

Using Risk Information and Insights to Support Aging Management

2025 Update



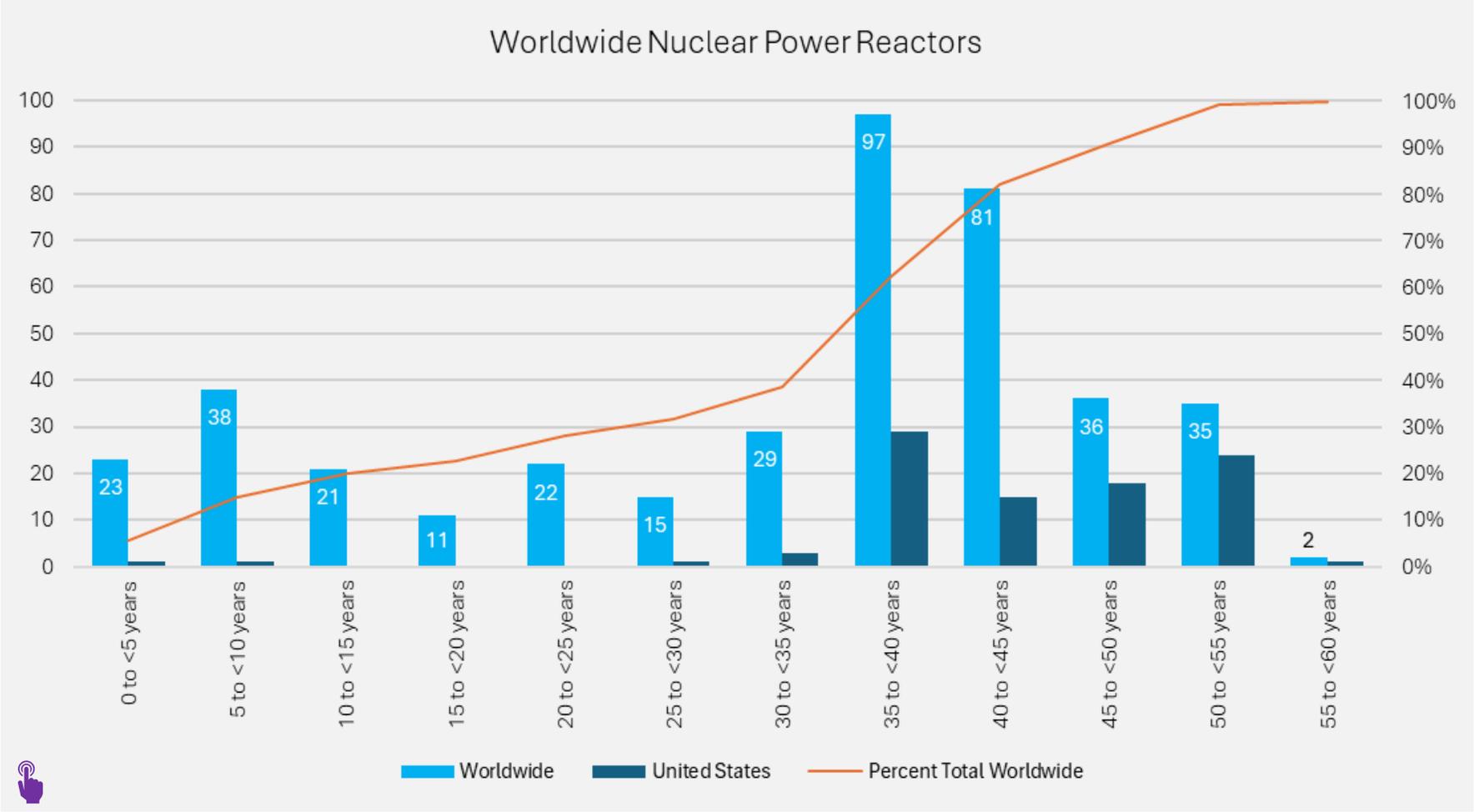
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Senior Technical Leader | Risk and Safety Management (RSM)

Second Steering Committee Meeting of the International Network of Life Management of Nuclear Power Plants
October 14 – 17

Why Aging Management Matters

410
operating reactors

33 years
average age

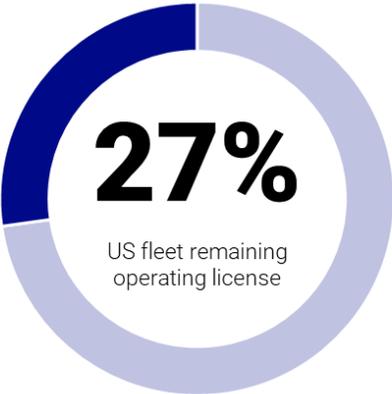
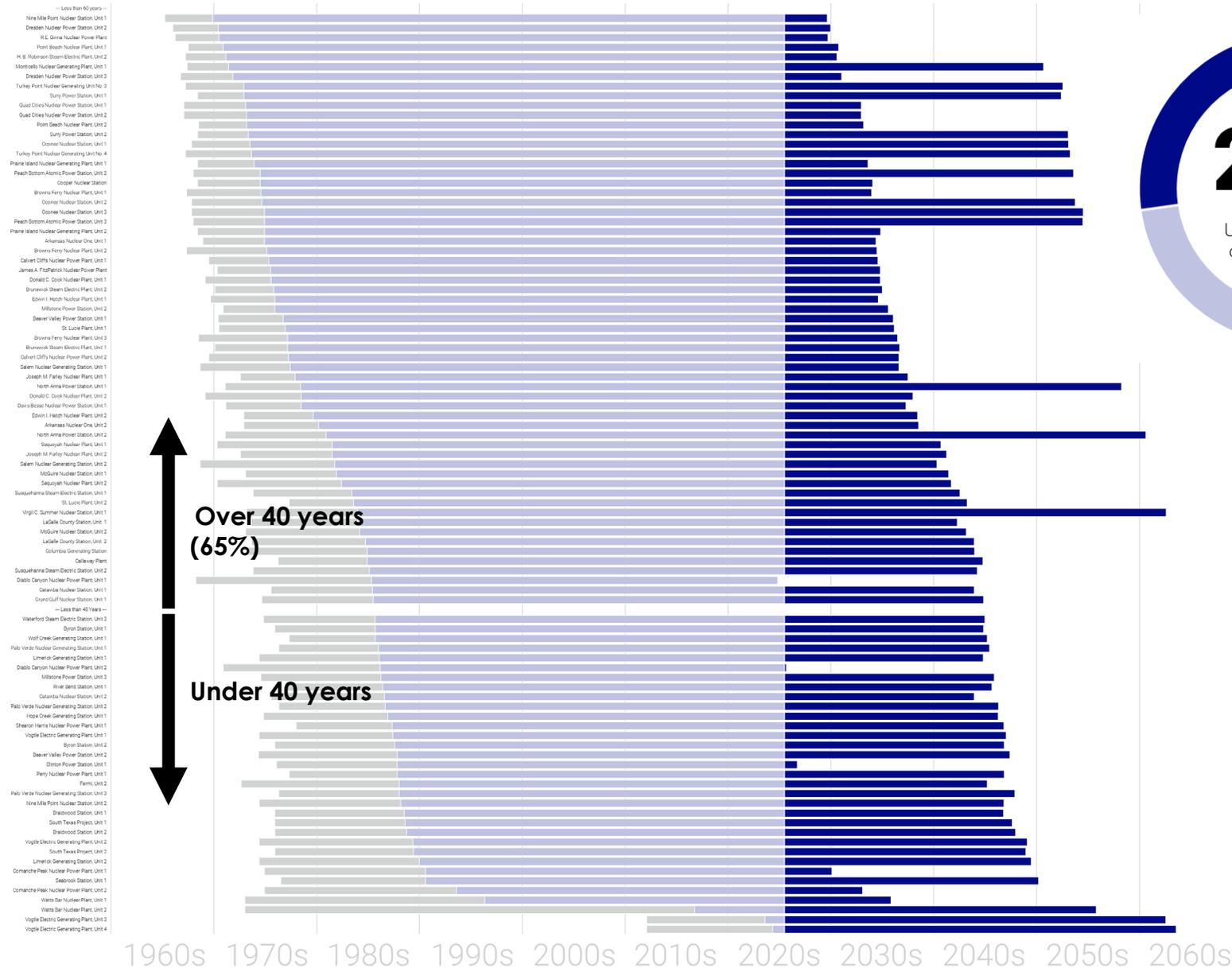


IAEA's "Nuclear Power Reactors in the World," 2024 Edition, Table 14 Data

Current Operating Fleet in the United States

43 years
average age

Construction
Operated
Remaining License





EPRI Research Activities

Risk Insights and Information in Support of
Aging Management (RIAM)

EPRI's Framework (2022)



Report 3002020713

Leveraging Risk Insights for Aging Management Program Implementation: 2022



This report presents the framework and pilot results of leveraging risk insights for AMP implementation. The pilot results showcase that current available information can support the robust use of risk insights in support of aging management programs.

This report is publicly available

Consequence Analysis Considerations (2024)



White Paper 3002029305
Leveraging Risk Insights for Aging Management – Consequence Analysis Update



This white paper focuses on important considerations when developing risk insights for aging management programs and reviews how to apply EPRI's risk-informed repair and replacement methodology (RI-RRA) when performing consequence evaluations.



This white paper is available to EPRI members

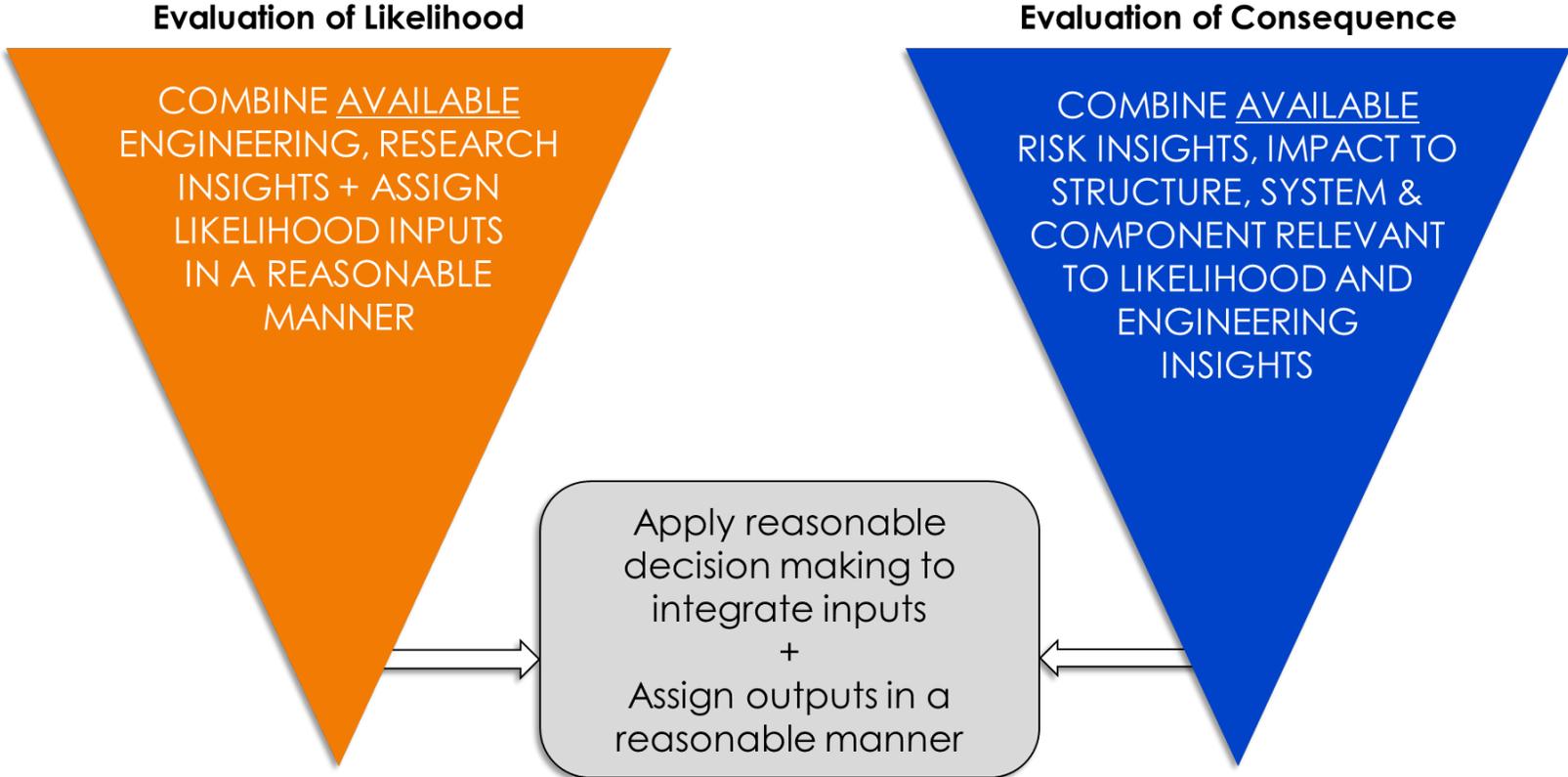
Additional RIAM Overviews

- 2025 video update providing an overview of the process to risk-inform the categorization of SSCs and how that process connects to the RIAM process (8-minute video).
- Video presentation for the recent IAEA Training Course on PLiM for LTO (30-minute video).



EPRI RIAM General Framework

Using risk insights and information to support aging management programs requires evaluating and categorizing an SSC's consequence of failure.



Overview of RIAM Steps in the EPRI Pilots



Select AMP for RIAM development



Develop the core team and identify stakeholders



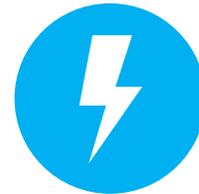
Collect the necessary information



Identify and group SSCs



Consider the necessary **likelihood** inputs and perform analysis



Consider the necessary **consequence** inputs and perform analysis



Develop the risk matrix



Revise aging management strategies

Likelihood Inputs (for a specific mechanism)

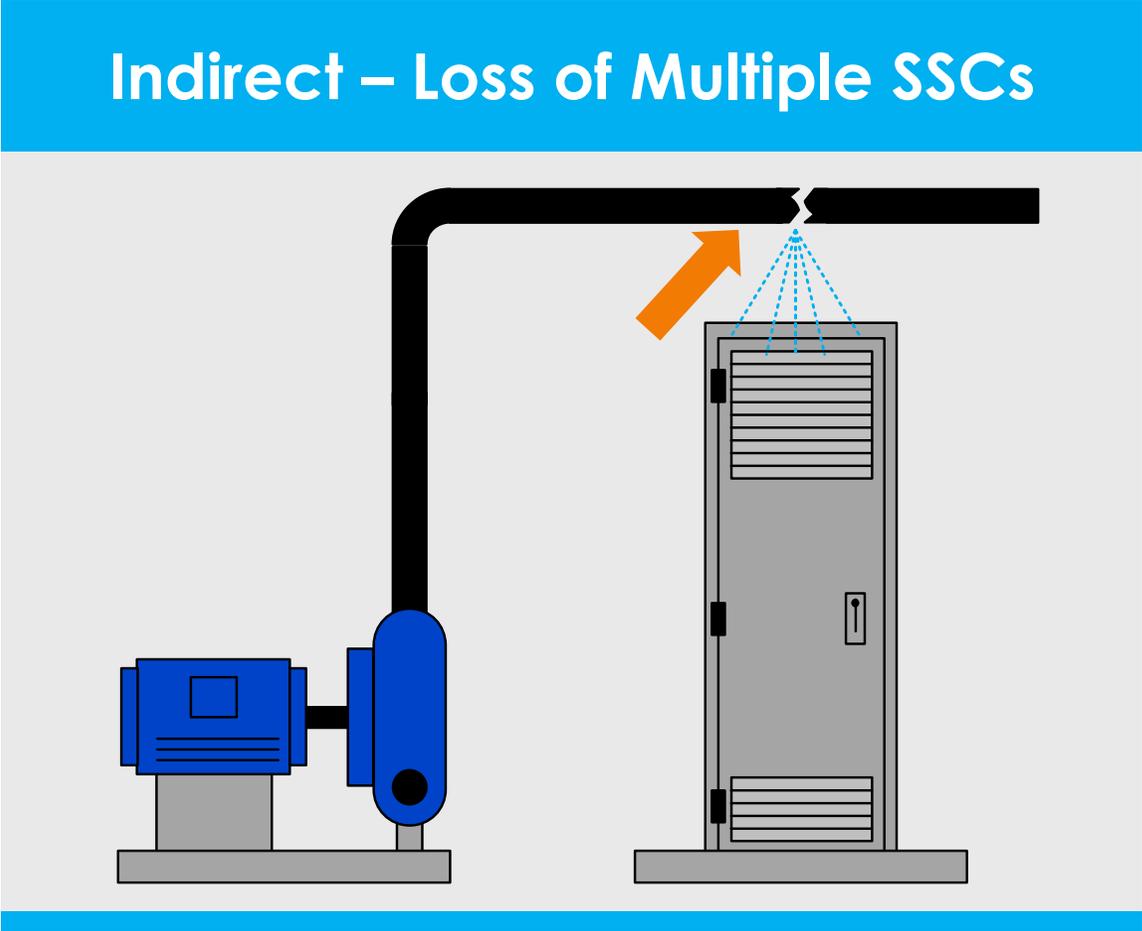
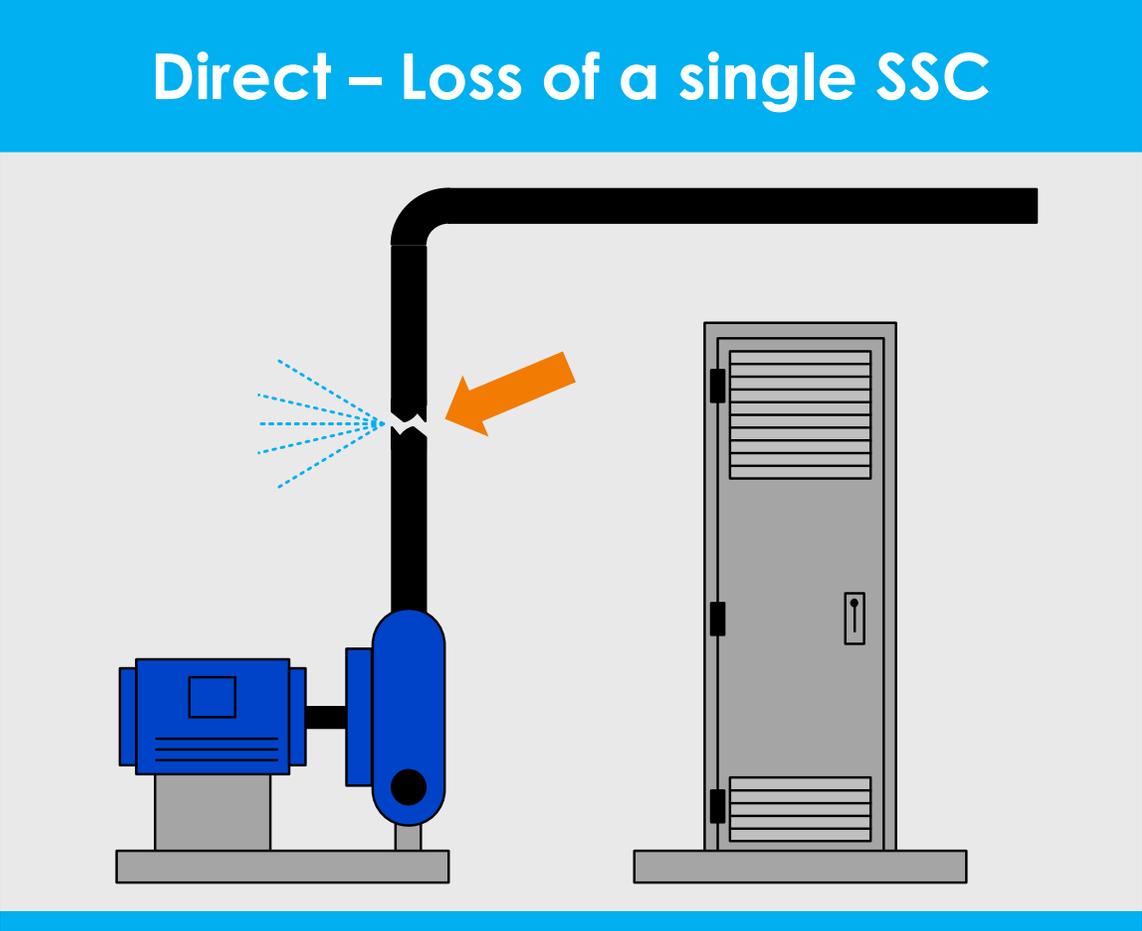
- Operational Experience
- Environment
- Condensation or Water Internal Environment-Specific Factors
 - Temperature
 - Flow Rate
- Soil External Environment-Specific Factors
 - Soil Corrosivity
 - Cathodic Protection
 - Coatings

For each SSC, these factors were evaluated and scored

Consequence Inputs (for a specific mechanism)

- “Consequence” means the resulting effect from the **loss of the intended function** with respect to the overall plant risk for each SSC within the scope of this pilot.
- Consequence information was developed using the following references:
 - The 50.69 categorizations for the system of interest
 - Risk-Informed Inservice Inspection (RI-ISI) results
 - PRA Basic Event data
 - Internal Events PRA data
 - Internal Fire PRA data
 - Internal Flooding PRA data

Direct and Indirect Impacts



Indirect impacts are particularly important when considering passive components

Risk-Informed Categorization

- Risk-informed categorization of SSCs helps focus attention on SSCs important to plant safety and allows for greater operational flexibility.
- NEI 00-04 provides the guidelines for SSC categorization in support of 10 CFR 50.69, *Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors*.



Can information gained from the risk-informed categorization of SSCs be used to support decision-making related to aging management programs?

RIAM Passive and Active Components & Functions

Active Components & Functions

The guidance presented in NEI 00-04 provides a method for classifying active components. However, the classification of passive components or the passive function of active components should use other guidance, such as ASME Code Case N-660 and EPRI's Risk-Informed Repair and Replacement (RI-RRA) methodology.

Passive Components & Functions

Aging management programs focus on passive components (sometimes referred to as pressure boundary components) or the passive function of active components.



Leveraging risk insights for aging management programs requires an evaluation of passive components and functions.

Quantitative Indices for Consequence Categorization

Table 3-1
Correspondence of Consequence Categories to Numerical Estimates of Conditional Core Damage Probability (CCDP) and Conditional Large Early Release Probability (CLERP)

Consequence Category	Corresponding CCDP Range	Corresponding CLERP Range
HIGH	$CCDP > 1E-4$	$CLERP > 1E-5$
MEDIUM	$1E-6 < CCDP \leq 1E-4$	$1E-7 < CLERP \leq 1E-5$
LOW	$CCDP \leq 1E-6$	$CLERP \leq 1E-7$

Table 2-5
Quantitative Indices for Consequence Categories

Conditional Core Damage Probability (no units)	Conditional Large Early Release Probability (no units)	Consequence Category
$>10^{-4}$	$>10^{-5}$	High
$10^{-6} < \text{value} \leq 10^{-4}$	$10^{-7} < \text{value} \leq 10^{-5}$	Medium
$\leq 10^{-6}$	$\leq 10^{-7}$	Low
No change to base case	No change to base case	None



EPRI TR-112657REVB-A

Revised Risk-Informed In-Service Inspection Evaluation Procedure



EPRI 1022945

Risk-Informed Repair/Replacement Methodology

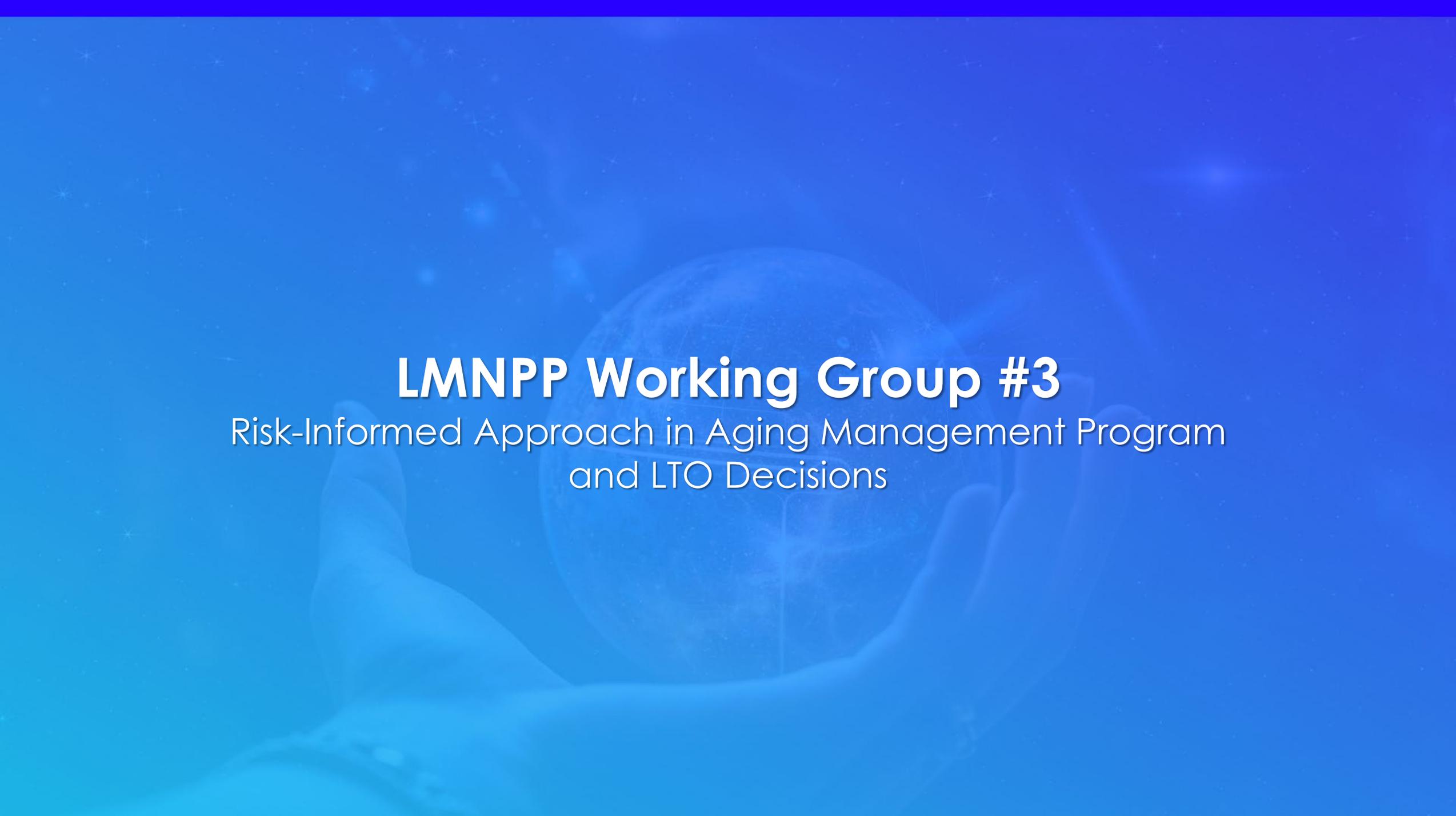


Consequence Inputs and Analysis

- Based on available risk information, such as risk-informed applications and PRA/PSA outputs, determine the severity of the consequence for each SSC within the scope of the AMP.
- Assign consequence of failure rankings (e.g., high/medium/low) based on the consequence/severity assessment.



Risk-informed approaches should consider both qualitative and quantitative risk information. Both qualitative and quantitative results can yield meaningful insights.



LMNPP Working Group #3

Risk-Informed Approach in Aging Management Program
and LTO Decisions

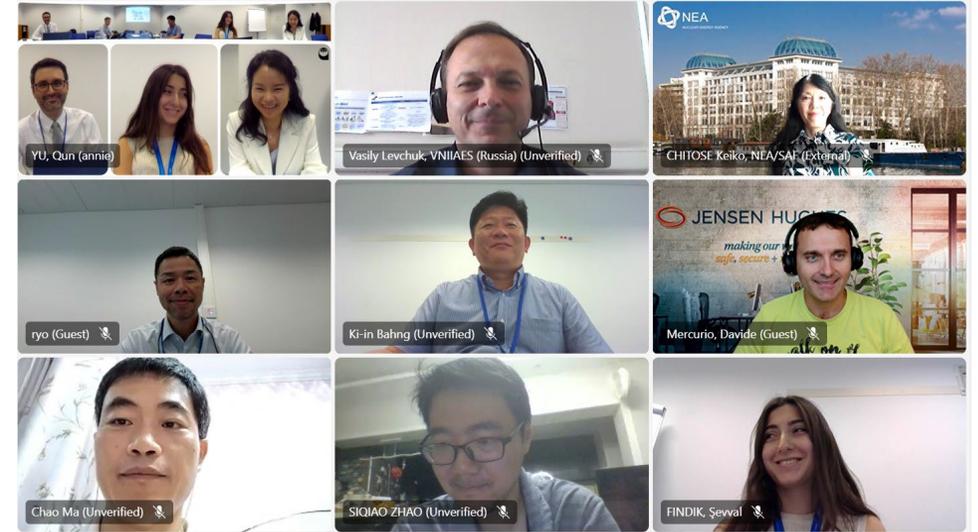
WG3: Risk Insights Supporting AM and LTO Decision

Explore and discuss the use of risk-insights and information to support aging management and long-term operations, and share the experiences of our members.



2024 Working Group Meeting

- **When:** September 2024
- **Where:** Vienna, Austria
- Attendees from China, Japan, Korea, Russia, Switzerland, the United States of America, and France.
- Utilities, Contractors, CRIEPI, EPRI, IAEA, INL, NEI, OECD/NEA.



Topics of Discussion & Presentations

- **EPRI (USA):** Introduction of EPRI RIAM Framework & Pilot Results
- **CNPE (China):** Risk Insights supporting Aging Management Program Implementation
- **CNPO (China):** Risk Insights supporting Aging Management Program Implementation
- **Japan:** Risk Insights supporting Aging Management Program Implementation and Long-term Operation Decisions
- **Korea:** Risk Insights supporting Aging Management Program Implementation
- **INL (USA):** The Risk Informed Ageing Management Project
- **South Texas Project (USA):** Risk Insights supporting Ageing Management Program Implementation
- **Jensen Hughes (USA/Switzerland):** Use of Non-Deterministic Approaches to Asset Management to Support LTO
- **OECD/NEA (France):** Activities on RIAM
- **EPRI (USA):** The practices on how to perform the consequence evaluation and determine the likelihood of selected AMPs for EPRI's Pilot cases.
- **NEI (USA):** Update on RIAM

Questions for the Working Group

How can the EPRI framework or similar frameworks support the analysis of additional AMP pilot studies, and which AMPs should be the focus?

How can risk information be used to support other working group missions (for example, integration of risk information in the design phase)?

How can a collaboration between our organizations support the development of RIAM?

How can PFM, and other tools, support the determination of aging mechanism likelihood?

Are there additional considerations related to non-LWR designs (specifically, PHWR)?

How best to risk rank SSCs without a specific "50.69 program" or similar risk-informed application?

Should CDF and LERF, and other traditional risk metrics, be the only figures of merit ("goals") when considering long-term operations and aging management?

As subject matter experts in risk or aging, are we effectively engaged with our counterparts? RIAM requires a robust team of SMEs from risk and aging management.

Consider how this risk information is presented to decision-makers.

Can an initial step in the process be to assume failure, and not attempt to assess the likelihood of failure (that is, assume SSC failure)?

What are some examples of the application/use of risk insights and information in support of long-term operations and aging management?

Outcome: CNNC RIAM Pilot

- China National Nuclear Corporation (CNNC), Nuclear Power Operations Research Institute (NPRI), China Nuclear Power Engineering Co., Ltd (CNPE), China Nuclear Power Operation Technology Corporation (CNPO), and CNNC Operation Maintenance Technology Co., Ltd (CNNC-OMT)
- **Fuqing Nuclear Power Plant (Unit 1):** Medium voltage cables
- **Fuqing Nuclear Power Plant (Unit 5, Hualong One):** Closed-cycle cooling water system





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