breaker. No voltage analysis for this supply has been provided to the NRC.

6.0 CONCLUSIONS

The voltage analyses submitted by Con Ed for the Indian Point Nuclear Station Unit 2 were evaluated in Section 5.0 of this report. Upon the completion of changes described in Section 4.1, it was found that:

1. Voltages within the operating limits of the class 1E equipment have not been supplied for all projected combinations of plant load and normal offsite power grid conditions; considering an accident in one unit and the safe shutdown of the other unit.

   Recommendations:

   a. Con Ed should either provide an analysis to show that one 13.8kV gas turbine generator can supply satisfactory voltage to all possible connected IE loads (on both Units 2 and 3) or have LOC requirements in the Technical Specifications preventing their use.

   b. Con Ed should either provide an analysis to show that the Buchanan 138/13.8kV tie, through the 13.8/6.9kV transformer can supply all class IE equipment to both units through the Unit 2/Unit 3 tie breaker considering the Buchanan grid at its minimum expected voltage or provide LCO requirements in the technical specifications preventing the use of this tie breaker to IE loads during operation of both Unit2 2 and 3.

2. The proposed test to verify the accuracy of the analysis is satisfactory if the test measurements are made with the IE buses and MCCs loaded to at least 30% of their full load rating. If this is not possible, Con Ed

should demonstrate that each bus or MCC is loaded sufficiently and the instrumentation is accurate enough to ensure the correct readings.

2. The proposed test will verify the analysis accuracy.

   However, it is recommended that Con Ed show in their test results that the test data used to verify their analysis is for class 1E bus loadings greater than 30%.

3. Con Ed 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 Indian Point Nuclear 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 Voltage," August 8, 1979.

2. Con Ed letter, W. J. Cahill, Jr., to Director of Nuclear Regulation, October 16, 1979.

3. Con Ed letter, W. J. Cahill, Jr., to Director of Nuclear Regulation, April 28, 1980.

4. Con Ed letter, P. Zarakas, to Director of Nuclear Regulation, August 1, 1980.