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ABSTRACT

This report documents the technical evaluation of the proposed design modification and Technical Specification changes for protection of Class 1E equipment from grid voltage degradation for the Turkey Point Nuclear Generating Plant, Units 3 and 4. The review criteria are based on several IEEE standards and the Code of Federal Regulations. The evaluation finds that the licensee has not provided sufficient information on the undervoltage protection system to allow a complete evaluation into the adequacy of protecting Class 1E equipment from sustained voltage degradation.

FOREWORD

This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues Program being conducted for the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by Lawrence Livermore National Laboratory.

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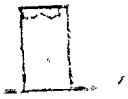

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1. INTRODUCTION

By letter dated June 3, 1977 [Ref. 1], the U. S. Nuclear Regulatory Commission (NRC) requested Florida Power and Light Company (FPL), the licensee, to assess the susceptibility of the Class 1E electrical equipment to sustained degraded voltage conditions at the offsite power sources and to the interaction between the offsite and onsite emergency power systems at the Turkey Point Nuclear Generating Plant, Units 3 and 4. In addition, the NRC requested that the licensee compare the current design of the emergency power systems at the plant facilities with the NRC staff positions as stated in the June 3, 1977 letter [Ref. 1], and that the licensee propose plant modifications, as necessary, to meet the NRC staff positions, or provide a detailed analysis which shows that the facility design has equivalent capabilities and protective features. Further, the NRC required certain Technical Specifications be incorporated into the facility's operating license.

By letters dated July 21, 1977 [Ref. 2], November 9, 1979 [Ref. 3], January 14, 1981 [Ref. 4], and May 10, 1982 [Ref. 5], the licensee proposed certain design modifications to the undervoltage protection system. The design modifications include the installation of a degraded voltage protection system for the Class 1E equipment.

The purpose of this report is to evaluate the licensee's proposed design modifications, Technical Specification changes, and proposed LCO's to determine that they meet the criteria established by the NRC for the protection of Class 1E equipment from grid voltage degradation.

2. DESIGN BASIS CRITERIA

The design basis criteria that were applied in determining the acceptability of the system modification to protect the Class 1E equipment from degradation of grid voltages are as follows:

(1) General Design Criterion 17 (GDC 17), "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," Code of Federal Regulations, Title 10, Part 50 (10 CFR 50) [Ref. 6].

(2) IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" [Ref. 7].

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

(4) NRC staff positions as stated in a letter dated June 3, 1977 [Ref. 1].

3. EVALUATION

3.1 EXISTING UNDERVOLTAGE PROTECTION

The present undervoltage protection design utilizes two undervoltage relays on each of the 4160-volt Class 1E buses (Buses A and B of Figure 1). The relays are instantaneous type HGA which respond at 40% - 50% of 4160 volts. These relays are used as loss-of-voltage protection.

The relay logic (2-out-of-2) is such that actuation of one relay (A1 or A2) on "A" bus in conjunction with the actuation of its interconnected relay (B1 or B2) on "B" bus will initiate the offsite source disconnection, load shedding, diesel generator starting and subsequent load sequencing on both buses. For example, the starting of diesel generator 3 and the disconnection of startup transformer 3 is initiated by the actuation of relay A1 on bus 3A and relay B2 on bus 3B or the actuation of relay A1 and the starting sequencing of diesel generator 4. This logic scheme results in two separate and redundant circuits.

The load shedding feature is bypassed when the Class 1E buses are being supplied by the diesel generators.

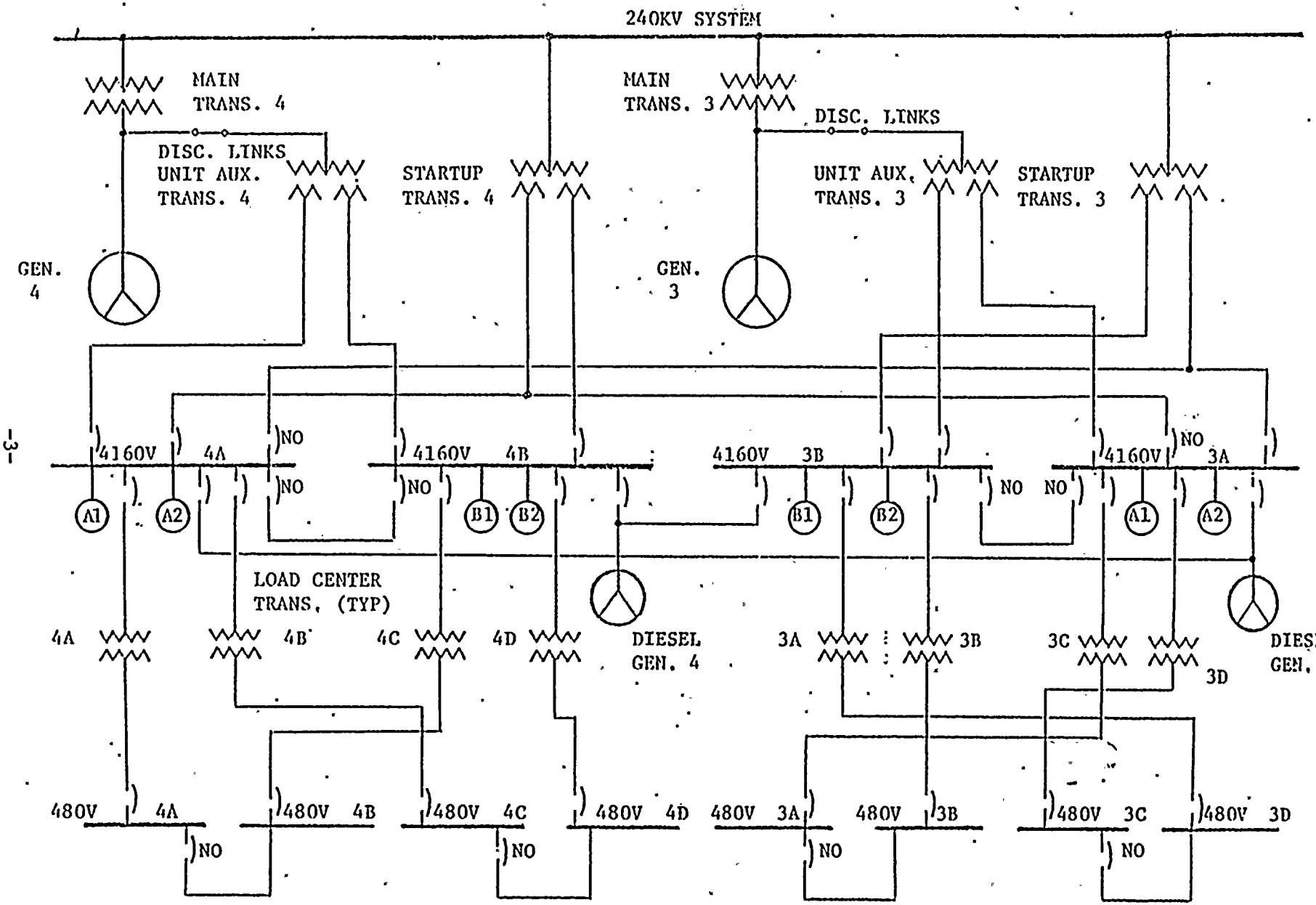

FIGURE 1 TURKEY POINT UNITS 3 AND 4 ELECTRICAL ONE-LINE DIAGRAM

3.2 MODIFICATIONS

The licensee is proposing design changes to the existing undervoltage protection system and are as follows:

(1) The logic of the existing relays will be reconnected such that the offsite source disconnection, load shedding, diesel generator starting, and load sequencing will occur only for that bus on which the loss of voltage occurs. The logic will remain 2-out-of-2 but the scheme on bus A will now be independent of that on bus B.

(2) The installation of two additional inverse time relays (type IAV) on each 4160-volt Class 1E bus. The function of these relays will be to protect the Class 1E equipment from sustained degraded voltages. These relays function similar to and utilize the same logic as the loss-of-voltage relays except via the "b" contact of the diesel generator breaker. Thus, when the breaker closes, the relays will be bypassed to disable the load shedding feature.

(3) The installation of two additional instantaneous relays (type ITE27H) on each 480-volt Class 1E load center. These relays in a 2-out-of-2 logic will be interlocked with a safety injection (SI) signal . When actuated after a time delay due to a degraded voltage condition concurrent with a SI, existing timers will then initiate the source disconnection, load shedding, diesel generator starting, and subsequent load sequencing.

3.3 DISCUSSION

This section presents a statement on the NRC staff position from their June 3, 1977 letter [Ref. 1] followed by an evaluation of the licensee's design.

3.3.1 NRC Staff Position 1: Second Level of Undervoltage or Overvoltage Protection with a Time Delay

This position is to be met by the licensee meeting certain criteria. Each criterion has been evaluated against the licensee's proposal and is addressed below.

(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 not submitted the voltage setpoints and associated time delays for the proposed additional relays. However, the licensee states [Ref. 4] that the voltage setpoints for the additional relays on the 4160-volt buses will be chosen to actuate when the voltage degrades below that required to safely operate the running Class 1E equipment. The voltage setpoint for the 480-volt load center relays will be selected to actuate when the voltage degrades below that required to safely start all Class 1E loads. The time delay will be based on load acceleration times. The licensee is required to verify that the voltage and time setpoints selected were based on an analysis of the voltage requirements of the Class 1E equipment at all Class 1E voltage distribution levels.

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

The proposed coincident logic of 2-out-of-2 will preclude spurious trips from the offsite sources.

(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 licensee has not submitted the time delays with tolerances associated with the proposed design changes nor has provided the time delay assumed in the FSAR accident analysis. The licensee is required to verify that the time delay with tolerances does not exceed the maximum time delay assumed in the FSAR accident analysis.

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

The licensee has not finalized the selection of the setpoints (voltage and time). Therefore, a determination cannot be made on the adequacy of the time delay for minimizing the effects of short duration transients. The licensee is required to verify that the time delay selected will be such that the effects of short duration transients will not cause the availability of the offsite sources to be reduced.

(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."

Since the time delay has not been finalized, a verification that all Class 1E equipment at all voltage distribution levels will be adequately protected has not been provided by the licensee. The licensee does state [Ref. 4] that the setpoints selected will ensure adequate protection to the running and starting Class 1E equipment. The licensee is required to verify that the time delay selected is protecting all the Class 1E equipment at all Class 1E voltage distribution levels.

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

The operation of the IAV relays on the 4160-volt Class 1E buses in a 2-out-of-2 coincident logic will automatically initiate the disconnection from the offsite source whenever the voltage and time delay setpoints are exceeded. Should a degraded voltage occur concurrent with a safety injection signal, the relays (ITE-27H) located on the 480-volt Class 1E load center buses in a 2-out-of-2 logic will initiate the auto-disconnection from the degraded offsite source.

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

The licensee states [Ref. 4] that the design modifications comply with the single failure requirement of IEEE 279-1971. However, the licensee has not verified that the proposed design modifications meet all the requirements of IEEE 279-1971. The licensee is required to verify that the proposed design changes to the Class 1E power system meet all the requirements of IEEE 279-1971 (such as qualification, independence, testibility, etc.).

(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 not submitted appropriate Technical Specification changes to reflect the design modfiications to the undervoltage protection system. The licensee is required to submit Technical Specifications changes to document the setpoints with tolerances, surveillance requirements, and limiting conditions for operation.

3.3.2 NRC Staff Position 2: Interaction of Onsite Power Sources with Load Shed Feature

The second position requires the system be designed to prevent automatic load shedding of the emergency buses once the onsite sources are supplying power to all sequenced loads. If an adequate basis can be provided for retaining the load-shed feature, the licensee must assign maximum and minimum values to the setpoint of the load-shed feature. These setpoints must be be documented in the Technical Specifications. The load-shedding feature must also be reinstated if the onsite source supply breakers are tripped.

The licensee is bypassing the load-shed feature once the onsite sources are supplying the Class 1E buses. This bypassing is accomplished by the interlocking of the load-shed relays on the 4160-volt Class 1E buses with the "b" contact of the diesel generator breaker. Tripping of the breaker will automatically reinstate the load-shed feature. The licensee is required to provide details on the bypassing/reinstatement of the relays on the 480-volt Class 1E load center buses.

3.3.3 NRC Staff Position 3: Onsite Power Source Testing

The third position requires that certain test requirements be included in the Technical Specifications. These tests are to "...demonstrate the full functional operability and independence of the onsite power sources 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 will verify the proper operation of the load-shed system, the load-shed bypass circuitry, and that there is no adverse interaction between the onsite and offsite power sources.

The licensee has not submitted appropriate Technical Specifications to document that the testing requirements of this position are met. The licensee is required to submit tests in the Technical Specifications which will demonstrate the operability and independence of the onsite sources, loss of offsite power in conjunction with an SI, and the interruption and subsequent reconnection of the onsite sources.

3.4 TECHNICAL SPECIFICATION

The licensee has not provided appropriate Technical Specification changes on the design modifications to the undervoltage protection system. The Technical Specification changes required by the licensee are to incude:

(1) Voltage and time delay trip setpoints with tolerances of the undervoltage relaying system.

(2) The required coincident logic (minimum 2-out-of-2).

(3) Surveillance requirements for a channel check at least once per 12 hours, a channel functional test at least once per 31 days and a channel calibration at least once per 18 months (refueling).

(4) Limiting conditions for operation including action statements when the number of required channels is less than the minimum number required.

(5) Test requirements to demonstrate the operability and independence of the onsite sources and the undervoltage relaying circuits modifications.

CONCLUSIONS

Based on the information submitted by Florida Power and Light Company, it has been determined that insufficient information has been submitted on the design modifications to determine that all the requirements of NRC Staff Position 1 are met. The information still required from the licensee for evaluation is as follows:

(1) Verification analysis which demonstrates that the selected voltage/time setpoints with tolerances of the undervoltage relays are protecting all Class 1E equipment at all voltage distribution levels and will minimize the effects of short duration transients.

(2) Voltage and time delay setpoints with tolerances of the proposed design modifications.

(3) Technical Specifications changes for the design modifications including the setpoints (voltage and time) with tolerances, surveillance requirements, and limiting conditions for operation (including action statements).

(4) Verification that the time delay selected does not exceed the maximum time delay assumed in the FSAR accident analysis.

(5) Verifcation that the design modifications to the Class 1E power system will comply with all the requirements of IEEE 279-1971.

The licensee is bypassing the load-shed feature once the onsite sources are supplying the Class 1E equipment and is auto-reinstating the feature following breaker tripping. Therefore, NRC Staff Position 2 is met. Details of this circuitry modification was provided for the load-shed relays on the 4160-volt buses but not for the relays on the 480-volt load center buses. The licensee is required to submit details of the bypassing/reinstatement at the 480-volt level.

The licensee has not provided appropriate Technical Specifications which demonstrate that the testing requirements of NRC Staff Position 3 are met. Therefore, the licensee is required to submit Technical Specifications to include test requirements which will demonstrate the full functional operability and independence of the onsite sources. The tests are to simulate loss of offsite power in conjunction with an SI and the interruption of the onsite sources with subsequent reconnection. These requirements will verify that there is no adverse interaction between onsite and offsite sources and the load-shed feature and the load-shed bypassing circuitry.

REFERENCES

1. NRC letter to Florida Power and Light Company (FPL), dated June 2, 1977.

2. FPL letter (R. E. Uhrig) to NRC (George Lear), dated July 21, 1977.

3. FPL letter (R. E. Uhrig) to NRC (W. G. Gammill), dated November 9, 1979.

4. FPL letter (R. E. Uhrig) to NRC (T. M. Novak), dated January 14, 1981.

5. FPL letter (R. E. Uhrig) to NRC (T. M. Novak), dated May 10, 1982.

6. Code of Federal Regulations, Title 10, Part 50 (10 CFR 50), General Design Criterion 17 (GDC 17), "Electric Power Systems" of Appendix A "General Design Criteria for Nuclear Power Plants."

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

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