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INTERIM REPORT

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TECHNICAL EVALUATION REPORT
DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

TROJAN NUCLEAR PLANT
Docket No. 50-344

December 1980

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ABSTRACT

In June 1977, the NRC sent all licensees a letter outlining three posititions the staff had taken in regards to the onsite emergency power system. Portland General Electric Company (PGE) was to assess the susceptibility of the safety-related electrical equipment at the Trojan Nuclear Plant (TNP) to a sustained voltage degradation of the offsite source and interaction of the otfsite and onsite emergency power systems. This report contains an evaluation of PGE's analyses, modifications, and Technical Specification changes to comply with these NRC positions.

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1.0 INTRODUCTION

On June 3, 1977, the NRC requested the Portland General Electric Company (PGE) to assess the susceptibility of the safety-related electrical equipment at the Trojan Nuclear Plant (TNP) 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, PGE 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 19, 1977, PGE proposed certain design modifications to satisfy the criteria and staff positions. A request for additional information, to clarify some points in PGE's proposal, was sent to PGE by the NRC on October 1, 1979.[3] PGE responded by letters dated December 11, 1979[4] and January 11, 1980[5]. The modifications consist of the installation of a second-level undervoltage protection system for the class 1E equipment. The NRC required that the setpoint, surveillance requirements, test requirements, and allowable limits were to be included by PGE in the plant Technical Specifications.

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 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[6]

2. IEEE Standard 279-1971, "Class 1E Power Systems for Nuclear Power Generating Stations"[7]

3. IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations"[8]

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)."[9]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of the existing undervoltage protection available to the TNP; 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. The present design uses two undervoltage relays on each of the two station 4160V class 1E safety buses to detect a loss of offsite power. These relays have a setpoint of 2560V (61.5%). When offsite voltage drops to this value and persists for at least one second, the offsite source breakers are tripped, load shedding is initiated, and the emergency diesel generators are started. The diesel generator breakers are closed automatically as soon as the unit reaches rated voltage and speed.[10]

Load shedding, once the diesel generators are supplying the class 1E buses, is not bypassed. The licensee's bases for retention of the load-shed feature is that it provides for automatic resequencing of the loads following any temporary loss of bus voltage.

3.2 Modification. The licensee has proposed, firstly, to add two more undervoltage relays to the existing two that sense loss of offsite power. These will be arranged in a two-out-of-four coincidence logic. They will maintain the same setpoint and time delay as was previously indicated, and the logic circuitry will perform the same sequence as stated above.

Secondly, to protect the class 1E buses from a sustained degraded voltage, each of the two 4160V class 1E buses will be provided with a set of four definite time (4 sec time delay) undervoltage relays. These relays will be arranged in a two-out-of-four coincidence logic to energize two timers, either of which will initiate tripping of the bus supply breaker. The relays will have a nominal setpoint of 3850 $\pm$ 80V (94% of bus voltage) with a relay/timer combined time delay of 55 $\pm$ 5 sec.

These relays will initate tripping of their respective bus supply breakers, and thereby causing the existing undervoltage relays (loss-of-voltage) to initiate the sequence of events as in Subsection 3.2 for the following two conditions:

1. An SI signal is present and undervoltage below the setpoint persists for four sec.

2. No SI signal and undervoltage below the setpoint persists for a maximum of 60 sec.

Load shedding is being maintained once the diesel generators are supplying their respective buses. The licensee's bases for this will be discussed below.

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 minumum and maximum setpoint limits was also part of the proposal.

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's proposed setpoint of 3850V at the 4160V bus is 96% of the motor-related voltage of 4000V. This setpoint reflected down to the 480V buses will be greater than 90% of the motor-rated voltage. As the motors are the most limiting equipment in the system, this setpoint is acceptable. The licensee's analysis considered these factors.

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-four 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 four seconds, with a SI signal present, does not exceed this maximum time delay. This is substantiated by the licensee in his proposal.

      Without the presence of a SI signal, the time delay of 60 seconds will not be the cause of any thermal damage to the safety-related equipment. The setpoint is within voltage ranges recommended by ANSI C84.1-1977.

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

      The 60-seconds time delay would allow the starting of the 12.47 kV reactor coolant pumps (6000 hp) without tripping 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.

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.

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.[12,14] The setpoint of 3850 $\pm$ 80V does not infringe into the expected operating envelope and will not compromise the life of the motors. Spurious trips are thereby not foreseen. The limiting conditions for operation, calibration checks, and surveillance requirements meet the criteria of the staff's positions.

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. In the event an adequate basis can be provided for retaining the load-shed feature when loads are energized by the onsite power system, the licensee's bases for the setpoint and limits must be documented.

The licensee has elected to retain the load-shed feature once the diesel generators are supplying their respective buses. As stated above, the second level undervoltage relays trip the offsite breakers at the setpoint of 3850 $\pm$ 80V. This action activates the loss-of-voltage relays set

at 2560V. These relays initiate load shedding. Since the offsite source breakers are already tripped when the diesel generators are supplying the class 1E buses, a voltage below 2560V would be needed to load shed the buses. It is the licensee's contention that only mechanical or electrical component failures of the diesel generator could cause the voltage to reach this level and that the second redundant safety train would safely shut down the plant. This bases for retaining the load-shed feature and the bases for the setpoint and limits are documented in his proposal.

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 testing procedures proposed by the licensee do comply with the full intent of this position.[13] Load shedding on offsite power trip is tested. Load sequencing, once the diesel generator is supplying the safety buses, is tested. The time durations of the tests 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 PGE, 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 existing load-shed circuitry, although it is not bypassed once the diesel generators are supplying the class 1E buses, will not cause interaction of the onsite and offsite sources.

The proposed changes to the Technical Specification 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 PGE's proposed modifications and Technical Specification changes are acceptable. It is also recommended that these modifications be incorporated in the plant design before Cycle 4 and that the Technical Specification changes be implemented at that time.

5.0 REFERENCES

1. NRC letter (A. Schwencer) to PGE (C. Goodwin, Jr.), dated June 3, 1977.
2. PGE letter (C. Goodwin, Jr.) to NRC (A. Schwencer), dated July 19, 1977.
3. NRC letter (A. Schwencer) to PGE (C. Goodwin, Jr.), dated October 1, 1979.
4. PGE letter (C. Goodwin, Jr.) to NRC (A. Schwencer) dated December 11, 1979.
5. PGE letter (C. Goodwin, Jr.) to NRC (A Schwencer), dated January 11, 1980.
6. 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."
7. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."
8. IEEE Standard 308-1974, "Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."
9. ANSI C84.1-1977, "Voltage Ratings for Electric Power Systems and Equipment," (60 HZ).
10. Final Safety Analysis Report (FSAR) for the Trojan Nuclear Plant (TNP).

11. PGE letter (C. Goodwin, Jr.) to NRC (A. Schwencer), dated February 25, 1980.

12. PGE letter (C. Goodwin, Jr.) to NRC (A. Schwencer), dated April 3, 1980.

13. PGE letter (C. Goodwin, Jr.) to NRC (A. Schwencer), dated November 30, 1977.

14. PGE letter (B. D. Withers) to NRC (R. A. Clark), dated November 12, 1980.