Risk-Informed Inservice Inspection Support, Extension, and Implementation

Project Updates

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NRC-Industry NDE Technical Information Exchange Meeting
1/22/2025

RFA: Risk-Informed ISI Development and Application

1995-2005

Development of the EPRI Traditional Risk Informed Inservice Inspection Methodology

- Pilot plants approved by NRC
- NRC approves RI-ISI Methodology for generic use
  - EPRI Report TR-112657, Rev B-A
- Streamlined regulatory review process defined

2005-2015

Wide scale application of RI-ISI in the US and several pilot studies and test cases within the international community

- EPRI Streamlined RI-ISI Methodology developed
  - EPRI Reports 1022944 and 3002003029
- Regulatory review and approval no longer required prior to implementation

2015-Present

Application to other regulatory environments and non-light water reactor designs

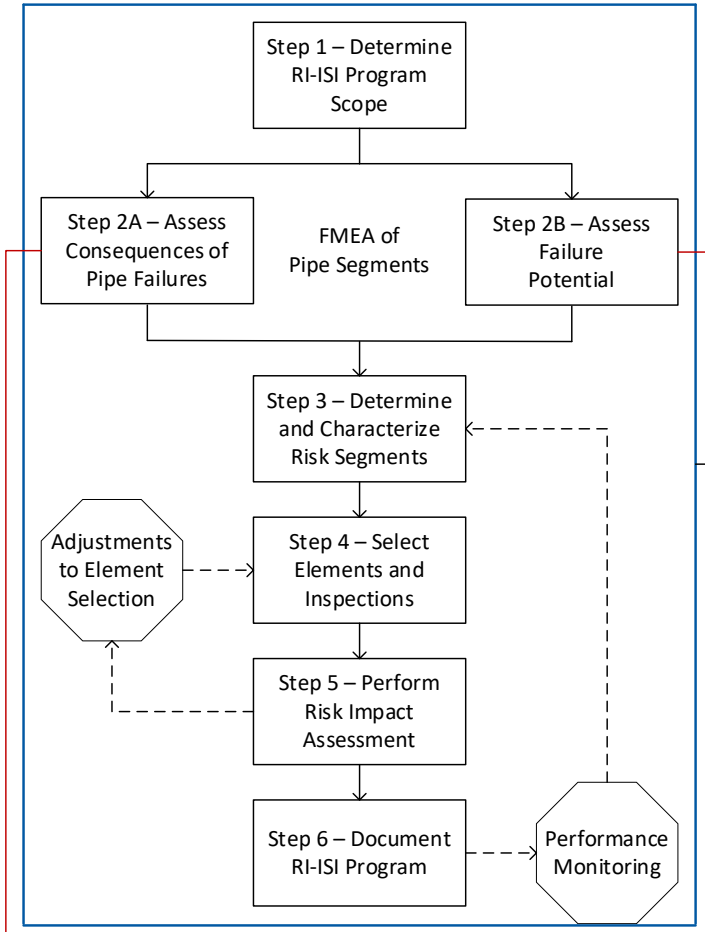
- RI surface examination requirements
- Alternative to address limited examination coverage requirements
- Alternative to RPV Threads-in-Flange examination requirements
- RI Repair/Replacement requirements
- Enhanced RI passive categorization method for 10CFR50.69 applications
- RI High Energy Line Break
- RI safety classification for New Builds
- Applications for Long Term Operation

EPRI research continues to inform the further development and application of risk concepts to ISI and other programs where it can be beneficial

Enhanced RI Passive Categorization and RI-HELB Projects

- **EPRI Report 3002025288** – Enhanced RI Categorization Methodology for Pressure Boundary Components
  - Provides an alternative categorization methodology for pressure boundary components based on a set of prerequisites and pre-determined HSS systems/subsystems, plus a plant-specific search for outliers that need to be upgraded to HSS
  - Evaluating the pressure boundary function of all safety related and non-safety related systems will result in a **Fullscope Approach**
  - Identifying all non-safety-related HSS components will result in a **Safety Benefit**
  - NRC audit completed/RAI responses being developed
- **EPRI Report 3002028939** – RI High-Energy Line Break Evaluation Requirements
  - Provides an approach to identify the safety significance of postulated pipe ruptures and as warranted, recommend appropriate plant actions (for example, plant modifications, inspection sample size), taking into account plant-specific design features and the safety benefit associated with possible plant modification while maintaining an adequate level of defense in depth
  - Of benefit to licensees that go through a plant evolution (for example, power uprate, subsequent license renewal) and, as such, wish to keep their overall HELB program intact but address changes with a **risk-informed approach**
  - NRC audit ongoing/RAIs forthcoming

Evolution of EPRI RI-technology to Pressure Boundary Components



Project ongoing for RI-HELB Methodology

VY – RI-ISI Pilot Study
Partial Scope Application to Class 1 Piping Only Based on ASME Code Case N-560
SE dated November 9, 1998
ML20195C416

ANO-2 – RI-ISI Pilot Study
Full Scope Application to Class 1, 2 and 3 Piping Based on ASME Code Case N-578
SE dated December 29, 1998
Letter 2CNA129805

ANO-1 – RI-ISI Pilot Study
Partial Scope Application to Class 1 Piping Only Based on ASME Code Case N-560
SE dated August 25, 1999
Letter 1CNA089904

EPRI TR-112657, Rev B-A
Traditional RI-ISI Methodology
Revised Risk-Informed Inservice Inspection Evaluation Procedure
dated December 1999
SE dated October 28, 1999
ML993190474
Incorporates Lessons Learned from the VY, ANO-2 and ANO-1 RI-ISI Pilot Plant Applications

EPRI Technical Update 3002028939
RI-HELB Methodology
Risk-Informed High-Energy Line Break Evaluation Requirements
dated June 2024
Establishes HELB response strategies based on the risk significance of postulated piping failures

EPRI TR-1006937
RI-BER Methodology
Extension of the EPRI Risk Informed Inservice Inspection Methodology to Break Exclusion Region Programs
dated February 2001
Incorporates Lessons Learned from RI-BER Pilot Plant Applications documented in EPRI TR-1006837

Damage Mechanism Evaluation portion of EPRI TR-112657 used to assess the susceptibility of HSS Components to DMs in the Streamlined RI-ISI Process

ASME Code Case N-716
Streamlined RI-ISI Methodology
Alternative Piping Classification and Examination Requirements
issued April 19, 2006
ASME Code Case N-716-1
Approved in RG 1.147 Revision 17
Streamlined process based on Extensive Experience with Traditional RI-ISI Methodology Applications

The risk-information requirements contained in Criterion 1-4 are based on an understanding of the importance of these systems / subsystems from a pressure boundary perspective with a focus on prevention. Criterion 5 included to capture plant-specific outliers important to safety.

HSS Components
1 Class 1 portions of the RCPB
2 Class 1 and 2 portions of systems located in the normal shutdown cooling flowpath
3 Class 2 portions of PWR main feedwater systems
4 Break Exclusion Region piping in high energy piping systems
5 CDF > 1E-06 or LERF > 1E-07

Consequence of Failure Evaluation portion of EPRI TR-112657 used for the RI-categorization of pressure boundary components

Continued on Slide 2 of 2

Evolution of EPRI RI-technology to Pressure Boundary Components

Project ongoing for Enhanced RI Passive Categorization Methodology

- *The risk-information requirements contained in Criterion 1-4 are identical to Code Case N-716 and are based on an understanding of the importance of these systems / subsystems from a pressure boundary perspective with a focus on prevention*
- *The risk-information requirements contained in Criterion 5-10 are added to address the expanded scope of this approach and are based on an understanding of the importance of these systems / subsystems from a pressure boundary perspective with a focus on a combination of prevention and mitigation*

CoF Evaluation portion of EPRI TR-112657

Continued from Slide 1 of 2

ANO2-R&R-004, Revision 1
Request to use Risk-Informed Safety Classification and Treatment for R/R Activities in Class 2 and 3 Moderate and High Energy Systems
SE dated April 22, 2009
ML090930246
RI-categorization process used for pressure boundary components in all 10CFR50.69 applications to date

VEGP – 10CFR50.69 Pilot Study
Vogtle Electric Generating Plant, Units 1 and 2 – Issuance of Amendments Re: Use of 10CFR50.69
SE dated December 17, 2014
ML14237A034
Uses the ANO2-R&R-004, Revision 1 passive categorization method to assess passive component failure risk

50 units have received approval to implement 50.69 using the ANO-2 RI-categorization method for PBCs

ASME Code Case N-752
EPRI RI-RRA Methodology
Risk Informed Categorization and Treatment for R/R Activities in Class 2 and 3 Systems
issued July 23, 2019
Uses the ANO-2 RI-categorization method for PBCs that is identical to ANO2-R&R-004, Revision 1

ANO-1/ANO-2 – RI-RRA Pilot Study
Relief Request No. EN-20-RR-001
Alternative to Use ASME Code Case N-752, Risk-Informed Categorization and Treatment for R/R Activities in Class 2 and 3 Systems
SE dated May 19, 2021
ML21118B039

Oconee approved to implement Code Case N-752 December 13, 2023 ML23262A967

EPRI Technical Report 3002025288
Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components
Final Report, June 2023
This new approach requires a full plant evaluation — that is, all safety-related and non-safety-related PBCs will be determined to be HSS or LSS

- *Criterion 11 is identical to that contained in Code Case N-716*
- *Similar to Criterion 11, Criterion 12 and Criterion 13 were added to provide additional means of ensuring that any plant-specific locations that are important to safety are identified*

Phase 1 → Prerequisites
- PREQ 1 – PRA Technical Adequacy
- PREQ 2a – Localized Corrosion Program
- PREQ 2b – FAC Program
- PREQ 2c – Erosion Program
- PREQ 3 – Protective Measures for IF events
- PREQ 4 – Reflects as-built/as-operated plant

Each of the above prerequisites must be met before proceeding to Phase 2

Phase 2 → Predetermined HSS Passive SSCs
- Criterion 1 – Class 1 portions of the RCPB
- Criterion 2 – Shutdown Cooling Function
- Criterion 3 – PWR Main Feedwater
- Criterion 4 – Break Exclusion Region
- Criterion 5 – Ultimate Heat Sink
- Criterion 6 – ECCS Inventory
- Criterion 7 – Condensate Storage Tank
- Criterion 8 – Component Cooling Water
- Criterion 9 – Heat Exchangers – Bypass
- Criterion 10 – Heat Exchangers – Others

*All components meeting any of these ten risk-informed criteria **must be assigned HSS***

Phase 3 → Design & Plant Specific
- Criterion 11 – CDF > 1E-06 or LERF > 1E-07
- Criterion 12 – CDF * CCDP > 1E-08
- Criterion 13 – LERF * CLERP > 1E-09

*All components exceeding criteria 11, 12 or 13 **must be assigned HSS***

Phase 4 → 10CFR50.69(c)(iv)
- Plant-specific sensitivity study conducted for candidate LSS components with failure rates increased by a factor of 3
- Results are compared to the quantitative acceptance guidelines of RG 1.174

Any components exceeding Reg Guide 1.174 acceptance criteria must be presented to IDP

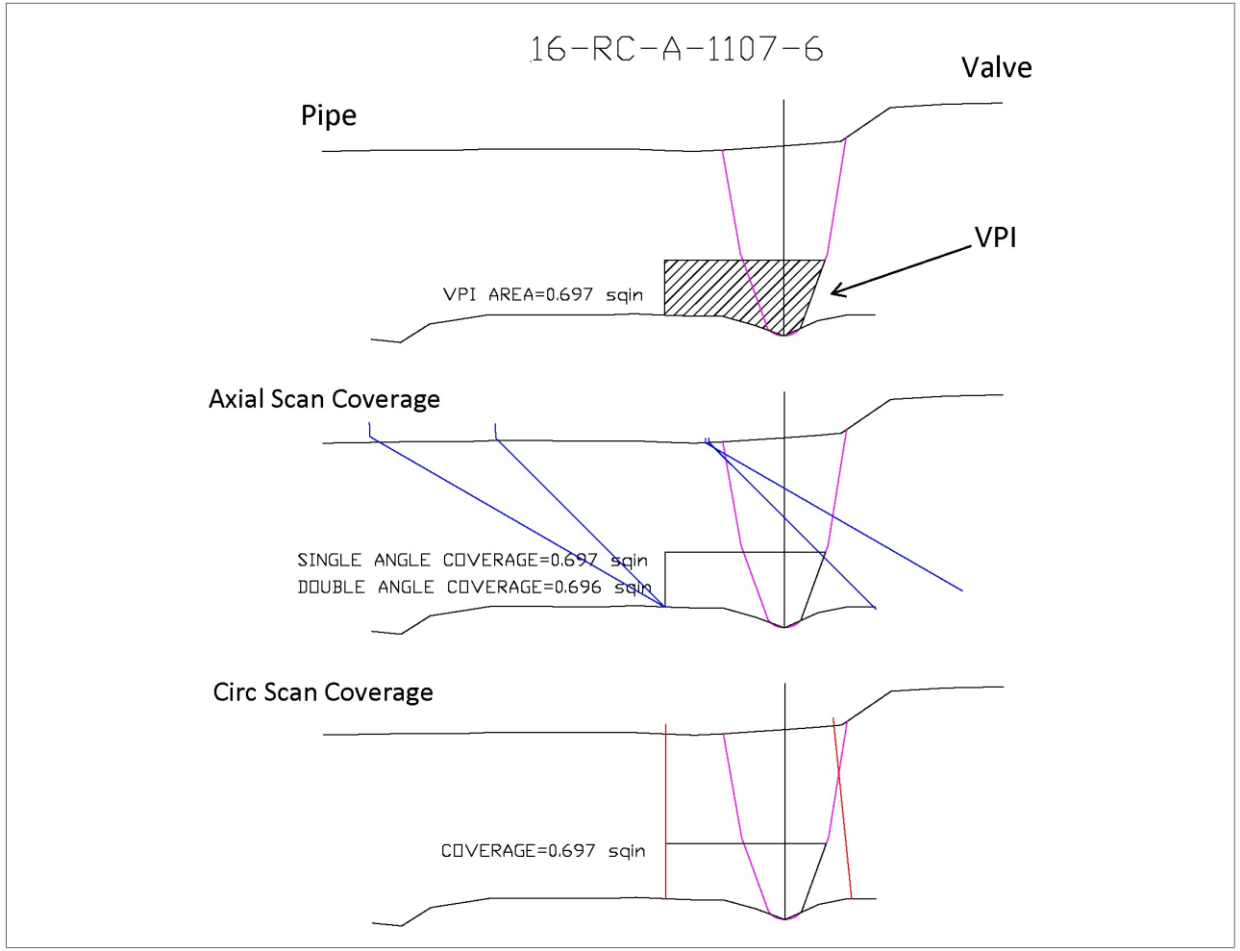
Phase 5 → Performance Monitoring
- Implement Alternate Treatment Strategy for LSS components

Confirm that alternative treatments provide reasonable confidence that the component will continue to fulfill its design basis functions under design basis conditions throughout its service life

Application of Alternative Examination Coverage Requirements

- This methodology provides an alternative approach to determining the acceptability of examination coverage
  - Did examination coverage capture the Volume of Primary Interest (VPI)?
- The VPI is defined for each degradation mechanism (DM), depending upon the individual component configuration
  - Successful examination coverage of the VPI will ensure detection of the DMs
  - Relief not required if the VPI is examined essentially 100%

DMs Identified	Process Decision Points	Volume Of Primary Interest	Axial Scan	Circ Scan
TASCS	c(no)→ e(yes)→ f→ h	weld, pipe side heat affected zone and pipe side counterbore transition located within ½" of the weld fusion line	100%	100%



Coverage Estimation Tool

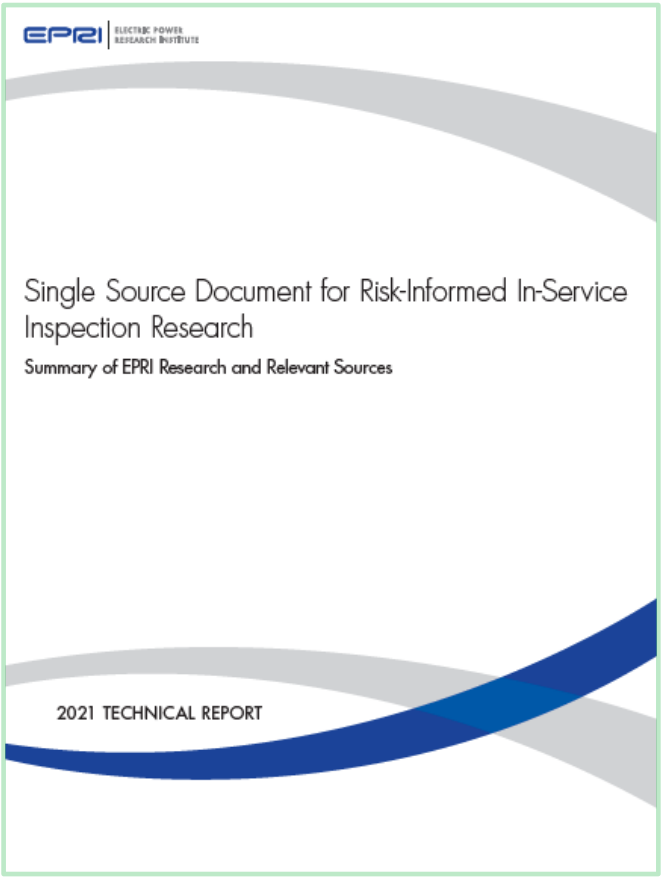
- To increase efficiency and reduce potential errors, EPRI members have asked us to develop a digital tool to aide in evaluating UT coverage
- A successful tool should exhibit the following features:
  - Easily import component geometry from T&C plots
  - Intuitive definition of the inspection volume and ultrasonic scan plan
  - Versatile enough to allow even complex components to be represented
  - Fast and interactive feedback to allow error-free input of the required parameters
  - Clearly indicated and interpretable coverage results
- This will be a web-based tool that will allow results to be saved locally to a computer

Coverage Estimation Tool (continued)

- Project Schedule
  - Pre-release version of the final tool was delivered in November 2024
  - The pre-release version is currently under going testing and validation until Q2 2025
  - Expected to migrate the final Coverage Estimation Tool and users guide from the test environment onto an EPRI website in **Q3/Q4 of 2025**

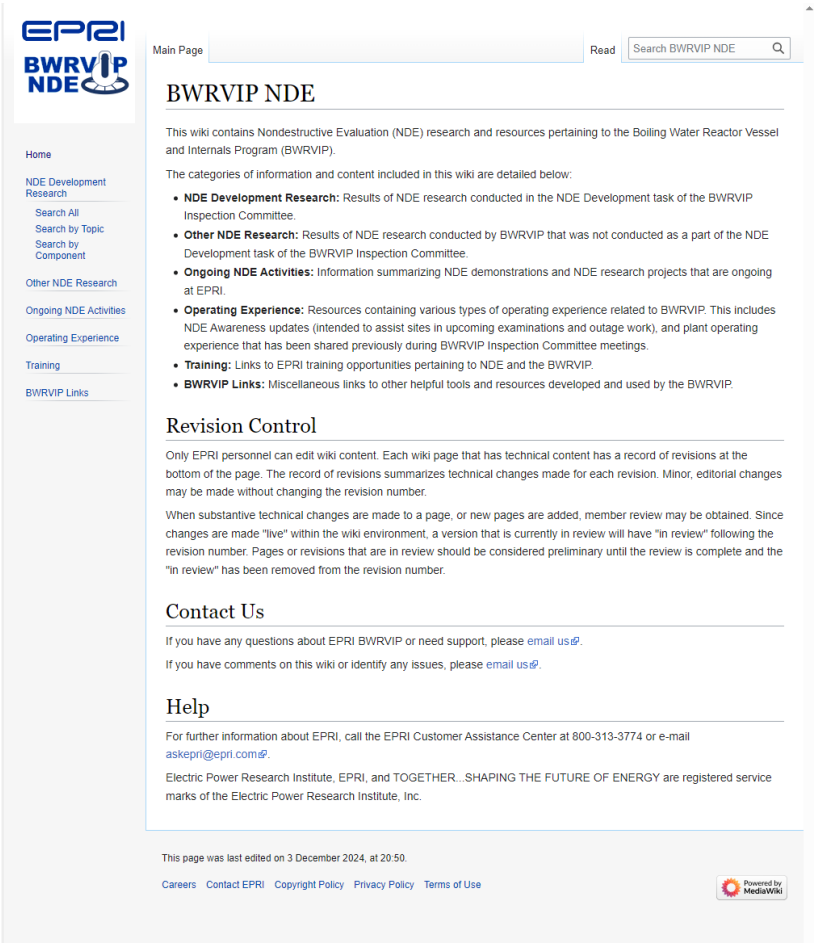
Single Source Risk-Informed In-Service Inspection Report

- Provides a single source document for applicable RI-ISI research results
  - Provides users with a description of all reports within the RI-ISI research portfolio
  - Report published in 2021 (3002021010)
- Updates to this report are expected to be published in **Q4 2025**



Risk-Informed In-Service Inspection – Wiki Page

- This Risk Informed ISI will be one of the pilot applications for the EPRI NDE Subject Area Wiki-pages
  - Modeled using the existing BWRVIP Wiki-page
    - Will provide similar information to the single source RI-ISI report
    - Allows EPRI Staff to update content more frequently
    - EPRI Members will be able to access source reports directly from the Wiki-page using hyper links
    - Expected to be available in **2025**



New and Future Projects

- Degradation Mechanism (DM) Assessment CBT and Documentation Tool – **Ongoing**
  - Historic context for each step in the DM assessment process
  - Applicable EPRI and industry guideline documents
  - Examples of completed DM assessments
  - Intuitive, menu-driven forms to collect, evaluate, and organize data for DM assessments
- Consequence of Failure (CoF) Evaluation CBT and Documentation Tool – **Starts in 2025**
  - Historic context of each step in the CoF evaluation process
  - Applicable EPRI and industry guideline documents
  - Examples of completed CoF evaluations
  - Intuitive, menu-driven forms to collect, evaluate, and organize data for CoF evaluations

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