PSA Data Needs for the Existing and Future Fleet

EPRI Perspective

Eric Thornsbury
Technical Leader IV

Mary Presley
Technical Executive

Joint WGRISK and Database Projects Expert Workshop on the Applicability and Applications of Operating Experience from the OECD/NEA Database Projects to Probabilistic Risk Assessment (PSA)
May 20-22, 2026

Overview - PSA data needs for the existing and future fleet

- Operating experience (OE) data can be used both qualitatively and quantitatively.
- Qualitative review of OE is a key part of constructing and updating models to ensure they reflect appropriate initiating events, failure modes and mechanisms.
- OE is also critical to informing quantitative inputs into the PRA/PSA models in terms of initiating event frequencies, failure rates and other inputs.
- EPRI supports the nuclear industry by providing PRA/PSA methods and data analyses which rely on existing data sources as well as working with stakeholders to understand and help support forward looking needs
  - Key data needs for both the **existing fleet** and the **future advanced reactor fleet** that need to be addressed to maintain a viable data pipeline to support PRA/PSA.
  - This presentation aims to provide a discussion of a subset of these gaps – particularly those relevant to the OECD databases – and some of the necessary characteristics of a data collection program suitable to fill these gaps.

Internal Flooding Frequencies [Passive Components]

- EPRI calculates Pipe Rupture Frequencies using a 2-step Bayesian method, requires:
  - # of Failures (failure defined as anything requiring repair/replacement)
  - Exposure time (Reactor Operating Year – Feet)
  - Size of each failure (estimated size or flooding volume/time)
  - Treatment of pipe segment (e.g., inspection frequency, etc.)
  - Age of pipe at time of failure
- Expanding number of pipe cases (e.g., plastic pipe not currently accounted for, but much more common) requires more data to be gathered.
- Pipe failure rate contingent on treatment of piping and how data can be grouped.
- Variety of aging management and other pipe maintenance methods may muddy the data (e.g., metallic sleeves on rubber expansion joints)
- Need timely, consistent, detailed and complete data reporting from a trusted source
  - International database efforts have historically been insufficient
  - EPRI has relied on hand-curated data, but is it sustainable?
- Do new reactors have fundamentally different operating practices and environments?

Can international databases be a trusted source?

Human Reliability

- Data needed to support understanding of risks for new plants/digitized plants, including:
  - Pre-initiators
  - Impact of concepts of operations
  - Automation interactions/errors of commission
  - HMI and procedure optimization
  - Dependencies

- Aggregate lower-level failures to gain insights
  - Qualitative data may be more important at this stage than quantitative information

Digital I&C Reliability Data

- Needs to match range of modeling approaches
- Needs to include data gathering to understand failure rates and modes/mechanisms for:
  - Hardware
  - Hardware CCF
  - Software
  - Software CCF
  - Design failures v. random failures
- Difficult to distinguish hardware failure from software failure without detailed root cause, so aggregate data may be more realistic
  - Failure rates linked to quality control measures, design and implementation – how to bin?
  - Agreed upon component boundaries and system definitions if gathering data at the component or system level, but…
  - new plants may have vastly different systems definitions
- Useful to converge on common taxonomy for data collection?
  - Use in PRA as well as in design process

Importance of Qualitative Data for New Reactors

- Quantitative data is highly sought after, but can't underestimate the value of well analyzed *qualitative* data, particularly for new plants.
- Qualitative data can be used to ensure:
  - appropriate initiating events are captured in the PSA
  - relevant failure modes and mechanisms are captured in the PSA
  - phenomenology and modeling tools/assumptions conform to reality of operations.
- Qualitative data requires expert processing to extract "so what"
  - data quality and detail of data gathered is often a higher bar than quantitative databases
- Clear root cause, compiled thoughtfully to understand the full range of applicability to different plant designs (not narrow interpretation leading to "it can't happen here" mentality)

What mechanisms exist to gather and compile this data across a global fleet of diverse technologies?

Data Needs for Advanced Reactors – Project Overview

- EPRI is conducting a research initiative to identify and assess data sources and key gaps for Advanced Reactor (AR) Probabilistic Risk Assessment (PRA) applications

- Phase 1: 2026
  - Literature review (e.g., component failures, SSC unavailability, phenomenology)
  - Industry interviews and surveys
  - Review recent AR data initiatives
  - Review available AR databases
  - Identify data gaps and future needs

- Phase 2: 2027+
  - Develop approaches to address identified gaps

Data Needs for Advanced Reactors – Initial Progress

- Databases
  - 14 AR databases identified
  - Access requirements to be determined
  - Assessment for PRA applicability in progress
- Codes and Modeling
  - Review of thermal-hydraulic codes
  - Assessing data needs for model validation
- Initial Gaps in Research
  - Phenomenological data to support passive safety systems
  - Component reliability/degradation effects in different environments
  - Test facility data limitations (e.g., scaling)
  - Increasing use of surrogate data in PRAs for licensing

Data Needs for Advanced Reactors – Next Steps

- Launch global industry survey to identify data sources and capture key data gaps
- Identify more specific research questions, such as:
  - What needs exist for additional data collection for SSCs or TH performance
  - For risk-informed decisions, how do we deal with uncertainties from limited data availability?
  - During initial operation, how do failures early in the bathtub curve impact the data analysis?
  - How do we prepare for long-term data collection and maintenance?

- If you would like to contribute, please contact Eric Thornsbury at ethornsbury@epri.com

TOGETHER…SHAPING THE FUTURE OF ENERGY®

www.epri.com