UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION
DEGRADED GRID PROTECTION FOR
CLASS IE POWER SYSTEMS
PILGRIM NUCLEAR POWER STATION

1.0 Introduction

By letter dated June 3, 1977, the U. S. Nuclear Regulatory Commission (NRC) requested the Boston Edison Company to assess the susceptibility of the Pilgrim Nuclear Power Station Unit 1 Class 1E electrical equipment to sustained degraded voltage conditions at offsite power sources and to the interaction between the offsite and onsite emergency power systems. In addition, the NRC requested that the licensee compare the current design of the emergency power systems at the plant facilities with the NRC staff positions as stated in the June 3, 1977 letter, and that the licensee propose plant modifications, as necessary, to meet the NRC staff positions, or provide a detailed analysis which shows that the facility design has equivalent capabilities and protective features. Further, the NRC required certain Technical Specifications be incorporated into all facility operating licenses.

By letters dated August 8, 1977, August 24, 1977, September 27, 1979, and March 28, 1980, Boston Edison Company proposed design modifications and additions to the licensee's Technical Specifications. The design modifications include the installation of a degraded voltage protection system for the Class 1E equipment, consisting of (1) automatic protection against degraded grid voltage when the startup transformer is supplying power, and (2) an alarm with operator action to restore the bus voltage when the unit auxiliary transformer is supplying power. The proposed additions to the Technical Specifications are in regard to the setpoints, calibrations, and surveillance requirements associated with the proposed voltage protection system.

2.0 Evaluation

Based on the information provided by Boston Edison Company, it has been determined that the proposed modifications comply with the staff's criteria when the emergency buses are being supplied by the startup transformer. All of the staff's requirements and design basis criteria have been met. The voltage setting and time delays will protect the Class 1E equipment from a sustained degraded voltage condition of the offsite power source.

However, the lack of automatic degraded voltage protection of Class 1E equipment when the emergency buses are being supplied by the unit auxiliary transformer is a concern because this is the prevalent mode of operation.

In a letter dated March 28, 1980, BECo committed to conduct new grid studies with the intent of providing automatic second level undervoltage protection for the unit auxiliary transformer. We agreed to allow credit for operator action during Cycle 5 power operation while new grid studies were being completed.

By letter dated October 26, 1981 Boston Edison Company (BECo) proposed a modification that would add a safety grade trip to the unit auxiliary transformer breakers (A505 and A506) which supply power to the 4160 volt Class 1E buses. Upon receipt of a reactor scram signal from the reactor protection system, the above breakers would immediately trip and fast transfer the Class 1E buses to the startup transformer. If this power source should be unavailable or in a degraded condition, the Class 1E buses would be transferred to the onsite emergency diesel generators. This modification has been installed. The above does not provide automatic second level undervoltage protection should the generator output voltage degrade to an unacceptable level.

A meeting was held with the licensee at NRC Headquarters on December 18, 1981 to discuss this issue. As a result of this meeting and subsequent discussions, BECo agreed to provide the results of studies that would demonstrate that additional protection was not required when the unit auxiliary transformer is providing power to the Class 1E buses.

In a submittal dated June 17, 1982 the licensee provided studies which consisted of the following:

1. Results of a voltage study of the voltage at the Pilgrim switchyard under conditions of varying losses of generation.

2. Results of a voltage study of the safety related buses with Pilgrim unit on-line and feeding an arbitrary adjusted grid system at various excitation levels.

3. The Pilgrim voltage schedule which directs the operators on control of voltage.

4. Results of a voltage study of the safety related buses with Pilgrim unit on-line, under normal conditions, at various MVAR loads.

5. A New York Power Pool Study of transmission system low-voltage conditions and recommended responses.

6. Rhode Island, Eastern Massachusetts and Vermont Energy Control (REMVEC) Report of the System Disturbance of July 30, 1979.

A review of these studies shows that during the 10 years of Pilgrim 1 operation only one recorded event which could be considered as degraded grid voltage has occurred. This event occurred on July 30, 1979 while Pilgrim was off-line. The minimum grid voltage during this event was approximately 321 kV on the 345 kV system. The voltage was below 328 kV (minimum acceptable voltage for the worst case plant loading condition) for approximately 20 minutes. The load flow studies show that with the unit on-line and the 345 kV grid voltage maintained within the anticipated operating range (328 kV to 362 kV) adequate voltage will be supplied to all Class 1E equipment. The licensee has established plant procedures and a system voltage schedule to insure that grid voltage will be maintained well within these limits. In the event that system voltage should fall below the established voltage schedule, alarm relays that have been installed on the 4160 volt Class 1E buses will alert the operator to this condition. These relays have a setpoint of 92.5% of nominal which is above the 90% required to provide acceptable voltage to Class 1E equipment. If the alarm is actuated while the unit is on-line, the operator will contact the REMVEC dispatcher and request that the voltage be raised. If the voltage cannot be raised by the dispatcher or by operator action using the generator voltage regulator, the operator will start the onsite emergency diesel generators, separate the Class 1E buses from the degraded power source and transfer the Class 1E buses to the onsite emergency diesel generators.

The enclosed Technical Evaluation Report (UCID-18689, Revision 1) was prepared for us by Lawrence Livermore Laboratory (LLL) as part of a technical assistance contract program. LLL's report provides its technical evaluation of the compliance of the licensee's submittals with NRC provided criteria.

LLL has concluded that the modifications proposed by Boston Edison Company comply with the staff positions on this issue and that Technical Specification (TS) changes proposed by Boston Edison (Ref. Amendments 42 and 61) likewise satisfy the NRC staff position.

Based upon the installed protection which will trip the unit auxiliary transformer power source to the Class 1E buses on a reactor trip, the installed alarm which alerts the operator to any degradation of this power source, and the extremely low probability of minimum grid voltage occurrence with the unit on-line, we concur with the licensee's conclusion that additional protection is not required on the unit auxiliary transformer supply to the Class 1E buses.

3.0 Conclusion

Issuance of amendment 42 determined that Cycle 5 power operation with automatic degraded grid voltage protection only when the startup transformer is supplying power to Class 1E buses was acceptable, provided that the technical specifications were modified to (1) require an operable

emergency bus undervoltage alarm system when the unit auxiliary transformer is supplying power to the Class 1E buses, and (2) require operator action to shutdown the reactor when Class 1E bus voltage reaches an unacceptable low level. Accordingly, the technical specifications were modified to include a limiting condition, required operator action, and surveillance requirements for the undervoltage alarm system.

Amendment 61 issued May 28, 1982 permitted operating during Cycle 6 while additional studies were being conducted to determine the need for additional protection on the unit auxiliary transformer power supply to the Class 1E buses. The review of these studies shows that the presently installed modifications, plant procedures, operating restrictions and voltages schedules will ensure that the Class 1E equipment will not be exposed to degraded voltage.

Based upon our review of the contractor's report of its evaluations, we conclude that the modifications and TS changes proposed by the licensee for Pilgrim satisfy the staff's criteria and are acceptable. We therefore concur with the licensee's conclusion that additional protection is not required for the unit auxiliary transformer power source to the Class 1E buses.

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