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NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SERVICE WATER SYSTEM LICENSING BASIS REQUIREMENTS

COMMONWEALTH EDISON COMPANY

ZION NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-295 AND 50-304

1.0 INTRODUCTION

During the period from June 4 through June 29, 1990, the staff conducted a diagnostic evaluation team (DET) inspection at the Zion Nuclear Power Station. The DET inspection report that was issued in August 1990 identified many weaknesses and deficiencies that required further staff review. The purpose of this SE is to review and evaluate the current licensing basis for the service water (SW) system. In the review, the staff considered the operation of both units in all modes of operations (from shutdown to power operations). The impact of the failure of nonsafety-related components on performing the safety function of the SW system was also reviewed and a determination was made as to whether licensing documents need to be revised.

2.0 BACKGROUND INFORMATION

2.1 Description of the Service Water System

The SW system at Zion consists of three pumps for each unit (total of six pumps) with a rated capacity of 22,000 gpm each. The SW pumps are located in the crib house and take suction from the forebay. The pumps discharge the service water through two parallel strainers (a total of four strainers for both units) to a 48" discharge header. Service water is directed from the discharge header to the various loads for each unit. The discharge header can be cross-connected between the two units, and separate supply lines are also provided to enable unit loads to be cooled by service water from either unit. Four of the six service water pumps receive emergency power from separate diesel generator sets that have been provided. The "O" diesel generator set is a "swing" power source that automatically provides emergency power to either the 1A or the 2A service water pump, depending on which unit is the "accident" unit.

2.2 DET Inspection Results

During the DET inspection at Zion, the staff identified several weaknesses in the design of the service water system which brought into question the licensing basis for the system. In particular, the following weaknesses were documented in the DET inspection report:

- a. Given the existing Technical Specification (TS) requirements, the number of operable service water pumps could be reduced to only two during postulated accident scenarios.
- b. The capability of two or three service water pumps to deliver design flow to safety-related loads during postulated accident conditions had not been demonstrated.
- c. Valves were not adjusted to balance flow in the service water system.
- d. Contrary to the Zion Updated Final Safety Analysis Report (UFSAR), single isolation valves exist in at least two locations between safety-related and nonsafety-related portions of the service water system.
- e. A failure of nonsafety-related structures, piping, or valves could reduce or eliminate flow through the safety-related portions of the service water system. For example, as much as 90% of all service water flow returns through a single nonsafety-related 36-inch line during two-unit operation, and numerous conditions exist where service water exits a safety-related heat load and goes into a common nonsafety-related header containing a manual or motor-operated valve.

Commonwealth Edison Company (CECo, the licensee) provided its response to the DET inspection findings in a letter dated November 2, 1990. In addition to addressing each specific weakness that was identified by the DET inspection, CECO described efforts that were underway to improve the existing UFSAR system descriptions and to develop system design reference documents. The licensee submitted a revision to the UFSAR description of the service water system on April 1, 1991, for the staff's review and also submitted the Service Water System Reference Document that was issued in May 1991 for informational purposes.

3.0 EVALUATION

3.1 Licensing Basis Review

The staff reviewed the licensing history for the Zion station to determine the licensing basis for the service water system. The following summary is provided for the various licensing documents that were found to be relevant:

- a. Safety Evaluation dated August 21, 1968

The staff reviewed the design of the Zion service water system as described in the Preliminary Safety Analysis Report and provided the following assessment:

"...We have required that these systems [component cooling water and service water] possess the same degree of active and passive component failure immunity as the ECCS itself. As a result, the applicant has modified the designs of these systems (Amendment 5) so that failure of a single pipe, pump or valve in either system will not prevent accomplishment of the heat-removal function. We have

reviewed these modified designs in detail and conclude that they are acceptable."

The design of the service water system that was accepted by the staff in 1968 is essentially the same as the design that exists today. Amendment No. 5 to the construction permits and operating licenses for Zion 1 and 2 dated March 1, 1968, clearly states that the service water system is common to both units with two of the three service water pumps from either unit "sufficient to supply the critical and normal shutdown demands of both units simultaneously," and that "...The operating philosophy, to be employed in conjunction with the service water system design would be to keep all valves open at all times except when a leak occurs somewhere in the system." The licensee credited water detectors with alarm capability to assist the operators in identifying pipe cracks and valve leaks in the auxiliary building.

b. Safety Evaluation dated October 6, 1972

The staff reviewed the design of the Zion service water system as described in the UFSAR and concluded that the service water system could provide adequate cooling water for safe reactor shut down and during accident conditions, and concluded that the system design was adequate. The staff specifically noted the following system design features:

- The service water system is headered downstream of the service water pumps so that various combinations of pumps can serve either one or both units.
- Under emergency shutdown or accident conditions, only one service water pump is required for each unit.
- Double isolation valves are provided in the loops and single isolation valves are provided in each of the feeds to the individual heat exchangers so that failure of a valve to close in the event of a line break will not jeopardize essential cooling.
- The non-essential equipment heat exchangers are fed from separate branch headers that can be isolated from the main headers under accident conditions to conserve water.

Though not specifically cited in the staff's SER, the UFSAR also established the following system design features:

- The service water headers are crosstied so that any combination of pumps can serve both units under normal operating conditions.
- The essential coolers are provided with two cooling water supplies by loop headers coming from each main supply header.
- The normal supply to the fire system and screen wash system through the service water booster pumps connects to each of the main headers

in the crib house and is isolated from the main headers under emergency conditions.

- The system pressure is maintained at 75-100 psig in the main supply header and any pump will automatically start when pressure drops in the main header.
- Under emergency conditions, all essential equipment requiring cooling is supplied, while double isolation valves in each main header isolate the supply to non-essential equipment. These include blowdown condensers, boric acid and radwaste evaporators and all of the secondary plant equipment.

c. Original Technical Specification Requirements

The Limiting Condition for Operation (LCO) for the service water system was initially issued in the Zion TS dated April 6, 1973. An editorial change was made to the initial LCO in November 1973 to more clearly account for two unit operation. The LCO required three service water pumps per unit to be operable before the reactor could enter the hot standby condition, and required three service water pumps per unit to be operable during hot standby and power operation. If one service water pump became inoperable, continued reactor operation was allowed provided that the other two service water pumps on the affected unit remained operable. The basis for the TS requirements stated: "A total of six service water pumps are installed; only one service water pump is required immediately following a postulated loss-of-coolant accident."

d. Change to the Technical Specifications dated September 1, 1976

Amendment Nos. 24 and 21 to the operating licenses for Units 1 and 2, respectively, changed the TS requirements for the service water system to allow the use of a service water pump of a unit in the cold shutdown or refueling mode to fulfill the operability requirement for one of the service water pumps on the operating unit.

The staff recognized that before entering the hot standby condition, the three "normal" service water pumps for the unit would still have to be operable initially, and stipulated that the service water pump that is subsequently credited from the non-operating unit must be of an independent power supply (i.e., the 1A and 2A service water pumps could not both be credited for the same unit because they each receive emergency power from the "swing" diesel generator).

e. Change to the Technical Specifications dated September 9, 1980

Amendment Nos. 57 and 54 to the operating licenses for Units 1 and 2, respectively, changed the TS requirements for the service water system to temporarily allow one service water pump to be inoperable for an indefinite period of time, and to allow (also on a temporary basis) a second service water pump to be inoperable for up to seven days. The licensee had determined that each of the six circulating water pumps

needed to be overhauled, which would involve dewatering each of the six forebays (one at a time). Since each forebay is common to both a circulating water pump and a service water pump, the associated service water pump would be inoperable during the period while the forebay was dewatered. The temporary change to the TS was only effective while repairs, which were scheduled for completion around December 31, 1981, were being made to the circulating water pumps.

In its evaluation, the staff recognized that five operating service water pumps will provide sufficient cooling for any postulated loss of coolant accident coincident with a loss of offsite power and with any other single failure of an active component. The staff also recognized that the main 48-inch service water header for each unit would be cross-tied, thereby allowing the service water requirements for one unit to be satisfied by pumps from either unit.

f. Change to the Technical Specifications dated December 31, 1981

Amendment Nos. 72 and 66 to the operating licenses for Units 1 and 2, respectively, changed the TS requirements for the service water system to allow an operable service water pump with an independent emergency power supply from either unit to be credited for operability on both units during periods when the pump discharge header is cross-tied between the units. The TS only allowed one of the six service water pumps to be used to fulfill the operability requirements for both Units 1 and 2. The staff recognized that five operable service water pumps will provide sufficient cooling for both units following any postulated loss of coolant accident coincident with a loss of offsite power and any other single active failure that might occur when the 48-inch pump discharge header is cross-tied.

The licensing basis requirements for the Zion service water system are defined to a large degree by the staff's position that "...the failure of a single pipe, pump or valve will not prevent the accomplishment of the heat-removal function..." (1968 SER). During initial licensing reviews, the staff recognized that (a) service water could be supplied to each component from either unit thereby assuring the diversity necessary to combat both active and passive failures, and (b) only one service water pump per unit is required during accident and emergency shutdown conditions. While the TS ensure that the required number of service water pumps will be operable assuming a single active failure, service water flow to each component assuming a single passive failure is not ensured. For example, when one unit is shut down, a pipe crack on the pump discharge header of the operating unit may make it necessary to use pumps associated with the non-operating unit to provide cooling water for both units. Based on these observations, it appears that the existing TS requirements are not sufficient to ensure that the licensing basis requirements are satisfied at all times. This matter must be reviewed and addressed by CECO.

3.2 DET Inspection Team Issues

As discussed in Section 2.2 of this evaluation, the DET identified a number of issues that brought into question the licensing basis for the Zion service water system. This section contains the staff's review of those DET issues:

- a. Given the existing TS requirements, the number of operable service water pumps could be reduced to only two during postulated accident scenarios.

The staff accepted the Zion service water system design on the basis that only one emergency service water pump per unit is required for emergency shutdown and accident conditions. Therefore, the number of service water pumps required to be operable is consistent with the licensing basis. However, as discussed in Section 3.1 above, the existing TS requirements do not appear to be sufficient to ensure that the licensing basis requirements are satisfied at all times.

- b. The capability of two or three service water pumps to deliver design flow to safety-related loads during postulated accident conditions had not been demonstrated.

The staff accepted the design of the Zion service water system, in part, based on the assertion that under emergency shutdown and accident conditions, only one service water pump is required for each unit. The licensee must demonstrate that this is in fact the case for all independent pump-pair combinations, assuming the worst-case system alignment scenarios.

- c. Valves were not adjusted to balance flow in the service water system.

For the service water system to perform its heat removal function, minimum flow requirements to each of the safety-related components must be satisfied. The licensee must demonstrate that system flow balance requirements will be satisfied for the various pump-pair combinations and system alignment scenarios discussed in (b) above.

- d. Contrary to the Zion UFSAR, single isolation valves exist in at least two locations between safety-related and nonsafety-related portions of the service water system.

The DET observation represents a design vulnerability which was not previously recognized by the staff and is contrary to the UFSAR description, and must be evaluated by CECO as required by 10 CFR 50.59. In this particular case, CECO must demonstrate that the "as-found" condition does not represent an unreviewed safety question. Otherwise, corrective actions will be required, as appropriate. If applicable, the notification and reporting requirements stated in 10 CFR 50.72 and 10 CFR 50.73 must be satisfied.

- e. A failure of nonsafety-related structures, piping, or valves could reduce or eliminate flow through the safety-related portions of the service water system.

The DET observation represents a design vulnerability which was not previously recognized by the staff and appears to be contrary to the licensing basis for the service water system. In particular, the service water system may not be able to perform its intended functions given a single active or passive failure as discussed in Section 3.1 of this evaluation, and flooding scenarios may also pose a problem. This condition must be evaluated by CECO to ensure that licensing basis requirements remain valid. If applicable, the notification and reporting requirements stated in 10 CFR 50.72 and 10 CFR 50.73 must be satisfied.

The observations made by the DET indicate that the Zion service water system may not satisfy the licensing basis requirements in all respects. The observations discussed in (d) and (e) require specific review and evaluation by CECO. Also, as discussed in (b) and (c), CECO must demonstrate that system flow requirements are satisfied.

4.0 CONCLUSIONS

The staff has reviewed licensing basis requirements and specific DET observations pertaining to the Zion service water system. Based on this review, it appears that current TS requirements for the Zion service water system are not sufficient to ensure that the licensing basis is satisfied at all times, especially with regard to passive failure scenarios. Relative to specific DET inspection issues, vulnerabilities were identified by the DET that appear to be contrary to the system licensing basis. These matters require further review and evaluation by CECO to ensure that the system licensing basis has not been compromised. Finally, with regard to flow, CECO must be able to demonstrate that service water system flow requirements will be satisfied during accident and emergency shutdown conditions.

Since the staff's position on the licensing basis for the service water system as discussed in this safety evaluation was not previously available to CECO, information that was provided addressing the DET inspection issues (SE Section 2.2) may not be valid and corrective actions that were taken may not be entirely appropriate. For example, the change that was made to the UFSAR may require prior NRC review and approval to properly account for the system licensing basis. Therefore, these submittals require further consideration by CECO to ensure that the licensing basis for the service water system has been properly reflected and accounted for.

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