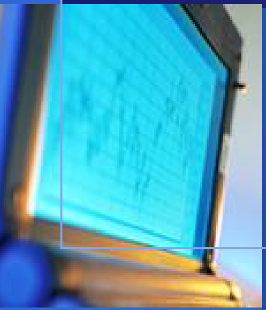
Risk-Informed Performance Based Regulations, Models,Issues, and Implications for Qualification Standards to Existing Plants and Future Plants



Presented at
SC-2 2006-2

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Chairman SC 2.1
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R	RESTRICTED
	UNDER 17 REQUIRES ACCOMPANING PARENT OR GUADIAN

The Future

The Doomed

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Proof of Performance

- The use of
- ASME NOG-1, ASME B&PVC,
- IEEE Nuclear Standards,
- ASME, and ACI codes and standards **alone,**
- are not sufficient proof of Performance in Risk-informed Performance based Regulation

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What else is needed?

- Answer: **Reliability** estimate of the code or standard

Who will provide this?

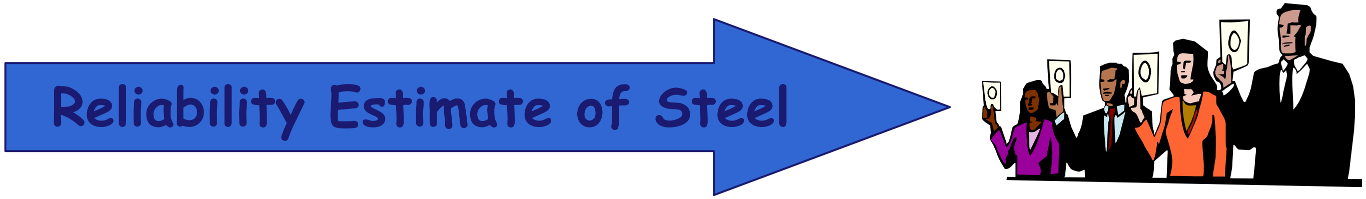
❖ Answer: The Standards Committees.

Reliability Estimates

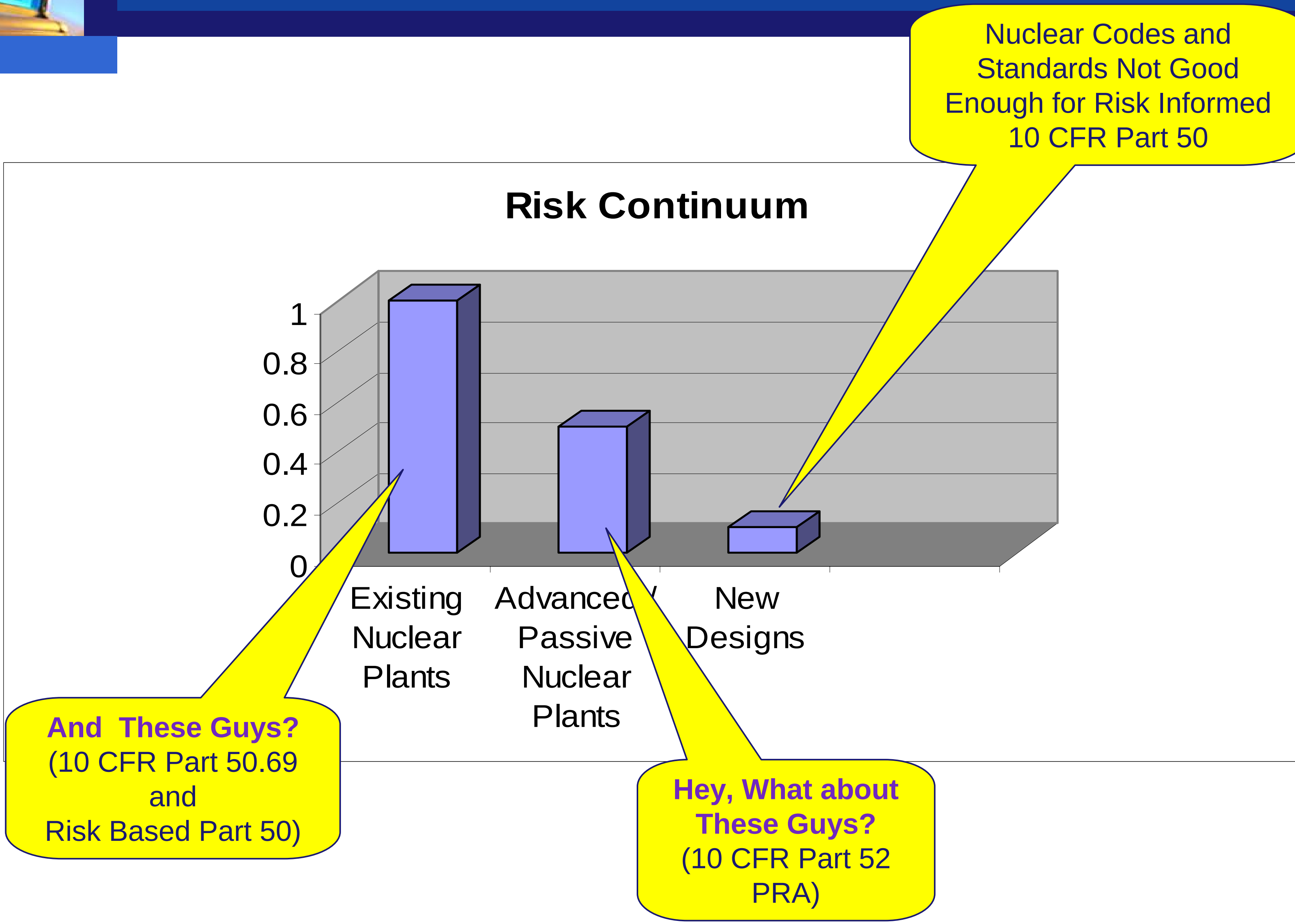
- **Reliability** Estimates are needed for a Risk-informed, Performance Based License
- **Reliability** data needs to be related to the design basis criteria of the SSCs credited with prevention or mitigation of an event sequence.

Performance Requirements

- **Reliability** information for SSCs (active and passive) is needed to demonstrate compliance with the performance requirements.

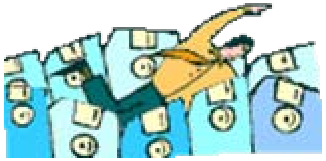


Risk Continuum



Burden for Predictable Performance

- I once said that for the nuclear power sector: “there is no credible industry without a credible regulator, and there is no credible regulator without a credible industry.” I will add to it that: “there is no predictable industry without a predictable regulator, and there is no predictable regulator without a predictable industry.”
- Burden for predictable performance is broadly distributed.



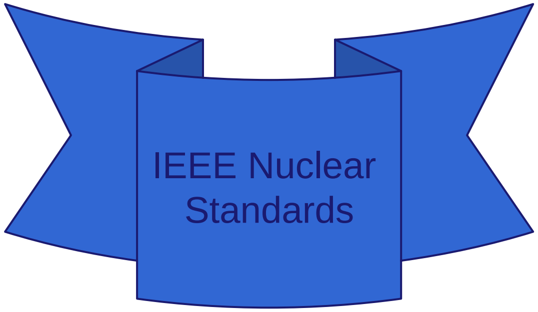
Center for Business Intelligence Nuclear Power Outlook 2004
Chairman Nils J. Diaz,
U.S. Nuclear Regulatory Commission

Predictable

- The performance based portion of a regulatory framework must
  - be able to be complete
  - have a definite end
  - be predictable

Nuclear Codes and Standards

- Nuclear codes and standards are unique.
- They have proven their worth.
- They have been maintained, are current, and are required to be periodically updated.



Framework RI 10CFR50

- The Protective Systems objective is to ensure that the systems that mitigate initiating events are adequately designed, and perform adequately, in terms of **reliability** and capability

Framework RI 10CFR50

- Establishing **reliability** goals for protective systems
- Redundancy, the use of more than a minimum number of sets of equipment to fulfill a given safety function, is an important design principle

Framework RI 10CFR50

- The PRA will provide a means of assessing the importance of common cause failures and provide the designer the ability to ameliorate the potential for these failures through selection of diverse materials, components, and manufacturing processes.

Ameliorate

Improve Revolutionize Remodel Rearrange Restore Amend

Or: Minimize Diminish Lessen Curtail Eliminate through Equipment Qualification?

Framework RI 10CFR50

- It is worth noting that the current treatment of common cause failures is often data-driven, i.e., historical data is use to determine which common cause events are most likely and, hence, should be incorporated into the PRA.

Framework RI 10CFR50

- Protection against common-cause failures has been, and will continue to be important as these types of failures can be expected to dominate the un**reliability** of systems with some degree of built in redundancy.

Amock

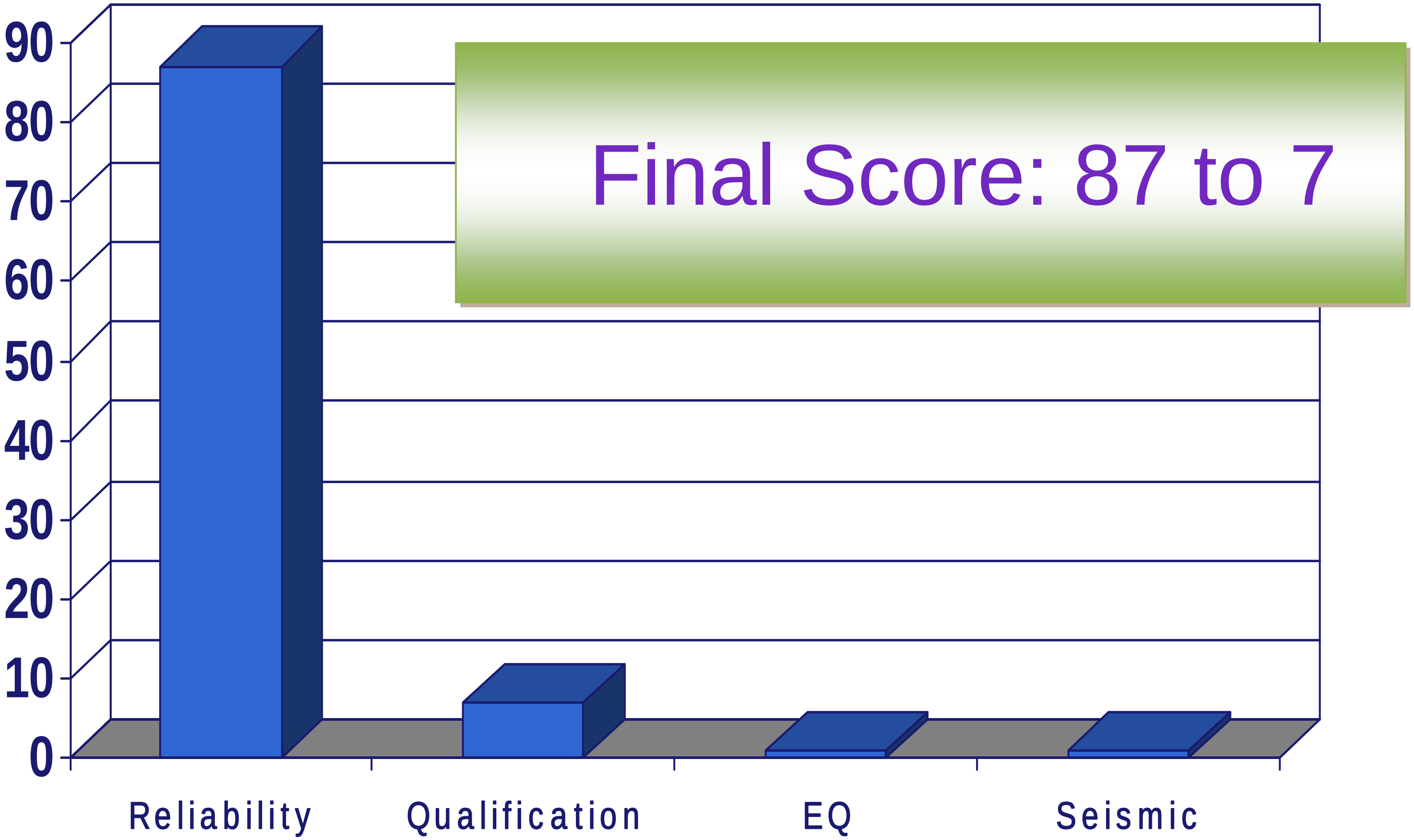
a frenzy that has traditionally been regarded
as occurring in certain cultures

Framework RI 10CFR50

- Verification of the functionality of the SSC under the required conditions is demonstrated via a **reliability** assurance program.

Equipment Qualification?

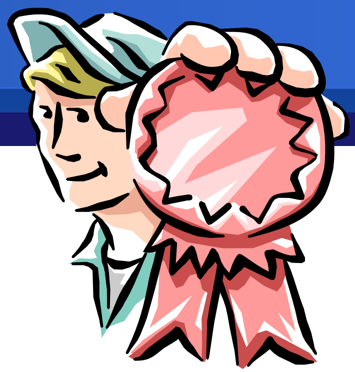
Framework RI 10CFR50



Demonstrated Performance

	Qualification	Reliability Estimate
1. Applies to Actual Installed Equipment	**YES**	**No**
2. Performance under Normal Conditions	**YES**	**YES**
3. Performance under Off Normal Conditions	**YES**	**No**
4. Performance under Design Basis Event Conditions	**YES**	**No**
5. Performance under Post Accident Conditions	**YES**	**No**
6. Performance under Seismic Conditions	**YES**	**No**
7. Performance under Radiation Conditions	**YES**	**No**
8. Performance under Aging Effects	**YES**	**No**
9. Performance due to maintenance	**YES**	**No**
10. Performance due to periodic testing	**YES**	**No**
11. Performance of replacement parts	**YES**	**No**

Call to Action



- IEEE SC-2
  - World's Nuclear Pedigree
  - Step up Leadership Role
  - Need to ensure Predictability in RIPB

Agenda

1. Risk Informed Regulation
2. IEEE Std 323 Working Group
3. Hazards, Risks, Requirements
4. Potential Risk Informed 323

The Future

Risk-Inform IEEE STD 323

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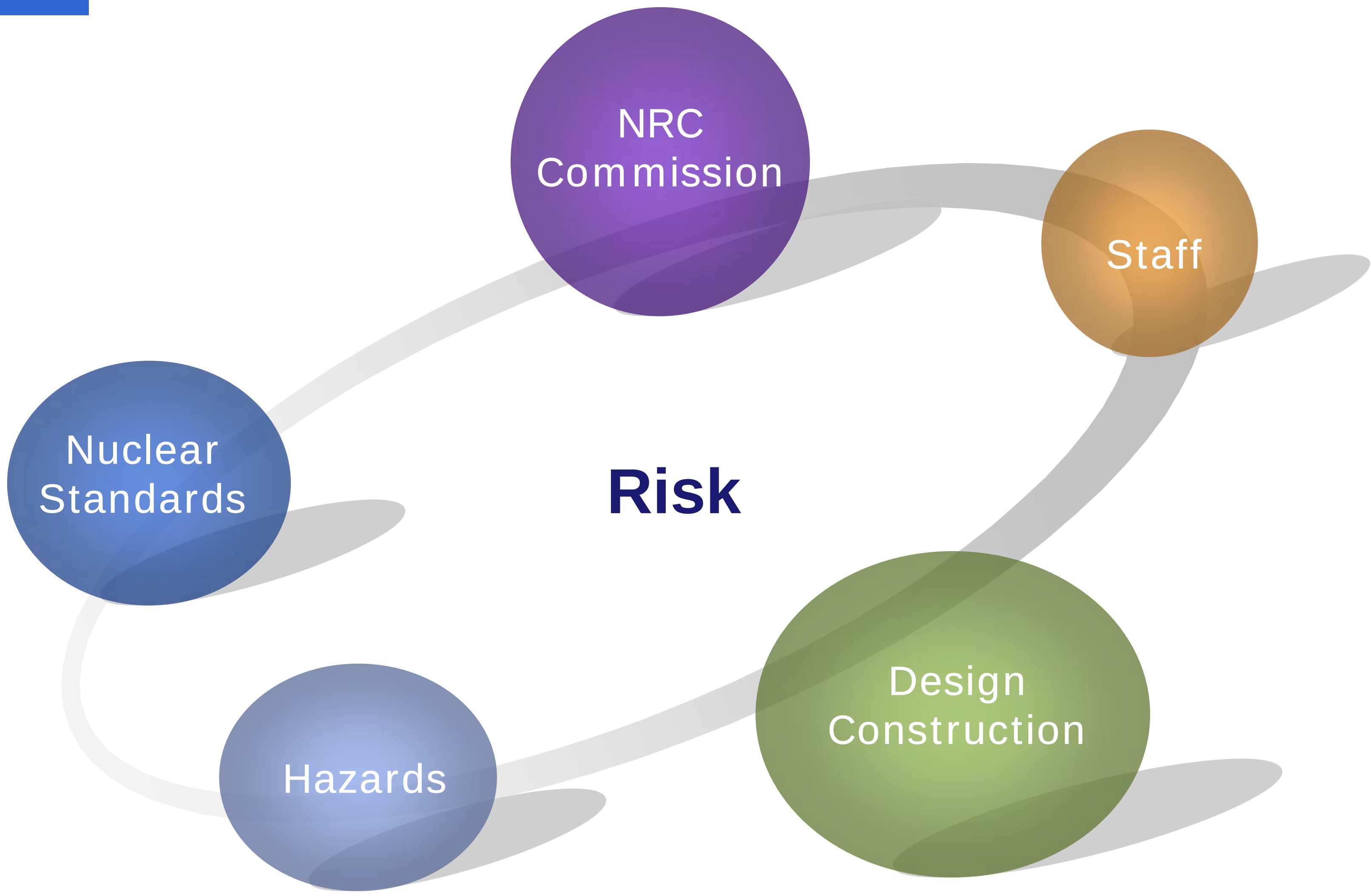
Cycle Diagram



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Progress Diagram

Phase 1

- Hazards Analysis

Phase 2

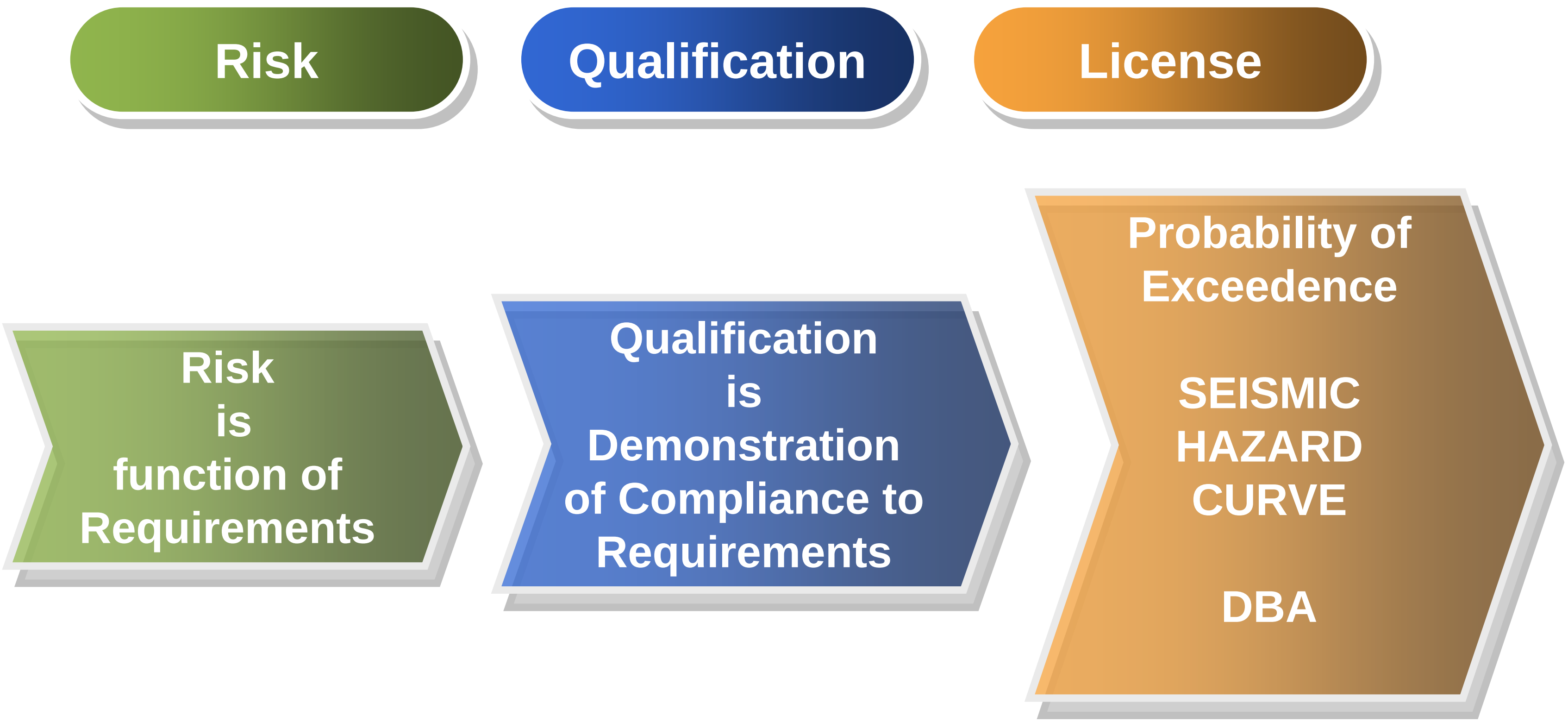
- Probabilistic Demand

Phase 3

- Probabilistic Capacity
- Probabilistic Demand
  <
  Probabilistic Capacity

  = License

EQ Progress Diagram



Probability of Exceedence

Probability of Exceedence

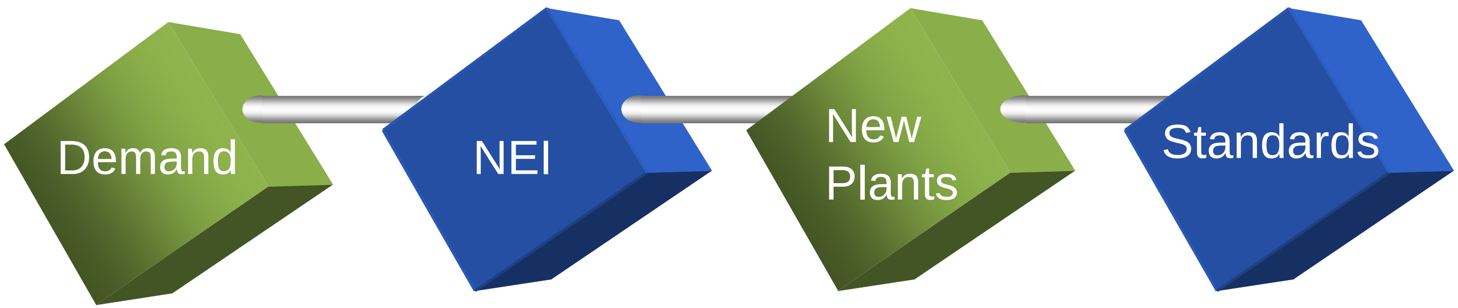
- Seismic Demand
  - SSE
  - SEISMIC HAZARD CURVE.
    - ANSI / ANS 2.27 and 2.29
    - ASCE 43-5
    - Not RG 1.165
- DBA Demand
  - DBA HAZARD LOCA, MSLB, HELB, Other Accident
  - Radiation Exposure

Risk Based Demand

Risk Based Demand

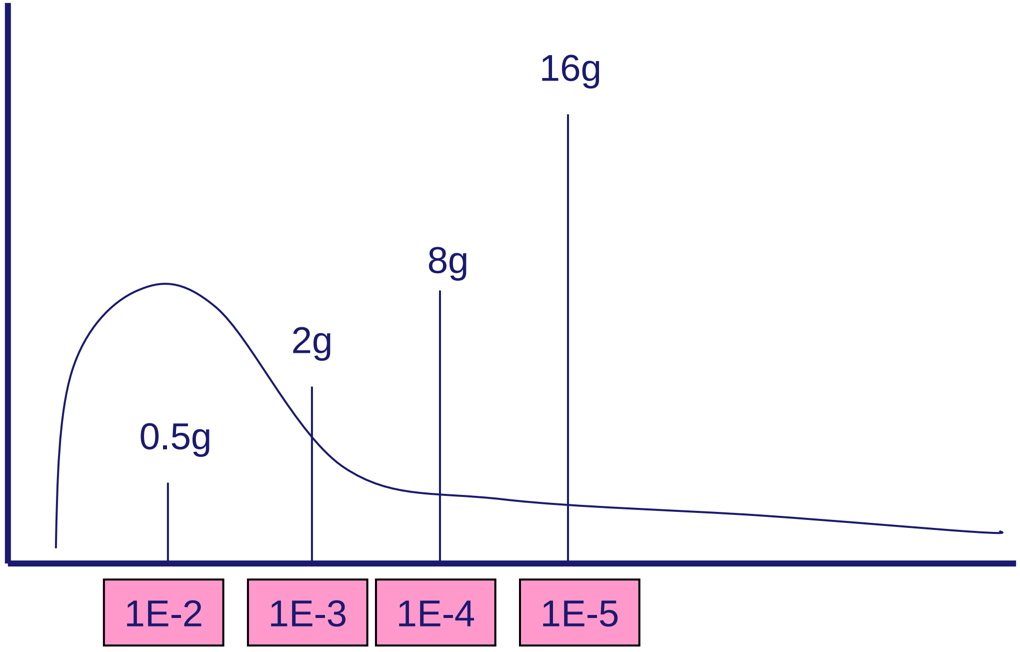
- Probability of Exceeding Demand
  - Typically < 1E-6
- **Seismic Demand**
  - SSE
- **DBA Demand**
  - LOCA, MSLB, HELB, Other Accident
  - Radiation Consequence

State of the Art



Demand	NEI	New Plants	Standards
Applying technical analysis to very low probability events	Unintended Consequences	Problematic in practical application	Resolutions

Extreme Value Distribution
very low probability seismic events



EQ Graded Approach

	EQ Risk D	EQ Risk C	EQ Risk B	EQ Risk A
Safety Significant	Yes	Yes	Yes	Yes
Safety Related	Yes	Yes	Yes	Yes
Harsh	No	No	Yes	Yes
Harsh Performance	No	No	Early	During/ After
Seismic	No	Yes	Yes	Yes

Graded Approach

Graded Approach

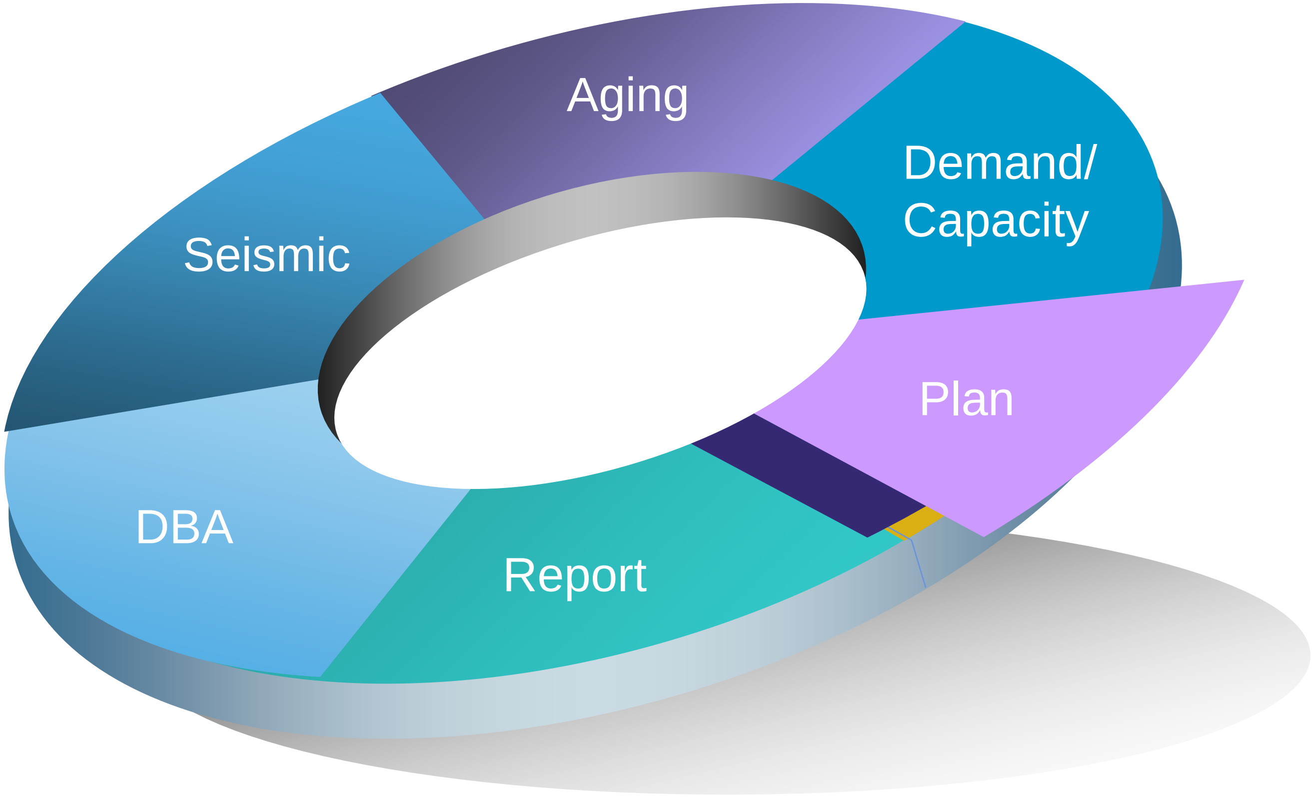
- Safety Significant and/or Safety Related
- EQ Risk D, Unchallenged
  - Mild Environment, Low Seismic Significance
    - Equipment can be maintained during Design Basis Events DBEs (Includes DBAs and Safe Shutdown Earthquake)
    - Low expectation of redundant failures during DBE (For mild environment - Safe Shutdown Earthquake Only)
- EQ Risk C, Seismic Only
  - Mild Environment, Seismic significant
    - Equipment can be maintained during DBE
    - Low expectation of redundant failures during DBE
    - Expectation of redundant failures during earthquake

Graded Approach

Graded Approach (Continued)

- EQ Risk B, Early Event Equipment
  - Harsh Environment - Seismic Significant
    - Early Event Equipment function only
    - Low expectation of exposure to significant radiation
- EQ Risk A, DBE Equipment
  - Harsh Environment - Seismic Significant
    - Safety Related function performed during and/or after DBE
    - Expectation of exposure to significant radiation

Proposed IEEE Std 323



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Proposed IEEE Std 323