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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 PILGRIM NUCLEAR POWER STATION, UNIT 1

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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 Pilgrim Nuclear Power Station, Unit 1. 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 Laboratory, Field Test Systems Division of the Electronics Engineering Department.

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(Docket 50-293)

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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 overriden or blocked during normal plant operations. These events resulted from procedural inadequacies, design deficiencies, and lack of proper management controls. These events also brought into question the mechanical 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, the NRC staff is reviewing the electrical override aspects and the mechanical operability aspects of containment purging for all operating power reactors. On November 28, 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 9, 1979, the Boston Edison Company (BECo), the licensee for the Pilgrim Nuclear Power Station, Unit 1, replied to the NRC generic letter. The evaluation of other engineered safety feature (ESF) systems was submitted in response to I&E Bulletin 79-08 [Ref. 3]. The licensee met [Ref. 4] with the NRC in Bethesda, M.D., on December 11, 1979, to discuss this issue further.

References 5 through 12 list the additional correspondence between the NRC and the licensee on this subject. Reference 13 is a conference call made to the licensee to discuss this subject.

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 PILGRIM NUCLEAR POWER STATION, UNIT 1

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 any other type of safety actuation signal (e.g., 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 when any override is active. (See R.G. 1.47).

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

(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.

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

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*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.

(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 has been reviewed by the Lessons Learned Task Force, based on the recommendations in NUREG-0578 Section 2.1.4 [Ref. 14]. 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

Pilgrim Nuclear Power Station, Unit 1, has two ESF trains which can cause isolation of the containment ventilation system, which is labeled Primary Containment Isolation System (PCIS) on this unit. One 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) Refueling floor ventilation exhaust high radiation
(b) High drywell pressure
(c) Low reactor water level
(d) Reactor building high radiation

(2) Manual Contacts

(a) Keylock system-level switches
(b) Individual PCIS valve manual switches

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 returns the circuit to the normal condition once the initiating signal is no longer present.

*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.

When a monitored plant condition calls for isolation, electric power is removed from the actuation relays (e.g., relay RPWA0), which in turn provides electric power to operate the slave relays (e.g., relay RPWA1). The slave relay contacts open to remove electric power from the solenoid valves, causing the isolation valves to close.

The slave relay circuit contains a seal-in contact which maintains this relay in an energized state after it has received a trip signal, until the initiating condition has been corrected and the system has been reset. With the slave relay energized, the PCIS valves will remain closed and cannot be opened even by their manual switches (with the exception of the valves in the bypass circuit described below).

There are four valves which can be opened by overriding an isolation signal. These are the two isolation valves in series in a two-inch line venting the suppression chamber and two isolation valves in series in a two-inch line venting the drywell to the Standby Gas Treatment System. The control logic for these valves allows an override of the containment isolation signal if the keylock control switches for these valves are in the "emergency open" position. With the switches in this position, however, the valves will reisolate upon receipt of a low-low reactor water trip signal.

The PCIS signal cannot be cleared until the initiating condition(s) is cleared. When all initiating conditions are cleared, the system may be reset by first placing the manual switches for each of the following valves into the "closed" position: drywell and torus air inlet valves; drywell and torus nitrogen inlet valves; and, drywell and torus exhaust valves (all two-inch and 20-inch valves). Once these control switches have all been placed in the "closed" position, the reset switches may momentarily be switched to the "reset" position to reset the system.

Upon system reset, the valves listed above will not reopen until their control switches are returned to the "open" position. All other PCIS valves will reopen, however, upon reset of the system if their control switches are left in the "open" position.

2.3 CONTAINMENT VENTILATION ISOLATION SYSTEM DESIGN EVALUATION

The PCIS actuation system has a reset switch, but does not have an override capability. However, four of the PCIS valves can be opened by overriding an isolation signal as discussed in Section 2.2. This override will cause the blocking of all other types of safety actuation signals, with the exception of reactor low-low water level.

The four valves which can be opened by overriding an isolation signal are two isolation valves (SV5041A and SV5041B) in series in a two-inch line venting the suppression chamber and two isolation valves (SV5043A and SV5043B) in series in a two-inch line venting the drywell to the Standby Gas Treatment System. The control logic for these valves allows an override of the containment isolation signal if the keylock control

switches for these valves are in the "emergency open" position. With the switches in this position, however, the valves will reisolate upon receipt of a low-low reactor water trip signal.

After reviewing the material submitted by the licensee, we recommend that the licensee:

1) remove the bypass of the automatic isolation signals;

2) show that the low-low-water level isolation signal provides all the protection required by the criteria when the normal isolation signals are bypassed; or

3) modify the design to satisfy review criterion number 1.

The existing PCIS signal override ("emergency open") for those valves which have the override capability uses a keylock control switch. We conclude that NRC staff criterion no. 2 regarding physical features that facilitate administrative controls is satisfied by this design.

The PCIS signal override for those valves which have the override capability is annunciated. We conclude that NRC staff criterion no. 3 is satisfied.

The PCIS automatic actuation signal is derived from diverse signals. Currently, no containment radiation monitoring instrumentation which provides a signal to the PCIS is installed at Pilgrim, Unit 1. As a result of this review, the licensee stated that they plan to install safety-grade radiation monitors which will provide a signal to the PCIS [Ref. 12]. Based on this commitment, we conclude that NRC staff criterion no. 4 will be satisfied.

The licensee indicated [Ref. 11] that the instrumentation channels and logic associated with the PCIS are safety-grade. We conclude that NRC staff criterion no. 5 is satisfied.

When all initiating isolation conditions have been cleared, and when the control switches for the drywell and torus air inlet valves, drywell and torus nitrogen inlet valves, and drywell and torus exhaust valves have been placed in the "closed" position, the PCIS actuation signal can be reset. Upon resetting, any of the other PCIS valves with their manual switch left in the "open" position will automatically reopen. The PCIS reset logic will be evaluated by the NRC staff as part of the I&E Bulletin 80-06 review; therefore, no conclusions regarding compliance with NRC staff criterion no. 6 will be made in this report.

2.4 OTHER ENGINEERED SAFETY FEATURE SYSTEM CIRCUITS

As part of this review, the High Pressure Core Injection (HPCI) system was selected for evaluation. It was determined from the information submitted by the licensee that both the HPCI auxiliary oil pump and the

HPCI gland seal condenser blower will stop once the initiating signal is no longer present and the reset pushbutton is depressed, returning the circuit to the normal condition. We conclude that all criteria except criterion no. 6 are satisfied for HPCI.

The HPCI reset logic will be evaluated by the NRC staff as part of the I&E Bulletin 80-06 review as will the reset logic for other ESFs. Therefore, no conclusions regarding compliance with NRC staff criterion no. 6 will be made in this report.

On the basis of this audit review, we conclude that there is reasonable assurance that other ESF systems comply with the remaining NRC staff criteria.

3. CONCLUSIONS

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

We conclude that the licensee should take appropriate action regarding the four isolation valves described in Section 2.3 so that the PCIS system will satisfy review criterion number 1.

As discussed in Section 2.4 of this report, separate evaluation will be made by the NRC staff for criterion no. 6 as applicable to HPCI. Therefore, no conclusions regarding compliance with this criterion were made in this report.

For the purposes of this report, we conclude that, with the installation of the safety-grade radiation monitors committed to by the licensee and with appropriate action on the PCIS, both the PCIS and the other ESFs will meet all the NRC staff criteria.

REFERENCES

1. NRC letter (A. Schwencer) to Boston Edison Company (BECo), "Containment Purging During Normal Plant Operation," dated November 29, 1978.

2. BECo letter (G. C. Andognini) to NRC (T. A. Ippolito), "Containment Purging During Normal Plant Operation," dated January 9, 1979.

3. BECo letter (G. C. Andognini) to NRC (B. H. Grier), "Response to I&E Bulletin 79-08," dated April 25, 1979.

4. NRC memorandum (J. N. Hannon) to distribution, "Meeting Summary," dated December 13, 1979.

5. BECo Letter (G. C. Andognini) to NRC (T. A. Ippolito), "Supplementary Information to I&E Bulletin 79-08," dated August 21, 1979.

6. BECo letter (G. C. Andognini) to NRC (T. A. Ippolito), "Supplemental Response to I&E Bulletin 79-08," dated November 6, 1979.

7. BECo letter (J. E. Howard) to NRC (T. A. Ippolito), "Interim Positions for Containment Purge and Vent Valve Operation," dated December 19, 1979.

8. BECo letter (G. C. Andognini) to NRC (D. G. Eisenhut), "Containment Purge and Vent Valve Operability," dated May 27, 1980.

9. BECo letter (G. C. Andognini) to NRC (T. A. Ippolito), "Supplemental Response to Containment Purge and Vent System Mechanical Review Questions," dated May 27, 1980.

10. BECo letter (A. V. Morisi) to NRC (T. A. Ippolito), "Additional Information on Bypass and Reset on Engineered Safety Features," dated September 28, 1980.

11. BECo letter (A. V. Morisi) to NRC (T. A. Ippolito), "Supplement to Information on Bypass and Reset of Engineered Safety Features," dated October 10, 1980.

12. BECo letter (W. J. Merritt) to NRC (D. G. Eisenhut). "TMI NUREG 0737 Commitments," dated February 27, 1981.

13. NRC conference call with BECo and EG&G, subject: "Questions on CVI and Other ESF Circuit Designs," February 10, 1981.

14. U.S. Nuclear Regulatory Commission, "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations," NUREG-0578, published July 1979.