ATTACHMENT

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TECHNICAL EVALUATION REPORT ON THE MONITORING OF ELECTRIC POWER TO THE REACTOR PROTECTION SYSTEM FOR THE DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

(Docket Nos. 50-237, 50-249)

James C. Selan

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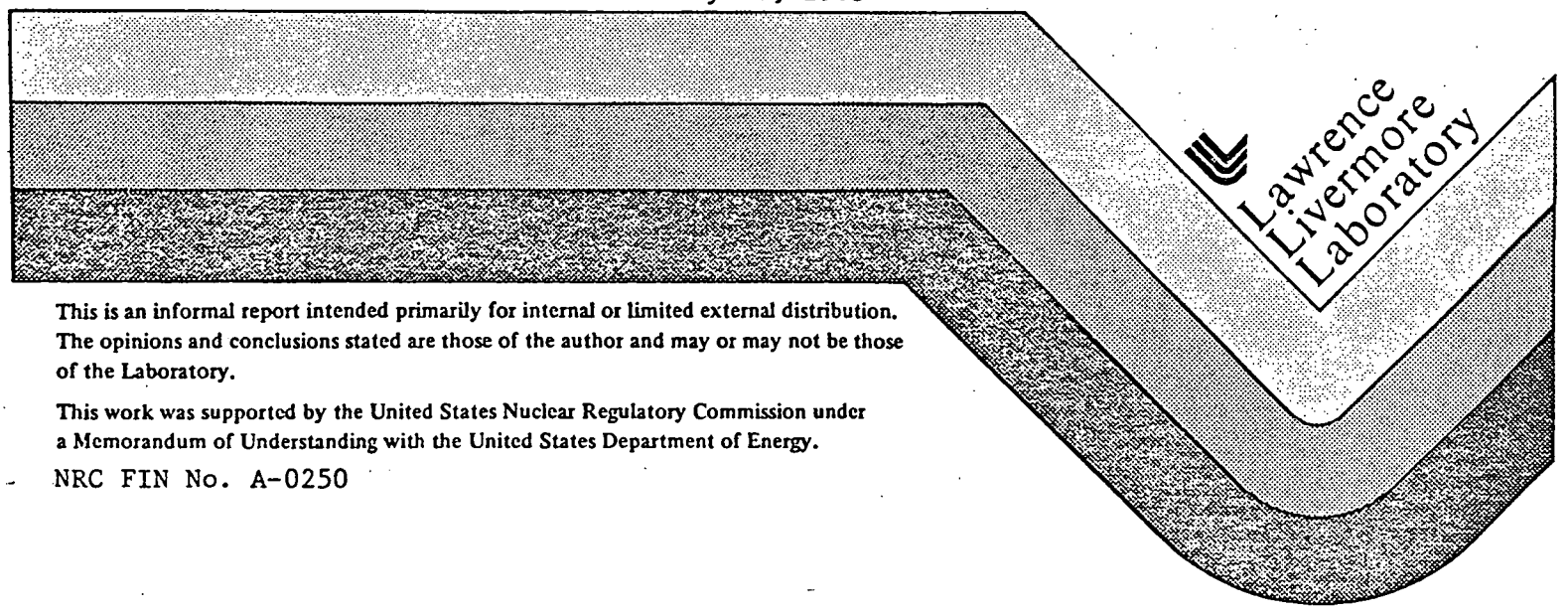

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ABSTRACT

This report documents the technical evaluation of the monitoring of electric power to the reactor protection system (RPS) at the Dresden Nuclear 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 will protect the RPS from sustained abnormal voltage and frequency conditions from the supplying sources.

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

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 January 12, 1982 [Ref. 8], April 19, 1982 [Ref. 9], July 23, 1982 [Ref. 10], February 4, 1983 [Ref. 12], April 20, 1983 [Ref. 13], May 6, 1983 [Ref. 14], and a telephone conference on August 20, 1982 [Ref. 11], Commonwealth Edison (CE), the licensee, submitted design modification details and Technical Specifications changes regarding the monitoring of electrical power to the RPS at the Dresden Nuclear 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 the GE designed "electrical protection assembly" (GE No. 914E175) to monitor the electric power in each of the six sources of power (two RPS M-G sets, and one alternate source per each unit) to the RPS. Each assembly (EPA) consists of two identical and redundant packages. Each package includes a circuit breaker and a monitoring module. When abnormal electric power is detected by either module, the respective circuit breaker will trip and disconnect the RPS from the abnormal power source.

The monitoring module detects overvoltage, undervoltage, and underfrequency conditions and provides a time-delayed trip when a setpoint is 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 is 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."

The monitoring module will detect overvoltage, undervoltage, and underfrequency conditions with the following setpoints.

Nominal voltage 115 volts, 60 Hz nominal

Condition	Setpoint	Time Delay
Overvoltage	126.5 volts Tolerance ± 2.5%	3.0 seconds Tolerance ± 5%
Undervoltage	108.0 volts Tolerance ± 2.5%	3.0 seconds Tolerance ± 5%
Underfrequency	56 Hz Tolerance ± 1%	3.0 seconds Tolerance ± 5%

GE certified RPS component (relays and contactors) operating capability is ± 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. Based on these values, the GE recommended setpoints for a system of 60 Hz and 120-volt nominal are 132 volts - 2.5% of nominal for overvoltage, 108 volts + 2.5% of nominal for undervoltage, and 57 Hz + 2% of nominal for underfrequency.

The licensee's proposed setpoints, specifically the tolerances, are evidently outside the GE recommended values. However, based on the results of RPS component testing (two HFA relays and one ASCO solenoid) performed by the licensee, the following is concluded:

(a) For the proposed undervoltage setpoint, the minimum terminal voltage at the downstream RPS components, considering the maximum cable voltage drop of 3.2 volts, will be 102.1 volts (1.4 volts below the above GE value).

(b) Similarly, for the proposed overvoltage and underfrequency setpoints, the respective maximum terminal voltage will be 126.5 volts and the minimum frequency will be 55.4 Hz (1.6 Hz below the GE value).

These abnormal voltages and frequency may be sustained for a maximum time of 3.15 seconds before the EPA trips.

Projecting these voltage (frequency)/time points onto the temperature/voltage (frequency) test curves, it is found that a negligible rise in coil temperature would result. Also shown in the test results was a negligible effect on the components' pickup and dropout voltages as the frequency varied. In addition to the above tests which generated the test curves compared above, a combined test of overvoltage, underfrequency, and high ambient temperature for a long period of time was performed. The test was conducted for 8 hours at 130 volts, 55 Hz, and in an ambient temperature of 55 °C.

Since high coil temperature is the most significant contributing factor affecting component operation, these tests demonstrated that no adverse effects resulted on the ability of the RPS components to perform their safety function. Therefore, all the above trip setpoints and time delays ensure adequate 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 of operation, surveillance requirements, and trip setpoints."

The monitoring packages are installed at Unit 2 and are planned for installation at Unit 3 in December, 1983. In accordance with the Standard Technical Specifications, the licensee has submitted [Refs. 13 and 14] Technical Specification changes which includes 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 Commonwealth Edison for the Dresden Nuclear 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 function.

(4) The following minimum and maximum limits to the trip setpoints, limiting conditions for operation (LCO), and surveillance requirements (as outlined in the Standard Technical Specifications), to be incorporated in the plant's Technical Specifications, will protect the RPS components from sustained abnormal power:

(a) Overvoltage $\leq$ 129.6 volts, time delay $\leq$ 3.15 seconds

Undervoltage $\geq$ 105.3 volts, time delay $\leq$ 3.15 seconds

Underfrequency $\geq$ 55.4 Hz, time delay $\leq$ 3.15 seconds

(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.

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. CE letter (T. J. Rausch) to the NRC (T. A. Ippolito), dated January 12, 1982.

9. CE letter (T. J. Rausch) to the NRC (T. A. Ippolito), dated April 19, 1982.

10. CE letter (T. J. Rausch) to the NRC (T. A. Ippolito), dated July 23, 1982.

11. Telecon, T. J. Rausch and B. Fancher (CE), J. VanVliet (NRC), J. Selan (LLNL), dated August 20, 1982.

12. CE letter (T. J. Raush) to the NRC (H. R. Denton), dated February 4, 1983.

13. CE letter (B. Rybak) to the NRC (H. R. Denton), dated April 20 1983.

14. CE letter (B. Rybak) to the NRC (H. R. Denton), dated May 6, 1983.