

TECHNICAL EVALUATION REPORT ON THE
MONITORING OF ELECTRIC POWER
TO THE REACTOR PROTECTION SYSTEM FOR THE
VERMONT YANKEE NUCLEAR POWER STATION

(Docket No. 50-271)

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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 Vermont Yankee Nuclear Power Station. 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

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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 its 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 27, 1981 [Ref. 8], February 25, 1983 [Ref. 9], August 5, 1983 [Ref. 10], and December 14, 1983 [Ref. 11], Vermont Yankee Nuclear Power Corporation (VYNPC), the licensee, submitted design modification details regarding the monitoring of electrical power to the RPS at the Vermont Yankee Nuclear Power Station.

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 installed the GE designed "electrical protection assembly" (GE No. 914E175) to monitor the electric power in each of the three sources of power (RPS M-G sets A and B, and the alternate source) 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 interim setpoints.

Nominal voltage 120 volts, 60 Hz nominal

Condition	Setpoint	Time Delay
Overvoltage	≤ 126 volts	≤ 4 seconds
Undervoltage	≥ 111 volts	≤ 4 seconds
Underfrequency	≥ 57 Hz	≤ 4 seconds

In a telecon dated November 28, 1983 [Ref. 12], the following additional information on the selection of the trip setpoints was provided by the licensee.

The present setpoints of the installed monitoring packages are: overvoltage of 129 volts, undervoltage of 108 volts, and underfrequency of 57.5 Hz. The time delay for each setpoint is ≤ 4 seconds. The selection of these setpoints are justified based on a low line voltage drop for the 115-volt rated components [Ref. 11]. Since the Vermont Yankee Station utilizes both 115-volt and 120-volt rated components, the selection of the setpoints must consider both the components' capabilities and the bandwidth for plant operation. Therefore, the present setpoints will be in effect until the next scheduled refueling outage (planned for June, 1984), at which time they will be changed to those listed above. These interim setpoints are based on a conservatively assumed line voltage drop of 3 volts. These new setpoints will be procedurally administered until a more extensive study on the voltage requirements, to optimize the setpoints, is completed. This study is planned for completion in late 1984 with a subsequent Technical Specification change request in February 1985 [Ref. 11].

The above chosen new setpoints allowing for an assumed line voltage drop of 3 volts will limit the voltage variation at the RPS components to be within the capabilities certified by GE of $\pm 10\%$ of the 115-volt and 120-volt ratings.

- (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 above protective setpoints are applicable only for an interim period and will be controlled administratively until the more extensive analysis is completed and the setpoints optimized. During this interim period, the output of the RPS power supplies will be checked on a once per shift basis in accordance with the NRC Generic letter dated August 7, 1978 [Ref. 13]. Formal Technical Specification changes will be submitted upon completion of the analysis.

The Technical Specifications submitted in Reference 10 were not, in part, in conformance with the model Standard Technical Specifications. Specifically, they did not include a 6-month functional test, the setpoints and time delays, the alternate source in the LCOs, and the 30-minute time limit in the LCOs for restoring at least one of two inoperable protective panels to an operable status. The licensee is required to commit to the conformance with the Standard Technical Specification requirements.

4. CONCLUSION

Based on the information submitted by Vermont Yankee Nuclear Power Corporation for the Vermont Yankee Nuclear Power Station, it is concluded that:

- (1) Considering the assumed line voltage drop to be conservative, the proposed interim setpoints of the relays in the two protective packages 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 installation of the Class 1E protective packages with the chosen setpoints in each of the non-Class 1E power supplies is better than the existing non-Class 1E monitoring system.
- (5) The continuation of the surveillance program of once per shift on the output of the RPS supplies in conjunction with the administratively controlled interim setpoints is a satisfactory interim surveillance until the finalization of the required Technical Specifications.
- (6) The licensee is required to commit to the conformance with the model Standard Technical Specification requirements.

Accordingly, I recommend that the NRC accept the interim setpoints which will be under administrative control, in conjunction with the additional surveillance program for protecting the RPS components for abnormal power, until such time that the additional analysis to optimize the setpoints is completed and formal Technical Specifications are submitted in accordance with the model Standard Technical Specifications.

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. VYNPC letter (L. H. Heider) to the NRC (T. A. Ippolito), dated January 27, 1981.
9. VYNPC letter (J. B. Sinclair) to the NRC (D. B. Vassallo), dated February 25, 1983.
10. VYNPC letter (L. H. Heider) to the NRC (D. G. Eisenhut), dated August 5, 1983.
11. VYNPC letter (J. B. Sinclair) to the NRC (D. B. Vassallo), dated December 14, 1983.
12. Telephone conference, J. Sinclair, P. Johnson, D. Reese, R. Padogin, and B. Wansick (VYNPC), V. Rooney and J. Donohew (NRC), and J. Selan (LLNL), dated November 28, 1983.
13. NRC letter (T. A. Ippolito) to VYNPC, dated August 7, 1978.

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