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TECHNICAL EVALUATION REPORT ON THE PROPOSED DESIGN MODIFICATIONS AND TECHNICAL SPECIFICATION CHANGES ON GRID VOLTAGE DEGRADATION FOR THE ST. LUCIE NUCLEAR POWER PLANT, UNIT 1

(Docket No. 50-335)

James C. Selan

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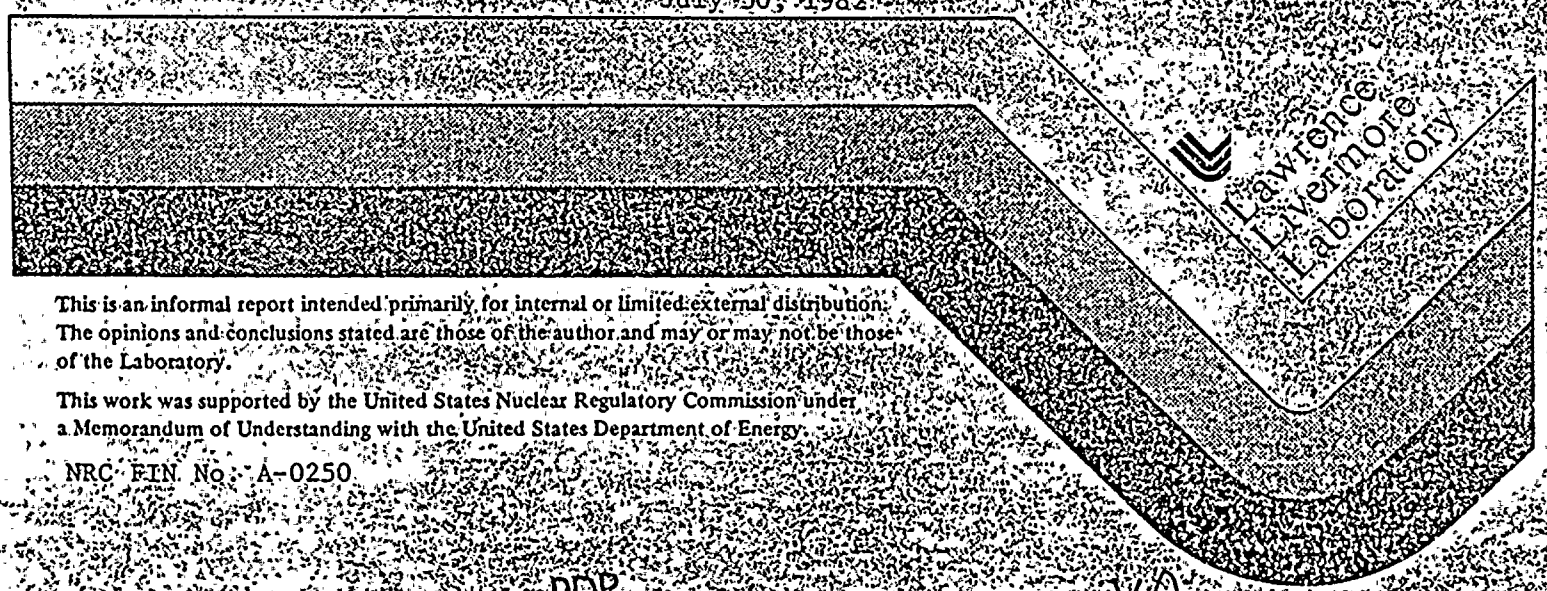

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NRC FIN No. A-0250

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 St. Lucie Nuclear Power Plant, Unit 1. 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

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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 St. Lucie Nuclear Power Plant, Unit 1, 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. 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 25, 1977 [Ref. 2], November 9, 1979 [Ref. 3], July 3, 1980 [Ref. 4], March 18, 1982 [Ref. 5], and May 24, 1982 [Ref. 6], 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. 7].

(2) IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" [Ref. 8].

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

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

3. EVALUATION

3.1 EXISTING UNDERVOLTAGE PROTECTION

The present design at St. Lucie, Unit 1, utilizes one undervoltage relay on each of three 4160-volt Class 1E buses. The relay is an induction disc type (CV-2) which inversely relates time and voltage. That is, the lower the bus voltage, the faster the relay responds. The relay's voltage setpoint is 88.34% of 4160 volts (3675 volts) with a time dial setting of 1. This setting corresponds to relay actuation in 6 seconds at 79.5% of 4160 volts (3307 volts) or in 3 seconds at 70% of 4160 volts (2912 volts). The 88.34% voltage relay setpoint corresponds to 85% voltage (408 volts) at the 480-volt MCC buses where undervoltage is monitored by an annunciator/alarm system.

The function of the relay is to initiate source disconnection, load shedding, diesel generator starting, and load sequencing whenever the voltage and time delay setpoints are exceeded on its respective bus.

The relay is automatically bypassed approximately .2 seconds after the diesel generator breakers are closed. Should the diesel generator breakers trip open, the relay and load shedding logic is automatically reinstated.

3.2 MODIFICATIONS

The licensee is proposing a design change to the existing undervoltage protection system. This design change will add a second CV-2 relay to each 4160-volt Class 1E bus. This relay will be in parallel to the existing relay with their normally closed contacts series connected to produce a 2-out-of-2 coincident logic. The function of these relays will remain the same (i.e., source disconnection, load shedding, diesel generator starting, and load sequencing on the effected train).

A second design change, which is already implemented [Ref. 6] was the addition of an undervoltage relay on each 480-volt Class 1E load center bus. This relay has a voltage setpoint of 429 volts (89.4% of 480 volts) with a time delay of 1 second. This relay is interlocked with a safeguard signal. Therefore, for a sustained degraded voltage concurrent with a safeguard signal, automatic offsite source disconnection, load shedding, diesel generator starting, and load sequencing will occur. This system will also be bypassed 0.2 seconds after diesel generator breaker closing and auto-reinstated following breaker tripping.

Both of the above systems at each voltage level are train independent of each other. That is, there are no interties between the A and B load group buses load shedding and diesel generator starting. Only the effected bus will be disconnected with the remaining train still connected to its source.

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 is still analyzing the voltage requirements of the Class 1E equipment with the voltage operating time curves for the selected relays. This analysis is being done to verify that the setpoints selected are adequately protecting all Class 1E equipment at each voltage distribution level. The licensee is required to submit this verification of setpoint selection.

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

With the addition of a second CV-2 relay on each 4160-volt Class 1E bus, spurious trips will be precluded with the 2-out-of-2 logic. By interlocking the safeguard signal with the undervoltage relay on each 480-volt Class 1E load center bus, a failure of the relay will not cause a spurious disconnection from the offsite source. However, a spurious actuation of the single relay following a safeguard signal would cause a spurious separation from the offsite source with load shedding and subsequent reloading on the effected train. To preclude spurious separations from the offsite sources, the licensee is required to install a second relay on the 480-volt Class 1E load centers to produce a minimum acceptable coincident logic of 2-out-of-2.

(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 provided the time delay with tolerances associated with the voltage setpoint of the CV-2 relays on the 4160-volt buses, nor the tolerances associated with the 1 second time delay of the 480-volt relays. Since the verification of the setpoint selection is still being analyzed by the licensee, an evaluation cannot be made until the final time delay and tolerances are provided. The licensee is required to verify that the selected time delays with tolerances do 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 inverse time characteristics of the CV-2 relay are designed such that the effects of short duration transients will be minimized. However, until the tolerances are submitted, an adequate determination cannot be made. The licensee is required to verify that the selected time delays with tolerances will minimize the effects of short duration transients.

(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 licensee is still verifying the Class 1E equipment voltage requirements with the operating time curves for the relays. Therefore, an evaluation cannot be completed. The licensee is required to verify that the time delays with tolerances will protect all 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 CV-2 relays 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 safeguard signal, the relay located on the 480-volt Class 1E load center buses 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. 6] that all the design modifications comply with the requirements of IEEE 279-1971. However, the failure of the single relay on the 480-volt load center bus would allow for no available protection of the Class 1E equipment. Therefore, with no protection available, adequate voltages cannot be assured to meet the design voltage ratings of the Class 1E equipment. Also during testing, maintenance, or calibration of the relays during power operation, undervoltage protection is not available. To meet all requirements of IEEE 279-1971, (i.e. single failure criterion, testibility, Class 1E system protection, etc.), the licensee is required to install additional relays to produce a minimum acceptable coincident logic scheme of 2-out-of-2.

(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 Specification changes to include trip setpoints with tolerances, surveillance requirements, and LCO's for the undervoltage relaying system.

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 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 occurs 0.2 seconds after the diesel generator breakers close and is auto-reinstated following breaker tripping. The licensee is required to submit details on the circuitry modifications for accomplishing this feature.

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.

Current Technical Specifications include tests which meet all the operational requirements of this position except for the auto-reinstatement of the load-shed feature and subsequent load sequencing following diesel generator breaker tripping. The licensee is required to include a test in the Technical Specifications to meet this requirement.

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 include:

(1) Trip setpoints of voltage and time with tolerances for the undervoltage relaying system.

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

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

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

(5) Test requirements to demonstrate the operability and independence of the onsite sources and the undervoltage relaying circuitry 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) Completed verification analysis which demonstrates that the voltage/time curve selected for the undervoltage relays is protecting all Class 1E equipment at all distribution voltage levels and will minimize the effects of short duration transients.

(2) Time delay associated with the CV-2 relay voltage setpoint (88.34% of 4160 volts) with tolerances for both voltage and time.

(3) Voltage and time delay tolerances associated with 480-volt load center relay.

(4) 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).

(5) Verification that the selected time delays with tolerances do not exceed the maximum time delay assumed in the FSAR accident analysis.

The design requirements of providing coincident logic and meeting IEEE 279-1971 are not met by the single relay installed on the 480-volt Class 1E load center buses. A spurious actuation of this relay following a safeguard signal would cause the spurious separation of the effected train from its preferred offsite source. The single relay does not meet the single failure criterion nor the testing/calibration/maintenance requirement of IEEE 279-1971. The failure of this single relay, or while being tested, maintained, or calibrated, would allow for no continued undervoltage protection of the Class 1E equipment. Therefore, to meet these requirements the

licensee must install additional relays to each 480-volt Class 1E load center bus. I recommend that additional relays be added to produce a minimum acceptable coincident logic scheme of 2-out-of-2. This logic scheme assures system reliability and meets IEEE 279-1971 requirements.

The licensee is bypassing the load-shed feature once the onsite sources are supplying the Class 1E equipment and will auto-reinstate the feature following breaker tripping. Therefore, NRC Staff Position 2 is met. The licensee is required to submit details of this circuitry modification for accomplishing this feature.

Existing Technical Specifications meet, in part, the requirements of NRC Staff Position 3. A test is required to be included in the Technical Specifications to demonstrate that following diesel generator breaker tripping, load-shedding, reconnection, and subsequent load sequencing occurs automatically. With this test included, all the requirements will be met.

REFERENCES

1. NRC letter to Florida Power and Light Company (FPL), dated June 3, 1977.
2. FPL letter (R. E. Uhrig) to NRC (Don K. Davis), dated July 25, 1977.
3. FPL letter (R. E. Uhrig) to NRC (W. G. Gammill), dated November 9, 1979.
4. FPL letter (R. E. Uhrig) to NRC (R. A. Clark), dated July 3, 1980.
5. FPL letter (R. E. Uhrig) to NRC (R. A. Clark), dated March 18, 1982.
6. FPL letter (R. E. Uhrig) to NRC (R. A. Clark), dated May 24, 1982.
7. 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."
8. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."
9. IEEE Standard 308-1974, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."