UCID- 19115 - Revision 1

TECHNICAL EVALUATION REPORT (REVISION 1) ON THE PROPOSED DESIGN MODIFICATIONS AND TECHNICAL SPECIFICATION CHANGES ON GRID VOLTAGE DEGRADATION FOR THE PEACH BOTTOM ATOMIC POWER STATION UNITS 2 AND 3

(Docket Nos. 50-277, 50-278)

James C. Selan

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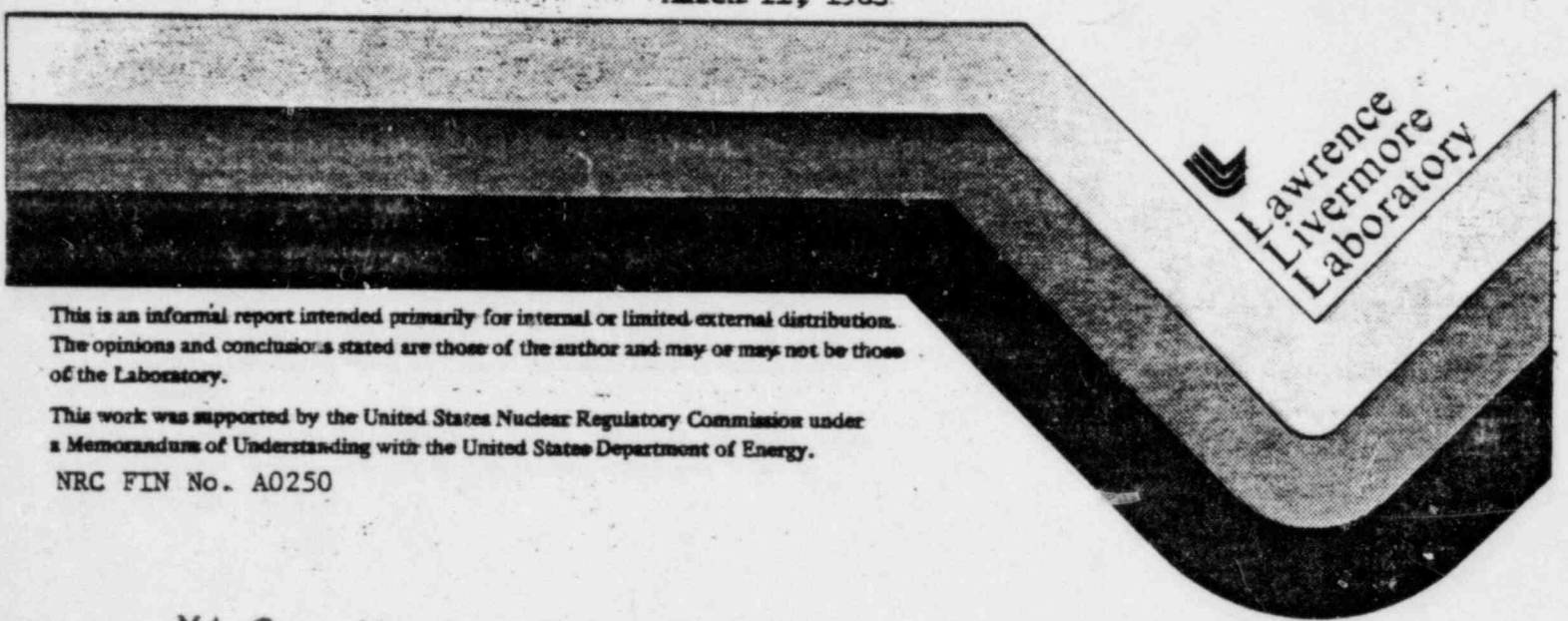

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ABSTRACT

This report is a revision of the technical evaluation documented in a separate report dated November 3, 1981 (UCID-19115) on the proposed design modification and Technical Specification changes for the protection of the Class 1E equipment from grid voltage degradation for the Peach Bottom Atomic Power Station, Units 2 and 3. The review criteria are based on several IEEE standards and The Code of Federal Regulations. The evaluation compares the submittals made by the plant with the NRC staff positions and the review criteria. The evaluation finds that the proposed design modifications and the required changes to the Technical Specifications will ensure that the Class 1E equipment will be protected from sustained voltage degradation.

FOREWORD

This report is supplied as part of the Selected Operating Reactor Issues Program II 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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1. INTRODUCTION

By letter dated June 2, 1977 [Ref. 1], the U. S. Nuclear Regulatory Commission (NRC) requested Philadelphia Electric Company, the licensee, to assess the susceptibility of the Peach Bottom Atomic Power Station, Units 2 and 3 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 2, 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 Specifictions be incorporated into the facility's operating license.

By letters dated July 21, 1977 [Ref. 2], December 22, 1977 [Ref. 3], December 31, 1979 [Ref. 4], March 21, 1980 [Ref. 5], February 13, 1981 [Ref. 6], June 16, 1981 [Ref. 7], July 22, 1981 [Ref. 8], May 12, 1982 [Ref. 9], July 22, 1982 [Ref. 10], and October 29, 1982 [Ref. 11], the licensee proposed certain design modifications, additions to the licensee's Technical Specifications, and limiting conditions for 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.

This report is a revision of the technical evaluation documented in a separate report dated November 3, 1981 (UCID-19115) based on new information submitted in References 9, 10, and 11.

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," in the Code of Federal Regulations, Title 10, Part 50 (10 CFR 50), [Ref. 12].

(2) IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" [Ref. 13].

(3) IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations" [Ref. 14].

(4) NRC positions as stated in a letter dated June 2, 1977 [Ref. 1].

3. EVALUATION

3.1 EXISTING UNDERVOLTAGE PROTECTION

A one-line diagram of Peach Bottom Atomic Power Station's Unit 2 and 3 (Peach Bottom) electrical distribution system is shown in Figure 1. This figure was adapted from Figure 1 of a September 15, 1976, Philadelphia Electric Company letter to the NRC [Ref. 15]. There are eight 4160-volt Class 1E buses. Under normal operating conditions these buses are energized from the offsite power sources through emergency transformers No. 2 and No. 3. Emergency transformer No. 2 is energized by startup transformer No. 2 which is equipped with automatic tap changers. With sustained grid voltage fluctuations, the automatic tap changer will index every 3-5 seconds after an initial 30 second time delay. Emergency transformer No. 3 is energized by a 50 MVA regulating auto transformer. The unit auxiliary buses are normally energized by the main generator. Upon shutdown of the main generator because of an accident or a transient trip, the unit auxiliary buses are automatically transferred to the offsite power sources.

The present design uses three sets of relays to detect a loss of voltage, shed the load, and restore the voltage on each of the eight 4160-volt emergency buses. Each set of relays and its function on a typical emergency bus is as follows:

(a) Two inverse time-delay voltage relays (type IAV) monitor the voltage on the source side of each of the two breakers feeding a Class 1E bus. These relays are set to operate at 60% $\pm$ 5% of

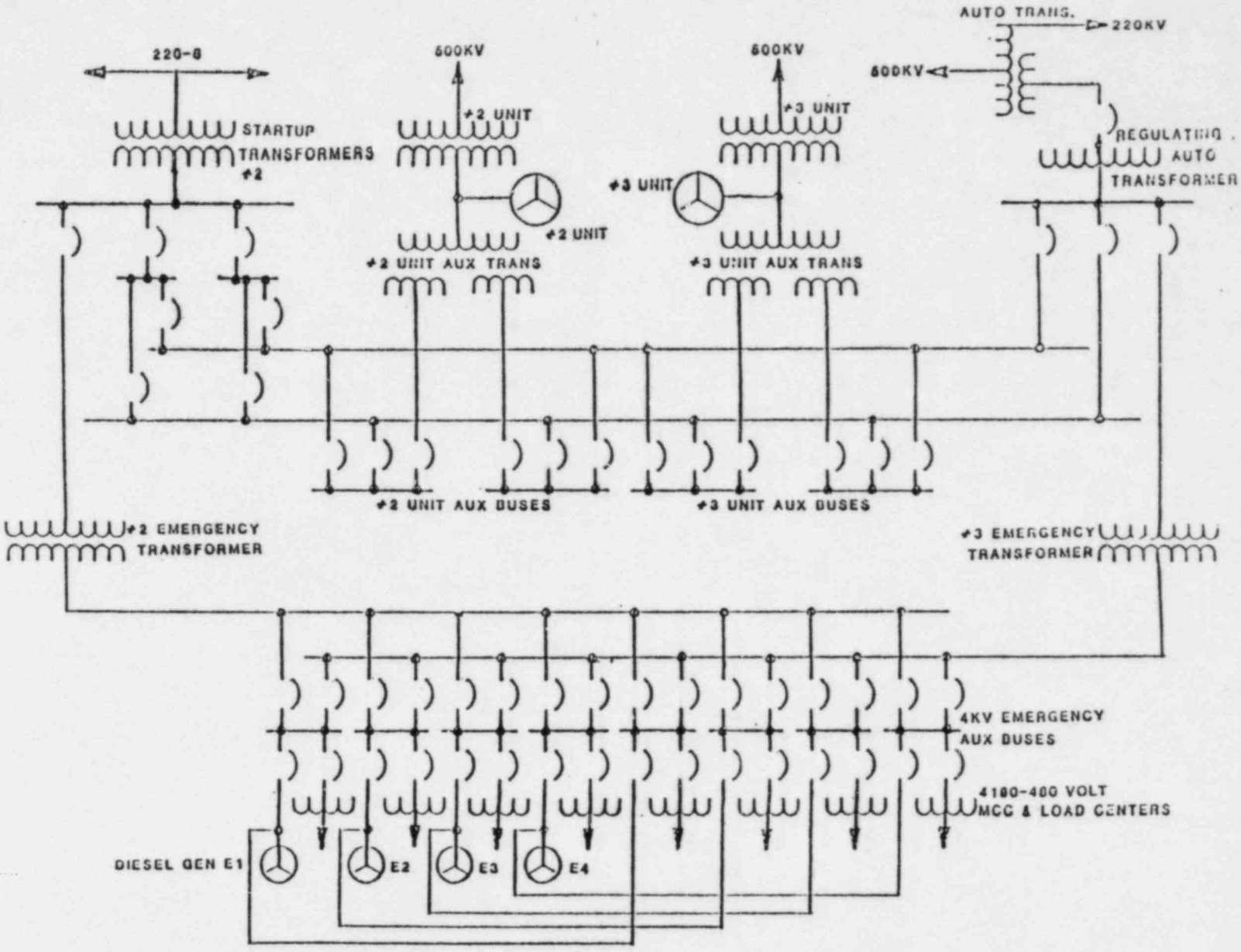

FIGURE 1 PEACH BOTTOM ATOMIC POWER STATION ELECTRICAL ONE-LINE DIAGRAM

of 4160 volts with a time delay of 1.8 seconds at 0 volts. The function of this set of relays is to sense a loss of voltage and trip the source breaker to its respective bus.

(b) An HGA relay (instantaneous) monitors the voltage on each bus. The relay functions with no appreciable time delay when the voltage falls below 25% ± 5% of 4160 volts. The function of this relay is to initiate load shedding and to provide a permissive signal to transfer the bus to the alternate source, or if the alternate source is not available, to start the emergency diesel generator.

(c) A third relay monitoring the bus voltage is an SV relay. It will actuate at 95% + 0%, - 10% of 4160 volts. The function of this relay is to initiate load sequencing once the voltage has been restored to the Class 1E bus.

Load shedding is maintained on the Class 1E buses when they are energized by the emergency generators. However, the load-shedding circuitry is not initiated until the voltage falls below 25% ± 5% of 4160 volts.

3.2 MODIFICATIONS

The licensee has proposed a design change for automatic degraded voltage protection on all Class 1E buses. The modification will incorporate the addition of an ITE-27D relay and a CV-6 relay to monitor the feeders to all 4160-volt Class 1E buses. An additional timing relay will be added to operate off the output of the ITE-27D relay. This relay is identified as a TR electronic timing relay.

The ITE-27D relay will operate a 60-second timer. If the voltage should fall below a setpoint of 3745 volts (90% ± 2% of 4160 volts) for more than 60 seconds ± 5%, the combination of the ITE-27D relay actuation and the timer timing out will trip the associated feeder breaker. The loss-of-voltage circuitry will then initiate the transfer of the bus to an alternate source. The time delay of 60 seconds is necessary to allow the automatic tap changers on the transformers to attempt to correct the voltage problem.

The CV-6 relay is an inverse time voltage relay. It will have a setpoint of 3619 volts (87% ± 5% of 4160 volts). The time delay of this relay will never be greater than the 60 second time delay of the ITE-27D relay. The CV-6 relay's function is similar to the ITE-27D relay; that is, to detect a degraded voltage and upon timing out, disconnect the Class 1E bus from the degraded source, and initiate the transfer to an alternate source. The relay will operate in 30 seconds (± 10%) at 2940 volts (71% of 4160 volts).

The TR relay will have a time delay of 6 seconds ± 5%. This relay will initiate an alarm in the control room and set up a permissive circuit for separation of the Class 1E buses from the offsite source in the event of

a degraded voltage condition and a subsequent SI signal. The purpose of this relay is to bypass the 60-second timer used with the ITE-27D relay. It will bypass the timer only in conjunction with an SI signal.

The licensee will maintain the load-shedding feature when the Class 1E buses are being energized by the diesel generators. The setpoint for the load-shedding feature is 25% ± 5% of 4160 volts (1248 volts to 832 volts). The Peach Bottom Technical Specifications presently contain the maximum and minimum limits of the load-shedding relays.

3.3 DISCUSSION

This section presents a statement on the NRC staff position from their June 2, 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."

With the licensee's proposed modification, two second-level undervoltage relays would monitor each offsite source to each 4160-volt Class 1E bus. This makes a total of four second-level undervoltage relays per bus. Two of the relays are ITE-27D relays with a setpoint of 90% ± 2% of 4160 volts. The other two relays are CV-6 relays with a setpoint of 87% ± 5% of 4160 volts. The 480-volt and lower voltage Class 1E buses are energized through transformers from these 4160-volt buses.

The ITE-27D relay is an instantaneous relay which starts a 60-second timer. The 60-second time delay is used to allow the automatic tap changers on the offsite power source sufficient time to index to try to correct the degraded voltage condition. The CV-6 relay is an inverse time-voltage relay set to actuate in 30 seconds (± 10%) at 2940 volts.

In addition to the ITE-27D relays and CV-6 relays, a TR electronic timing relay would be added to the output of the proposed second-level undervoltage logic scheme. The TR relay would have a time delay of 6 seconds. The function of the TR relay would be to set up a permissive signal to separate the Class 1E buses from the degraded offsite source. This

signal would only be used when an SI signal is also present. The object of the TR relay is to bypass the 60 second timer when an SI signal is present. The licensee's analysis demonstrates, and we concur, that these setpoints and time delays are satisfactory for continuous operation of 4160-volt and 480-volt Class 1E loads.

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

The modification proposed by the licensee does not include coincident logic of the undervoltage relays. There are two second-level undervoltage relays on each source energizing the emergency buses. These relays are independent of each other, and each has the function of removing the bus from the degraded source. If a degraded condition persists on one source and the alternate offsite source is available, the bus will be transferred to it. If the alternate source is unavailable, an emergency diesel start would be initiated and the bus transfer would be made to the onsite source.

The NRC requirement is that IEEE 279-1971 should be met. Paragraph 4.11 of this standard states that "The system shall be designed to permit any one channel to be maintained, and when required, tested or calibrated during power operation without initiating a protective action at the system levels." Paragraph 4.12 states that "Where operating requirements necessitate automatic or manual bypass of a protective function, the design shall be such that the bypass will be removed automatically whenever permissive conditions are not met."

The licensee maintains that the logic system at Peach Bottom offers equivalent protection to that required by the NRC. This is based on their argument that coincident logic is maintained at a system level. The actuation of one relay will not remove the Class 1E bus from the preferred offsite source but will merely transfer it to the other offsite source. In addition, the licensee argues that "channel bypasses" will be used for testing purposes. The bypass interval required for test, calibration or maintenance can be shown to be very short compared to the time in normal service. While this test block is in place for one Class 1E bus, an indicator would be actuated in the control room to show the presence of the block. The other three Class 1E buses would still have automatic protection.

We find the system as proposed by the licensee to be an acceptable protection system with regards to the coincident logic requirement.

(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 voltage setpoints, time delays, and logic scheme will not add to or exceed the time delay assumed in the FSAR accident analysis. This is assured through the use of a TR electronic timing relay with a time delay of 6 seconds. This relay will bypass the predominating 60-second timer in the event of a degraded grid signal and a subsequent SI signal.

(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 60 seconds is long enough to override any disturbances of short duration and long enough to allow the automatic tap changers to try to correct a degraded voltage condition. The 6-second time delay of the TR relay will also be long enough to prevent separation of the Class 1E buses from the offsite source for motor starting transients. The time delay of the CV-6 relay (inverse time), which will never be greater than the 60 seconds for the ITE relay, is also long enough to minimize the effect 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."

A review of the licensee's voltage analysis indicates that the time delay will not cause the failure of any equipment connected to and associated with the 4160-volt and 480-volt Class 1E emergency power systems.

(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 degraded voltage protection logic automatically disconnects the degraded offsite power source from the Class 1E emergency bus experiencing degraded voltage and initiates a transfer to the alternate offsite source if available. If the alternate source is unavailable, the transfer will be to the emergency diesel generator.

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

The licensee states that the relays will be installed in and considered part of the Class 1E switchgear" [Ref. 4].

(6) "The Technical Specifications shall include limiting conditions for operations, surveillance requirements, trip set points with minimum and maximum limits, and allowable values for the second-level voltage protection monitors."

The licensee has submitted, in part, acceptable Technical Specification changes which included limiting conditions for operation, surveillance requirements, voltage trip setpoints with minimum and maximum limits, and time delays with tolerances for the undervoltage protection schemes (see Section 3.4). Those changes to the Technical Specifications which are not acceptable are the increased time intervals in the surveillance requirements. The licensee has provided an acceptable basis for not performing a channel check surveillance in that the check would be redundant and only indicate whether AC or DC power is available to the relays. Because of the system design (undervoltage protection), loss of AC power would trip the feeder breaker and initiate a bus transfer while also annunciating in the control room. Loss of DC power would also annunciate a control room alarm. The licensee's basis for not performing a monthly functional test is based only on the high degree of reliability of the relays used. A monthly functional test would verify to a greater degree the operability of the trip and alarm functions.

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 proposes to maintain the load-shedding feature when the Class 1E buses are being energized by the onsite source. The setpoint for the load-shedding feature is 25% $\pm$ 5% of 4160 volts (1248 volts - 832 volts). These values are presently listed in the licensee's Technical Specifications for the Peach Bottom plant.

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 station electric distribution system operation by simulating the loss of offsite power in conjunction with a safety injection actuation signal once every operating cycle. The operating time on emergency onsite power will be at least 5 minutes. The licensee affirms that interruption of the diesel generators to test load-shedding and load-sequencing is not a necessary test for the Peach Bottom units. The plant's tests are presently covered in Peach Bottom Technical Specification 4.9.A.1.b.

3.4 TECHNICAL SPECIFICATIONS

The changes to the Technical Specifications submitted by the licensee reflect the design modifications to the undervoltage protection schemes. Specifically, the changes include:

(1) The voltage trip setpoint with time delays for the instantaneous relays (ITE-27D) of 90% (± 2%) of 4160 volts with a definite time delay of 60 seconds (± 5%) for non-accident conditions and 6 seconds (± 5%) for accident conditions.

(2) The voltage trip setpoint for the inverse time-delay relays (CV-6) of 87% (± 5%) of 4160 volts.

(3) Action statements regarding limiting conditions for operation when the number of operable channels cannot be met.

(4) The surveillance requirements for providing a channel calibration once per operating cycle, a functional test once per operating cycle and no channel check.

Formal changes to the Technical Specifications still required by the licensee are to include:

(1) The time delay for surveillance requirements for the CV6 relays of 30 seconds (± 10%) at 2940 volts and for the IAV relays of 1.8 seconds (± 10%) at 0 volts.

(2) The frequency of the surveillance requirements to conform to the Standard Technical Specifications for the instrumentation of the Engineered Safety Features system of a monthly functional test and a channel calibration once per operating cycle for the undervoltage protection schemes.

4. CONCLUSION

Based on the information provided by Philadelphia Electric Company, it has been determined that the proposed design modifications comply with NRC Staff Position 1. All of the staffs requirements and design basis criteria have been met with the exception of incorporating all the required changes to the Technical Specifications. Those changes still required pertain to the time delay surveillance setpoints for the CV6 and LAV relays and the surveillance frequency of a monthly functional test and a once per operating cycle calibration for the undervoltage protection schemes.

The licensee will maintain the load-shedding feature when the Class 1E buses are being energized by the onsite source. As the load-shedding setpoint is 25% of nominal voltage and the setpoints are included in the Technical Specifications, the intent of NRC Staff Position 2 is met.

The existing Technical Specifications for Peach Bottom meet the intent of NRC Staff Position 3 for testing the undervoltage detection system and emergency generator power system.

Accordingly, I recommend that the NRC approve the proposed design modifications, and upon receipt of the formal Technical Specifications accept those required changes which will insure that the Class 1E equipment will be protected from sustained degraded voltages.

REFERENCES

1. NRC letter (G. Lear) to Philadelphia Electric Co. (E. G. Bauer, Jr.), dated June 2, 1977.

2. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (G. Lear), dated July 21, 1977.

3. Philadelphia Electric Co. letter (E. J. Bradley) to the NRC, dated December 22, 1977.

4. Philadephia Electric Co. letter (S. L. Daltroff) to the NRC (T.A. Ippolito), dated December 31, 1979.

5. Philadelphia Electric Co. letter (E. J. Bradley) to the NRC (H. R. Denton), dated March 21, 1980.

6. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (R. W. Reid), dated February 13, 1981.

7. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (J. F. Stolz), dated June 16, 1981.

8. Philadelphia Electric Co. letter (J. W. Gallagher) to the NRC (J. F. Stolz), dated July 22, 1981.

9. Philadelphia Electric Co. letter (E. J. Bradley) to the NRC (H. R. Denton), dated May 12, 1982.

10. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (J. F. Stolz), dated July 22, 1982.

11. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (J. F. Stolz), dated October 29, 1982.

12. 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."

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

14. IEEE Standard 308-1974, "Criteria for Class IE Power Systems for Nuclear Power Generating Stations."

15. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (George Lear), dated September 15, 1976.