Codes and Standards for Structural and Seismic Safety: NESCC and the NRC Standards Forum

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Activities / Products

- NESCC – Nuclear Energy Standards Coordination Collaborative (NIST/ANSI and NRC)
  - 2009 to 2015
  - (https://www.ansi.org/standards_activities/standards_boards_panels/nescc/overview?menuid=3)
- NRC Standards Forum
  - Since 2016
- Timely identification, development, and revision of standards for the design, operation, development, licensing, and deployment of nuclear power plants

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Activities / Products

Concrete Codes and Standards for Nuclear Power Plants: Recommendations for Future Development (June 2011)

- Issues on different design approaches used for containments and other safety-related structures (need to account for the different kind of safety functions expected)
- Issues on hierarchy of codes and dependencies – Seismic design provisions for example
- Harmonization with codes for other construction types like steel and composite structures: load combinations for example

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Activities / Products

Concrete Codes and Standards for Nuclear Power Plants: Recommendations for Future Development (June 2011)

- Construction erection tolerances (liners and concrete)
- Specification for concrete material
- New technologies
  - Types of reinforcement and high-strength steel reinforcement

- "Anchorage of High-Strength Reinforcing Bars", David Darwin, University of Kansas, May 2015

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Activities / Products

Codes and Standards for the Repair of Nuclear Power Plant Concrete Structures: Recommendations for Future Development (September 2013)

- Inventory of related NRC documents
  - Refers only to aging management documents (monitoring)
- Evaluation of a concrete structure
- Assessment of repair strategy and design
- Implementation of repair
- Monitoring and quality control

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Steel and Steel Plate Plate Composite(SC) Structures – AISC N690

- The Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NUREG-0800), 2010 (**SRP**), refers to:
  - N690-1994 including Supplement 2 (2004)
- The Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility (NUREG-1718), 2000, refers to
  - N690-1984 in *Section 11.4.6.1 Regulatory Guidance*

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Steel and Steel Plate Composite (SC) Structures – AISC N690

- New reactors adopted modular SC structures as one of the major design features for some of their structures
- SC structures are used for the design of safety-related structures other than containment buildings
  - Containment internal structures for example

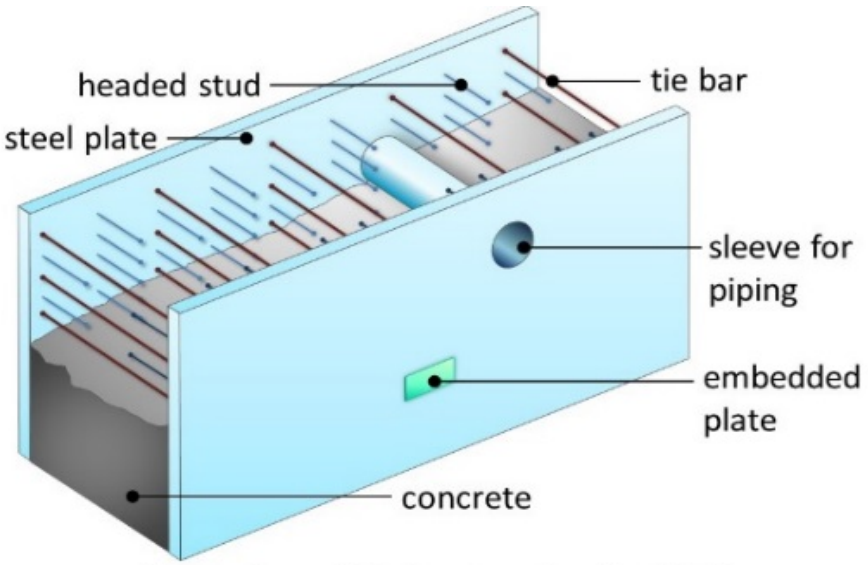

Illustration of SC Construction for Walls

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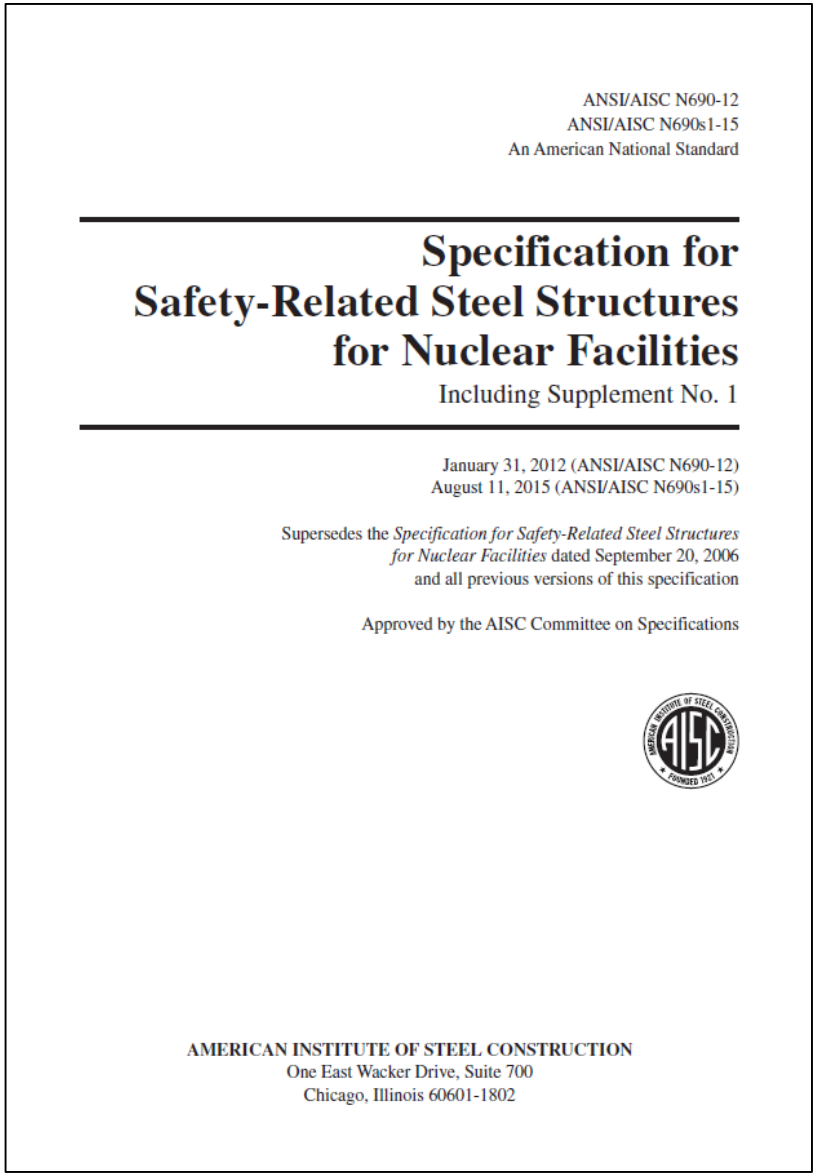
Steel and Steel Plate Composite (SC) Structures – AISC N690

- The AISC started a multiyear effort to develop a standard for the design of SC structures
- In 2015, the AISC published the first U.S standard for the design of safety-related SC structures (Appendix N9 to the 2015 supplement of N690)
- The NESCC provided a forum to discuss the progress of the standard and of the NRC review



ANSI/AISC N690-12
ANSI/AISC N690s1-15
An American National Standard

Specification for Safety-Related Steel Structures for Nuclear Facilities
Including Supplement No. 1

January 31, 2012 (ANSI/AISC N690-12)
August 11, 2015 (ANSI/AISC N690s1-15)

Supersedes the *Specification for Safety-Related Steel Structures for Nuclear Facilities* dated September 20, 2006 and all previous versions of this specification

Approved by the AISC Committee on Specifications

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Steel and Steel Plate Composite (SC) Structures – AISC N690

- Review of the N690s1-2015 requires review of:
  - AISC 360 (the N690 parent specification for the design of steel structures)
  - Evolution of the design of safety-related structures from the Allowable Stress Design (ASD) approach in the N690-1994 and its 2014 supplement to
  - The Allowable Strength Design (ASD) and Load and Resistance Factor Design approach (LRFD) in the current versions of N690
- The NRC review includes technical exchanges with AISC experts for clarifications and discussion of provisions in N690s1-2015 (for both steel and SC structures)

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Steel and Steel Plate Composite (SC) Structures – AISC N690

- During the review process, the AISC updated N690 (for possible publication as N690-2018)
- The NRC plans to complete a draft regulatory guide with the staff position on N690 as follows
  - Complete the N690 review using the most recent update of N690
  - Conduct one additional technical exchange with AISC experts for further clarification of provisions
  - Complete a draft regulatory guide (DG-1304) in the fourth quarter of FY19

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Risk-informed Performance-Based (RIPB) Approach to Seismic Safety

- Earlier briefings to the NESCC on this topic
  - "Improving regulations governing the seismic safety of nuclear facilities," A. S. Whittaker (University at Buffalo) and R. J. Budnitz (LBNL), October 13, 2015

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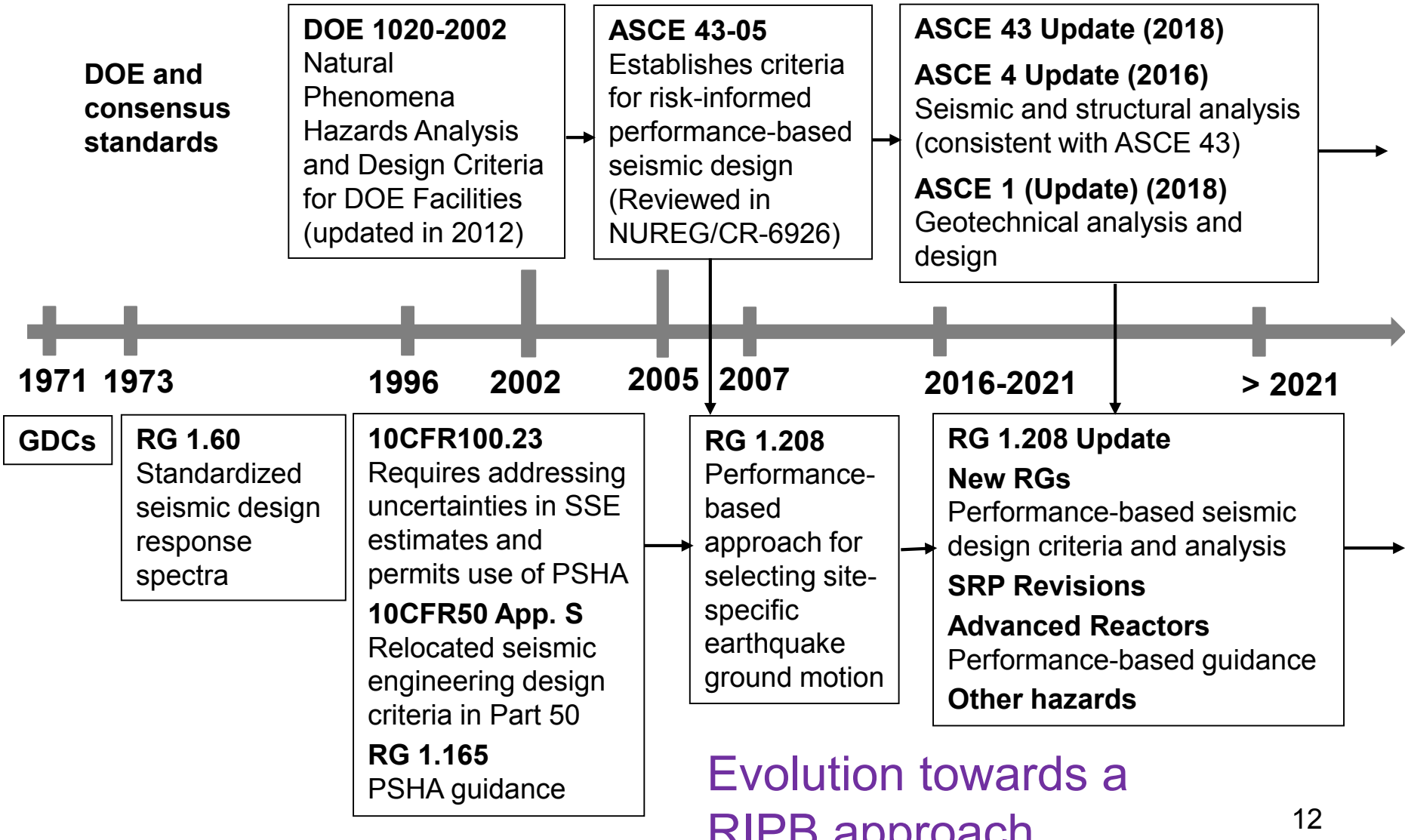
Risk-informed Performance-Based (RIPB) Approach to Seismic Safety



Evolution towards a RIPB approach

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Current Status of Risk-Informed Performance-Based Design

- No new designs have been carried out using ASCE 4 and ASCE 43
- ASCE 43 methods have been recommended for evaluation of existing DOE facilities
- Design basis ground motions for new reactors are based on ASCE 43 approach (Regulatory Guidance 1.208)
- The performance target for new reactors is at the plant level vs. component level target in ASCE 43 (ISG-DC/COL-20)

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Risk-informed Performance-Based (RIPB) Approach to Seismic Safety

Research Aspects

- Next steps in the development of risk-informed performance-based approaches to seismic safety
  - Technical basis for the update of Regulatory Guide 1.208
  - Bridging the gap between Regulatory Guide 1.208 and an integrated, performance-based approach to seismic/structural analysis and design of SSCs important to safety
  - Technical basis to update/develop staff positions on recent and forthcoming updates of standards for performance-based seismic analysis and design of structures and components in nuclear installations (ASCE 4-16, ASCE 43 and ASCE 1, for example)
  - Integration with other hazards
- Future direction to pursue possibilities outlined in NUREG/CR-7214

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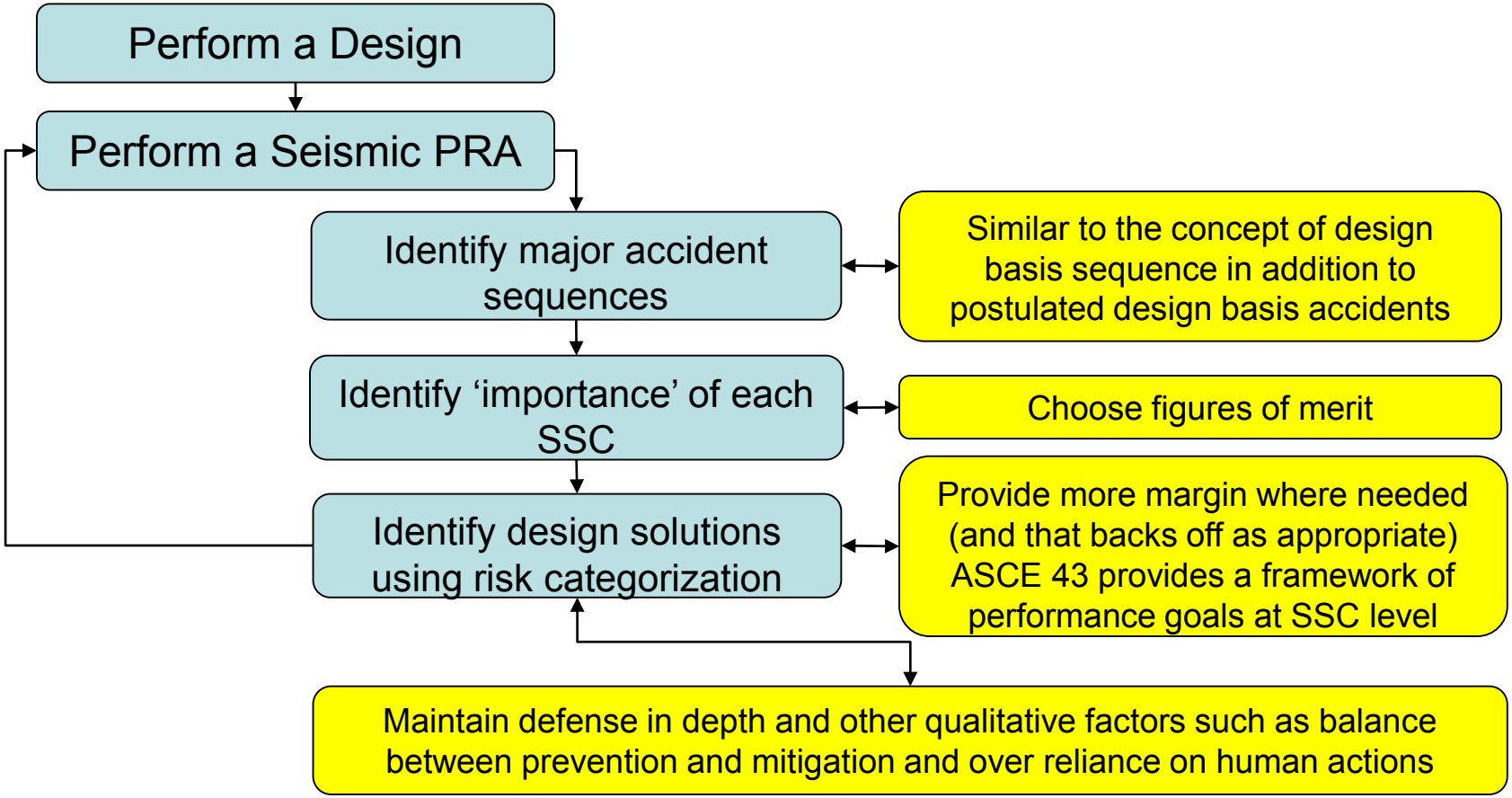
Future Direction – Broader Integrated Approach (NUREG/CR-7214)

- NUREG/CR-7214, "Toward a More Risk-Informed and Performance-Based Framework for the Regulation of the Seismic Safety of Nuclear Power Plants," R. Budnitz and M. Mieler, Lawrence Berkeley National Laboratory, May 2016. **https://www.nrc.gov/docs/ML1612/ML16126A008.pdf**



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Acronyms

- AISC – American Institute of Steel Construction
- ANSI – American National Standards Institute
- ASCE – American Society of Civil Engineers
- ASD – Allowable Stress Design
- DOE – Department of Energy
- LBNL – Lawrence Berkeley National Laboratory
- LRFD – Load and Resistance Factor Design
- PRA – Probabilistic Risk Assessment
- NRC – Nuclear Regulatory Commission
- SC – Modular Composite Construction (Wall modules constructed from large prefabricated sections of steel plates spaced apart and joined with intermittent steel members or tie bars, joined with other modules at the site, and then filled with concrete)
- SSC – Structures, Systems and Components
- SRP – Standard Review Plan