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Air Operated Valve Regulatory Activities

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AOV Users' Group
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NRC Regulations

- 10 CFR 50.55a – Codes and Standards (Inservice Testing)
- 10 CFR 50.65 – Maintenance Rule
- 10 CFR 50.69 – Risk-Informed Treatment
- 10 CFR Part 50, Appendix A – General Design Criteria
- 10 CFR Part 50, Appendix B – Quality Assurance
- 10 CFR Part 100 – Reactor Site Criteria (Seismic)

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Current AOV Issues/Activities

- 50.55a Rulemaking
- Regulatory Guide 1.192 Revision 1
- Operational Experience - 2014 AOV events
- NRC Perspective – Evolution of ASME OM Code Mandatory Appendix IV
- AOV Failure Study

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50.55a Rulemaking

- Currently reviewing ASME OM Code 2009 Edition, 2011 Addenda, and 2012 Edition for next rule making
- Tentative schedule - to be published and issued for public comment January 2015
- Tentative final rulemaking schedule - to be published January 2015

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Reg Guide 1.192 Operation and Maintenance Code Case Acceptability, ASME OM Code

- Regulatory guide lists OM Code Cases that are acceptable to the NRC for implementation in the Inservice Test (IST) of light-water-cooled nuclear power plants
- Revision 1 to RG 1.192 (NRC approval of ASME OM Code Cases, 2002-2006 Edition / Addenda) – Approved and effective in the Federal Register 12/05/2014

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2014 AOV Events

- Indian Pt. 3 – Main Feed Reg Valve failed closed due to failed flow controller (1/6)
- Vogtle 2 – Main Feedwater valve closed due to water intrusion into positioner (4/8)
- V.C. Summer – CCW emergency makeup valve failed to open. Apparent cause low valve manipulation frequency, added frictional forces due to untreated water, weakening of actuator springs, and high packing friction (4/26)
- V.C. Summer – Rx trip due to failed to open condensate bypass valve. Cause due to failed solenoid (7/22)
- LaSalle 2 – MSIV failed closed due to stem/disc separation (8/5)

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NRC Perspective – Evolution of ASME Mandatory Appendix IV

- Current NRC Requirements for AOVs
- NUREG-1275 Volume 2
- Generic Safety Issue 158 (GSI-158)
- Joint Owners Group on Air-Operated Valves (JOG AOV)
- NUREG/CR-6654
- NUREG-1275 Volume 13
- Closing of GSI-158
- Mandatory Appendix IV – Revision 0
- Mandatory Appendix IV – Revision 1

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NRC Requirements - AOV

- 10 CFR 50.55a(f) – Inservice Testing Requirements
  - AOV shall be tested per the ASME OM Code
  - Current ASME OM Code endorsed is 1995 Edition through 2006 Addenda

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ASME OM Code Requirements - AOV

- Subsection ISTA – General Requirements
  - ISTA-1100 Scope states in part “IST establishes the requirements for preservice and inservice testing and examination of certain components to assess their operational readiness in light-water reactor nuclear power plants”
- Subsection ISTC – Inservice Testing of Valves in Light-Water Reactor Nuclear Power Plants
  - Includes valves that are required to perform a specific function in shutting down a reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequences of an accident

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ASME OM Code Requirements - AOV

- Subsection ISTC cont'd
  - Preservice Test – test under conditions as near as practicable to those expected during subsequent inservice testing
  - Inservice Testing
    - Full stroke exercise (stroke time testing)
    - Valve Obturator Movement verification
    - Fail-Safe valve verification
    - Leak Test
    - Position verification

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NUREG-1275 – Volume 2 (1987)
Operating Experience Feedback Report
Air Systems Problems

- Report documents poor air quality systems and its affect on AOVs
  - Air Systems considered non-safety at most plants
  - Contaminants affect filters, regulators, solenoid valves, elastomers, I/P transducers, and valve positioners
  - Rust, Dirt, Water, Oil
  - Poor air quality system due to design and/or management deficiencies

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GSI-158 – Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions

- Operating experience and research results on MOVs, SOVs, AOVs, and HOVs indicated testing under static conditions did not always reveal how these valves would perform under design basis conditions
- A number of valve failures occurred as a result of inadequate design, installation, and settings
- GL-89-10 issued for MOV
- Study initiated to investigate if Generic Letter should be issued for AOV, SOV, HOV

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Joint Owners Group on Air-Operated Valves (JOG AOV)

- Industry initiative facilitated by Nuclear Energy Institute (NEI)
- Voluntary program for Air-Operated Valves
- Guidance on verification of safety-related AOVs categorized as high risk significant
- For low risk safety significant valves and non-safety high risk significant valves, a less rigorous verification and valve functionality guidance was provided
- Program completed and issued to the utilities in 1999
- Copy provided to NRC staff for comment

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Joint Owners Group on Air-Operated Valves (JOG AOV)

- NRC Staff Comments JOG AOV Program
  - NRC staff believes that the capability of the actuator should be verified by test information. This information should be either based on plant specific testing or justified based on industry information
  - Setpoints for AOVs should be defined in the JOG AOV program based on current vendor information or diagnostic testing and established such that the valve is capable of performing its design-basis function
  - Sufficient test data should be collected and evaluated prior to extending the test interval beyond the initial test frequency

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Joint Owners Group on Air-Operated Valves (JOG AOV)

- NRC Staff Comments JOG AOV Program cont'd
  - Non-safety-related AOVs that are determined to be high risk significant (or high safety significant as used in the JOG AOV program document) should be subject to the more extensive capability evaluation as intended for Category 1 valves

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NUREG/CR-6654 (1999) – A Study of Air-Operated Valves in U.S. Nuclear Power Plants

- AOVs may have reduced margins caused by:
  - Aging
  - Load mechanisms not understood or considered in the original design, or previously contaminated air
  - Valve calculations included mistakes or inaccurate information
- Air systems and solenoid operated valves continue to be sources for common cause failures of AOVs
- Accident sequence precursor analyses indicate that there have been a number of risk significant events involving AOVs
- AOVs have important role in system reliability

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NUREG-1275 (2000) – Volume 13 Evaluation of Air-Operated Valves at U.S. Light-Water Reactors

- Observations
  - Licensees maintenance rule scope generally includes AOVs – safety-related and non-safety-related
  - Licensees have identified risk significant and important AOVs – safety-related and non-safety-related
  - Significant variations exist in scope and focus of current licensees AOV programs
  - Air-Operated dampers are excluded from most current and proposed AOV programs
  - JOG AOV program is voluntary

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NUREG-1275 – Volume 13

- Observations cont'd
  - Current testing methods may not assess AOV performance under certain accident or transient conditions
  - Several licensees have used diagnostics on AOVs and found they would not perform as expected under certain accident or transient conditions
  - Several licensees have reanalyzed AOV capability using updated design and valve factor information and have discovered AOVs which would not perform under certain accident or transient conditions
  - Common cause failures included manufacturing errors, aged/degraded elastomers, and contamination from air systems

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NUREG-1275 – Volume 13

- Observations cont'd
  - Licensees have identified high risk AOVs – typically addresses risk of a single valve failure
  - Primary risk concern is potential for simultaneous common cause failure (CCF) of both trains of a safety system during an accident or transient due to design, manufacturing, maintenance, and testing deficiencies which do not properly account for pressure, temperature, and flow conditions expected to occur during accidents or transients
  - Another concern is the potential for simultaneous CCF mechanisms introduced by air system contamination, other contaminants, or aging of elastomeric parts

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NUREG-1275 – Volume 13

- Recommendations
  - Identify safety-related AOVs which are in a non-safety position and are expected to move to their safety position during accidents or transients
  - Identify safety-related AOVs which contribute the most risk should they fail to operate. For those valves with unconfirmed design margin, risk calculations which consider failures of redundant valves in both trains of a system may be appropriate
  - Establish confidence that risk significant AOVs will operate as required, subject to actual pressures, temperatures, and flows during transient and accident conditions by application of accepted and verified analysis or diagnostic testing methods
  - Assure continued operability through periodic testing

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NUREG-1275 – Volume 13

- Recommendations cont'd
  - Establish operations and maintenance practices which prevent introduction of contaminants to the pneumatic system or to the valves and their sub components and replace aging elastomers as appropriate
  - Identify non-safety related valves which have high risk significance and apply similar analysis or diagnostic techniques

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NRC Staff Comments on Closing GSI-158

- The JOG AOV group was formed and taking initiatives to address AOV concerns
- Recent commission policy was stated that NRC should now rely more on industry initiatives
- ASME is addressing AOV concerns through a risk-informed approach and is developing code cases, which NRC staff is working with ASME, to incorporate diagnostic testing of AOVs into the code
- Risk informed Regulatory Guides 1.174 and 1.175 have been developed and provide better direction on how to approach risk-informed reviews and testing issues

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NRC Staff Comments on Closing GSI-158

- Research study shows that the industry is on the right track
- NRC staff will continue to work with industry groups to ensure that safety-related AOVs are capable of performing their specified functions under design basis conditions
- If AOV functionality under design basis conditions is not adequately addressed by the industry, the NRC staff will take additional regulatory action as appropriate

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Mandatory Appendix IV – Revision 0

- Establishes the minimum requirements for safety-related AOVs to insure operational readiness
- Addresses NRC staff concerns such as:
  - Design basis review of system and component to include worst case conditions considering line pressures, flow rate, seat leakage, and valve function for verification and documentation of the adequacy of the AOV sizing
  - Verification of valve performance and property assumptions (i.e. valve friction factors, packing load, etc.) at worst case condition pressures and flows
  - Program is not voluntary

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Mandatory Appendix IV – Revision 1

- Deletes NRC staff concern:
  - Verification of valve property assumptions (i.e. valve friction factors, packing loads, etc.) and valve performance at worst case condition pressures and flows
- NRC staff believe valve assumptions & performance needs to be verified by one of four methods:
  - Test at or near design basis conditions
  - Engineering analysis (i.e. EPRI PPM, vendor verification)
  - Justification of AOV design basis based on AOV valve grouping
  - The use of other test data from other plants or research program
- Component verification will yield confident margins

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NRC Concerns- AOV

- Is AOV capable of performing its design basis function?
- Has AOV been set up correctly?
- Are all parameters that affect performance being monitored and trended?
- Is AOV susceptible to degradation over time?
- ASME OM Code and Mandatory Appendix IV Revision 1 does not address all NRC concerns

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AOV Failure Study

- Review INPO ICES database for the last 15 years (4/9/1999 to 4/9/2014)
- ICES search criteria:
  - Component Type = Valves, dampers
  - Component Type = Valve Operators
  - Sub Component Type = Valves, dampers – Operator – Pneumatic (Diaphragm or Cylinder) (AOV)
  - Text Exact Phrase = Failed to Open
  - Text Exact Phrase = Failed to Close

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AOV Failure Study

- 253 records captured for valves (gate, globe, butterfly, ball) Check valves not captured
- 86 events might have benefitted from a baseline and/or periodic diagnostic test
- The 86 events were reviewed for component being in IST program
- 59 events in IST program that might have benefitted from a baseline and/or periodic diagnostic test (28 additional IST events were not included due to solenoid valve failure because diagnostics would not identified)

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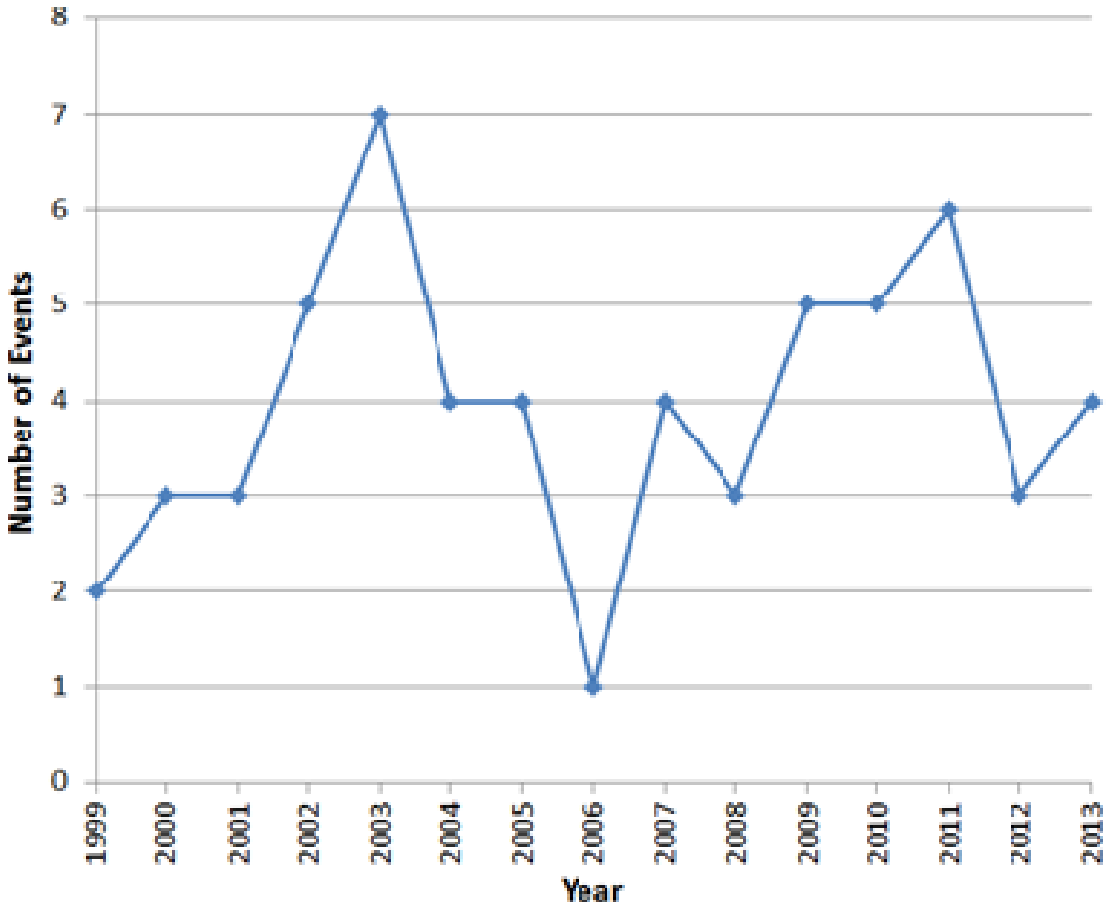
59 Failure Event Distribution by Year



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59 Failure Events – Valve Types

- Globe – 22
- Gate – 16
- Butterfly – 13
- Ball – 2
- Unknown - 6

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59 Failure Events – Apparent Cause

- Accessories – 11 Events
  - solenoid, air supply, lubricant, supporting equipment, maintenance errors
- Design – 20 Events
  - Inadequate design, improper setup, low margin, PLTB
- Mechanical – 28 Events
  - Binding, corrosion, fouling, wear, FME

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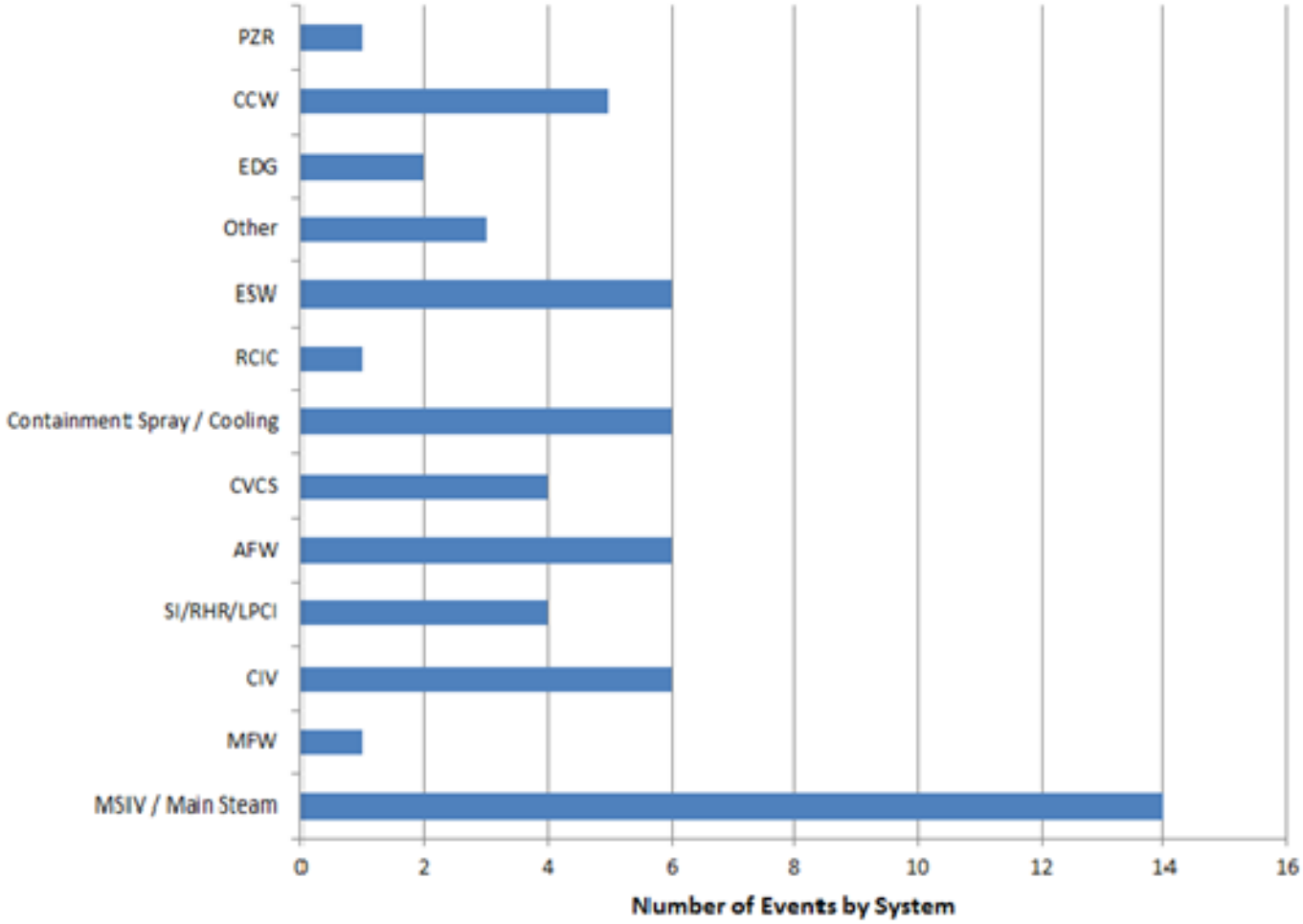
59 Failure Event Distribution - Systems



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QUESTIONS?

Future Questions

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