Standards Development Organizations Activities

- **Session Chair:** Meraj Rahimi, Chief, Regulatory Guide and Programs Management Branch, Division of Engineering, NRC Office of Nuclear Regulatory Research

- **Speakers:**
  - Andrew Sowder (ANS)
  - Thomas Vogan (ASME)
  - Richard Woods (IEEE)
  - Brian McDonald and Andrew Whittaker (ASCE)

American Nuclear Society

U.S. Nuclear Regulatory Commission Standards Forum
September 25, 2024

Andrew Sowder, Ph.D., CHP
ANS Standards Board Chair

ANS Standards – A Key Piece of the Nuclear C&S Pie

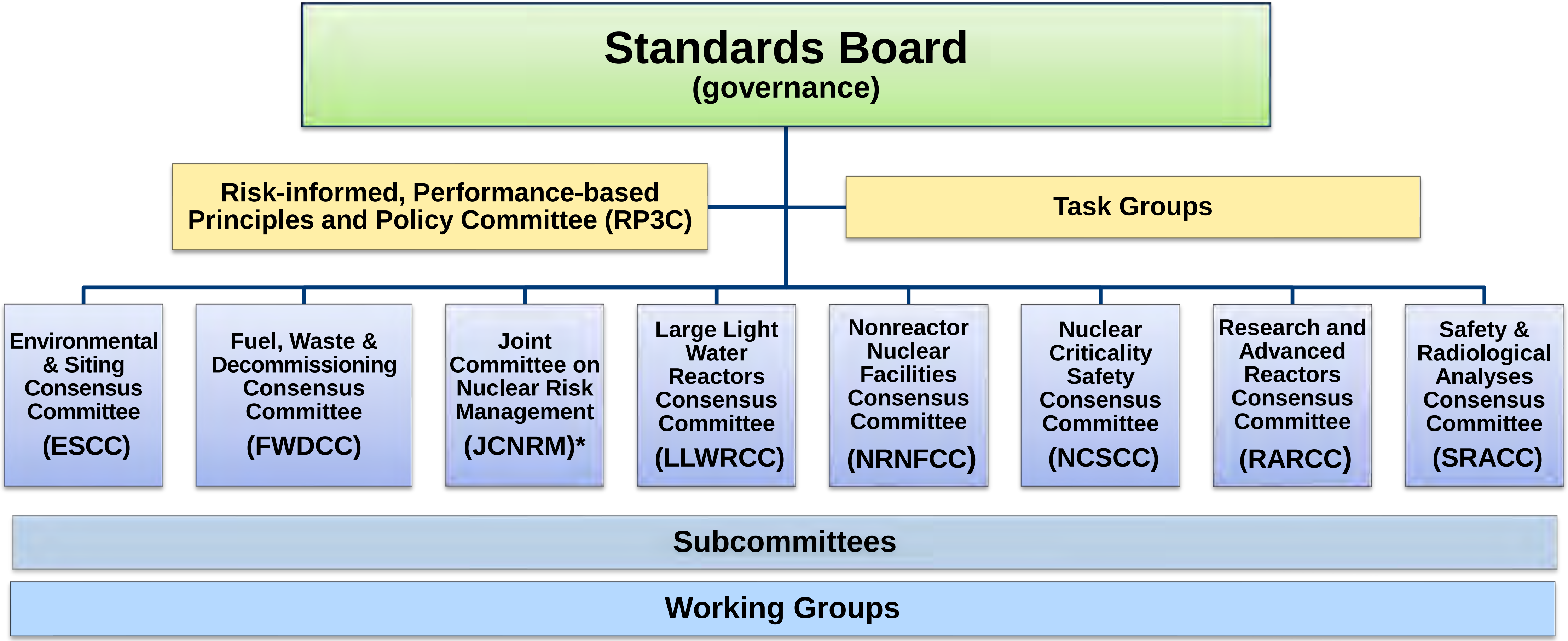
- ANS Standards Committee responsible for standards addressing
  - Design
  - Analysis, and
  - Operation

  of components, systems, and facilities related to the application of nuclear science and technology
  - **NOT for the application of radiation for medical purposes**

- Established in 1957
  - Produced earliest nuclear industry standards
  - Accredited by American National Standards Institute (ANSI) in 1967

- Maintains 90 current ANSI standards across 8 Consensus Committees

The ANS Standards Committee



**JCNRM is a joint ANS/ASME consensus committee.*

ANS Standards: Notable Activities and Initiatives

- Evaluating need for new standards to address nuclear-related applications of:
  - artificial intelligence (machine learning)
  - space power and propulsion
- Leadership of and support for the Advanced Reactor Codes and Standards Collaborative (element of the North American Advanced Reactor Roadmap)
- Evaluating the structure of the ANS standards program with respect to alignment to better support the future standards needs of the industry
- Promoting greater understanding and application of risk-informed and/or performance-based (RIPB) methods in ANS standards where practical

ANS Standards: Promotion of RIPB Methods

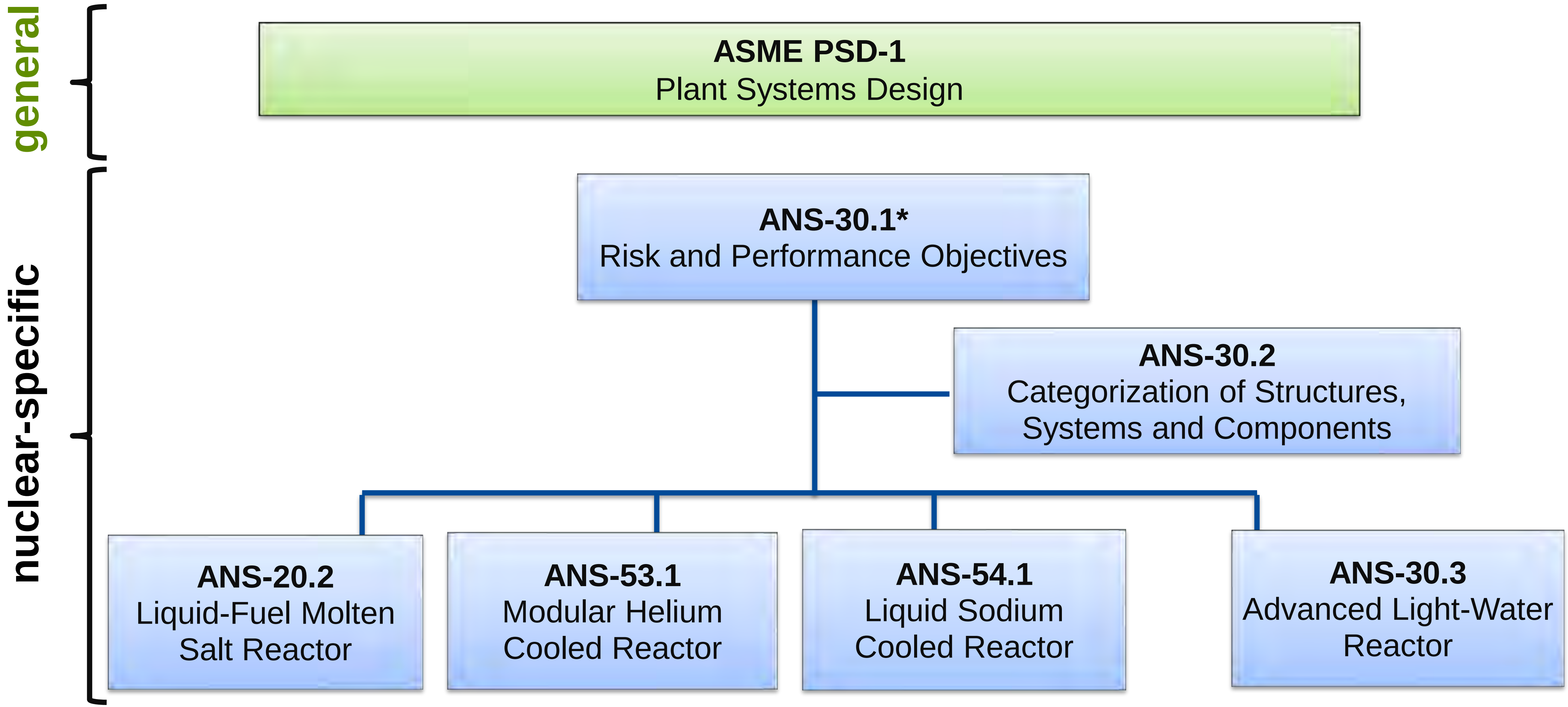
- The ANS Standards Committee is committed to promotion of incorporation of Risk-Informed, Performance-Based (RIPB) approaches in standards when appropriate
  - By policy, all ANS working groups consider RIPB when developing new or revising existing standards

- Risk-informed, Performance-based Principles and Policy Committee (RP3C) advises the ANS Standards Board and serves as an advisory resource for the Standards Committee at large

- Trial use guidance document ***Incorporating Risk-Informed and Performance-Based Approaches/Attributes in ANS Standards*** available online at: https://www.ans.org/file/6137/RIPB_GD_Rev_Issued_3-28-22_4_Trial-Use.pdf

- Best practices and case studies shared monthly via RP3C Community of Practice (CoP) series
  - Hosted virtually the last Friday of the month
  - Open to everyone
  - Links to presentations since February 2020 and upcoming CoP on the RP3C CoP webpage
  - Send requests to join the CoP list or for more information to standards@ans.org

ANS Standards: Hierarchy For Advanced Reactor Design

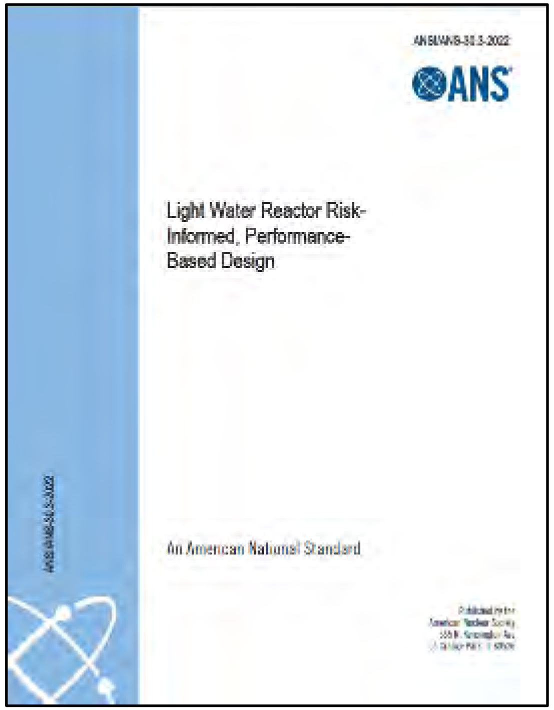


*ANS-30.1 is being prepared as an ANS guidance standard, not as an ANSI consensus standard

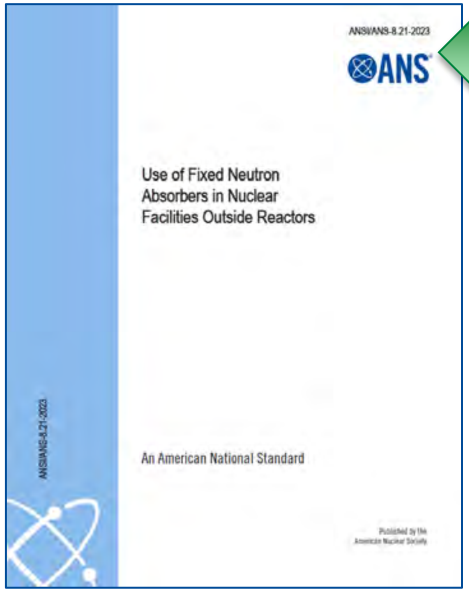
ANS Standards: USNRC Endorsement Request for 30.3

- An NRC public meeting was held July 15, 2024, at the request of ANS following comments exchanged between NRC and ANS regarding the endorsement of ANSI/ANS-30.3-2022, *Light Water Reactor Risk-Informed, Performance-Based Design*, per ANS's letter dated August 9, 2022.

- Note that it is ANS's practice to request review and consideration of endorsement/adoption of all newly published ANS standards from NRC and DOE.
- ANS-30.3 is a transitional, RIPB process standard which meets the technology-inclusive intent of the Nuclear Energy Innovation and Modernization Act.
- ANS-30.3 establishes a minimum set of process requirements for the designer to follow in order to combine deterministic, probabilistic, and performance-based methods for designing LWRs.
- NRC expressed concerns with what they see as a lack of details in ANS-30.3 requiring additional resources to review for endorsement without implementation guidance for regulatory clarity.
- ANS requested that the NRC formally provide their feedback in a response to ANS.
- NRC will use feedback gathered during the meeting considering available staff resources to inform the NRC's path forward on the request for endorsement.

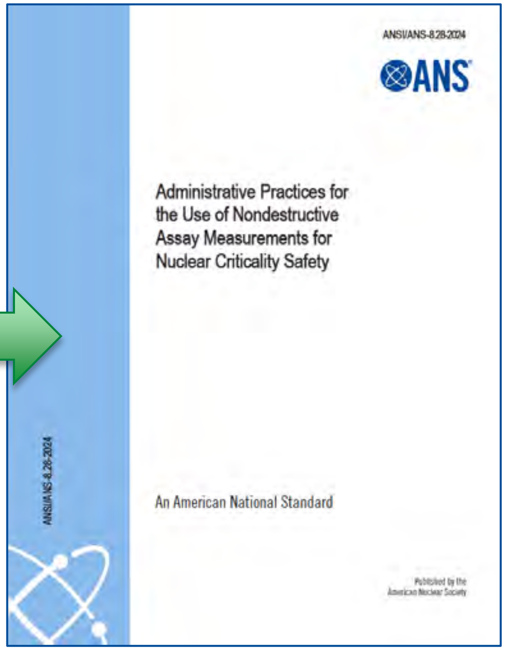


ANS Standards: Recently Published



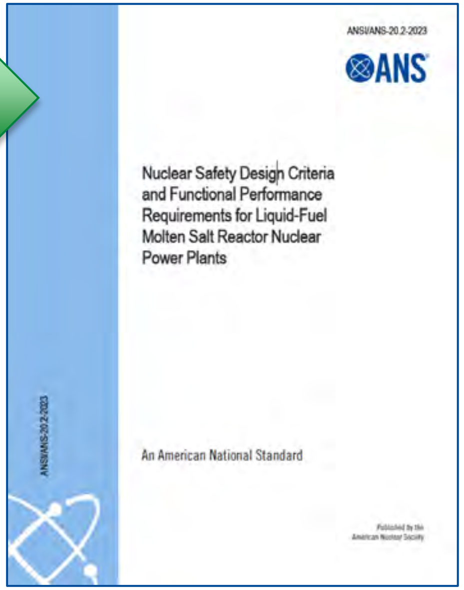
ANSI/ANS-8.21-2023, *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*

ANSI/ANS-8.28-2024, *Administrative Practices for the Use of Nondestructive Assay Measurements for Nuclear Criticality Safety*



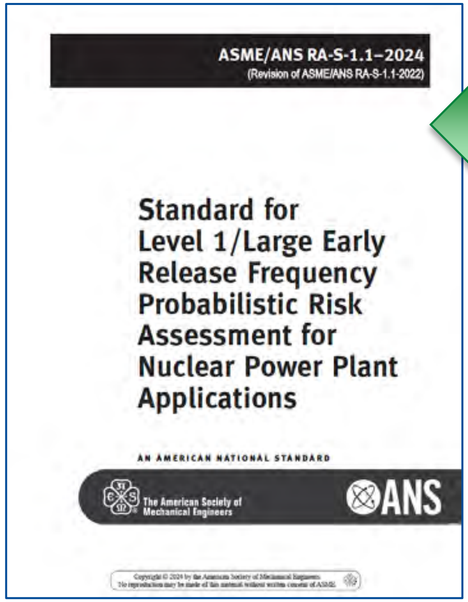
ANSI/ANS-8.21-2023 and ANSI/ANS-8.28-2024 under consideration for endorsement in revision of Regulatory Guide (RG) 3.71, "Nuclear Criticality Safety Standards for Nuclear Materials Outside Reactor Cores."

ANSI/ANS-20.2-2023, *Nuclear Safety Design Criteria and Functional Performance Requirements for Liquid-Fuel Molten Salt Reactor Nuclear Power Plants*



ANSI/ANS-20.2-2023 is currently under review by NRC staff for potential endorsement via RG 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors."

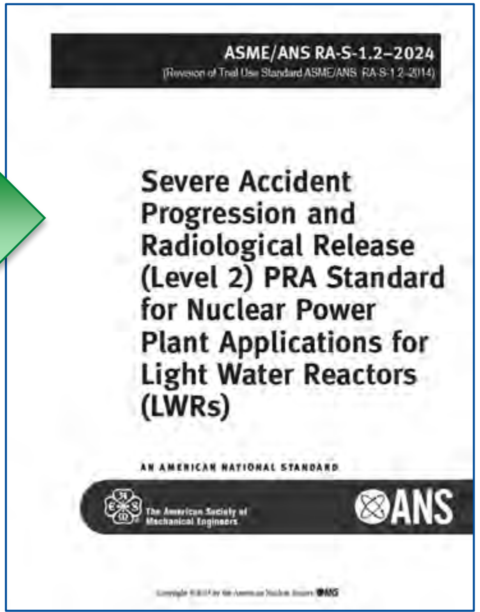
ANS Standards: Recently Published (Cont'd)



ANSI/ASME/ANS RA-S.1.1-2024, *Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Application*

NRC plans to endorse ANSI/ASME/ANS RA-S-1.1-2024 (Level 1/LERF) and ANSI/ASME/ANS RA-S-1.2-2024 (Level 2) in the next revision of RG 1.200, "Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities."

ANSI/ASME/ANS-RA-S-1.2-2024, *Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)*



ANS Feedback from 2023 ARCSC Gap Assessment Survey

- Feedback from 113 respondents to ARCSC survey
- 36 ANS standards in-use by AR community (with or without gaps)
- ANS review focused on 26 ANS standards in-use used with gaps
  - Follow-up on responses generic in nature or without explanations
  - Comments were classified as persuasive, non-persuasive, non-germane, or needs more investigation.
  - Comments deemed persuasive were considered a priority.
- Prioritization based on criteria in NEI 19-03, “Advanced Reactor Codes and Standards Needs Assessment.”

Structured Evaluation of ARCSC Survey Results

SDO committee questions:

1. Is there a **gap identified**? Y/N
2. [If Y] **Committee disposition of gap**: Persuasive (P) | Non-persuasive (NP) | Non-germane (NG) | Needs more investigation (NMI)
3. [If Persuasive] **Proposed action** to address gap: New standard | Update | Other solution
4. [Optional] **Anticipated timeline** for action to address gap: Start date | Completion date
5. [Optional] **Anticipated resources** needed for action to address gap: Liaisons |Technical basis | Funding

SDO	Designation	Title	Status	Applicable to ARs?	Relevant topical area	Gap identified from survey?	SDO input: gap disposition (P, NP, NG, NMI)	SDO input: proposed action to address gap	SDO input: timeline to address	SDO input: resources needed (liaisons/input from other SDOs, R&D, RIB, funding)

ANS Priorities from ARCSC Gap Assessment Survey

- **ANS-2.26-202x, *Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design* [revision of ANSI/ANS-2.26-2004 (R2021)]**
- ANS-6.4-202x, *Specification for Radiation Shielding Materials* [revision of ANSI/ANS-6.4-2006 (R2021)]
- ANS-15.8-202x, *The Quality Assurance Program Requirements for Research Reactors* [revision of ANSI/ANS-15.8-1995 (R2023)]
- ANS-53.1-202x, *Nuclear Safety Design Process for Modular Helium-Cooled Reactor Plants* [revision of ANSI/ANS-53.1-2011 (R2021)]
- ANS-54.8, *Liquid Metal Fire Protection* [proposed new standard/supersedes ANS-54.8-1988 (W1998)]
- ANS-X, generic standard on risk-informed, performance-based design process (proposed new standard)

Example from Gap Analysis: ANS-54.8

SDO	Standard	Title	Gap Description	Proposed Action	Resources Needed	Priority
ANS	ANS-54.8	Liquid Metal Fire Protection in LMR Plants	▪ Need current version of 54.8 ▪ Reinstate 54.8-1988	ANS-54.8 was issued in 1988 and withdrawn in 2000. The goal of this project is to re-issue and revise the standard utilizing a two-stage plan. Stage 1 is to re-issue ANS-54.8 as-is with only minimal changes to upfront material and references. Stage 2 is to revise the standard to include things such as risk-informed performance-based insights along with any updates reflecting newly developed strategies or components relevant to liquid metal fire protection systems. ▪ Stage 1 draft to be completed for internal approval process November 2024. ▪ Stage 2 draft optimistically to be completed for internal approval process June 2025.	While the 54.8 working group is open to new members, the existing membership is sufficient to perform the necessary duties and activities related to re-issue and revision of the standard. Funding would help to ensure timely completion of Stage 2.	High

ANS Standards on the Horizon

- ANS-2.35-202x, *Guidelines for Estimating Present & Projecting Future Socioeconomic Impacts from Construction, Operations, and Decommissioning of Nuclear Facilities* (proposed new standard)—draft completion expected December 2024
- ANS-3.11-202x, *Determining Meteorological Data for Nuclear Facilities* [revision of ANSI/ANS-3.11-2015 (R2020)]—publication expected November 2024
- ANS-8.26-202x, *Criticality Safety Engineer Training and Qualification Program* [revision of ANSI/ANS- 8.26-2007 (R2022)]—draft issued for final recirculation ballot September 2024
- ANS-19.10-202x, *Methods for Determining Neutron Fluence in BWR and PWR Pressure Vessel and Internals* [revision of ANSI/ANS-19.10-2009 (R2021)]—subcommittee ballot comments being addressed
- ANS-19.13-202x, *Initial Fuel Loading and Startup Tests for FOAK Advanced Reactors* (proposed new standard)—publication expected October 2024
- ANS-54.8-202x, *Liquid Metal Fire Protection* [proposed new standard/supersedes ANS-54.8-1988 (W1998)]—draft completion expected early 2025
- ANS-56.2-202x, *Containment Isolation Provisions for Fluid Systems* [proposed new standard/supersedes ANS-56.2-1984 (W1999)]—consensus committee ballot expected October 2025
- ASME/ANS RA-S-1.3-202x, *Standard for Radiological Accident Offsite Consequence Analysis (Level 3 PRA) to Support Nuclear Installation Application*" (revision of trial-use standard ASME/ANS RA-S-1.3-2017)—publication expected January 2025

ANS Standards Board Leadership

Andrew Sowder
ANS Standards Board Chair
asowder@epri.com

Todd Anselmi
ANS Standards Board Vice Chair
todd.anselmi@inl.gov

ANS Staff

John Fabian
ANS Director of Publications
jfabian@ans.org

Pat Schroeder
ANS Standards Manager
pschroeder@ans.org

ANS

1111 Pasquinelli Drive, Suite 350
Westmont, IL 60559
708-579-8269 (Pat)

ASME Advanced Reactor Standards Development

New & Advanced Reactors: Codes and Standards

NRC Standards Forum – September 25, 2024

Thomas Vogan, ASME Senior Vice President – Standards & Certification

SETTING THE STANDARD

Overview

- ASME Overview
- ASME Standards Development Activities including NRC support and R&D needs

ASME Facts and Figures

Established in 1880 and headquartered in New York City, the American Society of Mechanical Engineers is a not-for-profit international society.

90,000+
Worldwide Membership

135+
Countries with ASME Members

25+
Conferences Conducted Annually

200+
Technical Courses & Master Classes Offered Annually

Offices: New York, NY; Washington, DC; Little Falls, NJ; Houston, TX; Beijing, China; and New Delhi, India

Setting the Standard

Used in 100+ Countries

ASME is an international Standards Development Organization
- Accredited by ANSI
- Development process adheres to the principles and procedures outlined in the World Trade Organization's (WTO) Agreement on Technical Barriers to Trade (TBT) for development of international standards

500+ Standards & Products

Pressure Vessels, Piping, Nuclear Technologies, Elevators/Escalators, Cranes, Performance Testing, etc.

6,500+ Dedicated Volunteers

Engineers, Researchers, Government officials, etc. enhancing public safety, health, and quality of life

Transparency

Impartiality and Consensus

Coherence

Openness

Effectiveness and Relevance

Development Dimension

ASME SETTING THE STANDARD

ASME Consensus Process

Submission
- Submission of proposal
- Proposal evaluation (staff, subgroup/subcommittee)

Technical Approval
- Proposal voted on by committee
- Disapprovals addressed/recirculated (iterative)

Review
- ANSI Public Review (30-60 Days)
- Public Review comments addressed

Procedural Approval
- ASME supervisory board procedural review/approval
- ANSI procedural approval

Publication
- Editing, composition, review of proof pages
- Publication

The ASME Advantage

Maturity of our Standards

- Over 100 yrs. of consensus developed content that advances with technology and ensures high quality products and a commitment to overall public safety

Continuous Improvement

- ASME standards development committees continuously work to incorporate engineering lessons learned and advances in technology into the standards to ensure that the standards remain relevant and meet the needs of the industry.

Globally recognized and accepted

- Codes, Standards, and Conformity Assessment requirements aid manufacturers in the development and implementation of Standard through a Quality System in the manufacturing of boilers, pressure vessels, and pressure piping, etc.

Conformity Assessment Program

- ASME Conformity assessment allows the recognition of a company's or individual's capability to fulfill the requirements of an ASME standard in order to advance public safety and facilitate international commerce.

ASME Standards Development Activity NRC support and R&D needs

Nuclear Regulatory Commission

NRC Input

- Representation on ALL ASME Nuclear standards committees and most subordinate groups at the technical working level
- NRC Representation on the Board
- NRC Management Meetings

Standards Development

- Working with industry to develop consensus standards associated with systems, equipment, or materials used by the nuclear industry.

NRC Regulations and Regulatory Guides

- Rulemaking – Developing and amending regulations that licensees must meet
- Guides – Developing and revising guidance documents such as regulatory guides

Department of Energy and National Laboratories

DOE and National Lab Input

- Research
- Representation on standards committees
- DOE representation on the Board

Standards Development

- Working with industry to develop consensus standards associated with systems, equipment, or materials used by the nuclear industry.

DOE Orders and Guides

- Developing and revising orders and guidance documents

ASME SETTING THE STANDARD

ASME Nuclear Standards – BPV III

- **BPV III - Construction of Nuclear Facility Components**
  - Division 1: Metallic vessels, heat exchangers, storage tanks, piping systems, pumps, valves, core support structures, supports, and similar items.
  - Division 2: Concrete containment vessels with metallic liners
  - Division 3: Storage and transportation containments and their internal support structures for spent fuel and high-level radioactive material and waste.
  - Division 4: Fusion Energy Devices
  - Division 5: High temperature reactors providing rules suitable for construction of gas and liquid metal cooled reactors and are under a more active development to meet the evolving needs of our advanced reactor stakeholders
  - BPV II, V, IX & XIII Sections and BPV III Code Cases
- **Advanced Reactor Developers Requests:**
  - BPV Section III, Division 1: Seismic Analysis
  - BPV Section III, Division 5: High Temperature Materials for SMRs - Need continued support for materials research to support BPV III Division 5 Code Cases (e.g. Alloy 709) and expanded support for assessment of more materials at 500,000 hours (60 years).
  - BPV Section III, Division 5: Graphite Materials - Need ongoing support for R&D to expand material property data for nonmetallic materials and to clarify the concepts of crack initiation, damage tolerance, structural failure and lost of functionality.

ASME SETTING THE STANDARD

ASME Nuclear Standards - BPV XI

BPV XI – Nuclear Inservice Inspection

- Division 1: Inspection and Testing of Components of Light-Water-Cooled Plants
- Division 2: Reliability Integrity Management (RIM) A methodology to establish Inservice Inspection criteria independent of the SMR technology (e.g., Molten Salt, HTGR, Liquid Metal, etc.) Alternative approach to current ISI activities, needed to accommodate new technologies.
- BPV XI Code Cases

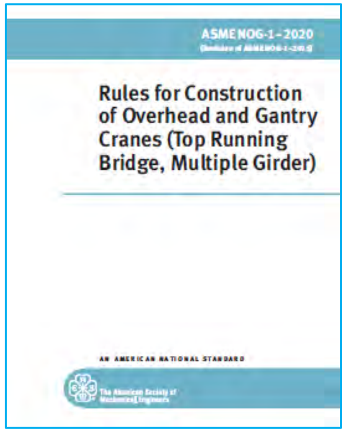
- **Advanced Reactor Developers Requests:**
  - BPV Section XI, Division 2: Inspection Protocols for Graphite and RIM for Sodium Fast Reactor - R&D is need to establish likely degradation mechanisms of graphite in molten salt and liquid metal coolant systems.

ASME SETTING THE STANDARD

ASME Nuclear Standards – CNF and CONAGT

CNF Cranes for Nuclear Facilities

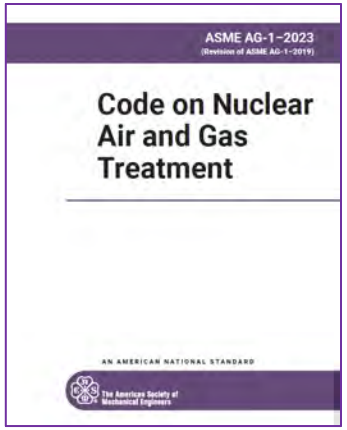
- HRT-1 - Rules for Hoisting, Rigging, and Transporting Equipment for Nuclear Facilities
- NML-1 Rules for the Movement of Loads using Overhead Handling Equipment in Nuclear Facilities
- NOG-1 - Rules for Overhead and Gantry Cranes
- NUM-1 - Rules for Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)
- OCS-1 Overhead Crane Safety Engineering: A Guide for Performing a Failure Modes and Effects Analysis (FMEA) and for Implementing a Crane Control Monitoring System (CCMS) for Enhanced Safety Cranes



- **Requests currently being discussed:** DOE-STD-1090-2020 parallels the recently published NML-1-2019 standard which is titled "Rules for the Movement of Loads using Overhead Handling Equipment in Nuclear Facilities". NML-1 was written so that it can be used at any facility that may have overhead handling lifts, especially those that require some special considerations. It could apply to any DOE facility, not just nuclear ones.

CONAGT Committee on Nuclear Air and Gas Treatment

- AG-1 Code on Nuclear Air and Gas Treatment
- N511 In-service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems



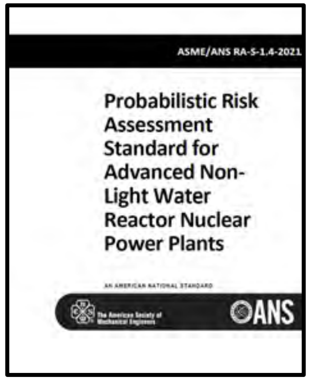
- **Requests currently being discussed:** A project task team of industry experts and DOE representatives are in the process of reviewing all DOE standards, handbooks and orders related to air filtration components and systems. At least 6 tasks have been identified to revise ASME standards and delete or revise DOE documents.

ASME SETTING THE STANDARD

ASME Nuclear Standards JCNRM

Joint Committee on Nuclear Risk Management – Joint Committee with ANS

- RA-S-1.1 Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment
- RA-S-1.2 Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Light Water Reactors (LWRs)
- RA-S-1.3 Standard for Radiological Accident Offsite Consequence Analysis (Level 3 PRA) to Support Nuclear Installation Applications
- RA-S-1.4 Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactors
- 58.22(RA-S-1.6) Requirements for Low Power and Shutdown Probabilistic Risk Assessment
- RA-S-1.5 Probabilistic Risk Assessment Standard for Advanced Light Water Reactor Nuclear Power Plants – In development
- RA-S-1.7 Multi-Unit Probabilistic Risk Assessment (Level1 +LERF) – in development
- RI-Security Risk Informed Security – In development



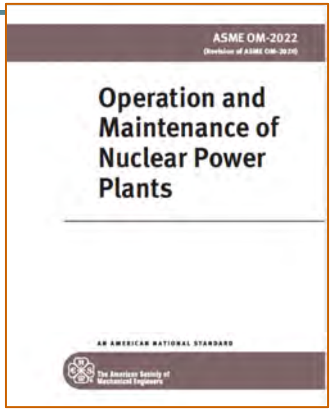
- **Advanced Reactor Developers Requests**
  - Updates to RA-S-1.2 Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Light Water Reactors (LWRs) were completed and the 2024 edition is published.

ASME SETTING THE STANDARD

ASME Nuclear Standards – OM and QME

OM Operation and Maintenance

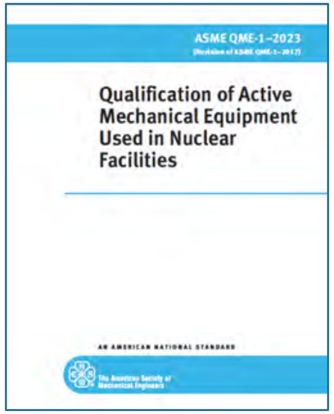
- OM-2022 Operation and Maintenance of Nuclear Power Plants
- OM-2 Rules for Inservice Testing Requirements for Pumps, Valves, and Dynamic Restraints at Nuclear Facilities. Expected in 2024
- OM-NRC Symposium – July/August 2025 In Washington D.C. area



- **Advanced Reactor Developers Request**
  - OM language was specific to LWRs. OM-2 will be applicable to all advanced reactors and will be published in October. NRC Staff is working to complete OM-2 acceptance in a Regulatory Guide once it is approved. Continued support of this effort is requested.

QME Qualification of Mechanical Equipment

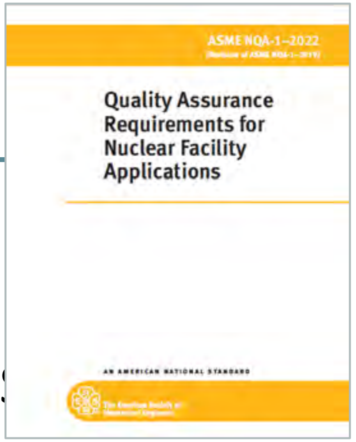
- QME-1 - Qualification of Active Mechanical Equipment Used in Nuclear Facilities



- **Advanced Reactor Developers Requests:**
  - QME-1 language was specific to LWRs. Revision of QME-1 is in progress to simplify the code, make is more applicable to non-light water reactors and remove the term "active". NRC staff plans to prepare Revision 5 to RG 1.100 to accept the ASME QME-1-2023 Standard and the reformatted QME-1 Standard (expected 2025). Continued support of this effort is requested.
  - Future actions to investigate RIM applications and risk informed qualification processes will be undertaken in future revisions.

ASME SETTING THE STANDARD

ASME Nuclear Standards – NQA and PSD



NQA Committee on Nuclear Quality Assurance

- NQA-1 Quality Assurance Requirements for Nuclear Facility Applications
- NQA.TR Evolution of Quality Assurance Principles and Requirements in the US Nuclear Industry

- **Advanced Reactor Developers Request**
  - Graded approach - NQA-1 already addresses the use of a graded quality approach. Potential future actions to better describe how to apply a graded quality approach commensurate with contributions to safety and/or risk and project phase (e.g., R&D, design, procurement, construction, installation, operation) and develop training or guidance for the Designer or Engineering to better describe how to apply risk basis analysis for safety significance assignments to systems, components, and items.

Plant Systems Design - PSD-1 in development. Publication expected mid to late 2025.

- A technology neutral standard for design of plant systems for nuclear and fossil power, petrochemical, chemical, and hazardous waste plants and facilities. The standard will provide processes and procedures for design organizations.

ASME SETTING THE STANDARD

Learn More and Participate

- ASME Code & Standards Committees
  - Participation on ASME's standards developing committees is free and open to technically qualified individuals with a willingness and ability to contribute.
  - You do not have to be a member of ASME to join a committee.
  - More information at: https://www.asme.org/codes-standards/asme-code-committee

- Standards Committee Meeting
  - Meetings are free to attend and open to the public,
  - Meeting schedules at: https://www.asme.org/conferences-events/events?eventType=4

- Catalog of Codes & Standards
  - ASME website: asme.org

- Find a Standard on searchable database: https://www.asme.org/codes-standards/find-codes-standards

- Board on Nuclear, Clean Energy, Power & Facilities Codes & Standards; and the Strategic Committee on Nuclear Facilities

Questions?

Tom Vogan

Vogant@asme.org

Contact Information

- Kate Hyam – Director, Nuclear, Clean Energy and Standardization Codes & Standards
  - HyamK@asme.org
- Adam Maslowski– Section III
  - Maslowskia@asme.org
- Daniel Miro-Quesada – Section XI
  - Miroquesadad@asme.org
- Jihoon Oh – CNF
  - ohj@asme.org
- Shaimaa Khalifa – CONAGT
  - khalifas@asme.org
- Oliver Martinez – JCNRM, OM
  - Martinezo@asme.org
- Daniel Wiener – QME
  - Weinerd@asme.org
- Abena Dinizulu – NQA
  - DinizuluA@asme.org
- Gerardo Moino– QPS-1
  - Moinog@asme.org

ASME SETTING THE STANDARD

Addressing New and Advanced Reactors in Standards for Instrumentation, Control, Electrical and Control Room Systems

Dr. Richard Wood

Nuclear Engineering Department
The University of Tennessee
rwood11@utk.edu

Presented at
NRC Standards Forum

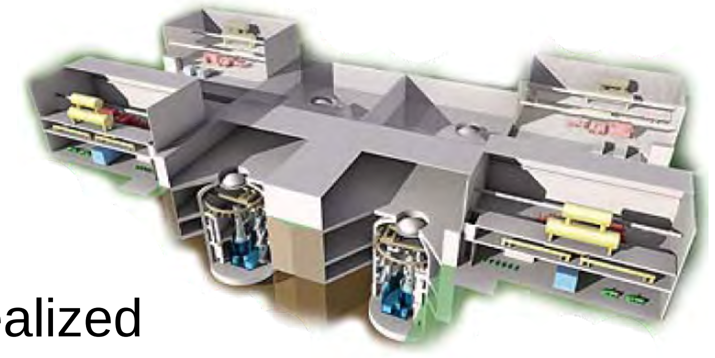
NRC Headquarters
Rockville, MD

September 25, 2024

TICKLE COLLEGE OF ENGINEERING
DEPARTMENT OF NUCLEAR ENGINEERING

A New Paradigm is Required to Offset Reduced Economy-of-Scale Savings for Small and Microreactors

- Plant design and management
  - Multiple units per site
  - Multiple product streams
  - More effective, efficient operation and maintenance
- Reduce capital costs
  - Extensive use of digital technologies
  - Optimized I&C
  - Reduce cable installation costs
- Reduce plant operations and maintenance costs
  - Plant availability
  - Efficiency of power conversion
  - Staffing requirements
  - Remote or near-autonomous operation
- I&C technology can enable this objective to be successfully realized



Economy of Automation in place of Economy of Scale

Two Primary SDOs Address Application of I&C, Electrical and Human Factors Technology for Nuclear Power

- Institute of Electrical and Electronic Engineers (IEEE)
  - Nuclear Power Engineering Committee (NPEC)
  - 5 Subcommittees
  - More than 50 standards
  - Based on individual participation of technical experts
- International Electrotechnical Commission (IEC)
  - Subcommittee 45A (SC45A)
  - 9 Working groups
  - More than 70 standards
  - Based on participation of technical experts from national committees

What is IEEE NPEC?

Nuclear Power Engineering Committee operates within IEEE Power and Energy Society

- SC 2 – Qualification
- SC 3 – Operations, Maintenance, Aging, Testing and Reliability
- SC 4 – Auxiliary Power
- SC 5 – Human Factors and Control Facilities
- SC 6 – Safety Related Systems

Several IEEE standards are endorsed by NRC in Regulatory Guidance

Safety/Protection System design criteria standards incorporated by reference into Code of Federal Regulation [10 CFR 50.55a(h) – IEEE Std 603-1991, IEEE 279-1971/1968]

What is IEC Subcommittee 45A?

SC 45A: Instrumentation, Control and Electrical Power Systems of Nuclear Facilities

- WG 02- Sensor and measurement techniques
- WG 03- Instrumentation and control systems: architecture and system specific aspects
- WG 05- Special process measurements and radiation monitoring
- WG 07- Functional and safety fundamentals of instrumentation, control and electrical power systems
- WG 08- Control rooms
- WG 09- System performance and robustness toward external stress
- WG 10- Ageing management of instrumentation, control and electrical power systems in NPP
- WG 11- Electrical power systems: architecture and system specific aspects
- WG 12- Artificial Intelligence/Machine Learning

IEEE and IEC Acting to Harmonize Standards and Resolve Guidance Needs for New Reactors

- IEEE and IEC have an agreement to jointly develop standards
  - 11 dual logo standards have been published to date
  - 5 joint projects are underway
- IEEE and IEC are participating in the ARCSC effort
- IEC performed an assessment of guidance needs/gaps for SMRs
  - IEC TR 63335:2021, Nuclear power plants - Instrumentation and control systems, control rooms and electrical power systems - Specific features of small modular reactors and needs regarding standards
  - Working group roadmaps to address needs were developed

Highlights of Assessment of Gaps/Needs to Accommodate SMRs in IEC Standards (1)

- Sensing and Measurement
  - Sensor technology (optical, ultrasonic, electromagnetic)
  - Qualification (harsh/unique environments, lifetime) and maintainability (access, longer operational intervals)
  - Implementation (physical constraints, interconnections/communication, embedded manufacturing)
- I&C architectures
  - Multi-unit or shared operational architectures
  - Integrated and/or wireless communications
  - Independence and defense-in-depth

Highlights of Assessment of Gaps/Needs to Accommodate SMRs in IEC Standards (2)

- Controls and Plant Operation
  - Concepts of operations
  - Multi-unit control
  - Remote monitoring and/or control
  - Advanced control and monitoring for extensive automation or near autonomy
  - Functional allocation between human and machine (degree of automation)
  - Alternate approaches to human-system interactions
- Classification and graded approach to guidance for advanced reactors

What’s Next

- Findings from ARCSC survey have been assessed and action plans developed
- IEC will implement working group roadmaps from SMR assessment
- Approaches for incorporating flexibility into guidance are being investigated
  - Risk insights
  - Performance-based enhancements
  - Graded approach to criteria
- Harmonization efforts will proceed
  - Dual logo standard development
  - Common adoption by national industries and regulators

NRC Standards Forum

Session 2 on Standards Development Organizations Activities; Updates to ASCE/SEI Standards 4 and 43

Dr. Brian McDonald, S.E.
VP and Principal Engineer
Exponent,. Inc.

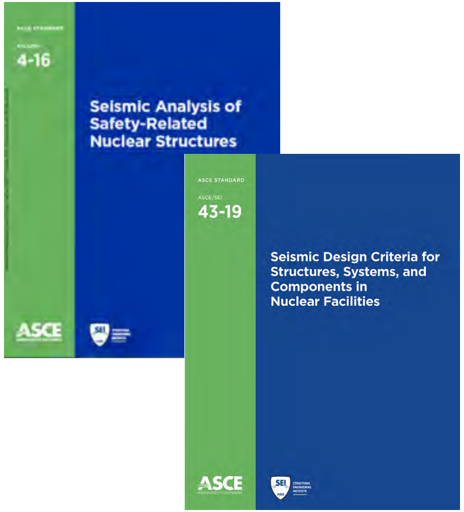
Dr. Andrew Whittaker, S.E.
SUNY Distinguished Professor
University at Buffalo

25 September 2024

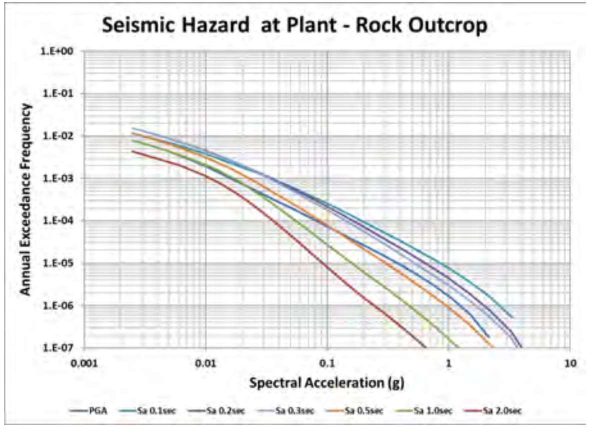
ASCE 4 and 43: Brief Overview of Current Standards

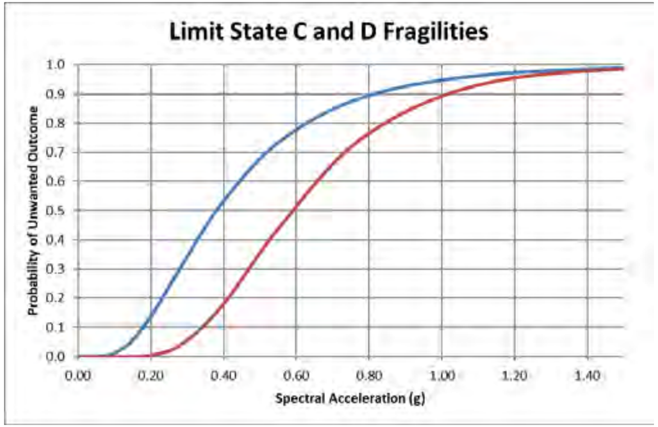
These standards are (and have been) performance-based, that is,

> "This standard [ASCE 43] … provides criteria for seismic design of safety-related structures, systems, and components (SSCs) to achieve target performance goals in nuclear facilities…
>
> More stringent design criteria are used to achieve better seismic performance for SSCs that have more serious failure consequences…"



These standards do this rigorously by treating both seismic hazard and structural response probabilistically



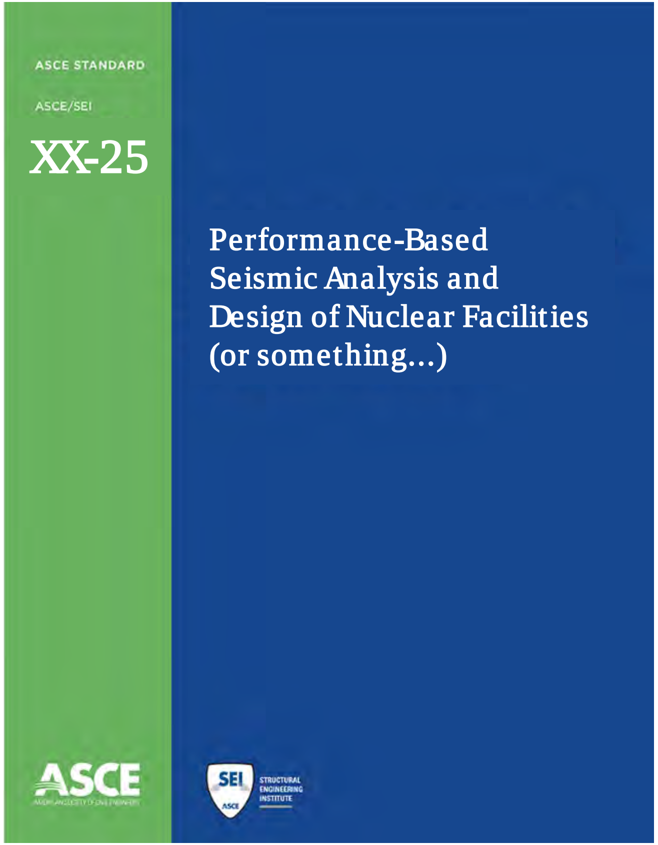


$$\lambda(t) = \int_0^\infty F(i) \times |dH(i)|$$

These standards have served the profession well, but it's time for a major update!

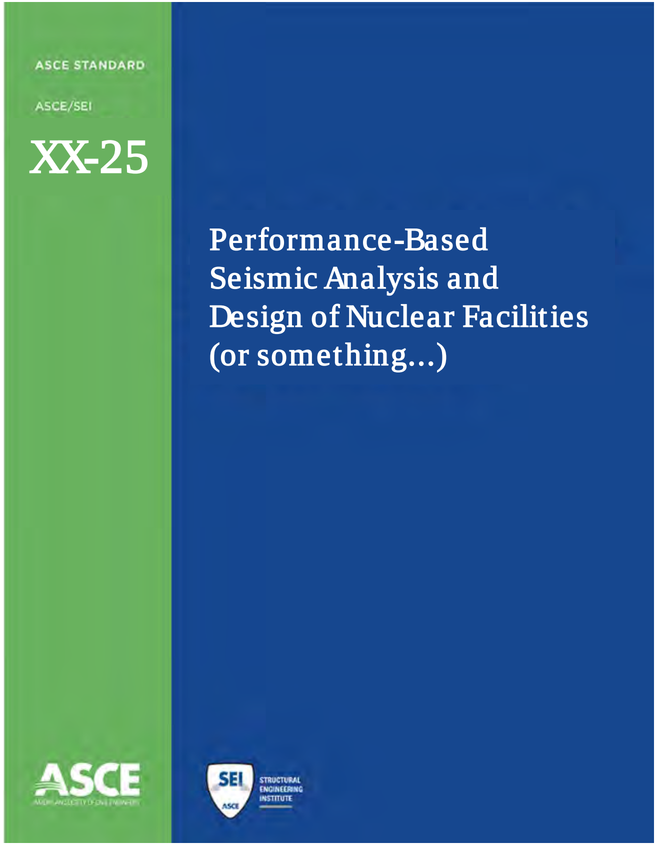
ASCE 4 and 43: The Big Plan (though yet to be balloted)

- Merge ASCE 4 (analysis) and 43 (design)
  - Consistent with merging of ASCE 41
- Play nicely with regulators and others
  - *Further* emphasize risk-informed, performance-based
  - US Department of Energy
  - US Nuclear Regulatory Commission
  - ANS / NEI / EPRI / ...
- Address next generation of nuclear plants
  - SMRs and Micro-Reactors (aka "advanced" or "non-light water")
- Connect with efforts to streamline delivery
  - Reliably achieve performance targets while reducing cost
  - NEI, EPRI, White House
- Stay in our *lane*—other SDOs doing likewise—to simplify design processes and avoid technical conflicts
  - Regular engagement with other SDOs (i.e., ANS, ASME)
  - Active participation in parallel efforts (Advanced Reactor Codes and Standards)
- Take better advantage of good work by others
  - USGS Mapping of seismic hazards and selection / scaling of records
  - Response of structures and components in extreme loading (ASCE 41)



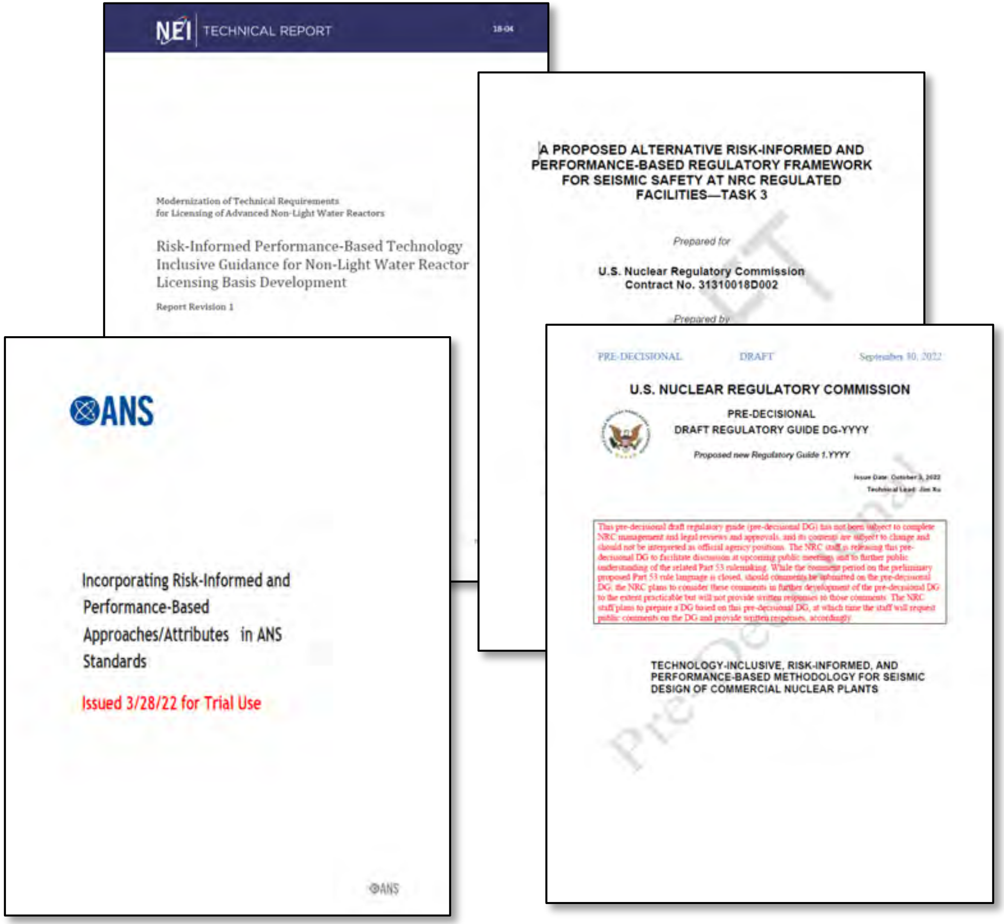
Merge ASCE 4 and ASCE 41

- No good reason remains for these to be separate standards
- Other ASCE standards have merged, it's time for us to do the same
- Just the process of merging provides many opportunities for streamlining design process
- Seems like common sense



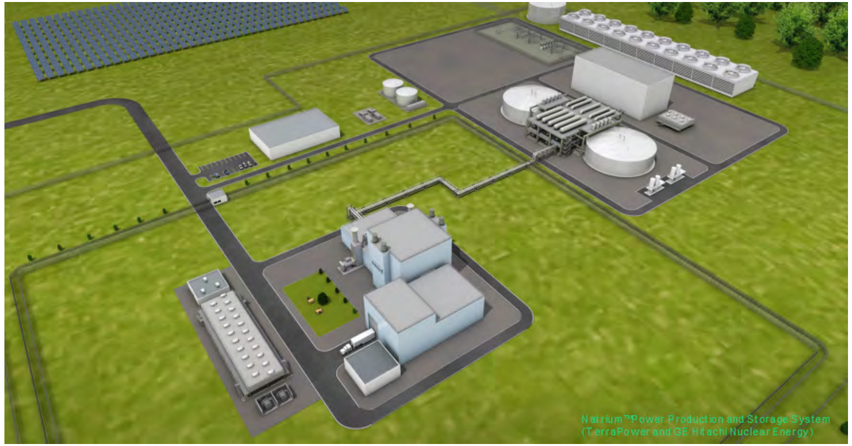
Play Nicely with Others

- ASCE 4/43 do not set performance criteria – these nominally come from ANS 2.26
- ANS 2.26 in midst of major rewrite, and coordination is essential
  - "Delegate" members on both DANS and ANS2.26 committees keep fingers on both pulses
- All of this in the larger context of SDOs moving towards RIPD regulatory environment
- Good news: ASCE 4/43 inherent design philosophy is, and has been, rigorously performance based – so open heart surgery is not required

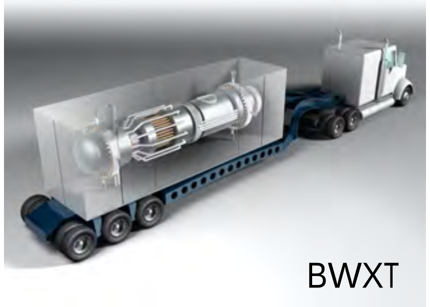


Not your Grandfather's NPP

TerraPower and GEH

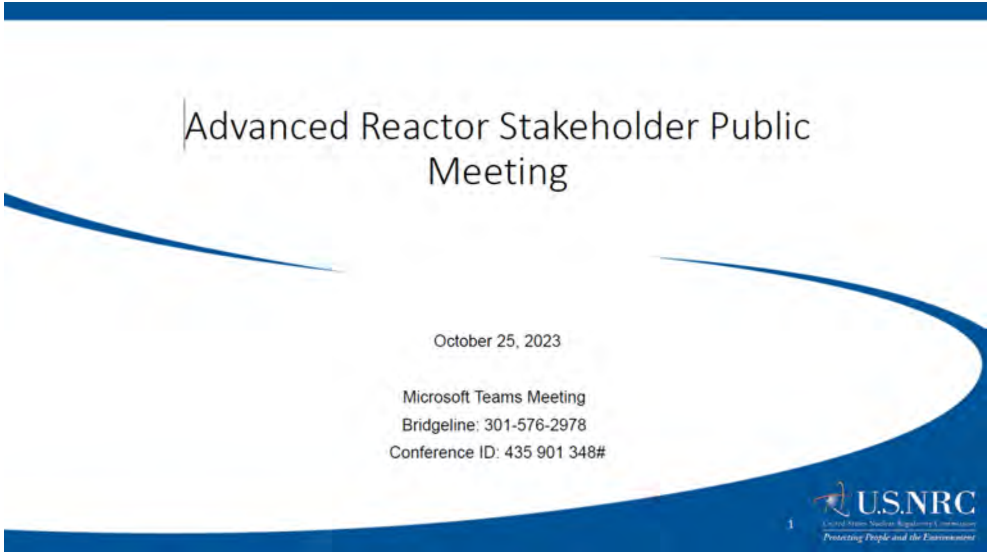


Georgia Power



Faster Approvals without Sacrificing Performance

- This work is connected with efforts to streamline delivery
- Prescriptions in both standards will be scrutinized to determine if duplicative, best-practice, or even required
- Not just us: NEI, EPRI, NRC, White House



Stay in Our Lane

- Surprise: Civil / Structural engineers, in general, are not very good at designing pressure vessels or all that ancillary piping and electrical equipment

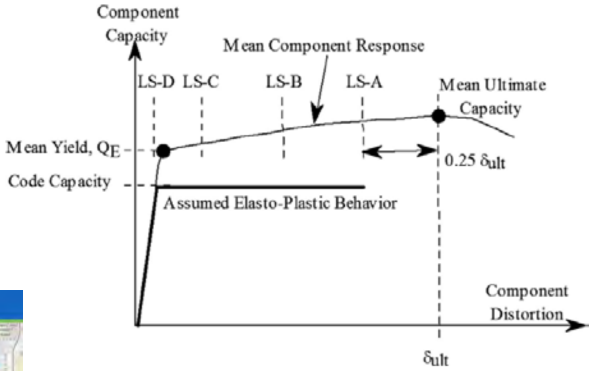
- We are happy to inform equipment designs with our best estimates of in-structure seismic response spectra and relative movements between SSCs

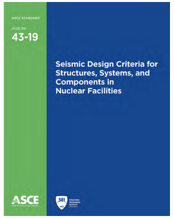
- We are even happier to kick the can full of all other aspects of equipment design down the road to ASME and others

Incorporate Good Work of Others

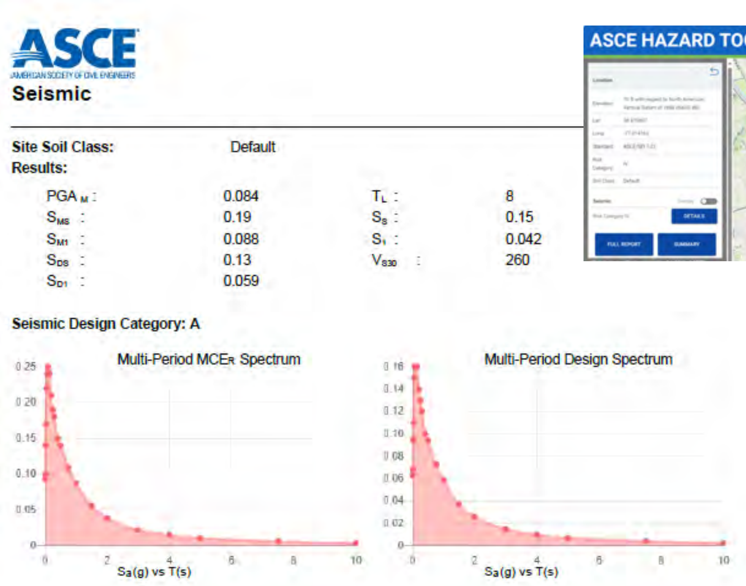
Take advantage of other advancements

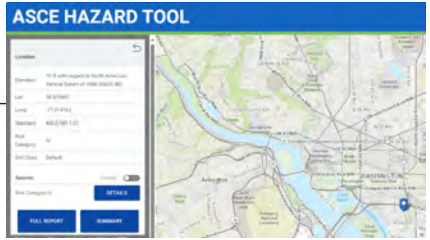
- Example: USGS Mapping of seismic hazards (ASCE Tool) and selection / scaling of records (ASCE 7)
- Example: Response of structures and components in extreme EQ loading (ASCE 41)

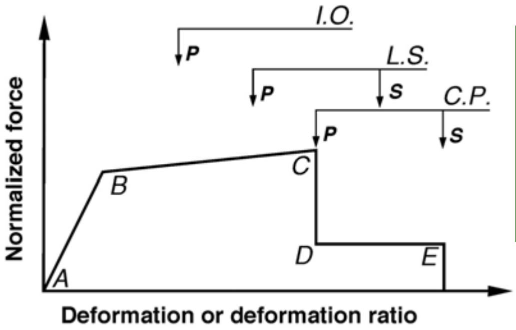


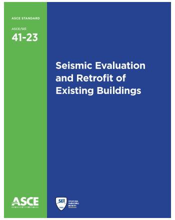


Us









Them

Immediate Plan Going Forward

- Merge 4/41 and delete overlap and legacy provisions
- Limit scope to SDC 3, 4, and 5, as defined in ANS 2.26
  - Unexpected consequences for DOE facilities falling into SDC2
- ASCE mandate: Point to other standards wherever appropriate
  - Map limit states in ANS 2.26 to performance levels in ASCE 41
  - Delete provisions that are the domain of other SDOs
  - ASME = piping and hangers, ANS = SPRA
- Allow seismic hazard calculations per USGS
- Rethink need for the default to SSI analyses
- All this will be presented to the committee at Oct. 1 Kickoff

Comments, compliments , and payments to mcdonald@exponent.com

Complaints to awhittak@buffalo.edu