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Overview of the EPRI RI-ISI Methodologies

Contents

- Background
- Status
- EPRI Traditional RI-ISI Methodology
- EPRI Streamlined RI-ISI Methodology

Background

- ASME Section XI Inservice Inspection Programs mandated by 10CFR50.55
  - Class 1 & 2: piping NDE requirements
  - Class 3: pressure/leak testing only
  - Class 4: no requirements
- Augmented Programs
  - IGSCC (Generic Letter 88-01)
  - FAC (Generic Letter 89-08)
  - MIC (Generic Letter 89-13)
- Other National C&Ss
  - CSA N285.4
  - NE-14
  - SKIFs
  - STUK (YVL 2.8, YVL 3.8)
  - VVERs

Background

Deterministic ISI rules provide for an adequate level of health and safety

In contrast, RI-ISI additionally provides for:

- Maintaining and/or improving plant safety
- Identifying significant locations / components for inspection
- Developing an "informed and plant-specific" basis for inspections
- Reduction in worker exposure
- Reduction in low value added inspections
- Reduction in outage complexity / duration

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Background cont.

- Inservice failures (cracks, leaks, or breaks) are caused by corrosion or fatigue
    - Thermal Fatigue (Thermal Transient & TASCS)
    - Stress Corrosion Cracking (IGSCC, TGSCC, PWSCC, ECSCC)
    - Localized Corrosion (MIC, Pitting, Crevice Corrosion.)
    - Flow Sensitive Attack (FAC, Erosion/Cavitation)
    - High Cycle Mechanical Vibration Fatigue

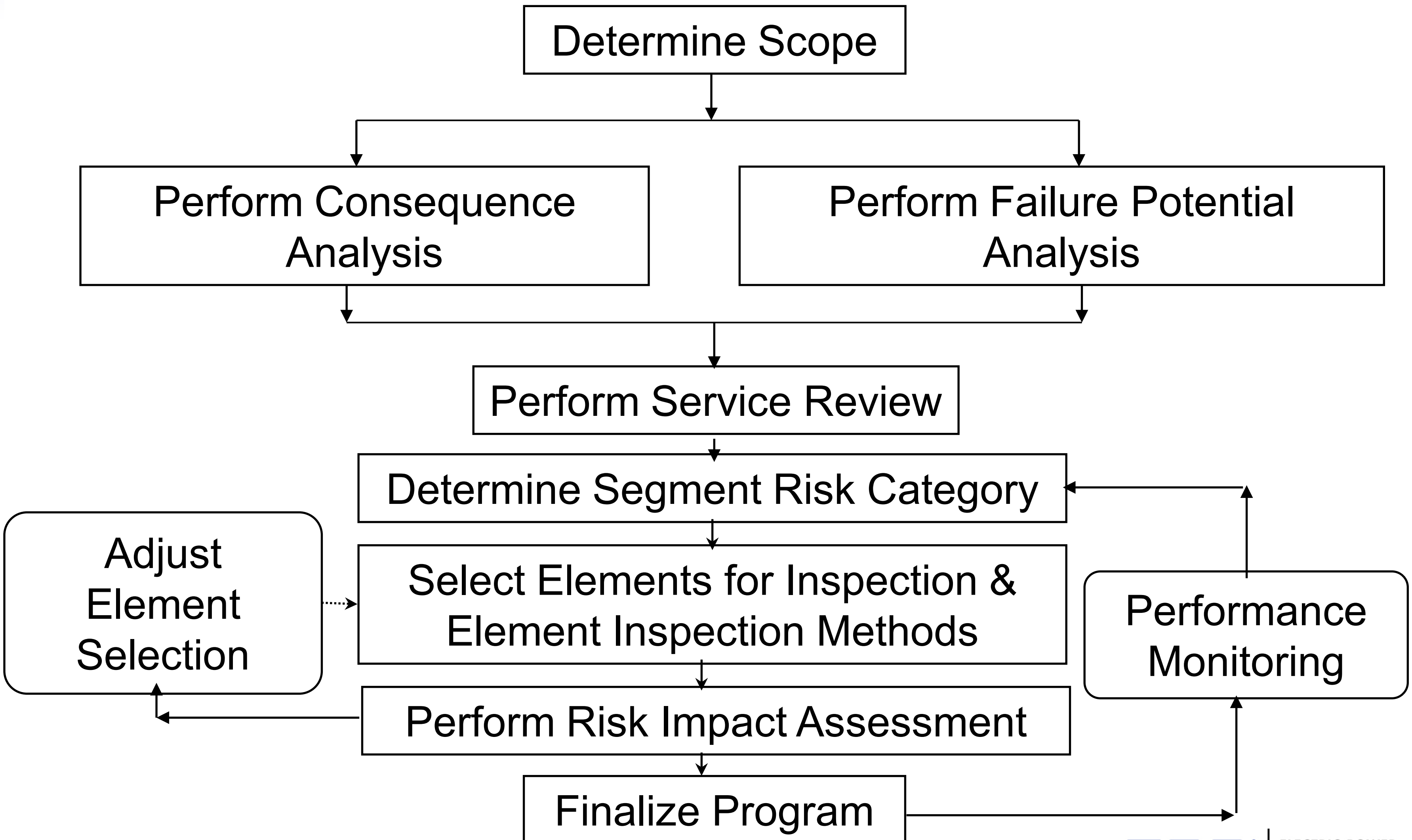
- Failures do not correlate with stress or fatigue usage factor values contained in Design Stress Reports
    - Deterministic ISI program focus on high stress / fatigue usage sites

- Failures do not always occur in welds

EPRI Traditional RI-ISI Methodology

- EPRI TR-112657, Rev B-A
- 1st RI-ISI Pilot Plant Approval - 1998
- Topical approved 1999
- Allows partial and full scope application
- Applications and pilot plants at over 75 units (domestic and international)
- BWRs (ASEA Atom, GE), PWRs (B&W, CE, West. & VVER) and CANDUs

EPRI Traditional RI-ISI Methodology



RISK EVALUATION

Consequence Evaluation

Failure Potential Assessment *(Degradation Mechanism)*

DEGRADATION CATEGORY Pipe Rupture Potential	CONSEQUENCE CATEGORY CCDP and CLERP Potential: NONE	LOW	MEDIUM	HIGH
HIGH	LOW (Cat. 7)	MEDIUM (Cat. 5)	HIGH (Cat. 3)	HIGH (Cat. 1)
MEDIUM	LOW (Cat. 7)	LOW (Cat. 6)	MEDIUM (Cat. 5)	HIGH (Cat. 2)
LOW	LOW (Cat. 7)	LOW (Cat. 7)	LOW (Cat. 6)	MEDIUM (Cat. 4)

Risk Matrix Concept

RISK = (Core Melt Potential/Pipe Rupture) vs. (Potential for Pipe Rupture)

- Core Melt Potential
  - PSA & Deterministic
  - Impact Groups
    - Initiating Event
    - Degraded Containment
    - Degraded System/Train
    - Combination
  - Consequence Ranking
    - HIGH
    - MEDIUM
    - LOW
- Potential for Pipe Rupture
  - Degradation Mechanisms
  - Service Experience
  - Rupture Potential Ranking
    - HIGH
    - MEDIUM
    - LOW

Consequence Assessment

- Goal
  - To assign a consequence rank to each location within the piping system.
- Parameters
  - Break size (small, large, worst case)
  - Isolability of the break (success and failure)
  - Direct effects (flow diversion)
  - Indirect effects (spatial, inventory loss)
  - Containment performance
  - Recovery

Consequence Assessment (cont.)

- Consequence Evaluation consists of four major steps:

  1. Plant PSA models, systems, and initiators are evaluated. The initial consequence rank is established based on the PBFs impact on CDF, by estimating CCDP values.

  2. Containment performance is evaluated. The consequence rank is reviewed and adjusted to reflect the PBFs impact on LERF, by estimating CLERP values, or by evaluating the likelihood of containment bypass.

Consequence Assessment (cont.)

3. Shutdown operation is evaluated. The consequence rank is reviewed and adjusted to reflect the PBFs impact on the plant operation during shutdown.

4. External events are evaluated. The consequence rank is reviewed and adjusted to reflect the PBFs impact on the mitigation of external events.

Consequence Considerations

- Initiating events
- Mitigating ability
  - Loss of system(s) or train(s)
  - Degradation of system(s) or train(s)
- Containment effects
  - Loss of containment integrity
  - Degradation of containment integrity
- Combination event

Consequences Ranking Numerical Criteria

Consequence Category	Corresponding CCDP Range	Corresponding CLERP Range
High	CCDP > 1E-4	CLERP > 1E-5
Medium	1E-6 < CCDP ≤ 1E-4	1E-7 < CLERP ≤ 1E-5
Low	CCDP ≤ 1E-6	CLERP ≤ 1E-7

BWR Initiating Events

Initiating Event (IE)	IE Freq.	CDF	CCDP	Rank
Transient	1.5	4.9E-7	3.3E-7	Low
MSIV Closure	0.3	7.0E-7	2.3E-6	Medium
TFWMS	0.1	6.3E-7	6.3E-6	Medium
SLOCA	1.0E-2	1.3E-8	1.3E-6	Medium
MLOCA	3.0E-4	2.5E-8	8.4E-5	Medium
LLOCA	1.0E-4	6.2E-8	6.2E-4	High
IORV	5.6E-3	1.5E-7	2.7E-5	Medium
ISLOCA	1.1E-9	1.1E-9	1.0	High
LOCA-OC	2.5E-7	3.4E-10	1.4E-3	High

PWR Initiating Events

Initiating Event (IE)	IE Freq.	CDF	CCDP	Rank
Rx Trip	3.0	5.3E-7	1.8E-7	Low
AMSIVs	2.4E-2	4.9E-9	2.0E-7	Low
TFWMS	1.4E-1	3.0E-8	2.2E-7	Low
SLOCA	7.5E-3	4.3E-7	5.8E-5	Medium
MLOCA	6.6E-4	2.7E-7	4.1E-4	High
LLOCA	2.9E-4	1.7E-7	5.9E-4	High
MSRV	5.0E-3	3.6E-9	7.2E-7	Low
SLBI	6.6E-4	1.8E-8	2.7E-5	Medium
ISLOCA	3.0E-8	2.3E-8	7.5E-1	High

Look-Up Table for Mitigative Systems

Affected Systems		Number of Unaffected Backup Trains							
Frequency of Challenge	Exposure Time to Challenge	0.0	0.5	1.0	1.5	2.0	2.5	3.0	>=3.5
Anticipated (DB Cat II)	All Year	HIGH	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	LOW*	LOW
	Between tests (1-3 months)	HIGH	HIGH	HIGH	MEDIUM*	MEDIUM	LOW*	LOW	LOW
	Long AOT (<=1 week)	HIGH	HIGH	MEDIUM*	MEDIUM	LOW*	LOW	LOW	LOW
	Short AOT (<=1 day)	HIGH	MEDIUM*	MEDIUM	LOW*	LOW	LOW	LOW	LOW
Infrequent (DB Cat. III)	All Year	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	LOW*	LOW	LOW
	Between tests (1-3 months)	HIGH	HIGH	MEDIUM*	MEDIUM	LOW*	LOW	LOW	LOW
	Long AOT (<=1 week)	HIGH	MEDIUM*	MEDIUM	LOW*	LOW	LOW	LOW	LOW
	Short AOT (<=1 day)	HIGH	MEDIUM	LOW*	LOW	LOW	LOW	LOW	LOW
Unexpected (DB Cat. IV)	All Year	HIGH	HIGH	MEDIUM	MEDIUM	LOW*	LOW	LOW	LOW
	Between tests (1-3 months)	HIGH	MEDIUM	MEDIUM	LOW*	LOW	LOW	LOW	LOW
	Long AOT (<=1 week)	HIGH	MEDIUM	LOW*	LOW	LOW	LOW	LOW	LOW
	Short AOT (<=1 day)	HIGH	LOW*	LOW	LOW	LOW	LOW	LOW	LOW

Quantitative Basis for Look-Up Table

Affected Systems		Number of Unaffected Backup Trains							
Frequency of Challenge	Exposure Time to Challenge	0.0	0.5	1.0	1.5	2.0	2.5	3.0	>=3.5
Anticipated (DB Cat. II)	All Year	3.2E-01	3.2E-02	3.2E-03	3.2E-04	3.2E-05*	3.2E-06	3.2E-07*	3.2E-08
	Between tests (1-3 months)	7.9E-02	7.9E-03	7.9E-04	7.9E-05*	7.9E-06	7.9E-07*	7.9E-08	7.9E-09
	Long AOT (<=1 week)	6.1E-03	6.1E-04	6.1E-05*	6.1E-06	6.1E-07*	6.1E-08	6.1E-09	6.1E-10
	Short AOT (<=1 day)	8.7E-04	8.7E-05*	8.7E-06	8.7E-07*	8.7E-08	8.7E-09	8.7E-10	8.7E-11
Infrequent (DB Cat. III)	All Year	3.2E-02	3.2E-03	3.2E-04	3.2E-05*	3.2E-06	3.2E-07*	3.2E-08	3.2E-09
	Between tests (1-3 months)	7.9E-03	7.9E-04	7.9E-05*	7.9E-06	7.9E-07*	7.9E-08	7.9E-09	7.9E-10
	Long AOT (<=1 week)	6.1E-04	6.1E-05*	6.1E-06	6.1E-07*	6.1E-08	6.1E-09	6.1E-10	6.1E-11
	Short AOT (<=1 day)	8.7E-05	8.7E-06	8.7E-07*	8.7E-08	8.7E-09	8.7E-10	8.7E-11	8.7E-12
Unexpected (DB Cat. IV)	All Year	3.2E-03	3.2E-04	3.2E-05*	3.2E-06	3.2E-07*	3.2E-08	3.2E-09	3.2E-10
	Between tests (1-3 months)	7.9E-04	7.9E-05*	7.9E-06	7.9E-07*	7.9E-08	7.9E-09	7.9E-10	7.9E-11
	Long AOT (<=1 week)	6.1E-05	6.1E-06	6.1E-07*	6.1E-08	6.1E-09	6.1E-10	6.1E-11	6.1E-12
	Short AOT (<=1 day)	8.7E-06	8.7E-07*	8.7E-08	8.7E-09	8.7E-10	8.7E-11	8.7E-12	8.7E-13

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BWR Trainworths

System/Function	Unavail.	Equivalent Trainworth
control rod insertion	1.0E-5	2.5
torus cooling (1 RHR)	1.0E-2	1.0
torus cooling (2 RHR)	5.5E-4	1.5
containment vent	1.5E-3	1.5
alternate injection (1 train)	1.0E-2	1.0
alternate injection (2 trains)	9.9E-5	2.0
HPCI	8.8E-2	0.5
RCIC	1.1E-1	0.5

Containment Bypass

Remaining Protection Against Containment Bypass	Consequence Category
1 Active[1]	HIGH
1 Passive[2]	HIGH
2 Active	MEDIUM
1 Active, 1 Passive	MEDIUM
2 Passive	LOW
More than 2	NONE
Note 1 - An Active Protection is presented by a valve which needs to close on demand Note 2 - A Passive Protection is presented by a valve which needs to remain closed.	

RISK EVALUATION

Consequence Evaluation

Failure Potential Assessment *(Degradation Mechanism)*

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HIGH	LOW (Cat. 7)	MEDIUM (Cat. 5)	HIGH (Cat. 3)	HIGH (Cat. 1)
MEDIUM	LOW (Cat. 7)	LOW (Cat. 6)	MEDIUM (Cat. 5)	HIGH (Cat. 2)
LOW	LOW (Cat. 7)	LOW (Cat. 7)	LOW (Cat. 6)	MEDIUM (Cat. 4)

Degradation Mechanism Category

Large Pipe Break Potential	Leak Conditions	Degradation Mechanism
HIGH	Large	Flow Accelerated Corrosion (FAC)
MEDIUM	Small	Thermal Fatigue Stress Corrosion Cracking (IGSCC, TGSCC,PWSCC, ECSCC) Localized Corrosion (MIC, Pitting, Crevice Corrosion) Erosion/Cavitation
LOW	None	No Degradation Mechanisms

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DM Attributes & Susceptible Regions

Degradation Mechanism		*Criteria*	*Susceptible Regions*
TF	***TASCS***	*– nps > 1 inch (DN25), and* *– pipe segment has a slope < 45° from horizontal (includes elbow or tee into a vertical pipe), and* *– potential exists for low flow in a pipe section connected to a component allowing mixing of hot and cold fluids, or* *potential exists for leakage flow past a valve (i.e., in-leakage, out-leakage, cross-leakage) allowing mixing of hot and cold fluids, or* *potential exists for convection heating in dead-ended pipe sections connected to a source of hot fluid, or* *potential exists for two phase (steam / water) flow, or* *potential exists for turbulent penetration in branch pipe connected to header piping containing hot fluid with high turbulent flow, and* *– calculated or measured $\Delta T > 50°F$ (28C), and* *– Richardson number > 4.0*	*nozzles, branch pipe connections, safe ends, welds, heat affected zones (HAZ), base metal, and regions of stress concentration*
	TT	*– operating temperature > 270°F (132C) for stainless steel, or* *operating temperature > 220°F (104C) for carbon steel, and* *– potential for relatively rapid temperature changes including* *cold fluid injection into hot pipe segment, or* *hot fluid injection into cold pipe segment, and* *– $\lvert \Delta T \rvert$ > 200°F (111C) for stainless steel, or* *$\lvert \Delta T \rvert$ > 150°F(84C) for carbon steel, or* *$\lvert \Delta T \rvert$ > ΔT allowable (applicable to both stainless and carbon)*	

DM Attributes & Susceptible Regions (cont'd)

SCC	***IGSCC (BWR)***	*–evaluated in accordance with existing plant IGSCC program per NRC Generic Letter 88-01*	*austenitic stainless steel welds and HAZ*
	IGSCC (PWR)	*–operating temperature > 200°F (93C), and* *–susceptible material (carbon content ≥ 0.035%), and* *–tensile stress (including residual stress) is present, and* *–oxygen or oxidizing species are present* *OR* *–operating temperature < 200°F (93C), the attributes above apply, and* *–initiating contaminants (e.g., thiosulfate, fluoride, chloride) are also required to be present*	
	TGSCC	*–operating temperature > 150°F (66C), and* *–tensile stress (including residual stress) is present, and* *–halides (e.g., fluoride, chloride) are present, or caustic (NaOH) is present, and* *–oxygen or oxidizing species are present (only required to be present in conjunction w/halides, not required w/caustic)*	*austenitic stainless steel base metal, welds, and HAZ*
SCC	***ECSCC***	*–operating temperature > 150°F (66C), and* *–tensile stress is present, and* *–an outside piping surface is within five diameters of a probable leak path (e.g., valve stems) and is covered with non-metallic insulation that is not in compliance with Reg. Guide 1.36, OR an outside piping surface is exposed to wetting from chloride bearing environments (e.g., seawater, brackish water, brine)*	*austenitic stainless steel base metal, welds, and HAZ*
	PWSCC	*–piping material is Inconel (Alloy 600), and* *–exposed to primary water at T > 570°F (299C), and* *–the material is mill-annealed and cold worked, or cold worked and welded without stress relief*	*nozzles, welds, and HAZ without stress relief*

DM Attributes & Susceptible Regions (cont'd)

LC	***MIC***	*–operating temperature < 150°F (66C), and* *–low or intermittent flow, and* *–pH < 10, and* *–presence/intrusion of organic material (e.g., raw water system), or water source is not treated w/biocides (e.g., refueling water tank)*	*fittings, welds, HAZ, base metal, dissimilar metal joints (e.g., welds, flanges), and regions containing crevices*
	PIT	*–potential exists for low flow, and* *–oxygen or oxidizing species are present, and* *–initiating contaminants (e.g., fluoride, chloride) are present*	
	CC	*–crevice condition exists (e.g., thermal sleeves), and* *–operating temperature > 150°F (66C), and* *–oxygen or oxidizing species are present*	
FS	***E-C***	*–operating temperature < 250°F (121C), and* *–flow present > 100 hrs/yr, and* *–velocity > 30 ft/s, and* –$(P_d - P_v) / \Delta P < 5$	*fittings, welds, HAZ, and base metal*
	FAC	*–evaluated in accordance with existing plant FAC program*	*per plant FAC program*

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Degradation Mechanism Report

System	ISO Number	Summary Number	Component ID	ASME Item	Description	TASCS	TT	IGSCC	TGSCC	ECSCC	PWSCC	MIC	PIT	CC	EC	FAC
RC	CR3-P-SK-1AC.5	B4.5.599	RCP-1B SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.600	RCP-1C SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.601	RCP-1D SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.602	RCP-1A SEAL COOLER	B9.40	P-E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.603	RCP-1B SEAL COOLER	B9.40	P-E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.604	RCP-1C SEAL COOLER	B9.40	P-E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.605	RCP-1D SEAL COOLER	B9.40	P-E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.606	RCP-1A SEAL COOLER	B9.40	E-P	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.607	RCP-1B SEAL COOLER	B9.40	E-P	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.608	RCP-1C SEAL COOLER	B9.40	E-P	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.609	RCP-1D SEAL COOLER	B9.40	E-P	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.610	RCP-1A SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.611	RCP-1B SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.612	RCP-1C SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.5	B4.5.613	RCP-1D SEAL COOLER	B9.40	P-PU	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.8	B4.1.1	MK45 TO 9	B5.40	NOZZLE TO SAFE-END	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.8	B4.1.3	MK31 TO 32 W-X AXIS	B9.21	N-WNK	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.8	B4.1.5	MK31 TO 32 X-Y AXIS	B9.21	N-WNK	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.8	B4.1.7	MK31 TO 32 Z-W AXIS	B9.21	N-WNK	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
RC	CR3-P-SK-1AC.8	B4.1.9	MK8 TO 37	B5.40	NOZZLE TO SAFE-END	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.526	MK 64 TO 1	B9.21	N-E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.527	MK 1 TO 4	B9.21	E-P	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.528	MK 4 TO RCV-22	B9.21	P-V	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.529	RCV-22 TO MK 4	B9.21	V-P	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.530	MK 4 TO 2	B9.21	P-T	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.531	MK 2 TO 3	B9.21	T-R	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
RC	CR3-P-SK-20.1	B4.5.532	MK 2 TO RCV-23	B9.21	T-V	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

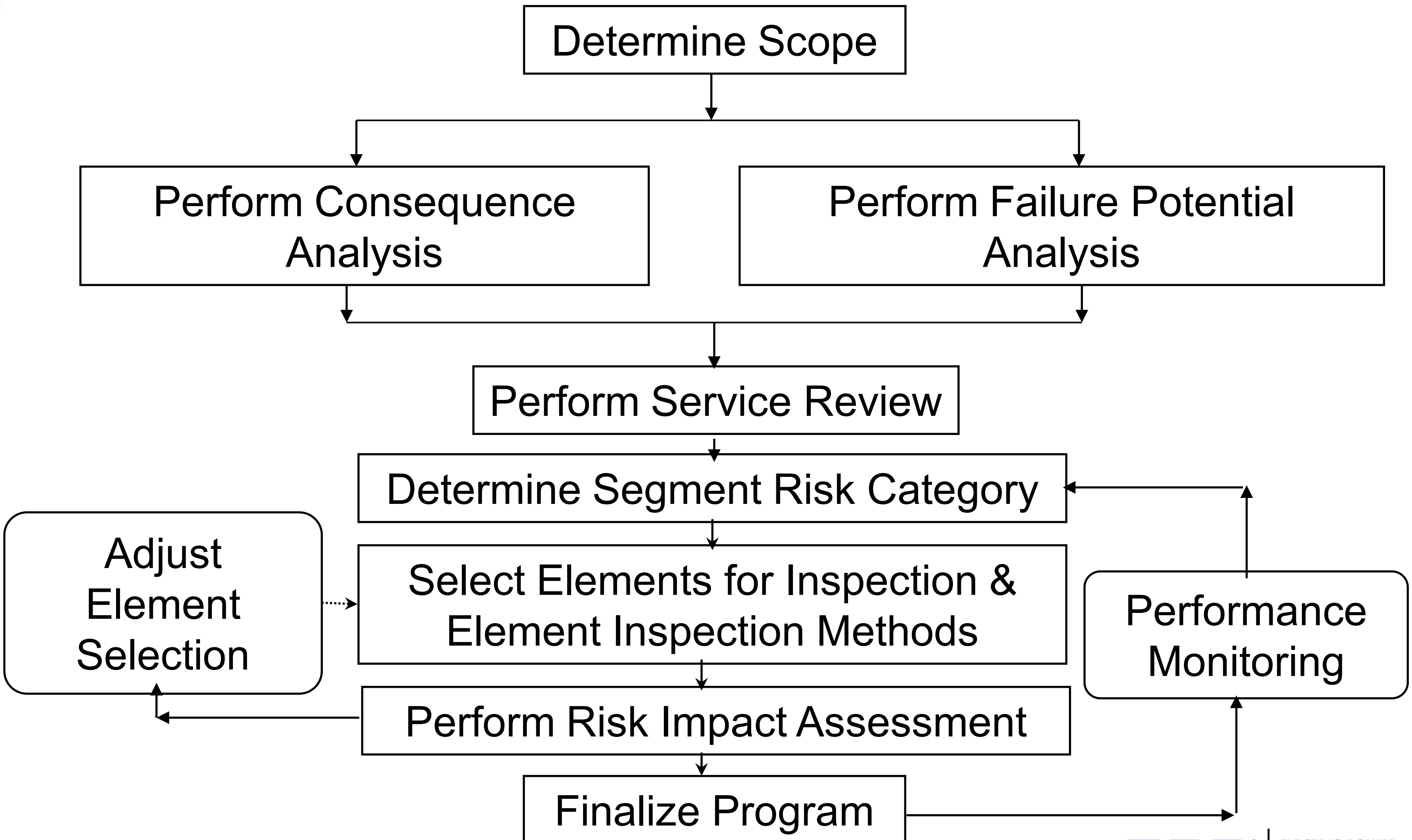
Degradation Mechanisms

TASCS - Thermal Stratification, Cycling and Striping
TT - Thermal Transients

IGSCC - Intergranular Stress Corrosion Cracking
TGSCC - Transgranular Stress Corrosion Cracking
ECSCC - External Chloride Stress Corrosion Cracking
PWSCC - Primary Water Stress Corrosion Cracking

MIC - Microbiologically Influenced Corrosion
PIT - Pitting
CC - Crevice Corrosion

EC - Erosion-Cavitation
FAC - Flow Accelerated Corrosion


Determine Scope
Perform Consequence Analysis
Perform Failure Potential Analysis
Perform Service Review
Determine Segment Risk Category
Adjust Element Selection
Select Elements for Inspection & Element Inspection Methods
Performance Monitoring
Perform Risk Impact Assessment
Finalize Program

System Risk Ranking Report

System	Risk		Consequence Rank	Failure Potential		Code Category	Weld Count	Section XI Selections		TR-112657 Selections	
	Category	Rank		DMs	Rank			Vol/Sur	Sur Only	RI-ISI	Other
01RCS	2	High	High	TASCS, TT, PWSCC	Medium	B-F	1	1	0	0	
01RCS	2	High	High	TASCS, TT	Medium	B-J	14	5	0	3	
01RCS	2	High	High	TT, PWSCC	Medium	B-F	1	1	0	1	
01RCS	2	High	High	TT	Medium	B-J	3	0	0	1	
01RCS	2	High	High	PWSCC	Medium	B-F	12	12	0	5	
01RCS	4	Medium	High	None	Low	B-F	8	8	0	0	
						B-J	200	35	11	25	
01RCS	6	Low	Medium	None	Low	B-J	9	0	5	0	
01RCS	6	Low	Low	IGSCC	Medium	C-F-1	6	0	0	0	
01RCS	6	Low	Low	ECSCC	Medium	C-F-1	1	0	0	0	
01RCS	7	Low	Low	None	Low	C-F-1	85	3	1	0	

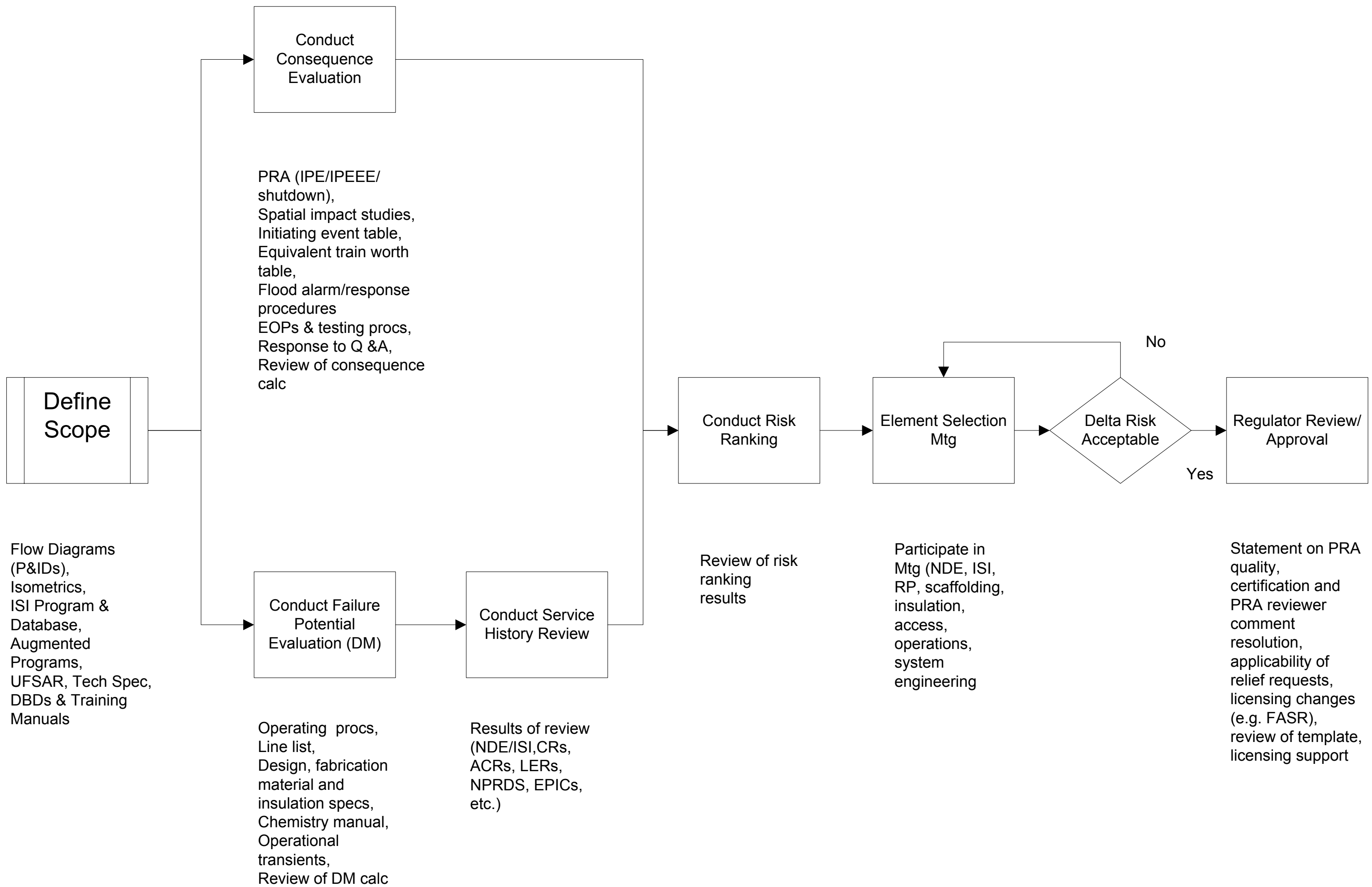
Example of Element Selection

Segment ID	ISI Drawing	Plant Drawing	Number of Welds	Lines in Segment	Welds in Segment	Degradation Mechanisms	Consequence Category	Risk Category	Risk Rank
SEG-001	A-RC-1	w 1218E54 - 1, 2	16	29-RC-1101-NSS - LOOP 1 31-RC-1102-NSS - LOOP 1 27.5-RC-1103-NSS - LOOP 1	***1***, 2, ***3***, 4, 5 1, 2, 3, 4, ***5***, 6, 7, 8, ***9*** ***1***, 3	None	HIGH	CAT4	MEDIUM
SEG-002	A-RC-1	w 1218E54 - 1, 2	2	27.5-RC-1103-NSS - LOOP 1	4, 5	TT	HIGH	CAT2	HIGH
SEG-003	A-RC-1	w 1218E54 - 1, 2	2	27.5-RC-1103-NSS - LOOP 1	6, ***7***	None	HIGH	CAT4	MEDIUM
SEG-004	A-RC-2	w 1218E54 - 1, 2	15	29-RC-1201-NSS - LOOP 2 31-RC-1202-NSS - LOOP 2 27.5-RC-1203-NSS - LOOP 2	***1***, 2, 3, 4, 5 1, 2, 3, 4, 5, 6, 7, 8, ***9*** ***1***	None	HIGH	CAT4	MEDIUM
SEG-005	A-RC-2	w 1218E54 - 1, 2	1	27.5-RC-1203-NSS - LOOP 2	3	TT	HIGH	CAT2	HIGH
SEG-006	A-RC-2	w 1218E54 - 1, 2	2	27.5-RC-1203-NSS - LOOP 2	4, ***5***	None	HIGH	CAT4	MEDIUM
SEG-007	A-RC-3	w 1218E54 - 1, 2	15	29-RC-1301-NSS - LOOP 3 31-RC-1302-NSS - LOOP 3 27.5-RC-1303-NSS - LOOP 3	***1***, 2, 3, 4, 5 1, 2, 3, 4, 5, ***6***, 7, 8, ***9*** ***1***	None	HIGH	CAT4	MEDIUM
SEG-008	A-RC-3	w 1218E54 - 1, 2	2	27.5-RC-1303-NSS - LOOP 3	***3***, 4	TT	HIGH	CAT2	HIGH
SEG-009	A-RC-3	w 1218E54 - 1, 2	2	27.5-RC-1303-NSS - LOOP 3	5, ***6***	None	HIGH	CAT4	MEDIUM
SEG-010	A-RC-4	w 1218E54 - 1, 2	1	29-RC-1401-NSS - LOOP 4	***1***	None	HIGH	CAT4	MEDIUM
SEG-011	A-RC-4	w 1218E54 - 1, 2	1	29-RC-1401-NSS - LOOP 4	***2***	TASCS,TT	HIGH	CAT2	HIGH
SEG-012	A-RC-4	w 1218E54 - 1, 2	16	29-RC-1401-NSS - LOOP 4 31-RC-1402-NSS - LOOP 4 27.5-RC-1403-NSS - LOOP 4	3, 4 1, 2, 3, 4, ***5***, 6, 7, 8, ***9*** ***1***, 3, ***4***, 5, ***6***	None	HIGH	CAT4	MEDIUM
SEG-089	A-RC-5	w 1218E54 - 1,2 (271C056)	1	16-RC-1412-NSS	***1*** Elbow between welds	TASCS,TT, PWSCC	HIGH	CAT2	HIGH
SEG-097	A-RC-6	w1721E38 - 1 thru 3	1	6-RC-1012-NSS	***1***	PWSCC	HIGH	CAT2	HIGH
SEG-098	A-RC-6	w1721E38 - 1 thru 3	5	6-RC-1012-NSS	2, ***3***, 4, 5, 6	None	HIGH	CAT4	MEDIUM

Change in Risk Assessment

- A "Delta Risk" calculation is performed to demonstrate that revision to ISI Program meets Regulatory Guide 1.174 guidelines
  - Risk decrease
  - Risk neutral
  - Insignificant risk increase
- Options available for satisfying this requirement
  - Qualitative
  - Bounding
  - Simplified
  - Complex

RI-ISI Process



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Pilot & Early Follow-on Plants

- ANO1 (Class 1)
- ANO2 (Full Scope)
- Fitzpatrick (Full Scope)
- Vermont Yankee (Class 1)
- STP 1&2 (Class 1)

ANO, Unit 1

- Class 1 systems
- NSSS - B & W
- A/E - Bechtel
- Submitted to NRC - June 1998
- RAI Response - May 1999
- USNRC Approval - August 1999

ANO, Unit 1 (cont.)

System No.	System	Safety Class
1	**Reactor Coolant (RCS)**	1
2	**Makeup and Purification (MUP) ***	1
3	**Decay Heat Removal (DHR) ****	1

* includes HPI, normal makeup and letdown
** includes LPI and core flood

ANO, Unit 2

- 10 systems including service water
- NSSS - ABB/CE
- A/E - Bechtel
- Submitted to NRC (without service water) - October 1997
- Service water submitted - April 1998
- RAI responses - November 1998
- USNRC Approval - December 1998

ANO, Unit 2 (cont.)

System No.	System	Safety Class
1	Reactor Coolant (RCS)	1
2	Chemical and Volume Control (CVCS)	1, 2
3	High Pressure Safety Injection (HPSI)	1, 2
4	Low Pressure Safety Injection (LPSI)	1, 2
5	Shutdown Cooling (SDC)	1, 2
6	Containment Spray (CS)	2
7	Main Steam (MS)	2
8	Main Feedwater (MFW)	2, NNS
9	Emergency Feedwater (EFW)	2, 3, NNS
10	Service Water (SW)	2, 3, NNS

Fitzpatrick

- 14 systems
- NSSS - GE
- A/E - S&W
- Submitted to USNRC - October, 1999
- USNRC Approval – September, 2000

Fitzpatrick, (cont.)

System No.	System	Safety Class
1	Reactor Water Recirculation (RWRS)	1
2	Main Steam (MS)	1
3	Main Feedwater (FW)	1
4	Core Spray (CS)	1, 2
5	Reactor Water Cleanup (RWCU)	1
6	Control Rod Drive (CRD)	2
7	High Pressure Coolant Injection (HPCI)	1, 2, NNS
8	Residual Heat Removal (RHR)	1, 2
9	Reactor Core Isolation Cooling (RCIC)	1, 2, 3, NNS
10	Nuclear Boiler Vessel Instrumentation (INST)	1
11	Standby Liquid Control (SLC)	1, 2
12	Fuel Pool Cooling (FPC)	3
13	Service Water & RHR Service Water (RHRSW)	3, NNS
14	Emergency Service Water (ESW)	3

Vermont Yankee

- Class 1 systems
- NSSS - GE
- A/E - Ebasco
- Submitted to NRC - August 1997
- First set of RAI responses - October 1997
- Second set of RAI responses - June 1998
- USNRC Approval - November 1998
- First USNRC Approved RI-ISI Application

Vermont Yankee (cont.)

System No.	System	Safety Class
1	Reactor Water Recirculation (RWRS)	1
2	Main Steam (MS)*	1
3	Main Feedwater (FW)	1
4	Core Spray (CS)	1
5	Reactor Water Cleanup (RWCU)	1
6	Residual Heat Removal (RHR)	1
7	Standby Liquid Control (SLC)	1

South Texas Project, Units 1 and 2

- Class 1 systems
- NSSS - West.
- A/E - B & R/Bechtel
- Submittal – December, 1999
- USNRC Approval – September, 2000

South Texas Project (cont.)

System No.	System	Safety Class
1	Reactor Coolant System (RCS)	1
2	Chemical Volume and Control (CVCS)	1
3	Safety Injection (SIS)	1
4	Resdiual Heat Removal (RHR)	1

ANO, Unit 1 - Ranking Summary

Categories

System	Total No. of Locations	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
RCS - Cold Leg	73	-	4	-	69	-	-	-
RCS - Hot Leg	26	-	1	-	25	-	-	-
RCS - Main Spray	25	-	16	-	4	5	-	-
RCS - Aux. Spray	6	-	2	-	4	-	-	-
RCS - Drain Line	37	-	7	-	-	-	30	-
RCS - Surge Line	11	-	11	-	-	-	-	-
MU&P - HPI "A"	37	-	5	-	5	3	24	-
MU&P - HPI "B"	39	-	5	-	6	4	24	-
MU&P - HPI "C"	17	-	4	-	7	3	3	-
MU&P - Makeup "D"	16	-	2	-	9	-	5	-
MU&P - Letdown	56	-	10	-	46	-	-	-
DHR - DHR/LPO/CF	36	-	11	-	2	-	23	-
DHR - Drop Line	15	-	5	-	8	-	2	-
Total:	394	0	83	0	185	15	111	0

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ANO, Unit 2 - Ranking Summary

Categories

System	Total No. of Locations	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
CSS	374	-	-	-	33	-	288	53
CVCS	184	-	10	-	83	-	81	10
EFW	652	-	-	-	-	26	276	350
HPSI	1115	-	34	-	8	27	1044	2
LPSI	374	-	11	-	187	-	176	-
MFW	65	-	-	65	-	-	-	-
MS	192	-	-	59	-	-	24	109
RCS	307	-	45	-	227	13	22	-
SW	1380	-	356	-	-	708	316	-
Total:	4643	0	456	124	538	774	2227	524

Fitzpatrick - Ranking Summary

Categories

System	Total No. of Locations	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
CRD	54	-	-	-	-	-	3	51
CS	218	-	-	-	8	33	29	148
ESW	42	-	4	-	-	38	-	-
FPC	30	-	-	-	-	-	-	30
FW	81	48	-	33	-	-	-	-
HPCI	212	-	1	2	21	17	171	-
INST	25	-	-	-	-	1	4	20
MS	144	44	-	74	6	4	16	-
RCIC	114	-	8	-	25	6	66	9
RHR	887	-	8	-	48	132	279	420
RHRSW	37	-	11	-	-	-	26	-
RWCU	36	2	-	8	12	13	1	-
RWRS	142	-	-	-	-	113	29	-
SLC	21	-	-	-	1	2	18	-
Total:	2043	94	32	117	121	359	642	678

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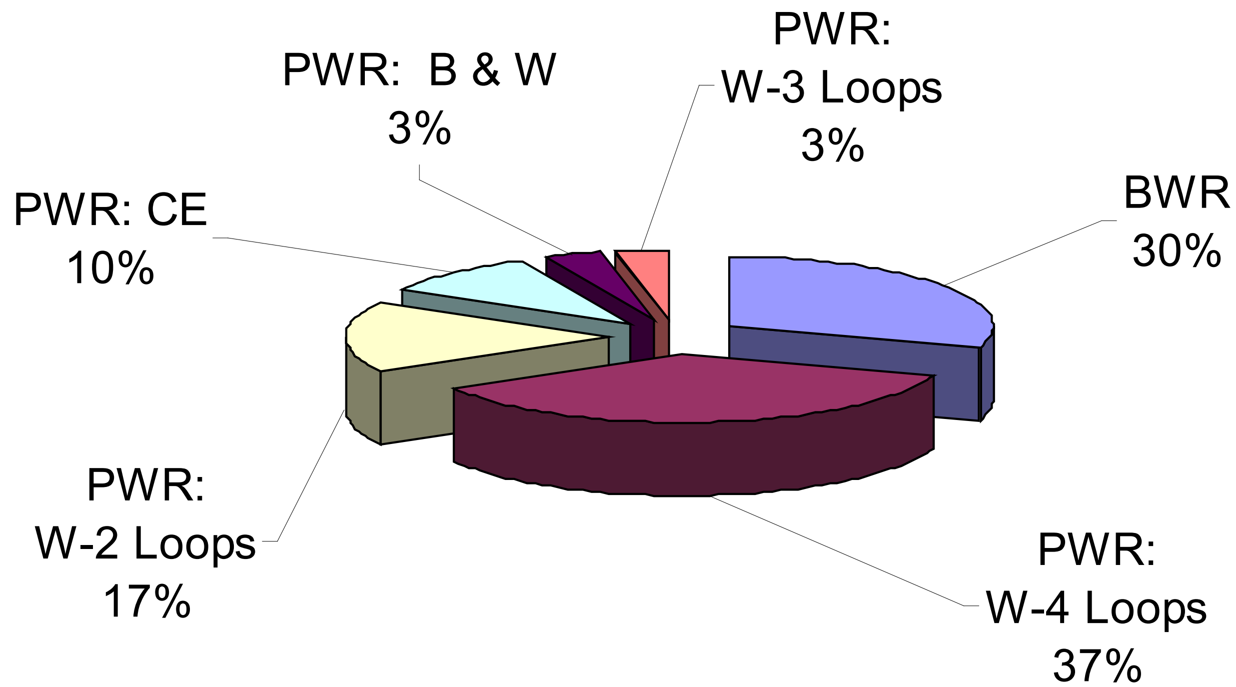
Vermont Yankee - Ranking Summary

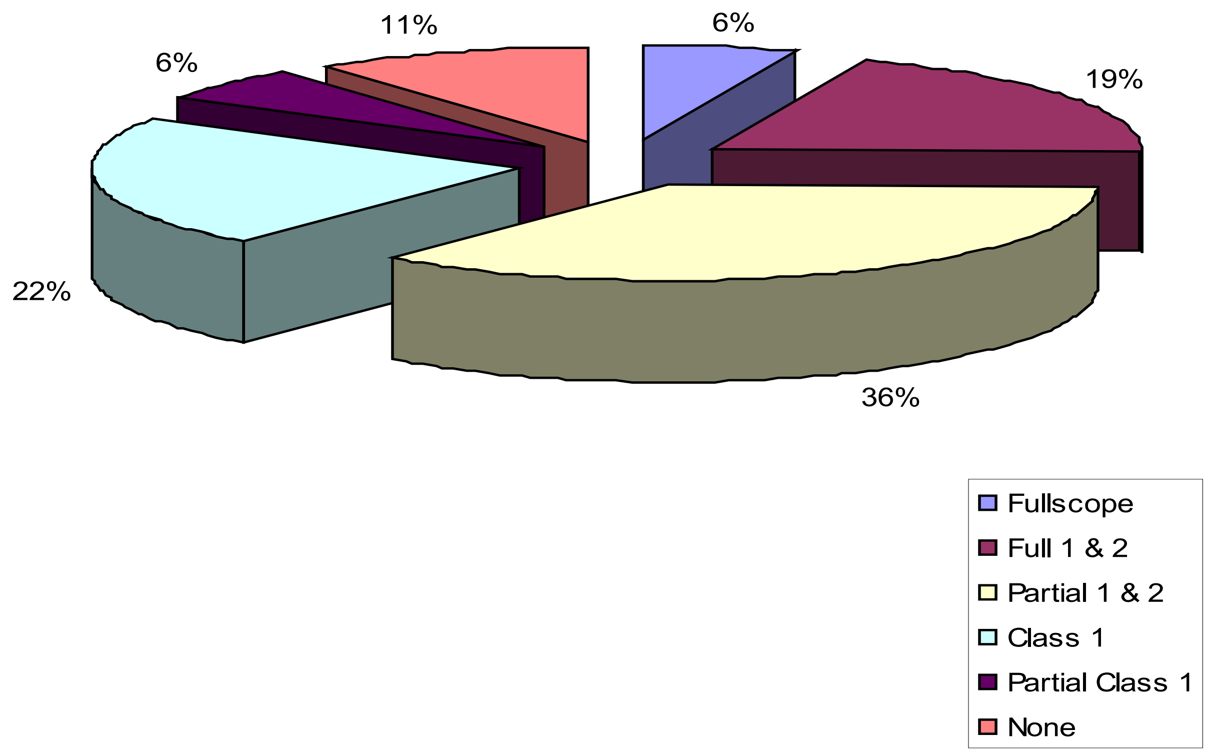
Categories

System	Total No. of Locations	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
CS	32	-	20	-	6	-	6	-
FW	69	9	24	-	34	1	1	-
HPCI	19	-	-	-	12	-	7	-
MS	117	-	-	-	105	-	12	-
MSD	62	-	-	-	-	6	56	-
RCIC	18	-	-	-	-	-	18	-
RECIRC	69	-	2	-	53	-	14	-
RHR	57	-	21	-	18	-	18	-
RWCU	22	-	-	-	2	-	20	-
Total:	465	9	67	0	230	7	152	0

Experience By Plant Type

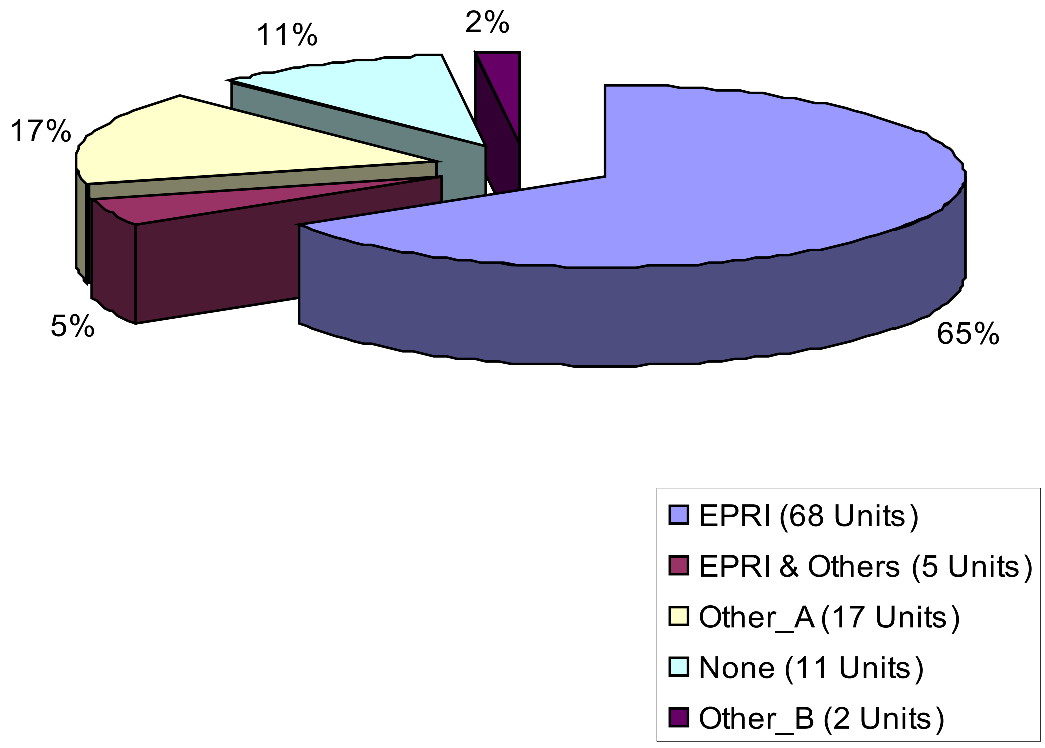


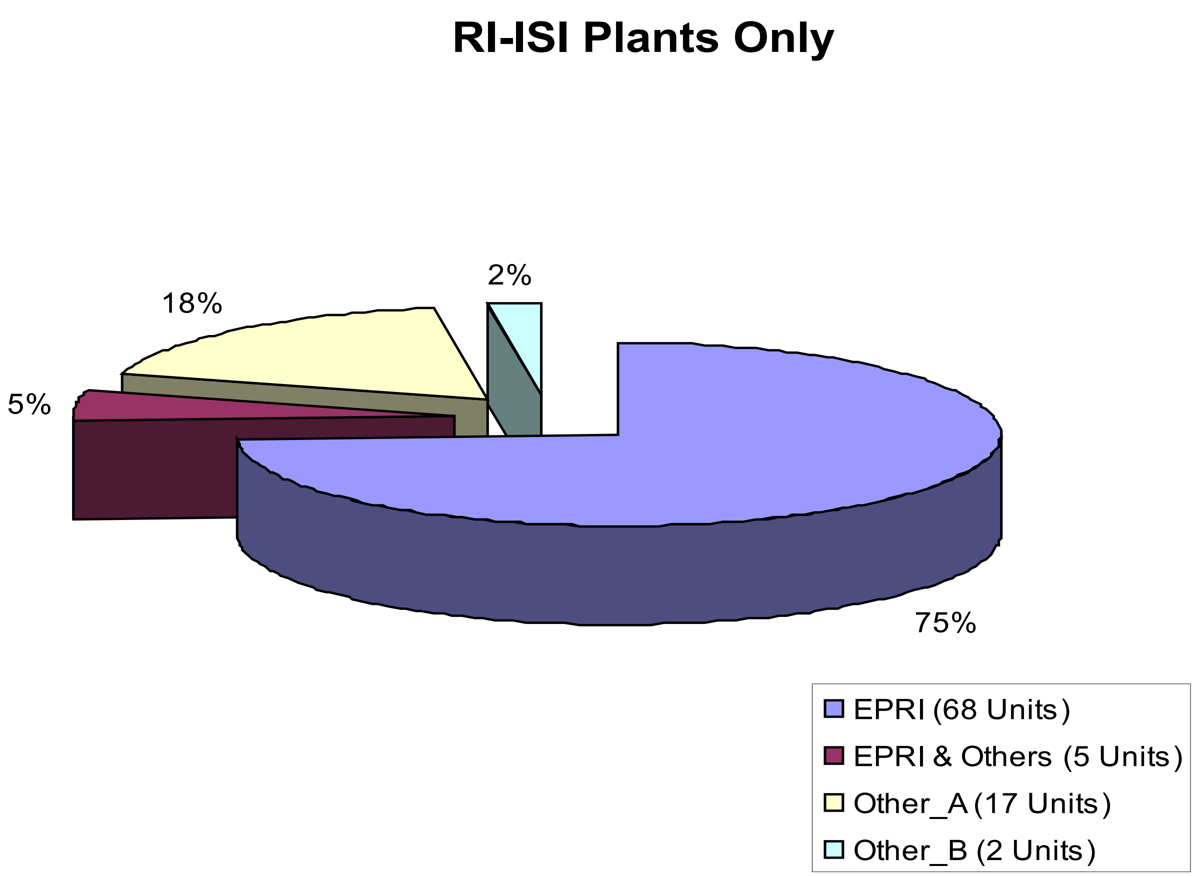
103 Plants



11%
6%
6%
19%
22%
36%
Fullscope
Full 1 & 2
Partial 1 & 2
Class 1
Partial Class 1
None

103 Plants


11%
2%
17%
5%
65%
EPRI (68 Units)
EPRI & Others (5 Units)
Other_A (17 Units)
None (11 Units)
Other_B (2 Units)


RI-ISI Plants Only
18%
2%
5%
75%
EPRI (68 Units)
EPRI & Others (5 Units)
Other_A (17 Units)
Other_B (2 Units)

RI-ISI Status - International

- IAEA Report No. NP-T-3.1 "*Risk-informed In-service Inspection of Piping Systems of Nuclear Power Plants: Process, Status, Issues and Development, 2010*

- Benchmark Study on Risk-Informed In-Service Inspection Methodologies (RISMET), Joint Report of NEA and EC-JRC, to be published in 2011

EPRI Streamlined RI-ISI Methodology

ASME CC N716 *"Risk-Informed / Safety Based ISI"* (RIS_B)

- Goal: Based upon the lessons learned from 50+ RI-ISI applications, developed a streamlined process for implementing and maintaining a RI-ISI program
- 25 units using EPRI Streamlined RI-ISI methodology
  - 6 units converting from ASME Section XI
  - 9 units converting from EPRI traditional RI-ISI methodology
  - 10 units converting from other RI-ISI methodologies
- 13 units approved by USNRC to date

EPRI Streamlined RI-ISI Methodology

- High Safety Significant (HSS)
  - Reactor Coolant Pressure Boundary (e.g. Class 1)
  - Shutdown Decay Heat Removal (out to containment isolation)
  - Break Exclusion Region (BER)
  - Main Feedwater from S/Gs to BER
  - Segments with > 1E-6 CDF (> 1E-07 LERF)

- Low Safety Significant (LSS)
  - Remaining items (i.e.
    - other Class 2,
    - all Class 3,
    - all NNS

EPRI Streamlined RI-ISI Methodology

- HSS inspection population equal to 10%, plus augmented programs
- Can not reduce inspection population below 10% of HSS
- HSS welds selected as follows:
  - A minimum of 25 percent of the population identified as susceptible to each degradation mechanism and degradation mechanism combination
  - For the RCPB, at least two thirds of the examinations shall be located between the first isolation valve (i.e., isolation valve closest to the RPV) and the reactor pressure vessel.
  - A minimum of ten percent of the welds in that portion of the RCPB that lies outside containment (e.g., portions of the main feedwater system in BWRs) shall be selected.
  - A minimum of ten percent of the welds within the break exclusion region shall be selected.

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EPRI Streamlined RI-ISI Methodology

Additional Requirements

- Risk assessment of internal flooding events (flooding, pipe whip, spray, etc.)
- Augmented inspection programs for FAC, IGSCC-BWRs and localized corrosion (HSS & LSS Systems)
- Delta risk per EPRI TR-112657

EPRI Streamlined RI-ISI Methodology

Additional Safety Improvements

- Traditional RI-ISI can be applied to a partial scope
  - Class 1 only
  - One system only
- This approach requires a cost-effective a full plant evaluation
  - Class 1, 2 , 3 and NNS
    - Improved HRA analyses
    - New / revised procedures
    - Hardware modification

Summary

- EPRI RI-ISI Methodology Approved for Generic Use by USNRC and being implemented internationally

- Specific Applications:
  - 80 percent of US industry using EPRI RI-ISI products
  - RI-ISI Efforts underway in:
    - Asia
    - Africa
    - Central Europe
    - IAEA
    - Western Europe

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