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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS,

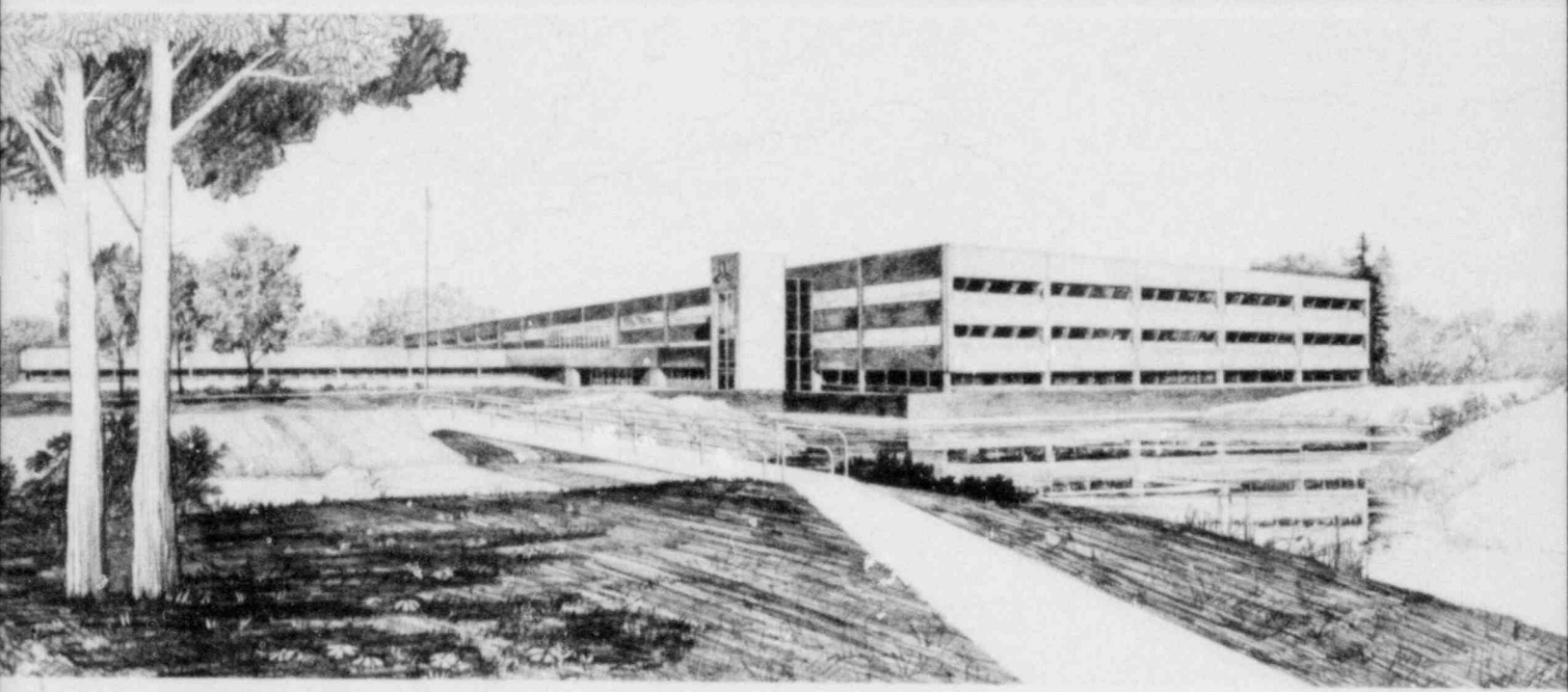
OYSTER CREEK NUCLEAR STATION UNIT 1, DOCKET NO. 50-219

D. A. Weber

PRELIMINARY

NRC Research and Technical Assistance Report

U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory



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INTERIM REPORT

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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

OYSTER CREEK NUCLEAR STATION UNIT 1

Docket No. 50-219

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June 1981

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ABSTRACT

In June 1977, the NRC sent all operating reactors a letter outlining three positions the staff had taken in regard to the onsite emergency power systems. Jersey Central Power & Light Company (JCP&L) was to assess the susceptibility of the safety-related electrical equipment at the Oyster Creek Nuclear Station, Unit 1, to a sustained voltage degradation of the offsite source and interaction of the offsite and onsite emergency power systems. This report contains an evaluation of JCP&L's analysis, modifications, and technical specification changes to comply with these NRC positions. The evaluation has determined that JCP&L does not comply with one of the NRC positions.

FOREWORD

This report is supplied as part of the "Selected Operating Reactor Issues Program (III)" 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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1.0 INTRODUCTION

On June 2, 1977,[1] the NRC requested the Jersey Central Power & Light Company (JCP&L) to assess the susceptibility of the safety-related electrical equipment at the Oyster Creek Nuclear Station to a sustained voltage degradation of the offsite source and 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, JCP&L 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.

JCP&L responded to the NRC letter of June 3, 1977 with a submittal dated September 25, 1979.[2] This submittal and submittals of September 16, 1976,[3] October 14, 1976,[4] November 5, 1976,[5] February 1, 1977,[6] April 18, 1977,[7] August 15, 1977,[8], November 1, 1979,[9] January 18, 1980,[10] August 11, 1980,[11] April 30, 1981,[12] and the Oyster Creek Final Safety Analysis Report (FSAR)[13] complete the information reviewed for this report.

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), "Electrical Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50[14]

2. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"[15]

3. IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations"[16]

4. Staff positions as detailed in a letter sent to the licensee, dated June 2, 1977[1]

5. ANSI Standard C84.1-1977, "Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)."[17]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of the existing undervoltage protection at Oyster Creek; 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. For loss-of-voltage protection, each of the safety-related 4160V buses 1C and 1D has a set of General Electric type 1AV53K under/overvoltage indication relays. The undervoltage trip setpoint for each relay is 68.8% (2864V). Each relay will operate in 3 seconds on total loss of power. The 68.8% on the 4160V buses will result in voltage of 317 (66%) and 297 (61.8%) for the 480V substations and motor control centers (MCC's), respectively. Operation of either relay will initiate isolation of the 4160V buses and loads, initiate load shedding and start of the emergency diesel generators (DG's), energize the emergency buses with permanently connected loads and energize the automatically connected emergency loads through a load sequencer.

3.2 Modifications. As a result of the NRC request, JCP&L has installed a second-level undervoltage scheme to protect safety-related equipment from a sustained degraded grid. The scheme consists of the addition of independent undervoltage relays for buses 1C and 1D. The three relays on each bus are connected in a two-out-of-three coincident logic, with a setpoint of 3671V $\pm$1% (36.7V) and a time delay of 10 seconds $\pm$1% (0.1 sec). Either bus relay logic will initiate disconnection of the offsite power source whenever the voltage setpoint and time limits have been exceeded. With the offsite power disconnected, the existing loss-of-voltage relays on the emergency buses will operate as described in Section 3.1.

The licensee has proposed changes to the plant's technical specifications including: relay surveillance requirements, setpoints and limits, and limiting conditions for operation.

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 system distribution levels."

   The licensee's proposed setpoint of 3671V (88.5% of 4160V) results in voltages of 89.9% at the 460V rated motor starters. The motor starters will pickup at 85% voltage and the control circuitry can withstand a lower voltage. This setpoint allows worst case terminal voltages of 91.6%, 85%, 87.4% and 90.4% for the corresponding safety-related 4000V, 480V, 460V, and 440 motors. The minimum rating is 90% for the 4000V motor, and 86.6% for the worst case 480V, 460V, and 440V motors (which consider a 1.15 service factor). At the proposed setpoint all 4000V, 460V, and 440V safety related

equipment will operate at voltages above the minimum required. However the setpoint allows the 480V motors to be operated continuously at voltages below their minimum rating. Therefore the proposed setpoint is not satisfactory.

The licenses submittal of April 30, 1981[12] points out that the analysis does not consider the automatic operation of newly installed voltage regulators which will maintain the 4160V bus at 4100V when the grid is at its minimum analyzed value. However, credit cannot be given for the regulators since they have a limited voltage control during degraded grid conditions.

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

The proposed modification incorporates a two-out-of-three coincident logic scheme, thereby satisfying 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 proposed maximum time delay of 10 seconds (±0.1 seconds) does not exceed this maximum time delay.[2]

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 minimum time delay of 10 seconds is long enough to override any short, inconsequential grid disturbances and voltage dips caused from 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."

A review of the licensee's voltage analysis indicates that the time delay will not cause any failures of the safety-related equipment.[2]

4. "The voltage monitors shall automatically initiate the disconnection of offsite power sources whenever the

voltage setpoint and time-delay limits have been exceeded."

A review of the licensee's submittals confirms that this criterion is met.

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 meet or exceed 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's proposal for technical specification changes includes all the required items.

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.

The existing undervoltage relaying scheme for the emergency buses already has these features incorporated. The second-level undervoltage protection will be blocked automatically when the emergency buses are being fed from the onsite sources.

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 testing procedures proposed by the licensee comply with the full intent of this position.[11] Load-shedding on offsite power trip is tested. Load-sequencing, once the diesel generator is supplying the safety buses, is tested. The time duration of the tests (equal to or greater than 5 minutes) will verify that the time delay is sufficient to avoid spurious trips and that the load-shed bypass circuit is functioning properly.

4.0 CONCLUSIONS

Based on the information provided by JCP&L, it has been determined that the installed modifications do not comply with NRC staff position 1. Certain 480V motors may operate at voltages below their minimum ratings at the present second-level undervoltage relay setpoint, when the offsite grid is at its minimum analyzed value. Credit cannot be given for the installed voltage regulators.

The existing load-shed circuitry complies with staff position 2 and will prevent adverse interaction of the offsite and onsite emergency power systems.

The proposed changes to the technical specifications adequately test the system modifications and comply with staff position 3. The surveillance requirements, limiting conditions for operation, minimum and maximum limits for the trip setpoint, and allowable values meet the intent of staff position 1.

It is therefore concluded that the setpoint of the installed second-level undervoltage relays is not acceptable. The proposed changes to the technical specifications are acceptable, except for the second-level undervoltage relay setpoint.

5.0 REFERENCES

1. NRC letter (R. W. Reid) to JCP&L, dated June 2, 1977.

2. JCP&L letter (I. R. Finfrock) to the Director, Nuclear Reactor Regulation, dated September 25, 1979.

3. JCP&L letter (I. R. Finfrock) to Mr. George Lear, Chief, Operating Reactors Branch No. 3, Division of Reactor Licensing, dated September 16, 1976.

4. JCP&L letter (I. R. Finfrock) to Mr. George Lear, Chief, Operating Reactors Branch No. 3, Division of Reactor Licensing, dated October 14, 1976.

5. JCP&L letter (I. R. Finfrock) to Mr. George Lear, Chief, Operating Reactors Branch No. 3, Division of Reactor Licensing, dated November 5, 1976.

6. JCP&L letter (I. R. Finfrock) to Mr. George Lear, Chief, Operating Reactors Branch No. 3, Division of Reactor Licensing, dated February 4, 1977.

7. JCP&L letter (I. R. Finfrock) to Mr. George Lear, Chief, Operating Reactors Branch No. 3, Division of Reactor Licensing, dated April 18, 1977.

8. JCP&L letter (I. R. Finfrock) to Mr. George Lear, Chief, Operating Reactors Branch No. 3, Division of Reactor Licensing, dated August 15, 1971.

9. JCP&L letter (I. R. Finfrock) to the Director of Nuclear Reactor Regulation, dated November 1, 1979.

10. JCP&L letter (I. R. Finfrock) to the Director of Nuclear Reactor Regulation, dated January 18, 1980.

11. JCP&L letter (I. R. Finfrock) to the Director of Nuclear Reactor Regulation, dated August 11, 1980.

12. JCP&L letter (I. R. Finfrock) to the Director of Nuclear Reactor Regulation, dated April 30, 1981.

13. Final Safety Analysis Report (FSAR) for the Oyster Creek Nuclear Station.

14. 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."

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

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

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

18. IEEE Standard 141-1976, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants."

19. NEMA Standard, NEMA MG1-1972. "Motors and Generators."