AEOD TECHNICAL REVIEW REPORT*

UNIT: Pilgrim Nuclear Power Station
DOCKET NO.: 50-293
LICENSEE: Boston Edison Company
NSSS/AE: General Electric/Bechtel

TR REPORT NO.: AEOD/T410
DATE: May 10, 1984
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SUBJECT: INJECTION VALVE FOR THE HIGH PRESSURE COOLANT INJECTION (HPCI) SYSTEM FAILURE TO OPEN DURING A SURVEILLANCE TEST

EVENT DATES: March 31, 1982 (LER 82-008/01X, Revision 1 and LER 82-008/01X)

SUMMARY

At the Pilgrim Nuclear Power Station on March 31, 1982, the injection valve for the HPCI system did not fully open during the performance of a surveillance test during startup after a six month refueling outage. The failure to operate was attributed to a missing bypass circuit around the torque switch. Subsequent licensee investigation identified a total of ten valves that did not have the bypass circuit installed Omission of the bypass circuit could result in failure of a valve to operate when needed. A prior IE Circular 81-13 had identified this problem at two other plants.

This evaluation identifies the situation as a common cause failure mechanism that could potentially have serious adverse effects on the availability of core cooling systems when needed. Valves affected by this failure mechanism have been found in the HPCI system, RCIC system, core spray system, and RHR system (both the low pressure coolant injection mode and containment spray mode) at BWR plants. At the three plants in which the omission has been found, it was subsequently determined that multiple valves did not have the bypass installed with nearly 20% affected at the subject plant. In addition, current inservice testing normally will not detect the bypass deficiency. Although the events have been at BWRs, the situation also applies to PWRs.

The report indicates that licensee investigations at Pilgrim subsequent to the event appear appropriate to conclude that bypass circuits around the torque switch have been installed in accordance with design requirements. However, since licensees were not required to report action pursuant to IE Circular 81-13, AEOD will continue to monitor operating experience for similar events.

*This document supports ongoing AEOD and NRC activities and does not represent the position or requirements of the responsible NRC program office.

DISCUSSION

At the Pilgrim Nuclear Power Station on March 31, 1982, the HPCI injection valve, MO 2301-8, did not fully open in the required manner during the performance of a surveillance test during startup from a refueling outage. LER 82-008, Revision 1, dated May 19, 1983, was the basis for investigation because it indicated that ten valves could have been affected in a similar manner. The valve failure to operate was attributed to the fact that an electrical bypass circuit around the torque switch on the valve operator was not installed as called for in the design. The purpose of the bypass circuit is to ensure availability of full motor torque by bypassing the torque switch at prescribed times during the operating cycle of the valve operation. The primary safety concern is that failure of this valve to open would prevent injection capability of the HPCI system.

IE Circular No. 81-13, Reference 1, was issued September 25, 1981, with specific information about electrical bypass circuits that had not been installed on five reactor core isolation cooling (RCIC) system injection valves at one plant and two residual heat removal (RHR) system injection line isolation valves (train A & B) at another plant. Reference 2 presents results of an investigation of other valve problems.

The chronological sequence leading to discovery of the missing bypass circuit at Pilgrim was as follows:

1. The Pilgrim Nuclear Power Station entered a refueling outage sometime in mid to late September 1981, and was down until late March 1982.

2. IE Circular No. 81-13 pertaining to missing bypass circuits was issued on September 25, 1981.

3. The HPCI injection valve at Pilgrim failed to fully open while conducting a surveillance test during startup, following a refueling outage, on March 31, 1982 (approximately six months after issuance of IE Circular 81-13). LER 82-008 was reported on April 14, 1982, indicating the cause of inoperability as the missing bypass circuit and stating that other valves had similar omissions. The LER also indicated an updated report would be issued upon completion of the program to review IE Circular 81-13.

4. The updated report identifying a total of ten valves with omitted bypass circuits was reported on May 19, 1983.

This event was also discussed in a SALP review, Reference 3.

For this event, the alert about missing bypass circuits was available in September 1981, approximately six months prior to discovery in March 1982, that the bypass circuit was missing. The bypass circuit was discovered missing as part of an investigation to determine the cause of valve failure

to meet the valve operability surveillance test during startup after refueling. It is important to recognize that discovery of the missing circuitry as a result of the surveillance test was most likely only an incidental result of the valve test requirement. The basic reason for this is that valve operability under test conditions usually will not require motor torque in excess of the torque switch setting unless some other factor (such as increased friction due to lack of lubrication, aging, or tightening of the packing nut) causes increased motor torque requirements. Therefore, valve operability testing in accordance with the inservice test program or technical specification requirements will not detect, in general, whether the bypass circuits have been installed. Conversely, successful operation during testing could provide a false sense of security because it could be interpreted as demonstration of a state of readiness of valve operability when, in reality, the bypass circuitry could be missing. A similar situation relative to valve failure and operation was mentioned in Reference 1.

Even if the bypass circuit is installed, its proper operation is dependent upon whether the limit switch setting for the bypass has been properly established and implemented. To be sure of proper operation, the bypass must be physically in place and the proper settings made to permit bypass of the torque switch for some portion of the valve stroke which could range between a small fraction, such as the disc lifting off the seat, to the full stroke. The proper setting depends upon application. Presence of the bypass circuitry does not mean correct application if the settings are not proper. Improper setting could result in either the valve not lifting from the seat or possible damage to the valve or operator if the bypass is too large a portion of the stroke.

Additional review and investigation of the event was conducted by way of discussions with licensee staff concerning information contained in an internal licensee report (Ref. 4) that was referenced in the LER (Ref. 1) about the event. The systems affected by the ten valves without the bypass circuit were the core spray system, high pressure coolant injection (HPCI) system, and the containment spray portion of the residual heat removal system. A review of the P&ID's for these systems revealed that six of the ten valves were normally closed such that safety function operation would require opening the valve without benefit of the bypass circuit around the torque switch. The valve purpose and number of valves involved in each system were as follows:

1. Core Spray (4) - Four valves including the pump suction valve for each train and the outboard and inboard injection valve (one valve was normally closed) of train B.

2. HPCI (3) - Three valves including two steam supply valves (one normally closed) to the turbine drive of the pump and one pump discharge valve (normally closed).

3. Containment Spray (3) - Three containment spray valves (out of four) including two in train B and one in train A. All three valves are normally closed.

To provide additional perspective on both the significance of the event and the impact of IE Circular 81-13, the review also considered the number of valves that may have been affected by the circular. For Pilgrim, it appears that just over 100 valves were identified by the licensee as possible candidates for review. After a final check of drawings, it was determined that 57 valves were required to have the bypass circuits around the torque switch. Therefore, 10 of 57 or 17.5% of the valves did not have the required bypass circuit and six of those ten were normally closed valves. It is also pertinent to understand that in order to determine whether or not the bypass was installed required physical removal of the valve operator cover at the valve location. Because of that, confirmation that the bypass was installed could be a relatively time-consuming process.

A review of the affected valves in this event together with those mentioned in IE Circular 81-13 indicates that most all core cooling systems for a BWR plant are potentially impacted by this bypass circuit not being installed. The Circular (Ref. 1) identified the RCIC system and low pressure coolant injection (LPCI) mode of RHR valves as not having the bypass circuit around the torque switch. In the report of this event, the HPCI system (both coolant injection and steam supply to the pump turbine drive), Core Spray system, and containment spray mode of RHR were found to have valves without the bypass. This situation represents an example of common cause failure that has been observed in core cooling systems of BWR plants and in the extreme could potentially lead to loss of all cooling when needed.

A circular, by its nature, does not have a requirement for the licensee to respond to NRC; Section 92717 of Reference 5 does not require NRC followup of all steps pertaining to receipt, review, or action by the licensee. Under these circumstances, there were no requirements for licensees to report that they confirmed either the presence of the bypass circuits or the number of valves that had to have the bypass circuit installed. Hence, there is neither a data base nor a mechanism to determine whether the Circular was effective in obtaining either corrective action or confirming that missing bypass circuits were only isolated situations at a few plants. A limited data base search of recent events has not identified similar events in which valve failure to operate was reported as caused by a missing bypass circuit. Although the events cited occurred at BWR plants, the bypass circuit is commonly used and the concern would apply to both BWR and PWR plants.

FINDINGS

This evaluation led to the discovery of a common cause failure mechanism involving nearly 20% of the valves that were required to have a particular bypass circuit around the torque switch. This situation could have posed very serious consequences relative to lack of valve operability in the event of a need for cooling water involving HPCI, core spray, and containment spray. The major findings are as follows:

1. Investigation after failure of a valve to operate during a required surveillance test resulted in finding that a required bypass circuit was missing on a total of 10 valves (including the one that failed to operate).

2. Neither the valve surveillance test requirement in the plant technical specifications nor the valve inservice test program will normally detect the absence of the bypass circuit. Even if the valve were to fail to operate, there is a high probability that operation would be restored by other corrective action, such as lubrication or torque switch adjustment (as indicated in Ref. 2), without finding the root cause; i.e., the missing bypass circuit. Hence, the valve could still fail to operate when needed.

3. Based on available data, it appears that valves in emergency core cooling systems for many BWR plants are designed to have these bypass circuits. For instance, valves in the HPCI system (both coolant injection and steam supply to the pump turbine drive), RCIC system, Core Spray system, and RHR system (LPCI and containment spray modes) were intended to have the specified bypass circuit, but were found with the circuit not installed.

4. The licensee action in response to IE Circular 81-13 concerning missing bypass circuits was not as timely as expected. This may have been related to activities associated with plant refueling efforts.

5. At the three plants in which a valve was found to be without the bypass circuit, it was subsequently determined that multiple valves did not have the bypass circuit installed as prescribed.

6. The information about the bypass circuit not being installed was disseminated by means of an IE Circular; therefore, there was no requirement for licensees to report on whether a review and confirmation of recommended action was completed. In addition, NRC rules do not require NRC staff follow-up on all steps pertaining to receipt, review, or action by the licensees. Hence, we have no way to readily ascertain the status of licensee responses to the Circular concerning the status of valves relative to the presence of the bypass circuit.

CONCLUSIONS

Based on the results of the licensee investigation subsequent to the valve failure to operate during the surveillance test at Pilgrim, it would seem appropriate to conclude that actions have now confirmed installation of the bypass circuits in accordance with design at that plant. However, since licensees were not required to report action pursuant to IE Circular 81-13, there is no readily available data from which to verify that such bypass circuits are in place at all plants. AEOD will continue to monitor operating experience reports for similar events.

REFERENCES

1. NRC, IE Circular No. 81-13: "Torque Switch Electrical Bypass Circuit for Safeguard Service Valve Motors," dated September 25, 1981.

2. NRC, E.J. Brown and F.S. Ashe, "Survey of Valve Operation Related Events Occurring During 1978, 1979, and 1980," AEOD/C203, dated May 1982.

3. NRC, "Systematic Assessment of Licensee Performance, Boston Edison Company, Pilgrim Nuclear Power Station," dated August 12, 1982.

4. ESR #78 Response NED 82-688, Internal Licensee Response Referenced in LER 82-008/01 X-1.

5. NRC, Inspection and Enforcement Manual.