

AEOD TECHNICAL REVIEW REPORT

UNIT: Pilgrim 1
DOCKET NO.: 50-293
LICENSEE: Boston Edison Company
NSSS/AE: GE/Bechtel

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SUBJECT: HPCI OVERSPEED TRIP LOSS EVENTS AND SUBSEQUENT
DAMAGE DUE TO WATER HAMMER

EVENT DATES: March 31, 1985 and May 18, 1985

SUMMARY

During routine HPCI operability flow testing while at 100% power, Pilgrim experienced two water hammer events. Because the events were so similar, a study was begun to determine whether the licensee's response was adequate, that is, whether the licensee's actions to prevent recurrence of this type of event seemed appropriate considering recent (since 1981) HPCI operating experience at Pilgrim. The study found that the licensee responded appropriately to these events, although this item remains unresolved pending development and approval of the licensee's final corrective action that is underway at this time.

DISCUSSION

A Daily Staff Note in May 1985 described an event at Pilgrim in which snubber damage had been found following a test of the high pressure coolant injection (HPCI) system. The note indicated that snubber damage had also been found following an earlier HPCI test. A technical review was made to determine whether or not licensee management actions following the first event were appropriate from a maintenance (human factors) standpoint.

A search of SCSS on August 19, 1985, was made to find LERs reporting HPCI events at Pilgrim. Seventeen (17) LERs were found (two in 1981, nine in 1982, four in 1983, zero in 1984, and two in 1985 [LERs 293-85-008 and 293-85-012]). The two 1985 LERs concerned events that were referred to in the Daily Notes. None of the events that occurred before 1985 concerned snubber damage.

In addition to data from the 1985 LERs, information on the 1985 events was obtained from the Resident Inspector (Martin McBride), from Inspection Report 50-293/85-18 dated August 5, 1985, and from the author of the inspection report (Harold Gregg of Region I). The technical details of the following discussion were taken directly from the inspection report or the LERs.

Coincident with the completion of this technical review, a safety system functional inspection (SSFI) of the HPCI at Pilgrim was conducted by IE, NRR, and Region I. Although the report of that inspection was not available, discussions with persons involved with the SSFI provided an informal source of information for this report.

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First Event

On March 31, 1985, during a HPCI pump operability flow rate test, the HPCI turbine tripped on overspeed. Reactor power was approximately 100% at the time of the event. Immediate corrective action by the licensee was initiated on a maintenance investigation and the surveillance testing required for an inoperable HPCI system.

On April 2, 1985, after necessary maintenance on the HPCI system, the HPCI operability test was rerun. During the test, a HPCI turbine exhaust high pressure alarm was received. Investigation found the first of two rupture discs in a series of two, were blown. While the rupture disc was being replaced, a snubber on the HPCI turbine exhaust line was observed to have a broken shaft at the point where it treaded into the clevis rod. Further investigation found the front baseplate of both snubbers in that hanger assembly in a degraded condition. The snubbers had been installed during a recent MKI torus modification.

The cause of the blown rupture disc, broken snubber, and degraded baseplates was ascribed to an anomalous event (water hammer).

After the event, Boston Edison Company retained Teledyne Engineering Company to perform conservative worst case analyses. The licensee stated the Teledyne conclusions were:

- the piping stresses were within allowable limits
- the loads on the two failed snubbers were as predicted and sufficient to fail these snubbers
- loading of other snubbers and supports were not high enough to cause them to fail
- the most critical point in the system was at the exhaust piping to torus penetration.

Second Event

On May 18, 1985, during a routine HPCI pump operability flow rate and valve test, the HPCI turbine tripped; the system was rapidly restarted several seconds later. At that time, a loud noise was heard by Operations personnel. Investigation revealed that a HPCI exhaust line upper snubber was broken, concrete expansion anchors were displaced, and the lower snubber piston rod was bent. Reactor power was approximately 100% at the time of discovery.

Cause of the broken and bent snubbers and the displaced anchors was believed to be the result of an anomalous event (i.e., water hammer) which occurred following the turbine trip and quick restart of the HPCI system.

The sequence of events--an automatic quick cold start followed by a HPCI turbine trip followed by an automatic restart within approximately three seconds--was recognized by the licensee to be similar to the first event. BECo contacted General Electric who came on-site to review the events and provide recommendations. Terry Turbine was also contacted and came on-site to work with the licensee. The GE representative advised that the quick restart following the trip was a significant factor in the event. Additionally, it was determined that the turbine reached too high a speed on start. The licensee adjusted the control circuitry to lower turbine speed and the snubbers were replaced.

General Electric discussed several publications with the licensee:

- GE SIL 30 (October 31, 1973) which recommended the installation of vacuum breakers in the HPCI exhaust line between the stop check valve and the torus.
- GE SIL 351 (February 18, 1981) which concerned the HPCI/RCIC turbine control system calibration.
- GE FDDR of March 8, 1985 which concerns the installation of a hydraulic bypass around the EG-R actuator at Limerick (and three other sites) to reduce the severity of quick starts.

Following some additional HPCI testing problems, BECo installed the bypass described in GE FDDR of March 8, 1985, and went to a manual HPCI start for testing.

On November 4, 1985, the NRC (IE, NRR, and Region I) began a safety system functional inspection (SSFI) of the HPCI system at Pilgrim. At the conclusion of the SSFI on November 22, 1985, BECo proposed plans to increase the size of the vacuum breaker on the HPCI steam exhaust line. The final corrective action that is proposed by BECo will be reviewed and approved by the NRC.

At the conclusion of this AEOD review of licensee management actions following the March 31 and May 18, 1985, HPCI water hammer events at Pilgrim, the final corrective action had not been completed.

FINDINGS

1. BECo reacted promptly to the first HPCI water hammer event retaining a consultant to evaluate the stresses on the HPCI system and the snubber failures.
2. General Electric issued Service Information Letter 30 (SIL-30) on October 31, 1973 regarding HPCI and RCIC turbine exhaust line vacuum breakers. Pilgrim had a one-inch vacuum breaker, although the SIL-30 recommended installing minimum two-inch diameter vacuum breakers.
3. BECo installed the bypass referred to in the GE FDDR of March 18, 1985. BECo is currently developing a work plan, part of which concerns installation of an enlarged vacuum breaker.

CONCLUSIONS

A review of the licensee actions taken after the March 31 and May 18, 1985 HPCI water hammer events at Pilgrim indicates licensee management reacted promptly in obtaining expertise to evaluate the effect of the events on the system and to attempt to correct the causes of the events. The licensee's final corrective action on this matter is being developed at this time and will be reviewed and approved by the NRC prior to completion.

This review did show that SIL's may not be effective if the licensee does not perceive a problem.