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TECHNICAL EVALUATION OF THE ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS OF THE OVERRIDE OF CONTAINMENT PURGE VALVE ISOLATION AND OTHER ENGINEERED SAFETY FEATURE SIGNALS FOR THE QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

(Dockets 50-254 and 50-265)

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(Dockets 50-254 and 50-265)

by

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ABSTRACT

This report documents the technical evaluation of the electrical, instrumentation, and control design aspects of the override of containment purge valve isolation and other engineered safety feature signals for the Quad Cities Nuclear Power Station, Units 1 and 2. The review criteria are based on IEEE Std-279-1971 requirements for the safety signals to all purge and ventilation isolation valves.

FOREWORD

This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues (SEICSI) Program being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Operating Reactors, by Lawrence Livermore National Laboratory, Field Test Systems Division of the Electronics Engineering Department.

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(Dockets 50-254 and 50-265)

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1. INTRODUCTION

Several instances have been reported where automatic closure of the containment ventilation/purge valves would not have occurred because the safety actuation signals were either manually overridden or blocked during normal plant operations. These events resulted from procedural inadequacies, design deficiencies, and lack of proper management controls. These events also brougnt into question the mecnanical operability of the containment isolation valves themselves. These events were determined by the U.S. Nuclear Regulatory Commission (NRC) to be an Abnormal Occurrence (#78-5) and were, accordingly, reported to the U.S. Congress.

As a follow-up on this Abnormal Occurrence, tne NRC staff is reviewing the electrical override aspects and the mechanical operability aspects of containment purging for all operating power rectors. On November 29, 1978, the NRC issued a letter entitled "Containment Purging During Normal Plant Operation" [Ref. 1] to all boiling water reactor (BWR) and pressurized water reactor (PWR) licensees. In a letter [Ref. 2] dated January 2, 1979, Commonwealth Edison, the licensee for the Quad Cities

Nuclear Power Station, Units 1 and 2, replied to the NRC generic letter. The evaluation of other engineered safety feature (ESF) systems was submitted in response to IE bulletin 79-08 [Ref. 3]. Additional information [see References] was subsequently received and evaluated.

This document addresses only the electrical, instrumentation, and control (EI&C) design aspects of the containment ventilation isolation (CVI) and other ESFs.

2. EVALUATION OF QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

2.1 REVIEW CRITERIA

The primary intent of this evaluation is to determine that the following NRC staff criteria are met for the safety signals to all ESF equipment:

(1) Criterion no. 1 - In keeping with the requirements of General Design Criteria 55 and 56, the overriding* of one type of safety actuation signal (e.g., radiation) should not cause the blocking of pressure) for those valves that have no function besides containment isolation.

(2) Criterion no. 2 - Sufficient physical features (e.g., keylock switches) are to be provided to facilitate adequate administrative controls.

(3) Criterion no. 3 - A system-level annunciation of the overridden status should be provided for every safety system impacted and when any override is active. (See R.G. 1.47).

Incidental to this review, the following additional NRC design criteria were used in the evaluation:

(1) Criterion no. 4 - Diverse signals should be provided to initiate isolation of the containment ventilation system. Specifically, containment high radiation, safety injection actuation, and containment high pressure (where containment high pressure is not a portion of safety injection actuation) should automatically initiate CVI.

*The following definition is given for clarity of use in this evaluation:
Override: The signal is still present, and it is blocked in order to perform a function contrary to the signal.

(2) Criterion no. 5 - The instrumentation and control systems provided to initiate the ESF should be designed and qualified as safety-grade equipment.

(3) Criterion no. 6 - The overriding or resetting* of the ESF actuation signal should not cause any valve or damper to change position.

Criterion 6 in this review applies primarily to other related ESF systems because implementation of this criterion for containment isolation have been reviewed by the Lessons Learned Task Force, based on the recommendations in NUREG-0578 Section 2.1.4 [Ref. 4]. Automatic valve repositioning upon reset may be acceptable when containment isolation is not involved; consideration will be given on a case-by-case basis. Acceptability would be dependent upon system function, design intent and suitable operating procedures.

2.2 CONTAINMENT VENTILATION ISOLATION CIRCUITS DESIGN DESCRIPTION

Quad Cities Nuclear Power Station, Units 1 and 2, has ESF trains for each unit which can cause isolation of the containment ventilation system. The containment ventilation system is labeled Primary Containment Isolation System (PCIS) on these units. One ESF train controls the inboard containment ventilation/purge isolation valves, and the other train controls the outboard isolation valves. The initiating contacts for each train are described below:

(1) Automatic contacts (all one-out-of-two, taken twice logic)

(a) High drywell pressure.
(b) Low reactor water level.

*The following definition is given for clarity of use in this evaluation:
Reset: The signal has come and gone, and the circuit is being cleared to return it to the normal condition.

(2) Manual Contacts

None at system level. (Isolation may be accomplished by the individual PCIS-valve manual switches.)

NOTE: There is no radiation initiated trip of the PCIS valves. High stack radiation will cause the reactor building ventilation ducts to trip shut to prevent the release from the stack.

The relays for each of the monitored plant conditions have contacts in each of the two trains that control the PCIS valves. Each train is powered by a different electrical bus. The PCIS circuits contain a reset switch, which functions as defined in this report.

The inboard torus and drywell vent valves are each bypassed with a 2-inch-diameter isolation valve. These two 2-inch valves plus the 6-inch-diameter isolation valve to the standby gas treatment system are utilized by the Atmospheric Control System (ACS) to control the containment during postaccident operations. These valves (e.g., 1601-61,-62 and -63 for Unit 1) have a designed electrical bypass capability. The bypass circuit contains an interlock to prevent its operation if the reactor is in the "run" mode. The bypass switch is a keylock switch with the key controlled by the shift supervisor. The bypass condition is annunciated.

When a monitored plant condition calls for isolation, electric power is removed from the slave relays (e.g., 595-104A). The slave relay contacts open to remove electric power from the solenoid valves, causing the isolation valves to close.

The PCIS-valve solenoid valves must remain energized in order for the isolation valve to be kept open. The solenoid valve trip circuit contains a seal-in contact to maintain electric power to it as long as a PCIS signal is not present. With a PCIS signal present, the valves will not remain open and cannot be opened by their manual switch (with the exception of the three valves in the bypass circuit as described above).

The PCIS signal cannot be cleared until the initiating condition(s) is cleared. When all initiating conditions are cleared, pressing the PCIS reset button will restore power to the solenoid valve circuits. Pressing the PCIS reset button will also clear a bypass condition of the postaccident operations system if one exists. The manual isolation valve switches are pistol-grip handle, maintained-contact type (GE type SBM SW). Hence, once electric power is restored to the solenoid valve circuits, any isolation valve with its switch in the "open" position will automatically reopen.

Incidental to this review, we have noted that the PCIS circuits do not contain a system-level manual isolation switch. To manually isolate the PCIS valves, each of the individual manual switches must be turned to "close."

2.3 CONTAINMENT VENTILATION ISOLATION SYSTEM DESIGN EVALUATION

In response to this issue, on an interim basis, the 18-inch containment ventilation/purge isolation valves at Quad Cities Nuclear Power Station, Units 1 and 2 are mechanically stopped from opening more than 40 degrees.

The PCIS actuation system has a reset switch but does not have an override capability. However, the ACS system has a postaccident bypass capability for three valves as discussed in Section 2.2. Since the ACS system is designed to control and/or mitigate the containment atmosphere following an accident, their evaluation has not been included since it is beyond the scope of criteria 1. Therefore, we conclude that NRC staff criterion no. 1 is satisfied for the PCIS system, except that no determination has been made for the ACS system.

The ACS system bypass has a keylock switch which facilitates administrative control, as well as annunciation of the bypass condition control, and there is annunciation of the bypassed condition. We conclude that NRC staff criteria nos. 2 and 3 are satisfied.

The containment isolation automatic actuation signal is formed by the two conditions described in Section 2.2. There is not an automatic PCIS actuation signal by high radiation. We conclude that NRC staff criterion no. 4 is not satisfied.

Judging from the information provided by the licensee, PCIS equipment at the Quad Cities Nuclear Power Station, Units 1 and 2, is designed and qualified as safety-grade equipment. We conclude that NRC staff criterion no. 5 is satisfied.

When all initiating isolation conditions have been cleared, the PCIS actuation signal can be reset. Upon resetting, any of the isolation valves with a manual switch in the "open" position will automatically reopen. In addition, any of the ACS valves with its manual switch in the "open" position will automatically reopen as soon as the postaccident bypass circuit is switched to "bypass." However, the licensee has completed an interim modification so that the control switches for all of the valves must be in the closed position before the isolation signal can be reset [Ref. 5]. The evaluation of this system has been done by the Lessons Learned Task Force as discussed in Section 2.1.

The PCIS circuits do not contain a system-level manual isolation switch as specified in the 1971 revision of IEEE Std-279. The switch was not included in the design because the date of these units precedes the 1971 revision. However, the addition of a manual isolation switch would provide a quick and efficient means for the operator to isolate the containment in an emergency. The work involved would be to install the switch in the control panel and connect the associated wiring to the PCIS logic circuits.

2.4 OTHER ENGINEERED SAFETY FEATURE SYSTEM CIRCUITS

The licensee discussed its evaluation of other ESF systems (Atmospheric Control System, Core Spray, HPCI, and RHR) in response to IE bulletin 79-08 [Refs. 6 through 8]. Based on these submittals, we conclude that the NRC criteria are satisfied.

3. CONCLUSIONS

The EI&C design aspects of containment purge valve isolation and other ESF signals for the Quad Cities Nuclear Power Station, Units 1 and 2, were evaluated using those design criteria stated in Section 2.1 of this report.

We conclude that the PCIS circuit design meets four of the six NRC staff criteria. One criterion not met is that under certain conditions the PCIS valves could automatically reopen. However, the evaluation and acceptability of this design will be performed by the Lessons Learned Task Force in a separate review. The other criterion not met is that the automatic containment isolation actuation signal does not include actuation by high radiation. We recommend the installation of safety-grade radiation monitors to provide diverse isolation signals.

We conclude that the other ESF circuit designs discussed meet the NRC staff criteria.

The PCIS circuits do not contain a system-level manual isolation switch as specified in IEEE Std-279-1971. We recommend that a manual system-level isolation switch be incorporated.

REFERENCES

1. NRC/DOR letter (T. Ippolito) to Commonwealth Edison, "Containment Purging During Normal Plant Operation," dated November 29, 1978.

2. Commonwealth letter (C. Reed) to NRC (T.A. Ippolito), Dockets 50-254 and 50-265, (no title), dated January 2, 1979.

3. Commonwealth reply to IE Bulletin 79-08, (D.L. Peoples) to NRC (H.R. Denton), (no title), dated December 14, 1979.

4. U.S. Nuclear Regulatory Commission, "TMI-2 Lessons Learned Task Force Status Report and Short-term Recommendations," NUREG-0578.

5. Commonwealth letter (N.J. Kalivianakis) to NRC (E.G. Case), Dockets 50-254 and 50-265, (no title), dated January 2, 1980.

6. Commonwealth letter (R.F. Janecek) to NRC (T.A. Ippolito), Dockets 50-254 and 50-265, (no title), dated February 28, 1980.

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8. Commonwealth letter (R.F. Janecek) to NRC (R.B. Bevan, Jr.), Dockets 50-254 and 50-265, (no title), dated July 29, 1980.

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