Reclaiming the PB in RIPB Regulation

DEEP FISSION

A Prerequisite for Regulatory Readiness and International Harmonization

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Initial Steps Toward Modernization in the U.S.

NRC's Oversight Regime (pre-1998)

- Systematic Assessment of Licensee Performance (SALP)
- Enforcement of compliance with prescriptive regulations

Towers Perrin Report, "Nuclear Regulatory Review Study" (1994)

NRC's "Near Death Experience" (1998-9)

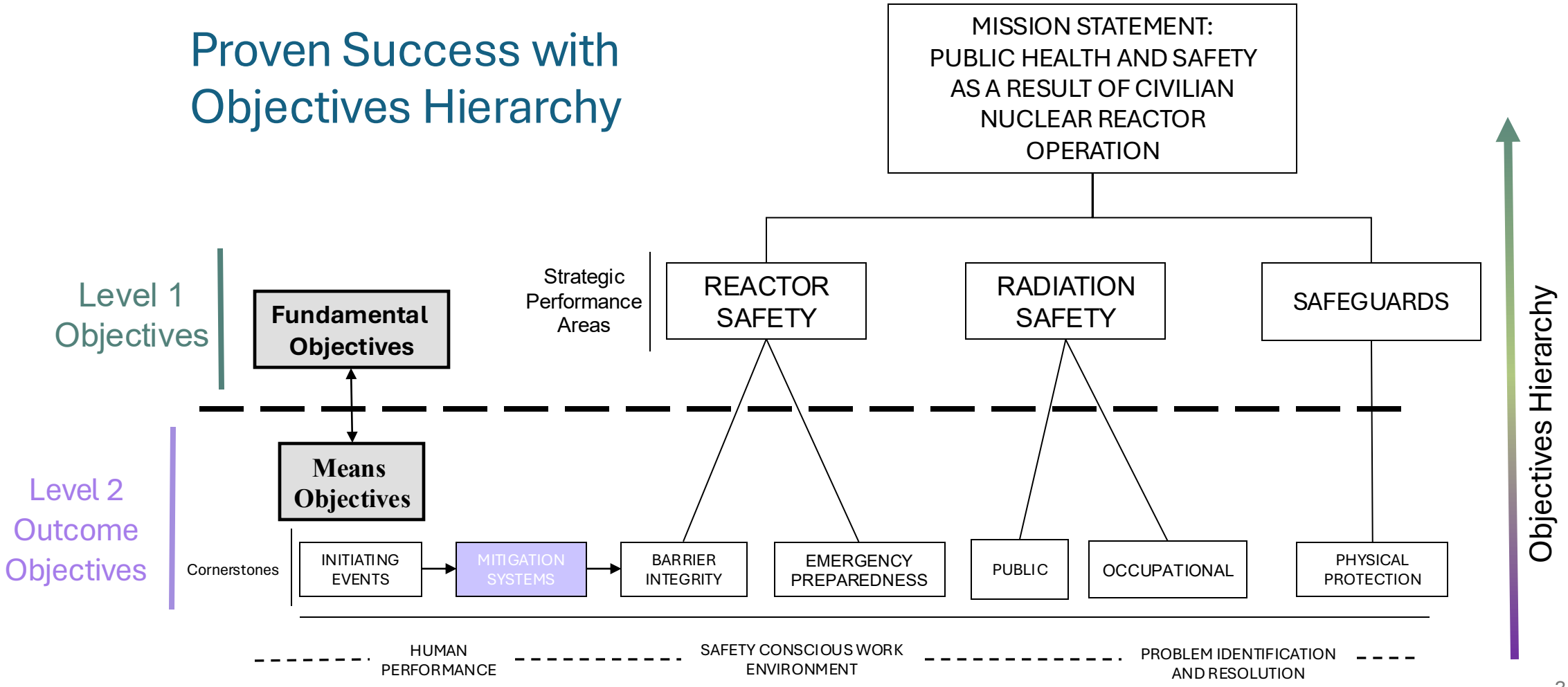
- Testimony by Joe Colvin before Senate EPW Subcommittee
- Staff Requirements Memorandum for SECY-98-144
- Defined terminology around Determinism vs Risk and Prescription vs Performance

Reactor Oversight Process (ROP, implemented in 2000)

- Risk-informed (RI) and performance-based (PB) inspection and assessment process
- NRC's "gold-standard" flagship program widely adopted in some form internationally
- Transformational for industry performance
- Reforms intended for licensing and rulemaking remain unfinished

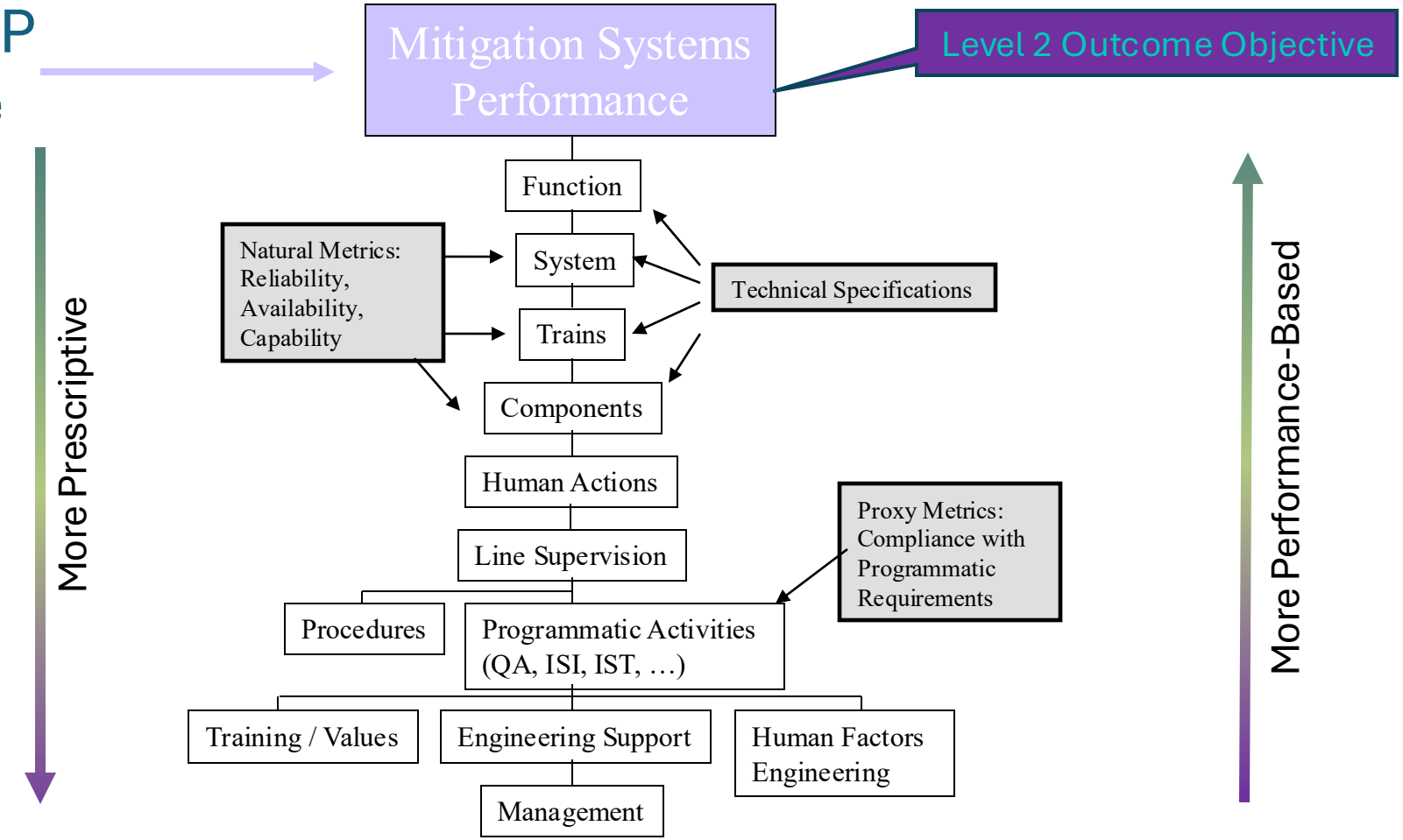
Reactor Oversight Process (ROP) since 2000

Proven Success with Objectives Hierarchy



Means Objectives Hierarchy with Cornerstones

Example ROP Cornerstone



Mandates for Regulatory Modernization in the U.S.

Defined in Nuclear Energy Innovation and Modernization Act of 2019 (NEIMA)

- Mandates RIPB and technology inclusive (TI) Reactor licensing framework
- Transformational approach to licensing advanced reactors, many public meetings, insufficient stakeholder influence
- September 6, 2022, Presentation to World Nuclear Association's (WNA) Law Working Group (LWG)
  - PB attributes recognized as ***key to international regulatory harmonization***

NRC Response: Title10 *Code of Federal Regulations* (CFR), Part 53 Rulemaking

- Draft rule published for comment October 31, 2024
- Voluminous, PRA-centric, and highly prescriptive, borrowing form existing regulations in Parts 50 and 52
- Performance-based attributes largely ignored, revealing knowledge gaps in PB attributes
- Comment period closed February 28, 2025, final rule issued no later than the end of 2027

Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act of 2024

- Reinforced RIPB approached to regulatory modernization
- Targeted mission alignment and culture change at the NRC

What does Performance-based look like?

Attributes Defined in Commission's SRM-SECY-98-144 (1999)

- (1) Measurable (or calculable) parameters (i.e., direct measurement of the physical parameter of interest or of related parameters that can be used to calculate the parameter of interest) exist to monitor system, including facility and licensee, performance…
- (2) Objective criteria to assess performance are established based on risk insights, deterministic analyses and/or performance history…
- (3) Licensees have flexibility to determine how to meet the established performance criteria in ways that will encourage and reward improved outcomes…
- (4) A framework exists in which the failure to meet a performance criterion, while undesirable, will not in and of itself constitute or result in an immediate safety concern.

Why is performance-based critically important?

- Achieves high levels of safety performance without undue regulatory burden

Impediments to Modernization and Harmonization

Resistance to Commission Policy Governing RIPB Since 2000

- Reforms limited to the ROP
- Risk aversion to legal challenge drive prescription (for enforceability) vice flexibility

Lack of Training Leads to Conflation of RI and PB Terminology

- NRC public meeting June 30, 2022, to align on terms, and again on July 28, 2022, to discuss NEIMA concepts
- Conflation persisted during March 27, 2024, and May 23, 2024, Advanced Reactor Stakeholder Meetings

NRC's Regulatory Information Conference (RIC), March 2024

- Question about whether NRC really is performance-based and risk-informed
- Response focused primarily on risk-informed, not performance-based

NRC's RIC, March 2025

- Sarah Eaton, Director General, Advanced Reactor Technologies, Canadian Nuclear Safety Commission (CNSC), Canada
  - Emphasized the need for efficiency and continuous monitoring
  - Described the objective-oriented regulatory regime
- Mark Foy, Chief Executive & Chief Nuclear Inspector, Office for Nuclear Regulation (ONR), United Kingdom
  - Emphasized the need for efficiency and enabling new and innovative nuclear technologies
  - Described the outcome-based regulatory regime

Executive Orders Issued May 23, 2025

Executive Order 14300

- Orders reform of the NRC
- Section 3 reiterates reform of NRC's culture

  … the NRC's mission shall include facilitating nuclear power while ensuring reactor safety. When carrying out its licensing and related regulatory functions, the NRC shall consider the benefits of increased availability of, and innovation in, nuclear power to our economic and national security in addition to safety, health, and environmental considerations.

- Section 5 orders reform and modernization of regulations

  (e) Establish a process for high-volume licensing of microreactors and modular reactors, including by allowing for standardized applications and approvals and by considering to what extent such reactors or components thereof should be regulated through general licenses.

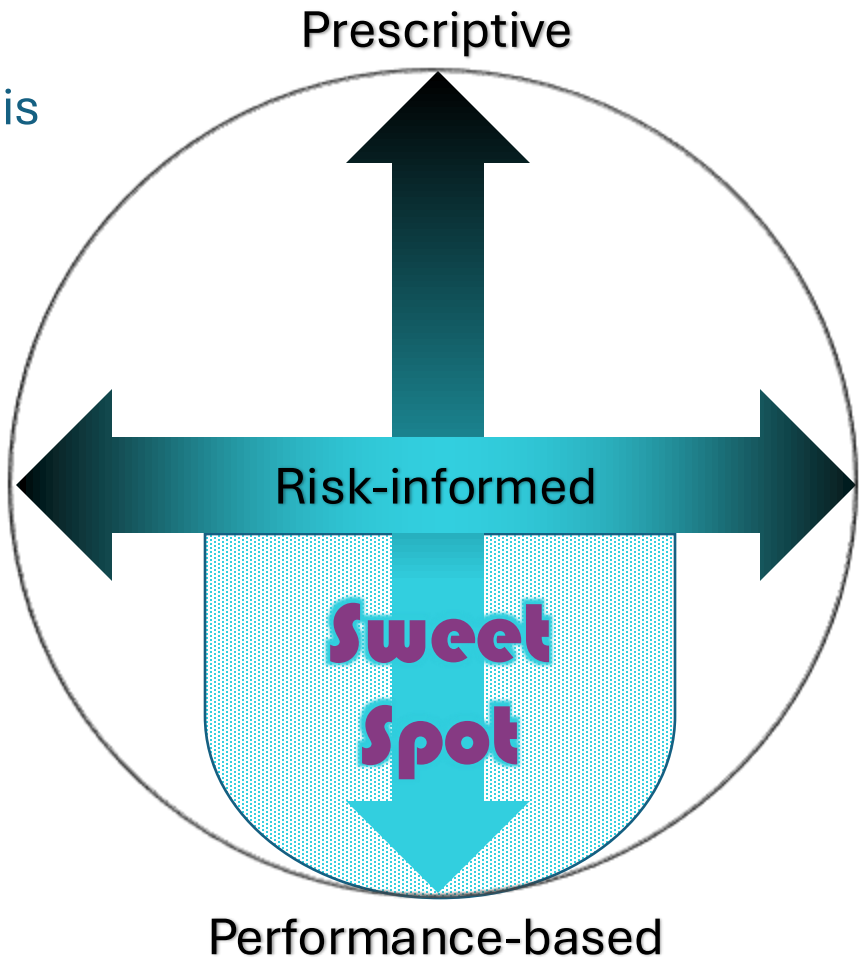
Executive Order 14301

- Orders reform of nuclear reactor testing at the Department of Energy (DOE)
- Section 5 orders establishment of a reactor pilot program outside the national laboratories

  (a) The Secretary shall create a pilot program for reactor construction and operation outside the National Laboratories, pursuant to the Atomic Energy Act's authorization of reactors under the Department's sufficient control, including reactors "under contract with and for the account of" the Department, in accordance with 42 U.S.C. 2140. The Secretary shall approve at least three reactors pursuant to this pilot program with the goal of achieving criticality in each of the three reactors by July 4, 2026.

Performance-based Independent of Risk-informed

Some amount of prescription is necessary to include “shall” statements in regulatory requirements.



Risk is defined as a situation involving exposure to danger.

Objectives Hierarchy:
A performance-based regulation identifies safety objectives at a high level.

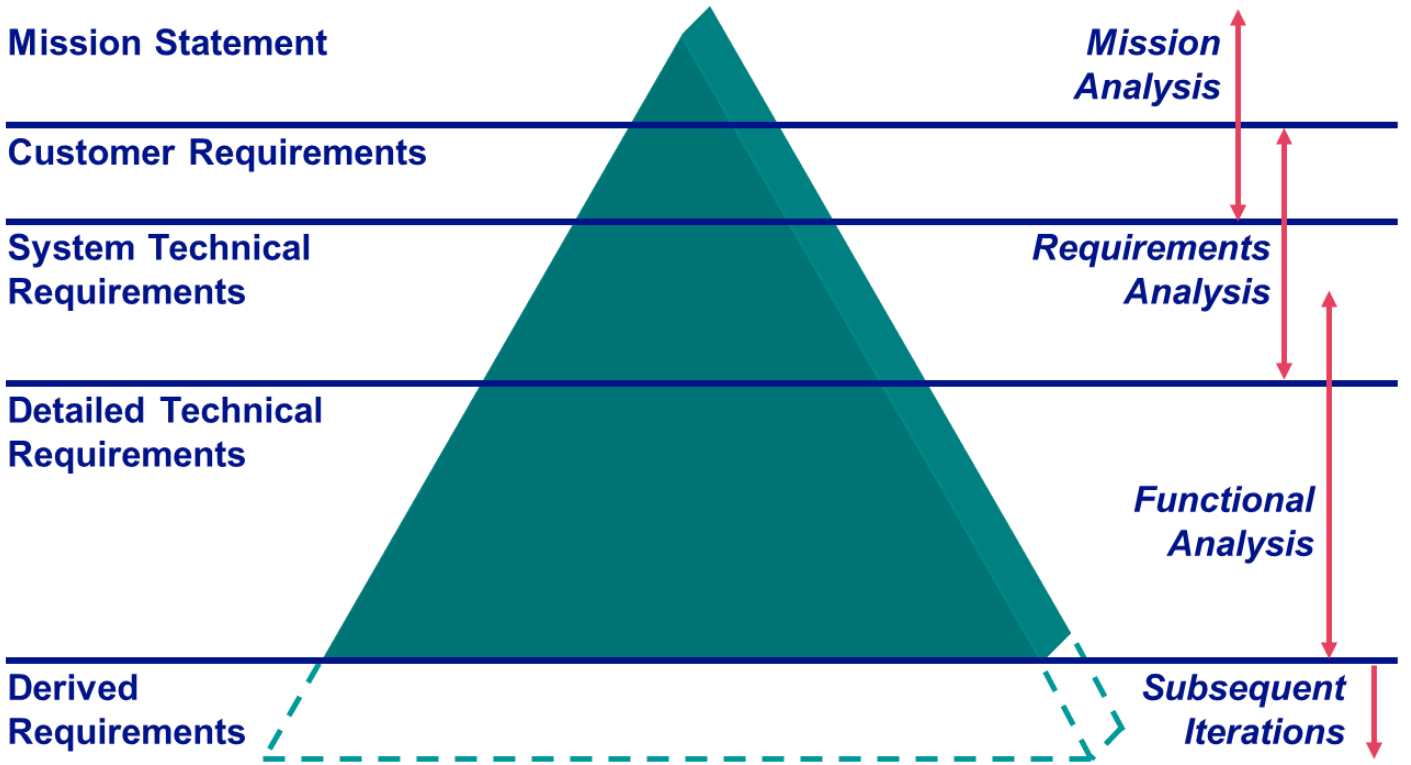
A continuum exists between deterministic, risk-informed, and risk-based.

Attribution: American Nuclear Society (ANS) RP3C Community of Practice, August 26, 2022, “What Society Needs in 10 CFR Part 53” (See https://doi.org/10.21955/nuclscitechnologenres.1115120.1, Slide 6

Typical Requirements Management Structure

Level 1 Objectives

Level 2 Outcome Objectives

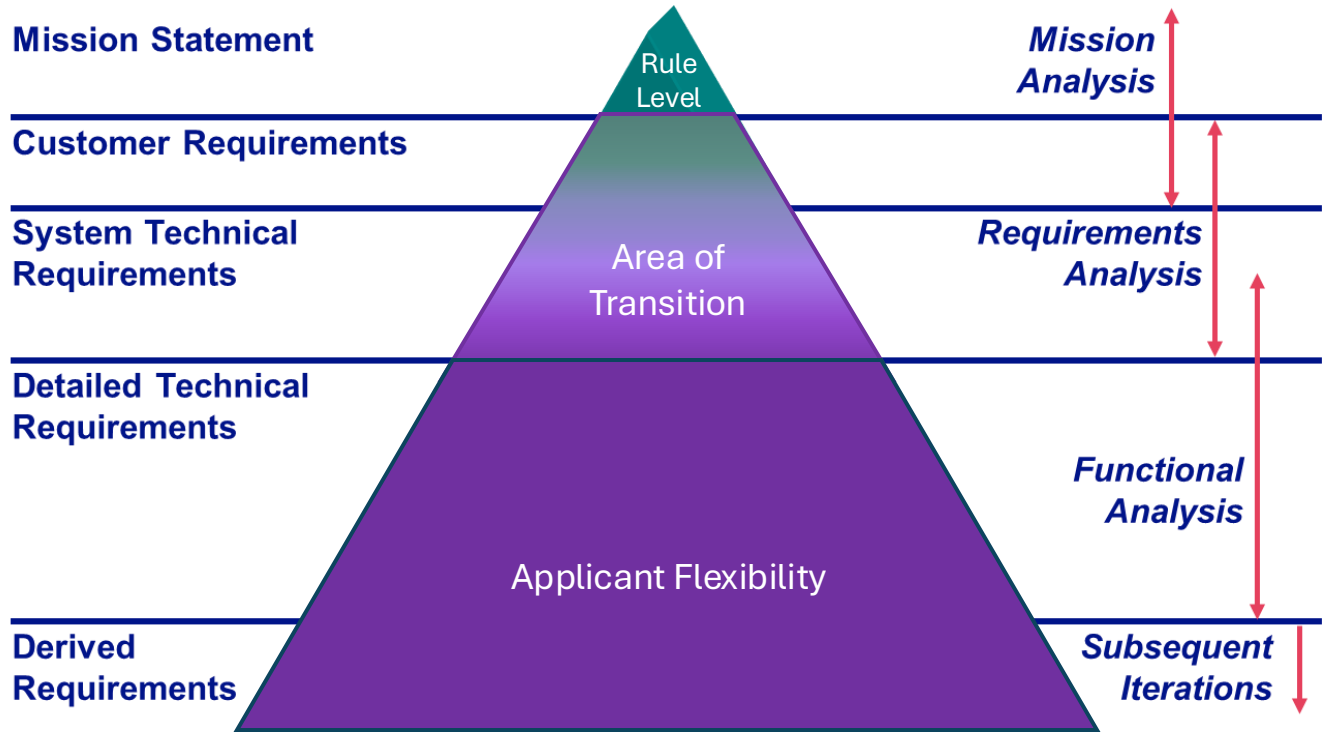


* Attribution: Kent Welter, NuScale Power https://www.ans.org/file/980/RIPB+CoP+2-28-20+Presentation+Systems+Engineering.pdf, Slide 8

Modern & Harmonized Requirements Management

Level 1 Objectives

Level 2 Outcome Objectives



Summary and Path Forward

- Regulatory modernization has been a culture journey in the U.S. since late 1990's
  - NRC had a strong start with the RIPB ROP
  - Resistance to change has impeded regulatory readiness
  - Knowledge of PB attributes atrophied while RI became synonymous with PRA
- Other countries (UK and Canada) have adopted PB approaches
- Modernization through PB attributes will facilitate international harmonization
  - International regulators more likely to agree on high-level safety outcome objectives (e.g., dose consequence)
- Executive intervention in May 2025 orders an alternative pathway
  - DOE appears to incorporate PB approaches to its authorization process
  - 10 CFR Part 57 Rulemaking is NRC's opportunity to meet the moment