UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION
MAINE YANKEE ATOMIC POWER STATION
DOCKET NO. 50-309
DEGRADED GRID VOLTAGE PROTECTION FOR THE CLASS 1E SYSTEM

INTRODUCTION AND SUMMARY

The criteria and staff positions pertaining to degraded grid voltage protection were transmitted to Maine Yankee Atomic Power Company (MYAPCo) by NRC Generic Letter dated June 3, 1977. In response to this, by letters dated July 18, 1977, July 24, 1980, January 20, 1981, March 5, 1981 and August 11, 1982, the licensee proposed certain design modifications and changes to the Technical Specifications. A detailed review and technical evaluation of these proposed modifications and changes to the Technical Specifications was performed by EG&G, under contract to the NRC, and with general supervision by NRC staff. This work is reported by EG&G in "Degraded Grid Protection for Class 1E Power Systems Maine Yankee Atomic Power Station" (attached). We have reviewed this technical evaluation report and concur in conclusion that additional information is still required in order to complete the evaluation of this multiplant action item.

EVALUATION CRITERIA

The criteria used by EG&G in its technical evaluation of the proposed changes include GDC-17 ("Electric Power Systems") of Appendix A to 10 CFR 50; IEEE Standard 279-1971 ("Criteria for Protection Systems for Nuclear Power Generating Stations"); IEEE Standard 308-1971 (Class 1E Power Systems for Nuclear Generating Station), ANSI-C84.1-1977 ("Voltage Ratings for Electrical Power Systems and Equipment - 60 Hz"); and staff positions defined in NRC Generic Letter to MYAPCo dated June 3, 1977.

PROPOSED CHANGES, MODIFICATIONS AND DISCUSSION

The existing undervoltage protection at Maine Yankee consists of two inverse time loss of voltage relays on each 4160 volt Class 1E bus. The relays are arranged in a two-out-of-two logic per bus with a setpoint of 3255 volts. Actuation of these relays will result in the automatic disconnection from the offsite power source, initiation of load shedding, automatic starting of the emergency diesel generator and subsequent load sequencing when the diesel generators have achieved satisfactory voltage and frequency.

The licensee has proposed to add two undervoltage relays to each 4160 bus to protect the Class 1E equipment from the effects of degraded voltage. The relays will be arranged in a two-out-of-two logic with a setpoint of 3720 $\pm$ 40 volts. The operation of this second level undervoltage protection is as follows:

If the 4160 volt Class 1E bus voltage should degrade to 3720 volts under non-accident conditions an alarm is initiated in the control room. Upon receipt of this alarm, the operator will notify the Central Maine Power (CMP) dispatcher and request an assessment of the degraded voltage condition. If the CMP system dispatcher is unable to restore the grid to an acceptable level within a reasonable time period, the operator will start the diesel generators and disconnect the Class 1E buses from the degraded offsite power source. The Class 1E loads will then be automatically sequenced on the onsite emergency diesel generators.

If a safety injection (SI) signal occurs at any time during level two actuation, the protective relays will automatically disconnect the offsite power source, initiate load shedding, and start the onsite emergency diesel generators. The safety loads will then be sequenced on the emergency diesel generator when acceptable frequency and voltage are achieved. The design will bypass the load shedding feature when the diesel generators are supplying the Class 1E buses. This feature will be automatically reinstated if the diesel generator breaker should trip. The licensee has not supplied the design details on how these features will be accomplished.

The licensee's proposed level two (degraded voltage) design will provide automatic separation of the Class 1E power system from offsite if a degraded grid exists coincident with a safety injection signal (SIS). This approach provides protection to the Class 1E equipment needed to mitigate the consequences of an accident and is acceptable. For a degraded grid condition without a SIS, an alarm will be actuated and operator action will be taken to restore the grid to an acceptable level. If the grid cannot be restored to an acceptable level within a reasonable time period, the operator will start the emergency diesel generators and disconnect the Class 1E buses from the offsite power system. The Class 1E buses will then be automatically sequenced on the onsite emergency diesel generators. This approach deviates from the staff position that requires automatic isolation of the offsite power system for such undervoltage after a time delay. Acceptability of this alternative approach requires demonstration by the licensee that adequate safety systems will be available for safe shutdown of the reactor for these conditions and that appropriate plant operating procedures are developed and available to the operator for

the required operator action. We require that these procedures be provided for NRC review.

In response to the above concerns, the licensee in a submittal dated August 11, 1982, provided a list of systems that will not be exposed to or rendered inoperative by degraded grid voltage and therefore would be available to place the plant in a safe shutdown status under non-accident conditions. The Reactor Systems Branch (RSB) and Auxiliary Systems Branch (ASB) have reviewed the listing and concurred with the licensee's approach that this equipment provides the capability to place the plant in a hot shutdown condition. This equipment additionally has the capability to maintain the plant in a hot shutdown condition for the time required to reset any overload protective devices, or replace fuses that may have operated as a result of the degraded voltage.

On the basis of the above and that protection devices, i.e., circuit breakers, fuses, relays, etc., are provided to prevent damage to the equipment required for long term plant safe shutdown, and that alarms are provided to alert the operator to this abnormal condition, we find the licensee approach using operator action under degraded grid conditions without an accident acceptable. Acceptability of this approach is subject to the completion of all proposed modifications and institution of adequate procedures covering actions to be taken by the operator during a degraded grid under non-accident conditions.

The licensee has provided preliminary information that covers the setpoint and tolerances of the degraded voltage relays but has not included these items in the technical specifications. Failure to include relay setpoints and tolerances in the technical specification does not provide assurance that this equipment will be operated and maintained within the limits required to ensure that the safety equipment will be protected from the adverse effects of degraded voltage. We require the licensee to include in the plant technical specification the setpoints and tolerances, limiting conditions for operation, and surveillance testing for the undervoltage protective relaying system.

CONCLUSIONS

We have reviewed the licensee submittals and the EG&G technical evaluation report and find that:

1. The proposed degraded grid modifications will protect the Class 1E equipment from sustained degraded voltage of the offsite power system during accident conditions and is acceptable.

2. The licensee's proposal to use operator action instead of automatic disconnection of the Class 1E buses from a degraded offsite power source under non-accident conditions does not meet the staff's position. To justify this alternate approach the licensee has shown that adequate safety systems, which are not exposed to or rendered inoperable by degraded grid voltage, are available to place and maintain the plant in a safe shutdown condition. The staff has reviewed the licensee's shutdown system and concurred that these systems are adequate to effect a plant shutdown under

non-accident conditions. Based on the above, we find the licensee's alternate approach acceptable.

3. The licensee is required to provide the following:

   (a) Design details and a description of the operation of the proposed load shedding bypass circuitry and how this feature will be reinstated on a diesel generator breaker trip.

   (b) Technical Specifications to cover the setpoints and tolerances, limiting conditions for operation and surveillance testing for the undervoltage protective relaying system. In addition the technical specification shall include a test that simulates a loss of offsite power coincident with an accident signal, verifying the start of the diesel generators, load shedding and load sequencing. The test shall also verify that on a diesel generator breaker trip the load shedding and load sequencing are reinstated.

   (c) Plant operating procedures to cover operator actions for degraded grid under non-accident conditions.

We therefore find the Maine Yankee Atomic Power Station design acceptable subject to resolution of item 3 above. After resolution of item 3 with MYAPCo, the staff will issue a supplement to this evaluation report.

Principal Contributor: R. Prevatte

Attachment: EG&G Technical Evaluation Report

EGG-EA-5377

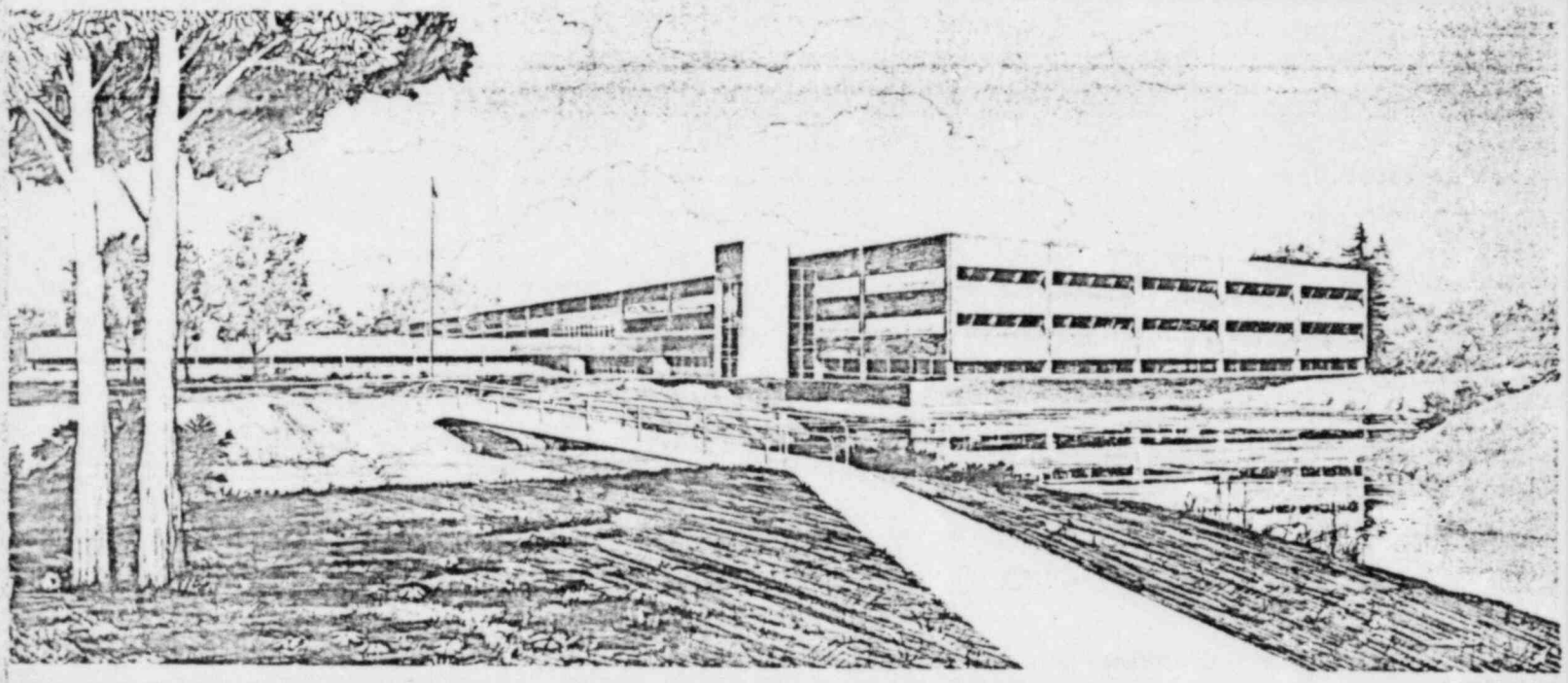
AUGUST 1982

DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

MAINE YANKEE ATOMIC POWER STATION

A. C. Udy

Idaho National Engineering Laboratory
Operated by the U.S. Department of Energy



This is an informal report intended for use as a preliminary or working document

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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

MAINE YANKEE ATOMIC POWER STATION

August 1982

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Reliability and Statistics Branch
Engineering Analysis Division
EG&G Idaho, Inc.

TAC No. 10032
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ABSTRACT

This EG&G Idaho, Inc. report reviews the susceptibility of the safety-related electrical equipment, at the Maine Yankee Atomic Power Station, to a sustained degradation of the offsite power sources.

FOREWORD

This report is supplied as part of "Selected Operating Reactor Issues" being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by EG&G Idaho, Inc., Reliability and Statistics Branch.

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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

MAINE YANKEE ATOMIC POWER STATION

1.0 INTRODUCTION

On June 3, 1977, the NRC requested the Maine Yankee Atomic Power Company (MYAPCo) to assess the susceptibility of the safety-related electrical equipment at the Maine Yankee Atomic Power Station to a sustained voltage degradation of the offsite source and the interaction of the offsite and onsite emergency power systems.[1] The letter contained three positions with which the current design of the plant was to be compared. After comparing the current design to the staff positions, MYAPCo was required to either propose modifications to satisfy the positions and criteria or furnish an analysis to substantiate that the existing facility design has equivalent capabilities.

By letter dated July 18, 1977,[2] MYAPCo responded to the NRC letter. On May 5, 1980, a meeting was held between the NRC and MYAPCo.[3] The NRC positions were fully explained in this meeting. As a result, MYAPCo sent some information to the NRC on July 24, 1980.[4] On October 2, 1980, a formal request for information that was still unavailable was sent to MYAPCo by the NRC.[5] On January 20, 1981, MYAPCo submitted design modifications and answers to the request for additional information.[6] Additional information was submitted on March 5, 1981[7] and August 11, 1982.[8] The modifications consist of the installation of a coincident second-level undervoltage (UV) protection system for the Class 1E equipment. To date, MYAPCo has not supplied or committed to supply the required technical specifications.

2.0 DESIGN BASE CRITERIA

The design base criteria that were applied in determining the acceptability of the system modifications to protect the safety-related equipment from a sustained degradation of the offsite grid are:

1. General Design Criterion 17 (GDC 17), "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50.[9]

2. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."[10]

3. IEEE Standard 308-1974, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."[11]

4. Staff positions as detailed in a letter sent to the licensee, dated June 3, 1977.[1]

5. ANSI Standard C84.1-1977, "Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)."[12]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of the existing undervoltage protection at the Maine Yankee Atomic Power Station; in Subsection 3.2, a description of the licensee's proposed modifications for the second-level undervoltage protection; and in Subsection 3.3, a discussion of how the proposed modifications meet the design base criteria.

3.1 Existing Undervoltage Protection

On each of the two 4160V Class 1E buses, there are two electromagnetic inverse time undervoltage relays to detect loss of power. They are arranged in a two-out-of-two logic scheme with a setpoint of 3255V.[13]

Should this relay logic detect a loss of voltage, the offsite power feed breakers to that bus will be tripped, the diesel generator associated with that bus will be started, and selected 4160V loads will be dropped. The diesel-generator breaker automatically closes as the generator voltage and frequency become acceptable.

3.2 Modifications

The licensee has proposed to change the Maine Yankee undervoltage protection scheme. In addition to the existing loss-of-voltage relay protection, each bus will be protected against sustained degraded voltage. Two undervoltage relays per bus will detect any voltage below 3720 ± 40V on each of the 4160V Class 1E buses. An instantaneous alarm occurs if any relay is tripped. A two-out-of-two logic per bus in coincidence with an accident signal would, after a ten second time delay, automatically open the bus offsite source breaker. This is turn actuates the loss-of-voltage relays. With no coincident accident signal, manual operator intervention is required to restore the voltage, as no automatic action would occur.

MYAPCo has not supplied technical specifications regarding the setpoints, the allowable upper and lower limits of the setpoint tolerance, the time delays, the allowable limits of the time delay, limiting conditions of operation, surveillance, or testing requirements.

3.3 Discussion

The first position of the NRC staff letter[1] required that a second level of undervoltage protection for the onsite power system be provided. The letter stipulates other criteria that the undervoltage protection must meet. Each criterion is restated below, followed by a discussion regarding the licensee's compliance with that criterion.

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 distribution system levels."

   MYAPCo has provided voltage and time setpoints per this NRC requirement. The degraded voltage relays trip should the voltage be lower than 3720 ± 40V. After ten seconds below this setpoint concurrent with an accident signal, the offsite source circuit breaker is tripped and the loss of voltage relays initiate diesel

generator start, load shedding and load sequencing. This setpoint and time delay were chosen to provide adequate voltage to the most limiting 480V equipment.

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

   The proposed modification incorporates two-out-of-two logic that satisfies this criterion.

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 time delay will be approximately ten seconds. The time delay will be finalized in the technical specification submittal, and must assure that emergency core coolant is delivered within the time delay assumed in the FSAR.

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

      The licensee's proposed time delay is long enough to override any short term grid disturbances or voltage perturbations caused by the starting of large motors.

   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."

The licensee has shown that the time delay will not cause the failure of safety-related equipment, because the setpoint was chosen to provide adequate voltage to the most limiting (480V) equipment.

4. "The voltage monitors shall automatically initiate the disconnection of offsite power sources whenever the voltage setpoint and time-delay limits have been exceeded."

   The logic proposed by MYAPCo meets this NRC criterion.

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

   The licensee has stated in his proposal that the modifications are designed to satisfy the requirements of IEEE Standard 279.

6. "The technical specifications shall include limiting conditions for operation, surveillance requirements, trip setpoints with minimum and maximum limits, and allowable values for the second-level voltage protection monitors."

   The licensee has not proposed any technical specifications for the second-level voltage protection monitors.

The second NRC staff position requires that the system design automatically prevent load-shedding of the emergency buses once the onsite sources are supplying power to all sequenced loads. The load-shedding must also be reinstated if the onsite breakers are tripped.

Bypass of the load shedding feature is automatic when the diesel generator circuit breaker is closed.[6] MYAPCo is modifying the emergency buses at the Maine Yankee Atomic Power Station to reinstate automatic load shedding should the diesel generator circuit breaker be opened subsequent to the diesel generator being connected to the bus.[7]

The third NRC staff position requires that certain test requirements be added to the technical specifications. These tests were to demonstrate the full-functional operability and independence of the onsite power sources, and are to be performed 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 verify the proper operation of the load-shed system, the load-shed bypass when the emergency diesel generators are supplying power to their respective buses, and that there is no adverse interaction between the onsite and offsite power sources.

The current technical specifications comply with the requirement to test by simulated loss of offsite power in conjunction with a safety-injection signal. However, MYAPCo has not included testing in the technical specifications to simulate interruption and subsequent reconnection of the onsite power sources.

4.0 CONCLUSIONS

Based on the information provided by MYAPCo, it has been determined that protection of the Class 1E equipment from sustained degraded grid voltages concurrent with an accident condition meet Criterion 1 of the June 3, 1977[1] letter. For non-accident conditions, the automatic disconnection requirement is not met. Instead of providing this automatic disconnection feature, the licensee has provided a list of available redundant systems[7] (that are not exposed to the same degraded voltage) that, if required, are capable of obtaining and maintaining the unit in a safe shutdown condition. This equipment listing will be reviewed and evaluated by the Reactor Systems Branch and the Auxiliary Systems Branch of the NRC to determine acceptability.,

The load shed circuitry will be modified to fully comply with NRC Criterion 2, and this will prevent adverse interaction of the offsite and onsite emergency power systems.

To complete this topic, MYAPCo should provide:

1. Technical specifications to cover the setpoint, time delays and their tolerances, the limiting conditions of operation, surveillance testing for the undervoltage protection relaying system and a test that simulates a loss of offsite power coincident with an accident signal, verifying the start of the diesel generator, and load shedding and load sequencing. Additionally, this test should verify that the load shedding and the load sequencing are reinstated if the diesel generator breaker is tripped.

2. Plant operating procedures that specify operator actions for a degraded grid under non-accident conditions.

5.0 REFERENCES

1. NRC letter to MYAPCo, dated June 3, 1977.

2. MYAPCo letter, E. W. Jackson, to Office of Nuclear Reactor Regulation, NRC, July 18, 1977, WMY-77-72.

3. Meeting May 5, 1980, MYAPCo and NRC, Bethesda, MD.

4. MYAPCo letter, D. E. Vandenburgh, to Office of Nuclear Reactor Regulation, NRC, "Mitigating the Effects of Grid Degradation on Safety Related Electrical Equipment," July 24, 1980, WYR-80-83.

5. NRC letter, R. A. Clark, to MYAPCo, R. H. Groce, October 2, 1980.

6. MYAPCo letter, R. H. Groce, to Office of Nuclear Reactor Regulation, NRC, "Mitigating the Effects of Grid Degradation on Safety-Related Electrical Equipment," January 20, 1981, FMY 81-5.

7. MYAPCo letter, J. H. Garrity to NRC, attention Division of Licensing, "Mitigating the Effects of Grid Degradation on Safety-Related Electrical Equipment," March 5, 1981, FMY 81-32.

8. MYAPCo letter, J. H. Garrity to NRC, attention R. A. Clark, "Degraded Grid Voltage," August 11, 1982, MN-82-153.

9. General Design Criterion 17, "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

10. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations."

11. IEEE Standard 308-1974, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations."

12. ANSI C84.1-1977, "Voltage Ratings for Electric Power Systems and Equipment (60 Hz)."

13. MYAPCo letter, E. W. Jackson, to Office of Nuclear Reactor Regulation, NRC, July 18, 1977, WMY-77-72.