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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS, BIG ROCK POINT NUCLEAR PLANT

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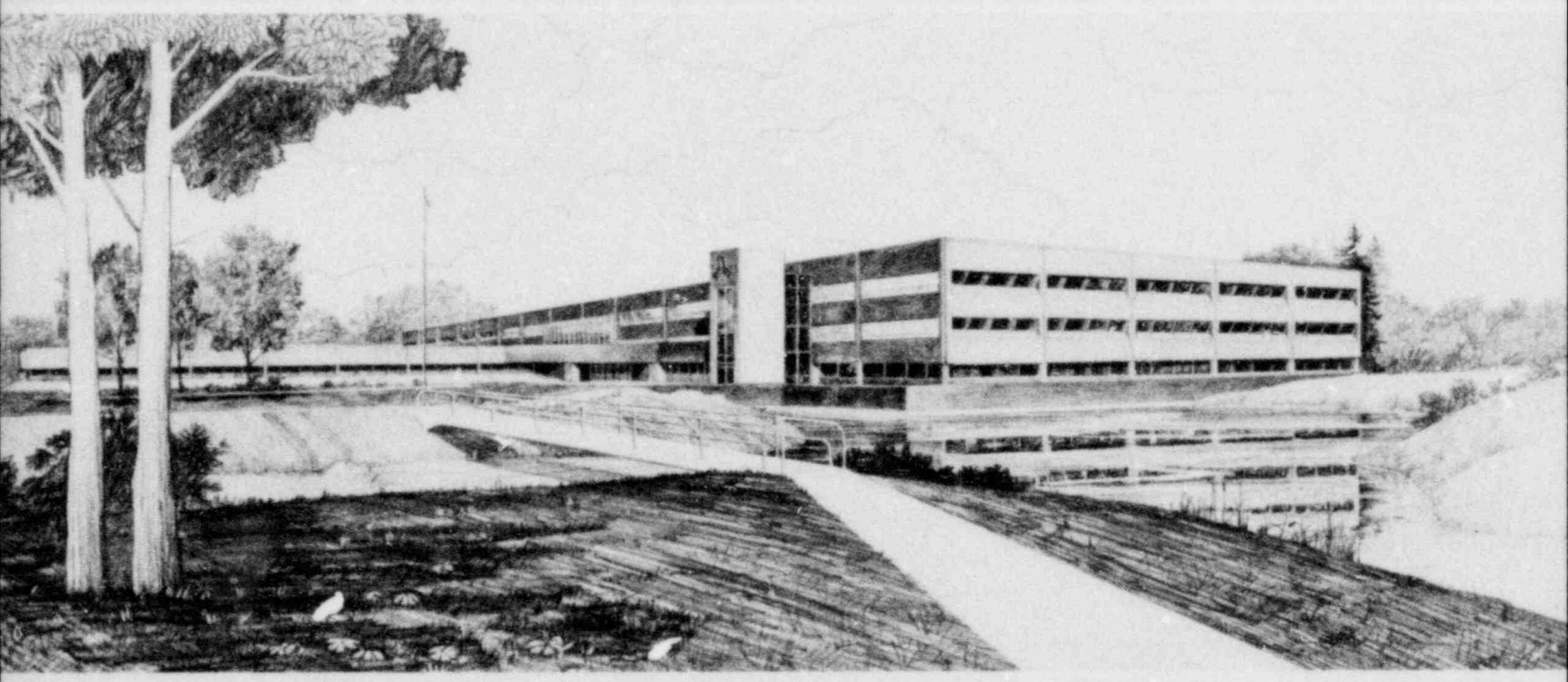

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INTERIM REPORT

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DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

BIG ROCK POINT NUCLEAR PLANT

Docket No. 50-115

C. J. Cleveland/E. W. Roberts
Reliability and Statistics Branch
Engineering Analysis Division
EG&G Idaho, Inc.

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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. Consumers Power Company (CPC) was to assess the susceptibility of the safety-related electrical equipment at the Big Rock Point Nuclear Plant 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 CPC's analyses, modifications, and technical specification changes to comply with these NRC positions. The evaluation has determined that CPC does not comply with all of the NRC positions.

FORWORD

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

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THREE MILE ISLAND NUCLEAR STATION UNIT 1

1.0 INTRODUCTION

On June 3, 1977, the NRC requested the Consumers Power Company (CPC) to assess the susceptibility of the safety-related electrical equipment at the Big Rock Point Nuclear Plant (BRP) 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, CPC 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 20, 1977, CPC acknowledged receipt of the NRC letter and stated that by early October 1977, an analysis would be completed and a thorough response would be submitted.[2] On February 7, 1978, CPC wrote the NRC explaining that, due to unforeseen manpower and equipment problems, the response would be delayed until May 1978.[3] By letter dated June 4, 1978,[4] CPC proposed certain design modifications and analyses in response to the June 1977 NRC letter. On September 1, 1978, CPC submitted a schedule of implementation of these modifications.[5] On April 2, 1979, upon completion of my initial review, several areas were in need of clarification by the licensee and a request for additional information was sent to the NRC. BY letter dated July 9, 1979, the NRC requested CPC to furnish the needed information. By letter dated August 23, 1979, CPC stated that, because of other commitments, a response to the request for information would not be completed until January 15, 1980.[6] By letter dated August 20, 1980, CPC responded to the request.[7] In October 1980, a second request for additional information was sent to the licensee by the NRC. The licensee responded to the request by letter dated December 12, 1980.[8] These submittals contained the analyses and modifications the NRC requested for second-level undervoltage (UV) protection.

By letter dated February 3, 1981,[9] CPC submitted a request for technical specification changes as requested by the NRC letter of June 3, 1977. The NRC required that UV relay setpoint and time delay, with maximum and minimum allowable limits, surveillance requirements, and certain test requirements be included in the technical specification changes.

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, "Class 1E Power 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 the existing undervoltage protection at BRP; 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 the 480V safety-related bus 2B there are two UV relays set less than or equal to 50%. These relays are arranged in a two-out-of-two coincident logic scheme and are instantaneous. Upon actuation, the diesel generator is started. When the diesel generator reaches more than 91% voltage, an overvoltage (OV) relay in coincidence with the two UV relays trip the feed breakers to 2B and close the diesel-generator (DG) breaker. The 2B safety-related bus is not load shed prior to closing the DG breaker and, consequently, the bus is block loaded. The UV relays do not annunciate; however, the feed breakers to the 2B bus are annunciated as they open.

3.2 Modifications. The modification proposed by the licensee for second-level undervoltage protection will consist of three UV relays arranged in a three-out-of-three coincident logic scheme. These relays will have a setpoint of 89% (+2%, -0%) and will monitor the bus voltage of the 2400V non-class 1E bus that feeds the 480V safety-related bus. These relays have a time delay of 0.5 s (+0.1 s) whose coincident signal is fed through a single time delay relay set at 10 s (±0.5 s). This logic will then trip the feed breaker (1136) to the 2400V bus. This will, in turn, trip the UV relays on the 480V bus 2B and initiate the sequence of events as described above.

This plant does not load shed or sequence load on the safety-related bus 2B. The diesel generator is block loaded as the DG reaches at least 91% voltage.

Changes to the plant's technical specifications were also proposed by the licensee, adding a requirement to test and calibrate the new UV relays and adding a limiting condition of operation stating that any one of these relays may be taken out of operation as long as the output from it is in the tripped condition.

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 89% (-2, -0%) reflected down to the 480V bus 2B corresponds to a voltage of 402.5V to 412.1V. This value was arrived at using the licensee's submittal of August 22, 1980,[7] and the worst case shown. This value was also arrived at using the voltage drops through the transformers. The licensee did not state if these were full-load values as well as minimum values of the sources, however. I find this setpoint as reflected to bus 2B to be too low as the licensee has stated that his MCCs are rated for a low voltage of 408V. This being the case, there is a possibility of one or more contactors not picking up.

   This setpoint reflected from the 2B bus to the 100 hp electric fire pump would be 396.5V to 406V using the supplied voltage drop of 1.5%.[8] As this is the worst case condition and the motors are qualified for 396V (440 $\pm$ 10%), I find the setpoint acceptable at this level.

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

   The proposed modification incorporates a three-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."

      The proposed maximum time delay of the UV relays and time delay relay of 11.1 s does not exceed this maximum time delay.

   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 s is long enough to override any short, inconsequential grid disturbances. The licensee has analyzed for this condition in his submittal.[4]

c. "The allowable time duration of a degraded voltage condition at all distribution system voltage levels shall not result in failure of safety systems or components."

A review of the licensee's submittals reveals that the time delay in combination with the setpoint will not cause thermal damage to the safety-related motors.

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.[4] However, upon review of his submittals and logic diagrams, I conclude that the modifications do not meet IEEE Standard 279. The one time-delay realy in series with the second-level UV relays could be the cause of a single failure incident negating the trip of the offsite source, thereby subjecting the safety-related bus to a degraded voltage that would cause thermal damage to the safety systems motors.

It was also the staff's intention that this relay scheme for second-level UV protection be a part of the class 1E power system and be designed as such. Inasmuch as the licensee has proposed to install the relays on a non-class 1E bus, to trip a nonsafety-related breaker, with no provision that these relays directly trip the safety-related bus feed breakers, I find this unacceptable.

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 limiting conditions for operation (LCO) proposed by the licensee does not meet the intent of this NRC position. There is no time limit that a channel must be placed in the tripped position when it is removed. Furthermore, there is no requirement for channel functional tests called out in the technical specifications, only calibration tests once per operating cycle. This could result in a failed relay negating a safety function if a degraded grid condition came about. For this same reason, the surveillance requirements do not meet the intent of this NRC position.

In addition, the licensee has failed to include proposed trip setpoints and allowable limits in the technical specifications. The failure to include the second-level UV protection setpoints, time delays, and allowable limits in the technical specifications disagrees with the NRC criteria and is unacceptable.

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.

I find this position does not apply to this plant as it does not use a load-shed scheme nor does it sequence on their safety-related loads.

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 used by the licensee at present do adequately test the diesel generator as far as this position is concerned. Since the plant does not load shed or sequence safety-related loads, the third NRC position is not applicable to Big Rock Point.

4.0 CONCLUSION

Based on the information provided by CPC, I find that the proposed modifications comply with the criteria or the intent of the NRC in meeting position 1. However, the licensee fails to meet the NRC technical specification requirements of position 1 (criteria 6) since the proposed surveillance requirements do not satisfy the NRC criteria and setpoints, allowable limits, and time delays are not included in the licensee's proposal.

I also find that staff positions 2 and 3 do not pertain to this plant.

5.0 REFERENCES

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

2. CPC letter (D. A. Bixel) to NRC (Director) dated July 20, 1977.

3. CPC letter (W. S. Skibitsky) to NRC (D. L. Ziemann) dated February 7,, 1978.

4. CPC letter (W. S. Skibitsky) to NRC (D. L. Ziemann) dated June 14, 1978.

5. CPC letter (D. A. Bixel) to NRC (D. L. Ziemman) dated September 1, 1978.

6. CPC letter (D. A. Bixel) to NRC (D. L. Ziemann) dated August 23, 1979.

7. CPC letter (D. P. Hoffman) to NRC (D. M. Crutchfield) dated August 22, 1980.

8. CPC letter (D. P. Hoffman) to NRC (D. M. Crutchfield) dated December 12, 1980.

9. CPC letter (D. P. Hoffman) to NRC (D. M. Crutchfield) dated February 3, 1981.

10. General Design Criterion 17, "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR 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)."

14. CPC letter (R. B. Sewell) to NRC (Director) dated December 7, 1976.

15. Final Hazard Safety Report, Appendix A, Big Rock Point Plant Technical Specifications.