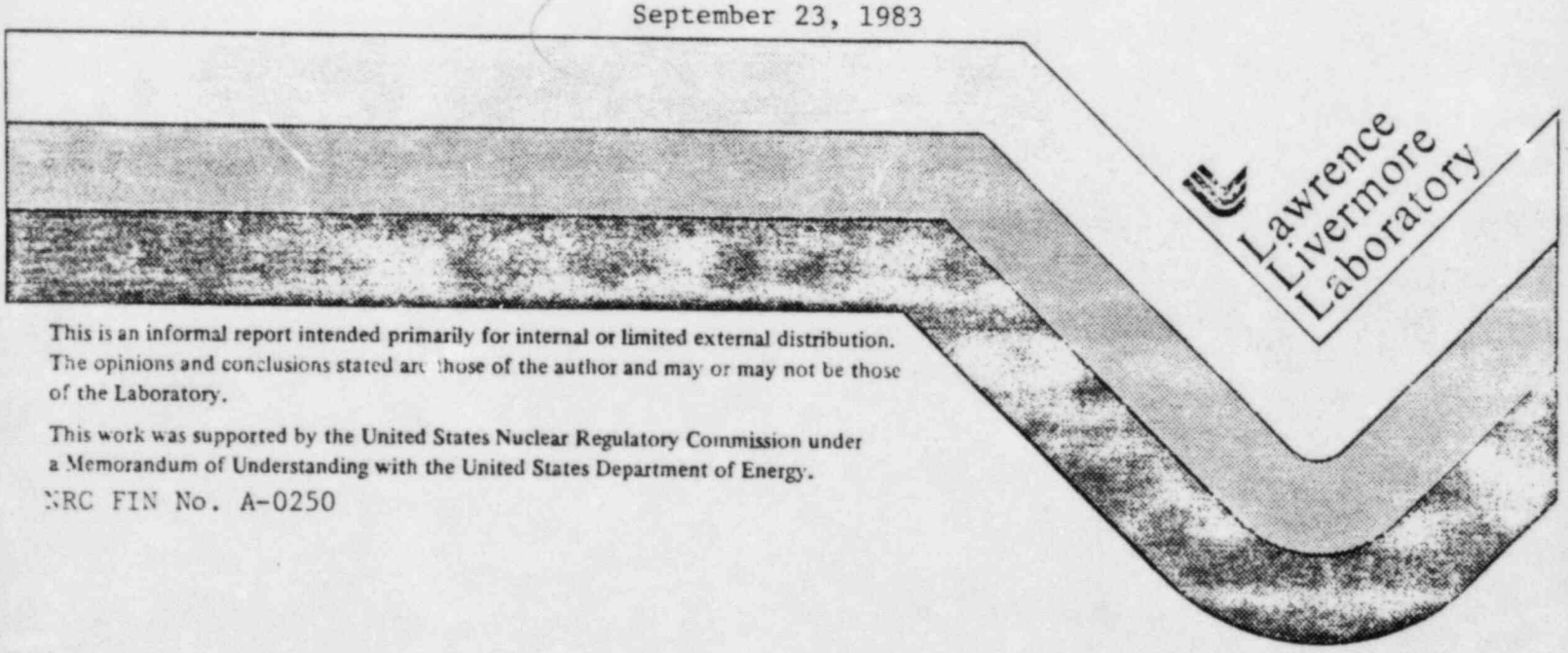
UCID- 19720

TECHNICAL EVALUATION REPORT ON THE MONITORING OF ELECTRIC POWER TO THE REACTOR PROTECTION SYSTEM FOR THE PEACH BOTTOM ATOMIC POWER STATION UNITS 2 AND 3

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

James C. Selan

September 23, 1983



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.
NRC FIN No. A-0250

8310200445 XA

ABSTRACT

This report documents the technical evaluation of the monitoring of electric power to the reactor protection system (RPS) at the Peach Bottom Atomic Power Station, Units 2 and 3. The evaluation is to determine if the proposed design modification will protect the RPS from abnormal voltage and frequency conditions which could be supplied from the power supplies and will meet certain requirements set forth by the Nuclear Regulatory Commission.

The proposed design modifications and Technical Specification changes will provide the required protection for the RPS components from sustained abnormal power.

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.

The U. S. Nuclear Regulatory Commission funded the work under the authorization entitled "Selected Operating Reactor Issues Program II," B&R B&R 20 19 10 11 1, FIN No. A0250.

TABLE OF CONTENTS

TECHNICAL EVALUATION REPORT ON THE MONITORING OF ELECTRIC POWER TO THE REACTOR PROTECTION SYSTEM AT THE PEACH BOTTOM ATOMIC POWER STATION UNITS 2 AND 3

(Docket No. 50-277, 50-278)

James C. Selan

Lawrence Livermore National Laboratory, Nevada

1. INTRODUCTION

During the operating license review for Hatch 2, the Nuclear Regulatory Commission (NRC) staff raised a concern about the capability of the Class 1E reactor protection system (RPS) to operate after suffering sustained, abnormal voltage or frequency conditions from a non-Class 1E power supply. Abnormal voltage or frequency conditions could be produced as a result of one of the following causes: combinations of undetected, random single failures of the power supply components, or multiple failures of the power supply components caused by external phenomena such as a seismic event.

The concern for the RPS power supply integrity is generic to all General Electric (GE) boiling water reactors (BWR) MARK 3's, MARK 4's, and MARK 5's and all BWR MARK 6's that have not elected to use the solid state RPS design. The staff therefore pursued a generic resolution. Accordingly, GE proposed a revised design, in conceptual form, for resolution of this concern [Ref. 1]. The proposed modification consists of the addition of two Class 1E "protective packages" in series between each RPS motor-generator (M-G) set and it's respective RPS bus, and the addition of two similar packages in series in the alternate power source circuit to the RPS buses. Each protective package would include a breaker and associated overvoltage, undervoltage and underfrequency relaying. Each protective package would meet the testability requirements for Class 1E equipment.

With the protective packages installed, any abnormal output type failure (undetectable random or seismically caused) in either of the two RPS M-G sets (or the alternate supply) would result in a trip of either one or both of the two Class 1E protective packages. This tripping would interrupt the power to the effected RPS channel, thus producing a scram signal on that channel, while retaining full scram capability by means of the other channel. Thus, fully redundant Class 1E protection is provided, bringing the overall

RPS design into full conformance with General Design Criteria (GDC)-2 [Ref. 2], and GDC-21 [Ref. 3] (including IEEE-279 [Ref. 4] and the standard review plan [Ref. 5]). The NRC staff reviewed the proposed GE design and concluded that the modification was acceptable [Ref. 6], and should be implemented in conformance with the applicable criteria for Class 1E systems.

The NRC requires that the components of the RPS not be exposed to unacceptable electric power of any sustained abnormal quality that could damage the RPS. This involves providing means to detect any overvoltage, undervoltage, or underfrequency condition that is outside the design limits of the RPS equipment and to disconnect the RPS from such abnormal electric power before damage to the RPS can occur. The equipment which performs these functions must satisfy the single failure criterion and be seismically qualified. The NRC issued a generic letter [Ref. 7] to all operating BWR's requesting the licensees to submit design modification details and Technical Specifications for post implementation review.

By letters dated November 26, 1980 [Ref. 8], March 9, 1981 [Ref. 9], October 30, 1981 [Ref. 10], December 23, 1981 [Ref. 11], May 21, 1982 [Ref. 12], November 8, 1982 [Ref. 13], March 30, 1983 [Ref. 14], June 2, 1983 [Ref. 15], and a telephone conference on September 12, 1983 [Ref. 16], Philadelphia Electric Company, the licensee, submitted design modification details and Technical Specifications changes regarding the monitoring of electrical power to the RPS at the Peach Bottom Atomic Power Station, Units 2 and 3.

The purpose of this report is to evaluate the licensee's submittal with respect to the NRC criteria and present the reviewer's conclusion on the adequacy of the design modifications to protect the RPS from abnormal voltage and frequency conditions.

2. DESIGN DESCRIPTION

The licensee has proposed to install two Class 1E detection and isolating packages (similar to the approved GE conceptual design) to monitor the electric power in each of the three sources of power (two M-G sets and an alternate source per each unit) to the RPS. Each package is identical and consists of a circuit breaker, undervoltage relay (ITE 27), overvoltage relay (ITE 59), underfrequency relay (SFF 31), and a time-delay relay (ETR). The time-delay relay is used only in conjunction with the underfrequency relay. The control power for the time delay relay is 125 Vdc. When abnormal electric power is detected by either package, the respective circuit breaker will trip and disconnect the RPS from the abnormal power source.

The monitoring packages associated with the MG sets will detect overvoltage and undervoltage conditions and provide an instantaneous trip when the voltage setpoints are exceeded, while providing a time-delayed trip upon detection of an underfrequency condition when the frequency setpoint is exceeded. The monitoring packages associated with the alternate sources provide an instantaneous trip when the overvoltage, undervoltage and underfrequency setpoints are exceeded.

3. EVALUATION

The NRC stated several requirements that the licensee must meet in their design modification to monitor the power to the RPS. A statement of these requirements followed by an evaluation of the licensee's submittals are as follows:

(1) "The components of the RPS shall not be exposed to unacceptable electric power of any sustained abnormal quality that could damage the RPS."

Each monitoring package will detect overvoltage, undervoltage, and underfrequency conditions with the following setpoints.

*Nominal voltage 120 volts, 60 Hz nominal

Condition	Setpoint	Time Delay
Overvoltage	131 $\pm$ 2 volts	Instantaneously for MG sets and alternate sources
Undervoltage	113 $\pm$ 2 volts	Instantaneously for MG sets and alternate sources
Underfrequency	57 $\pm$ 0.2 Hz	6 $\pm$ 1 seconds for MG sets Instantaneously for alternate sources

*Voltage measurements indicated a 6.5 to 7.5 volt drop in voltage from the MG set output to the scram solenoid valve fuse panels. The MG set output will be adjusted to maintain 115 $\pm$ 2 volts at the hydraulic control units [Refs. 14 and 16].

GE certified RPS component (relays and contactors) operating capability is $\pm$ 10% of 115 volts and - 5% of 60 Hz on its terminal, resulting in a voltage range of 126.5 to 103.5 volts and a frequency range of 60 to 57 Hz [Ref. 17]. For the above proposed setpoints and measured voltage drops, a minimum RPS component terminal voltage of 103.5 volts and a maximum terminal voltage of 127 volts could occur at which time the protective relaying will trip instantaneously.

The 6-second time delay associated with the 57 Hz underfrequency setpoint is greater than the time delay recommended or accepted by GE. Tests results on MG set coast-down showed that the

lowest frequency of 54.4 Hz was reached in a maximum of 11 seconds [Ref. 13]. Based on this, the licensee performed time/underfrequency tests on an HFA relay, scram contactor, and a scram solenoid valve to determine the effects on component coil temperature rise as a result of sustained underfrequency. These tests were conducted by gradually decreasing the frequency to 53 Hz during 11-second and 15-second intervals. A total of 20 tests per component (10 for the 11-second interval and 10 for the 15-second interval) was made.

For the proposed underfrequency setpoint, the minimum terminal frequency of 56.8 Hz for a maximum of 7 seconds would result before protective relay tripping occurs. The tests indicated for a 110 °F ambient temperature (maximum temperature of 105 °F expected in the operating environment) and decreasing frequency to 53 Hz during an 11-second and 15-second interval, less than a 0.2 °F rise in coil temperature resulted. Since high coil temperature is the most significant contributing factor affecting component operation, these tests demonstrated that the resulting small rise in the coil temperature did not degrade component performance nor effect the pickup and dropout capability of the components.

Based on the above maximum measured voltage drops and the results of the time/underfrequency tests, the proposed trip setpoints and time delays will provide RPS component protection from sustained abnormal power.

(2) "Disconnecting the RPS from the abnormal power source shall be automatic."

The monitoring module will automatically disconnect the RPS buses from the abnormal power supply after the set time delay should the parameters setpoints be exceeded.

(3) "The power monitoring system shall meet the requirements of IEEE 279-1971, GDC-2 and GDC-21."

The monitoring packages meet the Class 1E requirements of IEEE 279, the single failure criteria of GDC-21, and the seismic qualifications of GDC-2.

(4) "Technical Specifications shall include limiting conditions for operation, surveillance requirements, and trip setpoints."

In accordance with the Standard Technical Specifications, the licensee submitted [Refs. 11, 14, 15, and 16] Technical Specification changes which included limiting conditions for operation when the number of operable monitoring systems is less than required and surveillance requirements which included a functional test, channel calibration, and verification of the trip setpoints.

4. CONCLUSION

Based on the information submitted by Philadelphia Electric Company for the Peach Bottom Atomic Power Station, Units 2 and 3, it is concluded that:

(1) The proposed setpoints of the relays in the two protective packages to be installed in series, in each of the power sources to the RPS buses, will automatically protect the RPS components from sustained abnormal overvoltage, undervoltage, and underfrequency conditions outside the design limits of the RPS components.

(2) The protective packages meet the requirements of Class 1E equipment (IEEE 279), single failure criteria (GDC-21), and seismic qualification (GDC-2).

(3) The proposed time delay before circuit breaker tripping will not result in damage to components of the RPS or prevent the RPS from performing its safety functions.

(4) The following minimum and maximum limits to the trip setpoints, limiting conditions for operation (LCO), and surveillance requirements, as proposed by the licensee in accordance with the Standard Technical Specifications, will protect the RPS components from sustained abnormal power:

(a)	Overvoltage	$\leq$ 133 volts	Instantaneously
	Undervoltage	$\geq$ 111 volts	Instantaneously
	Underfrequency	$\geq$ 56.8 Hz	Time delay $\leq$ 7 seconds for MG sets
			Instantaneously for alternate sources

(b) With one RPS electric power monitoring channel for an inservice RPS MG set or alternate power supply inoperable, restore the inoperable channel to operable status within 72 hours or remove the associated RPS MG set or alternate power supply from service.

(c) With both RPS electric power monitoring channels for an inservice RPS MG set or alternate power supply inoperable, restore at least one to operable status within 30 minutes or remove the associated RPS MG set or alternate power supply from service.

(d) A functional test at least once per 6 months and a channel calibration once per operating cycle to determine the operability of the protective instrumentation including simulated automatic actuation, tripping logic, output circuit breaker tripping, and verification of the setpoints.

Accordingly, I recommend the NRC approve the proposed design modification and Technical Specification changes for monitoring the electric power to the reactor protection system.

REFERENCES

1. General Electric Company letter, MFN 408-78 (G. G. Sherwood) to NRC (R. S. Boyd), dated October 31, 1978.

2. General Design Criteria-2 (GDC-2), "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," in the Code of Federal Regulations, Title 10, Part 50 (10 CFR 50).

3. General Design Criteria-21 (GDC-21), "Protection System Reliability and Testability," of Appendix A, "General Design Criteria for Nuclear Power Plants," in the Code of Federal Regulations, Title 10, Part 50 (10 CFR 50).

4. IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."

5. NUREG-75/087, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants."

6. NRC memorandum from Faust Rosa to J. Stolz, T. Ippolito, and G. Lainas, dated February 19, 1979.

7. NRC letter to Operating BWR's, dated September 24, 1980.

8. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (R. W. Reid), dated November 26, 1980.

9. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (R. W. Reid), dated March 9, 1981.

10. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (J. F. Stolz), dated October 30, 1981.

11. Philadelphia Electric Co. letter (E. J. Bradley) to NRC (H. R. Denton), dated December 23, 1981.

12. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (J. F. Stolz), dated May 21, 1982.

13. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (J. F. Stolz), dated November 8, 1982.

14. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (J. F. Stolz), dated March 30, 1983.

15. Philadelphia Electric Co. letter (S. L. Daltroff) to NRC (J. F. Stolz), dated June 2, 1983.

16. Telephone conference; W. Birely (PECo), G. Gears (NRC), and J. Selan (LLNL), dated September 12, 1983.

17. GE letter No. G-EE-8-86 (R. F. Thibault) to the Northeast Utilities Service Company (A. Roby).