



Use of Probabilistic Fracture Mechanics

Remarks by

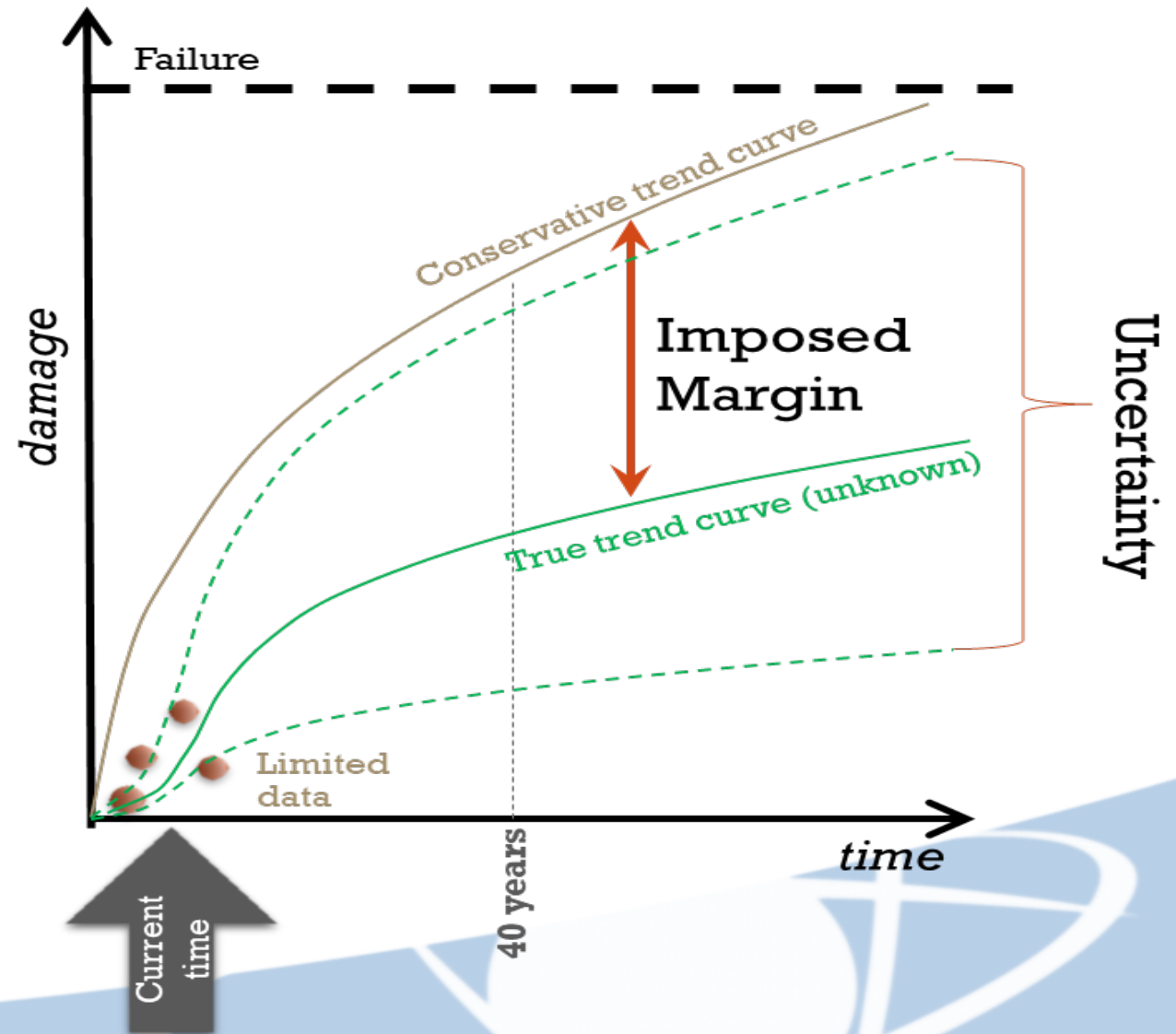
David L. Rudland, Ph.D.
Senior Level Advisor for Materials
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulations

Advisory Committee on Reactor Safeguards
Meeting of the Subcommittee on Fuels, Materials, & Structures
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Motivation for Probabilistic Analyses

- **Early in Life**

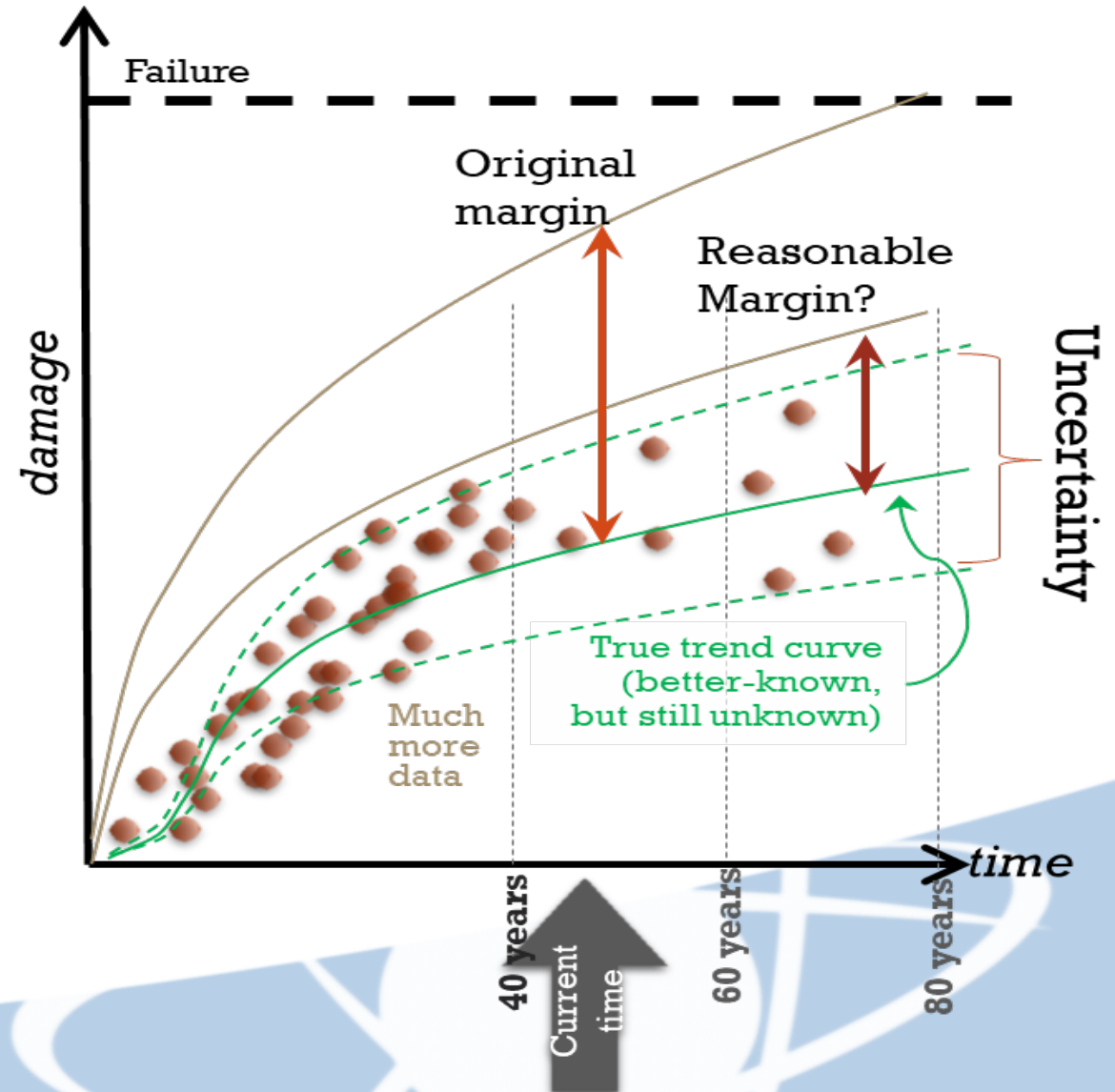
- Limited data – large uncertainty
- Every discipline gets its own margin
 - Loading over-estimated
 - Material resistance under-estimated
- Conservatism does not limit operability
 - Plants are new
 - No plant near failure



Motivation for Probabilistic Analyses

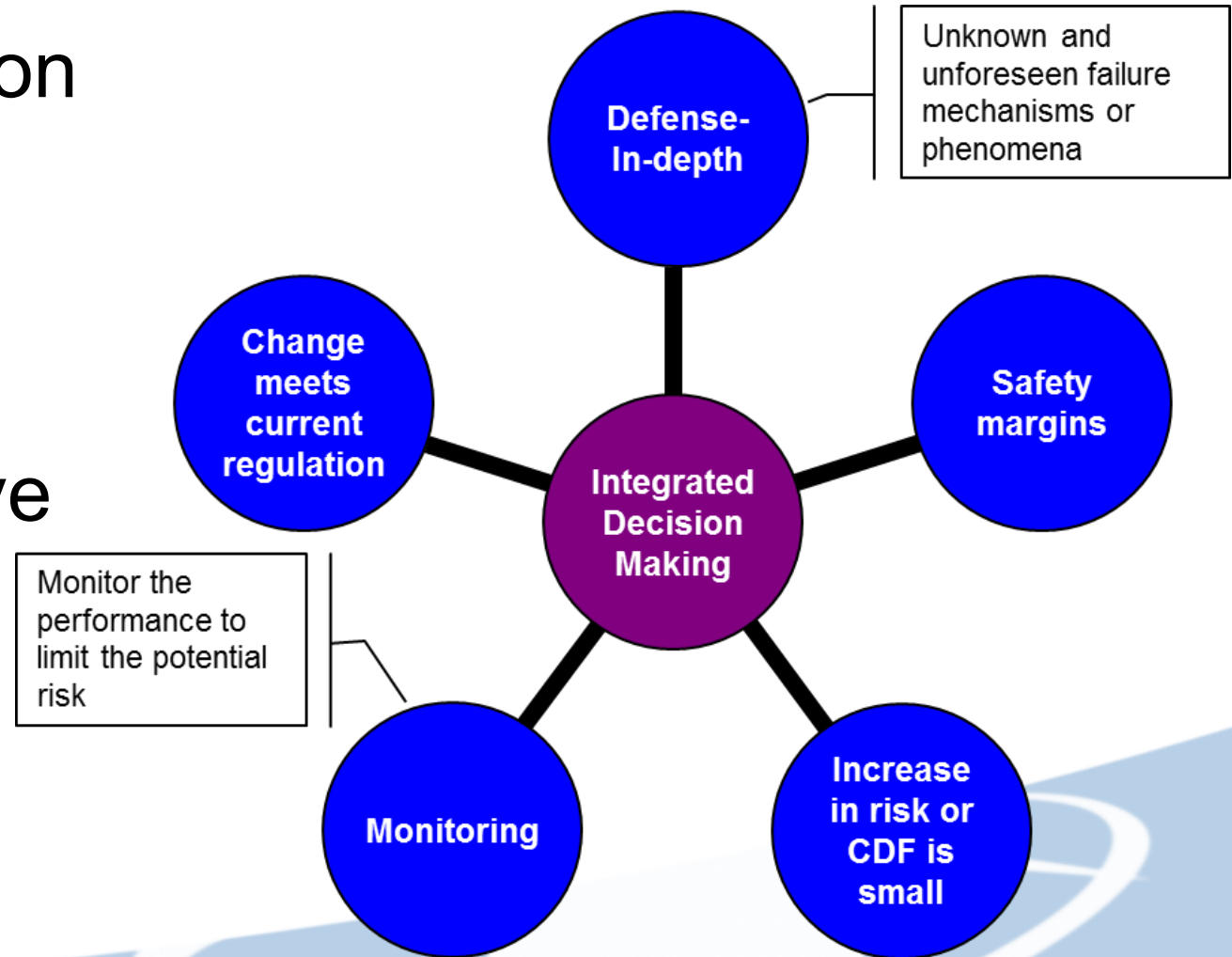
• Later in Life

- More data & knowledge support improved models – less uncertainty
- Original margin overly burdensome? Do we change the margin with time?
- Issues
 - Deterministic margins make all inputs conservative
 - Deterministic approaches
 - Not well suited to quantifying actual risk
- Solution: Probabilistic analyses –
 - Properly account for true uncertainty



Integrated Decision Making

- Objective is integrated decision making
- Key is risk informed not risk based
- Use of risk insights for passive component integrity



If CDF is invoked, RG 1.174 submittal may be needed

Probabilistic Fracture Mechanics

Probabilistic Fracture Mechanics (PFM) brings together information from the risk-triplet,



What can happen?



How often?



What are the consequences?

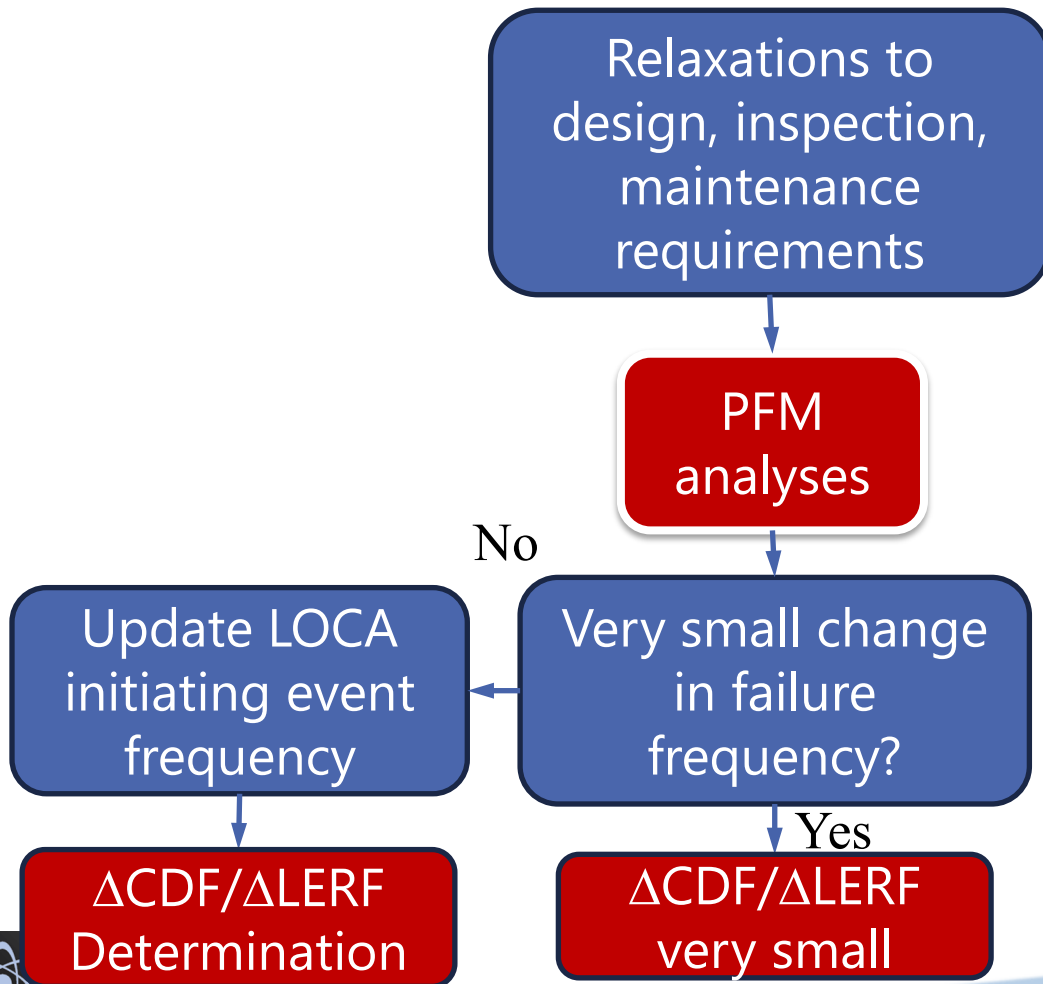
For example, PFM can be used to estimate the probability of leakage or rupture of a pressure-boundary component

The outcome of PFM is inherently a risk-insight

U.S. NRC recognizes PFM as a leading technique for managing risk-informed management of long-lived passive components



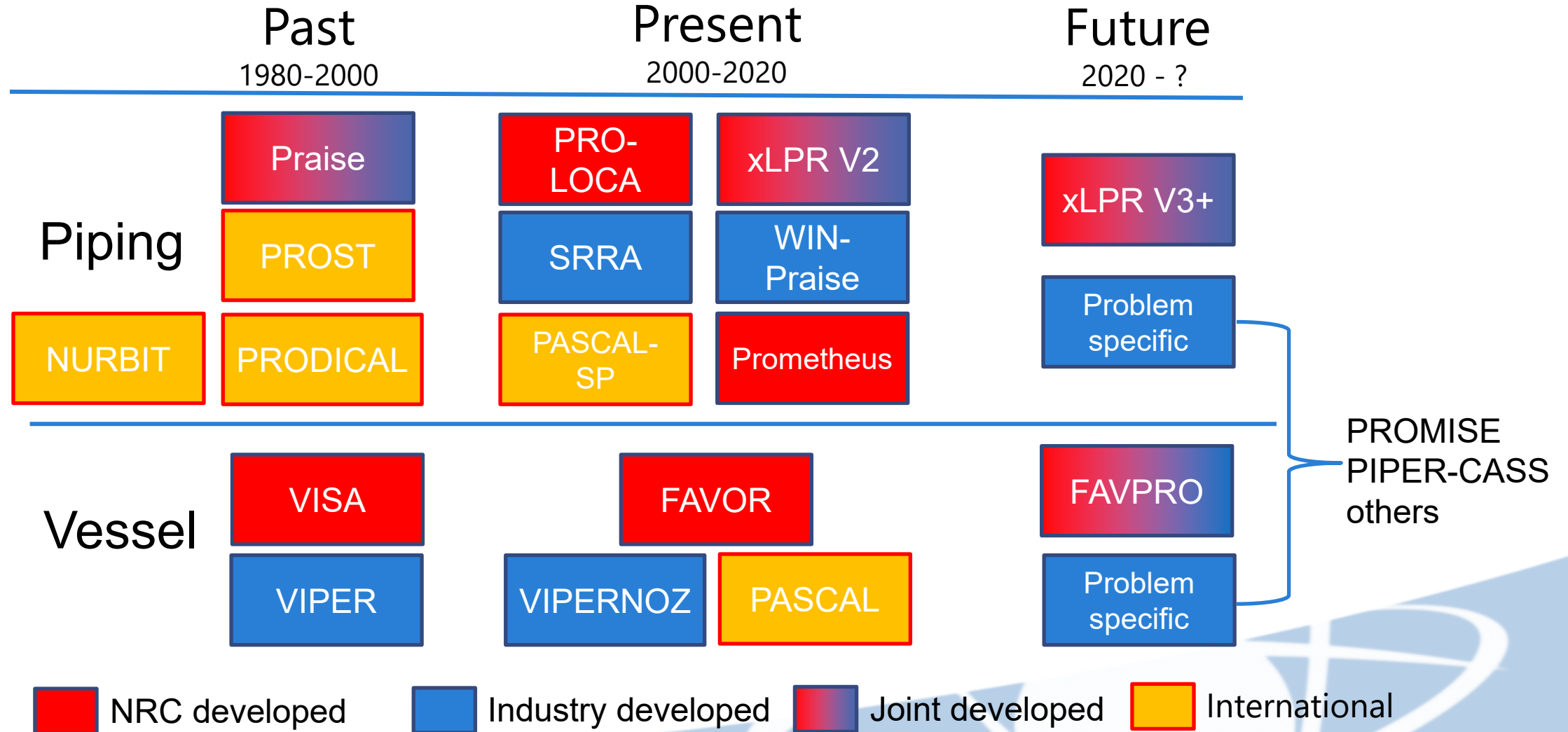
PFM is only one Part of Risk-informed Decision Making



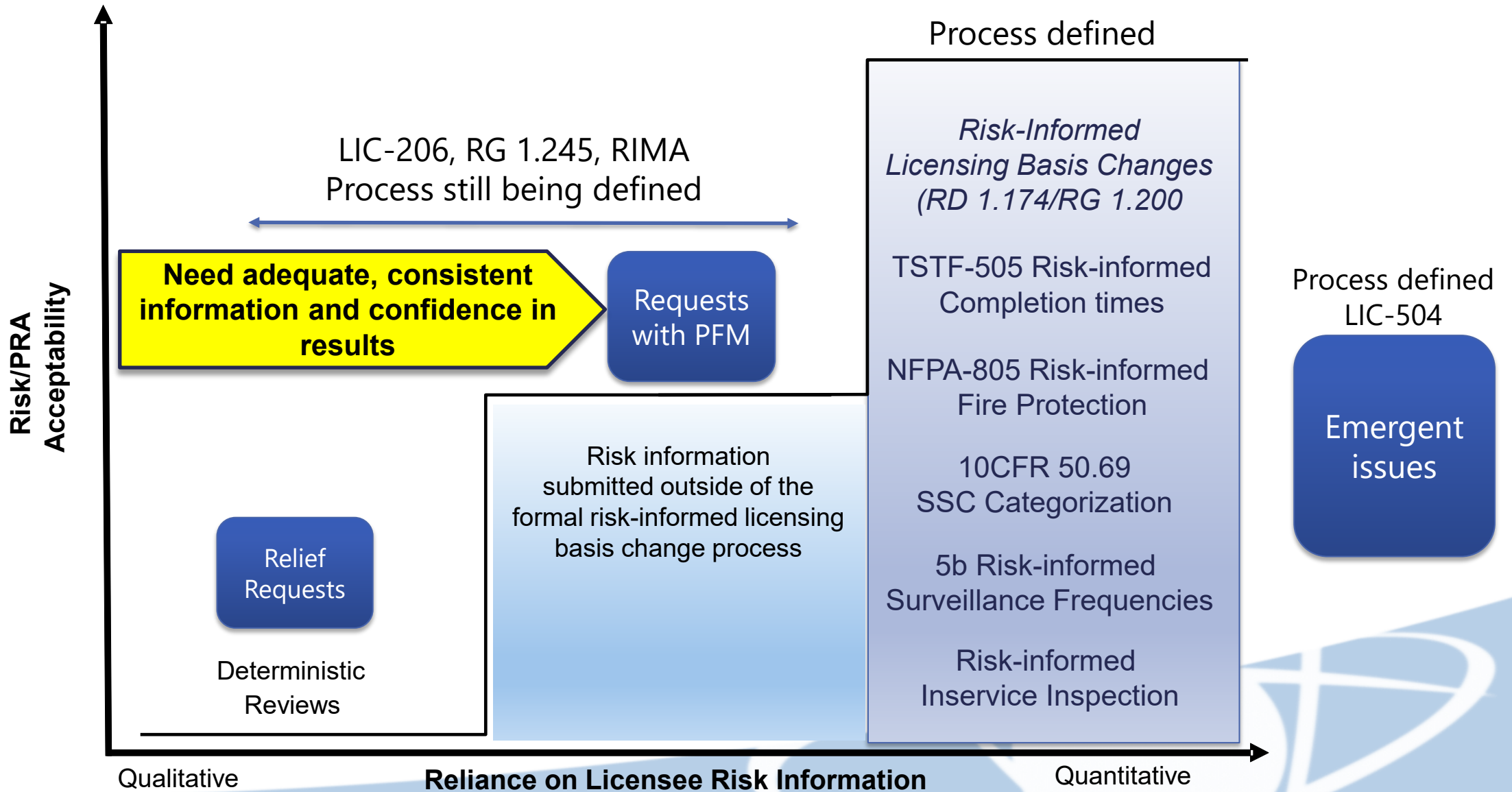
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Piping and Vessel PFM Codes

Not exhaustive list



Licensing Reviews and Emergent Issues



Timeline of PFM Applications

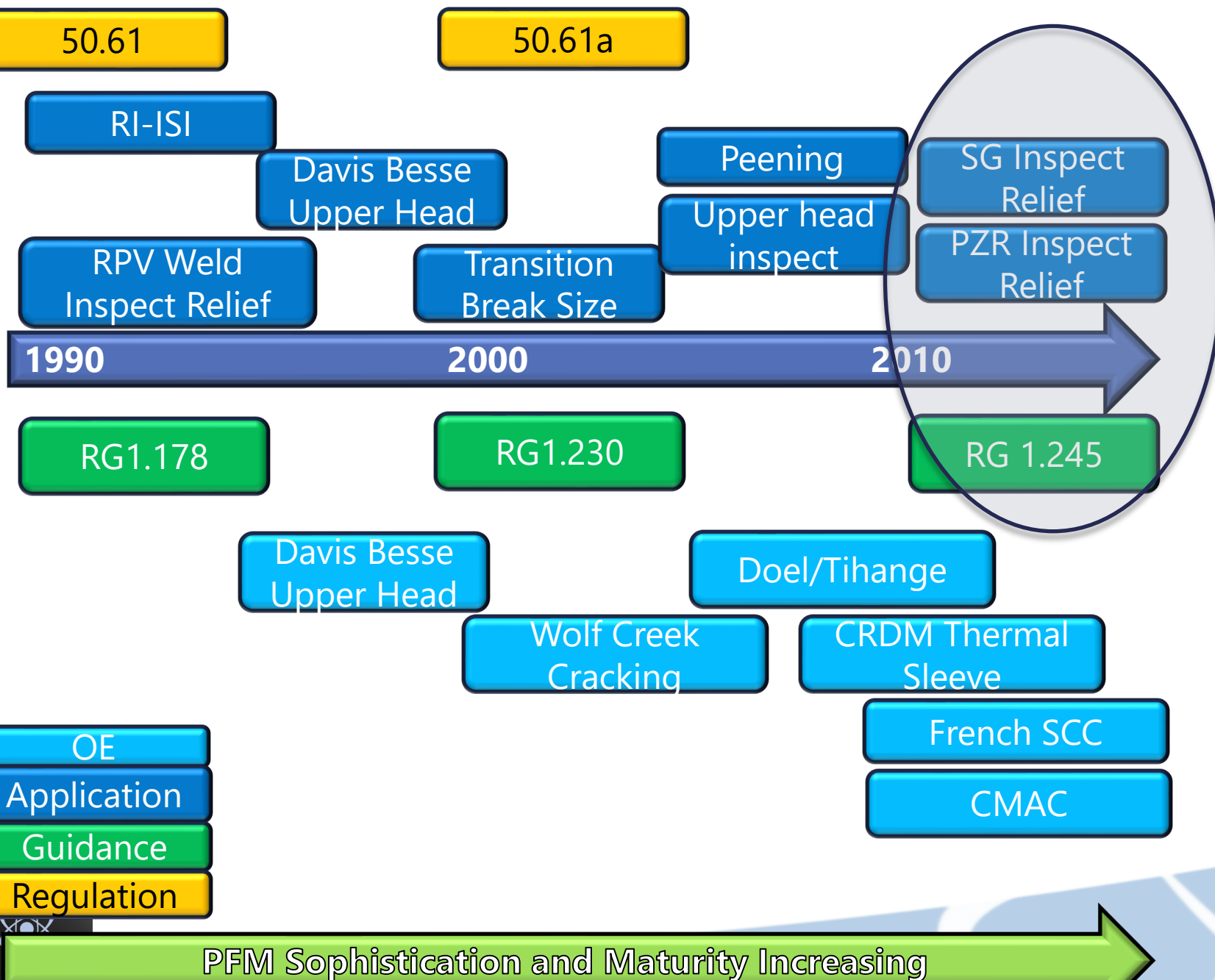
Not exhaustive list

Future Applications

50.46

Other Inspection Relief

RIMA



OE
 Application
 Guidance
 Regulation

PFM Sophistication and Maturity Increasing

Bases for Past Success



- Computer code bases were technically adequate (V&V)
- RG 1.174 process was followed, or probabilities were very small – performance monitoring was sufficient
- In many cases, deterministic and probabilistic analyses were used
- Sensitivity/uncertainty analyses used to demonstrate impact of important variables



Past challenges in Piping and Vessels Probabilistic Integrity Analyses

- Incomplete uncertainty characterization
- Code and basis not submitted for review
- Incomplete code technical basis and/or V&V
- Ignored tenants of risk-informed decision making – performance monitoring
- Acceptance criteria
- Guidance being (or has been) developed to address challenges

Summary

- U.S. NRC recognizes PFM as a leading technique for managing risk-informed management of long-lived passive components
- PFM, used with or without PRA, can be a useful tool in optimizing inspection as long as other risk-informed principles are considered
- NRC continues to develop guidance to address PFM challenges

