



WGRISK Technical Session: Non-CDF/LRF Metrics and Advanced Reactors

27th Meeting of the OECD/NEA
Working Group on Risk Assessment (WGRISK)



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Risk Metrics for Advanced Reactors

OBJECTIVES

- Investigate the range of risk metric options available for use in advanced reactors
- Assess their strengths and weaknesses
- Recommend a common approach for advanced reactor risk calculations to support risk-informed decision making

KEY QUESTIONS

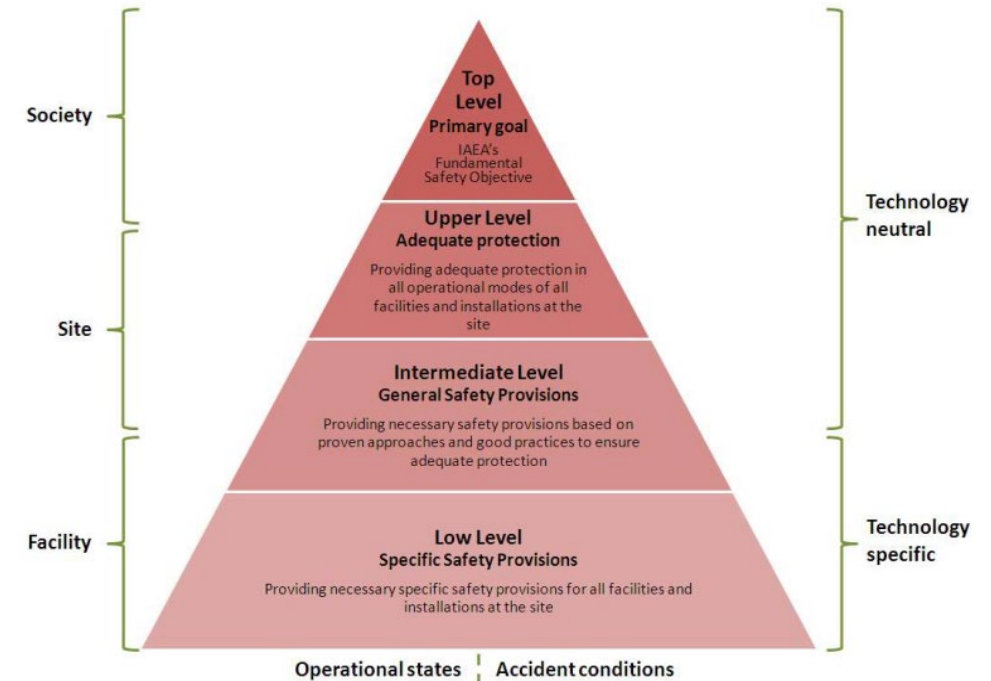
- While CDF and LERF/LRF work well for the current fleet of LWRs, what are their strengths and weaknesses for application to advanced reactors?
- What is the background for the NRC's Quantitative Health Objectives (QHOs), and what are its strengths and weaknesses for risk-informed decision making for advanced reactors?
- For advanced reactor designs that are not conducive to the use of CDF and LERF/LRF, what are the other options for risk metrics and how are they related to higher level objectives such as the QHOs?

Risk Metrics for Advanced Reactors - Background

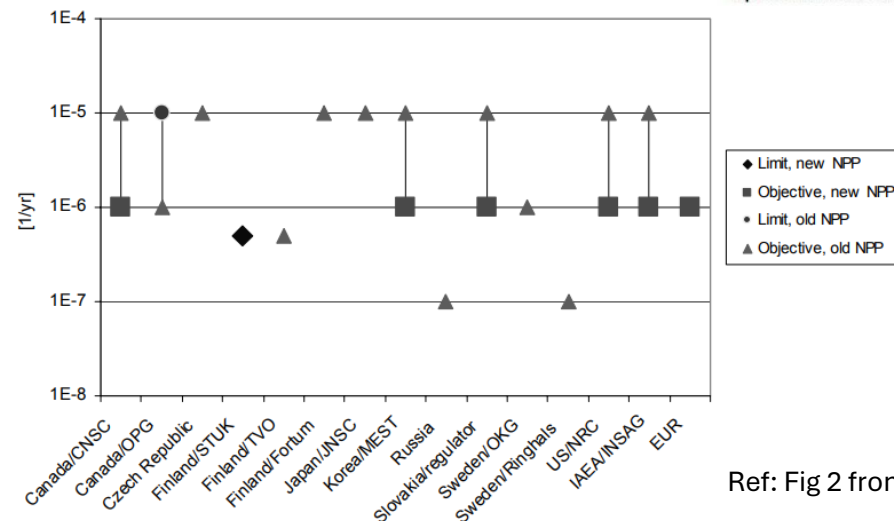
- Background on CDF/LERF/LRF
 - How was development related to US Quantitative Health Objectives?
 - What are the underlying assumptions in current metrics?
 - What are global perspectives on metrics?
 - What are global thresholds for risk?

- Options for risk metrics

- Analogies to CDF/LERF/LRF
- New design-specific metrics
- New technology-neutral metrics
- Existing options (e.g., NEI 18-04)



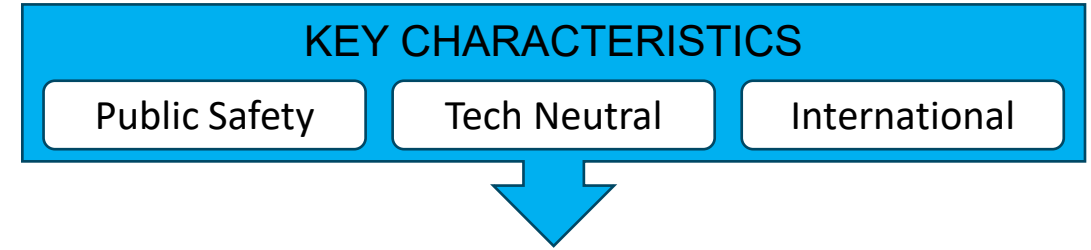
Ref: Fig 2 from IAEA TECDOC-1874



Ref: Fig 2 from NEA/CSNI/R(2009)16

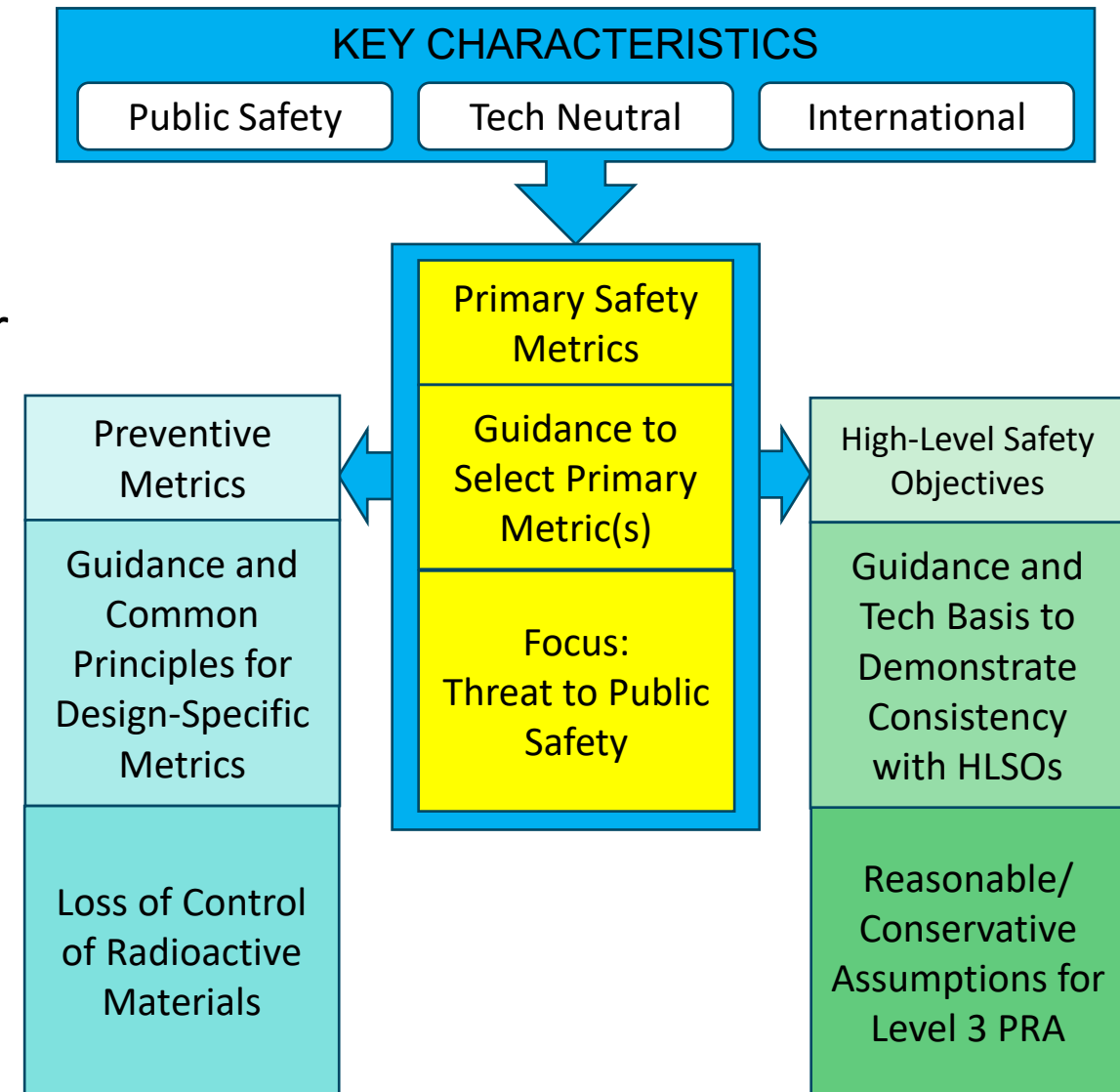
Risk Metrics for Advanced Reactors – EPRI Approach

- Key Characteristics for Risk Metrics
 - Focus on public safety
 - As codified in regulations
 - Technology-neutral
 - To apply to LWRs & NLWRs
 - International
 - To support global deployment



Risk Metrics for Advanced Reactors – EPRI Approach

- Primary Safety Metric(s)
 - Guidance for common metric selection
 - Focus on public safety
 - Potential metrics based on release and/or dose
- Preventive Safety Metric
 - Guidance for design-specific metrics
 - Loss of control of radioactive materials
 - Core Damage Frequency or similar
- High-Level Safety Objectives
 - Guidance to demonstrate that surrogate metrics are consistent with HLSOs
 - Underlying assumptions for Level 3 PRA

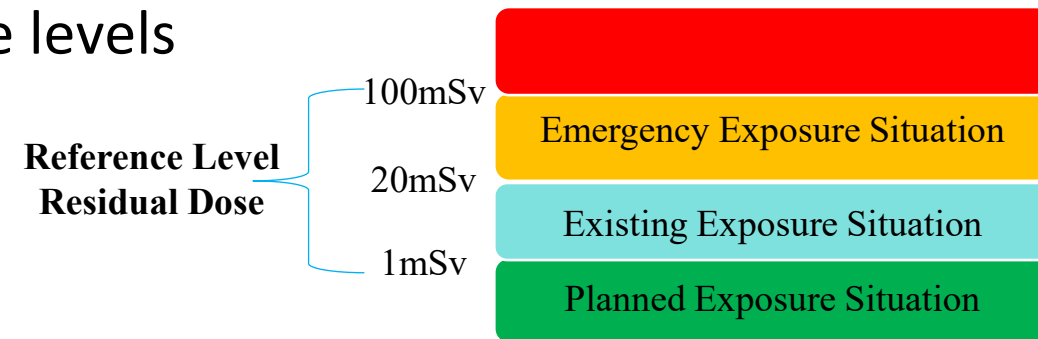


Component 1: The Consequence

- Recommended consequence: Dose
 - Non-selected options
 - Large/Early Release – difficulty in variable definitions, dependencies on offsite actions, questionable applicability to some designs
 - Activity of Release – difficulty in selection of specific radionuclides due to variation among different reactor fuel types, assumptions related to offsite impacts
 - May be useful for land contamination or other impacts
 - Why dose?
 - Independent from reactor design
 - Direct measure of potential offsite impacts
 - Existing regulatory requirements and other documents

Component 2: The Consequence Metric

- Primary goal: Focus on public safety
 - Limit the need for offsite response to protect the public
- Emergency action levels vary by regulatory authority
 - IAEA GSR Part 7 provides reference dose levels
 - 50mSv for evacuation
 - US Protective Action Guides
 - 10-50mSv (1-5 rem) over 4 days
 - Shelter-in-place / evacuation
- Distance for the dose can be set at the boundary to align with goal to limit the need for offsite response
- Recommendation: specified dose at the boundary for a set time
 - Dose of 50mSv (5 rem) encompasses most definitions for necessary offsite action
 - Recognize that different regulatory environments may require different definitions

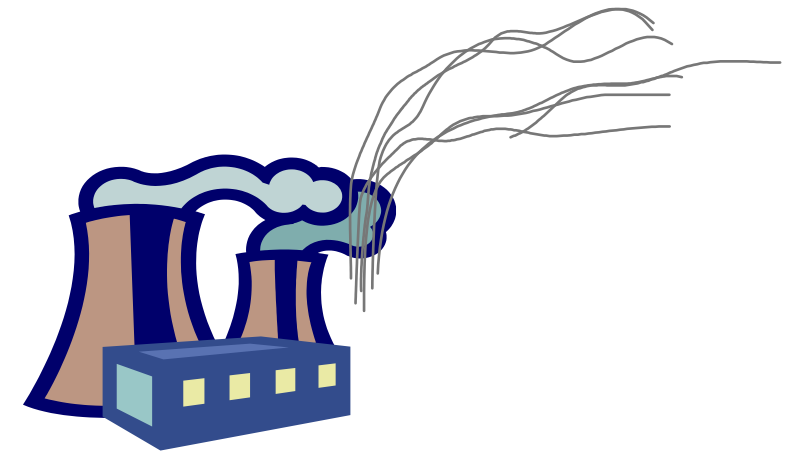
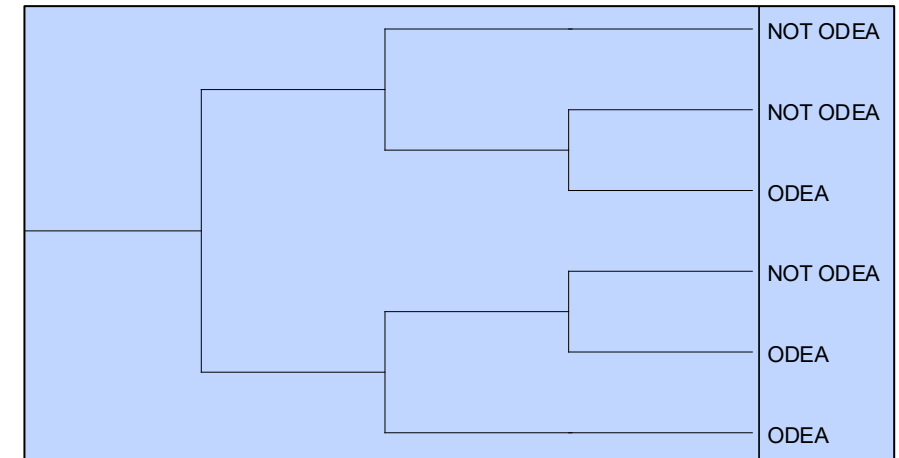


Component 3: Frequency & Acceptance

- Components 1&2 indicate a risk metric for exceeding a defined level of offsite dose (e.g., 50mSv)
 - Doses below the selected limit would have insignificant offsite impacts
 - Metric can be calculated as end-state of Level 2 / early Level 3 PRA model
 - Sum of sequences exceeding the defined dose limit
 - Fractional contributions from sequences may also be considered
- Considerations for a target value
 - A range of risk targets exist, but none match this metric yet
 - Different plant designs may require a different target value based on different maximum potential release
 - If a facility is below the to-be-identified target, then the QHOs or other high-level safety objectives can be assumed to be met

Suggested Primary Technology Neutral Risk Metric

- Offsite Dose Emergency Action Frequency (ODEAF)
 - Use best-estimate consequence estimates based on current PRA expectations
 - Subject to regulatory requirements for dose calculations
 - Simplified/conservative approaches may be acceptable in some cases
 - Geographic boundary to be defined by licensee (e.g., site or EAB)
 - Include consideration of all hazards and all sources
- Meets the PRA purpose to address the low-frequency/high-consequence realm
- Differentiates between licensee vs regulatory authority



Guidance for Preventive Metrics

- Purpose: Indicate accident scenarios prior to offsite release to support defense in depth
 - Allows for actions to be taken to remedy the undesirable plant safety performance
 - Indicates a change in the reactor's state of operation that defeats a layer of defense-in-depth
 - Available supporting methods such as Objective Provision Trees from IAEA TECDOC-1570
 - EPRI report includes a technology-neutral approach to identify and select appropriate preventive metrics



Guidance for High Level Safety Objectives

- Purpose: Justify the use of the surrogate metric
 - Linkage of the primary risk metric to national and/or international high-level safety objectives
 - Identify and re-evaluate assumptions related to existing surrogate metrics
 - Identify plant-specific information needs (related to Level 3 PRA)
 - EPRI report includes a technology-neutral approach to demonstrate consistency between surrogate metrics and high-level safety objectives



Risk Metrics for Advanced Reactors – EPRI Research

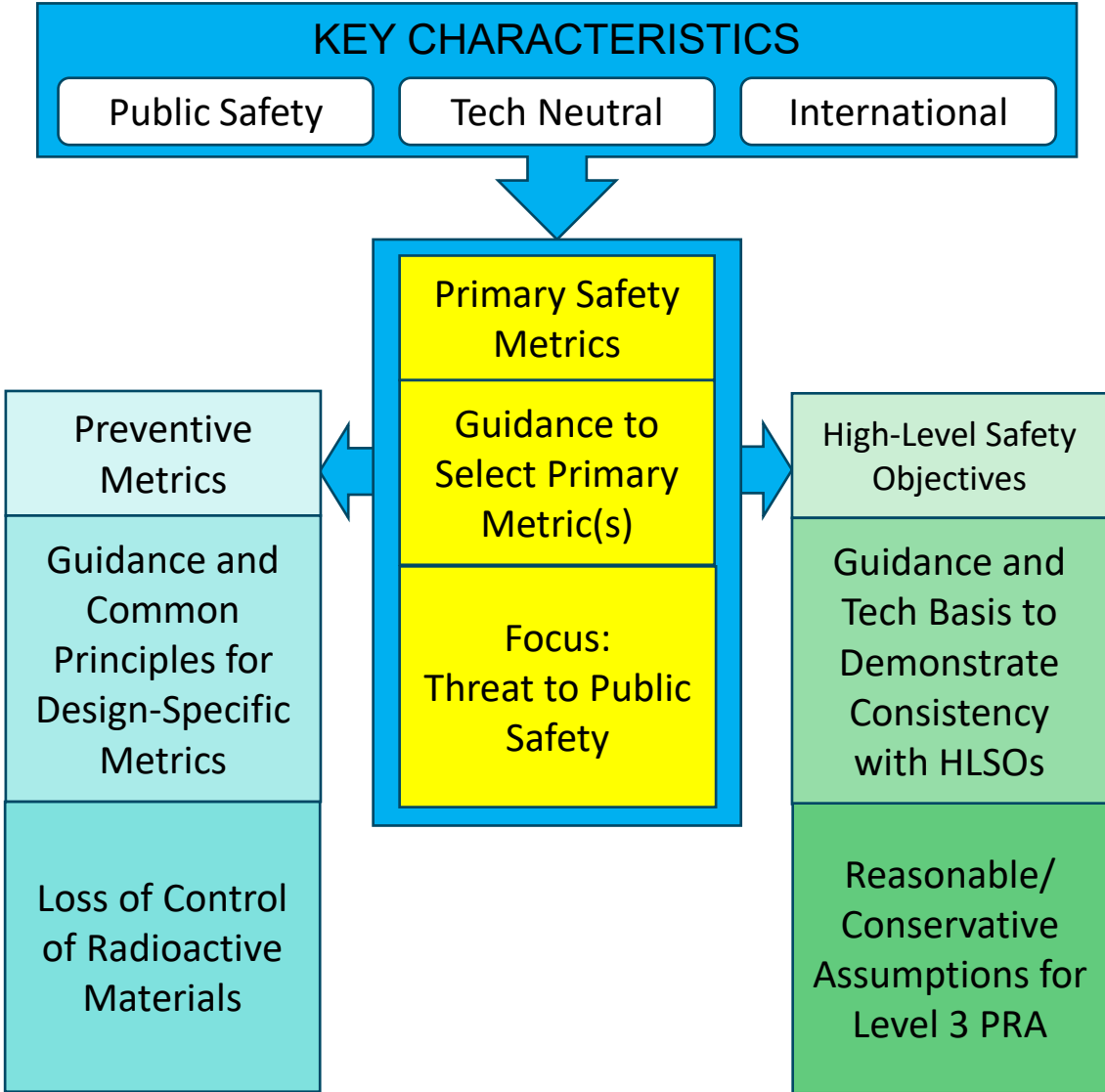
- Next Steps

- EPRI Report 3002029252, Guidance for Selection of Risk Metrics for Advanced Reactors

- published November 2024



- Interaction with regulators and other stakeholders





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