

Duane Arnold...

Safe – Reliable – Predictable – Leader

NRC Briefing

HPCI

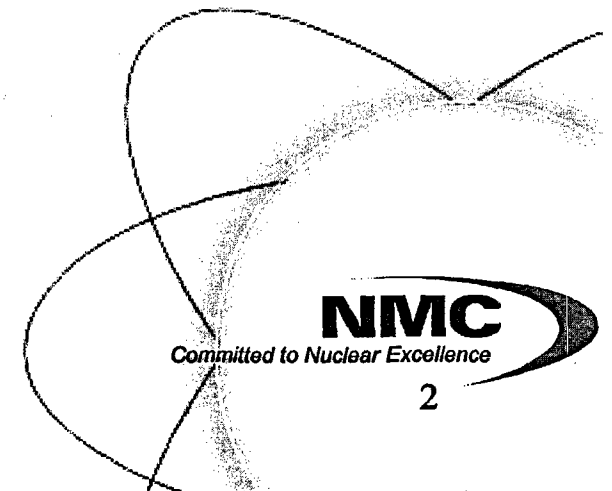
December 2005

NMC
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Duane Arnold NRC Briefing

HPCI

- Operability Determination
- Interim Corrective Actions & Results
- Root Cause Evaluation
- Further Analysis

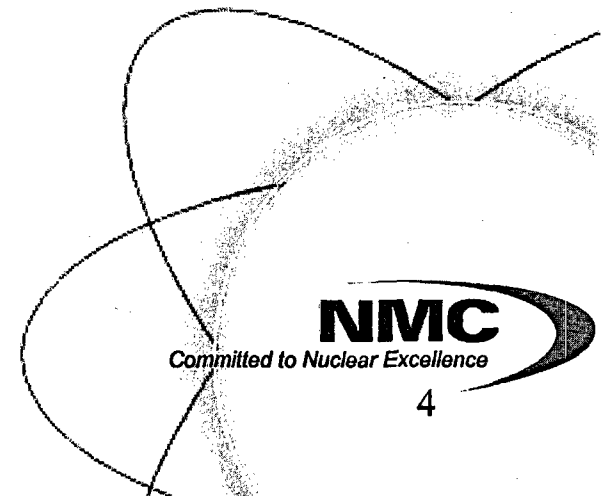


Operability Determination

- Issues Identified:
 - Existence of a steam void at the top of the discharge pipe.
 - Identified non-conformances associated with HPCI discharge pipe temperatures higher than design.
 - Discharge piping should not have been insulated.
 - September 29 venting done at lower CST level.

Operability Determination

- Actions Taken:
 - Established Event Response Team
 - Around-the-clock Engineering support.
 - Obtained additional resources from Monticello and MPR.
 - Successfully vented HPCI several times with higher CST level.
 - Completed OE review:
 - Internal
 - External
 - Operating Modes

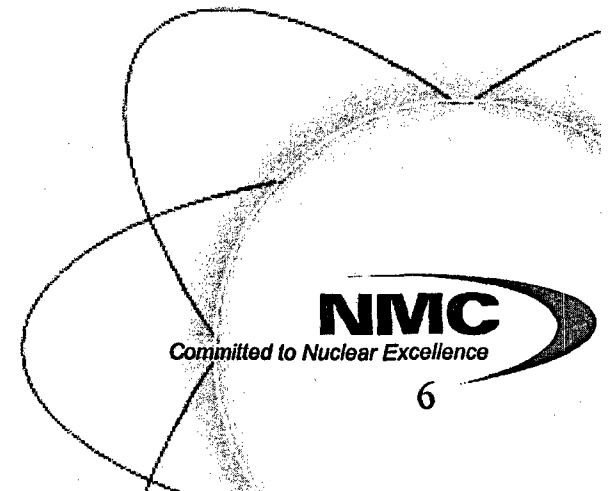


Operability Determination

- Actions Taken:
 - Evaluated Non-Conformances (insulation and high pipe temperatures).
 - Reviewed Transient Recorder data.
 - Completed thorough system walkdown.
 - Note: Operations performs quarterly leakage detection walkdowns.
 - Static and dynamic testing performed.
 - Static – with pressure transducer.
 - Dynamic – with accelerometer.
 - Conducted three NMC challenge boards.

Operability Determination

- Potential Causes of Steam Void Formation:
 - Valve leakage.
 - Heat conduction from feedwater line.
 - Lower CST water level.



Operability Determination

- Conclusions:

- HPCI was capable of performing its safety function.
- Non-conformances do not impact system operability.
- Steam volume near MO-2312 disc does not cause detrimental water hammer.
- Steam volume does not affect HPCI start times.
- Void size collapse similar for both surveillance and injection modes.
- No current or past evidence of water hammer.
- HPCI declared Operable, but degraded & non-conforming on 10/12/05.

Interim Corrective Actions & Results

- Interim Compensatory Actions:

1. HPCI suction lined up to CST with water level of 15 ft or greater, otherwise HPCI keep fill system in service.
2. Periodic venting of HPCI discharge piping.
 - Started at an increased frequency then extended out to TS SR frequency based on results.
 - Performed to validate conclusions of OPR.
3. Shiftly monitoring of HPCI discharge piping temperatures.
 - Performed to verify void size does not change.

Interim Actions & Results

- Results:
 - Discharge pipe temperatures monitored shiftly.
 - Acceptance criteria: $< 115^{\circ}\text{C}$.
 - Results: Upper pipe temp steady @ $\sim 113^{\circ}\text{C}$.
 - Table below summarizes venting and temperature monitoring results:

Date	Oct 14	Oct 17	Oct 21	Oct 26	Nov 1	Nov 8	Nov 22	Dec 6
Vent Time	24 sec	8 sec	11 sec	28 sec	21 sec	15 sec	6.3 sec	30 sec
Pipe Temp	113°C	113°C	113°C	113°C	113°C	113°C	111°C	114°C

- Results support original conclusions in CE 3049.

Root Cause Evaluation

Root Causes

The effects of “turbulent penetration” were not taken into account in the original HPCI system design.

- Unknown to the site, thermal energy was being delivered to MO-2312 via the phenomenon of turbulent penetration.
- Thermal energy is being conducted through MO-2312’s valve disc.
 - Steam is being produced on the low-pressure side of the MO-2312 valve disc due to higher than designed temperatures existing.

Root Cause Evaluation

- Turbulent Penetration:
 - Previously un-recognized phenomena.
 - Discussed in:
 - IAEA-TECDOC-1361, Assessment and management of aging of major nuclear power plant components important to safety, dated July 2003.
 - EPRI MRP-32, Thermal Fatigue Monitoring Guidance, dated April 2001.

Further Analysis

- Analysis to be performed:
 - Determine bounding void size.
 - Determine minimum CST water level to assure operability.
 - Determine effects of pipe movement with determined void size and collapse under normal and automatic start scenarios.
 - Complete a past operability determination.
- Current Schedule.