Risk Informed Decision Making in Canada

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34th Annual Regulatory Information Conference
RIC 2022, March 8-10, 2022

Outline

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- RIDM Key Principles
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- PSA use to support RIDM
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- Benefits and pitfalls of PSA use in RIDM
- Summary

RIDM in the Regulatory Framework

- REGDOC-3.5.3 "*Regulatory Fundamentals*" describes the risk-informed approach to licensing and compliance activities: Focus on issues of higher risk to improve regulatory effectiveness and efficiency

- Internal RIDM policy that further elaborates on situations where staff can apply a risk-informed approach for regulatory requirements and guidance, and for regulatory decisions.

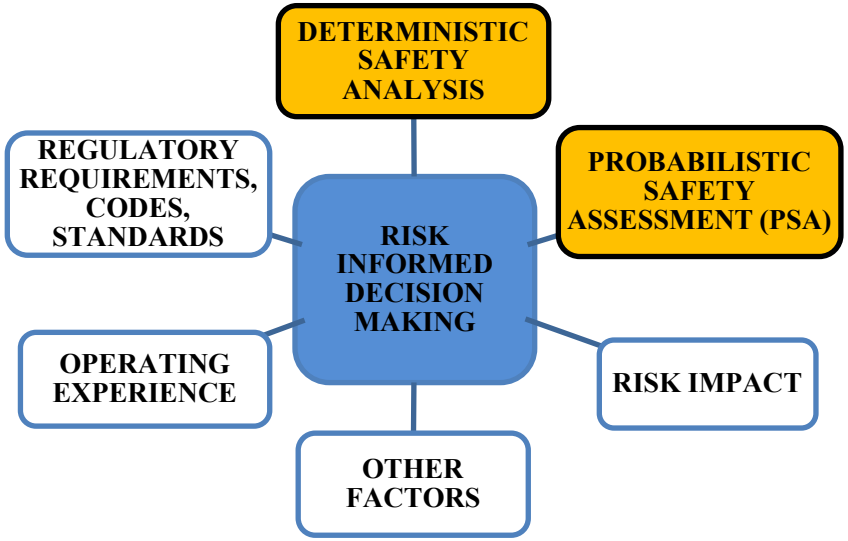
- The risk-informed approach emphasizes that PSA results can be used to complement the deterministic approach, and RIDM key principles
  - PSA limitations, such as the degree of uncertainty should be considered

RIDM in the Regulatory Framework

RIDM integrates insights from DSA, PSA, OPEX, and the mandatory requirements.

Types of decision Candidates for RIDM

- **Design :** e.g., Comparing design alternatives
- **Siting**
- **Licensing:** e.g., Changes in OP&Ps (TEC-SPECS)
- **Operation, Maintenance and testing**
- **Regulatory Oversight** including Operational events reviews
- **PSR and Life Extension**
- **Decommissioning**



RIDM Key Principles

- **Relevant regulations are met**
- **Defence in depth (DID) is maintained**

Generally assessed without invoking PSA. However, Cutsets inform by revealing how many failures must occur for CDF or LRF

- **Safety Margins (SM) are maintained**

In some cases, PSA can inform where SMs are degraded, e.g.: Changes in SSC seismic fragilities; quantifying the failure point of Containment through Level 2 PSA; Cliff-edge effect assessment

- **Acceptable Risk Impact**

PSA evaluates the risk significance by calculating ΔCDF/ΔLRF

- **Monitor Performance**

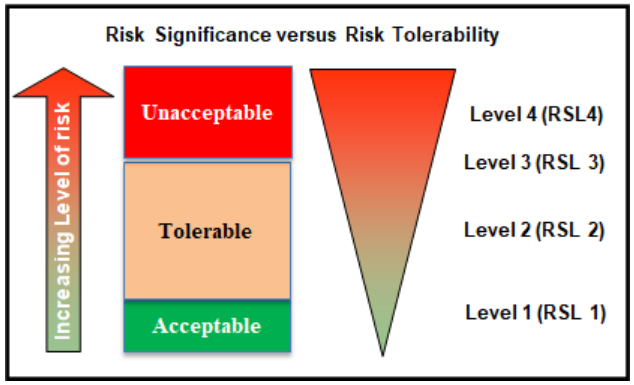
Challenge:
Is-there a balanced way for the consideration of these key principles in an integrated RIDM?

Brief History of RIDM in Canada

- **Traditionally:** Decision making heavily relied on DID and Expert Judgment
- **Last decades:** Increasing use of PSA information in RIDM
  - **June 4, 1996:** Ottawa workshop on "**Risk-Based Regulation**
  - **2005:** Issuance of PSA, and Reliability Regulatory Documents (S-294 and S-98)
  - **2007-2011:** Staff developed RIDM procedure based on CSA Q850 "*Risk management*".
  - **2008-2012:** All Licensees submitted full scope PSA methodologies and reports
  - **2018:** Regulatory document REGDOC-3.5.3 "*Regulatory Fundamentals*". This REGDOC is updated in 2021
  - **2019:** CSA N290.19 "RIDM for NPPs", building on Staff procedure

Staff Procedure for Risk Evaluation

- Uses Risk Tolerability scale for determining the risk significance levels (RSL)
- Risk Evaluation is based on using matrices (consequences/likelihoods) for defining RSL
- Introduces consideration of **Time at Risk** to provide guidance on Risk Control Measures



Risk Significance Levels

Consequences			
C4	3	4	4
C3	1	3	4
C2	1	2	3
C1	1	1	2
	L1	L2	L3

Likelihood

This has been successfully applied for the reclassification of the CANDU Generic Safety Issues, e.g.;

- Pressure tube failure coincident with moderator heat sink failure (LOCA/LOMA)
- Safety improvements for Steam Line Breaks for multi-unit NPPs
- Large LOCA reclassification of certain break size to BDDA

PSA Use to Support RIDM

"Risk Handbook", a web-based application tool

PSA and the Reliability Program results and insights are used to risk-inform the Licensing and Compliance verification activities

Other PSA uses to support RIDM include

- **Risk Management for Outage Planning and On-Line Maintenance** (Risk monitor)
- **Life extension projects**: PSA help identify plant Safety Improvement Opportunities (e.g.; Installation of CVFS, Emergency Mitigating Equipment (EME), …)
- **SAMG development**: PSA inform SAMG development by characterizing the potential timing and magnitude of hazards during a severe accident.
- **Emergency Preparedness Drills and Exercises**: Simulated scenarios are typically derived from Level 2 PSA analyses.

CNSC Risk Handbook

Purpose: Risk Handbook is developed as part of the CNSC's risk-informed, performance-based approach to support the regulatory compliance program, focusing primarily on applications for inspections

Risk Handbook used to:

1. **Optimize inspection planning and improve efficiency:** Focus on risk significant SSCs, Initiating Events, and Human Actions, Specific hazard information
2. **Provide risk insights** to define the scope of existing regulatory inspection procedures: (Electrical/Mechanical Systems Inspections; Human performance; EQ, and seismic qualification inspections; Fire and flood hazards inspections)
3. **Evaluate inspection results**, and provide a rough estimate to Inspectors of the risk impacts in situations where an SSC is taken out of service, or a system experiences an impairment level
4. **Help in the determination of safety significance** of operational events

Emergency Mitigating Equipment Credit in PSA

EME mitigating functions

1. **Prevention of a severe accident:** Inject water into the SG to restore heat sink before occurrence of fuel channel failure
2. **Repower instrumentation and monitoring of critical safety parameters**
3. **Prevention of severe core damage:** Prevent severe core damage by injecting water into the calandria
4. **In-vessel retention of collapsed core:** Provide effective cooling so accident progression is arrested by retaining the debris inside the calandria vessel
5. **Repower containment supporting functions** (containment heat removal, hydrogen control, accident filtered release, etc.)

Applicable to Level 1 PSA (Modelled in ET and FT logic)

Applicable to Level 2 PSA

Emergency Mitigating Equipment Credit in PSA

Pre-requisite for EME credits in PSA

- There is clear guidance to deploy EME, and
- Decisions are made with the MCR or Secondary Control Room by authorized staff (e.g., Control Room Shift Supervisor, Shift managers)

Challenges

- **Use of PSA models, with or without EME credit, for different applications**
  - Comparison against safety goals,
  - Identification and classification of Systems Important to Safety (SIS),
  - Risk monitor,
  - Risk significance determination for operational events and inspection findings,
- **EME credits in Multi-unit PSA**
- **Surveillance requirements for EME**

Benefits and Pitfalls of PSA Use in RIDM

Benefits

- PSA provides a rigorous and reproducible assessment of incremental risk (ΔCDF, ΔLRF), as well as (ICDP, ICLRP), compared to RSL determination using the risk matrix (based on subjective judgment)

  e.g.; in Traditional deterministic approach: "*If the system redundancy is reduced, repairs shall be made* ***promptly,*** *or other action taken to ensure adequate system reliability and capability".*

Pitfalls

- **Absence of cause-and-effect relationship in some cases:** e.g., ECCS valve passing (not modelled in PSA); Change in Methodology for trip set points determination; Piping Inspection; ….
- **Uncertainties in the PSA**
- Caution about over reliance on PSA to address all safety concerns

Risk informed as opposed to "Risk Based" is a recognition of limitations and uncertainties associated with the PSA

Summary

- Guidance is needed on how to assess the impacts on DID; Safety Margins; as well as the principles and process for Benefit Cost Analysis
- PSA is one of the key principles of the IRIDM. It can provide valuable qualitative and quantitative risk insights for the decision maker to complement the current Staff procedure for risk evaluation based on risk tolerability
- PSA uncertainties should be considered when evaluating the risk, and more emphasis is put on uncertainty if PSA results are close to acceptance guidelines

Development of RIDM guidance allows a transparent and reproducible process for regulatory decisions to support operations and operational events analyses

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