EG&G Idaho, Inc.

FORM EG&G-398
(Rev. 12-78)

INTERIM REPORT

Accession No. _____

Report No. EGG-EA-5109

Contract Program or Project Title: Electrical, Instrumentation & Control System Support

Subject of this Document: "Technical Evaluation Report of the Degraded Grid Protection for Class IE Power Systems at the Brunswick Steam Electric Plant, Unit Nos. 1 and 2, Docket Nos. 50-325 & 50-326"

Type of Document: Technical Evaluation Report

Author(s): C. J. Cleveland

Date of Document: February 1980

Responsible NRC Individual and NRC Office or Division: Paul Shemanski, Division of Operating Reactors

This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

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Prepared for the
U.S. Nuclear Regulatory Commission
and the U.S. Department of Energy
Idaho Operations Office
Under contract No. EY-76-C-07-1570
NRC FIN No.

A6256

INTERIM REPORT

EGG-EA-5109

February 1980

TECHNICAL EVALUATION REPORT OF THE DEGRADED GRID PROTECTION FOR CLASS IE POWER SYSTEMS AT THE BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2, DOCKET NOS. 50-325 AND 50-326

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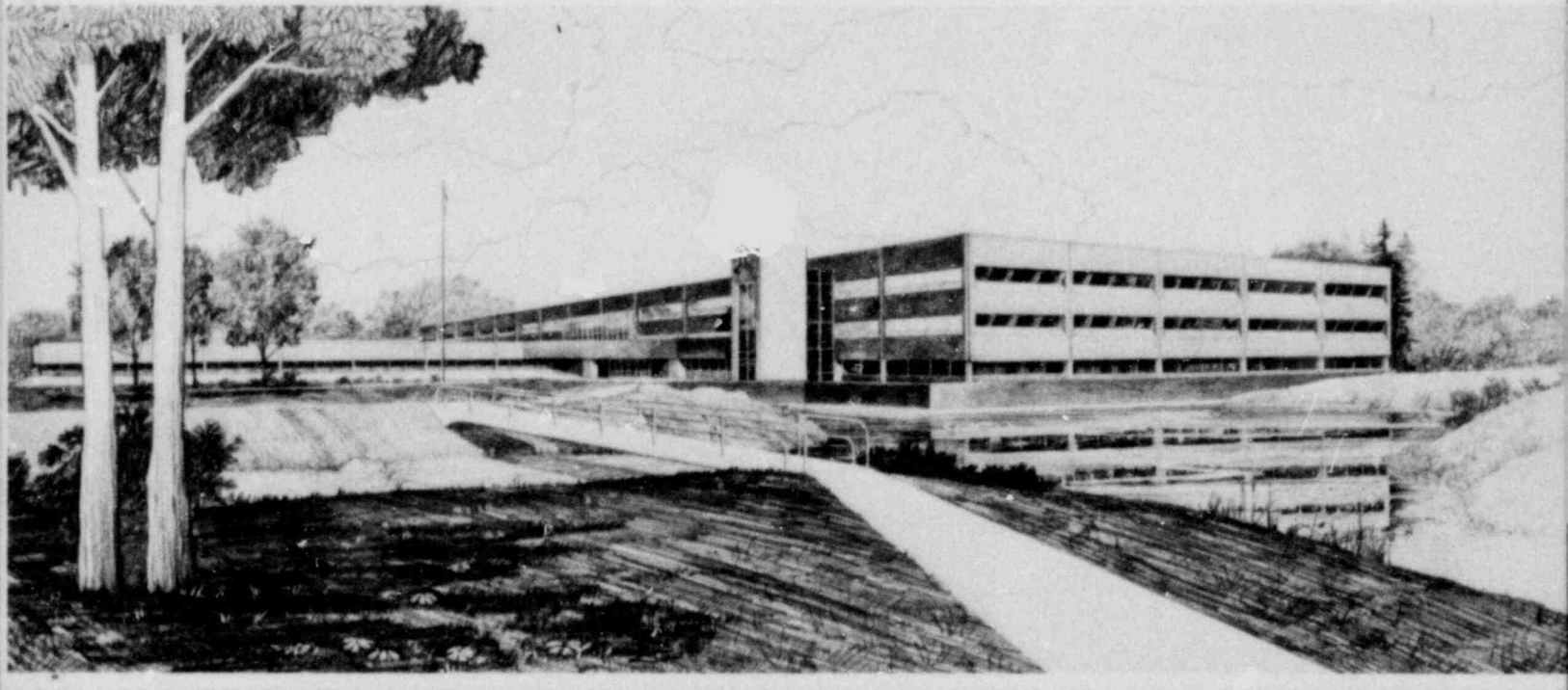
U.S. Department of Energy
Idaho Operations Office • Idaho National Engineering Laboratory



Prepared for the
U.S. Nuclear Regulatory Commission
Under DOE Contract No. DE-AC07-76ID01570
FIN No. A6256

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INTERIM REPORT

1358F

TECHNICAL EVALUATION REPORT
DEGRADED GRID PROTECTION FOR CLASS IE POWER SYSTEMS

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2

Docket Nos. 50-325 and 50-326

C. J. Cleveland

February 1980

(TACs 10013, 10014)

ABSTRACT

In June 1977, the NRC sent all operating reactors a letter outlining three positions the staff had taken in regards to the onsite emergency power system. Carolina Power & Light Company was to assess the susceptibility of the safety-related electrical equipment at the Brunswick Steam Electric Plant, Units 1 and 2 to a sustained voltage degradation of the offsite source and interaction of the offsite and onsite emergency power system. This report contains an evaluation of CP&L's analyses, modifications, and technical specification changes to comply with these NRC positions.

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TECHNICAL EVALUATION REPORT
DEGRADED GRID PROTECTION FOR CLASS IE POWER SYSTEMS

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2

1.0 INTRODUCTION

On June 3, 1977, the NRC requested the Carolina Power & Light Company (CP&L) to assess the susceptibility of the safety-related electrical equipment at the Brunswick Steam Electric Plant, Units 1 and 2 (BSEP-1&2) 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, CP&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.

By letter, dated March 6, 1979, CP&L proposed certain design modifications and changes to the Technical Specifications to satisfy the criteria and Staff Positions.[2] The modifications consist of the installation of a second-level undervoltage protection system for the class 1E equipment, and blocking of the load shedding feature when the diesel generator is supplying power to the emergency buses. The NRC required that the setpoint, surveillance requirements, test requirements, and allowable limits were to be included by CP&L in the plant 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), "Electrical Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," of 10 CFR 50[3]

2. IEEE Standard 279-1971, "Class IE Power Systems for Nuclear Power Generating Stations"[4]

3. IEEE Standard 308-1974, "Class IE Power Systems for Nuclear Power Generating Stations"[5]

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)."[6]

3.0 EVALUATION

This section provides, in Subsection 3.1, a brief description of the existing undervoltage protection at the BSEP-1&2; in Subsection 3.2, a description of the licensee's proposed modifications for the second-level undervoltage protection; in Subsection 3.3, a discussion of how the proposed modifications meet the design base criteria.

3.1 Existing Undervoltage Protection. The present design uses one inverse time delay voltage relay on each of the four station 4160 V Class IE safety buses to detect a loss-of-offsite power. These relays have a maximum setpoint of 2940 V (71%). The characteristics of the relay are such that when the offsite voltage drops to this value and persists for at least ten seconds, the offsite sources are tripped, emergency diesel generator start is initiated, load shedding is initiated, and the undervoltage condition is annunciated at the Reactor-Turbine Generator (RTG) boards.

The existing system does not disable or bypass the load-shedding feature once the emergency diesels are feeding the emergency buses. The time duration and magnitude of any voltage transients caused by starting large motors are stated by the licensee as not being large or long enough to trip the loss-of-power undervoltage relays.

3.2 Modifications. The licensee has proposed adding 12 definite time undervoltage relays to the four 4160 V Class IE buses. There will be three relays per bus, one per phase, arranged in a two-of-three coincident logic. These relays will have a nominal setpoint of 3727 V (89.5% of bus voltage) with a time delay of ten (10) seconds. When an undervoltage condition persists below the setpoint for at least ten seconds, the feeder breaker from the BOP switchgear and the incoming line breaker to the emergency bus

will be tripped. This is accomplished when the undervoltage relay contacts energize an existing auxiliary relay (94). A contact from a time-delay on drop-out relay, set at two seconds, is wired in series with the undervoltage relay contacts to prevent tripping of the breakers as the emergency bus is initially energized until the voltage reaches rated value. This time-delay relay is energized by a "b" contact of the incoming line breaker.

To block load shedding once the emergency bus is being supplied by its diesel generator, a "b" contact of the diesel generator breaker is being wired in series with the existing undervoltage auxiliary relays that initiate load shedding on the ESF buses.

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. An analysis to substantiate the limiting conditions and minimum and maximum setpoint limits was also part of the proposal.

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 3727 V at the 4160 V bus is 93% of the motor-rated voltage of 4000 V. This setpoint reflected down to the 480 V buses will be greater than 90% of the motor-rated voltage. As the motors are the most limiting equipment in the system, this setpoint is acceptable. The licensee's analysis considered other factors such as MCC contactor pick-up voltage and drop-out voltage.

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

The proposed modification incorporates a two-out-of-three 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."

Inasmuch as the time delay proposed is the same as for the time delay for loss-of-power relays, the proposed time delay of ten seconds with the 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 setpoint is within voltage ranges recommended by ANSI C84.1-1977 for sustained operation.

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 of ten seconds is long enough to override any short inconsequential grid disturbances. Further, we have reviewed the licensee's analysis and agree with the licensee's finding that 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[7] indicates that the time delay will not cause any failures of the safety-related equipment since the voltage setpoint is within the allowable tolerance of the equipment-rated voltage.

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 proposal that the modifications are designed to meet or exceed IEEE Standard 279 as well as GDC 17. Also stated in the proposal, the Quality Assurance Program, in effect, incorporating the requirements of 10 CFR 50, Appendix B, will be applied to the extent necessary. A test switch is designed into the circuitry so testing can be performed. The licensees submittal states that the design characteristics of the relays exceed the environmental and seismic load requirements.

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 licencee's proposal for Technical Specification changes does include all of the required items. An analysis is also provided which assures that the range between the minimum and maximum trip point settings, as well as the allowable limits, will not be the cause of spurious trips of the offsite source nor will they allow the voltage to be so low as to allow damage to the safety equipment. Instrument drift, transformer accuracy, and calibration accuracy were factors in this analysis.

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 licensee's proposal states that modifications will be made to comply with this position. The addition of a "b" contact of the diesel generator breaker in series with the undervoltage auxiliary relay contact will satisfy this position.

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 interrruption 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 the full intent of this position. Load shedding on offsite power trip is tested. Load sequencing once the diesel generator is supplying the safety buses is tested. Because of the design of the Brunswick load-shedding circuits, the licensee felt that the test calling for tripping the diesel breaker and restarting was redundant. The addition of the diesel breaker "b" contact is the only change to the logic circuit. Any time the diesel breaker is closed, the existing undervoltage relays that initiate load shedding will be disabled. This is tested adequately by position three (test b). The time durations of the tests (five minutes with full safety loads) 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 CP&L, it has been determined that the proposed modifications comply with NRC staff position 1. All of the staff's requirements and design base criteria have been met. The modifications will protect the class 1E equipment from a sustained degraded voltage condition of the offsite power source.

The modifications to the logic of the load shed circuitry do 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 meet the intent of staff position 1.

It is therefore concluded that CP&L's proposed modifications and Technical Specification changes are acceptable.

5.0 REFERENCES

1. NRC (Schwencer) letter to CP&L (Utley), dated June 3, 1977.

2. CP&L (Utley) letter to NRC (Ippolito), dated March 6, 1979.

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

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

5. IEEE Standard 308-1974, "Standard Criteria for Class IE Power Systems for Nuclear Power Generating Stations."

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

7. CP&L (Utley) letter to NRC (Ippolito), dated October 8, 1979.

8. Final Safety Analysis Report (FSAR) for the Brunswick Steam Electric Plant, Units 1 and 2.

9. CP&L (Utley) letter to NRC (Rusche), dated October 25 1976.

10. CP&L (Utley) letter to NRC (Swencer), dated July 28, 1977.