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TECHNICAL EVALUATION REPORT ON THE PROPOSED DESIGN MODIFICATIONS AND TECHNICAL SPECIFICATION CHANGES ON GRID VOLTAGE DEGRADATION FOR THE SURRY POWER STATION, UNITS 1 AND 2

(Docket Nos. 50-280, 50-281)

James C. Selan

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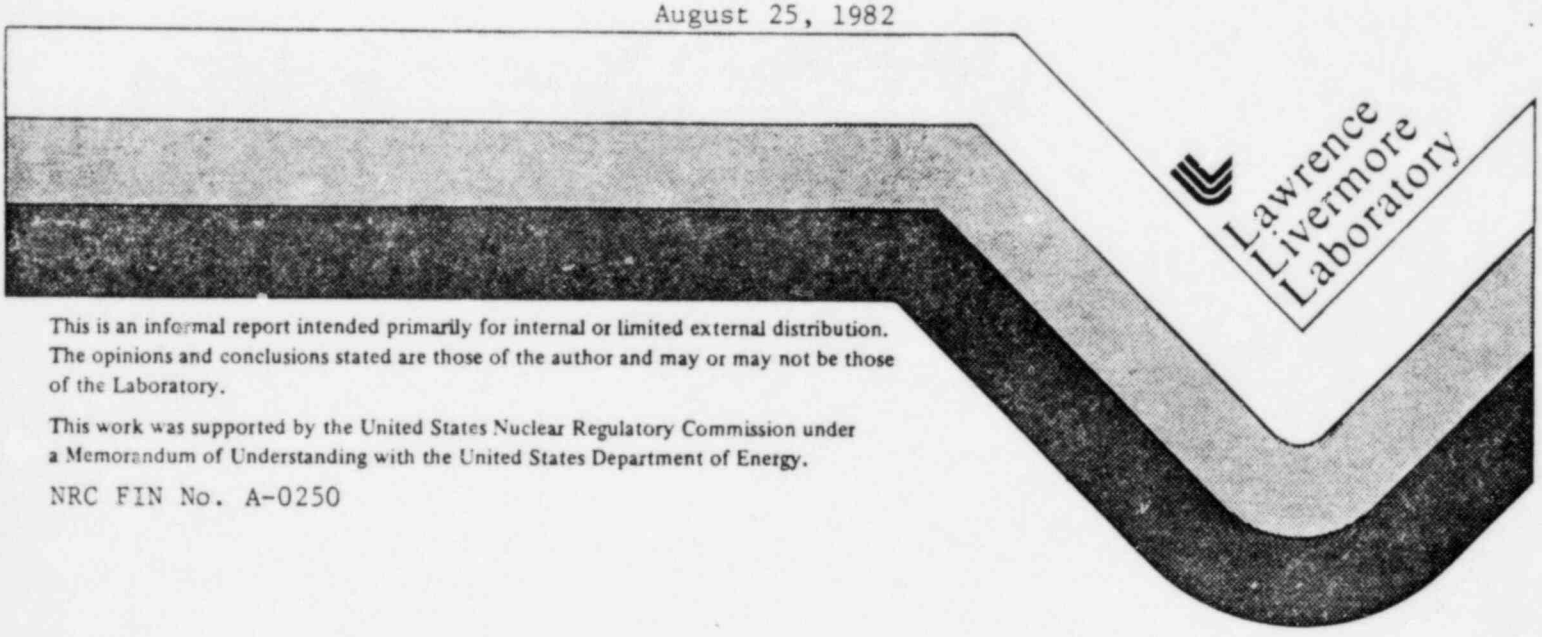

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ABSTRACT

This report documents the technical evaluation of the proposed design modifications and Technical Specification changes for protection of the Class 1E equipment from grid voltage degradation for the Surry Power Station, Units 1 and 2. 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 protected 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 the Virginia Electric and Power Company (VEPCO), 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 Surry Power Station, Units 1 and 2. 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 September 26, 1977 [Ref. 2], October 15, 1979 [Ref. 3], May 26, 1981 [Ref. 4], March 31, 1982 [Ref. 5], June 11, 1982 [Ref. 6], June 30, 1982 [Ref. 7], and August 10, 1982 [Ref. 8], the licensee proposed certain design modification details, additions to the Technical Specifications, and limiting conditions for operation (LCO's). The design modification details a degraded voltage protection system for the Class 1E equipment. The additions to the Technical Specifications and LCO's are in regard to calibrations, surveillance requirements, test requirements, and "action" statements associated with the existing undervoltage 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. 8].

(2) IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" [Ref. 9].

(3) IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations" [Ref. 10].

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

3. EVALUATION

3.1 EXISTING UNDERVOLTAGE PROTECTION

The Class 1E power system is supplied from the 34.5/4.16 kV reserve station service transformers (RSST's). The RSST's are equipped with automatic load tap changers (LTC) on the secondary side. The LTC's provide an output voltage adjustment of ±10% voltage over full range operation by 32 taps, each of 0.625% voltage adjustment. Each tap change takes approximately 1.9 seconds.

The present undervoltage protection system design consists of two undervoltage relays on each 4160-volt Class 1E bus in a 2-out-of-2 coincident logic. After a bus voltage of 84% of 4160 volts (3494 volts) for 12 seconds, the relays initiate diesel generator starting. Continued voltage degradation to 79.5% of 4160 volts (3307 volts) for 12 additional seconds will cause the relays to initiate bus disconnection from the offsite source, load shedding of certain loads, and diesel generator breaker closing.

Another level of undervoltage protection exists on 4 kV transfer buses D, E, and F in a 2 out-of-2-coincident logic. This detection system has a voltage setpoint of 45.8% of 4160 volts (1905 volts). Actuation of these relays will automatically start the auxiliary feedwater pump and align appropriate MOV's under CLS conditions.

The existing design does not have a feature to automatically load shed the normally running loads on the Class 1E buses when transferring from the offsite sources to the diesel generators. The only loads which are automatically shed in the transfer are the residual heat removal (RHR) and component cooling (CC) pumps. These loads are connected to the stub buses which are fed from the 4160-volt Class 1E buses. After the diesel generator breaker closes and the bus voltage returns above the 79.5% voltage setpoint, the load shedding capability is restored for the RHR and CC pumps. Following diesel generator breaker tripping, manual load shedding may be required to limit the starting load on the bus after manually resetting and reclosing the breaker.

3.2 MODIFICATIONS

The licensee has proposed the following modifications to the existing undervoltage protection scheme (first level) in addition to adding a second level of undervoltage protection for sustained degraded voltages. The existing first-level scheme will be modified to a 2-out-of-3 coincident logic system. This scheme will initiate the automatic transfer of the Class 1E buses from the offsite source to the diesel generator at a voltage setpoint of 75% $\pm$ 1% of 4160 volts (3120 volts) with a time delay of 2 seconds, + 5 seconds, - 0.1 seconds. The functions of these relays remain the same.

The second-level scheme will consist of adding three undervoltage and time-delay relays on each 4160-volt Class 1E bus in a 2-out-of-3 coincident logic scheme. Additional auxiliary relays and alarms will also be incorporated into the design. The two different types of auxiliary relays to be used will operate in 0.014 and 0.084 seconds. The setpoints for this system are 90% $\pm$ 1.0% of 4160 volts (3744 volts) with a time delay of 7 $\pm$ 0.35 seconds for a safety injection (SI) or consequence limiting sequence (CLS) and 90% $\pm$ 1.0% of 4160 volts (3744 volts) with a time delay of 60 $\pm$ 3 seconds for non-accident conditions. System operation is as follows:

(1) For voltage degradation to 90% of 4160 volts, the 2-out-of-3 logic scheme will initiate an alarm in the control room at 10 seconds, start the diesel generators at 50 seconds, and transfer the Class 1E buses from the offsite source to the diesel generators at 60 seconds. If an SI or CLS signal is concurrent with the degraded voltage, the 10, 50, and 60 second time delays are bypassed and a 7 second time delay is used. At 7 seconds the diesel generators receive a start signal and the transfer from offsite to onsite power is initiated.

(2) Upon transfer initiation for an SI or CLS condition, the offsite source feeder breakers to the Class 1E buses, the stub bus tie breaker, the RHR and CC pumps, and a charging pump are automatically tripped.

(3) Once the diesel generators reach a specified level of rated speed and voltage, the output breakers close 2 seconds after the feeder breaker opens. Upon closing of the breaker the first and second levels of undervoltage protection are automatically bypassed. Following breaker tripping, both levels of protection are automatically reinstated.

(4) For an SI condition concurrent with undervoltage actuation, the charging pump, low head safey injection pump, and the filter exhaust fans receive immediate starting signals. At 50 seconds after the SI, the steam generator auxiliary feedwater pumps are started.

(5) For a CLS condition concurrent with undervoltage actuation, the loads associated with a SI plus the containment spray pumps receive immediate start signals. In addition to the starting of the steam generator auxiliary feedwater pumps at 50 seconds, the inside recirculation spray pumps start at 120 seconds and the outside recirculation spray pumps start at 300 seconds.

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's analysis shows that the setpoint of 90% of 4160 volts (3744 volts) with a time delay of 7 seconds for an accident condition or 60 seconds for a non-accident condition will provide protection of all Class 1E equipment including relays, contactors, and other components whose functional performance would be inadequate because of undervoltage.

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

The proposed modifications incorporate a 2-out-of-3 coincident logic to preclude spurious tripping from the offsite source.

(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 maximum time delay assumed in the FSAR accident analysis is 10 seconds. That is, the diesel generators must be up to speed and voltage and accepting load within 10 seconds. The time delay of 7 $\pm$ .35 seconds (for accident conditions) and the 2 seconds, + 5 seconds, - 0.1 second for diesel generator breaker closure do not exceed the 10 second time delay.

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

The time delays selected are long enough to override any 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's analysis has shown that the time delays will not cause the failure of any equipment connected to and associated with the Class 1E power system.

(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 2-out-of-3 coincident logic of the undervoltage relays will initiate the automatic disconnection of the Class 1E buses from the offsite source whenever the voltage and time delay setpoints are exceeded.

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

The licensee states and my review finds that the proposed modifications will comply with the requirements of IEEE 279-1971.

(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 submitted draft Technical Specifications for the proposed design modifications which included trip 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 documented in the Technical Specifications. The load-shedding feature must also be reinstated if the onsite source supply breakers are tripped.

The undervoltage relays (both first and second levels) are disabled once the diesel generators are supplying the Class 1E buses. This allows for the loads starting not to interact with the load shedding feature. Following tripping of the onsite sources the undervoltage relays are reinstated.

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 will verify the requirements of the NRC with a test of the system by simulating a loss of offsite power in conjunction with a LOCA signal. The test sequence will be bus de-energization, load shedding, voltage restoration, and load sequencing. The operating time on emergency onsite power will be at least 5 minutes with full load. The licensee will also interrupt the diesel generator power source while they are supplying the Class 1E buses to test the reinstatement of the load-shedding circuitry, the load-shedding operation and then upon re-energization of the onsite power source, test the load-sequencing circuitry.

3.4 TECHNICAL SPECIFICATIONS

The changes proposed by VEPCO to the Surry Power Station, Units 1 and 2 Technical Specification, reflect the proposed design modifications. Specifically, the proposed changes:

(1) Include the trip setpoints for the loss of voltage scheme of 75% $\pm$ 1% of 4160 volts (3120 volts) with a time delay of 2 seconds, + 5 seconds, - 0.1 second.

(2) Include the trip setpoints for the degraded voltage scheme of 90% ± 1% of 4160 volts (3744 volts) with a time delay of 60 ± 3 seconds for non-CLS or non-SI conditions and 7 ± 0.35 seconds for CLS or SI conditions.

(3) Provide the required coincident logic (2-out-of-3).

(4) Provide the surveillance requirements to demonstrate at least once per 18 months that the loss of offsite power in conjunction with an SI signal will provide the sequence of Class 1E bus de-energization, load shedding, voltage restoration, and load sequencing. Also, that upon interruption of the onsite sources the loads are shed, buses re-energized, and subsequent load sequencing occurs as designed.

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

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

4. CONCLUSIONS

Based on the information submitted by VEPCO, it has been determined that the proposed design modifications and Technical Specification changes meet the requirements of NRC Staff Position 1. The voltage trip settings and time delays for both accident and non-accident conditions will automatically protect the Class 1E equipment from sustained voltage degradation.

The licensee is automatically bypassing the load-shed feature once the diesel generators are supplying the Class 1E buses and will auto-reinstate the load-shed feature following generator breaker tripping. Therefore, NRC Staff Position 2 is met.

The proposed additions to the Technical Specifications and the method of testing the logic circuitry have been reviewed and found to meet the requirements of NRC Staff Position 3.

The licensee is required to submit formal Technical Specifications to document the modifications to the undervoltage protection scheme and the onsite source test requirements.

Accordingly, I recommend that the NRC approve the proposed design modifications and proposed Technical Specifications changes.

REFERENCES

1. NRC letter to VEPCO, dated June 3, 1977.

2. VEPCO letter (C. M. Stallings) to NRC (E. G. Case), dated September 26, 1977.

3. VEPCO letter (C. M. Stallings) to NRC (H. R. Denton), dated October 15, 1979.

4. VEPCO letter (P. R. Sylvia) to NRC (H. R. Denton), dated May 26, 1981.

5. VEPCO letter (R. H. Leasburg) to NRC (H. R. Denton), dated March 31, 1982.

6. VEPCO letter (R. H. Leasburg) to NRC (S. A. Varga), dated June 11, 1982.

7. VEPCO letter (R. H. Leasburg) to NRC (S. A. Varga), dated June 30, 1982.

8. Telecopy (G. S. Shukla) to NRC (D. Prevatte), dated August 10, 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."