27
12/23/81.
(85) NTIS I-529
①
UCID--19115

DE82 005460

MASTER

TECHNICAL EVALUATION OF THE
PROPOSED DESIGN MODIFICATIONS AND TECHNICAL
SPECIFICATION CHANGES ON GRID VOLTAGE
DEGRADATION (PART A) FOR THE PEACH BOTTOM
ATOMIC POWER STATION, UNITS 2 AND 3

Robert L. White

SELECTED ISSUES PROGRAM)

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

November 3, 1981

Lawrence
Livermore
Laboratory

This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the Laboratory.

This work was supported by the United States Nuclear Regulatory Commission under a Memorandum of Understanding with the United States Department of Energy.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

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 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 licensee meets the requirements of the NRC except for the submittal of proposed Technical Specification changes to substantiate the proposed circuit modifications and relay setpoints.

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 Operating Reactors, by Lawrence Livermore National Laboratory.

The U. S. Nuclear Regulatory Commission funded the work under the authorization entitled "Electrical, Instrumentation and Control System Support," B&R 20 19 04 031, FIN A-0250.

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION.	1
2. DESIGN BASIS CRITERIA	2
3. EVALUATION	2
3.1 Existing Undervoltage Protection	2
3.2 Modifications.	4
3.3 Discussion.	5
3.3.1 NRC Staff Position 1: Second Level of Undervoltage or Overvoltage Protection with a Time Delay	5
3.3.2 NRC Staff Position 2: Interaction of Onsite Power Sources with Load-Shed Feature	8
3.3.3 NRC Staff Position 3: Onsite Power Source Testing	8
3.4 Technical Specifications	9
4. CONCLUSION	10
REFERENCES	11

ILLUSTRATIONS

<u>FIGURE 1</u>	<u>Page</u>
Peach Bottom Atomic Power Station Electrical One-line Diagram	3

TECHNICAL EVALUATION REPORT
PROPOSED DESIGN MODIFICATIONS AND TECHNICAL SPECIFICATIONS CHANGES
ON GRID VOLTAGE DEGRADATION
FOR THE
PEACH BOTTOM ATOMIC POWER STATION
(DOCKET Nos. 50-277, 50-278)

Róbert L. White
Lawrence Livermore National Laboratory, Nevada

1. INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) by letter dated June 2, 1977 [Ref. 1], requested the Philadelphia Electric Company to do an assessment of their offsite and onsite power sources for the Peach Bottom Power Station, Units 2 and 3. The assessment was to include:

- (1) The susceptibility of Class 1E electrical equipment to sustained degraded voltage conditions at the offsite power sources.
- (2) Any possible interaction between the offsite and onsite emergency power systems.
- (3) A comparison of the current design of the emergency power systems with the NRC staff positions as stated in the letter.
- (4) A proposal for any plant modifications, as necessary, to meet the NRC staff positions or a detailed analysis which shows that the facility design has equivalent capabilities and protective features.
- (5) The Technical Specifications necessary to ensure the proper protection as modeled by enclosures in the letter.

By several letters [References 2-8], Philadelphia Electric Company proposed certain design modifications and additions to the plant's Technical Specifications. The design modifications include the installation of a degraded voltage protection system for the Class 1E equipment.

The proposed additions to the Technical Specifications are in regard to the setpoints, calibrations, and surveillance requirements associated with the proposed voltage protection system.

The purpose of this report is to evaluate the licensee's proposed design modifications and Technical Specification changes and 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," in the 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 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. 12]. 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 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 a voltage

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

between 2275 volts and 2450 volts with a time delay of approximately 1.75 seconds. 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 monitors the voltage on each bus. The relay functions with no appreciable time delay when the voltage falls below approximately 1225 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 approximately 3675 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 1225 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 ($90\% \pm 2\%$ of 4160 volts) for more than 60 seconds $\pm 5\%$, 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 time to attempt to adjust to the voltage problem.

The CV-6 relay is an inverse time voltage relay. It will have a setpoint of 3619 volts ($87\% \pm 5\%$ 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 TR relay will have a time delay of 6 seconds. 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 $25\% \pm 5\%$ of 4160 volts (1248 volts - 832 volts). The Peach Bottom Technical Specifications presently contain the maximum and minimum limits of the load-shedding relays.

The licensee's letter to the NRC dated March 21, 1980 [Ref. 5], included Technical Specifications documenting setpoints and surveillance requirements. However, additional letters from the licensee to the NRC dated October 14, 1980 [Ref. 13] and February 13, 1981 [Ref. 6], refined the setpoints and surveillance requirements. Proposed Technical Specifications changes documenting the later revisions have not been submitted for evaluation.

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 $90\% \pm 2\%$ of 4160 volts. The other two relays are CV-6 relays with a setpoint of $87\% \pm 5\%$ 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 adjust to a degraded voltage condition. The CV-6 relay is an inverse time-voltage relay. The licensee states that its actuation curve is asymptotic to the ITE-27D relay and the time delay would always be within the 60 second time delay of the ITE-27D relay.

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 six 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 time 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.

- (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 Technical Specifications that incorporate the latest set-points and modifications have not been submitted for evaluation [see paragraph 3.4].

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 $25\% + 5\%$ 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. 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.a.A.1.b.

3.4 TECHNICAL SPECIFICATIONS

Philadelphia Electric Company, in a letter dated March 21, 1980 [Ref. 5] to the NRC, submitted proposed changes to the Technical Specifications. Additional analyses resulted in the need for additional changes to the proposed Technical Specifications. The licensee, however, has not submitted additional Technical Specification changes but has proposed the changes in letter format. The following is a culmination of the March 21, 1980 proposed changes and the latest proposed changes submitted in a February 13, 1981 letter [Ref. 6], an October 14, 1980 letter [Ref. 13], and a July 22, 1981 letter [Ref. 8] to the NRC:

- (1) Set trip setpoints on the ITE-27D undervoltage relays for $90\% \pm 2\%$ of 4160 volts with 2 relays per 4160-volt Class 1E bus.
- (2) Set trip setpoints on the CV-6 undervoltage relays for $87\% \pm 5\%$ of 4160 volts with 2 relays per 4160-volt Class 1E bus.
- (3) Set the time delay on the TR relay to 6 seconds.
- (4) Perform an instrument functional test on the degraded voltage relays on a once-per-operating-cycle basis.
- (5) Perform calibration on the degraded voltage relays on a once-per-refueling-outage cycle.

Technical Specifications or proposals have not been submitted that would provide action statements regarding limiting conditions for operations when the number of operable channels for degraded voltage is reduced.

4. CONCLUSION

The proposed modifications submitted by Philadelphia Electric Co., for Peach Bottom Atomic Power Station, Units 2 and 3, deviate from the NRC requirements for Position 1. The deviations are:

1. The degraded undervoltage relays are not coincident. If actuated, however, the relays do not transfer the Class 1E equipment to the onsite sources but to the alternate offsite source. If the alternate offsite source is degraded or not available, the transfer will then be to the onsite source. This circuit logic provides coincidence at a systems level. This deviation has been determined to be acceptable.

2. The licensee has not submitted Technical Specifications covering all the latest proposed modifications and changes. These Technical Specifications should be submitted by the licensee.

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 Position 2 is met.

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

Accordingly, we recommend that the NRC approve the proposed setpoints and circuit logic for Position 1. The justification for maintaining the load-shed feature in Position 2 should be also approved. The NRC should enjoin the licensee to submit Technical Specifications to cover the modifications.

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. Philadelphia 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. 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 IE Power Systems for Nuclear Power Generating Stations."
12. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (George Lear), dated September 15, 1976.
13. Philadelphia Electric Co. letter (S. L. Daltroff) to the NRC (R. W. Reid), dated October 14, 1980.

Technical Information Department • Lawrence Livermore Laboratory
University of California • Livermore, California 94550