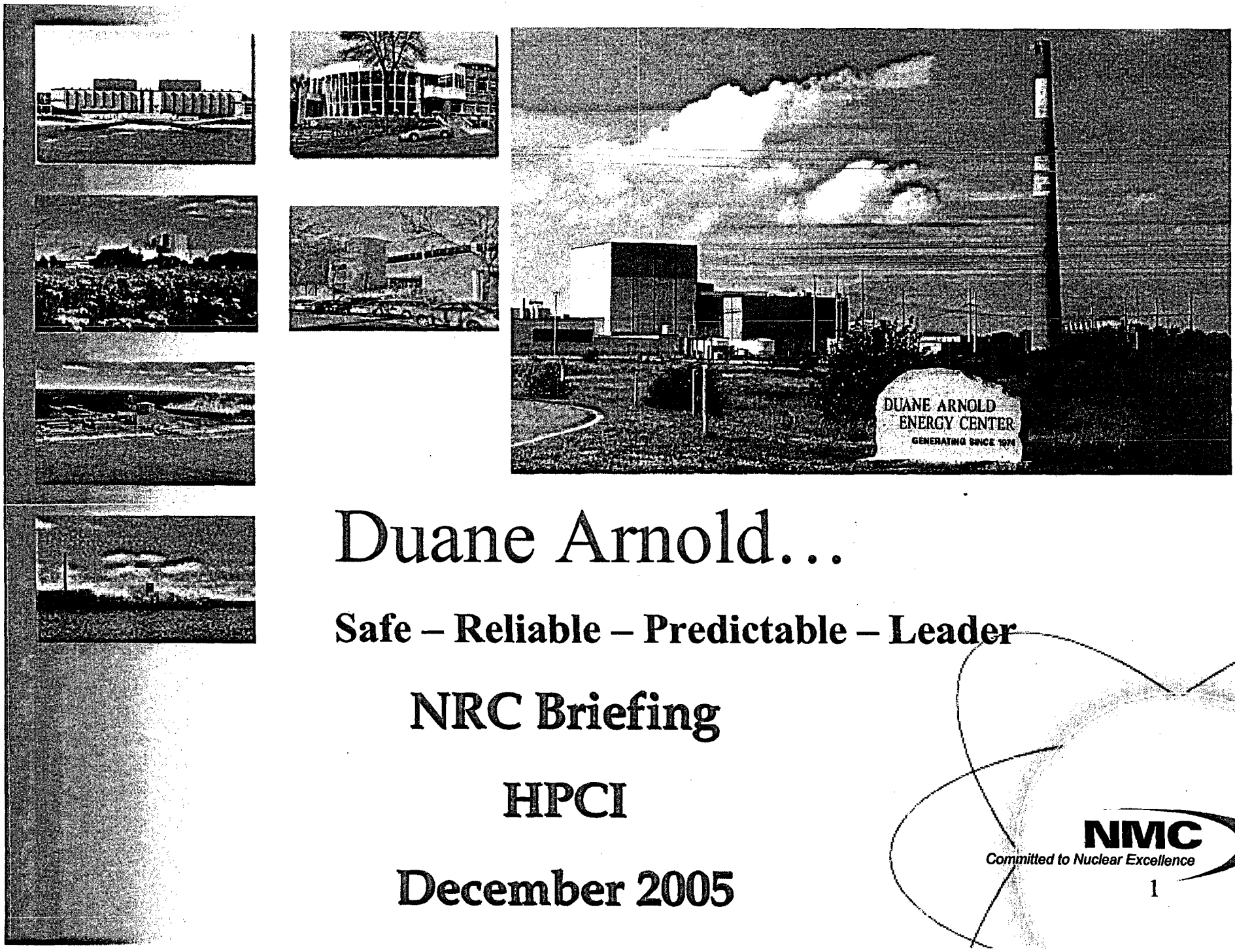

Duane Arnold…

Safe – Reliable – Predictable – Leader

NRC Briefing

HPCI

December 2005

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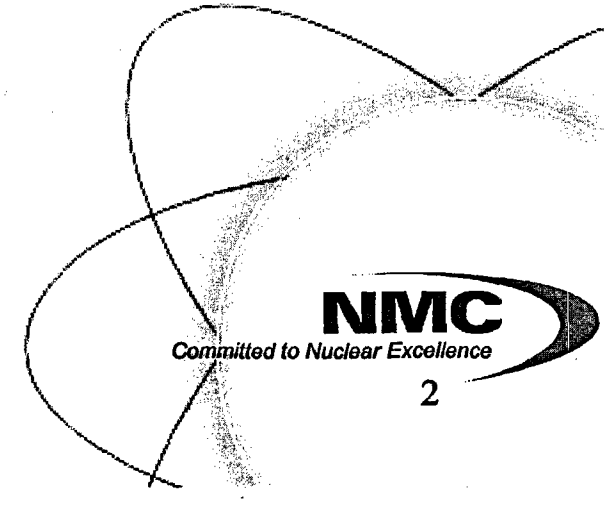
Duane Arnold NRC Briefing
HPCI

- 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.

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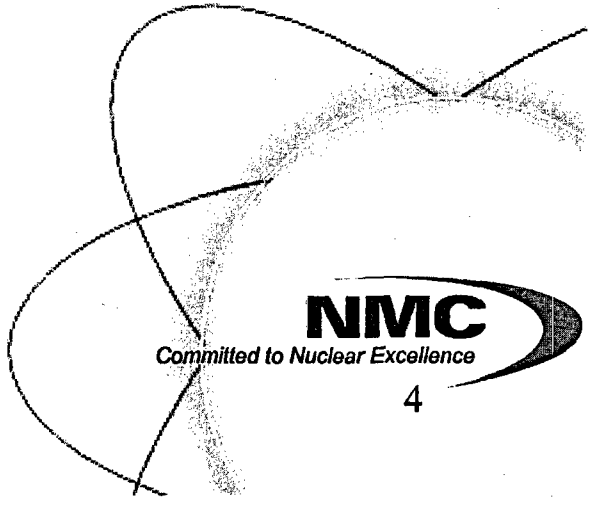
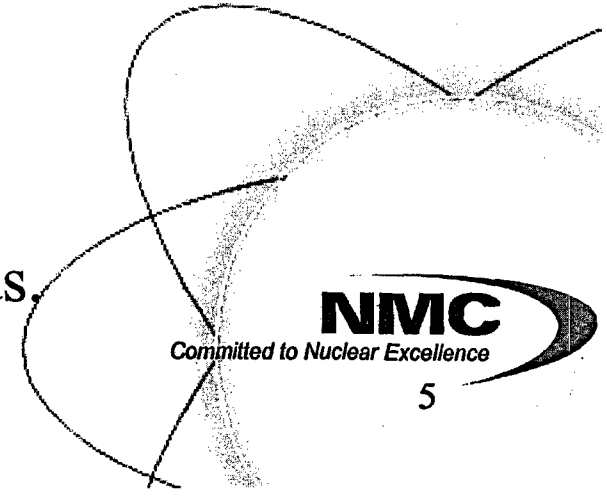
Operability Determination

- 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



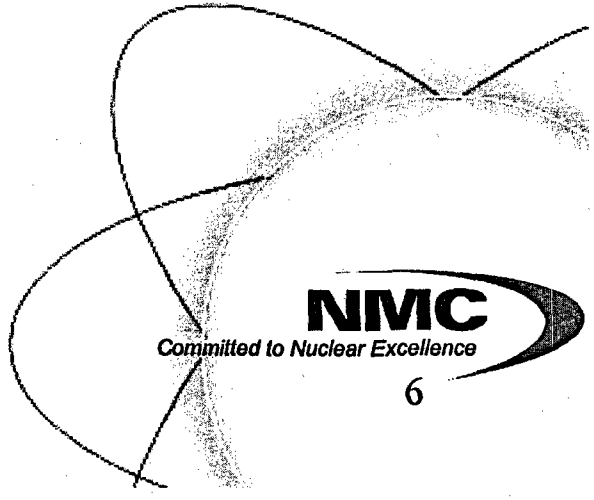
Operability Determination

- 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.

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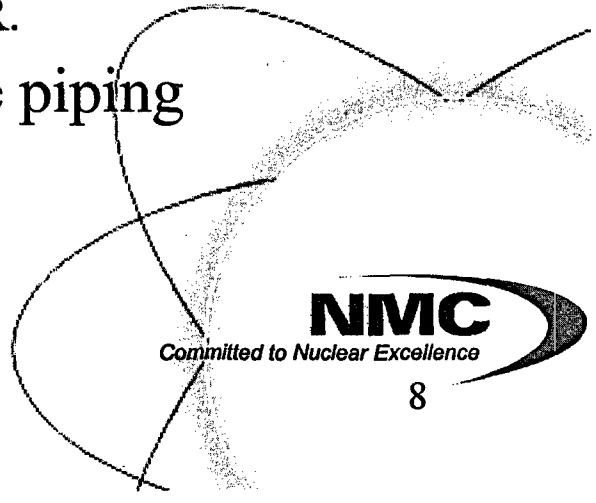
Interim Corrective Actions & Results

- 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 °C.
    - Results: Upper pipe temp steady @ ~ 113 °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.

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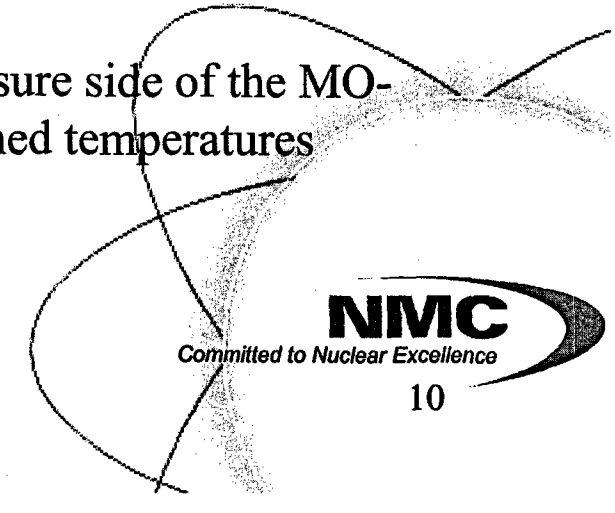
Root Cause Evaluation
Root Causes

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.



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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.

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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.