RISK-INFORMED INSERVICE INSPECTION (RI-ISI)

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Washington, DC 20555-0001
1996 PRA Implementation Plan established plans for the development of a General RG and SRP and four application specific RGs and SRPs
- Technical Specifications
- ISI
- IST
- Graded QA
Objectives of ISI Program is to identify degraded conditions that are precursors to pipe failures.

Regulatory requirements for ISI are specified in 10 CFR 50.55a(g).

10 CFR 50.55a(g) references ASME Code Section XI for ISI requirements.

10 CFR 50.55a(a)(3)(i) provides for authorization of alternative ISI programs by Director of NRR.

Relief request required for staff review and approval.
Risk-Informed Inservice Inspection (RI-ISI) has been one of the most successful risk-informed initiatives

- Number of Units (of 103) expected to implement RI-ISI programs: 99
- Number of Units That Have Submitted RI-ISI Programs: 76
- Number of Plants Currently under Review: 6
RI-ISI GUIDANCE

- Approved well defined generic methodologies via Topical Reports (WOG and EPRI):
  - SER for WOG Topical Report issued in December 1998
  - SER for EPRI Topical Report issued in October 1999
The WOG and EPRI methodologies are generally similar but use different techniques at different stages.

Issued Regulatory Guidance:
RI-ISI PROCESS OVERVIEW

- Divide Systems into Piping Segments
- Evaluate Consequences of Segment Failures
- Determine Failure Potential of Each Segment
- Categorize Risk Significance of Each Segment
- Select Welds and Elements for Inspection
- Assess Impact on CDF and LERF
- Demonstrate Conformance with RG 1.174
WOG METHODOLOGY

- Detailed fracture mechanics method used to calculate piping failure probability/frequency
- Piping segments categorized based on risk reduction worth (normalized fractional contribution to risk) and probability of leak
EPRI METHODOLOGY

- Failure potential used to classify piping segments
- Piping segments categorized based on failure potential and consequences of failure
RI-ISI GUIDANCE

- Adopted “template” submittal specifying the contents of the relief request:
  - brief description of evaluations performed
  - overview of results from each major evaluation
  - any deviations from methodologies must be identified and justified
“Template” initially evolved but has stabilized
Staff issued notice (IN 98-44) stated the staff would consider granting relief of up to 2 years from current inspection requirements for licensees that intend to implement RI-ISI Programs if licensees make such a request
UNDERLYING ASSUMPTIONS

- U.S. plants are designed and constructed to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code
- The Code inservice inspection requirements did not consider risk insights.
- Inspection resources should be focused in those areas which are most safety and risk significant
REVIEW OBSERVATIONS
AND CONTINUING ACTIVITIES

- PRA Quality - September 2003 Version of RG and SRP includes guidance on submitting industry PRA quality peer review results
- Start of ISI Program - When changing to a RI-ISI program within the 10 year interval, the Code minimum and maximum percentages of examination per period still apply to RI-ISI
REVIEW OBSERVATIONS AND CONTINUING ACTIVITIES

- Additional Examinations - The number of additional elements to be examined equals the number of elements with the same postulated failure mode originally scheduled for examination in the fuel cycle
- Updates to RI-ISI Programs
- Application to BER Piping
UPDATES TO RI-ISI PROGRAMS

- RI-ISI programs should be living programs and should be changed if needed to reflect new relevant information such as:
  - major updates to plant PRA models
  - new trends in service experience with piping systems at the plant and across the industry
  - new information on element accessibility

- At a minimum, risk ranking should be reviewed and adjusted on an ASME-period basis
UPDATES TO RI-ISI PROGRAMS

- RI-ISI programs should be updated and submitted to NRC:
  - at the end of the 10-year ISI interval
  - prior to the end of the 10-year interval if there is a deviation from the RI-ISI methodology described in the initial submittal, or if industry experience determines that there is a need for significant revision to the program
APPLICATION TO BER PIPING

- Modification of inspections within the break exclusion region (BER) not permitted in the original EPRI and WOG RI-ISI methodologies
- Both EPRI and WOG have developed methodologies to apply RI-ISI methodology to piping within the BER
  - SER on EPRI submittal completed in June 2002
  - SER on WOG Submittal completed in March 2004
APPLICATION TO BER PIPING

- When BER program is in FSAR, the extension of RI-ISI methodology to BER piping may be done via the 10 CFR 50.59 process
LONG-TERM ACTIVITIES

- Staff is working with ASME to develop acceptable Code Cases and an Appendix for RI-ISI applications
  - Code Case N-560 (Class 1, EPRI Method)
  - Code Case N-577 (Class 1, 2, 3, WOG Method)
  - Code Case N-578 (Class 1, 2, 3, EPRI Method)
  - Appendix X (Class 1, 2, 3, WOG and EPRI Methods)
LONG-TERM ACTIVITIES

- Endorsement of Code Cases in RG 1.147, with limitations and conditions where appropriate
- Anticipate that Code Cases will be incorporated into the ASME Code
- Eventual rulemaking to incorporate by reference the ASME Code with limitations, if necessary
## COMPARISON OF ASME XI AND RI-ISI

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ASME XI</th>
<th>RI-ISI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicability</td>
<td>As defined in the appropriate ASME XI</td>
<td>Currently applicable to piping only</td>
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<tr>
<td>Percentage of examinations for Class 1 piping</td>
<td>Category BF Welds: 100% Category BJ Welds: 25%</td>
<td>As Defined in the Approved RI-ISI Program for the Plant</td>
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<tr>
<td>Percentage of examinations for Class 2 piping</td>
<td>Categories C-F-1, C-F-2 Welds: 7.5%</td>
<td>As Defined in the Approved RI-ISI Program for the Plant</td>
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<tr>
<td>Examination locations</td>
<td>Terminal ends, locations of high stresses and fatigue usage factors, etc</td>
<td>As defined in the approved RI-ISI program for the plant</td>
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</table>
## COMPARISON OF ASME XI AND RI-ISI

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ASME XI</th>
<th>RI-ISI</th>
</tr>
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<tbody>
<tr>
<td>Examination method</td>
<td>As defined in the appropriate ASME XI table, usually depends on pipe size and weld type</td>
<td>As defined in the applicable approved topical report, usually depends on degradation mechanism</td>
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<tr>
<td>Examination volume</td>
<td>As defined in the appropriate ASME XI Table</td>
<td>As defined in the applicable approved topical report, depends on degradation mechanism and usually more volume than ASME XI</td>
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<tr>
<td>Examination Frequency</td>
<td>10 Year inspection interval defined in ASME XI</td>
<td>Same as ASME XI</td>
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<tr>
<td>ITEM</td>
<td>ASME XI</td>
<td>RI-ISI</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----------------------------------------------</td>
<td>----------------------</td>
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<tr>
<td>Definition of inspection periods</td>
<td>Three periods as defined in ASME XI</td>
<td>Same as ASME XI</td>
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<tr>
<td>Minimum examinations during</td>
<td>16%, 50%, and 100% at the end of three</td>
<td>Same as ASME XI</td>
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<tr>
<td>inspection periods</td>
<td>periods</td>
<td></td>
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<tr>
<td>Examination acceptance standards</td>
<td>Defined in ASME XI</td>
<td>Same as ASME XI</td>
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<tr>
<td>Flaw evaluation standards</td>
<td>Defined in ASME XI</td>
<td>Same as ASME XI</td>
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<tr>
<td>High Failure Importance</td>
<td>Low Failure Importance</td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td><strong>P_{\text{Large Leak}} &gt; 10^{-4}</strong></td>
<td><strong>1(A)</strong> Susceptible Locations (100%)</td>
<td></td>
</tr>
<tr>
<td><strong>Owner Defined Program</strong></td>
<td><strong>1(B)</strong> Statistical Inspection Location Selection Process</td>
<td></td>
</tr>
<tr>
<td><strong>Statistical Inspection Location Selection Process</strong></td>
<td><strong>2</strong> Statistical Inspection Location Selection Process</td>
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<tr>
<td><strong>Low Safety Significant</strong></td>
<td><strong>High Safety Significant</strong> R R W \geq 1.005</td>
<td></td>
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<table>
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<tr>
<th>3</th>
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<tbody>
<tr>
<td><strong>Only System Pressure Test &amp; Visual Examination</strong></td>
<td><strong>Low Safety Significant</strong></td>
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## EPRI RISK MATRIX

**CONSEQUENCE CATEGORY**
CCDP and CLERP Potential

<table>
<thead>
<tr>
<th>FAILURE POTENTIAL</th>
<th>NONE</th>
<th>LOW</th>
<th>MEDIUM</th>
<th>HIGH</th>
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<tr>
<td>HIGH</td>
<td>LOW</td>
<td>MEDIUM</td>
<td>HIGH</td>
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<tr>
<td></td>
<td>(Cat 7)</td>
<td>(Cat 5)</td>
<td>(Cat 3)</td>
<td>(Cat 1)</td>
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<tr>
<td>MEDIUM</td>
<td>LOW</td>
<td>LOW</td>
<td>MEDIUM</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>(Cat 7)</td>
<td>(Cat 6)</td>
<td>(Cat 5)</td>
<td>(Cat 2)</td>
</tr>
<tr>
<td>LOW</td>
<td>LOW</td>
<td>LOW</td>
<td>LOW</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>(Cat 7)</td>
<td>(Cat 7)</td>
<td>(Cat 6)</td>
<td>(Cat 4)</td>
</tr>
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