



# **EVOLUTION OF SEISMIC PRA METHODOLOGY AND ITS APPLICATIONS**

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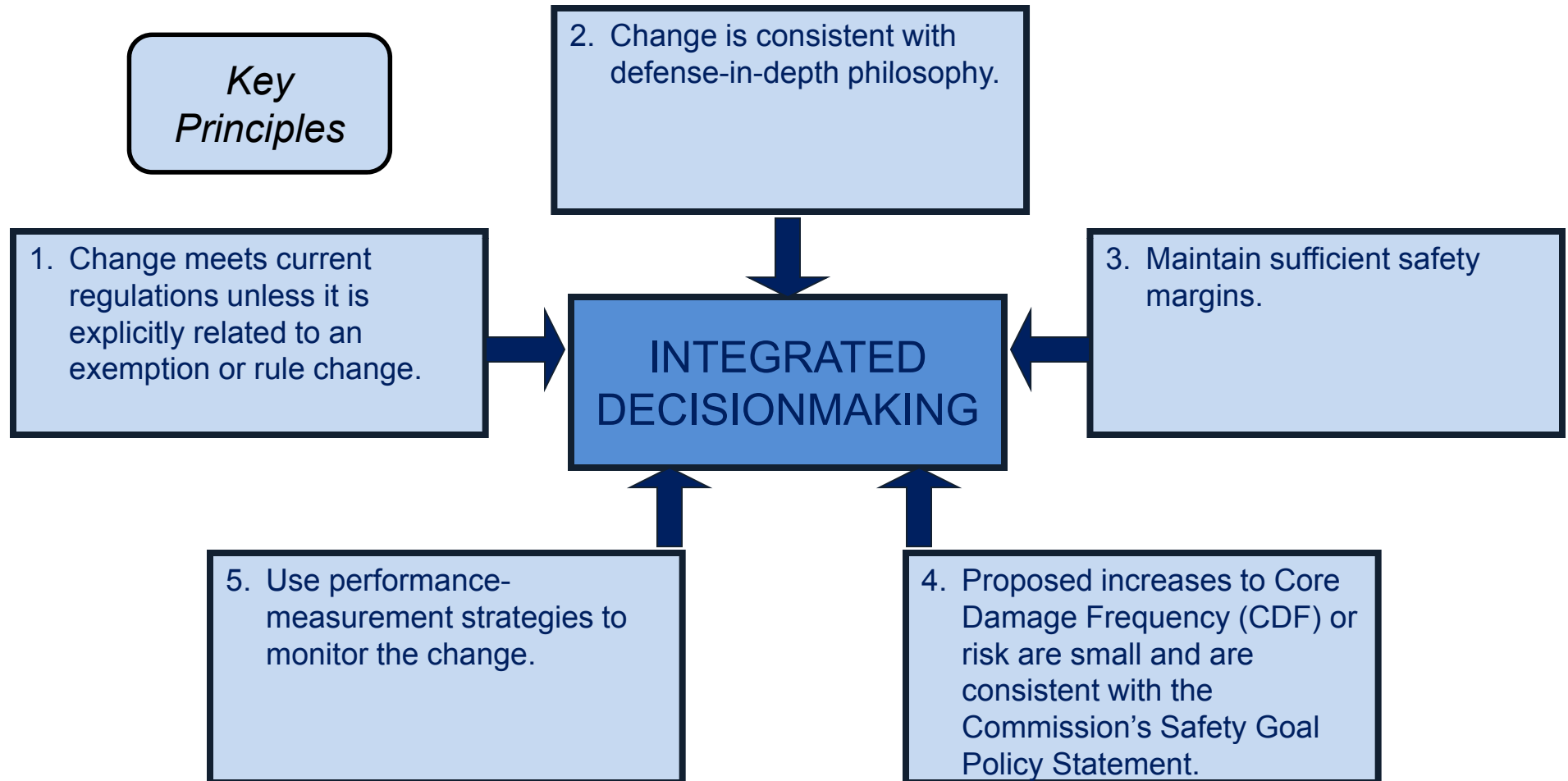
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# PRA Policy Statement

1995

- The use of Probabilistic Risk Assessment (PRA) technology should be increased in all regulatory matters to the extent supported by the state of the art in PRA methods and data
- PRA should be used in a manner that complements the NRC's deterministic approach and supports the NRC's traditional defense-in-depth philosophy.

# Principles of Risk-Informed Regulation



(Source: RG 1.174, 11/02)

# Evolution of Seismic PRA before 1990

1968	Seminal Paper on PSHA by Professor C. Allin Cornell
Late 1970 – early 1980s	NRC's Seismic Safety Margin Research Program Oyster Creek Seismic PRA by Industry
Early 1980s	Issue NUREG/CR-2300 PRA Procedures Guide Development of Seismic margin approaches based on SPRA insights
1980s	Several Plants Complete Level-3 Internal and External Event PRAs (e.g. Indian Point, Limerick, Millstone 3, Seabrook, and Zion)

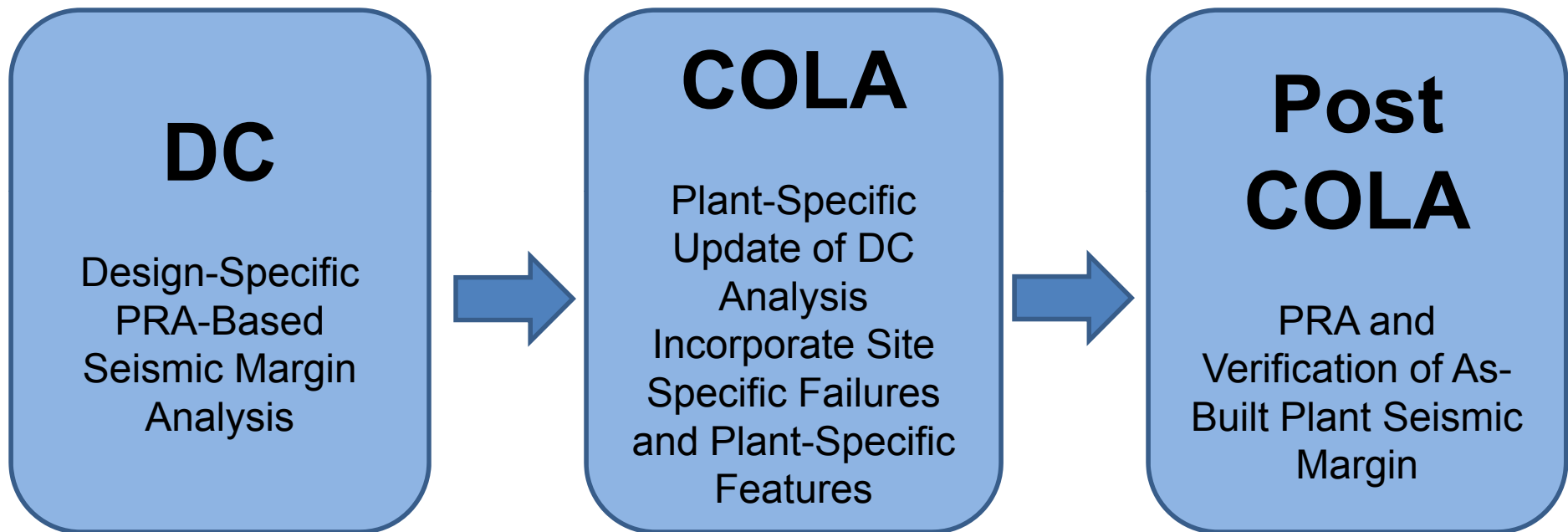
# Evolution of Seismic PRA 1990s - Now

Early 1990s	LLNL and EPRI complete Probabilistic Seismic Hazard Analysis (PSHA) studies
1997	Publication of Senior Seismic Hazard Analysis Committee guidance on PSHA/ Recommendation of Probabilistic Seismic Hazard Analysis Guidance on Uncertainty and Use of Experts, NUREG/CR-6372
	Revision of Siting Regulation – Explicit requirement to address uncertainties in developing seismic design basis
1990s	Individual Plant External Events Examination (IPEEE)
2007	Publication of regulatory guidance incorporating risk-informed, performance-based approach to establish design basis for new reactors
2003 2013	Publication of ASME/ANS Standard on external event PRAs in 2013 Originally published in 2003 as an ANS Standard

# Applications of Seismic PRA Methodology

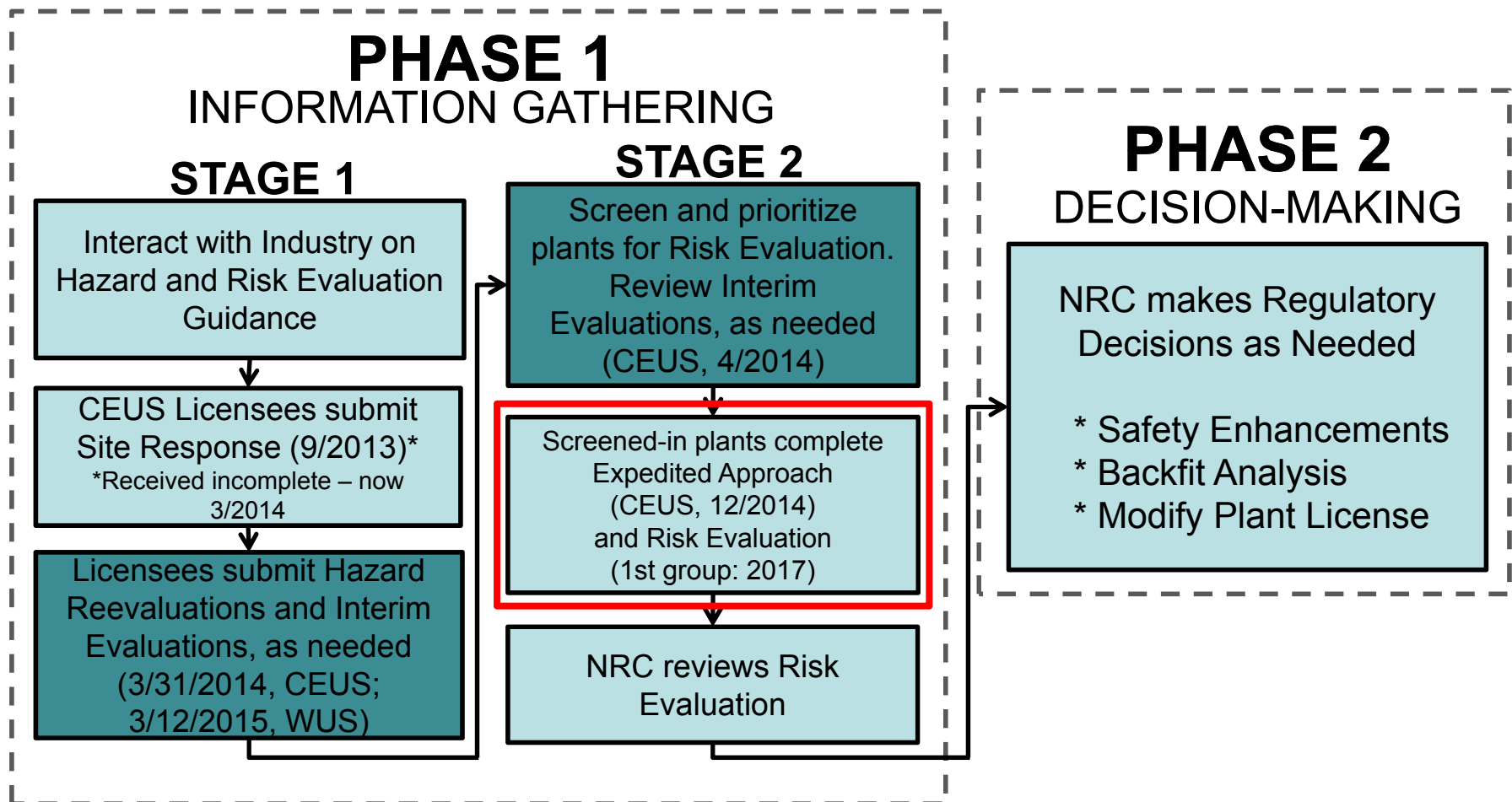
- Risk informed revisions to regulations
  - GDC 4 – decoupling of Large LOCA SSE
  - 50.46(a) – Transition Break Size (NUREG-1903, Seismic Considerations for the Transition Break Size)
- Seismic design basis for new reactors – Regulatory Guide 1.208
- Resolution of generic safety issues
- IPEEE program to identify vulnerabilities and safety enhancements:
  - Dominant contributors included electrical system components, building and structural failures - especially block walls, tanks, intake structures, and front line and support systems.
  - Seventy percent of the plants proposed improvements (many dealing with the addition of new anchorages or supports, or strengthening of existing ones)

# SPRA in New Reactor Licensing



Design enhancements and demonstration of adequate seismic margin through PRA approaches

# Implementation of NTTF Recommendation 2.1 - Seismic





# Summary

- SPRA are being used to enhance safety, seismic events are significant contributors to risk in many cases
- SPRA state-of-practice is mature and applied worldwide
- Provides an integrated response of a plant to a seismic event considering as-built, as-operated conditions
- Provides a robust basis for risk-informed decisions, complements deterministic processes
- Allows to evaluate impact on plant safety as new information/knowledge emerges
- Explicitly addresses uncertainties, improves transparency and understanding