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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS, EDWIN I. HATCH NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

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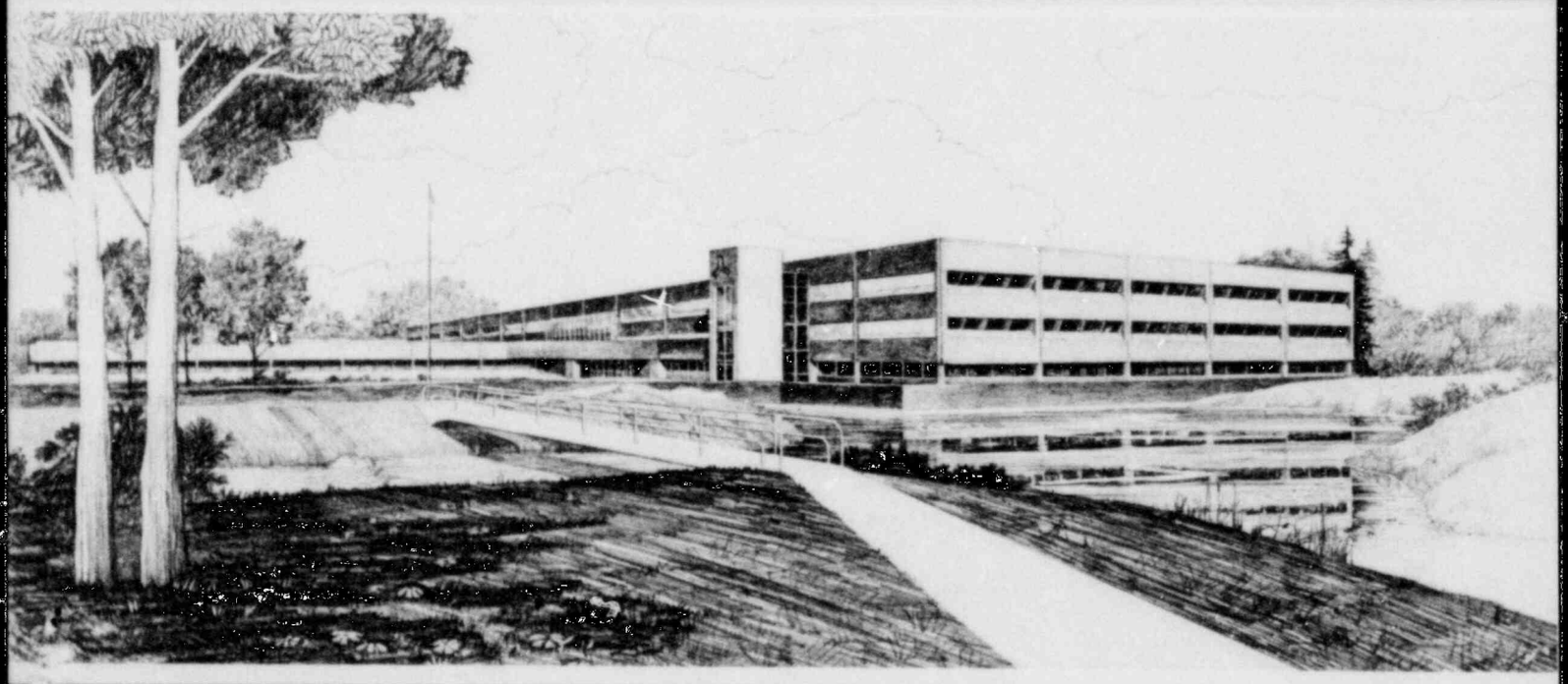

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EDWIN I. HATCH NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

February 1982

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Reliability and Statistics Branch
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EG&G Idaho, Inc.

TAC Nos. 10026 and 11262
Docket Nos. 50-321 and 50-366

ABSTRACT

This EG&G Idaho, Inc. report reviews the susceptibility of the safety-related electrical equipment at the Edwin I. Hatch Nuclear Power Plant to a sustained degradation of the offsite power sources.

FOREWORD

This report is supplied as part of the "Selected Operating Reactor Issues Programs (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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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

EDWIN I. HATCH NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

1.0 INTRODUCTION

On June 2, 1977, the NRC requested the Georgia Power Company (GPC) to assess the susceptibility of the safety-related electrical equipment at the Edwin I. Hatch Nuclear Plant Unit 1 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, GPC 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.

GPC replied to the NRC letter on July 22, 1977.[2] GPC supplied additional information and technical specification changes on October 9, 1980[3] and on May 21, 1981.[4] On October 2, 1981,[5] GPC submittal modified technical specification changes for Unit No. 1 and similar technical specification changes for Unit No. 2. This submittal had a typing error corrected on December 2, 1981.[6] Additional information is found in GPC letters dated September 17, 1976,[7] and January 12, 1982.[8] On January 26, 1982, GPC submitted all of the revised pages for the Unit 1 technical specifications.[9]

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[10]

2. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"[11]

3. IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations"[12]

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)."[13]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of existing undervoltage protection at the Hatch Station; in Subsection 3.2, a description of the licensee's proposed scheme for the second-level undervoltage protection; and in Subsection 3.3, a discussion of how the system meets the design base criteria.

3.1 Existing Undervoltage Protection. The previous design utilized four undervoltage relays on each 4160V Class 1E emergency bus. They were arranged in a one-out-of-two-taken-twice logic scheme. The relays were set to operate at a voltage of 2912V (70%). These relays were used to sense a loss of offsite power. Should the voltage on the Class 1E buses fall to the setpoint, automatic fast transfer is initiated to the alternate offsite source by this relay logic and the diesel generators are started. If the alternate source is not available, the buses are load-stripped and the preferred and alternate source breakers are tripped and locked-out. As the diesel generators reach 90% of rated voltage and frequency, the diesel-generator bus breaker is automatically closed. The undervoltage condition is also annunciated in the main control room.

This system disables the load-shed feature once the Class 1E buses are being supplied by the diesel generators. Prior to the modification proposed in 1976, this was not disabled.[5] Non-essential loads, however, are load-shed when an accident signal exists whether the Class 1E buses are being supplied from the offsite or the onsite power sources.

3.2 Modifications. To protect the Class 1E safety-related equipment from the effects of a degraded grid condition, GPC has proposed changing the setpoints on the existing undervoltage relays. The relays used are Westinghouse type CV-7 inverse-time undervoltage relays. The two degraded voltage relays, arranged in a two-out-of-two logic, will have a nominal setpoint of 3280V (78.8% of bus voltage) with a time delay of less than or equal to 21.5 seconds. When a loss-of-voltage occurs, two other relays, also utilizing a two-out-of-two logic, will operate at a setpoint of greater than or equal to 2800V (67.3% of bus voltage) with a time delay of less than or equal to 6.5 seconds. GPC has submitted a diagram showing the relay charateristics both above and below these nominal values.[8] Upon a trip signal from both degraded voltage relays or both loss-of-voltage relays the sequence of events will be as stated in Subsection 3.1, except that the operation of any one of the four mentioned relays will initiate the start of the diesel generator associated with that bus. The voltages and time delays specified are one point on the calibration curve for that relay. The relays operate with less time delay at lower voltages, and a greater time delay at higher voltages. GPC has shown that the operating characteristics of the relays will not spuriously trip the Class 1E buses from offsite power for all expected combinations of offsite grid voltage and unit loads.

Load-shedding is blocked once the diesel generator is supplying power to its Class 1E bus, except for non-essential loads, by use of a "b" contact of the diesel-generator breaker. The load shedding is reinstated should the diesel generator breaker subsequently reopen. As stated above, this is already incorporated in the existing logic circuit.

Proposed changes to the plant's technical specifications, adding the surveillance requirements, allowable limits for the setpoint and time delay, and limiting conditions for operation for the second-level undervoltage monitors, were also furnished by the licensee. Bases for limiting conditions of operation as well as bases for surveillance requirements pertaining to these relays were also included in the technical specification changes.

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."

   GPC has analyzed for the voltage requirements for the safety-related loads at all onsite distribution system levels.[3] These studies have contributed to the selection of the proposed relay settings.

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

   The relay logic is arranged in a 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 bases for limiting conditions of operation submitted by the licensee states that the proposed time delay, including margin, does not exceed the maximum time delay as analyzed in the FSAR.

      The proposed time delay will not be the cause of any thermal damage to the safety-related equipment. The equipment is rated to operate at the setpoint voltage for in excess of 30 seconds.

   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 characteristics provide a time delay long enough to override any short inconsequential grid disturbances. Any voltage dips caused from the starting of large motors will not trip the offsite source.

   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[3] indicates that the time delay will not cause any failures of the

safety-related equipment since the relay characteristics will disconnect a degraded source of AC power before the stall rating of the equipment is exceeded.

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 proposal substantiates 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 submittal that all circuits associated with the undervoltage relays meet IEEE Standard 279-1971.[2,8]

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."

   The licensee's latest draft proposal for technical specification changes[5,9] includes all of the required items except for instrument check. The instrument check is normally done by verifying that normal voltage is present at the input to each undervoltage relay. The Hatch station does not have voltmeters or indicators at this location, therefore the instrument check is not applicable. Analyses have been performed which assure that the range between the maximum and the minimum settings (allowable limits) will not be the cause of spurious trips of offsite power nor will they allow the voltage to be so low as to allow damage to the safety equipment.

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.

GPC states that this feature is already incorporated in the circuit design.[2,5] A review of the logic circuitry substantiates that the load-shed is blocked by a contact of the diesel-generator breaker. All non-essential loads are, however, load-shed when the onsite source is supplying power to the Class 1E buses.

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 simulated 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 do comply with this position. Load-shedding when offsite power is tripped is tested. Load-sequencing, once the diesel generator is supplying the safety buses, is tested. A simulated loss of the diesel generator and subsequent load-shedding and load-sequencing once the diesel generator is back on-line is tested. The time durations of the tests will verify that the time delay of the undervoltage relays 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 GPC, it has been determined that the proposed changes do comply with NRC staff position 1. All of the staff's requirements and design base criteria have been met. The setpoint and time delay will protect the Class 1E equipment from a sustained degraded voltage condition of the offsite power source.

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

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

It is therefore concluded that the modifications and the proposed technical specification changes for Unit 1^{9} and for Unit 2^{5} are acceptable. These new setpoints and time delays have been implemented and it is, therefore, recommended that the changes to the technical specifications be approved and implemented at the earliest opportunity.

5.0 REFERENCES

1. NRC letter, V. Stello to C. F. Whitmer, GPC, dated June 2, 1977.

2. GPC letter, C. F. Whitmer, to Office of Nuclear Reactor Regulation, NRC, "Emergency Power Systems," July 22, 1977.

3. GPC letter, W. A. Widner to Office of Nuclear Reactor Regulation, NRC, "Response to Request for Additional Information--System Voltage Study," October 9, 1980.

4. GPC letter, J. T. Beckham to Office of Nuclear Reactor Regulation, NRC, "Emergency Power Systems," May 21, 1981.

5. GPC letter, W. A. Widner to Director of Nuclear Reactor Regulation, NRC, "Emergency Power Systems," October 2, 1981.

6. GPC letter, J. T. Beckham to Director of Nuclear Reactor Regulation, NRC, "Revised Technical Specifications for Degraded System Voltage," December 2, 1981.

7. GPC letter, C. F. Whitmer to Office of Nuclear Reactor Regulation, NRC, "Operation During Degraded Grid Voltage Conditions," September 17, 1976.

8. GPC letter, J. T. Beckham to Division of Licensing, NRC, "Adequacy of Station Electric Distribution System Voltages, Response to Request for Additional Information," January 12, 1982.

9. GPC letter, W. A. Widner to Director of Nuclear Reactor Regulation, "Emergency Power Systems," January 26, 1982.

10. 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."

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

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

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