

**P30: Case Studies on the Use of PSA
for Operational Decision Making at
Exelon NPPs**

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presentation by

Eric R. Jebsen

Site Risk Management Engineer – Quad Cities

Exelon Corporation

Case Studies on the Use of PSA for Optimizing Operational Safety

OBJECTIVES

- Illustrate how the application of PSA can improve safety decisions
- Appreciate cost savings produced as illustrated by examples
 - Integrated Leak Rate Testing
 - Motor Operated Valve Risk Ranking
 - Risk-Informed ISI
 - Evaluating license conditions

Integrated Leak Rate Testing (ILRT)

- An Integrated Leak Rate Test is a test of the capability of the primary containment to withstand design pressures.
- It is performed by closing all containment penetrations, then pressurizing the containment and watching the rate of pressure decay.
- It validates the fundamental function of the primary containment.

Integrated Leak Rate Testing (ILRT)

(continued)

ILRT Extension Request

- Background
- Purpose
- Methodologies
- Assessment Approach
- Insights
- Conclusions

Integrated Leak Rate Testing (ILRT) Background

- Revisions to 10CFR50, Appendix J (Option B) allow individual plants to extend the ILRT Type A surveillance testing requirements from 3-in-10 to 1-in-10 yrs. provided previous tests were successful.
- Substantial outage time and cost savings can occur by obtaining a one-time extension of the testing requirement to 1-in-15 years.
- Approximately 10 one-time deferral requests have been granted from the NRC. Many others in progress or pending

Integrated Leak Rate Testing (ILRT)

Purpose

- Confirm conclusions from NUREG-1493.
 - Results for Grand Gulf indicate that an increase in leakage rate from 0.5% to 5% per day leads to less than 1% increase in population exposure; increase in leakage rate to 50% increases population exposure by just 3%.
 - Results for PBAPS (BWR, Mark I) even less significant.
- Provide justification to obtain a one time extension for the ILRT to 1 in 15 years.
- Apply guidance from Regulatory Guide 1.174 in evaluating the results.

Integrated Leak Rate Testing (ILRT) Methodology

- Methods were consistent with NUREG-1493 and EPRI TR-104285
 - Quantify baseline risk per EPRI Release Types
 - Develop plant-specific population dose results
 - Evaluate the risk impact of extending the ILRT interval in terms of change in dose
 - Determine the change in LERF and evaluate in accordance with Reg. Guide 1.174

Integrated Leak Rate Testing (ILRT) Approach

➤ Peach Bottom

- First BWR plant to request an ILRT extension
- Used $T_{1/2}$ assumption and information that demonstrated only 3% of ILRT tests identified leakage.
- Additionally, a three day detection and correction time was assumed for inerted BWR containments.
- Focused on potential for large isolation failures from existing full Level 2 model since leakage known not to be considerable (NUREG-1493).

Integrated Leak Rate Testing (ILRT)

Approach (continued)

- Evaluate the risk impact of extending the ILRT interval in terms of change in dose:
 - CDF does not change, only LERF and Dose are impacted.
- Determine the change in LERF and evaluate in accordance with Reg. Guide 1.174:
 - Changes in population dose and in the Conditional Containment Failure Probability (CCFP) also need to be reported.
 - Changes should be reported from current 1-in-10 to desired 1-in-15 year interval.
 - Change in LERF should be $<1E-7$, and change in Dose and CCFP need to be “small” since no specific quantitative goal exists.

Integrated Leak Rate Testing (ILRT)

Conclusions

- Consistent with the conclusions in NUREG-1493 and in EPRI TR-104285, the ILRT extension leads to a negligible increase in the calculated risk at most sites.
- Based on the application guidelines from Regulatory Guide 1.174, the ILRT extension is of very low risk significance for most sites with a calculated increase in LERF $\ll 1E-7$.
- The changes in Population Dose and CCFP are also “small”, and therefore confirms that the ILRT extension is of low risk significance.
- Substantial cost-savings can occur by obtaining a one-time extension of the testing requirement to 1-in-15 years.
 - **Peach Bottom saved 34 hours off the critical outage path, total savings was \$1.3M**

Motor Operated Valve (MOV) Risk Ranking

- Scope of MOVs defined by Generic Letter (GL) 89-10.
 - The scope of MOVs consisted of safety-related valves.
- The original intent of GL 89-10 required valve testing every 5 years.
- Application of the PSA showed many safety-related MOVs were not risk significant due to the redundancy of safety-related systems

Motor Operated Valve (MOV)

Risk Ranking *(continued)*

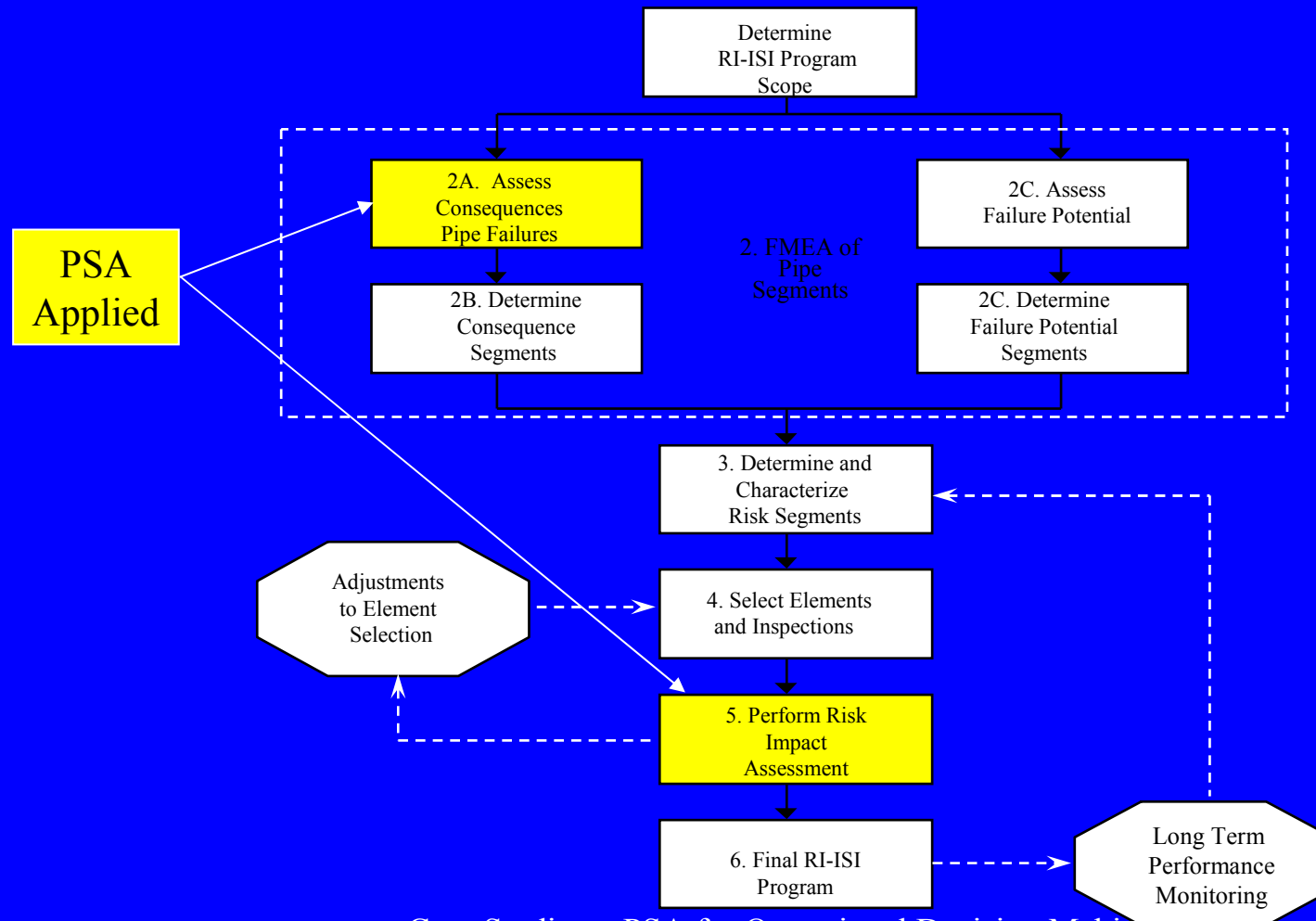
- Utilities developed risk ranking methods to demonstrate the importance of the MOVs varies, therefore the testing requirements should vary as well.
- Risk ranking methods across the industry have generally concluded that 10 to 20% of the MOVs are considered “risk significant”. These valves should be focused on more than the other MOVs within the program.
- Those MOVs considered low risk significant could have the testing requirements relaxed.

Motor Operated Valve (MOV)

Risk Ranking Results *(continued)*

- One Exelon BWR MOV program contains over 400 MOVs for a two unit site.
- Approximately 10% of the valves are considered risk significant. The combination of risk significance along with valve margin and service attributes allows a graded approach in implementing GL 89-10.
- The non-risk significant valves with greatest margin are tested at a maximum 10 year interval.
- The approach focuses on the most important set of MOVs while significantly reducing the cost of testing across the population of MOVs.

Risk-Informed In-Service Inspection



Inservice Inspection

CONSEQUENCE RANKING

- HIGH $CCDP > 10^{-4}$ or $CLERP > 10^{-5}$
 - Severe Initiating Events
 - Severe Loss of Mitigation
 - High Risk of Containment Bypass
- MEDIUM $10^{-6} < CCDP < 10^{-4}$ or $10^{-7} < CLERP < 10^{-5}$
 - Moderate Initiators
 - Moderate Loss of Mitigation
 - Moderate Risk of Containment Bypass
- LOW $CCDP < 10^{-6}$ and $CLERP < 10^{-7}$
 - Mild Initiators
 - Minimal Loss of Mitigation
 - Full Containment

Inservice Inspection

RISK MATRIX

Consequence Assessment

Failure Potential Assessment (Degradation Mechanism)

		CONSEQUENCE CATEGORY Conditional Core Melt Potential			
DEGRADATION CATEGORY Pipe Rupture Potential		LOW (Cat. 7)	MEDIUM (Cat. 5)	HIGH (Cat. 3)	HIGH (Cat. 1)
		LOW (Cat. 7)	LOW (Cat. 6)	MEDIUM (Cat. 5)	HIGH (Cat. 2)
		LOW (Cat. 7)	LOW (Cat. 7)	LOW (Cat. 6)	MEDIUM (Cat. 4)

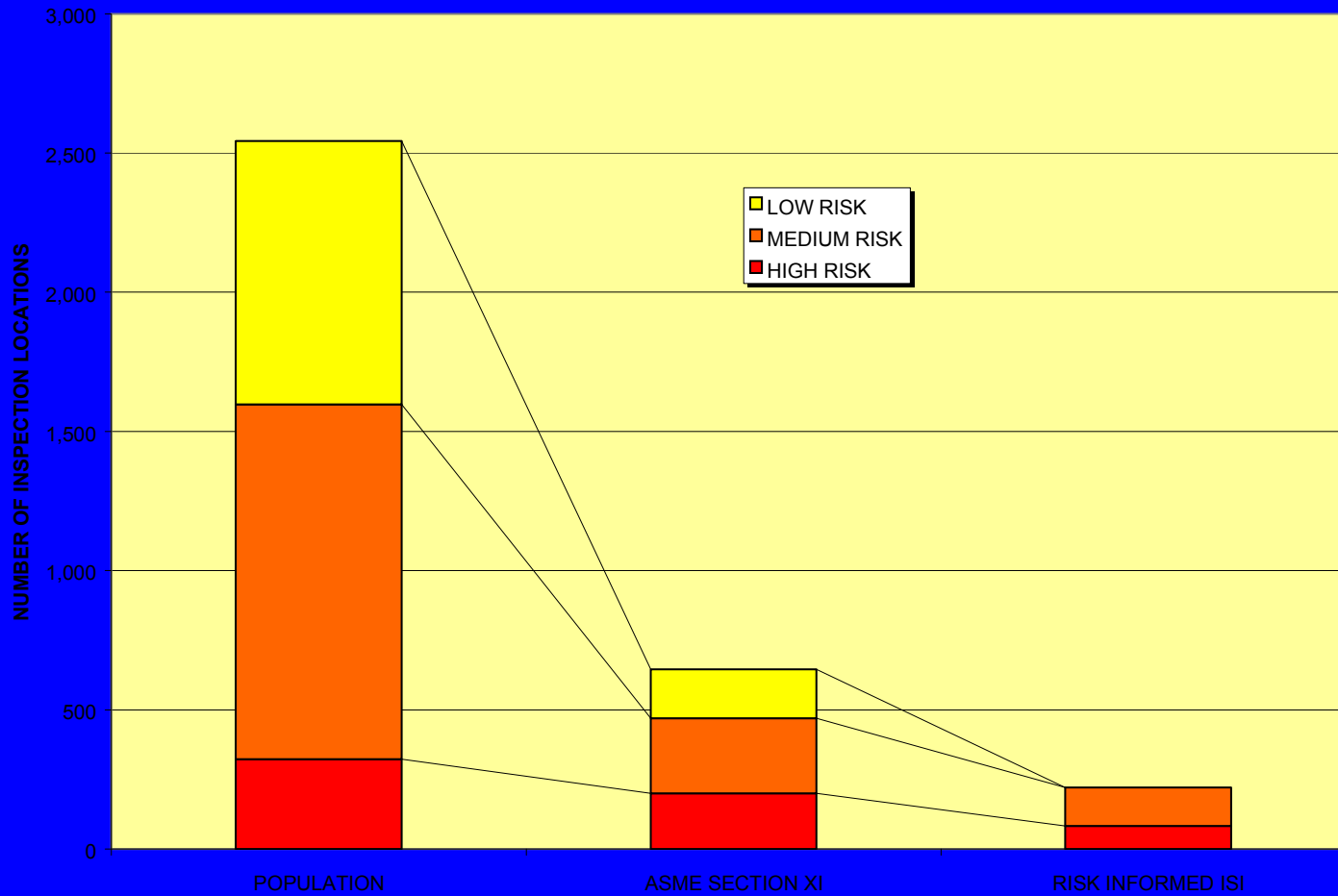
Inservice Inspection

RISK IMPACT ASSESSMENT

- Determine changes in pipe rupture frequency due to changes in ISI program
 - Exams may be added to the segment
 - Exams may be removed from the segment
 - Effectiveness of exams may be improved due to “inspection for cause” principle
- Determine change in risk at each weld due to ISI changes
 - Multiply change in pipe rupture frequency at each weld times the segment CCDF for Δ CDF or CLERP for the Δ LERF
- Determine risk impact as the sums of Δ CDF and Δ LERF

Inservice Inspection

EXAMPLE INSPECTION REDUCTION



Evaluating License and Design Basis Conditions

- License Amendment Requests (LARs)
 - Design Basis Amendments
 - AOT (Allowed Outage Time) Extensions
 - STI (Surveillance Test Interval) Extensions
 - Tech Spec Improvements
- Notices of Enforcement Discretion (NOEDs)
 - LCOs (Limiting Conditions for Operation)
 - Maintenance AOT extensions
 - STI extensions
 - ISI extensions

Conclusions:

- PSA information has been successfully used to focus plant resources.
- Focus on risk-significant areas improves operational safety.
- Focus on risk-significant areas also reduces cost.