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TECHNICAL EVALUATION REPORT ON THE DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS FOR THE D. C. COOK NUCLEAR PLANT UNIT 1, DOCKET NO. 50-315

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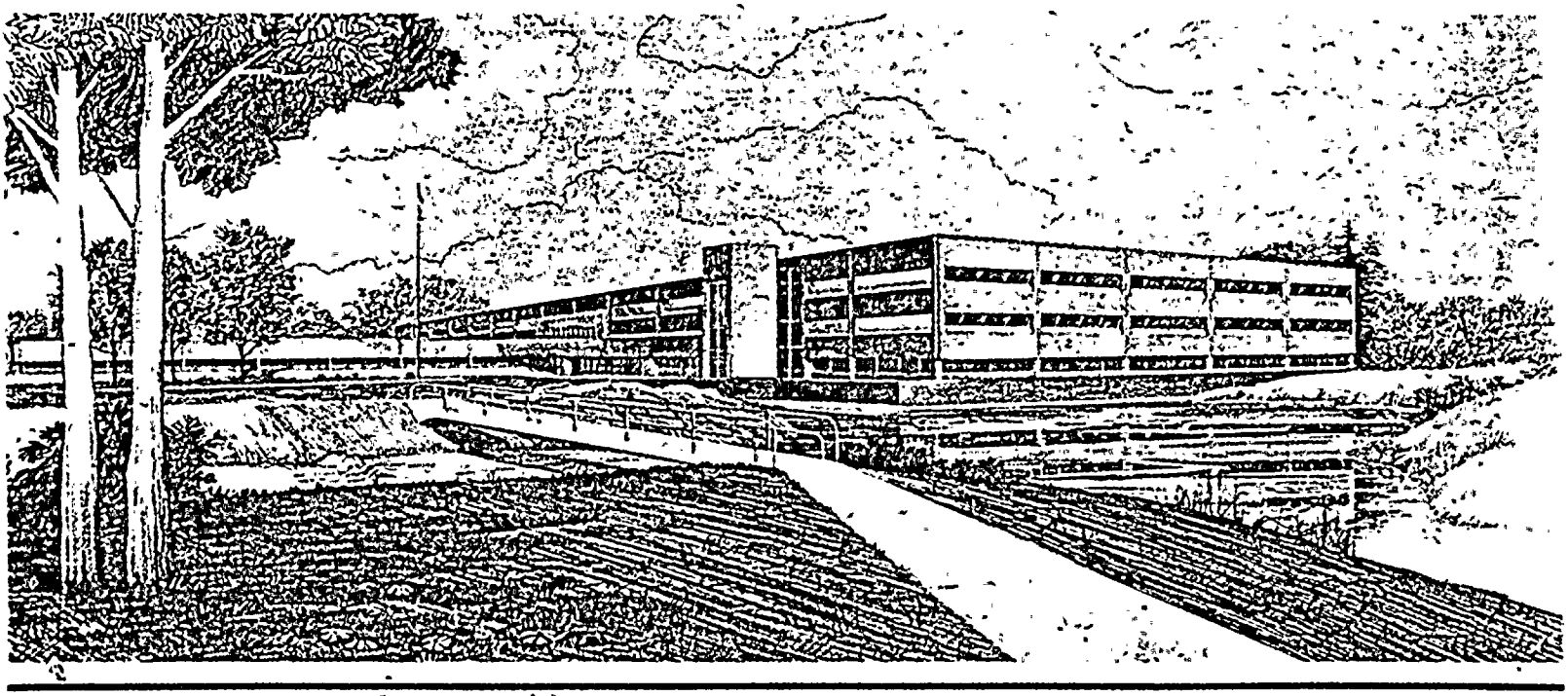

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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS
D. C. COOK NUCLEAR PLANT UNIT 1

Docket No. 50-315

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ABSTRACT

In June 1977, the NRC sent all licensees a letter outlining three positions the staff had taken in regards to the onsite emergency power system. Indiana & Michigan Electric Company (IMECo) was to assess the susceptibility of the safety-related electrical equipment at the Donald C. Cook Nuclear Plant Unit 1 (CNP-1) to a sustained voltage degradation of the offsite source and interaction of the offsite and onsite emergency power systems. This report contains an evaluation of IMECo's analyses, modifications, and Technical Specification changes to comply with these NRC positions.

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1.0 INTRODUCTON

On June 3, 1977, the NRC requested the Indiana & Michigan Electric Company (IMECo) to assess the susceptibility of the safety-related electrical equipment at the D. C. Cook Nuclear Plant Unit 1 (CNP-1) 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, IMECo 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.

By letter, dated July 22, 1977, IMECo proposed certain design modifications to satisfy the criteria and staff positions.[2] A request for additional information, to clarify some points in IMECo's proposal, was sent to IMECo by the NRC. IMECo responded by letters dated October 5, 1979,[3] December 17, 1979,[4] February 22, 1980,[5] and May 28, 1980.[6] The modifications consist of the installation of a second-level undervoltage protection system for the class 1E equipment, and blocking of the load-shedding feature when the diesel generator is supplying power to the emergency buses. The NRC required that the setpoint, surveillance requirements, test requirements, and allowable limits were to be included by IMECo in the plant technical specification.

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[7]

2. IEEE Standard 279-1971, "Class 1E Power Systems for Nuclear Power Generating Stations"[8]

3. IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations"[9]

4. Staff positions as detailed in a letter sent to the licensee, dated June 3, 1977[1]

5. ANSI Standard C84.1-1977, "Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)."[10]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of the existing undervoltage protection at to the CNP-1; in the 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. The present design uses two undervoltage relays on each of the four station 4160V class 1E safety buses to detect a loss of offsite power. These relays have a setpoint of 2400V (60% of 4000V).[11] When the offsite voltage drops to this value and persists for at least eight cycles, the offsite power source breakers are tripped and the emergency diesel is started and the generator breaker is allowed to close automatically as soon as the unit has attained rated speed and voltage. An undervoltage relay on each of the 4160V and 600V class 1E buses initiates an alarm in the control room when the voltage drops to 0.90 pu.[4]

The existing system does not disable the load-shedding circuits once the diesel-generator breaker is closed.

3.2 Modifications. The licensee has proposed adding three new undervoltage relays to protect each of the 4160V safey trains. These relays will be on buses T11A and T11D and will be arranged in a two-out-of-three coincidence logic. These relays will have a setpoint of 3596 ± 18V (86.4% of bus voltage) with a time delay of two minutes ± six seconds. When an undervoltage condition persists below the setpoint for at least two minutes the offsite power source to the 4 kV class 1E buses is tripped, the diesel generators are started, and load shedding on the 4 kV class 1E buses is initiated. When the diesel generators reach rated speed and voltage the diesel generator breaker is closed and the 4 kV class 1E buses are sequentially loaded.

The class 1E bus loss-of-power relay scheme will also be modified. Each 4 kV class 1E bus will have three relays arranged in a two-out-of-three coincidence logic, with a setpoint of 3196 ± 18V (76.8% of bus voltage) with a time delay of 2 ± 0.2 seconds. When the voltage decreases to this value for at least two seconds the relays will respond and initiate the same sequence of events as described above.

Load shed blocking, once the diesel generator is supplying power to the class 1E buses, will be incorporated. A means of testing this interlock will also be incorporated in the circuit design. Interruption of power to the safety equipment from the diesel generator by opening of the diesel generator breaker will restore its respective buses load shedding and re-sequencing capability.

Proposed changes to the plant's Technical Specifications, adding the surveillance requirements, allowable limits for the setpoint and time delay, and limiting conditions for operation for the second-level undervoltage monitors, were also furnished by the licensee. An analysis to substantiate the limiting conditions and minimum and maximum setpoint limits was also part of the proposal.

3.3 Discussion. The first portion of the NRC staff letter[1] required that a second level of undervoltage protection for the onsite power systems 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's proposed setpoint of 3596V at the 4160V bus is 89.9% of the motor-related voltage of 4000V. This setpoint reflected down to the 600V buses will be greater than 88% of the motor-rated voltage. Inasmuch as all safety related motors, as stated by the licensee, have a service factor of 1.15, the continuous operation of these motor just above this setpoint will be within the operating capability of the motors. As the motors are the most limiting equipment in the system, this setpoint is acceptable. The licensee's analysis considered motor starters, motor ratings, and control circuits. The proposed setpoint with service factor is within the voltage range recommended by ANSI C84.1-1977 for continues operation.

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

   The proposed modification incorporates a two-out-of-three logic scheme, thereby satisfying 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 two minutes does not exceed this maximum time delay. This is substantiated by the licensee in his proposal.

The proposed time delay will not be the cause of any thermal damage to the safety-related equipment.

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 time delay of two minutes is long enough to override any short inconsequential grid disturbances. Further, we have reviewed the licensee's analysis and agree with the licensee's finding that any voltage dips caused from the starting of large motors will not trip the offsite source.

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."

A review of the licensee's voltage analysis[11] indicates that the time delay will not cause any failures of the safety-related equipment since the

voltage setpoint is within the allowable tolerance of the equipment-rated voltage taking into consideration the motor's service factors.

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 the requirements of IEEE Standard 279.

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

   The licensee's proposal for Technical Specification changes does include all the required items. An analysis has been performed which assures that the range between the minimum and maximum trip point settings, as well as the allowable limits, will not be the cause of spurious trips of the offsite source nor will they allow the voltage to be so low as to allow damage to the safety equipment.

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 source breakers are tripped.

The licensee has stated that this position will be met by the use of interlocks. These proposed design will include a means to test this interlock.[2]

The third NRC staff position requires that certain test requirements be added to the Technical Specifications. These test 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 testing procedures proposed by the licensee do comply with the full intent of this position. Load shedding on offsite power trip is tested. Load sequencing, once the diesel generator is supplying the safety buses, is tested. Automatic restoration of load shedding and sequencing once the diesel generator breaker is tripped and reclosed is also tested. The time duration of the test (five minutes with full safety loads) will verify that the time delay is sufficient to avoid spurious trips and that the load shed bypass circuit is functioning properly.

4.0 CONCLUSIONS

Based on the information provided by IMECo, it has been determined that the proposed modifications comply with NRC staff position 1. All of the staff's requirements and design base criteria have been met. The modifications will protect the class 1E equipment from a sustained degraded voltage condition of the offsite power source.

The modified load-shed circuitry does comply with staff position 2 and will prevent adverse interaction of the offsite and onsite emergency power systems.

The proposed changes to the Technical Specifications do adequately test the system modifications and do comply with staff position 3. The surveillance requirements, limiting conditions for operation, minimum and maximum limits for the trip point, and allowable values meet the intent of staff position 1.

It is therefore concluded that IMECo's proposed modifications and technical specification changes are acceptable.

5.0 REFERENCES

1. NRC (D. K. Davis) letter to IMPCo (J. Tillinghast), dated June 3, 1977.

2. IMPCo (J. Tillinghast) letter to NRC (E. G. Case), dated July 22, 1977.

3. IMPCo (R. S. Hunter) letter to NRC (H. R. Denton), dated October 5, 1979.

4. IMECo (J. E. Dolan) letter to NRC (H. R. Denton), dated December 17, 1979.

5. IMECo (J. E. Dolan) letter to NRC (H. R. Denton), dated February 22, 1980.

6. IMECo (J. E. Dolan) letter to NRC (H. R. Denton), dated May 28, 1980.

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

8. IEEE Standard 179-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."

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

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

11. IMPCo (J. Tillinghast) letter to NRC ((B. C. Rusche), dated November 17, 1976.

12. Final Safety Analysis Report (FSAR) for the D. C. Cook Nuclear Plant Unit 1.