ARCSC Advanced Reactor Codes and Standards Collaborative

SUMMARY OF
ADVANCED REACTORS CODES & STANDARDS COLLABORATION (ARCSC)
2025 WORKSHOP

December 4, 2025

Washington, DC - EPRI Headquarters

Contents

- Action Items / Key Takeaways
- Meeting Summary
- Agenda
- Presentation Summaries / Highlights
- Attendance / Participation
- Extracted Key Sources/References from Online Chat

Links to presentation slide decks and video recordings are throughout the summary and agenda.

ACTION ITEMS / KEY TAKEAWAYS

At the conclusion/wrap-up of the workshop, 10 actions or takeaways were identified.

1. Flag closure on how actions on gaps in standards have been addressed.
2. Share criteria on how the high priority standards were chosen (NEI 93-01).
3. Highlight ASME PSD-1 design standard for RIPB
4. Can SDO copyrighted material be shared or accessed to leverage artificial intelligence tools for standards users.
5. Who is already developing standards for artificial intelligence? Are there nuclear specific applications of AI that require the development of standards?
6. How does the RIPB guidance document/ARCSC Task Group report close out any of the roadmap objectives (CS-02).
7. How do we increase developer input into ARCSC activities.
8. Do we need more participation from suppliers in ARCSC activities.
9. Promote ARCSC accomplishments to developers and suppliers to help with their recruitment
10. ARCSC should have more focused, more detailed, and properly directed attempts at funding for standards development activity for advanced reactors – possibly have a funding task group

Executive Meeting Summary

ARCSC Workshop – December 4, 2025 – Washington, DC (EPRI Headquarters)

Participants - *See participant list following the individual presentation summaries.*

Meeting Overview

The meeting focused on advancing advanced nuclear reactor codes and standards through broad stakeholder collaboration. Key themes included adoption of risk-informed, performance-based (RIPB) approaches, improving regulatory efficiency, strengthening the supply chain and workforce, and evaluating the appropriate integration of artificial intelligence (AI) within nuclear design, licensing, and operations frameworks.

Key Discussion Points

1. Codes and Standards Strategy

- The discussion centered on the 4th Annual Advanced Reactor Codes and Standards Collaborative Workshop, emphasizing structured stakeholder feedback to guide future standards development.
- EPRI reaffirmed its mission to support safe, affordable, reliable, and clean energy through technical leadership.
- An updated codes and standards roadmap report highlighted recent industry progress and opportunities to improve regulatory efficiency.
- Seismic considerations were identified as a priority area, with a related standards product anticipated in 2026.

2. Regulatory Framework and Endorsement Efficiency

- NRC emphasized transparency and prioritization of standards and regulatory consents in safety decision-making.
- Participants noted measurable progress in endorsement efficiency, improving NRC review timelines for new materials and standards.
- Concerns were raised that the current regulatory framework remains overly prescriptive, driving high costs and limiting technology inclusivity.
- A lack of consistent understanding of performance-based regulation across NRC and industry stakeholders was identified as a barrier to implementation.
- NRC engagement with international regulators continues to support harmonization of global codes and standards.

3. Industry and Standards Development Activities

- NEI discussed efforts to integrate non-nuclear standards into the nuclear supply chain.
- The ASME PSD-1 standard was highlighted as a forthcoming design-focused standard validating key engineering concepts.
- The task group's Section Three work focuses on aligning codes and standards with advanced reactor community needs, driven by stakeholder input.
- Collaboration with industry groups aims to improve regulatory acceptance and streamline construction and deployment processes.

4. Risk-Informed, Performance-Based Engineering

- Participants emphasized the need for a common definition of "risk-informed" and "performance-based" to enable effective communication.
- Effective requirements management was identified as critical for prioritizing resources in system design and safety evaluations.
- Integration of RIPB principles was highlighted as essential for civil and seismic structure design, balancing safety with constructability and cost.
- Quality engineering practices—design detail, peer review, and construction observation—were emphasized over reliance on conservative material margins.
- While nuclear hazards are unique, high-performance engineering principles from non-nuclear sectors were viewed as broadly applicable.

5. Resources, Deployment, and DOE Engagement

- Discussions addressed manpower and funding constraints impacting advanced reactor deployment targets around 2026.
- Participants stressed the importance of submitting specific, well-defined proposals to Department of Energy to support standards and quality assurance development.

6. Artificial Intelligence and Digital Tools

- AI was discussed as a tool to enhance safety, efficiency, maintenance, and information management in nuclear applications.
- NEI described collaboration on a virtual assistant to improve access to industry records.
- Innoslate was highlighted as a tool to improve traceability and reduce engineering silos.
- Participants emphasized the need for rigorous standards, oversight, and IP protection for AI applications.
- Ongoing coordination among standards organizations seeks to establish AI-related codes while avoiding duplication

ARCSC Advanced Reactor Codes and Standards Collaborative

4th Annual Advanced Reactor Codes and Standards Collaborative Workshop

DATE: Thursday, December 4, 2025
TIME: 9:00 a.m. to 5:00 p.m. EASTERN
PLATFORM: Hybrid (In-Person and Virtual)
PLACE: Electric Power Research Institute
1325 G. Street NW
Washington, DC 20005

AGENDA

Session Time	Session Title	Session Presenter(s)
8:00 – 9:00 a.m.	**In-Person Arrival and Check-In**	
9:00 – 9:05 a.m.	**Welcome and In-Person Logistics** - Video	➢ Andrew Sowder, EPRI, ANS Standards Board Chair
9:05 – 9:10 a.m.	**Review of Agenda and Workshop Purpose** - Video	➢ Andrew Sowder, EPRI, ANS Standards Board Chair
9:10 – 9:25 a.m.	**Progress to Date, Future Actions Advanced Reactor Codes and Standards Collaborative (ARCSC)** - Video	➢ Don Eggett, Eggett Consulting LLC, ARCSC Co-chair ANS Immediate Past Chair Standards Board
9:25 – 10:00 a.m.	**EPRI/NEI North American Advanced Reactor Roadmap (NAARR) Rev. 1 Part 1: Technical Readiness – SUPPLY CHAIN** - Video *See page 3 of this agenda*	➢ Don Eggett, ANS, ARCSC Co-Chair ➢ Mark Richter, NEI, Director
10:00 – 10:30 a.m.	**NRC Activities in Codes & Standards** - Video	➢ Raj Iyengar, Ph.D., NRC Chief, Reactor Engineering Branch Division of Engineering Office of Nuclear Regulatory Research
BREAK 10:30–10:45 a.m.		
10:45–12:00 p.m.	**Designer Feedback** The Role of RIPB Codes & Standards in Regulatory Modernization...and Reestablishing the U.S. as the Global Leader in Nuclear Energy - Video	➢ Rani Franovich, Deep Fission, Vice President of Regulatory Strategy

LUNCH 12:00 – 12:45 p.m.		
12:45 – 2:15 p.m.	**Guided Discussion:** Risk-Informed, Performance-Based Industry Needs RIPB Guidance for Designers and Standards Setters - Video ASME Section III - Recent Activities and Alternate Requirements for Items Commensurate with their Contribution to Safety or Risk - Video American Nuclear Society (ANS) Standard 2.26 - Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design - Video	➢ N. Prasad Kadambi, RIPB TG Chair ➢ Jon Facemire, NEI ➢ Rachel Romano, MPR, Secretary TG on Alternate Requirements ➢ Doug Clark, Oak Ridge National Laboratory (ORNL) and ANS 2.26 Chair
BREAK 2:15 – 2:30 p.m.		
2:30 – 3:30 p.m.	**Guided Discussion:** RIPB Design and Opportunities for Right-Sizing Regulatory Requirements for Civil Structures - Video Part 1: RIPB Seismic Design of Nuclear Civil Structures - Video Part 2: Right Sizing Requirements for Nuclear Civil Structures - Video	➢ Brian McDonald, Ph.D., S.E., Principal Engineer and Corporate Vice President, Exponent; Chair, ASCE DANS Committee ➢ Andrew Whittaker, Ph.D., S.E., SUNY Distinguished Professor, University at Buffalo; Chair, ASCE Nuclear Standards Committee
3:30 – 3:45 p.m.	**EPRI/NEI North American Advanced Reactor Roadmap (NAARR) Rev. 1 Part 2: Technical Readiness – CODES & STANDARDS** - Video *See page 4 of this agenda*	➢ Don Eggett, ANS, ARCSC Co-Chair ➢ Mark Richter, NEI, Director
3:45 – 4:35 p.m.	**Guided Discussion:** Incorporating artificial intelligence (AI) into work/applications; how to approach and controls needed for AI Introductory Comments - Video Nuclear Industry Virtual Assistant (NIVA) Pilot Project - Video Incorporating Artificial Intelligence (AI) Into Work/Applications; How to Approach And Controls Needed for AI - Video	➢ Don Eggett, ANS, ARCSC Co-Chair ➢ Jim Slider, NEI ➢ Todd Anselmi, INL
4:35 – 5:00 p.m.	**Wrap up and Follow-up Actions** - Video Facilitators: Don Eggett, Andrew Sowder, Mark Richter	➢ All participants
5:00 p.m.	**Adjournment**	➢ Don Eggett, ANS, ARCSC Co-Chair

EPRI/NEI North American Advanced Reactor Roadmap (NAARR) Rev. 1 PART 1

- Discussion on changes to the NAARR Rev. 1 report, in general
  The Roadmap is available at EPRI-NEI_NAARR_Sept_2025.PDF.

- Summary of new action items from NAARR Rev. 1 for SDOs/ARCSC

  Technical Readiness – SUPPLY CHAIN

  ACTION Priority 2 (p. 55): Commercialize advanced manufacturing capabilities.

  - Document current domestic/regional capabilities and projected demand. Identify gaps and develop plans to close said gaps for strategic advanced manufacturing technologies that address other manufacturing gaps. Include documentation of successful models or approaches to inform moving these technologies from development to commercialization.
  - Provide proof-of-concept research and prototype demonstrations for strategic and high manufacturing and technology level readiness techniques.
  - **Expedite qualification of strategic techniques and materials in C&S and regulatory bodies based on deployment timeline and demand.**
  - Connect designers, developers, original equipment manufacturers, and advanced manufacturers through workshops and industry events to tie demand with capabilities.

  Action Owner: EPRI, OCNI, CAMiNA, DOE, AMMT, ARCSC, CSA, NEI

  Need Date: 2023–2030

Technical Readiness – CODES & STANDARDS **PART 2**

ACTION Priority 1 (p. 59): Identify gaps in and timelines for advanced reactor C&S.

- Consolidate and update prior advanced reactor C&S gap analyses
- Define development timelines for commercial relevance
- Prioritize gaps and associated actions
- Secure resources, manpower, and funding to address gaps in and timelines for advanced reactor C&S development

Action Owner: SDOs, NEI, CNA, CSA, EPRI, INPO, and advanced reactor vendors

Need Date: 2024 gap identified (complete), 2025 for timeline and assigned resources

Progress to Date on Addressing Key Issue: ARCSC was established. This collaboration will ensure coordination and engagement among Standards Development Organizations (SDOs), reactor designers, regulators, and other interested stakeholders to develop a roadmap of needs for new or updated codes and standards, to record which SDO is undertaking specific activities, and to track the progress of new and revised standards development. Through a gap analysis exercise performed in 2023 and 2024, industry standards of significance were identified. Those standards with the highest-ranking priority were identified and validated by the advanced reactor designers for concurrence. ARCSC is in the process of listing those standards in need of the highest priority for both manpower and funding.

ACTION Priority 2 (p. 60): Demonstrate RIPB classification approaches: Develop and execute at least one pilot project that applies RIPB methods in development of a new advanced reactor standard jointly with U.S. and Canadian SDOs.

Action Owner: American Nuclear Society (ANS), ASME, and CSA with NEI, CNA and advanced reactor vendors

Need Date: 2025

> ***ACTION Priority 1 (p. 60)***: Update or develop C&S to support RIPB approaches: Update existing C&S to incorporate the benefits of RIPB approaches. These updates should account for pressure boundaries and reactor buildings that no longer perform safety-related fission product retention functions, electrical and instrumentation and control (I&C) equipment that no longer must design to the single failure criterion, a general move from prescriptive requirements to performance-based targets and methods for achieving those targets, and an emphasis on reliability goals instead of deterministic requirements. If necessary, create new C&S to facilitate more efficient C&S development.

Action Owner: NEI, ASME, ANS, American Society of Civil Engineers, SDOs, and advanced reactor vendors

Need Date: 2025

Progress to Date on Addressing Key Issue: Relationships and regular engagement among potential collaborators have been established under the ARCSC SDO collaborative umbrella.

Individual Presentation Summaries / Highlights

Welcome and Review of Workshop Purpose/Agenda – Video – Andrew Sowder, EPRI, ANS Standards Board Chair

- Andrew Sowder welcomed the attendees, reviewed meeting logistics, provided a short history on EPRI, verified the presentations and recordings will be available after the meeting, reviewed safety precautions, and finally reviewed the **AGENDA** for the day.
- This workshop continues the ARCSC work started four years ago to coordinate standards development activity for advanced reactors among standards developers, industry organizations, developers, designers, government agencies, and other key stakeholders.

ARCSC Progress to Date – Video – Don Eggett, ANS, ARCSC Co-Chair

- Don Eggett reviewed the accomplishments of the ARCSC since its inception, current activities, and planned future activities.
- The Advanced Reactor Codes and Standards Collaborative (ARCSC) was established to support timely commercialization of advanced reactors by identifying, prioritizing, and closing gaps in U.S., Canadian, and international nuclear codes and standards aligned with the EPRI/NEI North American Advanced Reactor Roadmap.
- Between 2023 and 2025, ARCSC developed its charter and processes, conducted a comprehensive gap assessment survey across multiple standards development organizations (SDOs), launched a public website, and held annual workshops to share results and gather stakeholder feedback.
- Survey results enabled identification of "highest priority" codes and standards gaps, as well as cross-cutting themes such as risk-informed, performance-based (RIPB) methods, digitalization, advanced manufacturing, seismic analysis, and functional containment.
- A major ongoing focus is the development and demonstration of risk-informed, performance-based approaches (TR-CS-02), including pilot projects and coordination among SDOs to modernize standards while avoiding overly prescriptive requirements.
- Planned 2026 activities emphasize continued stakeholder engagement, refinement of standards development timelines and resource needs, expanded RIPB guidance, and alignment of priority standards with advanced reactor deployment schedules.
- There was a question on the promotion of ARCSC products such as the RIPB guidance document/ARCSC Task Group RIPB report.
- It was also stated that ARCSC should track the closure of gaps identified during the 2023-2025 gap analysis work.
- Question was made on how 'priority' standards were identified; it was stated that priority standards were identified through the gap analysis work which was a thorough survey of stakeholders of advanced reactor commercialization.

EPRI/NEI North America Advanced Reactor Roadmap (NAARR) - Part 1: Technical Readiness – SUPPLY CHAIN – Video – Don Eggett, ANS, ARCSC Co-Chair and Mark Richter, NEI, Director

- The presentation introduced Revision 1 of the EPRI/NEI North American Advanced Reactor Roadmap, highlighting changes and newly available content, with a focus on Part 1: Technical Readiness – Supply Chain.
- New and updated action items were outlined for Standards Development Organizations (SDOs) and ARCSC, derived from NAARR Rev. 1, to better align standards and infrastructure with advanced reactor deployment needs.
- A key priority action is to commercialize advanced manufacturing capabilities, including documenting current capabilities, identifying gaps, and developing plans to transition technologies from development to commercialization.
- The roadmap emphasizes proof-of-concept research, prototype demonstrations, and expedited qualification of materials and manufacturing techniques within codes, standards, and regulatory frameworks, consistent with deployment timelines and demand.
- It calls for strong coordination across industry, government, and standards bodies—connecting designers, vendors, manufacturers, and regulators—to align supply chain capabilities with projected advanced reactor needs through 2030.
- The discussion placed advanced reactor deployment within a rapidly changing energy landscape, emphasizing growing demand driven by clean energy goals, U.S. energy dominance priorities, AI growth, and the need for both small and gigawatt-scale nuclear capacity.
- Codes and standards were framed as an enabling function of the nuclear supply chain, particularly for advanced manufacturing, materials, and new technologies necessary to support large-scale reactor deployment.
- NEI described efforts to expand and modernize the supply chain, including use of ISO 9001 *with supplemental nuclear controls* alongside existing Appendix B/NQA-1 requirements to increase supplier capacity without reducing safety rigor.
- Significant attention was given to ongoing NRC wholesale rulemaking, expected to be extensive and fast-paced, with industry engagement critical to reviewing and shaping outcomes that affect deployment timelines.
- NEI, EPRI, DOE labs, and industry partners are exploring a multi-organization accelerated deployment initiative to reduce silos, clarify ownership across deployment activities, identify gaps and overlaps, and better align research, manufacturing, codes, and standards with industry needs.
- It was clarified through questioning that using non-nuclear standards to close the needs gap for commercialized advanced reactors is an option currently being evaluated.
- It was clarified through questioning that NEI 22-04 is meant to provide a path for screening suppliers for nuclear applications. Approval of the NEI 22-04 path is currently undergoing NRC review.

NRC Activities in Codes & Standards – Video – Raj Iyengar, Ph.D., NRC, Chief Reactor Engineering Branch, Division of Engineering

- The presentation described the NRC's role and policy framework for participation in voluntary consensus standards (VCS), guided by Management Directive 6.5, the National Technology Transfer and Advancement Act (NTTAA), and OMB Circular A-119, which prioritize use of industry standards over government-unique standards where practical.
- NRC staff actively participate in numerous standards development organizations (SDOs) (e.g., ASME, ANS, IEEE, ASTM, CSA) and coordinate with industry, ARCSC, national laboratories, and other federal agencies to support nuclear safety and innovation.
- Recognizing limitations of past approaches, the NRC is enhancing its codes and standards program to improve timeliness, efficiency, and flexibility, particularly for advanced reactors and risk-informed, performance-based (RIPB) applications.
- An NRC Codes and Standards Action Plan was developed through public engagement in 2024 and finalized in August 2024, consisting of 17 actions across three focus areas: standards development improvements, endorsement process enhancements, and leveraging commercial standards.
- The action plan is structured across short-term, intermediate, and longer-term program enhancements, including prioritizing key standards, expediting endorsement of advanced reactor codes, piloting efficiency improvements, and exploring use of artificial intelligence in regulatory guide updates.
- NRC highlighted progress to date, including creation of a public NRC Codes and Standards Participation Database, completion of several swift actions, and ongoing collaboration with ARCSC and industry stakeholders.
- The NRC reaffirmed that codes and standards remain a critical regulatory tool, and emphasized its commitment to continued stakeholder engagement through forums, workshops, and iterative improvement of its standards program to support advanced reactor deployment.
- During questioning NRC determined its prioritization of standards needs from ARCSC, ASME, ANS, and many industry stakeholders. The needs of NRC were also paramount in its prioritization of needs.
- It was asked if NRC would recognize authorization of other major federal nuclear regulators such as Canada, UK, etc.; Raj responded that there is material on the NRC site explaining NRC's acceptance of international standards. The tri-lateral agreement with Canada and UK regarding licensing information sharing was highlighted. A recent presentation on the IAEA at the 2025 Standards Forum was mentioned as a good source.
- It was mentioned that NRC staff is applying artificial intelligence to licensing processes to facilitate and speed up processing.
- It was mentioned that NRC has recognized or endorsed publications that are not standards such as technical reports.

The Role of RIPB Codes & Standards in Regulatory Modernization…and Reestablishing the U.S. as the Global Leader in Nuclear Energy – Video – Rani Franovich, Deep Fission

- The speaker (Rani Franovich, Deep Fission) argued that advanced reactor developers need flexible, outcome-focused standards and a requirements-management framework that supports risk-informed, performance-based (RIPB) regulation without constraining innovation, using Deep Fission's gravity reactor as a case study.
- She traced the historical evolution of prescriptive codes and regulations—from early boiler safety and the ASME Boiler and Pressure Vessel Code to 10 CFR Part 50 and §50.55a—showing how increasing prescription has driven cost, rigidity, and technology specificity beyond what is necessary for safety.
- The presentation emphasized that prescription scales with volume of regulatory text, noting that early regulations and code provisions were short and flexible, while modern requirements have expanded dramatically without always providing commensurate safety benefits.
- Franovich highlighted that NRC's 1999 policy direction to adopt risk-informed, performance-based regulation successfully transformed oversight (e.g., Reactor Oversight Process) but was never fully extended to rulemaking, codes, and standards, leaving licensing frameworks overly prescriptive.
- A key distinction was reinforced: "risk-informed" defines acceptable risk levels, while "performance-based" defines outcome objectives without prescribing how to meet them; conflating these concepts has led to confusion, inconsistent implementation, and regulatory burden.
- International examples (UK, Canada, IAEA practices) were cited to show that performance-based regulation is feasible and widely used, but insufficiently understood or deliberately applied in the U.S. nuclear regulatory system.
- The speaker argued that future licensing frameworks for advanced and high-volume deployment reactors must target the "RIPB sweet spot"—objectives-driven, technology-inclusive, and minimally prescriptive—to enable innovation, reduce costs, and support global competitiveness.
- Several questions were raised if Part 50 allows non N-stamp vessels. It was clarified that N-stamps are only relevant for light water reactors; it is not applicable for non-light water reactors. It was also clarified that there is an alternate path for certification; however, the path is difficult and there was doubt if current culture in the NRC would support any alternate paths being approved. It was mentioned that there is another alternate path for certification through the NRR Office Director that has been used in the past, which has been completed at least once within 2 months but often times has not been approved by the NRR Director. The practicality of taking a path other than the N-stamp for certification was deeply questioned.
- During question period there was a good discussion on the competing effects of moving toward a performance-based approach and the current trend in NRC licensing to be more efficient that, in practice, leads to a more prescriptive regulatory approach, which is opposite to a performance-based approach and out of step with legislative mandates to be performance-based..

- The group discussed the new ASME standards PSD-1. The creation of the standard within the Innoslate program was discussed. The standard was described by one workshop attendee as being both performance-based and risk-informed. Deep Fission is using PSD-1 in the design of its advanced reactor with positive comments from the design engineers using it.
- There was extended conversation on the challenge of developing a shared understanding of the term ‘performance-based’. It is key that NRC is synced with the consensus industry understanding of this term; workshops on this topic would be useful.
- The discussion concluded that meaningful reform requires shared terminology, cultural change, NRC engagement, and SDO alignment, with developers, regulators, and standards bodies converging on a common understanding of what RIPB regulation truly means in practice.

Guided Discussion: Risk-Informed, Performance-Based Industry Needs

RIPB Guidance for Designers and Standards Setters – Video – N. Prasad Kadambi, RIPB TG Chair and Jon Facemire, NEI

- It was explained that the ARCSC RIPB Task Group was created to move risk-informed, performance-based (RIPB) concepts from theory into practice by piloting updates to standards and continuously tracking how codes and standards evolve. The intent is to actively push standards in a RIPB direction using structured feedback from developers and regulators.
- A major focus is establishing a shared, practical understanding of what “risk-informed,” “performance-based,” and “risk-informed performance-based” actually mean. Without common definitions, engagement with regulators and standards organizations becomes inconsistent and inefficient.
- The guidance being developed is intentionally not a prescriptive rulebook but a living decision-making framework. It is designed to help designers and standards developers decide which requirements are necessary and how to justify them, rather than documenting every possible requirement.
- Effective RIPB implementation depends on strong requirements management grounded in systems engineering principles. Requirements should be documented, analyzed, tracked, and verified across the full lifecycle, with clear traceability from high-level project objectives down to systems, components, and procurement decisions.
- Traceability ensures that every requirement can be justified by a higher-level objective and helps prevent silos that create friction and inefficiency. This structure allows teams to show that each requirement contributes meaningfully to overall project success, not just compliance.
- A key distinction of performance-based approaches is their emphasis on outcomes rather than artifacts or intermediate products. Instead of equating documents or analyses with success, RIPB focuses on how design features and requirements actually support safety, reliability, and project objectives.
- RIPB approaches provide flexibility to right-size requirements and margins, which can reduce costs without sacrificing safety. By explicitly understanding margins and

acceptance criteria, designers can choose lower-cost alternatives that still meet functional and safety goals.
- Robust requirements traceability is especially valuable during periods of regulatory change. When top-level requirements evolve or are removed, traceability allows designers and standards developers to quickly identify which derived requirements remain necessary and which can be eliminated, supporting more efficient modernization.
- The presentation closed with a list of several resources available to developers to help implement an risk-informed approach or performance-based approach including: the ARCSC RIPB TG, ASME/ANS's SCoRA Subcommittee, these presenters. This assistance is also available to standards committees who are trying to transition their standards to more risk-informed and performance-based approaches.

ASME Section III - Recent Activities and Alternate Requirements for Items Commensurate with their Contribution to Safety or Risk – Video – Rachel Romano, Secretary, TG on Alternate Requirements

- Rachel Romano (MPR Associates) describes ASME Section III's push to ensure the code keeps pace with advanced reactor needs and doesn't "lag" industry. She emphasizes structured stakeholder input—advanced reactor designers participating directly in meetings, plus executive-level strategic advisory forums and surveys—to steer committee priorities.
- Section III keeps pace with the industry needs through predictable publication cycles and faster mechanisms for issuing rules like Code Cases. She also notes deliberate outreach via groups like NEI organizing NRC public meetings to reduce regulatory friction and improve acceptance of new or updated rules.
- A major theme is "increasing value" by adapting Section III to advanced reactor safety cases that differ from traditional LWR assumptions. The goal is to preserve core nuclear design rules and margins while modifying construction requirements that may not be appropriate for components with lower risk or safety significance.
- The "alternate requirements" work is framed around graded treatment for components in an intermediate safety category (agreed by owner and regulator), though determining safety categorization itself is outside the scope of Section III. The intent is to define minimum, technically justified requirements that lower cost and schedule while staying within the Section III construction framework.
- Section III argues it can be advantageous as a single nuclear construction code because it addresses nuclear-specific needs (e.g., creep design life considerations and seismic rules) that may not be fully covered in commercial codes. At the same time, Rachel stresses Section III won't be the right choice for every design, but consensus standards can help reduce uncertainty of regulatory acceptance.
- The committee identified high-value opportunities for cost/schedule reduction in material procurement, NDE/testing, and quality assurance, and has pursued an incremental strategy since 2021 rather than an "all-in-one" approach to facilitate the paradigm shift. Examples include alternate procurement paths for material and an NDE/testing code case under revision, plus ongoing work to develop alternate minimum QA requirements that allow use of commercial practices where appropriate.

- A newer Section III "Division 6" exploratory effort is investigating broader structural changes to address increasing the nuclear supply-chain, including options that reduce barriers for certificate holders and allow more flexible fabrication pathways. The group is drafting a framework white paper targeted for August 2026.
- A question was raised on the use of "components" in ASME Section III and how it is tightly defined for stamping and don't map cleanly to ANS's broader "SSCs". They stand on their own within their own standards framework and there is no current plan to formally align the definitions.

American Nuclear Society (ANS) Standard 2.26 - Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design – Video – Doug Clark, Oak Ridge National Laboratory (ORNL) and ANS 2.26 Chair

- The speaker noted their RIPB guidance document already contains a strong cross-section of existing examples (regulatory guidance, SECYs, NRC guides, and standards) and that the team has enough material to proceed without waiting. They emphasize the goal is to highlight key "real-world" RIPB implementations rather than chase a perfect or exhaustive catalog.
- Doug Clark (Y-12 Chief Engineer and long-time chair of the ANS-2.26 working group) argues ANS 2.26 has been risk-informed and performance-based since 2004, though many users miss that because the most RIPB-relevant content lives in the appendices. He frames 2.26 as a practical framework that structural engineers often treat as a quick lookup, but which actually supports broader decision-making.
- Clark explains 2.26 as an integrating "hub" standard that interfaces with other ANS and industry standards (e.g., seismic approaches relying heavily on ASCE/SEI 43) and supports using building code inputs where appropriate. He notes DOE applies the core concepts beyond seismic to other natural phenomena hazards by using the same hazard-curve interfacing logic.
- The standard uses a graded approach that combines qualitative and quantitative criteria, scaling rigor based on consequences to workers, the public, and the environment. Clark highlights the linkage to DOE-style consequence thresholds and explains how these thresholds drive seismic design categorization and limit-state selection.
- Limit states (A–D) are presented as the core of "performance space," defining allowable damage/function expectations and feeding design demands back into system/component design. The appendices provide component-level guidance so analysts and designers can align on limits early, typically selecting the highest applicable limit state across credible upsets.
- Clark stresses that misapplication is common when teams automatically assume worst-case categories early (driving unnecessary cost) or try to "limbo under" thresholds (later discovering insufficient margin). The standard's framework includes ways to evaluate significance when hazard curves change over long projects and to define corrective actions based on available margin.
- The presentation links RIPB decision-making to defense-in-depth and system interaction/common-cause failure management, offering multiple options and allowing designers to tailor strategies system-by-system rather than forcing a single approach

plantwide. Clark emphasizes binary-style measures (yes/no attributes like redundancy or common-cause vulnerability) alongside more "constructed" measures (e.g., robustness, margins), to focus effort where it matters without excessive analysis.

- It was asked how did ANS-2.26 transition to RIPB impact its document length. Clark indicated that ANS-2.26 has always contained RIPB but initially the RIPB concepts were in its appendices. Prasad clarified that ANS-2.26 was initially created as an RIPB standards and that he believes it was the first RIPB standard published.
- It was noted that Appendix S is part of the changes NRC is making to rulemaking. It was asked if ANS-2.26 has been brought forward as a topic of discussion with regards to these changes. Clark indicated that it has not, but is an evolving situation. However, he does not see it impacting the rule changing.
- It was asked how do we reconcile creating RIPB standards for industry if the current regulations are prescriptive. An example of how GDC 16 was initially considered prescriptive leak type containment, but NRC issued a 2018 SECY clarifying that functional containment was allowed. This is an example of what was initially thought was prescriptive was truly written as a performance-based regulation. It was countered that this requires the regulator to change their approach in enforcing the regulations. This was followed by the argument that industry must drive this change.
- Ralph Hill adds that the plant systems design (PSD-1) standard explicitly integrates risk evaluations at each design phase, allocating risk down to systems/components and optimizing between safety risk and "unavailability" (productivity) risk, enabled by strong requirements traceability when requirements change.

Guided Discussion: RIPB Design and Opportunities for Right-Sizing Regulatory Requirements for Civil Structures – Video

Part 1: RIPB Seismic Design of Nuclear Civil Structures – Video – Brian McDonald, Ph.D., S.E., Principal Engineer and Corporate Vice President, Exponent; Chair, ASCE DANS Committee

- McDonald continues the session using a real standard as a case study, focusing on risk-informed, performance-based (RIPB) requirements for civil/structural design in nuclear. He emphasize they're not "pivoting" to RIPB because his civil-structures approach has effectively been RIPB since the mid-1990s, and he wants feedback rather than a one-way lecture.
- He explained RIPB by contrasting prescriptive requirements (e.g., specifying cement "sacks per yard") with performance specifications (e.g., requiring 7 ksi compressive strength and durability). The message is to define the required outcome and let engineers/contractors determine the best means, rather than carrying forward "because we've always done it" prescriptions.
- The talk outlines the risk-informed inputs a structural engineer needs from ANS 2.26: (1) an allowable damage/limit state and (2) the tolerable frequency of exceeding that state (tied to consequences like dose at the exclusion boundary, with references to NEI guidance). Those inputs translate into structural design targets through seismic hazard curves and fragility curves, using total probability to compute exceedance frequency.

- He describes standards integration: the structural side uses ASCE 43 (and related ASCE standards like ASCE 41) to turn the risk-informed targets into design loads (e.g., via scale factors on a uniform hazard response spectrum). The group aims to update/merge standards (mentioning ASCE 4 and 43 evolving toward something referred to as ASCE 92) and to leverage the broader commercial experience base rather than rewriting detailed prescriptive provisions.
- A key theme is that RIPB creates an opportunity to "right size" standards by removing outdated, overly prescriptive "zombie requirements." Coordination between committees (e.g., those aligned with ANS 2.26, ACI, AISC, and the evolving ASCE civil-structures standard) is highlighted as essential to keep the risk-informed criteria and structural implementation "playing nicely together."

Part 2: Right Sizing Requirements for Nuclear Civil Structures – Video – Andrew Whittaker, Ph.D., S.E., SUNY Distinguished Professor, University at Buffalo; Chair, ASCE Nuclear Standards Committee

- Whittaker frames Part 2 as "right-sizing requirements" for nuclear civil structures as ASCE 92 is developed, coordinating closely with ANS 2.26 so the risk inputs and structural standard "play nicely together." The intent is to modernize how civil structures are specified without losing alignment across standards bodies.
- They emphasize ASCE 92 must handle an expanded reactor/application scope, from gigawatt-scale reactors (Limit State D / Seismic Design Category 5) to SMRs and microreactors, and even non-electric applications like high-temperature reactors supporting synthetic hydrogen production. That diversity requires a standard that supports multiple design targets rather than a single "one-size" LWR template.
- A key motivation is cost and deployment rate: civil structures are cited as ~55% of total plant cost today, with a goal to reduce toward ~20% to enable broad buildout. The speaker argues the historic approach of the last 25–30 years won't scale to the deployment pace envisioned.
- They propose leaning more on non-nuclear civil standards (updated on regular 5–6 year cycles) for reinforced concrete and structural steel, including ASCE 41 and ASCE 7. However, they caution that nuclear structures can have irregularities (to accommodate "nuclear kit"), so applying ASCE 7 "blindly" may not work and may need ASCE 41-style thinking.
- The presenters note that commercial codes effectively cover multiple performance levels/limit states (analogous to A–D), while key nuclear material standards (e.g., ACI 349 and AISC N690) largely deliver only Limit State D. That gap is a major reason ASCE 92 needs to embrace non-nuclear standards to support performance across all limit states.
- They list "proven ingredients" for high-quality civil structures: experienced teams with construction experience, early contractor engagement, peer review, good materials understanding, strong detailing, complete construction documents, and field supervision/inspection. A provocative takeaway is "nuclear is not special" for civil structures—it should be treated like other mission-critical buildings in terms of good engineering practice.

- On materials, they argue the industry often over-focuses on concrete compressive strength (f_c), even though standard QC practices typically yield in-service strengths above specified minimums. They contend that even a sizable reduction in f_c often has limited impact on key capacities, and that detailing and constructability are more decisive for real performance.
- During questions the statement 'nuclear is not special' was challenged. McDonald indicated that nuclear considerations (e.g., radiation) is covered in the design choice of limit state dictated through use of the NEI 18-04 graph for margin/safety factor. It was suggested nuclear is special in regards to the unique safety culture in nuclear. The presenters reinforced that their "nuclear is not special" statement is primarily about radiological consequence/risk targets (dose vs frequency), while structural engineering should design to the specified targets without unnecessary margin, since extra margin translates directly to added cost.
- For QA/QC, it was argued NQA-1 is a poor fit for civil structures, and one needs only map applicable practices to the intent of 10 CFR Part 50, Appendix B.

EPRI/NEI North American Advanced Reactor Roadmap (NAARR) Rev. 1 Part 2: Technical Readiness – CODES & STANDARDS - Video – Don Eggett, ANS, ARCSC Co-Chair and Mark Richter, NEI, Director

- Eggett emphasized that securing resources—manpower and funding—is now a top priority, particularly to support standards needed for advanced reactor deployment. The implementation board is seeking clear direction on how this effort will move forward into 2026, given earlier target dates are slipping.
- There is strong encouragement to submit focused, well-justified proposals to DOE for specific standards needs, including rationale and timelines. Recent discussions indicate DOE is willing to support targeted efforts if requests are clearly scoped rather than broadly framed.
- The presentation highlights the ongoing need to advance risk-informed, performance-based (RIPB) approaches by updating existing standards across structures and SSCs. While the original need date of 2025 remains challenging, the effort is described as a continuation from 2023 that will require regular updates and adjustments as progress continues.

Guided Discussion: Incorporating artificial intelligence (AI) into work/applications; how to approach and controls needed for AI

- **Introduction**: Eggett introduced the upcoming discussion on artificial intelligence (AI) in the nuclear context, setting the stage for other presenters to lead the detailed conversation. He notes that AI is not new—dating back to the 1950s—and broadly defined it as computer systems capable of learning, reasoning, and problem-solving to support automation, efficiency, and decision-making. While highlighting significant benefits for nuclear energy—such as improved safety, predictive maintenance, real-time monitoring, and accelerated advanced reactor research—they also stress the associated risks, including privacy, safety, human–automation interaction, and the need for strong governance. The remarks concluded by emphasizing that AI must be used safely, responsibly, and with proper oversight as its role in nuclear applications expands.

Nuclear Industry Virtual Assistant (NIVA) Pilot Project - Video – Jim Slider, NEI

- Slider describes a collaborative "nuclear industry virtual assistant" initiative using AI to make it easier for industry users to access and search major nuclear information repositories. The project is led by INPO, EPRI, and NEI, with the goal of enabling a "log in once" experience and federated access while preserving each organization's intellectual property.
- They outline three initial use cases: a knowledge assistant for learning and knowledge transfer, an operating experience search tool to query INPO's IRIS database, and a troubleshooting tool based on EPRI's troubleshooting records. The intent is to deliver chatbot-style querying similar to commercial LLM experiences, but grounded in curated, authoritative industry sources.
- The architecture includes an LLM developed with contractor support (Atomic Canyon) that can pull from INPO/EPRI/NEI records and also from curated NRC ADAMS subsets with improved metadata. The vision is that utilities can combine results from these external repositories with plant-specific internal data to speed problem-solving and research.
- The project is in a pilot/testing phase, with staged development: early testing of the knowledge assistant, followed by operating experience tooling, then EPRI troubleshooting integration. They note that the pilot will help determine real-world usage patterns and the cost of sustaining a production platform, with later decisions on broader rollout.
- They identify early participants and supporters, including seed funding from Constellation and pilot interest from several utilities (e.g., PG&E, Southern, OPG, NextEra). The longer-term goal is a scalable, ethical, transparent, and trustworthy platform with additional use cases over time.
- The Q&A also addresses IP protection and boundaries: the platform is meant to provide access to the three institutions' repositories, while utilities remain responsible for protecting their own proprietary/vendor information and controlling how outputs are used internally. This reinforces that the tool is an access-and-search enabler, not a centralized ingestion of all utility IP.
- A key discussion point is how to extend value by incorporating codes and standards into the same AI-accessible environment, but copyright and licensing limits are cited as a barrier (standards often sold as single-user copies, not database-ingestible). Participants question where these restrictions are written and argue it hinders efficient, "smart" application of purchased codes inside protected company AI environments.
- Has this team engaged with INL in their work on leveraging AI for automating the licensing process from initial design to submission? The vendor working on the NIVA has had discussion with INL, but no more is known about collaboration between the NIVA team and INL.

- It was suggested that this LLM cast a broader net into including freely available sources on nuclear, in particular RIPB. The ANS Community of Practice content was an example given of a valuable source of information.
- It was asked will this system be useful for new advanced reactor design. The answer is that since NEI has several documents and reports that are pertinent to new advanced reactor design, that it could be useful.
- It was asked how is the proprietary information of the member plants protected in this system. It was answered that there are controls in place to protect the member plants' intellectual property.
- Finally, they stress verification and governance: users still need expertise to validate AI outputs, likened to supervising an "intelligent intern" that retrieves relevant records. Participants recommend independent review/validation and integrated project teams, while the presenter notes an executive steering committee and broader governance structure already meets regularly to oversee development and ask the hard questions.

Incorporating Artificial Intelligence (AI) Into Work/Applications; How to Approach And Controls Needed for AI – Video – Todd Anselmi, INL

- Anselmi frames this segment as a discussion, not a lecture, centered on whether the nuclear ecosystem (particularly SDOs) should develop codes/standards and controls for AI, and if so, what the scope should be. ANS has already done an internal assessment/white-paper-style scoping exercise and initiated a project initiation notification (PIN) to begin standards work in a cautious "first step" way rather than trying to do everything at once.
- ANS's near-term focus is a computer-vision/AI use case: using monitoring and field instrumentation data with AI to help confirm modeling assumptions and that conditions meet a minimum standard (i.e., validating inputs/outputs and the way models are being applied). They also identify broader candidate topics such as human–AI integration, design/engineering requirements for connecting AI models to plant data, and common definitions/terminology/metrics.
- The presentation then highlights INL-related work tied to the "Genesis mission" and introduces a newly public "Prometheus project" (described as announced only days earlier). It involves an AI modeling consortium led by a national lab (noted as ANL) and aims to establish a cloud-based model ecosystem, with redirected FY27 funding and outreach to advanced reactor vendors/designers to participate.
- Prometheus is portrayed as an effort to accelerate nuclear deployment by enabling a software platform ecosystem for more autonomous approaches—ranging from autonomous design of nuclear plants to longer-term aspirations around autonomous operations—with eventual physical demonstration. The speaker stresses details are still emerging and the initiative is very new.
- The facilitator shares an example of how AI is already being used internally at INL via a secured Microsoft Copilot environment, where queries can search internal, licensed content (emails, past presentations, and documents) and quickly surface relevant prior work. This is positioned as an illustration of what might be feasible—and standardizable—when AI is deployed inside controlled data boundaries.

- How is the Prometheus initiative aligned with the NIVA project? Anselmi indicated that the only connection he is aware of is the involvement of the vendor, Atomic Canyon, in both projects. The Prometheus is a DOE driven project which has only just begun and while there may or may not be alignment with the NIVA at this time, Anselmi suggested that there would be a good chance of alignment in the near future.
- A core debate follows: whether AI standards should be nuclear-specific or whether the nuclear community should primarily adopt existing cross-industry standards being developed by the broader AI/software industry. Some participants argue "nuclear isn't special" from a standards perspective and the better question is who is already developing AI standards that the nuclear sector can leverage.
- Others argue there is still value in industry/sector guidance and conformity assessment, citing organizations like ASME (with experience beyond nuclear) as a plausible SDO to lead safety/conformity programs. Concerns include verification/validation, quality assurance, and guarding against unreliable or counterfeit-like outputs—paralleling the role of audits and certification programs in traditional component quality.
- The discussion also surfaces international harmonization opportunities and the idea that AI could help compare standards across jurisdictions (U.S., Japan, Canada, IEC/IEEE, etc.), even though current SDO policies can limit that kind of cross-document analysis. INL notes an ongoing project comparing DOE vs NRC licensing pathways where AI is being used at a high level, but they are not yet deep into the codes and standards layer—though they expect it will become an important issue soon.

END OF PRESENTATION SECTION

Attendance / Participation

In-Person Attendees

	Name	Company
1.	Andrew Sowder	EPRI
2.	Andrew Whittaker	University at Buffalo
3.	Brian McDonald	Exponent & ASCE
4.	Deric Tilson	Breakthrough Institute
5.	Donald Eggett	Eggett Consulting LLC
6.	Frances Pimentel	NEI
7.	Franklin Hope	Jensen Hughes
8.	Hanh Phan	US Nuclear Regulatory Commission
9.	James Slider	Nuclear Energy Institute
10.	Jason Christensen	Idaho National Laboratory
11.	John Gayler	American Nuclear Society
12.	John Gregg	NuScale Power, LLC
13.	John Richards	Electric Power Research Institute (EPRI)
14.	Jon Facemire	Nuclear Energy Institute
15.	Kathryn Hyam	ASME
16.	Larisa Logan	CSA Group
17.	Mark Richter	Nuclear Energy Institute
18.	Maury Pressburger	Sargent & Lundy LLC
19.	Michael Melton	ZettaJoule. Inc.
20.	N. Prasad Kadambi	Kadambi Engineering Consultants
21.	Rachel Romano	MPR Associates
22.	Rani Franovich	Deep Fission
23.	Richard Stattel	General Electric Vernova
24.	Robert Youngblood	Bob Youngblood Consulting LLC
25.	Suresh Channarasappa	Westinghouse Electric
26.	Todd Anselmi	Idaho National Laboratory
27.	Anonymous	Anonymous

Online Attendees

	Name	Company
1.	Alan Stevenson	Rolls-Royce
2.	Alec Neller	US Nuclear Regulatory Commission
3.	Aleksey ReZVOi	NuCon Company
4.	Alyson Coates	ORNL
5.	Amir Afzali	Nuclear Consulting Group
6.	Andrew Morley	Rolls-Royce
7.	Angela Buford	US NRC
8.	Aswin Kumar Anand	PolyEnergetics

9. BABUL PATEL	Parina Engineers
10. Ben Pellereau	Rolls-Royce
11. Brett McGlone	NUSOURCE, LLC
12. Bruce Lin	U.S. NRC
13. Carolyn LaFleur	Engineering Support
14. Chandrakanth Bolisetti	Idaho National Laboratory
15. Christopher Leffler	Virginia Commonwealth University
16. Craig Stover	Dominion Engineering
17. Crystal Slavens	Energy Northwest
18. Curtis Lurvey	Nuclear Regulatory Commission
19. Dale Matthews	Framatome
20. Daniel Suarez	University of Tennessee
21. Diona Russell	Burns & McDonnell
22. Donald Harker	DKMT Consulting LLC
23. Donald Spellman	Cardinal Capital Corporation
24. Douglas Clark	CNS Y-12, LLC
25. Elena Yegorova	US NRC
26. Emmet Berlin	TerraPower
27. Eric Young	Framatome
28. Farshid Shahrokhi	Framatome, U.S. Operations
29. Fred Grant	Simpson Gumpertz & Heger Inc.
30. Frederick Sock	Zachry Nuclear Engineering
31. Greg Hudson	Metcalfe PLLC
32. Greg Oberson	USNRC
33. Gus Shryack	Terrapower
34. Herve KENSOUNG NGUEMO	Nano Nuclear Energy Inc.
35. Ira Strong	INL
36. Irene Dudley	National Institutes for Standards and Technology
37. Ismael Garcia	US NRC
38. James Zess	Zess Engineering
39. Jeff Lane	Numerical Advisory Solutions
40. Jim Herrold	ISO/TC 85 - University of Wyoming
41. Jodine Jansen Vehec	BWXT ADVANCED TECHNOLOGIES
42. Joseph Bass	NRC
43. Kathy Murdoch	American Nuclear Society
44. Kent Welter	NuScale Power
45. Kermit Bunde	US Department of Energy
46. Kevin Kelly	Electric Power Research Institute (EPRI)
47. Lauren Hughes	Atlantic Council
48. Lynessa Erler	MPR Associates
49. Marc Nichol	Nuclear Energy Institute
50. Mark Peres	Deep Fission Inc
51. Mark Shaver	NuScale Power
52. Matt Laney	TerraPower
53. Matthew Hiser	USNRC

54. Memarie Burke	NuScale Power
55. Michael Muhlheim	ORNL
56. Michael O'Neill	retired
57. Patrick Frias	U.S. DOE, EHSS-22
58. Patrick Koch	U.S. NRC
59. Pietro Porco	Westinghouse Electric Co
60. Rachel Czuba	Sonic Systems International LLC
61. Raj Iyengar	US NRC
62. Ralph Hill	Hill Eng Solutions 2, LLC
63. Rebecca Owston	BWXT
64. Richard Kaylor	James Fisher Technologies
65. Richard Sobotka	Terrestrial Energy
66. Rob Burg	EPM, Inc.
67. Robert Kalantari	EPM
68. Robert Roche-Rivera	US NRC
69. Ryan Mott	Hadron Energy Inc.
70. Sara Hauptman	MIT
71. Shunhao (Sean) Ni	Candu Energy Inc.
72. Siavash Dorvash	Simpson, Gumpertz & Heger, Inc.
73. Steven Levitus	NRC
74. Sungjae Lee	Korea Electric Association
75. Sven Bader	Electric Power Research Institute (EPRI)
76. Temi Adeyeye	Andorvia Consulting / ANS Pittsburgh
77. Thien Nguyen	ORNL
78. Thomas Vogan	ASME
79. Thomas Weaver	US NRC
80. Trace Orf	Oklo
81. Vincent Paglioni	Colorado State University
82. Walid Metwally	Oak Ridge National Laboratory
83. Wesley Steh	X-energy
84. WiSON LUANGDiLOK	H2Technology
85. Yann Le Pape	Oak Ridge National Laboratory

Extracted Key Sources/References from Online Chat

Websites / Online Databases

- **EPRI Product Page – Advanced Reactor Roadmap**
  https://www.epri.com/research/products/000000003002027504
- **NEI-hosted ARCSC Website**
  https://arcsc.nei.org/Events
- **NRC Codes and Standards Engagement Database (Power BI)**
  https://app.powerbigov.us/view?r=eyJrIjoiYzY0NTIyN2MtY2NkMy00NTZmLTkxYTMtZTFjZDRhZmYyMjA0IiwidCI6ImU4ZDAxNDc1LWMzYjUtNDM2YS1hMDY1LTVkZWY0YzY0ZjUyZSJ9
- **IEC JTC 1 – Artificial Intelligence Standards Portal**
  https://jtc1info.org/technology/subcommittees/ai/
- **NRC – International AI Principles (Externally Focused)**
  https://www.nrc.gov/ai/externally-focused#international

Standards and Formal Documents

- **ASME Plant Systems Design Standard (PSD-1)**
  (Approved; publication imminent at time of meeting)
- **Standards**
  - ANS-2.26 (referenced in discussion)
  - ASME Section III (N-Stamp)
  - ASME Section VIII (referenced as alternative construction standard)
  - ASME NCA-9200 (component definition)
- **ISO Standards**
  - ISO 9001 (referenced as used for OPAL reactor QA)

Government / Regulatory Documents

- **Letter to Congress on ADVANCE Act Section 401 (January 6, 2025)**
  - https://www.nrc.gov/docs/ML2432/ML24320A078.pdf
  - https://www.nrc.gov/docs/ML2429/ML24292A171.pdf

Academic / Technical Publications

- **"Systems Engineering in the Business Case Phase to Reduce Risk in Megaprojects"**
  https://www.mdpi.com/2075-5309/14/8/2585
- **"Status of Research and Development of Learning-Based Approaches in Nuclear Science and Engineering: A Review"**
  https://www.researchgate.net/publication/338116897_Status_of_research_and_development_of_learning-based_approaches_in_nuclear_science_and_engineering_A_review

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Organizational Statements / Position Papers

- **ASME Position Statement on the Use of Artificial Intelligence (AI)**
  https://www.asme.org/topics-resources/society-news/letters-official-statements/asme-position-statement-on-the-use-of-artificial-intelligence-(ai)-for-asme

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Referenced but Not Linked

- NRC White Papers on Risk-Informed, Performance-Based regulation
- IAEA questionnaire on AI use in the nuclear industry
- PVP 2026 conference paper (in development)
- PVP 2025 keynote presentation (contact author directly)