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TECHNICAL EVALUATION REPORT ON THE PROPOSED DESIGN MODIFICATIONS AND TECHNICAL SPECIFICATION CHANGES ON GRID VOLTAGE DEGRADATION FOR THE YANKEE ROWE NUCLEAR POWER STATION

(Docket No. 50-029)

James C. Selan

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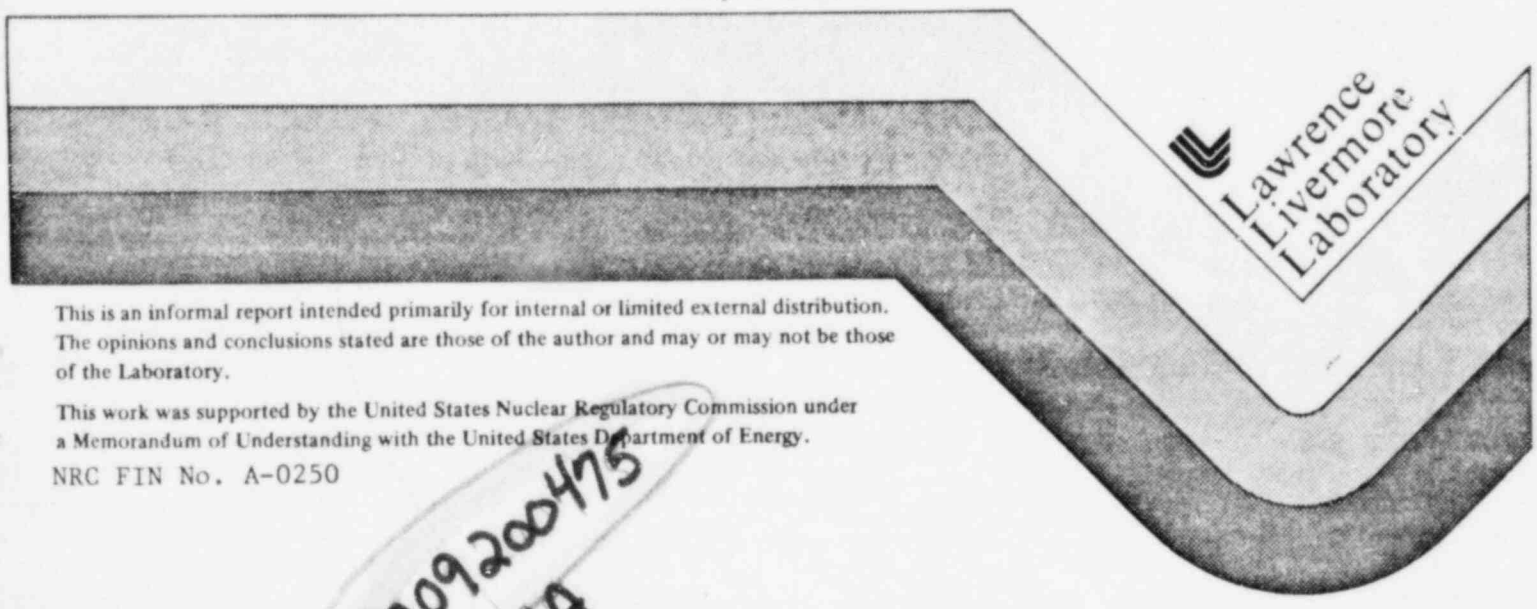

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ABSTRACT

This report documents the technical evaluation of the proposed design modifications and Technical Specification changes for protection of Class 1E equipment from grid voltage degradation for the Yankee Rowe Nuclear Power Station. The review criteria are based on several IEEE standards and the Code of Federal Regulations. The evaluation finds that the proposed design modifications and Technical Specification changes will ensure that the Class 1E equipment will be automatically protected from sustained voltage degradation concurrent with an accident. For non-accident conditions, plant procedures and the availability of redundant systems (pending NRC acceptance) ensure that if required, a safe shutdown of the plant could be obtained and maintained should the normally operating Class 1E equipment be lost under degraded grid conditions.

FOREWORD

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1. INTRODUCTION

By letter dated June 3, 1977 [Ref. 1], the U. S. Nuclear Regulatory Commission (NRC) requested the Yankee Atomic Electric Company (YAECO), 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 Yankee Rowe Nuclear Power Station. 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 18, 1977 [Ref. 2], March 29, 1978 [Ref. 3], July 24, 1980 [Ref. 4], May 5, 1981 [Ref. 5], May 19, 1982 [Ref. 6], June 24, 1982 [Ref. 7], and July 2, 1982 [Ref. 8], the licensee proposed certain design modifications to the undervoltage protection scheme, additions to the Technical Specifications, and limiting conditions of operation (LCO's). The design modifications include the installation of a degraded voltage protection system for the Class 1E equipment. The proposed additions to the Technical Specifications and LCO's are in regard to calibrations, surveillance requirements, test requirements, and "action" statements associated with the proposed voltage protection system.

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. 9].

(2) IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" [Ref. 10].

(3) IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations" [Ref. 11].

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

3. EVALUATION

3.1 EXISTING UNDERVOLTAGE PROTECTION

The existing undervoltage protection scheme uses an undervoltage relay (loss-of-voltage) on each of the three 480-volt Class 1E buses. The relay (induction disc type) is set to actuate in 1.8 seconds upon complete loss of power, 3.0 seconds at 277 volts (58% of 480 volts), and in 7.0 seconds at 370 volts (77% of 480 volts) with the tap setting of 105 volts. This tap setting corresponds to 399 volts or 83.25% of 480 volts. The actuation of this relay will energize an auxiliary relay which initiates the following actions:

(1) A lockout relay is picked up which isolates the 480-volt Class 1E buses, starts the diesel generators, and permits closure of the output breakers.

(2) Trips the high pressure safety injection (HPSI) pump.

(3) Once the diesels are up to speed and voltage, the breakers close de-energizing the auxiliary relay which then allows the start of the low pressure safety injection (LPSI) pump and the removal of the HPSI trip.

(4) The starting of the HPSI pump occurs 10 seconds after the start of the LPSI pump and recovery of the voltage to normal.

The load shedding feature for the HPSI pump is retained as no other loads are sequenced on following the HPSI pump start. The LPSI pump is never shed.

3.2 MODIFICATIONS

The licensee is proposing design changes to the undervoltage protection system. The first design change includes the adding of an additional relay to the existing loss-of-voltage relay to provide coincident logic in a 2-out-of-2 scheme. The remaining design changes include the adding of a second-level (degraded voltage) of undervoltage protection. This second level will consist of two additional relays on each 480-volt Class 1E bus in a 2-out-of-2 coincident logic scheme for breaker tripping. These relays are set to actuate at 91.5% $\pm$ 1% of 460 volts (421 volts) with a time delay of 10 seconds $\pm$ 1 second. Operation of this second level is as follows:

(1) Should the voltage degrade below that required for continuous operation for the Class 1E equipment (exceeding the relay setpoints), the relays will initiate an alarm to alert the operator of a degraded voltage condition. Upon receiving this alarm, the operator (through established plant procedures) will contact the Rhode Island, Eastern Massachusetts and Vermont Energy Control (REMVEC) system operator to request an assessment of the degraded voltage condition. Following the assessment, appropriate actions will then be taken to restore voltage. Should the restoration fail, the operator will initiate the offsite source disconnection and the onsite source re-connection.

(2) Should the voltage degrade below the relay setpoints concurrent with an accident signal, the disconnection of the degraded offsite source, load shedding, diesel generator starting, and subsequent load sequencing will occur automatically.

The licensee is also proposing to automatically reinstate the load-shed feature and subsequent load sequencing onto the diesel generators following diesel generator breaker tripping.

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 proposed setpoint of 91.5% ± 1% of 460 volts (421 volts) is above the -10% continuous voltage rating for the Class 1E equipment. The 10 second ± 1 second time delay was selected to prevent spurious actuation caused by grid fluctuations or voltage transients on the auxiliary power system.

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

The proposed second-level of undervoltage protection scheme is designed using a 2-out-of-2 coincident logic to preclude spurious trips.

(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 states that the time delay of 10 seconds ± 1 second does not exceed the time delay assumed in the FSAR accident analysis [Ref. 8].

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

The licensee's proposed time delay of 10 seconds ± 1 second was selected to override short duration voltage transients on the transmission and auxiliary power systems.

(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 voltage analysis which is documented in a seperate LLNL report entitled "Technical Evaluation Report on the Adequacy of Station Electric Distribution System Voltages for the Yankee Rowe Nuclear Power Station," (UCID No. 18966, TAC No. 12768) demonstrates that the proposed time delay of 10 seconds will not result in any failure of Class 1E systems or components.

(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 undervoltage protection system design changes will only allow for automatic disconnection from the degraded offsite sources whenever an accident condition occurs concurrently with a degraded grid voltage. Without an accident condition present, actuation of the second-level undervoltage protection scheme will initiate an alarm which signals the operator of a degraded voltage condition. Plant procedures will then direct the operator for corrective actions.

The licensee has provided justification for not providing automatic disconnection from the offsite source unless a SI signal is present. Detailed information on the following points of justification can be found in Refs. 4 and 6:

(a) Operating experience, i.e. the number of incidents of sustained degraded grid voltages experienced.

(b) Auto-tripping of plant could cause a "cascading effect" in the transmission distribution system (effect on other nuclear power plants).

(c) Availability of redundant systems not exposed to degraded voltages for obtaining and maintaining the plant in a safe shutdown.

The licensee has not provided the following information to support this method of providing undervoltage protection for the Class 1E equipment from sustained voltage degradation:

(a) Detailed plant procedures outling operator actions for voltage restoration during non-accident conditions.

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

The licensee states that the proposed design changes will satisfy the requirements of IEEE 279-1971 [Ref. 8].

(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 submitted draft Technical Specification changes to include the design changes of the undervoltage protection tection system. The changes include setpoints with tolerances, surveillance requirements and LCO's. The licensee is required to submit formal Technical Specification changes for the undervoltage protection 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 when the diesel generators are supplying the Class 1E buses and is proposing to auto-reinstate the load-shed feature 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 demonstrate the operability and independence of the onsite power sources (i.e. once per 18 months the simulating of loss-of-power in conjunction with a safety injection). The licensee submitted a draft Technical Specification change which included a test to simulate the interruption of the onsite sources with subsequent load shedding, reconnection, and load sequencing. The licensee is required to submit a formal Technical Specification change to include this test requirement.

3.4 TECHNICAL SPECIFICATION

The licensee has provided draft Technical Specification changes to reflect the proposed design modifications to the undervoltage protection system. Specifically, the proposed changes:

(1) Include the trip setpoints (voltage and time with tolerances) for the undervoltage protection relays.

(2) Provide the required coincident logic (2-out-of-2).

(3) Incorporate action statements regarding limiting conditions for operation when the number of operable channels for undervoltage protection is reduced.

(4) Provide the surveillance requirements for channel calibration during refueling shutdown and the monthly channel functional test.

(5) Include test requirements to demonstrate the operability and independence of the onsite sources and the operation of the undervoltage relaying modifications.

4. CONCLUSIONS

Based on the information provided by Yankee Atomic Electric Company, it has been determined that protection of the Class 1E equipment from sustained degraded grid voltages concurrent with an accident condition meet the requirements of NRC Staff Position 1. For non-accident conditions, the automatic disconnection requirement is not met. Instead of providing this automatic disconnection feature, the licensee maintains that by utilizing corrective measures by the plant operator and the REMVEC system control operator continued plant operation reduces the possibility of total collapse of the transmission system (i.e. cascading effect to other nuclear plants). The licensee provided a list of the available systems (not exposed to the degraded voltage condition) that can, if required, obtain and maintain the plant in a safe shutdown. Upon evaluation and acceptance of the list of available systems (not exposed to degraded voltages) by the Reactor Systems Branch of the NRC, I recommend that the alternative method be accepted.

The licensee is bypassing the load-shed feature to prevent adverse interaction when the onsite sources are supplying the Class 1E buses. The licensee is proposing to auto-reinstate the load-shed feature following diesel generator breaker tripping. Thus, NRC Staff Position 2 is met.

The proposed additions to the Technical Specifications and the testing of the logic circuitry meet the requirements of NRC Staff Position 3.

Accordingly, the licensee is required to submit the following information for NRC review:

(1) Detailed plant procedures defining operator actions being taken to restore adequate voltage to the Class 1E buses during non-accident conditions.

(2) Details of the circuitry modifications which accomplish the disabling of the load-shed feature when on the diesel generators and the auto-reinstatement of the load-shed feature following generator breaker tripping.

(3) Formal Technical Specification changes for the modifications to the undervoltage protection system and associated test requirements.

REFERENCES

1. NRC letter (A. Schwencer) to YAECO, dated June 3, 1977.

2. YAECO letter (E. W. Jackson) to the NRC, dated July 18, 1977.

3. YAECO letter (R. H. Groce) to the NRC, dated March 29, 1978.

4. YAECO letter (D. E. Vandenburgh) to the NRC, dated July 24, 1980.

5. YAECO letter (J. A. Kay) to the NRC (D. M. Crutchfield), dated May 1, 1981.

6. YAECO letter (J. A. Kay) to the NRC (D. M. Crutchfield), dated May 19, 1982.

7. YAECO letter (J. A. Kay) to the NRC (D. M. Crutchfield), dated June 24, 1982.

8. YAECO telecopy (Paul Johnson) to the NRC (Dick Prevatte), dated July 2, 1982.

9. 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."

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

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