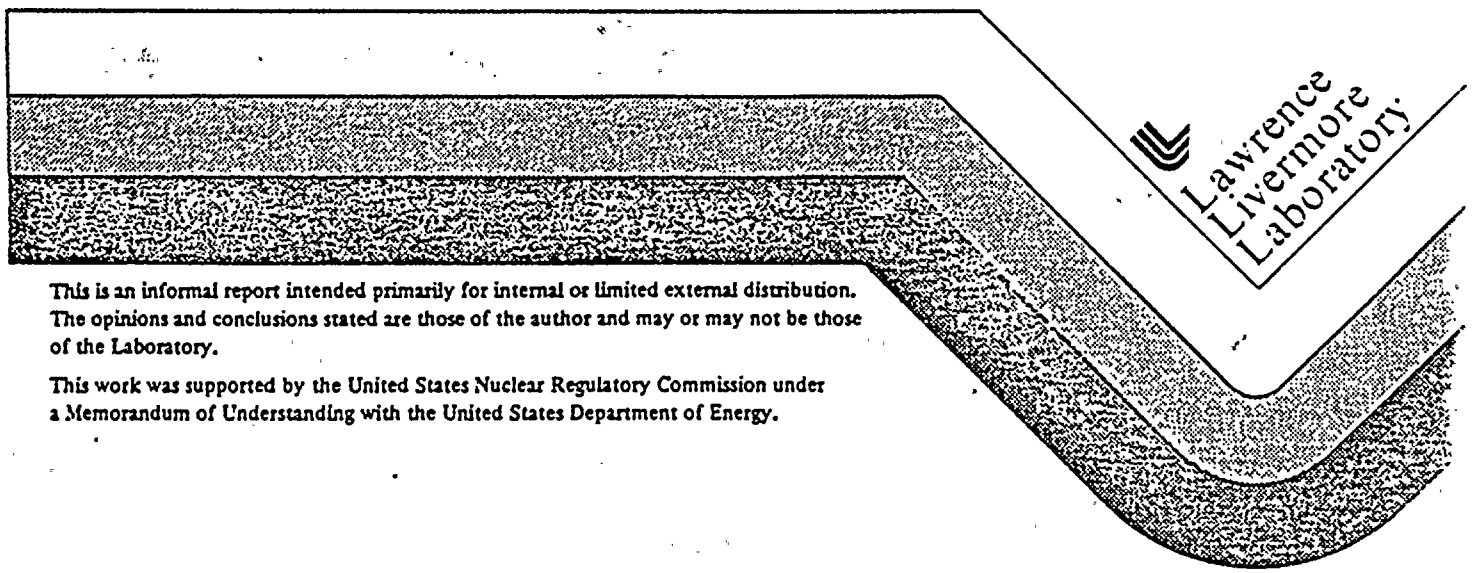
UCID- 18691

TECHNICAL EVALUATION OF THE PROPOSED DESIGN MODIFICATIONS AND TECHNICAL SPECIFICATION CHANGES FOR THE R. E. GINNA NUCLEAR POWER PLANT, UNIT 1

James C. Selan



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

ABSTRACT

This report documents the technical evaluation of the proposed design modifications and technical specification changes on grid voltage degradation for the R. E. Ginna Nuclear Power Plant Unit 1. The review criteria are based on IEEE Std. 279-1971, IEEE Std. 308-1974, and General Design Criteria 17 of the Code of Federal Regulations, Title 10, part 50, Appendix A requirements for determining the acceptability of the proposed system to protect the Class 1E equipment from degradation of grid voltages.

FOREWORD

This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues (SEICSI) Program being conducted for the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Operating Reactors, by Lawrence Livermore National Laboratory, Engineering Research Division of the Electronics Engineering Department.

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-0231.

TABLE OF CONTENTS

ILLUSTRATIONS

TECHNICAL EVALUATION REPORT
PROPOSED DESIGN MODIFICATIONS
AND TECHNICAL SPECIFICATIONS
ON GRID VOLTAGE DEGRADATION
FOR THE
R. E. GINNA NUCLEAR POWER PLANT
UNIT 1

(Docket No. 50-244)

Lawrence Livermore National Laboratory, Nevada

1. INTRODUCTION

By letter dated June 3, 1977 [Ref. 1], the U. S. Nuclear Regulatory Commission (NRC) requested the Rochester Gas and Electric Corporation (RG&E) to assess the susceptibility of the R. E. Ginna Nuclear Power Plant, Unit 1, Class 1E electrical equipment to sustained degraded voltage conditions at off-site 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 3, 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 that certain Technical Specifications be incorporated into all facility operating licenses.

In letters dated July 21, 1977 [Ref. 2], November 21, 1977 [Ref. 3], December 22, 1977 [Ref. 4], August 3, 1979 [Ref. 5], December 19, 1979 [Ref. 6], and September 9, 1980 [Ref. 7], RG&E proposed certain design modifications and additions to the licensee's Technical Specifications. These 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. 8].

(2) IEEE Std. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations" [Ref. 9].

(3) IEEE Std. 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations" [Ref. 10].

(4) NRC staff positions as stated in a letter dated June 3, 1977 [Ref. 1].

3. EVALUATION

3.1 EXISTING UNDERVOLTAGE PROTECTION

The present design uses undervoltage relays to sense the loss of offsite power. There are no Class 1E loads on the 4160-volt buses. This design consists of two relays per 480-volt Class 1E bus (two Class 1E buses per redundant load group) for the first level of undervoltage protection. An undervoltage condition (loss-of-voltage) will result in isolating the Class 1E buses from all offsite sources, initiating emergency diesel generator start and load shedding on the Class 1E buses, permitting closure of the diesel generator supply breakers, and lastly, the loads will be automatically time-sequenced onto the buses. Actuation begins with loss of voltage to 368 volts (77% of 480 volts). The existing system does not bypass the load-shedding feature once the emergency diesel generators are energizing the Class 1E buses.

3.2 MODIFICATIONS

The licensee has proposed a design change which includes automatic degraded voltage protection. This modification consists of the addition of two time-delayed, undervoltage relays on each 480-volt Class 1E bus, to provide the second level of undervoltage protection. After a preset time delay, according to the relay-tripping characteristics defined in Figure 1, the second-level protection scheme will automatically monitor and initiate both the offsite source disconnection and the onsite source connection when the voltage

degrades below the safe operating voltage level. The limiting conditions for operation and surveillance requirements for the proposed design changes presented in this evaluation are documented in the licensee's proposed Technical Specifications.

3.3 DISCUSSION

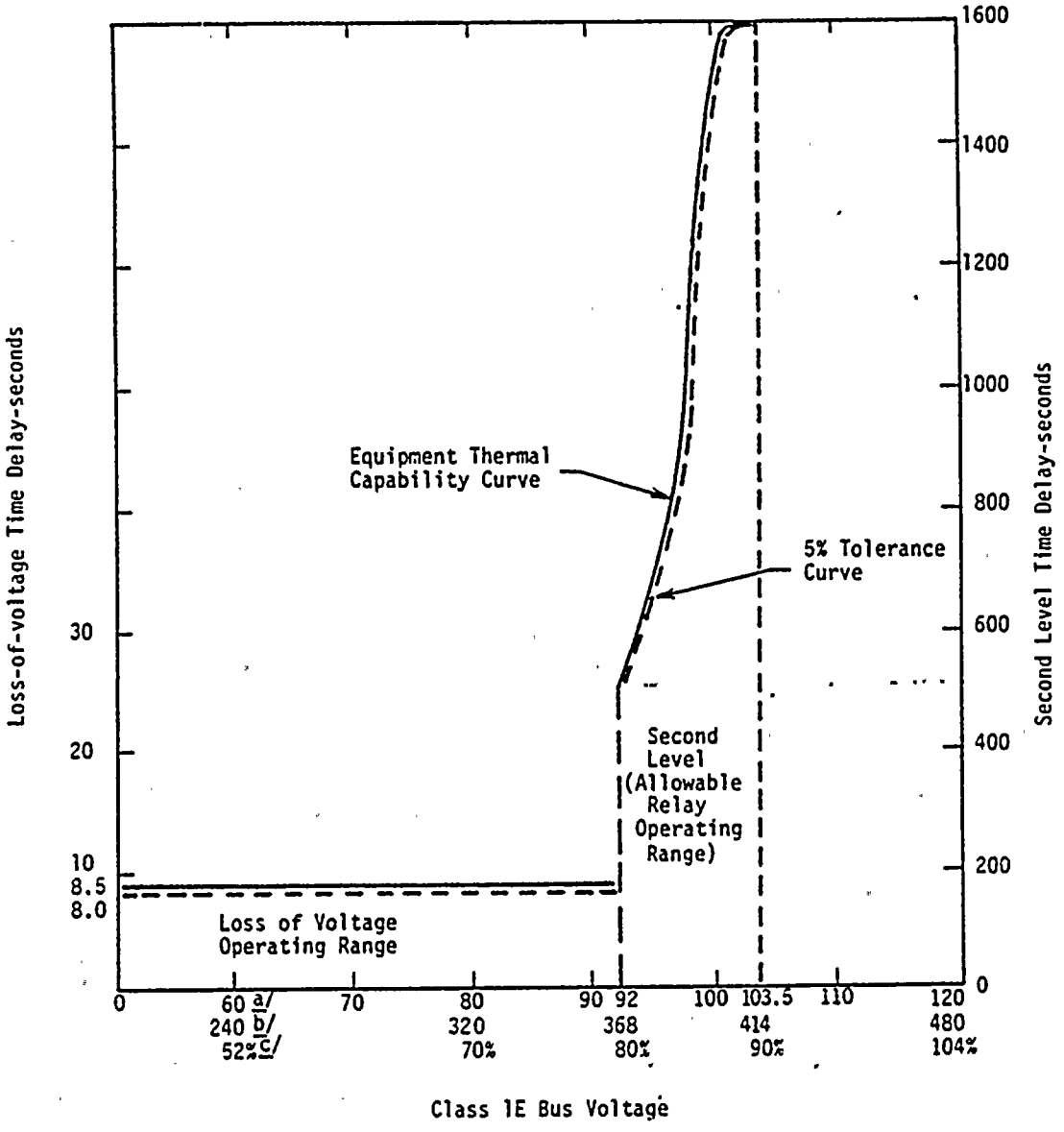
This section presents a statement on the NRC staff positions from their June 3, 1977 letter [Ref. 1] followed by an evaluation of the licensee's design.

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."

The licensee's second level of undervoltage protection setpoints (voltage and time delay) are defined by the curves shown in Figure 1. The solid-line curve defines the maximum time (determined by equipment manufacturers) that the Class 1E equipment can operate for a specific degraded voltage without causing equipment damage, loss of equipment life, or affecting the ability of the equipment to perform a required function. The maximum time delay at the 414-volt setpoint is 1600 seconds. The dotted-line curve (5% tolerance band) defines the maximum allowable time delay before protective relaying actuation is initiated. This tolerance band was determined by all the accuracies of the relay test instrumentation. The relays will be tested to insure that they perform according to their design operating characteristics, which must fall within the area defined by the dotted-line curve in Figure 1.



a/ Secondary volts (120 volts)
b/ Primary volts (480 volts)
c/ Percent volts (460 volt base)

NOTE: This figure has been reproduced from the information in Figure 2.3-1 in the Proposed Technical Specifications (Ref. 7) for the R.E. Ginna Nuclear Power Station, Unit 1.

Figure 1. Loss-of-voltage and second-level undervoltage relay operating ranges.

Any deviation outside the limits defined in Figure 1 will result in recalibration of the relay. The licensee's analysis has been reviewed and shows that this protection range is satisfactory for the 480-volt Class 1E loads and other components whose functional performance would be inadequate because of undervoltage.

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

The second-level protection scheme will be designed using two-out-of-two coincident logic. The integration of the second-level protection system into the first level of undervoltage protection can be seen in Figure 2. If a loss-of-voltage condition exists, relays 27 and 27B will drop out and initiate the automatic voltage-restoring scheme. For a degraded voltage condition, relays 27SL and 27BSL will drop out after the time-delay setpoints are exceeded and will initiate the automatic voltage-restoring scheme.

(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."

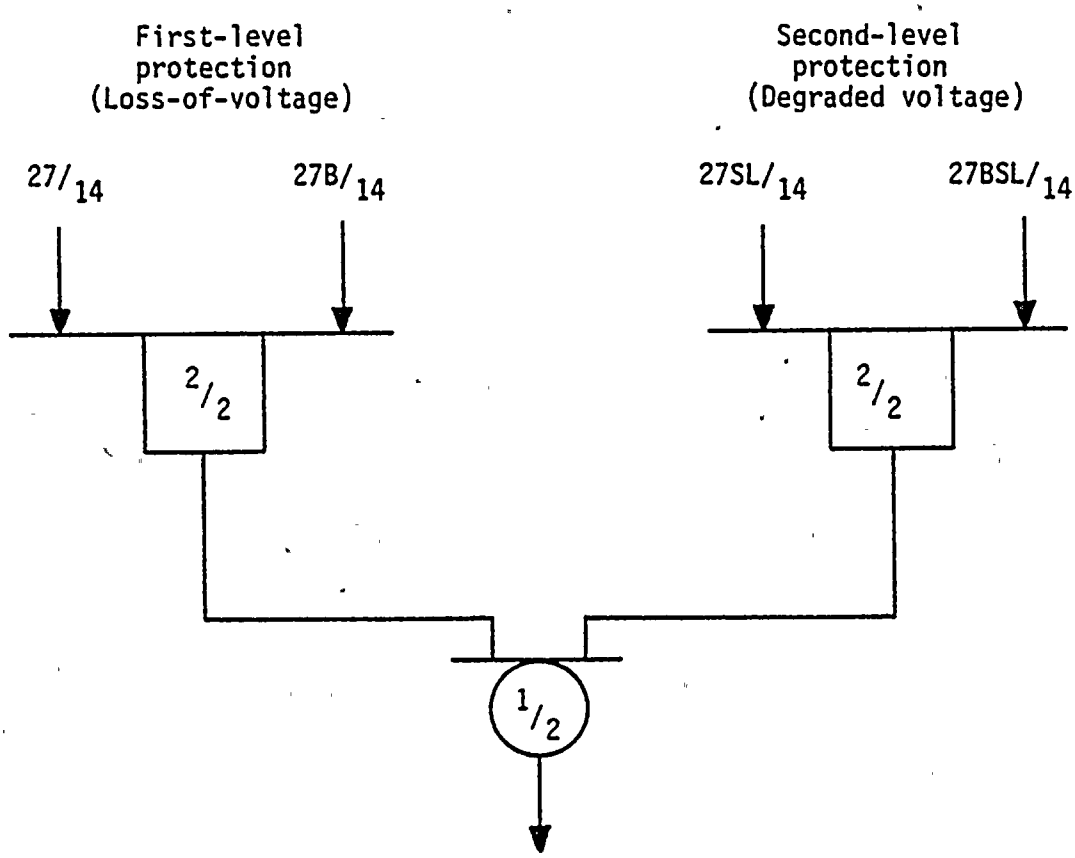
The second-level undervoltage relay setpoints defined in Figure 1 are such that the relay operating characteristics will protect the Class 1E equipment from sustained degraded voltage and also insure that all Class 1E motors will start successfully and be loaded onto the diesel generator within the time assumed in the FSAR accident analysis.

(b) "The time delay shall minimize the effect of short-duration disturbances from reducing the unavailability of the offsite power sources."

The licensee's proposed time delay defined in Figure 1 is long enough to override any short grid disturbances.

(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 any failure of any equipment connected to and associated with the Class 1E emergency power system.



Trip Logic and Voltage Restoring Scheme

NOTE: This logic diagram also applies to buses 16, 17, and 18.

Figure 2. Coincident trip logic for bus 14.

(4) "The undervoltage monitors shall automatically initiate the disconnecton of offsite power sources whenever the voltage setpoint and time delay limits have been exceeded."

The two-out-of-two coincidence logic automatically disconnects offsite power from the Class 1E buses experiencing degraded voltage and initiates the voltage-restoring scheme.

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

The licensee states that the relays and relaying scheme is in compliance with IEEE Std. 308-1974, and my review confirms that the requirements of IEEE 279-1971 are met.

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

Limiting conditions for operation and surveillance requirements, as well as trip setpoints for allowable values for degraded voltage protection, are included in the licensee's proposed Technical Specifications.

3.3.2 NRC Staff Position 2: Interaction of Onsite Power Sources with Load-Shed Feature.

The second position requires that the system be designed to prevent load shedding of the emergency buses automatically 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 be reinstated if the onsite source supply breakers are tripped.

The licensee is retaining the load-shed feature once the emergency buses are being supplied by the onsite sources on the basis that the load-shed feature is to protect the Class 1E equipment from unsatisfactory bus

voltages. To meet the requirements of NRC Staff Position 2, the licensee has proposed in the Technical Specifications the maximum setpoint values of 368 volts and 8.5 seconds to the loss-of-voltage (load-shed feature) relay. These maximum limits on the voltage and time-delay values of the load-shed feature will ensure that relay operating drift will not cause spurious trips of the onsite source while the Class 1E loads are being sequenced onto the buses.

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 when the emergency diesel generators are supplying their respective buses, and that there is no adverse interaction between the onsite and offsite power sources.

The licensee will satisfy the requirements of the NRC by testing the system by initiating loss of offsite power in conjunction with a simulated safety injection signal. The tests sequence will be bus de-energization, load shedding, voltage restoration, and load sequencing. The operating time with full load on emergency onsite power will be at least five minutes.

3.4 TECHNICAL SPECIFICATIONS

The changes proposed by Rochester Gas and Electric Corporation to the R. E. Ginna Unit 1 Nuclear Power Plant Technical Specifications reflect the proposed design modifications. Specifically, the proposed changes:

(1) Include the trip setpoints for the degraded voltage protection sensors and the associated time delays (Figure 1).

(2) Provide the required coincidence logic (two-out-of-two).

(3) Incorporate action statements regarding limiting conditions for operations when the number of operable channels for degraded voltage protection is reduced.

(4) Provide the surveillance requirements for channel calibration during refueling shutdown and the monthly channel functional test.

(5) Provide surveillance requirements to demonstrate at least once per 18 months that the loss of offsite power in conjunction with a safety injection actuation signal will provide the sequence of Class 1E bus de-energization, load shedding, voltage restoration, and load sequencing.

4. CONCLUSION

Based on the information provided by Rochester Gas and Electric Corporation, it has been determined that the proposed modifications comply with NRC Staff Position 1. All of the staff's requirements and design basis criteria have been met. The voltage setting and time delays will protect the Class 1E equipment from a sustained degraded voltage condition of the offsite power source.

The licensee is retaining the load-shed feature while the onsite sources are supplying the Class 1E buses, and has submitted in the proposed Technical Specifications the maximum limits to the setpoint values of the loss-ofvoltage (load-shed feature) relay. A review of the setpoint values, limits, and logic circuitry has determined that there will be no adverse interaction of the onsite sources with the load-shed feature during load sequencing, thus the requirements of NRC Staff Position 2 are met.

The proposed additions to the Technical Specifications and the method of testing the logic circuitry have been reviewed and found to meet the requirements of NRC Staff Position 3.

Accordingly, I recommend that the NRC approve the proposed design modifications and proposed Technical Specifications changes.

REFERENCES

1. NRC letter (A. Schwencer) to RG&E (L. D. White, Jr.), dated June 3, 1977.

2. RG&E letter (L. D. White, Jr.) to NRC (A. Schwencer), dated July 21, 1977.

3. RG&E letter (LeBoeuf, Lamb, Leiby and Macrae) to NRC (E. Case), dated November 21, 1977.

4. RG&E letter (LeBoeuf, Lamb, Leiby and Macrae) to NRC (E. Case), dated December 22, 1977.

5. RG&E letter (LeBoeuf, Lamb, Leiby and Macrae) to NRC (H. Denton), dated August 3, 1979.

6. RG&E telecopy (G. Daniels) to NRC (J. Shea), dated December 19, 1979.

7. RG&E letter (L. D. White, Jr.) to NRC, dated September 9, 1980.

8. 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."

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

10. IEEE Std. 308-1978, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."