Rationalist-Based Regulatory Framework: Foundation for Enabling Innovation

REGULATORY INFORMATION CONFERENCE (RIC) 2023
BUILDING ON A STRONG FOUNDATION:
A VOYAGE THROUGH RISK INFORMED DECISION-MAKING
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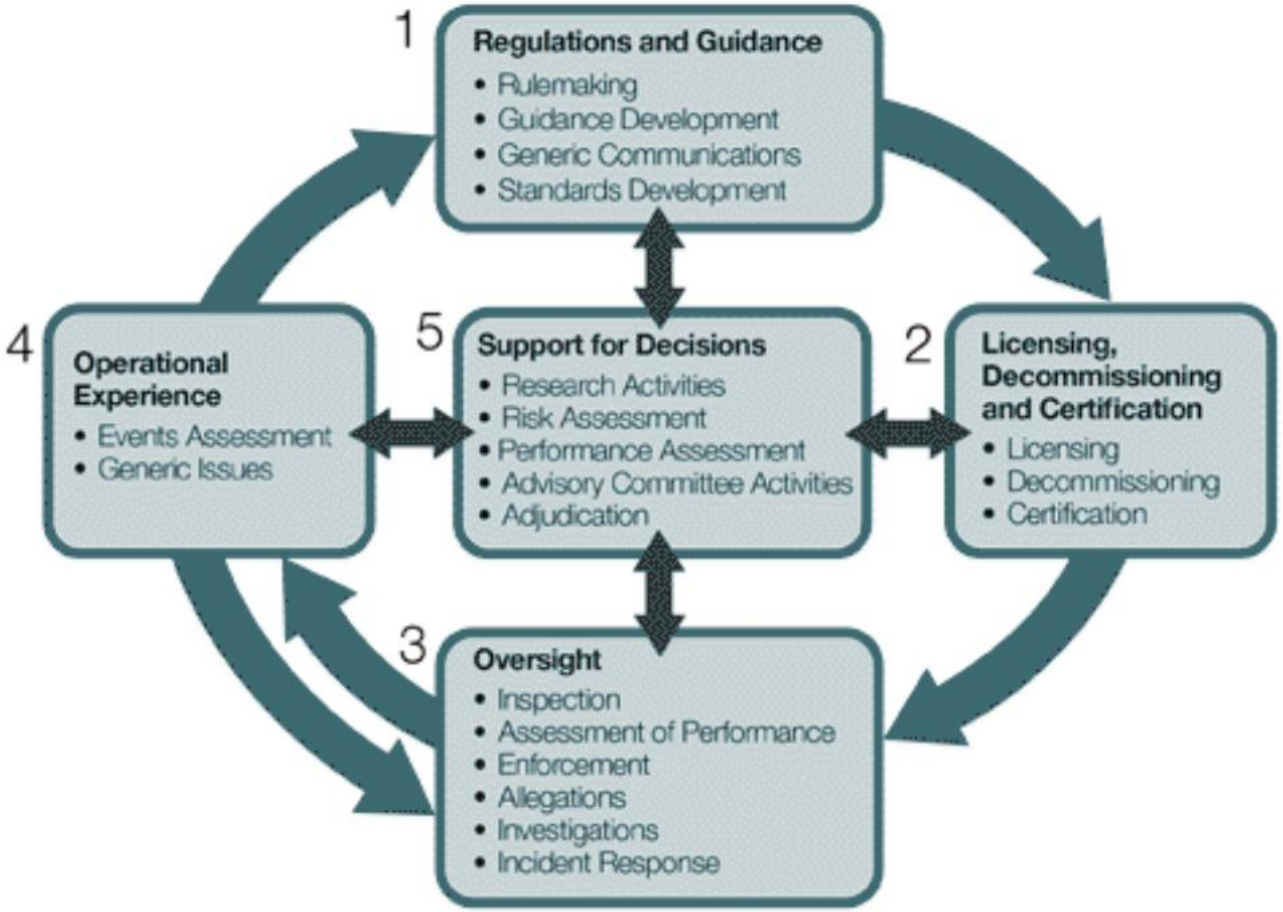
The Premise

- Innovation is vital for the nuclear energy to remain relevant long-term option for energy generation
- A regulatory framework based on a rationalist approach and executed through risk- informed/performance-based programs is the best option to enable innovation while ensuring reasonable assurance of adequate protection of the public

Presentation Context:

NRC Regulatory Framework



1. *Developing regulations and guidance for applicants and licensees.*
2. *Licensing or certifying applicants to use nuclear materials, operate nuclear facilities, and decommission facilities.*
3. *Inspecting and assessing licensee operations and facilities to ensure licensees comply with NRC requirements, responding to incidents, investigating allegations of wrongdoing, and taking appropriate followup or enforcement actions when necessary.*
4. *Evaluating operational experience of licensed facilities and activities.*
5. *Conducting research, holding hearings, and obtaining independent reviews to support regulatory decisions.*

Presentation Context: Regulations' Intent

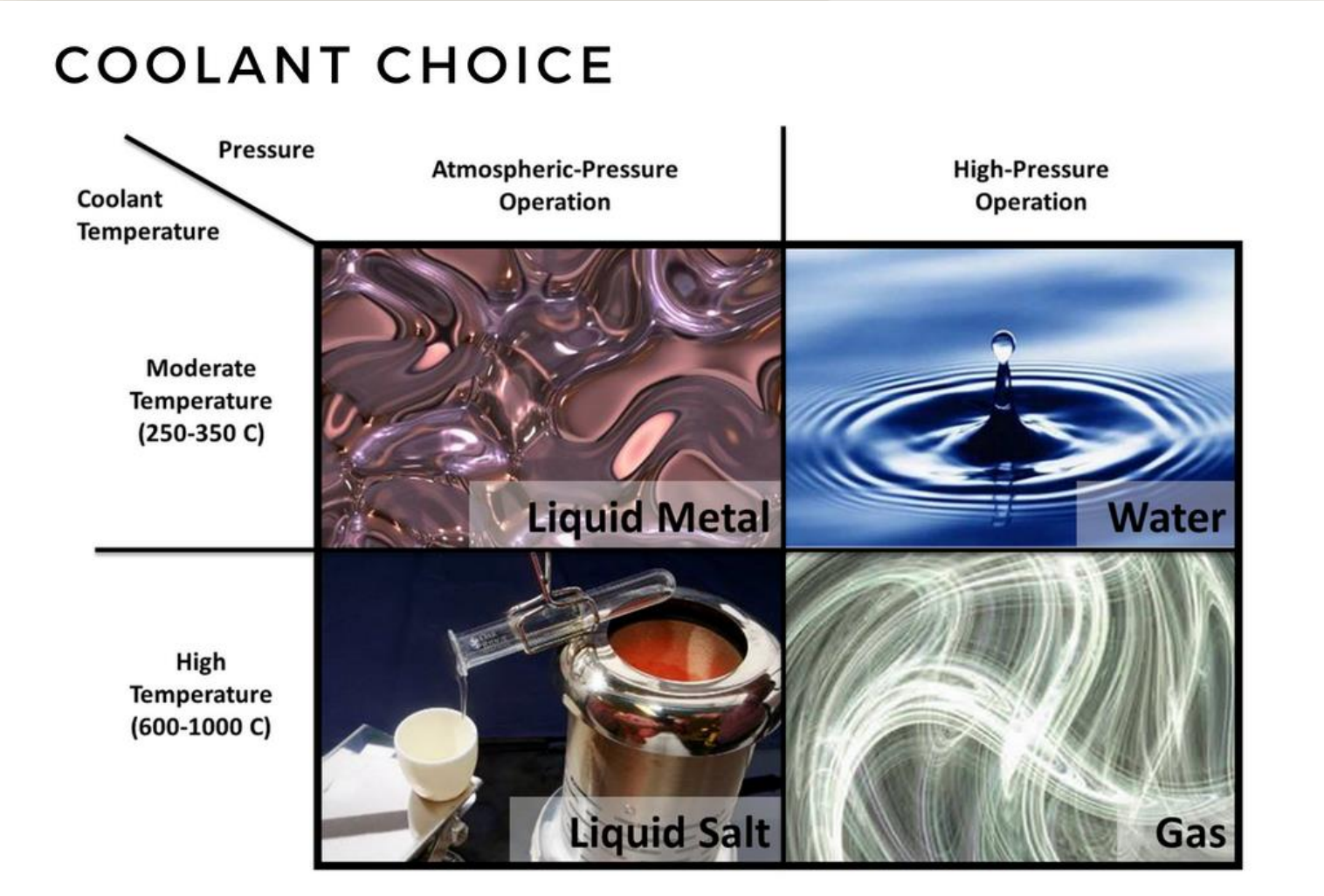
To deal with risk to the public through the principles of defense in depth (DID) and safety margins during life cycle of a plant

Possible regulatory framework constructs

- Unstructured:
  - **Ad hoc,** resulting in case-by-case evaluation of a design and to provide oversight during its life cycle.
- Structured- Two primary constructs:
  - The **structuralist** construct which asserts that DID is embodied in the structure of the regulations and in the design of the facilities built to comply with those regulations
  - The **rationalist** construct which asserts that DID is the aggregate of provisions made to compensate for uncertainty and incompleteness in our knowledge of accident initiation and progression

Presentation Context:

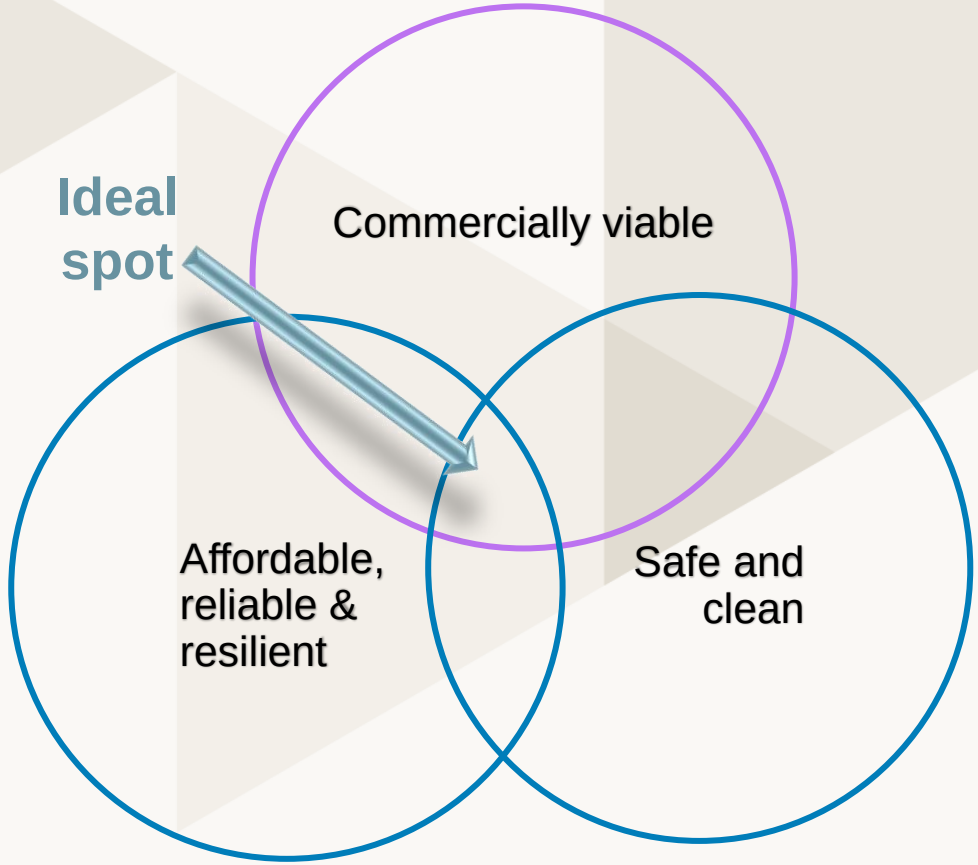
Technology options being considered based on business needs



Innovation is Required to Remain an Option for Safe, Affordable, Reliable, and Resilient Energy Generation

To enable energy providers to meet their **responsibilities** to their stakeholders on the **right timeline**:

- **Commercially viable** – Through minimizing construction and operational costs and deployment timeline while maximizing energy production
  - *Target*: Shareholders
- **Affordable, Reliable, Resilient Product**
  - *Target*: Customers
- **Safety and Environmental**
  - *Target*: Public

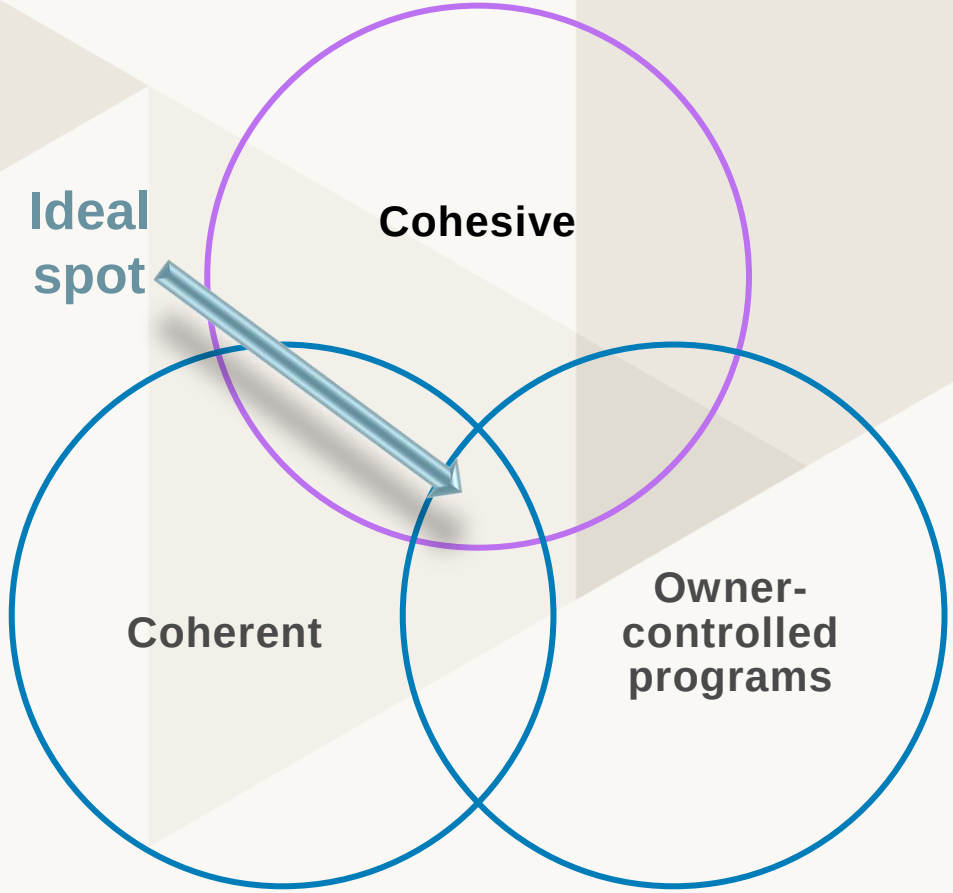


“Innovation is the only way to win”- Steve Jobs

Goals of Innovation Enabling Regulatory Framework

Goals-

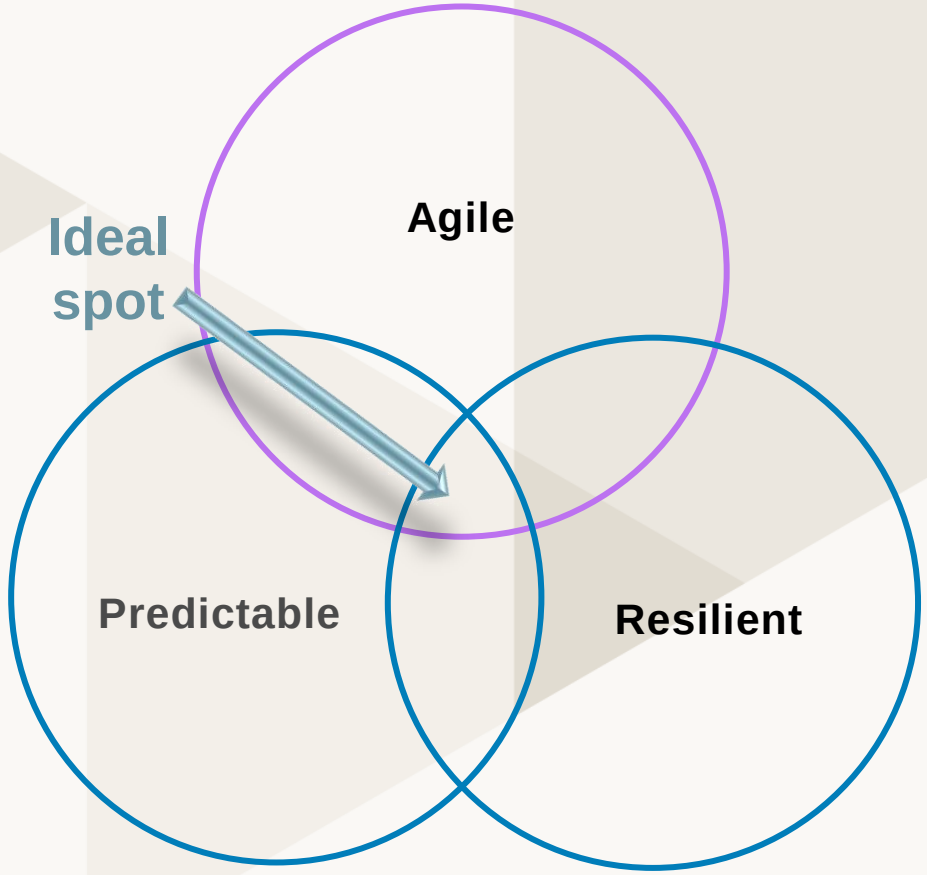
- **Cohesive** technical requirements and regulatory oversight programs to be set for all stages of a nuclear power plant life cycle (Design, Licensing, Construction, Operation, and Decommissioning)
- **Coherent** to set consistent regulatory requirements and oversight programs for different designs based on design-specific safety margins
- **Owner-controlled programs** for managing reasonable assurance, which will have shown to improve efficiency and effectiveness of such programs (programmatic requirements such as Risk-Informed Inservice Inspection)



Attributes of Innovation Enabling Regulatory Framework

Attributes:

- **Agile:**
  - Integrated requirements for entire plant life cycle to equitably treat a variety of nuclear energy generating systems
- **Predictable:**
  - Performance objectives are explicitly established
  - Technology-inclusive guidance to meet the expected objectives are provided
- **Resilient:**
  - Manages state of knowledge and state of art changes effectively without unnecessary burden, delay or disruption
  - Enables and incentivizes safety improvements



A regulatory framework based on a rationalist approach and executed through risk- informed/performance-based programs is the best option to achieve all the desired goals and characteristics (outlines on slides 6 and 7)

Examples of Current RIPB/Owner-Controlled Programs
Improving Safety and Reducing Unnecessary Burden

Regulatory Framework Component 1

- Technical Specifications (e.g., Allowed Outage Time (aka initiative 4b)),
- Fire Protection Plan (e.g., NFPA-805),
- RIPB Inservice Inspection of piping (RI-ISI),
- RIPB Surveillance Frequency Program (aka Initiative 5b)
- 10CFR 50.69 (RI categorization and treatment of structures, systems and components).

Regulatory Framework Component 2

Regulatory Framework Component 3

- Reactor Oversight Program (e.g., Significance Determination Program)
- 10CFR50.65 Requirements for monitoring the effectiveness of maintenance at nuclear power plants

Regulatory framework Component 4

- Operational Experience Evaluation – LIC-504 "Integrated Risk-Informed Decision-Making Process for Emergent Issues."

Regulatory Framework Component 5— Research in support of the other four components

- Level 3 PRA, RIPB seismic design basis, analytical tools, etc.

All these RIPB programs, almost all of which are executed through owners-controlled programs, have replaced prescriptive programs and

- **have proven** to
  1) **improve safety,**
  2) **reduce unnecessary burden, and**
  3) **optimize use of (owner-operators and regulator) staff time.**
- **have facilitated** cultural transition from a **compliance-mindset** to **excellence-mindset** decision-making where compliance is the minimum objective.

Examples of RIPB/Owner-Controlled Programs
Enabling Safety Improvement and Burden Reduction

Regulatory Framework Component 1

- **Approved for use in Part 50 and 52, can be used - NEI 18-04:** RIPB method for Design Basis Events (AOOs, DBAs, BDBEs), SSC classification, and Defense-in-Depth adequacy evaluation for non-LWRs (AKA LMP) (both Advanced Reactor Demonstration Projects (ARDP) are using the methodology)
- **Underdevelopment Part 53 - Risk Informed,** Technology-Inclusive Regulatory Framework for Advanced Reactors, **Framework "A"**
- **Should be developed** – All programmatic requirements (e.g., RI-ISI, RIPB surveillance frequency program, etc.) needed to support meeting the "reasonable assurance" standard
  - **Particular attention should be made to the RIPB owner-controlled program for change evaluation during construction**

Regulatory Framework Component 2

- **Underdevelopment** - Technology-Inclusive content of application for non-LWRs, allowing, amongst other enhancement, RIPB approach for establishing Principal Design Criteria (PDC)

Regulatory framework Component 3

- **Should be developed- Modernized** Reactor Oversight Program (including modernized RIPB Significance Determination (SDP))
  - **Particular and immediate attention should be made to SDP for managing inspection finding during construction**

Regulatory Framework Component 4

- Operational Experience Evaluation – LIC-504 "Integrated Risk-Informed Decision-Making Process for Emergent Issues"
  - **Particular attention should be made to credit the proposed Subpart F of the proposed Part 53, Framework "A" (preferably primarily relying on the owner-control program and a modernized INPO's operational experience program)**

Regulatory Framework Component 5— Research in support of the other four components

- Use of first principle analytical tools (e.g., physics of failure-based reliability estimators) for establishing failure probabilities
- Use of analytical-based models for V&V of Modeling and Simulation (M&S) models used for predicting functional and systems behaviors

Lessons Learned:

From over 30 years of nuclear power plant operation

Lesson 1: Developing a technology specific regulatory framework based on a structuralist construct for light water reactors has shown to result in:

- ***Unnecessary burden*** (as conclusively shown by the results of the current RIPBs)
- ***Siloed conservatism*** (e.g., Design basis for Large Break LOCA + Loss of Offsite Power + Single Failure while missing Small Break LOCA, station-blackout, importance of operator action, etc.)
- ***Additive requirements*** (e.g., issues being addressed by the Cumulative Effects of Regulation (CER) initiative)

Lesson 2: The rationalist approach, using owner-controlled risk-informed and performance-based programs, has resulted in added safety focus, reduction of unnecessary burden, and increased transparency of how requirements are met, operators' performances are evaluated, and state-of-the-knowledge changes are addressed

Lesson 3: Use of Probabilistic Risk Assessment (PRA) insights and results in combination with prescriptive rules (Risk-Informed) will result in

- ***Conservative decision making*** based on realistic analysis
- ***Robust risk-informed*** selection and identification of risk-important events (e.g., WASH-1400)

Conclusion:

From over 30 years of nuclear power plant operation

A rationalist approach, using risk-informed/performance-based methods and programs, is the most likely construct for timely development of a regulatory framework which

- Achieves goals of being **cohesive, coherent**, and enable **owner-controlled programs**
- Will have the **agility, predictability, and resiliency** attributes to enable innovation
- Will ensure the **NRC's mission** " . . to license and regulate the Nation's civilian use of radioactive materials to provide reasonable assurance of adequate protection of public health and safety and to promote the common defense and security and to protect the environment" **is successfully, systematically and transparently met**

Part 53, framework A provides a good starting point for such a regulatory framework and should be:

- Made available as an option for future owner/operators
- Used as a platform for modernizing the entire regulatory framework