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"Supplemental Guidance for Radiological Consequence Analyses Using Alternative Source Terms"

DRA-ISG 2021-XX

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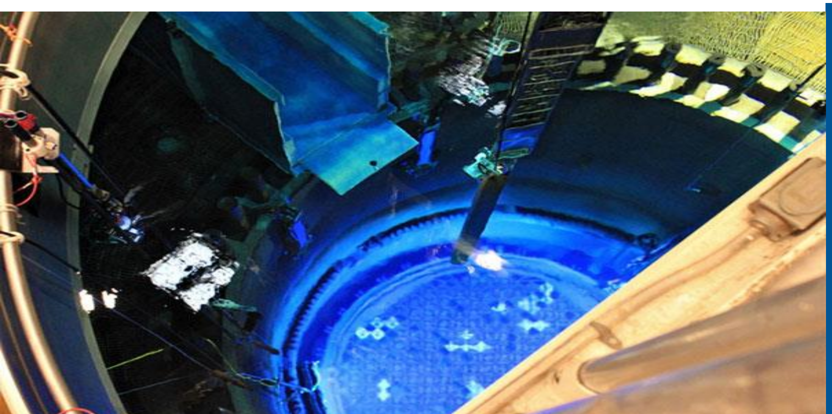
Office of Nuclear Reactor Regulation (NRR)



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

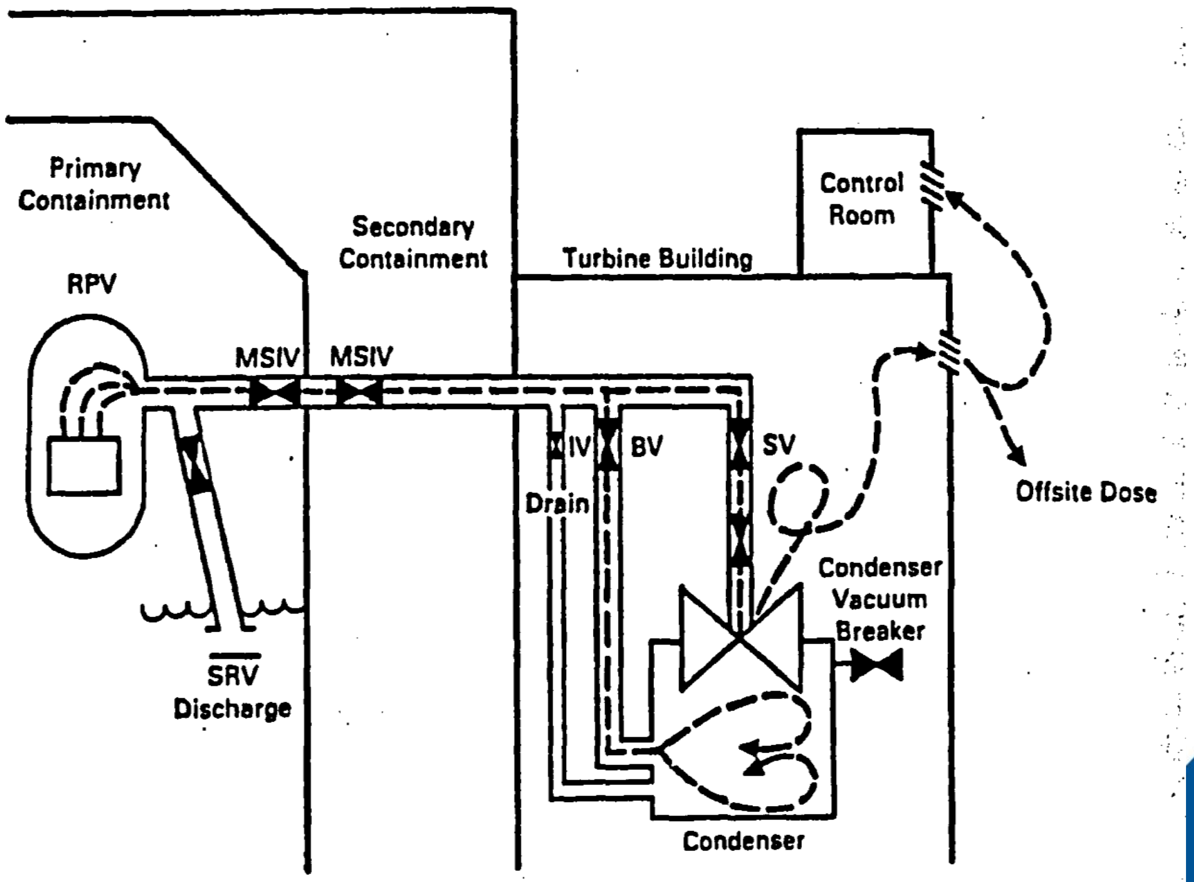
- Commission direction to become a modern, risk-informed regulator (e.g., SRM-SECY-19-0036; ML19183A408)
- Four license amendment requests (LARs) to increase MSIV leakage in 2019
  - Challenges due to uncertainty in input parameter values in dose calculations
  - LIC-206 (ML19031C861) invoked for multi-disciplinary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



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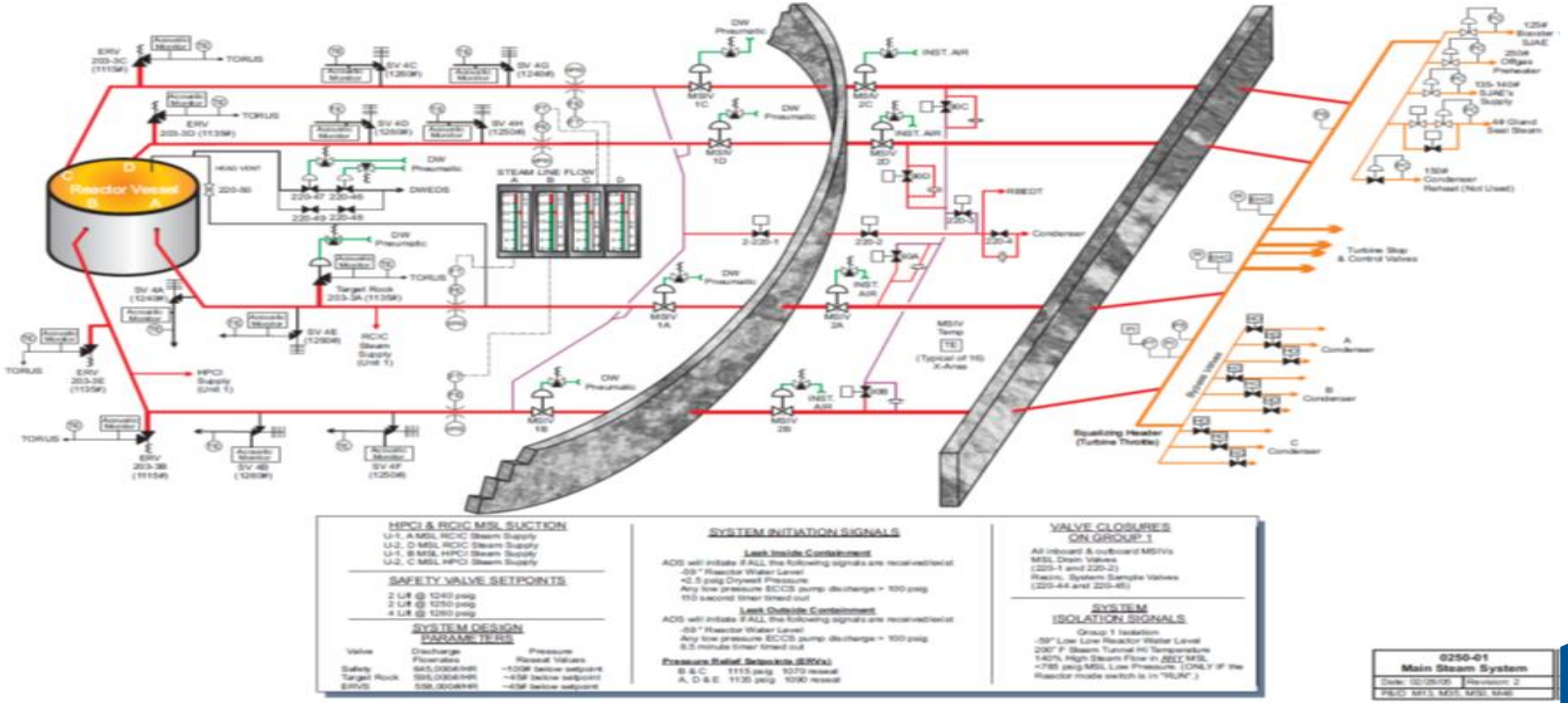
Large Holdup Volume in PCS



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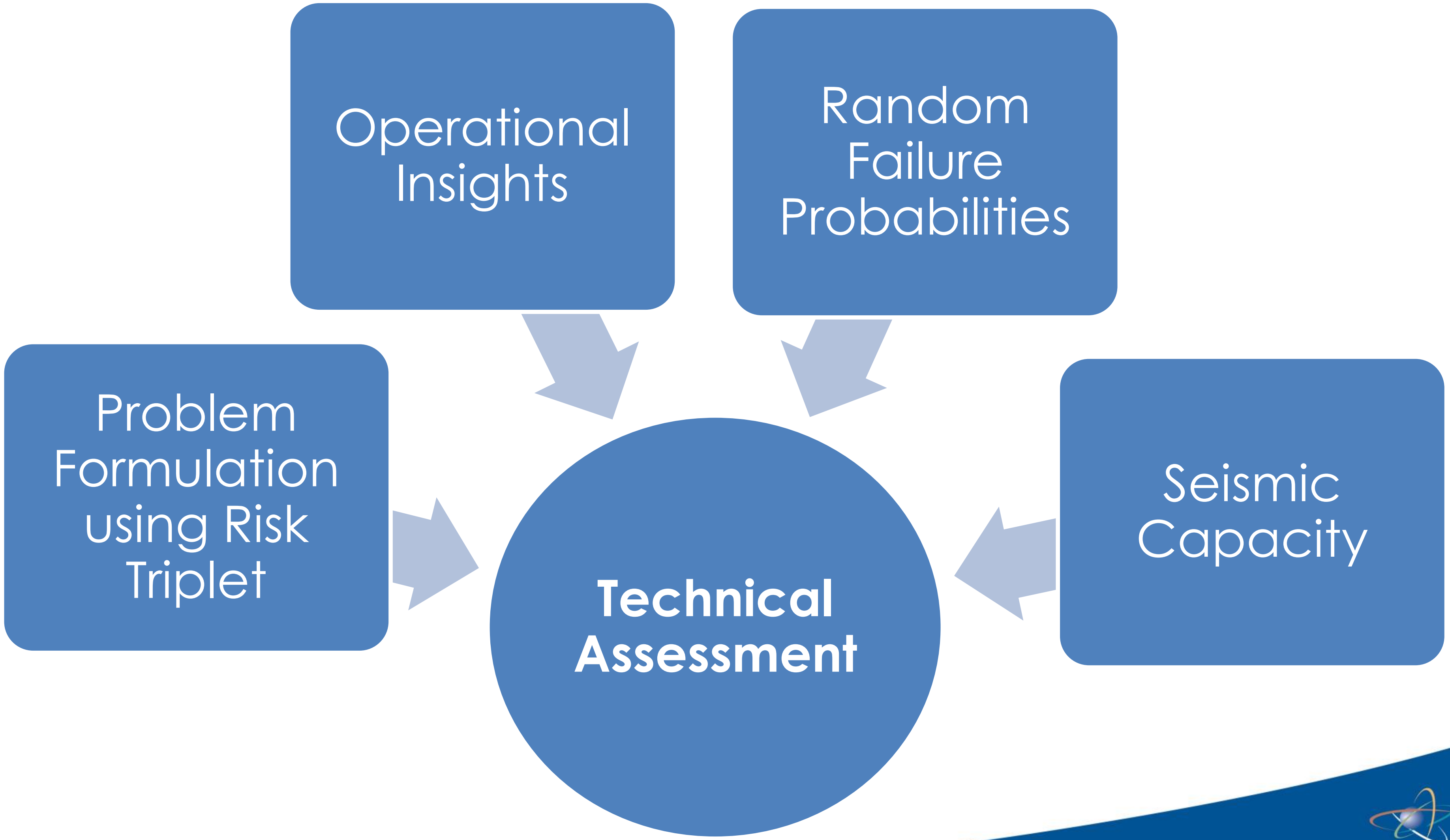
Technical Assessment - Overview



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

<u>Impact of Undesirable Outcome</u>

3. Frequency of radiological release

<u>Likelihood of Undesirable Outcome</u>

1. Likelihood of realistic pathway not being available
2. Failure of SSCs in realistic pathway at SSE

Assessment of risk of unavailability of alternate pathway at SSE

4. Uncertainty consideration

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

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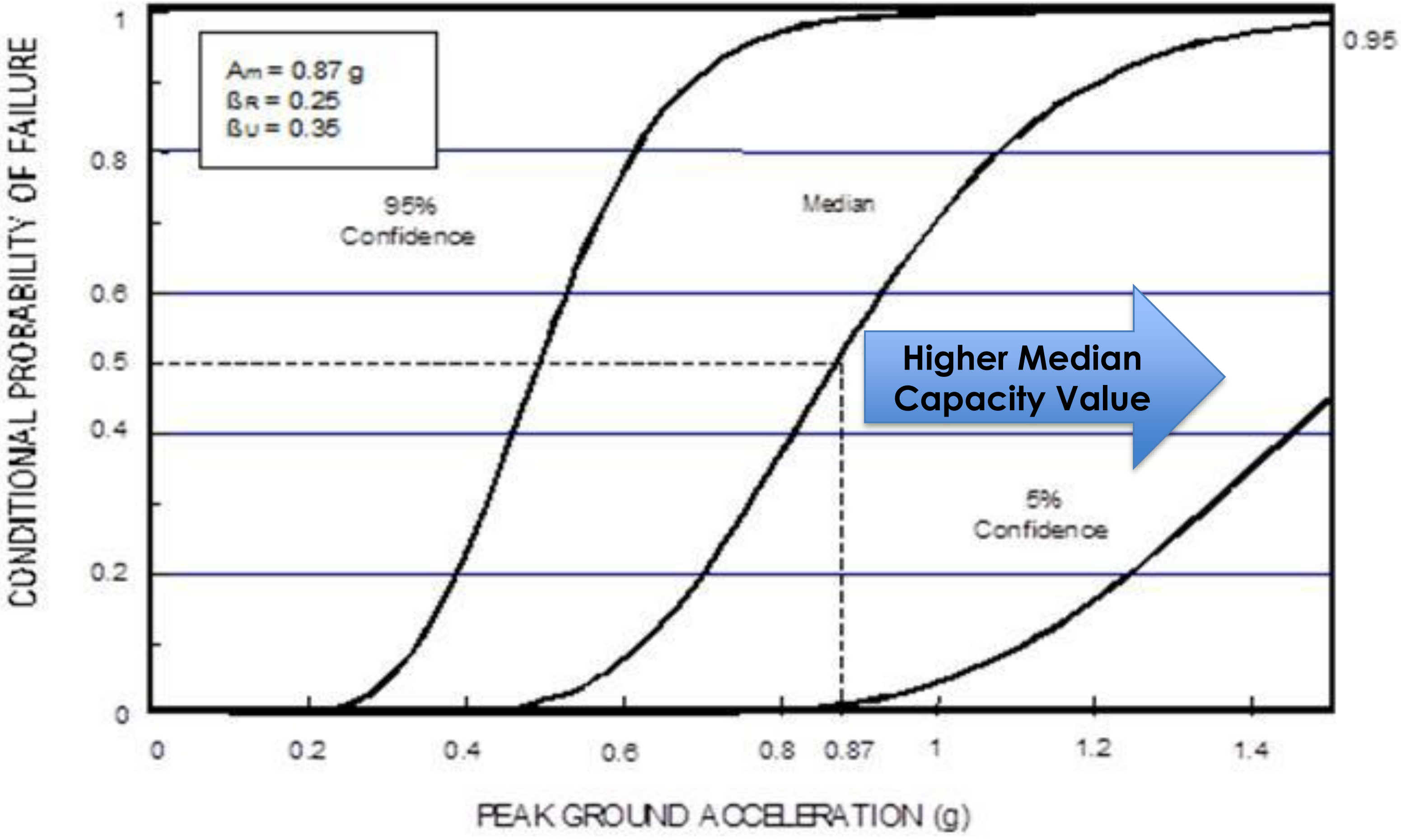
Seismic Capacity: A Primer

- **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