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"Supplemental Guidance for Radiological Consequence Analyses Using Alternative Source Terms" DRA-ISG 2021-XX

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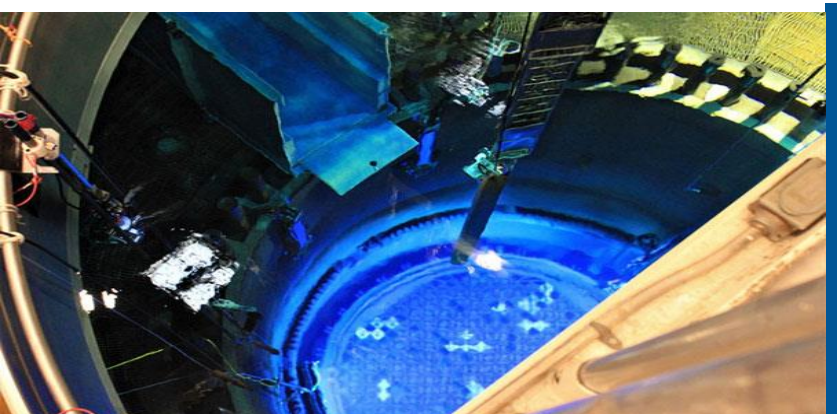
Office of Nuclear Reactor Regulation (NRR)



Outline

- Overview of the Interim Staff Guidance (ISG)
- Background of ISG
- Basis for ISG – Technical Assessment
  - Overview
  - Details
- Difference between ISG and Regulatory Guide 1.183 Revision
- Takeaways

Overview of ISG - Timeline

- Published in *Federal Register* for public comment
  - 30-day comment period closes on June 21, 2021
- Advisory Committee on Reactor Safeguards (ACRS) subcommittee briefing scheduled for July 23, 2021
- ACRS full committee briefing in September 2021 (tentative)
- OMB approval - November 2021 (tentative)
- Final FRN - December 2021 (tentative)

Overview of ISG – Primary Insight

- **High probability** that doses will be **lower** than those estimated strictly using traditional deterministic methods, which **include accepted assumptions**, that **do not credit** hold-up and retention of the Main Steam Isolation Valve (MSIV) leakage within the power conversion system (PCS)

Overview of ISG – Objective and Expectation

- **Objective:** Near-term formal regulatory footprint for staff's use of primary insight
- **Expectations:**
  - Used by staff to offset uncertainty in input parameter(s) for deterministic calculations
  - Supports reasonable assurance finding during reviews
  - Transitioned to Standard Review Plan Chapter 15.0.1
- **Caveat:** Does not change acceptable methods to demonstrate conformance with 10 CFR 50.67

Background of ISG - Genesis

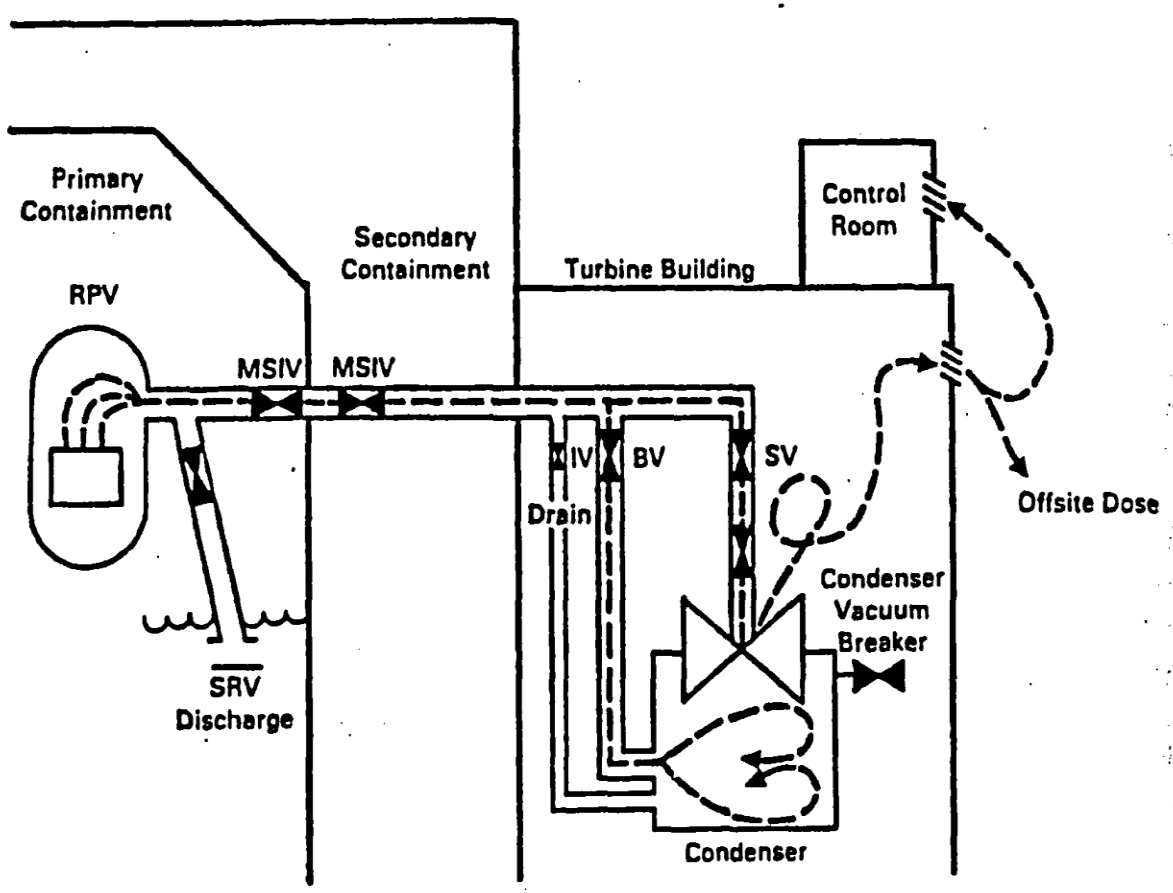
- Commission direction to become a modern, risk-informed regulator (e.g., SRM-SECY-19-0036; ML19183A408)
- Four license amendment requests (LARs) to increase MSIV leakage in 2019
  - Challenges due to uncertainty in input parameter values in dose calculations
  - LIC-206 (ML19031C861) invoked for multi-disciplinary risk insights

Background of ISG – Genesis (Cont'd)

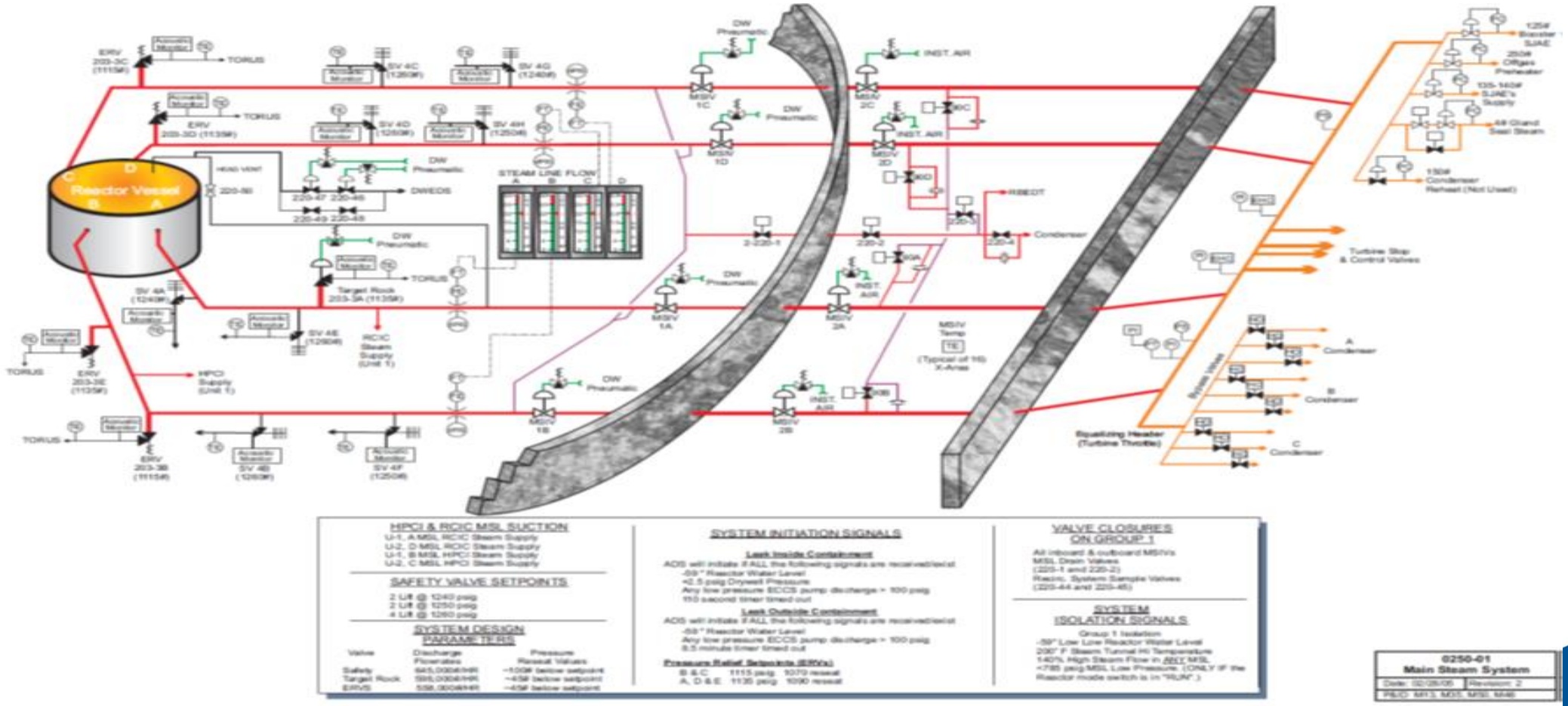
- Integrated review team approach following LIC-206 guidance
- Identified that risk insights support consideration of holdup in PCS
  - Ability to offset challenges without changing calculation methods and assumptions
- Documented insights in technical assessment
  - Internal reviews and deliberations
- Implementation of LIC-206 in a deterministic LAR
  - Included in all four safety evaluations for the four LARs to increase MSIV leakage (ML20140A070; ML20150A328; ML20241A190; ML20265A240)

Basis for ISG – Technical Assessment

- Dose calculations often do not credit any SSCs beyond outboard MSIVs
- "Formal" credit for condenser through safety evaluation on BWROG Topical Report
- Large holdup volume exists in PCS beyond second MSIV



Large Holdup Volume in PCS



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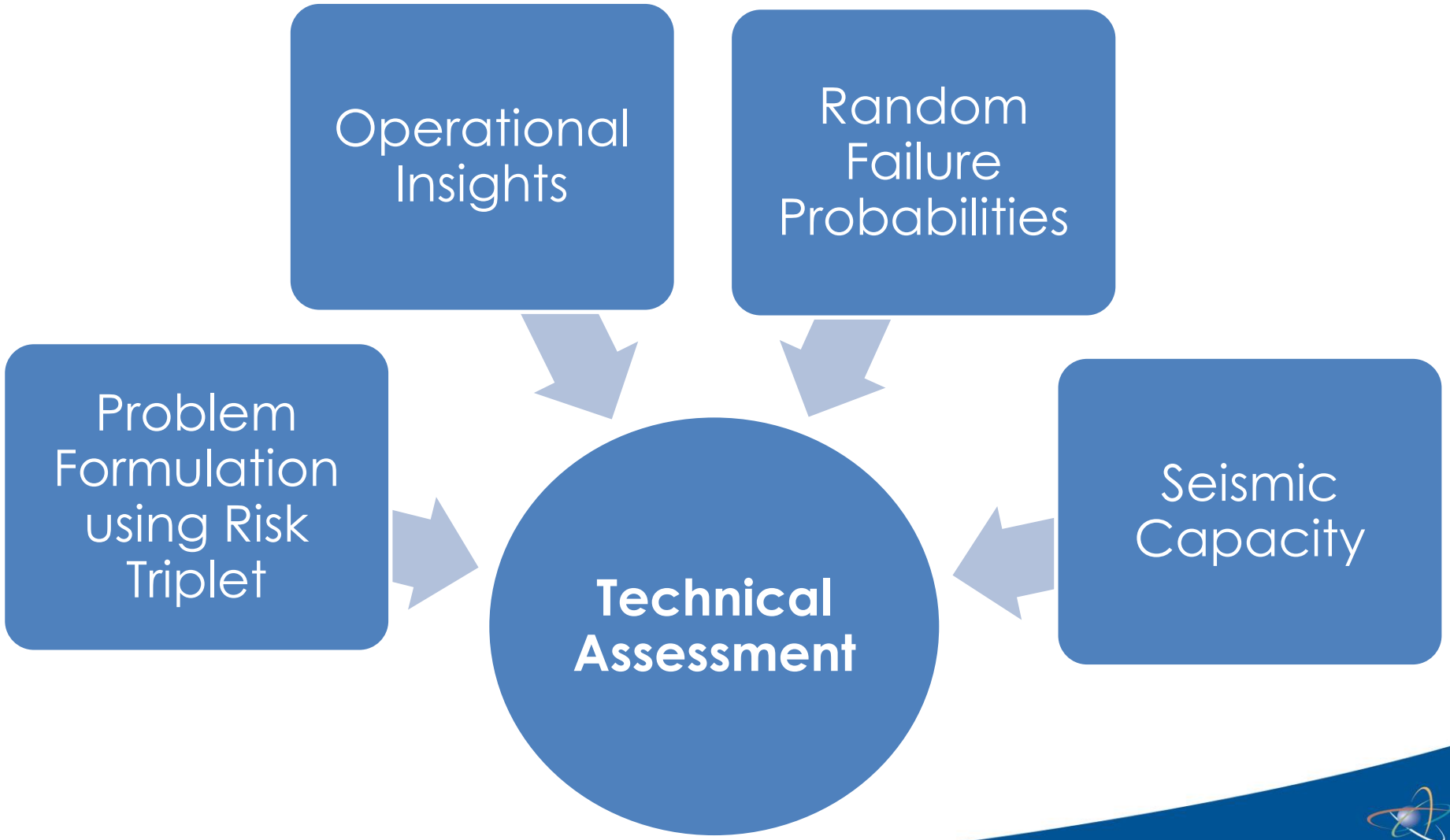
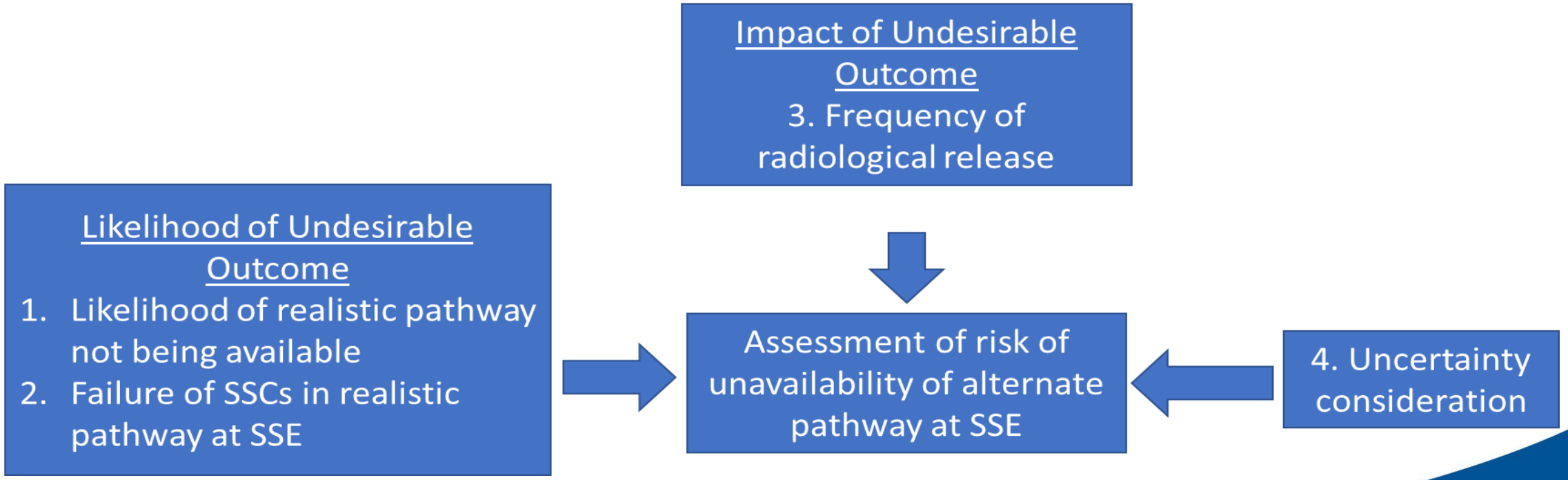
Technical Assessment - Overview



Technical Assessment – Risk Triplet Formulation

Risk = What Can Go Wrong x How Likely Is It x What are the Consequences
= (Likelihood x Impact) of Undesirable Outcome
= (Likelihood x Impact) of Fission Products Not Retained in Power Conversion System



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Operational Insights

- Main Steam System Piping:
  - Large internal volume
  - Typically designed to B31.1.0, "Power Piping"
  - Constructed with augmented quality
  - BWR 5 and BWR 6 designed to B&PV Code – safety-related
- Main Steam Isolation Valves:
  - Typically, large globe valves that seat with pressure
  - Stem leakage from outboard valve considered a small fraction of measured seat leakage
- Passive features provide hold-up volume for MSIV seat leakage

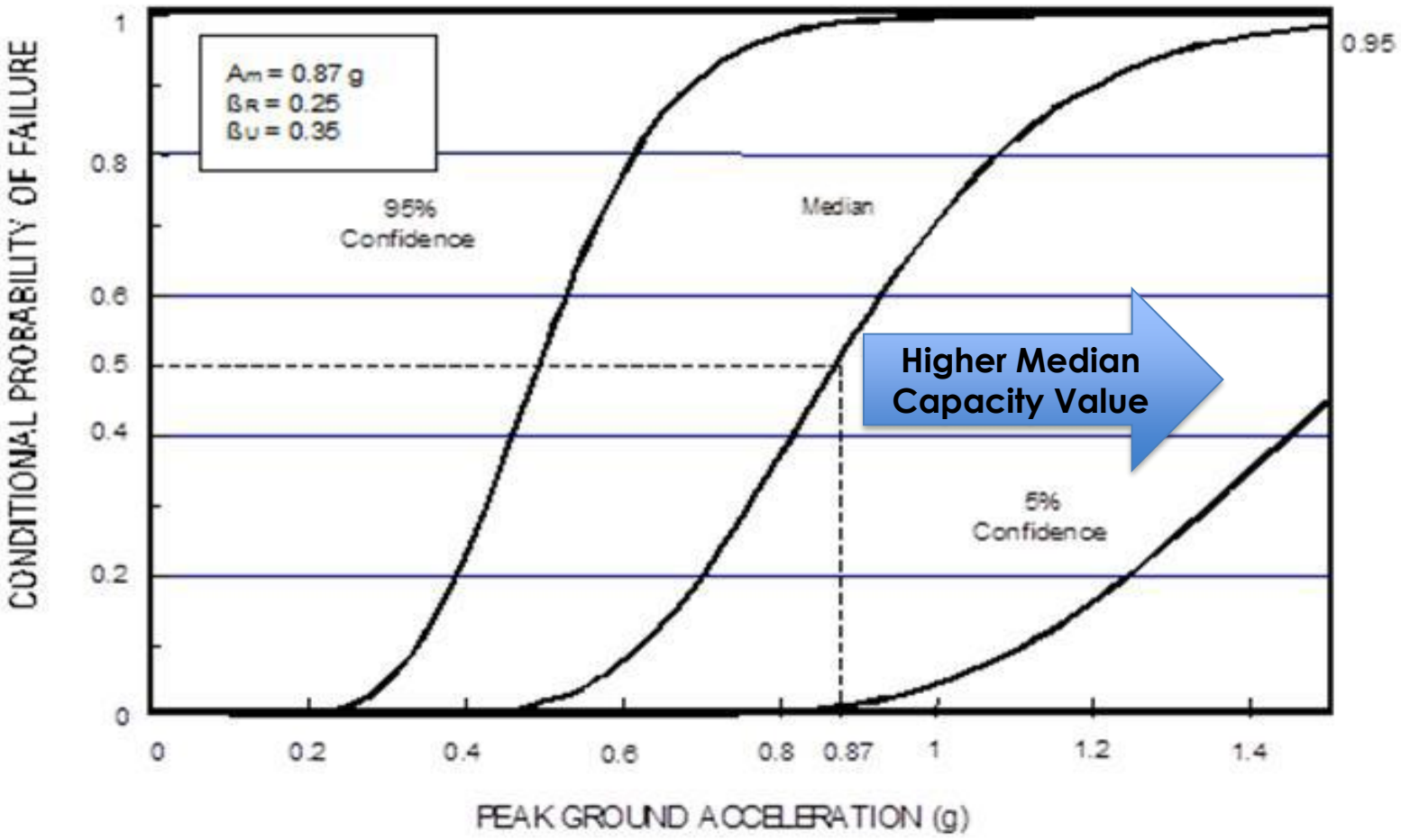
Realistic Transport Pathway

- Consideration of piping attached to steam lines
  - No alignment of specific leakage path
  - Reliability of complete isolation; larger valves leak more
- Functional drain lines flow to main condenser
- Turbine bypass valves also flow to main condenser
- Other leakage, primarily through stop and governor valves to high pressure turbine, provide for less holdup and deposition than main condenser

Seismic Capacity: A Primer

- **Fragility**: Conditional failure probability as a function of seismic acceleration; Analytically determined; Lognormally distributed
- **Median fragility (Am)**: Seismic acceleration at which there is 50% probability of failure
- **Lognormal uncertainty parameters** (β_r for randomness; β_U for uncertainty): Parameters characterizing the uncertainty in the fragility
- **Seismic acceleration**: Measure of strength of earthquake in terms of multiples of gravitational acceleration (e.g., 0.1g, 1g)
- **Peak ground acceleration**: Commonly used acceleration level for seismic analysis; corresponds to acceleration of 100 Hz oscillator

Seismic Capacity: A Primer



From Electric Power Research Institute Report 1025287
(also known as SPID; ML123330282

Approach for Seismic Capacity Evaluation in Assessment

Fragility Data
- Multiple and diverse sources
- Recent seismic probabilistic risk assessments (PRAs)

Operating Experience - Walkdowns
- North Anna
- Kashiwazaki-Kariwa
- The Great Tohoku Earthquake of 2011

Representative Risk
- Hazard and fragility convolution

→ Lower Bound Median Fragility to Encompass Seismic Failure Modes

Seismic Capacity Insights

- Welded piping, bolted piping, and valves have high median fragilities
- Main condenser is usually a seismic Category II structure
  - Anchorage designed to avoid failure at design-basis seismic loads
- Post-earthquake walkdowns of plants demonstrate high seismic capacity of SSCs in PCS
- Seismic risk from accelerations at and below plant's safe shutdown earthquake (SSE) is small

Seismic Capacity Insights

- Lower bound median fragility parameters
  - Am = 0.4g; β_r = 0.22; β_U = 0.22
  - Based on fragility of expansion joint connecting circulating water piping to condenser
  - Encompasses failure modes of relevant SSCs
  - Supports low likelihood of gross failure of SSCs in PCS

Seismic Capacity Insights – Representative Risk Calculation

- Convolution of range of hazards with lower bound median fragility parameters
  - Provides estimate of risk of gross failure of SSCs in PCS
  - Uses latest seismic hazard curves
- Estimates demonstrate low risk of gross failure
  - Even lower if contribution only till SSE is considered

Uncertainty Consideration

- Uncertainty in median fragility explicitly included
- Conservatisms exist that address uncertainty in selected median fragility
  - Use of lower bound median fragility
  - Consideration of SSE concurrent with the accident postulated for dose calculations
  - Conservatisms in remainder of dose calculation guidance are unchanged

Difference between ISG and Regulatory Guide 1.183 Revision

- Regulatory Guide Revision:
  - Provides guidance for quantitative credit for holdup and deposition in main condenser
  - Provides guidance for establishment and qualification of leakage pathway
  - Quantitative credit changes the licensing basis dose calculations
- Interim Staff Guidance:
  - Does not provide guidance or assumptions for licensee developed dose calculations
  - Provides risk-informed basis supporting acceptance of uncertainties in parameters and assumptions

Takeaways

- ISG will result in consideration of large holdup volume in future MSIV leakage LARs
  - Offset uncertainty in input parameter(s) for deterministic calculations
  - Support reasonable assurance finding during reviews
- ISG is expected to be transitioned to SRP Chapter 15.0.1
- Formal condenser holdup credit for licensee's is being considered in revision to Regulatory Guide 1.183