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Office of Nuclear Reactor Regulation
Division of Safety Systems –
Status of Systems Gas Issues and
Resolution Plans

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March 11, 2015

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Introduction

- Gas Accumulation is a consideration at all United States nuclear power plants and has been since the beginning of nuclear power plant operation.
- Over 100 gas accumulation events have occurred during the past few years.
- Accumulated gas has rendered safety-significant systems inoperable and non-functional
- It is a safety-significant issue

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Introduction, continued

- NRC actions are focused on reasonably ensuring that gas issues that may affect safe operation are acceptably addressed.
- The remainder of this presentation will:
 - Summarize successes.
 - Identify remaining issues.
 - Describe planned NRC actions.
 - Provide references.

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Successes - Generic Letter 2008-01

- Required licensees to provide information to demonstrate that the systems are and will continue to be in compliance with the licensing bases and regulations.
- Excellent support was provided by NEI, the owners groups, INPO, EPRI, and licensees.
- Licensees conducted in-depth system walkdowns and improved gas management procedures.
- Extensive testing and analyses were conducted.

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Successes – NEI 09-10 Rev 1a-A

- NRC-endorsed without exception.
- Provides operational guidance.
 - Example: NRC reported the simplified equation was acceptable for operability evaluation provided specified criteria were satisfied.
- Design basis and operational requirements are better defined.

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Successes – NEI 09-10 Rev 1a-A

- Systems will be designed, operated, and maintained in a manner to prevent accumulation of gas.
- Discovered gas that exceeds the design basis must be removed as soon as is practical.

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Successes – NRC Inspections

- Temporary Instruction (TI) 2515/177 completed.
- Regional inspections identified new issues and weaknesses.
- In-depth inspections at several plants resulted in significant improvement to NRC staff understanding of issues.
- Various licensee approaches for developing procedures (Design Basis, Operational, and Vortex) accepted by the staff.

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Successes – Acceptance Criteria

Tools available to licensee’s for Design Basis evaluations:

- NEI 09-10 pump suction void criteria
- Results from acceptable tank and sump drain tests
- Use of Froude number to assess gas/water movement

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Successes – Additional Tools

- Pump suction criteria provided in Huffman, K., “Report of the Expert Panel on the Effect of Gas Accumulation on Pumps,” EPRI Report Number 1026498, August, 2012 may be useful for operability determinations.
- EPRI Report not submitted for NRC approval.
- EPRI Report pump void criteria more comprehensive than NEI 09-10.
- EPRI Report may be useful in identifying conservatisms if NEI 09-10 pump suction criteria are satisfied.

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Other Industry Successes

- The Purdue 4, 6, 8, and 12 inch pipe diameter transient tests were well documented and provided valuable information.
- FAI/09-130-P reported that homogeneous bubbly flow would exit a downcomer if the initial void volume above the downcomer was < 4 times the downcomer volume. This is conservative by at least 30%.
- FAI/08-70 (ML090990426) provided water hammer test data and insights

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Successes - TSTF-523

- Addresses gas management TS issues and surveillance requirements.
- 34 Units have submitted license amendment requests (LARs) to adopt the TSTF
- 16 Units have extended the LAR submittal date
- 1 Unit has informed NRC that they do not plan to adopt the TSTF

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Remaining Issues

Gas Vortexing

- Extensive test data available to industry to make decisions.
- Continue to receive design basis and operability questions (scaling, test repeatability, operational issues).
- No single publicly-available document exists that address the NRC staff position on vortexing issues.

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Remaining Issues, continued

Gas Transport - Correlations

- Strong technical basis is necessary.
- Test Data is available for several configurations.
- Much of the data has not been made available to NRC.
- Transport correlations need to have clearly defined limitations and restrictions and their applicability to plant configurations needs to be demonstrated.

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Remaining Issues, continued

Gas Transport – Computer Codes

“any computer code used to develop a system specific model should be verified to be applicable to solve problems involving gas transport in piping systems via comparisons with laboratory test data or other appropriate methods. Further, a suitable safety factor should be added to predicted results to reasonably ensure the predictions encompass actual behavior.” NEI/NRC (ML13136A129)

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Remaining Issues, continued

Gas Transport – Computer Codes

- No generic code approvals exist for prediction of gas movement.
- Plant-specific uses of GOTHIC and RELAP5 have been found acceptable but are not generically applicable and this approach is labor-intensive.
- Licensees often use other codes, such as PIPER, SYSFLO, and AIRDIST.

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Plans

- Publish a draft NUREG on Vortexing for public comment
 - Potentially follow with a Regulatory Guide
- Evaluate Industry-led initiative to define acceptable use of Purdue correlations.
- Complete the Gas Action Plan.

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References

- Generic Letter 2008-01: ADAMS Accession Number ML072910759
- NEI 09-10 Rev 1a-A: ML13136A129
- TI 2515/177: ML100261300
- Robinson Inspection: ML13270A176
- Gas Action Plan: MLXXXXXXXX
- WCAP 17271: ML110490342
- FAI/08-70: ML090990426
- FAI/09-130: ML110480452

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