COMMONWEALTH EDISON COMPANY
DRESDEN STATION - UNITS 2 & 3
QUAD CITIES STATION - UNITS 1 & 2

DIVERSITY EVALUATION FOR AGASTAT TRIP RELAYS USED IN BOTH THE ALTERNATE ROD INJECTION (ARI) SYSTEM AND THE REACTOR PROTECTION SYSTEM (RPS)

Nuclear Safety-Related

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Prepared by: David J. Cyko Date: 7-15-91

Reviewed by: S. L. Halverson Date: 7-15-91

Approved by: John O'Hara Date: 7-15-91

Purpose

The purpose of this evaluation is to demonstrate that the functional diversity that exists between Agastat trip relays (manufactured by the Amerace Company) used in both the Alternate Rod Injection (ARI) System and the Reactor Protection System (RPS) is adequate and sufficient to satisfy the diversity requirements of 10CFR50.62, "Requirements for Reduction of Risk from Anticipated Transients Without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants". This report will be used to support an exemption request requiring the replacement of either ARI System relays or RPS relays to achieve additional diversity based on an analysis of relevant failure data on these relays.

Background

Reference 1 transmitted the NRC's evaluation (SER) of Dresden's and Quad Cities' compliance to the requirements of 10CFR50.62 for the ARI System. In the SER the NRC stated that insufficient diversity existed between the RPS and the ARI System to meet the rule. Commonwealth Edison pursued the resolution of this issue through the BWR Owners' Group.

In Reference 2 the NRC provided their final position on the issue of RPS and ARI System diversity. Subsequently, in a letter dated January 11, 1991, (Reference 3) the NRC requested Commonwealth Edison's schedule for the implementation of the staff's position. Commonwealth Edison's schedule for achieving compliance was provided in a letter dated March 15, 1991 (Reference 4).

To achieve compliance with the NRC staff's position on equipment diversity at Dresden and Quad Cities, it was determined that the trip relays in the either the ARI System or RPS Reactor Water Level (RWL) instrumentation channels must also be replaced in addition to the Rosemount trip units. The ARI System and the RPS both use Agastat model GP relays to initiate control rod insertion upon sensing low reactor water level. Since replacement of the ARI System trip relays in either system is a significant design change, an investigation was initiated to evaluate the Agastat relays to determine if a Common Mode Failure (CMF) could result in failure of the low RWL instrumentation in both the ARI System and the RPS (a postulated worst case failure).

Justifications

The depth of diversity between the Agastat relays used in the low reactor water level trip instrumentation channels in both the ARI System and RPS is sufficient based on the following:

1. The RPS relays are normally energized and must be de-energized for the contacts to open and insert the control rods. The ARI System relays are normally de-energized and must be energized for contacts to close and insert the control rods. Thus, these relays achieve diversity as defined in NUREG/CR-5460, "A Cause-Defense Approach to the Understanding and Analysis of Common Cause Failures." This document defines diversity as either equipment, functional, or staff (maintenance or operating) diversity. Opposite energization states for actuation of the relays is a type of functional diversity that will prevent simultaneous failures from a common cause of the ARI System and the RPS actuation logic.

2. The worst-case CMF for the existing Agastat relays is failure of the relay contacts to change state (i.e., failure of the RPS contacts to open and failure of the ARI System contacts to close) due to failure of the contact actuating mechanism (e.g., mechanical binding). This type of failure would prevent the low RWL trip instrumentation in both the ARI System and RPS from initiating the insertion of control rods regardless of the opposite energization logic of the relays.

   A review of industry failure data for 157 Agastat, Series GP relays, documented in References 5 and 6, was performed, and four (4) potential CMFs were identified where the relay failed to change state due to mechanical binding. However, the review determined that this failure mode does not occur in relays which are normally de-energized since the cause of failure (thermal aging due to ohmic heating) is not present. Therefore, while this cause of failure is present in the normally energized RPS relays, it is not a credible cause of an identical CMF in the normally de-energized ARI System relays and, hence, a worst case CMF cannot occur.

3. The remaining 153 Agastat relay failures reported via the NPRDS are summarized below.

   - Failure effects on the ARI System and the RPS for two (2) of the reported failures could not be determined from the information given in the data base. However, neither failure data provided evidence of credible CMFs which would prevent the low RWL instrumentation in both the ARI System and the RPS from inserting the control rods.

   - Twenty one of the reported failures were not applicable to this analysis because they were attributed to failures external to the relay (e.g., blown fuses, wiring errors, inadequate circuit design, etc.) or were concerned with the failure of time delay relays. Therefore, these failures were omitted from this analysis.

- Fourteen of the reported failures were of the type that would have disabled the low RWL trip instrumentation in the RPS if more than one undetected failure occurred in either of the two channels of the actuation logic.

  One (1) of these failures was attributed to slow response time for contacts to change state upon de-energization of a normally energized relay due to a relaxed spring-return mechanism. However, because of the existing functional diversity provided by the opposite energization logics, this failure mode cannot degrade the low RWL instrumentation in both the ARI System and the RPS. Causes for the remaining thirteen failures could not be determined from the information provided in the failure descriptions. However, the data indicated that all thirteen failures occurred only in normally energized relays and therefore are not a postulated worst case CFM. Therefore, these 13 failures cannot degrade the low RWL instrumentation in both the ARI System and the RPS.

- One hundred sixteen of the reported failures were of the type that would have disabled the low RWL trip instrumentation in the ARI System if more than one undetected failure occurred in either of the two channels of the actuation logic. These failures were attributed to coil failure, relay socket failure, and inadequate electrical contact. A review of the failure modes of these 116 relays indicated that the majority of these failures were isolated single random failures. However, some of the failures may be CMFs which could affect more than one relay (e.g., several failures were related to socket failures). Nevertheless, these types of CMFs cannot disable or degrade the actuation logic for both the ARI System and the RPS. Although a single failure of a relay could degrade the ARI System and remain undetected, the same failure would place the RPS in a safe (half scram) condition and hence is detectable immediately.

Conclusion

The existing ARI System and RPS trip relays meet the intent of the ATWS Rule by the nature of the design to actuate in opposite energization states. A review of the failure data and existing design provides assurance that a CMF due to either a manufacturing defect or power failure will not prevent both the ARI System and the RPS from performing their safety-related function. Therefore, the cost of implementing the design changes required to replace the ARI System relays is not justified based on the low probability of an ATWS event and the low probability of an unknown common mode relay failure.

References

1. Letter dated November 8, 1988, from B. Siegel (NRC) to H. E. Bliss (CECo) transmitting NRC Safety Evaluation for compliance with ATWS Rule 10CFR50.62 relating to Alternate Rod Insertion and Recirculation Pump Trip System.

2. Letter dated September 20, 1990, from J. M. Taylor (NRC) to J. J. Beck (BWR Owners' Group) transmitting the NRC decision on the BWR Owners' Group appeal on diversity.

3. Letter dated January 11, 1991 from R. J. Barrett (NRC) to T. J. Kovach (CECo) requesting implementation schedule for the diversity requirements of 10CFR50.62.

4. Letter dated March 15, 1991, from D. L. Taylor (CECo) to Office of Nuclear Reactor Regulation transmitting schedule for implementation of ARI diversity requirements.

5. NPRDS Report Id NPRP06AA; run date 05/17/91; Selected Component is Relay; Selected Manufacturer is Control Products Div./Amerace Agastat; Manufacturer Models that contain GP.

6. NPRDS Report Id NPRPOGAA; run date 06/18/91; Selected Component is Relay; Selected Manufacturer is Amerace Corp.; Manufacturer Models that contain GP.