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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

INDIAN POINT NUCLEAR STATION, UNIT NO. 3

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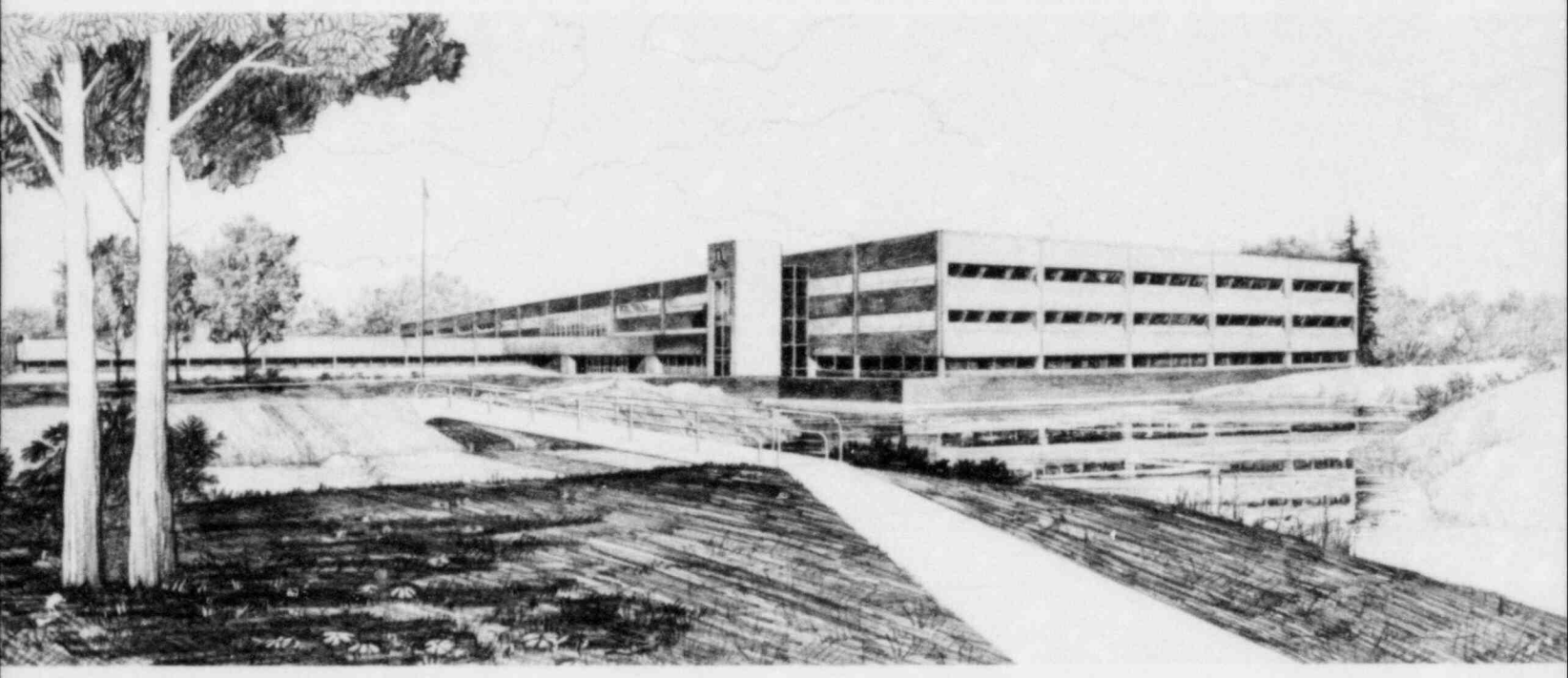

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INDIAN POINT NUCLEAR STATION, UNIT NO. 3

August 1982

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ABSTRACT

This EG&G Idaho, Inc., report reviews the susceptibility of the safety-related electrical equipment, at Unit 3 of the Indian Point Nuclear Station, to a sustained degradation of the offsite power sources.

FOREWORD

This report is supplied as part of the "Selected Operating Reactors Issues" 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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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS
INDIAN POINT NUCLEAR STATION, UNIT NO. 3

1.0 INTRODUCTION

On June 3, 1977, the NRC requested the Consolidated Edison Company (Con-Ed) to assess the susceptibility of the safety-related electrical equipment at the Indian Point Nuclear Station, Unit No. 3 (IP-3) to a sustained voltage degradation of the offsite source and interaction of the offsite and onsite emergency power systems.[1] The letter contained three positions with which the current design of the plant was to be compared. After comparing the current design to the staff positions, Con-Ed was required to either propose modifications to satisfy the positions and criteria or furnish an analysis to substantiate that the existing facility design has equivalent capabilities. Since the NRC's original letter of June 3, 1977, the Power Authority of the State of New York (PASNY) has assumed the license and ownership of the IP-3 facilities.

Con-Ed responded to the NRC letter with two submittals dated August 29, 1977.[2,3] These submittals and the submittals of September 20, 1976,[4] September 24, 1976,[5] December 17, 1976,[6] March 31, 1977,[7] September 19, 1977,[8] February 11, 1980 (PASNY),[9] and May 30, 1980 (PASNY),[10] provide the information reviewed for this report. On April 13, 1982,[11] PASNY submitted an application to amend the operating license at IP-3, to use the newly installed modifications of the Class 1E undervoltage protection system.

2.0 DESIGN BASE CRITERIA

The design base criteria that were applied in determining the acceptability of the system modifications to protect the safety-related equipment from a sustained degradation of the offsite grid are:

1. General Design Criterion 17 (GDC 17), "Electrical Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50[12]

2. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"[13]

3. IEEE Standard 308-1974, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations"[14]

4. Staff positions as detailed in a letter sent to the licensee, dated June 2, 1977[1]

5. ANSI Standard C84.1-1977, "Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)."[15]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of the existing undervoltage protection at IP-3; in Subsection 3.2, a description of the licensee's proposed modifications for the second-level undervoltage protection; and in Subsection 3.3, a discussion of how the proposed modifications meet the design base criteria.

3.1 Existing Undervoltage Protection

There are four 480V Class 1E buses (2A, 3A, 5A, and 6A) for IP-3. Each of the buses is equipped with CV-7 inverse-time relays set at 46% (220V) which automatically remove [except safeguard motor control center (MCC) numbers 36A, 36B and 36C] their associated loads after 2 seconds. These relays, which use a one-out-of-two logic, initiate load shedding, starting of the emergency diesel generators, and energizing the emergency buses through the load sequencer.

3.2 Modifications

The licensee has proposed to install two degraded voltage relays on each 480 volt safety-related bus, using two-out-of-two logic to trip the offsite power source should a degraded voltage occur. The setpoint for each relay is specified as ≥398 volts with a time delay of ≤210 seconds.[11] The time delay on the loss-of-voltage relays is not specified, as these are inverse time delay relays whose time delay is dependent on the voltage observed. The loss-of-voltage relays will start the diesel generators and initiate load sequencing. The degraded voltage relays will only trip the bus offsite power source. Proposed changes to the plant's technical specifications were also furnished by the licensee.

3.3 Discussion

The first position of the NRC staff letter[1] required that a second level of undervoltage protection for the onsite power system be provided. The letter stipulates other criteria that the undervoltage protection must meet. Each criterion is restated below, followed by a discussion regarding the licensee's compliance with that criterion.

1. "The selection of voltage and time setpoints shall be determined from an analysis of the voltage requirements of the safety-related loads at all onsite system distribution levels."

   The licensee has identified the 480V MCC contactors, with a minimum pick-up rating of 85% of 480V (408V), as being the limiting equipment of the Class 1E distribution system.[2] PASNY has proposed a setpoint of ≥398V for the degraded voltage monitors. Thus the chosen setpoint does not assure that all Class 1E equipment will start when required.

2. "The voltage protection shall include coincident logic to preclude spurious trips of the offsite power sources."

   The proposed modification for the degraded voltage relays incorporates a two-out-of-two logic scheme that satisfies this criterion. The existing loss of voltage relays use a one-out-of-two logic that does not satisfy this criterion.

3. "The time delay selected shall be based on the following conditions:

   a. "The allowable time delay, including margin, shall not exceed the maximum time delay that is assumed in the FSAR accident analysis."

      The proposed time delay of ≤210 seconds exceeds the maximum analyzed time delay for an accident condition.

   b. "The time delay shall minimize the effect of short-duration disturbances from reducing the unavailability of the offsite power source(s)."

      The licensee's proposed specified time delay of ≤210 seconds does not include a minimum time delay that allows the override of any short, inconsequential grid disturbances or the effects of the starting of large motors.

   c. "The allowable time duration of a degraded voltage condition at all distribution system levels shall not result in failure of safety systems or components."

The proposed time delay ≤210 seconds could result in the safety systems failing to function as designed.

4. "The voltage monitors shall automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time-delay limits have been exceeded."

   A review of the licensee's proposal substantiates that this criterion is met.

5. "The voltage monitors shall be designed to satisfy the requirements of IEEE Standard 279-1971."

   The licensee has stated in his proposal that the modifications are designed to meet or exceed IEEE Standard 279.[10]

6. "The technical specifications shall include limiting conditions for operation, surveillance requirements, trip setpoints with minimum and maximum limits, and allowable values for the second-level voltage protection monitors."

   The licensee has provided surveillance requirements but the requirement to "test" every 18 months (noted as "R" for refueling in the proposed technical specifications") is not acceptable. The channel functional test frequency should agree with the NRC model technical specifications (at least once per 31 days). The channel check capability is not available at IP-3, therefore, this surveillance is not applicable.

The second NRC staff position requires that the system design automatically prevent load-shedding of the emergency buses once the onsite

sources are supplying power to all sequenced loads. The load-shedding must also be reinstated if the onsite breakers are tripped.

The degraded voltage monitors affect only the offsite source circuit breaker. The diesel generator has undervoltage protection that is set higher than the bus loss-of-voltage relays. Therefore, any bus relays will not affect load-shedding while the diesel generator is supplying power to a Class 1E bus.

The third NRC staff position requires that certain test requirements be added to the technical specifications. These tests were to demonstrate the full-functional operability and independence of the onsite power sources, and are to be performed at least once per 18 months during shutdown. The tests are to simulate loss of offsite power in conjunction with a safety-injection actuation signal, and to simulate interruption and subsequent reconnection of onsite power sources. These tests verify the proper operation of the load-shed system, the load-shed bypass when the emergency diesel generators are supplying power to their respective buses, and that there is no adverse interaction between the onsite and offsite power sources.

The Indian Point, Unit No. 3 Technical Specifications describe tests to demonstrate the full-functional operability and independence of the onsite systems with a simulated loss of offsite power in conjunction with a safety injection. The load sequencers, by design, are reset when voltage is restored to the bus. Thus, the specified testing satisfies this position.

4.0 CONCLUSIONS

Based on the information provided by Con-Ed and PASNY, it has been determined that the proposed system modifications do not comply to the NRC staff positions as described in their letter of June 3, 1977. The voltage protection system is inadequate in the following areas:

1. The proposed setpoint for the degraded voltage relays of ≥398V is too low to assure the pickup of the Class 1E motor control center contactors,

2. The loss of voltage relays utilize a one-out-of-two logic which could be subject to spurious trips on a single failure,

3. The proposed time delay for the degraded voltage relays exceeds the time delay assumed in the FSAR for delivering cooling to the core under accident conditions,

4. The proposed time delay for the degraded voltage relays does not include a minimum time delay to allow the override of short term grid disturbances or the effects of the starting of large motors, and

5. The channel functional test requirement proposed by the licensee is in excess of "at least once per 31 days" that is required by the June 3, 1977 letter.[1]

5.0 REFERENCES

1. NRC letter (R. W. Reid) to Con-Ed, "Staff Positions Relative to the Emergency Power Systems for Operating Reactors," dated June 3, 1977.

2. Con-Ed letter (W. J. Cahill, Jr.) to NRC (R. W. Reid), dated August 29, 1977. (A complete response to the NRC's generic letter of August 12, 1976, and updating Con-Ed's letter of September 24, 1976.)

3. Con-Ed letter (W. J. Cahill, Jr.) to NRC (R. W. Reid), dated August 29, 1977. (Responding to the NRC letter of June 3, 1977.)

4. Con-Ed letter (W. J. Cahill, Jr.) to NRC (R. W. Reid), dated September 20, 1976.

5. Con-Ed letter (W. J. Cahill, Jr.) to NRC (R. W. Reid), dated September 24, 1976. (A partial response to the NRC's generic letter of August 12, 1976, (Effects of Degraded Grid Voltage) and updating the Con-Ed letter of September 20, 1976.)

6. Con-Ed letter (W. J. Cahill, Jr.) to NRC (R. W. Reid), dated December 17, 1976.

7. Con-Ed letter (W. J. Cahill, Jr.) to NRC (R. W. Reid), dated March 31, 1977.

8. Con-Ed letter (W. J. Cahill, Jr.) to NRC (W. Gamill), dated September 19, 1977.

9. PASNY letter (Paul J. Early) to NRC (W. Gammill), dated February 11, 1980.

10. PASNY letter (Paul J. Early) to NRC (S. A. Varga), dated May 30, 1980.

11. PASNY letter, J. P. Bayne to S. A. Varga, NRC, "Proposed Changes to the Technical Specifications Related to the Indian Point 3 Station Electrical Distribution System," April 13, 1982, Serial IPN-82-32.

12. General Design Criterion 17, "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

13. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."

14. IEEE Standard 308-1974, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."

15. ANSI C84.1-1977, "Voltage Ratings for Electric Power Systems and Equipment (60 Hz)."

16. IEEE Standard 141-1976, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants."

17. NEMA Standard, NEMA MG1-1972, "Motors and Generators."