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INTERIM REPORT

TECHNICAL EVALUATION REPORT
DEGRADED GRID PROTECTION FOR CLASS 1E POWER SYSTEMS

BEAVER VALLEY POWER STATION, UNIT NO. 1

Docket No. 50-334

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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. Duquesne Light Company (DLC) was to assess the susceptibility of the safety-related electrical equipment at the Beaver Valley Power Station, Unit No. 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 DLC's analyses, modifications, and technical specification changes to comply with these NRC positions.

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BEAVER VALLEY POWER STATION, UNIT NO. 1

1.0 INTRODUCTION

On June 3, 1977, the NRC requested the Duquensne Light Company (DLC) to assess the susceptibility of the safety-related electrical equipment at the Beaver Valley Power Station, Unit No. 1 (BVPS-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, DLC 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 October 15, 1979, DLC proposed certain design modifications and committed to furnishing technical specification changes in the future to satisfy the criteria and staff positions[2]. By letters dated May 14, 1980[3], and July 24, 1980[4], DLC did submit technical specification changes to comply with the staff positions. 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 DLC 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[5]

2. IEEE Standard 279-1971, "Class 1E Power Systems for Nuclear Power Generating Stations"[6]

3. IEEE Standard 308-1974, "Class 1E Power Systems for Nuclear Power Generating Stations"[7]

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)."[8]

3.0 EVALUATION

This section provides; in Subsection 3.1, a brief description of the existing undervoltage protection at the BVPS-1; 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. The present scheme at BVPS-1 consists of six undervoltage (UV) relays on each load group. (The station distribution system consists of two load groups.)

1. Two UV relays on each 4160V nonclass 1E bus. One relay is called out as the primary relay and the other as the secondary relay with setpoints of 80% voltage and 32-cycle time delay and that of 0 volts and three-second time delay, respectively. Either of these relays will trip the supply and feeder breakers to the associated 4160V class 1E bus and load shed the 4160V nonclass 1E bus.

2. Two UV relays on each 4160V class 1E bus. One set at 83% voltage with a 12-cycle time delay that starts the associated diesel generator. The other relay is set at 80% voltage with a three-second time delay. This relay sheds all 480 and 4160V bus loads except the 4160/480V transformers feeding the emergency buses.

3. Two UV relays, one each on the two 480V class 1E buses, set at 83% of 480V and a 41-second time delay. These relays shed all the loads on their associated 480V class 1E bus.

3.2 Modifications. The existing UV relay functions and/or setpoints included in Section 3.1 will be itemwise modified as follows:

1. The relays on the 4160V nonclass 1E bus will not trip the supply and feeder breakers to the bus.

2. The load-shedding relay on the 4160V class 1E bus will have its setpoint changed to 75% of 4160V with a one-second time delay. This relay will trip the supply and feeder breakers to the bus and be used to sense a loss-of-offsite power.

3. The load-shedding relays on the 480V class 1E buses will have their voltage setpoints changed to 75% of 480V.

For second-level undervoltage protection, the licensee has proposed adding two relays to each 4160V emergency bus and two relays to the secondary of the 4160/480V transformer feeding one of the 480V, class 1E buses. These relays will have a setpoint of 90% (+3, -0) of bus voltage. Each

pair of these relays will have their contacts wired in series to a timing relay set for 90 ± 5 seconds time delay on pickup. The timing relay will initiate the trip of the incoming line and feeder breakers to the 4160V, class 1E bus.

Load-shedding, once the diesel generator is supplying the class 1E buses, will be disabled. The load-shed feature will be reinstated when the buses are supplied from the offsite source.

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 protection) were also furnished by the licensee.

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 3744V at the 4160V bus is 90% of the motor-rated voltage of 4160V. This setpoint, reflected down to the 480V 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.

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

   The proposed modification incorporates a two-out-of-two 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 95 seconds does not exceed this maximum time delay. This is substantiated by the licensee in his proposal.

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 minimum time delay of 85 seconds is long enough to override any short, inconsequential grid disturbances. Further, I 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[2,10,11] 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.

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 proposal for technical specification changes includes all the required items. The setpoint of 3744V (+125, -0) does not infringe into the expected operating envelope and will not compromise the life of

the motors. Spurious trips are, thereby, not foreseen. The limiting conditions for operation, calibration checks, and surveillance requirements meet the criteria of the staff's positions.

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 has stated in his proposal that this position will be met in the new undervoltage protection scheme.

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 existing test procedures used by the licensee comply with the full intent of this procedure. Load-shedding on offsite power trip is tested. Load-sequencing, once the diesel generator is supplying the safety buses, is tested. The time durations of the tests (5 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 DLC, it has been determined that the proposed changes 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 modified 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 DLC's proposed modifications and technical specification changes are acceptable.

5.0 REFERENCES

1. NRC letter (R. W. Reid) to DLC (C. N. Dunn), dated June 3, 1977.

2. DLC letter (C. N. Dunn) to NRC (A. Schwencer), dated October 15, 1979.

3. DLC letter (C. N. Dunn) to NRC (S. A. Varga), dated May 14, 1980.

4. DLC letter (C. N. Dunn) to NRC (S. A. Varga), dated July 24, 1980.

5. 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."

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

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

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

9. DLC letter (C. N. Dunn) to NRC (R. W. Reid), dated July 22, 1977.

10. DLC letter (C. N. Dunn) to NRC (R. W. Reid), dated November 11, 1976.

11. DLC letter (C. N. Dunn) to NRC (A. Schwencer), dated February 22, 1980.

12. Final Safety Analysis Report (FSAR) for the Beaver Valley Power Station, Unit 1.