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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES, INDIAN POINT NUCLEAR POWER STATION--UNIT NO. 3, DOCKET NO. 50-286

D. A. Weber

NRC Research and Technical Assistance Report

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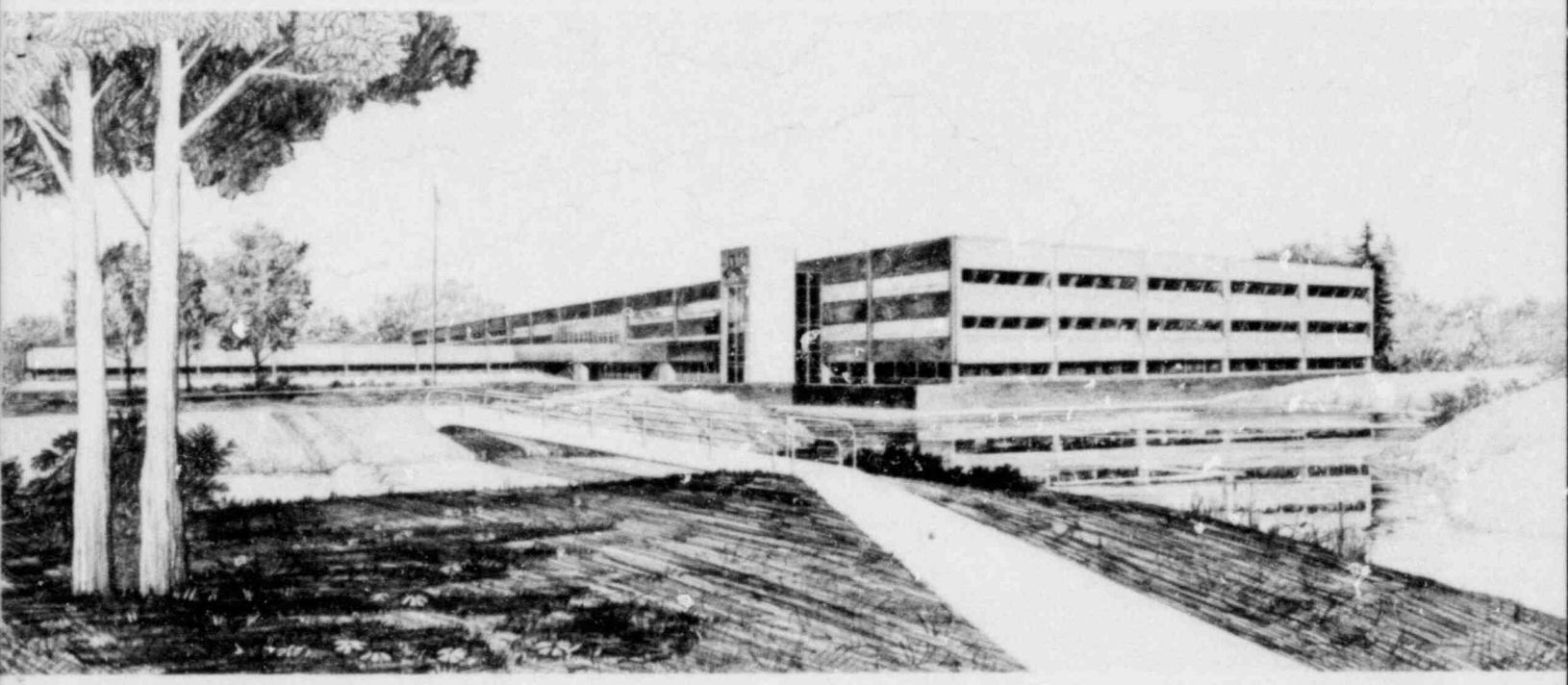
Idaho Operations Office • Idaho National Engineering Laboratory



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INTERIM REPORT

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ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES

INDIAN POINT NUCLEAR POWER STATION--UNIT NO. 3

Docket No. 50-286

July 1981

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EG&G Idaho, Inc.

TAC No. 12993

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 Unit 3 Nuclear Power Station.

The onsite distribution system, in conjunction with the offsite power sources, has been shown to have sufficient capacity and capability to operate all required safety related loads, within the equipment rated voltage limits, in the event of either an anticipated transient or an accident condition for the analyzed offsite sources. However, analysis has not been provided for other possible offsite sources supplying the onsite distribution system, or for any of the offsite sources supplying more than one unit through unit tie breaker(s).

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

INDIAN POINT NUCLEAR STATION--UNIT NO. 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.

In response to the NRC generic letter, the Power Authority of the State of New York (PASNY) submitted a voltage analysis on May 30, 1980.[2] This review is based on this submittal, PASNY's submittals of February 11, 1980,[3], June 12, 1981,[4] and the Final Safety Analysis Report (FSAR) for Unit 3.

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

A single-line diagram of the AC electrical system at Indian Point 3 is shown in Figure 1.

During normal operation, the 6.9 kV buses 1, 2, 3, and 4 and the 480V 1E 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 1E 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 2 loads via a Unit 2/Unit 3 tie breaker. This also holds true for the Unit 2-13.8/6.9kV transformer.

The Technical Specifications require that the 1E 480V bus inter-ties must be open when Unit 3 is operating.

The 1E 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 Analysis Conditions. PASNY 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.

PASNY has analyzed two offsite sources (the 138kV and the 13.8kV sources) 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

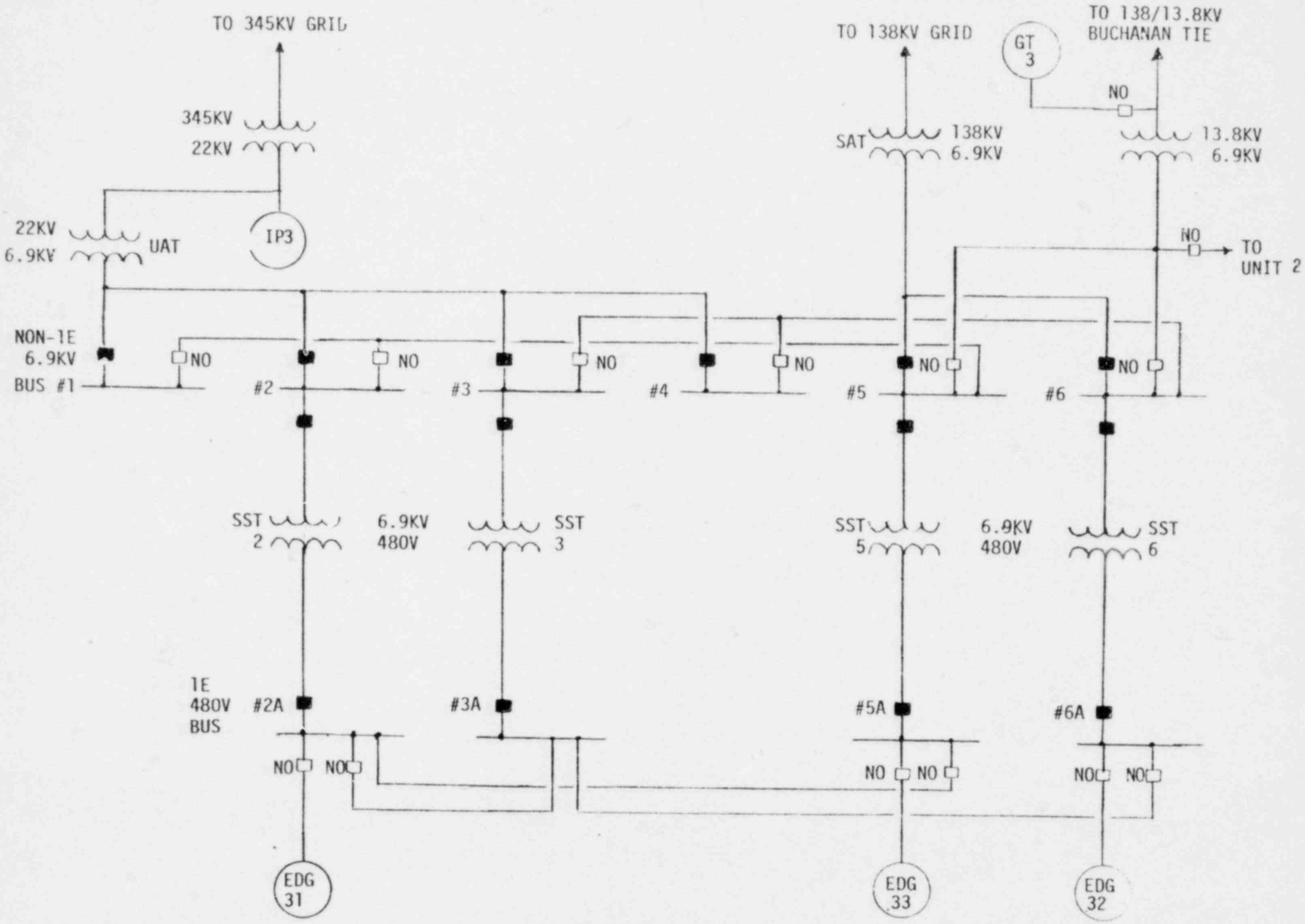

Figure 1. Indian Point Unit 3 electrical single-line diagram.

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 1E loads are in operation.

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.

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

4.3 Analysis Verification. PASNY has stated that current and voltage measurements will be obtained from the 480V 1E buses 2A, 3A, 5A, and 6A on a sample basis during normal plant operations. Measurements will also include motor starting and running values. Motors which cannot be safely operated during normal plant operations will be operated on a sample basis during the 1981 refueling outage. The expected auxiliary plant load during the normal plant operation is estimated at 37 megawatts.

The test values will be used as computer input data and the computed values will be compared with the test values to verify the accuracy 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.

PASNY 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). Transient values for the 480V starters were not provided, but are expected to be above the minimum pick-up and drop-out values. In addition, PASNY has not provided analysis showing the capability and capacity of the 13.8kV system to supply all Unit 3 and Unit 2 loads through a Unit 3/Unit 2 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 1E 480V loads via the 13.8/6.9kV transformer. PASNY has not provided an analysis to demonstrate that the GTs are capable of starting and of continuously operating all required 1E equipment within the equipment voltage rating to either Unit 3 or both units via the Unit 3/Unit 2 tie breaker.

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	--	82.27[e]
	Operate	110	112[d]	90	92.5	--
460V Motors	Start	--	--	80	--	84.78[e]
	Operate	110	107	90	93.9	--
480V Starters[f]	Pickup	--	--	85	--	--
	Dropout	--	--	60	--	--
	Operate	110	103	90	90	--
Other Equipment[g]						

a. 138kV source: maximum analyzed = 105.6%.

b. 13.8kV source: minimum analyzed = 99.27%

c. Licensee did not provide transient values for the start of a large Non-1E load. However they analyzed the start of the 900 hp Circulating Water Pumps and stated that "the starting of one of these pumps would cause voltages to drop several percent for approximately two (2) seconds, during which time voltages at all equipment would remain above minimum levels required."[4]

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

e. These values are for individual 440V or 460V motors with the lowest starting voltage under conditions of minimum grid and bus voltage.[2]

f. Transient voltages not supplied for the load centers and MCC buses.

g. Analyzed voltages are within the operating range of the 480V battery chargers. Instrument buses are supplied by inverters from 125V DC batteries and are unaffected by any offsite occurrences.[4]

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.

PASNY 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. 10029).

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

PASNY has provided a test description[4] but did not state when the test results would be available. The proposed test is acceptable if the test values used are obtained when each of the 1E buses are loaded to at least 30% of rated load. Measurements should also be obtained at the MCC buses 36A and 36B. These buses were not included in their test description. In addition, the test results should include an analysis of the capability of the 480V motor starters to pick up due to the start of a 460V or 440V motor with the lowest starting motor terminal voltage, and not to drop out due to the start of a large 1E load under conditions of minimum grid and maximum load. These transient values were not provided in the original analysis. See 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).

PASNY 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 1E loads of the other unit through a tie breaker. PASNY has not provided an analysis for this connection. Additionally, the Indian Point Station has three gas turbine generators that could supply power to class 1E 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 PASNY for the Indian Point Nuclear Station Unit 3 were evaluated in Section 5.0 of this report. It has been determined 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: PASNY should either provide an analysis to show that one 13.8kV gas turbine generator can supply satisfactory voltage to all possible connected 1E loads (on both Units 2 and 3) or have LCO requirements in the Technical Specifications preventing their use.

b: PASNY 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 1E equipment to both units through the Unit 3/Unit 2 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 1E loads during operation of both Unit 3 and Unit 2.

2: PASNY should provide LCOs in their Technical Specifications which would require that the circuit breaker control switches located in the control room, which control the automatic transfer of the 6.9kV buses 1, 2, 3, and 4 to buses 5 and 6, be "locked out" and tagged anytime the 13.8 kV source is connected to buses 5 and 6. This situation is presently covered under Standard Operating Procedure No: SOP-EL-5.

3: The proposed test to verify the accuracy of the analysis is satisfactory if the test measurements are made with the 1E buses and MCCs loaded to at least 30% of their full load rating. If this is not possible, PASNY should demonstrate that each bus or MCC is loaded sufficiently, and the instrumentation is accurate enough, to ensure the correct readings. The test results should also include an analysis of the 480V motor starters to operate due to the start of 1E and non-1E loads under conditions of minimum grid voltage and maximum plant loads.

4: PASNY 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 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. PASNY letter, P. J. Early, to Director of Nuclear Reactor Regulation, May 30, 1980.

3. PASNY letter, P. J. Early, to W. Gammill, U.S. Nuclear Regulatory Commission, February 11, 1980.

4. PASNY letter, J. P. Bayne, to Director of Nuclear Reactor Regulation, June 12, 1981.