U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Advanced Reactor Stakeholder Public Meeting

July 24, 2024

Microsoft Teams Meeting
Bridgeline: 301-576-2978
Conference ID: 590 049 732#

Advanced Reactor Program

Time	Agenda	Speaker
10:00am	Opening Remarks	Steven Lynch (NRR)
10:15am	Insights from Public Workshop on Risk Metrics to Support Risk-Informed Programs for Advanced Reactors	Gerardo Martinez-Guridi (RES), Marty Stutzke (NRR)
10:30am	Guidelines for the Seismic Isolation of Advanced Reactors: Topical Report	Benjamin Carmichael (Southern Company), Brandon Chisholm (Southern Company), Jason Redd (Southern Company), Andrew Whittaker (University at Buffalo)
11:30am	Observations on the Southern Company Draft Base Isolation Guidelines Report	Thomas Weaver (RES), Weijun Wang (RES), Jose Pires (RES)
12:00pm	Lunch Break	
01:00pm	Key Terms in NEIMA: Performance-based, Technology-inclusive and Risk-informed	Rani Franovich (Nuclear ROSE Consulting, LLC)
01:15pm	DG-1290, Revision 1 – Proposed Revision 3 to Regulatory Guide 1.59	Jenise Thompson (NRR)
01:30pm	Licensing and Deployment Considerations for Nth-of-a-Kind Micro-Reactors	Duke Kennedy (NRR), Jackie Harvey (NRR), Peyton Doub (NMSS)
02:30pm	Adjourn	

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Opening Remarks

Advanced Reactor Program

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Advanced Reactor Program Recent Highlights

Advanced Reactor Program

Highlights

- TerraPower, LLC -- Kemmerer Power Station Unit 1 Construction Permit Application
  - 05/21/2024 - Docketing Decision Letter Issued/Acceptance Review Complete (https://www.nrc.gov/docs/ML2413/ML24135A109.pdf)
  - 06/12/2024 - Review Schedule Established/Schedule Letter Issued to Applicant (https://www.nrc.gov/docs/ML2416/ML24162A063.pdf)
  - 07/15/2024 – NRC issued General Audit Plan to USO (TerraPower) (https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML24187A117)

- July 19, 2024 - Safety Evaluation (SE) for the Kairos Power LLC Construction Permit Application for the Hermes 2 Non-power Test Reactor Facility (https://www.nrc.gov/docs/ML2420/ML24200A114.html)
  - The SE was completed 4-months ahead of the 14-month review schedule.
  - The final Environmental Assessment (EA) is on track to be issued in August 2024.
  - Total resources are anticipated to be less than 60% of the original estimate for the review and issuance of the SE and EA.
    - The staff leveraged the recently completed Hermes 1 CP application review to identify efficiencies in the review.

Highlights (continued)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- 07/18/2024 - SRM to SECY-24-003, "Revisiting the Mandatory Hearing Process at the U.S. Nuclear Regulatory Commission" (https://www.nrc.gov/docs/ML2420/ML24200A044.pdf)
- 06/18/2024 - SRM to SECY-22-0072, "Proposed Rule: Alternative Physical Security Requirements for Advanced Reactors (RIN 3150-AK19)" (https://www.nrc.gov/docs/ML2417/ML24170A753.html)

Highlights (continued)

- September 25, 2024 –**2024 NRC Standards Forum**
  - This will be a hybrid meeting:
    - In-person at the TWFN Auditorium
    - Online via MS Teams
  - The meeting notice and registration page are available:
    - **Meeting Notice** (https://www.nrc.gov/pmns/mtg?do=details&Code=20240927)
    - **Registration Page** (https://events.gcc.teams.microsoft.com/event/3da8da0e-f4ed-4ec0-92e8-1a8e75daffcb@e8d01475-c3b5-436a-a065-5def4c64f52e)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Insights from Public Workshop on Risk Metrics and Reliability Data to Support Risk-Informed Programs for Advanced Reactors

NRC Working Group on Technology Inclusive Risk Metrics

Office of Nuclear Regulatory Research (RES)

- **Gerardo Martinez-Guridi**
- Matt Humberstone
- Jeffery Wood

Office of Nuclear Reactor Regulation (NRR)

- **Marty Stutzke**
- Hanh Phan

Periodic Advanced Reactor Stakeholder Meeting
July 24, 2024

NRC Considering Needs for Non-LWR Risk Metrics and Reliability Data

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

In 1990, the Commission established three risk metrics for new reactors and associated quantitative goals:

- **Core Damage Frequency (CDF) < 1×10^{-4}/year** – A measure of overall safety performance in prevention of severe accidents
- **Large Release Frequency (LRF) < 1×10^{-6}/year** – A measure of prevention of significant offsite consequences
- **Conditional Containment Failure Probability (CCFP) < 0.1** – A measure of the capability of design to mitigate a severe accident

Traditional risk metrics, e.g., CDF, have been used effectively in NRC's risk-informed decision-making processes

- *May not be applicable to all advanced reactor designs*

SRM SECY-23-0021 provides direction on applicant proposed risk metrics

"The staff should revise draft 10 C.F.R. 53.220 to specify that applicants must propose a comprehensive plant risk metric (or set of metrics) …"

Need to consider alternative risk metrics that:

- Are applicable to Non-light-water reactor (NLWR) designs
- Support NRC licensing and regulatory processes

Public Workshop on July 18, 2024

- SRM-SECY-23-0021 provided motivation and direction to staff-related NLWR risk metrics, but this workshop was *not* part of the Part 53 rulemaking

- Presented NRC staff's ongoing efforts on developing the following items related to risk metrics for NLWRs:
  - **Interim staff guidance (ISG) on the review of applicant-proposed risk metrics**
  - **Potential NRC risk metrics**
  - **Reliability data**

- **166 online attendees and 19 in-person attendees**

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

External Presenters (sorted by last name)

Name and Organization	Presentation Title
Cyril Draffin, U.S. Nuclear Industry Council	USNIC Perspectives on Risk
Dave Grabaskas, Argonne National Lab.	NLWR Data Insights and Experience
Kyle Hope, Westinghouse Electric Company	Challenges and Lessons Learned in Applying NEI 18-04 During Active Design: The eVinci™ Microreactor
Ed Lyman, Union of Concerned Scientists	UCS Views on Advanced Reactor Risk Metrics
Jessica Maddocks, X-Energy	Hazard Level Selection for LMP
Diego Mandelli, Idaho National Laboratory	Intertwining of Data, Decisions, and Reliability
Adam Stein, The Breakthrough Institute	Breakthrough Institute Perspectives on Risk Metrics
Eric Thornsbury, Electric Power Res. Inst.	EPRI's Risk Metric Work
Patrick White, Nuclear Innovation Alliance	NIA Perspectives on Comprehensive Risk Metrics
Sai Zhang, Idaho National Laboratory	Advanced Reactor Operating Experience Data Analysis to Support Risk Estimation - Challenges, Current Practice, and Needs

Development of ISG to Review Applicant-Proposed Risk Metrics

- The staff presented its tentative approach to developing interim staff guidance (ISG) for review of applicant-proposed risk metrics:
  - ISG applicability
  - Terminology related to risk metrics
  - Flowchart for conducting the review
  - Change provisions
  - Intellectual property

Summary of Initial Approach to Risk Metrics for NLWRs

- For accident prevention:
  - Use CDF whenever core damage is applicable
  - Use new metrics when core damage is not applicable (e.g., frequency of failure of initial confinement of radioactive material)
- For accident mitigation, large early release frequency (LERF) and LRF are technology inclusive
- Consequence metrics are technology inclusive, but there are challenges associated with them
- Desirable attributes for risk metrics and for using the metrics were proposed

Planned Data Activities

- ✓ Workshop (July 18, 2024)
- Examine available existing databases of operating experience of advanced reactors
- Establish database templates, reporting criteria, and data methods/procedures to support risk modeling and regulatory oversight
- Populate the new database with operational data from prominent advanced reactor designs

Next Steps

- Received many constructive and thoughtful suggestions during the workshop
  - The staff looks forward to continued stakeholder engagement
- Develop **ISG on the review of applicant-proposed risk metrics**
  - Tentative plan to issue the ISG when proposed Part 53 is finalized
- Develop **NRC white paper on potential risk metrics**
  - Tentative middle of calendar year 2025
- Establish a **task on reliability data**
  - By the end of calendar year 2024

- Contact if interested in providing additional feedback
  - Jeffery Wood (jeffery.wood@nrc.gov)

Acronyms

CCFP	Conditional Containment Failure Probability
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
ISG	Interim Staff Guidance
EPRI	Electric Power Research Institute
LERF	Large Early Release Frequency
LMP	Licensing Modernization Project
LRF	Large Release Frequency
NEI	Nuclear Energy Institute
NIA	Nuclear Innovation Alliance
NRC	Nuclear Regulatory Commission
NRR	(NRC) Office of Nuclear Reactor Regulation
RES	(NRC) Office of Nuclear Regulatory Research
UCS	Union of Concerned Scientists
USNIC	U.S. Nuclear Industry Council

United States Nuclear Regulatory Commission
Protecting People and the Environ

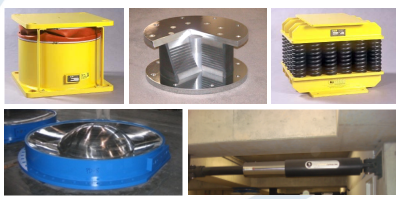
ML24134A173
Guidelines for the seismic isolation of advanced reactors: topical report

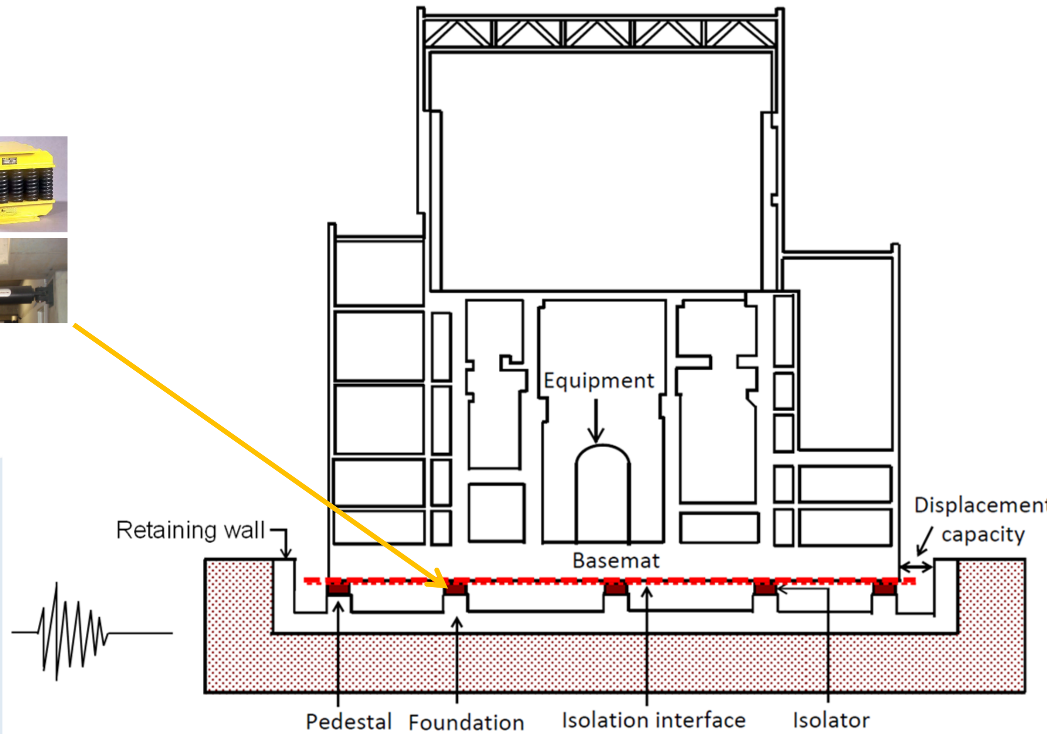
Ben Carmichael, Southern Company
Brandon Chisholm, Southern Company
Jason Redd, Southern Company
Andrew Whittaker, University at Buffalo

Project background

- Effort selected for cost-shared funding in 2020 by DOE through Funding Opportunity DE-FOA-0001817, "US Industry Opportunities for Advanced Nuclear Technology Development"
- Builds upon decades of non-nuclear seismic isolation experience and efforts to develop standards for use in nuclear industry
- Modeled an archetype advanced reactor building, equipment, and site on which to demonstrate a pathway for performance-based design of a seismic isolation system
- Requesting NRC endorsement of the pathway via a Topical Report
- Developed plans for commercial grade dedication and dynamic testing as well as example specifications for isolator procurement
- Regular engagement with NRC and industry to validate direction and incorporate feedback to promote/maximize usefulness of pathway

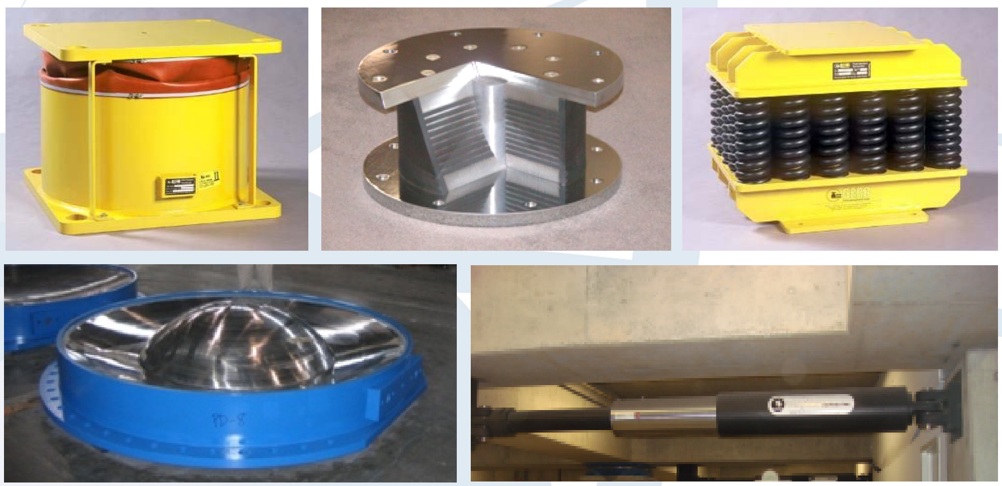
Some terminology

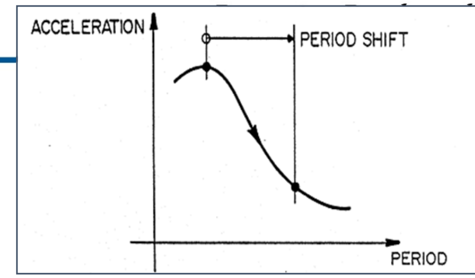


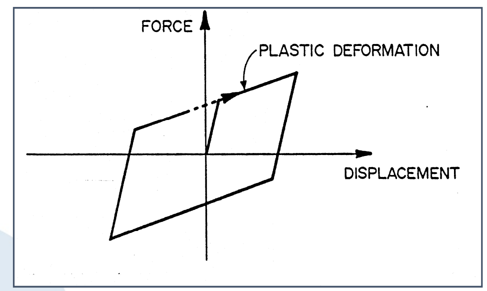


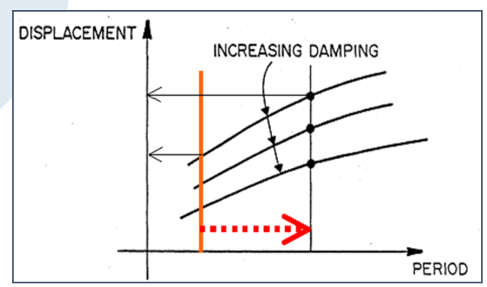
Seismic isolation

- 2D horizontal or 3D
  - Nearly all 10,000+ applications 2D horizontal



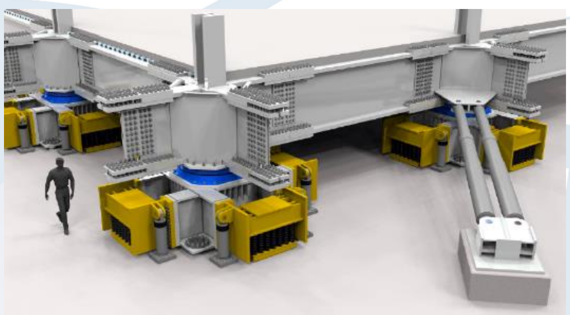




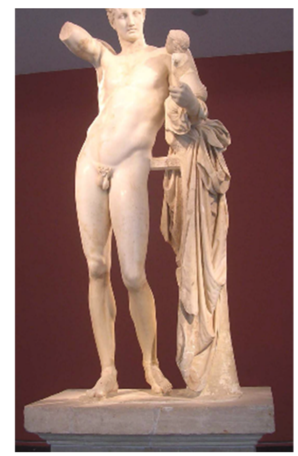


Seismic isolation

- Isolated LLWRs: Cruas and Koeberg
  - Synthetic rubber bearings
  - 2D horizontal isolation



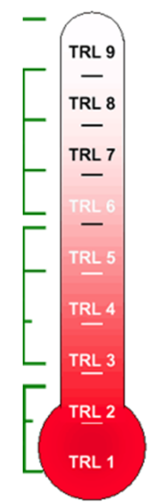
Arup, 2020



Technical basis, USNRC- and DOE-funded

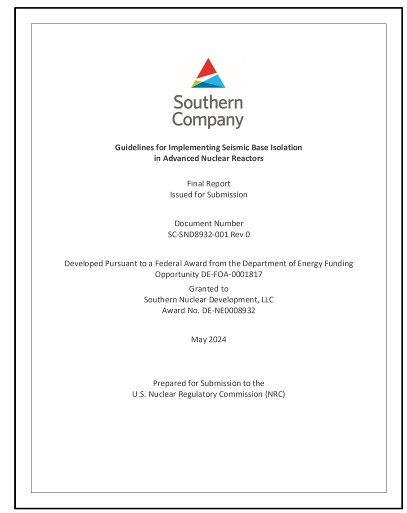
- USNRC (2008-2017): Seismic isolation of large light water reactors
- DOE (2014-2016): Seismic isolation of components in advanced nuclear reactors
- DOE (2016-2018): Evaluation of the potential effect of seismic risk at DOE facilities
- DOE (2017-2019): Seismic isolation of advanced reactors with considerations of fluid structure interaction
- DOE (2018-2020): Seismic isolation of major advanced reactor systems for economic improvement and safety assurance
- EPRI (2018-2019): Cost basis for utilizing seismic isolation for nuclear power plant design
- ARPA-E (2018-2021): Reducing the overnight capital cost of advanced reactors using equipment-based seismic protective systems
- DOE via Southern Company (2021-2024): Topical report on seismic isolation of advanced reactors
- DOE ARDP via MIT (2021-2024): Horizontally configured high-temperature gas reactor
- DOE NEUP (2022-2025): Gamma irradiation effects on the mechanical properties of seismic protective devices

Technology readiness: seismic isolation



Seismic isolation topical report

- Develops a reactor-agnostic pathway for applicants to develop, document and qualify a seismic isolation system for an advanced reactor by including
  - Seismic isolation systems: technology, use, guidelines
  - Earthquake shaking definitions, performance expectations
  - Archetype reactor building, equipment, siting
  - Risk-based design of a seismic isolation system
  - Qualification, prototype, and production testing
  - Specifications for supply of isolators and dampers
  - Commercial grade dedication
  - Generating a displacement demand curve
  - Achieving a risk target, including derivation of fragility functions
  - Selecting a target performance goal: how to start?
  - Isolation-system options: judging different systems


Southern Company

Guidelines for Implementing Seismic Base Isolation in Advanced Nuclear Reactors

Final Report
Issued for Submission

Document Number
SC-SND8932-001 Rev 0

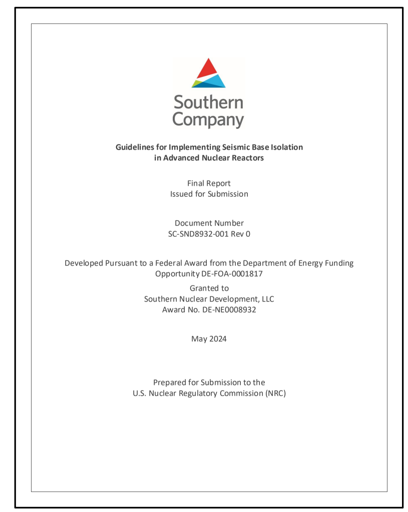
Developed Pursuant to a Federal Award from the Department of Energy Funding Opportunity DE-FOA-0001817
Granted to
Southern Nuclear Development, LLC
Award No. DE-NE0008932

May 2024

Prepared for Submission to the
U.S. Nuclear Regulatory Commission (NRC)

Seismic isolation topical report

- Front matter
  - Cradle to grave guidance
  - Passive isolation systems only
    - No semi-active or active systems, why?
  - Which one: risk-based, risk-informed, or performance based?
  - Applicability
    - Microreactors, advanced reactors/SMRs, large light water reactors
  - Seismic isolation checklist
  - Role of isolation in defense-in-depth
    - Additional echelon of defense via reduced seismic demands
    - Superior quality, passive, predictable performance (how?)
    - Does not change the need to confirm adequate DiD


Southern Company

Guidelines for Implementing Seismic Base Isolation in Advanced Nuclear Reactors

Final Report
Issued for Submission

Document Number
SC-SND8932-001 Rev 0

Developed Pursuant to a Federal Award from the Department of Energy Funding Opportunity DE-FOA-0001817
Granted to
Southern Nuclear Development, LLC
Award No. DE-NE0008932

May 2024

Prepared for Submission to the
U.S. Nuclear Regulatory Commission (NRC)

Seismic isolation checklist

- Establish a target performance goal (TPG) for the seismic isolation system
- Generate seismic hazard curves, uniform hazard response spectra, and ground-motion time series
- Establish an isolation-system-specific seismic displacement demand curve
- Determine the median displacement capacity of the isolation system required to achieve the TPG
- Establish DB earthquake shaking for the isolation system
- Compute displacements, velocities, and forces for prototype and production testing
- Compute earthquake-induced demands on the superstructure and substructure
- Prepare specifications for supply of isolators and dampers
- Prepare specifications for prototype and production testing of isolators and dampers
- Prepare a plan for commercial grade dedication of isolators and dampers
- Prepare requirements for maintenance, operation, and testing of isolators and dampers

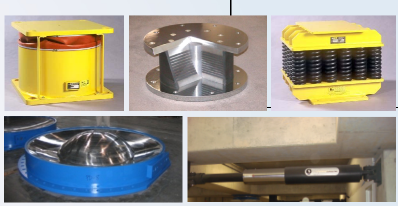
❖ SSCs above the isolation interface treated per industry practice

Requested NRC review and possible endorsement via a SER

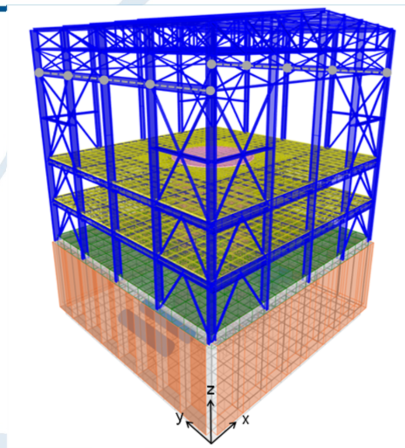
- Role of seismic isolation solutions in ensuring adequate defense-in-depth
- Earthquake shaking definitions for isolation-system design
- Performance expectations for the seismic isolation system
- General requirements for isolation-system design
- Requirements for seismic inputs to support performance calculations
- Methods of dynamic analysis, and numerical models for isolators and dampers
- Requirements for design of connections for isolators and dampers; isolation-system substructure; structures, systems, and components above the seismic isolation interface; systems and components crossing the seismic isolation interface; and clearance around the isolated building
- Performance-based design of a seismic isolation system
- Minimum standards for qualification, prototype, and production testing of isolators and dampers
- Specifications for supply of isolators and dampers
- Plan for commercial grade dedication of isolators and dampers
- Process to establish a log standard deviation for the fragility function of a seismic isolation system

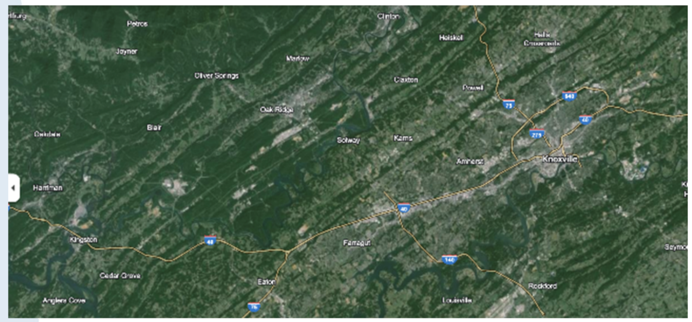
Performance expectations for isolators and dampers

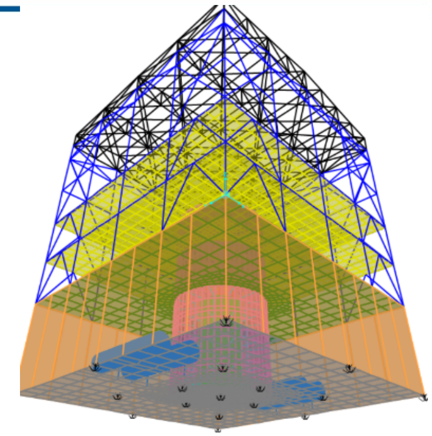
	DB shaking	@TPG
Use	Production testing of isolators and dampers	Prototype testing of isolators and dampers
Isolator and damper displacement	Mean maximum	D_{50} from fragility analysis
Damper velocity	Mean maximum	Mean maximum from TPG shaking
Acceptance criteria	Production testing of each isolator for mean maximum horizontal displacement and corresponding axial force	Prototype testing of three isolators of each type and size for D_{50} displacement and TPG axial force
	Production testing of each damper for mean maximum displacement and corresponding maximum velocity	Prototype testing of three dampers of each type and size for D_{50} displacement and TPG velocity
	No damage to isolators	Isolator damage is acceptable but load-carrying capacity for gravity loading is maintained
	No damage to dampers	No damage to dampers

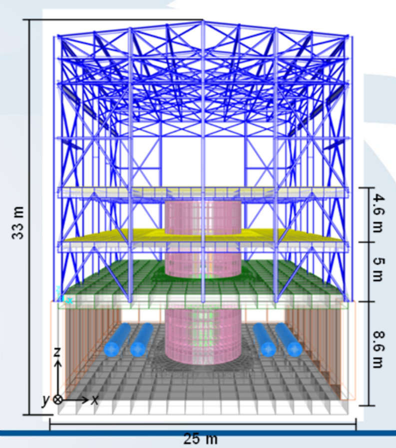


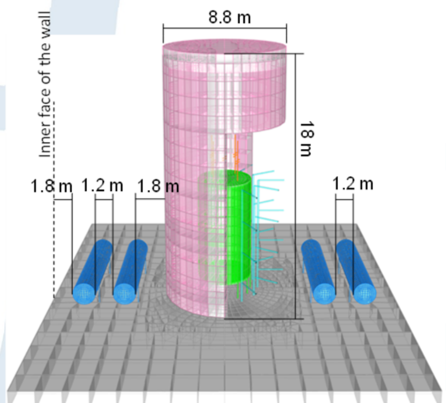
Archetype reactor building, equipment, siting, SDC4

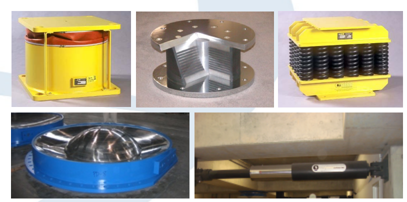


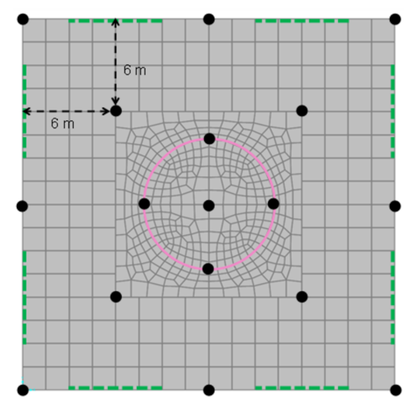




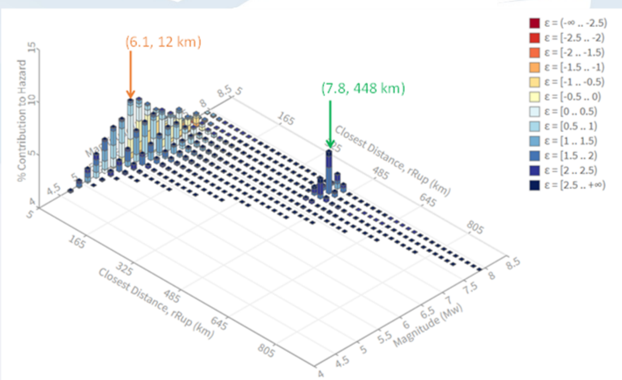


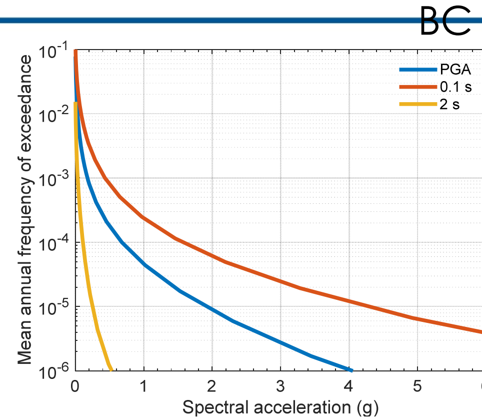


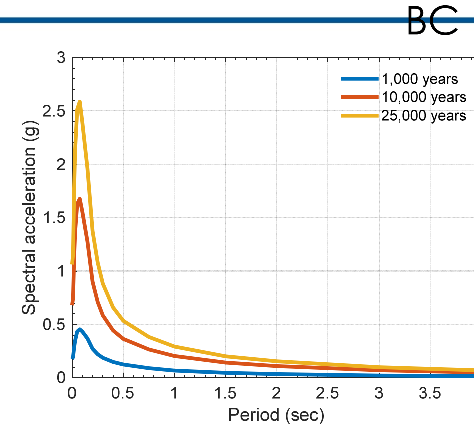


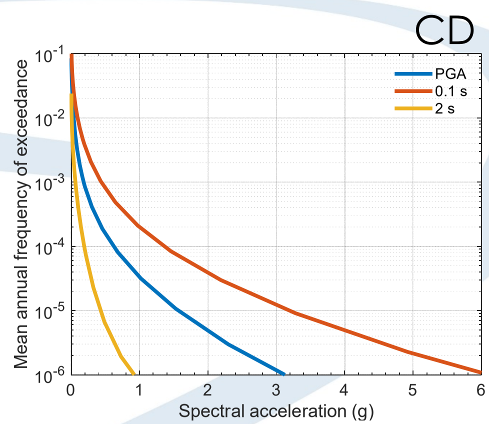


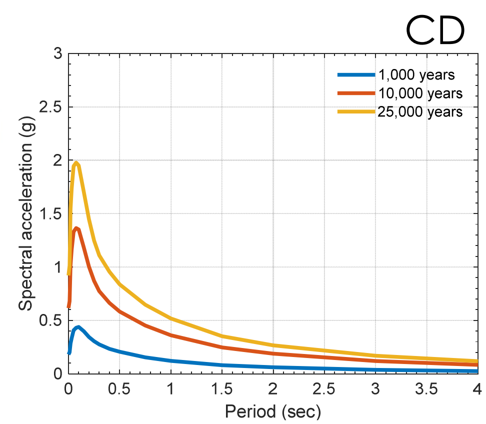
Performance-based design of a seismic isolation system



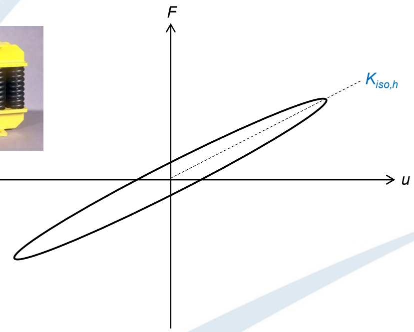


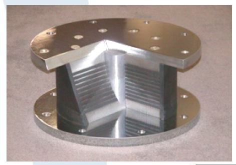


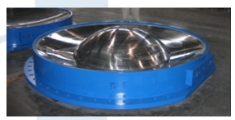


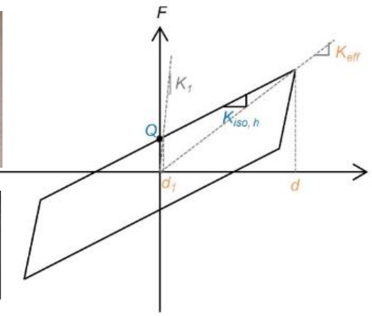


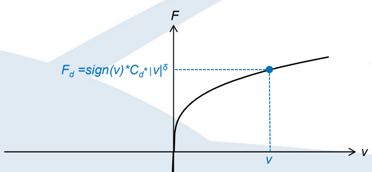
Performance-based design of a seismic isolation system

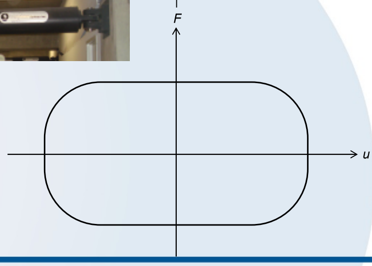


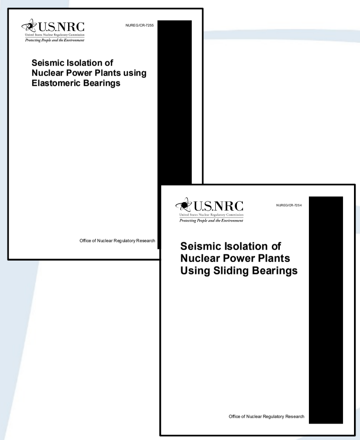


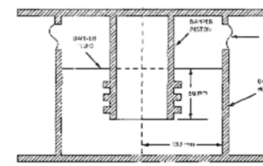


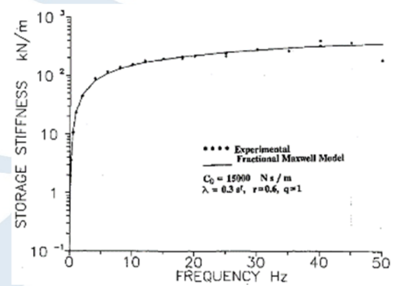


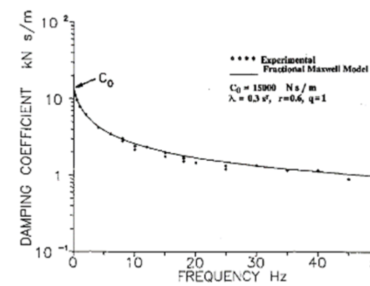






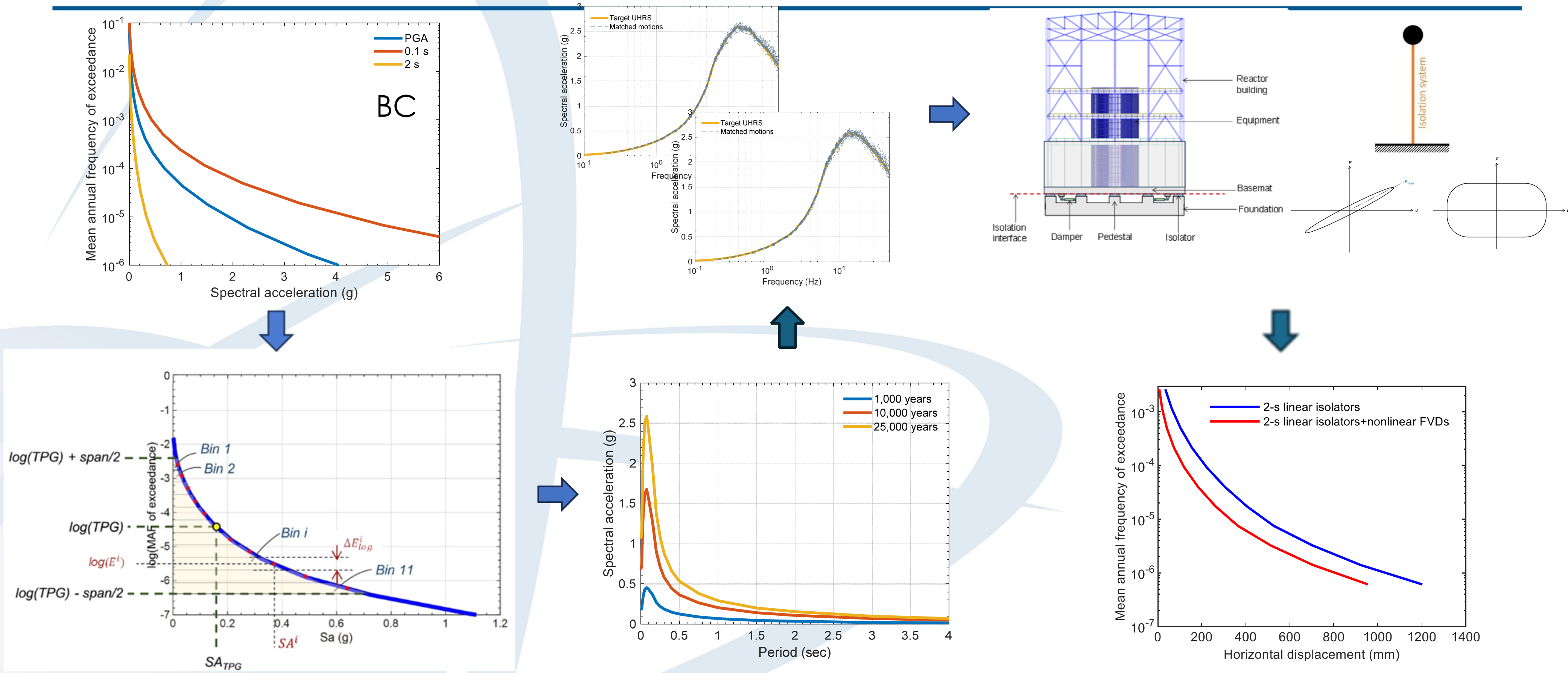






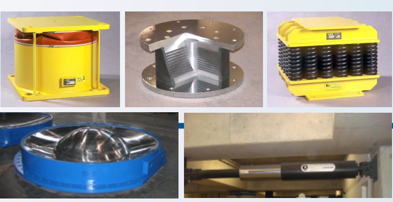
Makris and Constantinou, 1992
Parsi et al., 2024

Generating a displacement demand curve



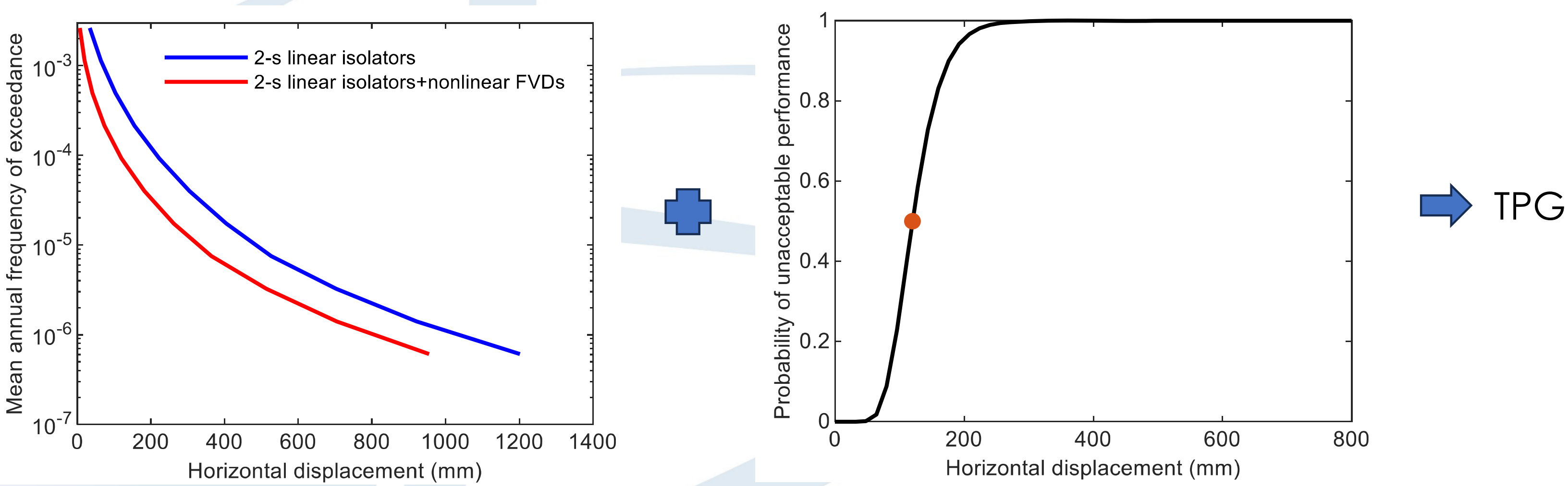
Deriving an isolation system fragility function

- Isolation-system fragility function
  - Defined by a median capacity (D50) and a log standard deviation, beta
    - Median capacity underestimated by testing, why?
  - Beta addresses uncertainties in displacement demand and capacity
    - Parameters per EPRI (2018)
      - Ground motion, modeling, damping, mode contribution, input time series, foundation-structure interaction, strength, inelastic energy absorption
      - Monte Carlo analysis of Huang et al. (2009) for linear and bilinear isolation systems for beta for ground motion and modeling
      - Beta for model fidelity uncertainty per EPRI (2018) = 0.05
    - Composite beta = 0.13 for linear systems, = 0.22 for nonlinear systems



Performance-based design of a seismic isolation system

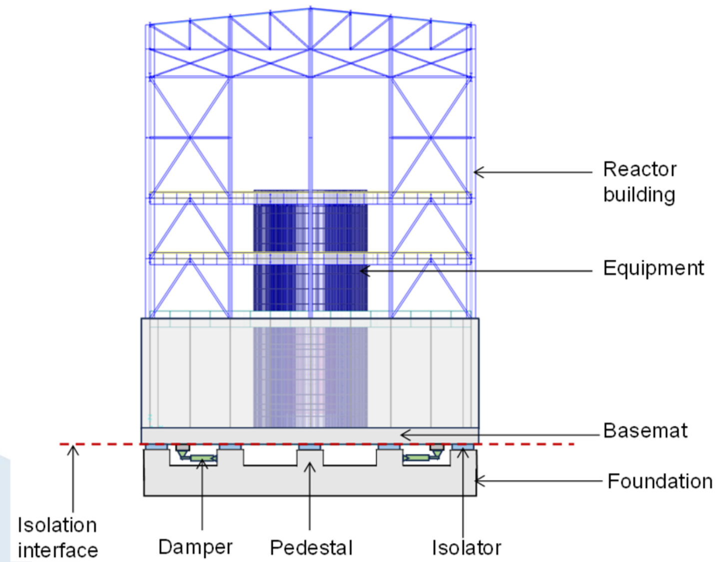
- Isolation-system fragility function
  - Pre-determined log standard deviation per Appendix D (0.15 to 0.25)
  - Increment D50 to achieve user-specified target performance goal (TPG)

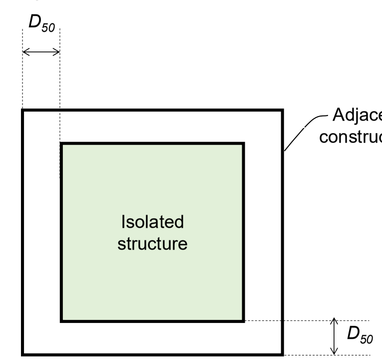


Performance-based design of a seismic isolation system

- Use of displacement F50
  - Prototype testing of isolators and dampers
  - Clearance to adjacent construction
  - Forces at F50 along each horizontal axis + TPG shaking demands
    - Design and detailing of substructure (pedestals, foundation)
    - Design of connections to substructure and superstructure

❖ Analysis and design of SSCs





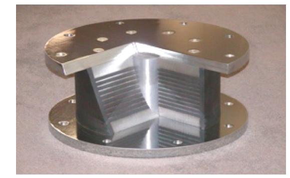
Qualification, prototype, and production testing

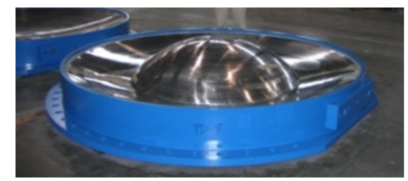
- Requirements based on 35 years of US industry practice
  - ASCE 7, ASCE 41, AASHTO, applications to mission-critical structures
  - Nuclear applications no less onerous requirements than non-nuclear
- Qualification testing
  - Project independent, to be executed before being considered for a nuclear energy application
  - Dynamic testing of devices and shake-table testing of systems of devices
  - Verified and validated numerical models
  - Demonstrate that change in mechanical properties less than (+20%, -20%) over design life
    - Obliges prior experience and testing of technology, accelerated aging tests not permitted
  - Prior deployment in non-nuclear, mission-critical applications in the US, moderate to high seismic hazard
- Prototype testing
  - Project specific, requirements for all isolators and dampers addressed in the topical, full size
  - Test three of each type and size of isolator and damper (rationalize number of types)
  - Demonstrate that isolators and dampers can sustain demands consistent with the TPG
  - Dynamic per loading environment
- Production testing
  - Project specific, requirements for all isolators and dampers addressed in the topical
  - Test 100% of isolators and dampers prior to shipment to construction site
  - Demonstrate that isolators and dampers can sustain demands consistent with DBE shaking
  - Dynamic or slow speed, depending on device; dampers tested dynamically

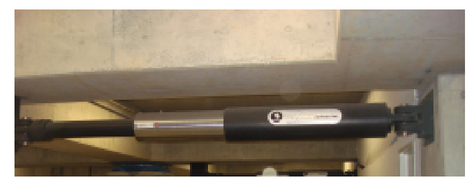
	DB shaking	@TPG
Use	Production testing of isolators and dampers	Prototype testing of isolators and dampers
Isolator and damper displacement	Mean maximum	D_{50} from fragility analysis
Damper velocity	Mean maximum	Mean maximum from TPG shaking
Acceptance criteria	Production testing of each isolator for mean maximum horizontal displacement and corresponding axial force	Prototype testing of three isolators of each type and size for D_{50} displacement and TPG axial force
	Production testing of each damper for mean maximum displacement and corresponding maximum velocity	Prototype testing of three dampers of each type and size for D_{50} displacement and TPG velocity
	No damage to isolators	Isolator damage is acceptable but load-carrying capacity for gravity loading is maintained
	No damage to dampers	No damage to dampers

Specifications

- Provides a pathway for both applicants and regulator
- Based on 35 years of US industry practice
  - Low-damping natural rubber bearings
  - Lead-rubber bearings, natural rubber as the base elastomer
  - Spherical sliding bearings (or Friction Pendulum™)
    - Single concave and triple concave
  - 1D fluid viscous dampers
- Generated by best-in-class consultants
  - Deep experience in seismic isolators and dampers
    - Analysis, design, testing, procurement, inspection
- Reviewed by the US suppliers of isolators and dampers







Commercial grade dedication

- Why? The alternative to NQA-1
- CGD undertaken to "…provide reasonable assurance that a commercial grade item to be used as a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR Part 50, Appendix B…"
- Assurance is achieved by "… identifying the critical characteristics of the item and verifying their acceptability by inspections, tests, or analyses by the purchaser or third-party dedicating entity."
- Draws on EPRI (2014) "Plant engineering: guideline for the acceptance of commercial-grade items In nuclear safety-related applications"
- Chapter 8 plan for CGD
  - Step 6: select acceptance criteria methods and document acceptance criteria
  - Step 7: conduct acceptance activities
    - 100% testing of all production isolators and dampers for DBE demands
      - No other safety-related items in a nuclear power plant are tested so rigorously

Acknowledgments

- US Department of Energy, Award No. DE-NE0008932
- University at Buffalo: Sharath Parsi, Kaivalya Lal, Ching-Ching Yu, Faizan Ul Haq Mir, Manish Kumar^2, Yin-Nan Huang
- Idaho National Laboratory: Chandrakanth Bolisetti
- Kairos Power: Matt Denman, Brian Song
- SGH: Mohamed Talaat
- KPFF: Reid Zimmerman
- Advisory committee: Jacopo Buongiorno and Koroush Shirvan (MIT), John Richards and Hasan Charkas (EPRI), Karl Fleming (KNFC), Troy Morgan (Exponent)
- NEI Advanced Reactor Regulatory Task Force: Bob Iotti (ARC Clean Energy), Mory Diane (Oklo), Jim Kinsey (INL), Amanda Spalding (WEC), Dennis Henneke (GEH), and Ian Gifford (TerraPower)

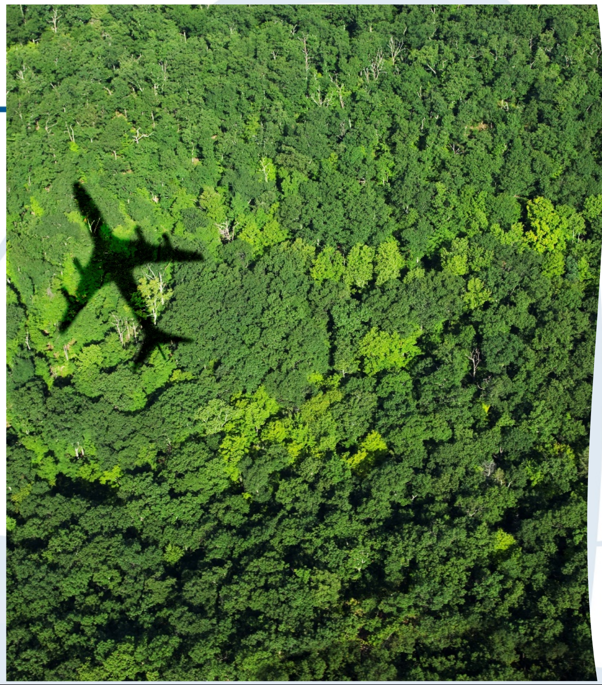
U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Observations on the Southern Company Draft Base Isolation Guidelines Report

Thomas Weaver, Weijun Wang, and Jose Pires
Office of Nuclear Regulatory Research, Nuclear Regulatory Commission

July 24, 2024
Advanced Reactors Stakeholders Meeting

Overview



Draft Report:
Guidelines for Implementing Seismic Base Isolation in Advanced Nuclear Reactors, Southern Company, Document Number SC-SND8932-001 Rev A, May 2024

- Draft Report Purpose and Scope:
  - *Document and provide the technical justification for a process to select, analyze, design, and deploy a passive isolation system beneath an advanced reactor building that meets applicable regulatory requirements*
  - The guidelines are limited to the isolation system design and do not address design of SSCs supported by base isolators and viscous dampers
- To be submitted to NRC as topical report for formal review and issuance of a safety evaluation report.
- Staff observations provided for consideration in developing a final draft.

Endorsement Request (Section 1.2)

- Section 1.5
  - The role of seismic isolation solutions in defense-in-depth
- Section 3.2 – 3.7
  - Earthquake shaking definitions, performance expectations, and other requirements
- Section 5
  - Performance-based design of a seismic isolation system
- Section 6
  - Qualification, prototype, and production testing
- Section 7
  - Specifications for the supply of isolators and viscous damping devices
- Section 8
  - Commercial grade dedication of seismic isolators and dampers
- Appendix D
  - Achieving a performance target for a seismic isolator

Endorsement Request (Section 1.2) and Seismic Isolation Checklist (Section 1.3)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Item 7 in Section 1.2 includes requirements for design of structures, systems and components above the seismic isolation interface
  - Confirm that the requirement for the SSCs above the seismic isolation interface is only the one pertaining to their seismic design category (SDC) vis-à-vis the SDC for the isolation system (Section 3.7.4)
- Section 1.3 states that the seismic isolation checklist does not apply to structures, systems and components above the isolation plane
  - The last paragraph of Section 1.3 provides a guideline for the analysis and design of the SSCs above the isolation plane including referring to standards for the assignment of seismic design categories
    - Confirm that if this is outside the scope of the report guidelines for which endorsement is requested

Role of Isolator Solutions in Defense-in-Depth (Section 1.5)

- Key Attribute of Defense in Depth
  - Multiple independent and redundant layers of defense so that no single layer, no matter how robust, is exclusively relied upon
- Draft Guidance: "seismic isolation supports the objective of defense-in-depth…"
  - Reduces earthquake demands
  - Seismic isolation augments the approach to achieve defense-in-depth
  - The rules for implementing seismic isolation systems satisfy criteria for implementation of defense in depth
- Needs clarification of what specific endorsement is requested
  - E.g., if the endorsement is for a process to assess the isolation system contribution, what are the specific steps for that assessment?

Earthquake Shaking Definitions, Performance Expectations, and Other Requirements (Section 3)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Additional technical information and discussion on the following is recommended:
  - Is the use of a scale factor SF = 0.5 to calculate the DB spectral from the TPG spectra a simplification for the examples shown or a guideline? (Section 3.2)
  - Details on how to evaluate the isolators and viscous dampers so that they do not suffer damage under wind loads (Section 3.4.1.4 and 3.4.1.1) including wind-borne missiles (Section 3.4.1.1)
  - Power spectral density (PSD) requirements for spectrally matched input motions (Sections 3.5, 3.7 and 5.2.2 for example)
  - Can the recommended use of 11 sets of ground motion be compared with the use of 30 sets of ground motions used in the example of Section 5? (Section 3.5)
  - Discussion to support comments in the report on the significance of soil-structure-interaction for base-isolated advanced reactor buildings and equipment (e.g., Section 3.6.1; Appendix D 2.2) (e.g., contrasting with ASCE 4-16 provisions in Section 12.3)

Earthquake Shaking Definitions, Performance Expectations, and Other Requirements (Section 3)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Additional technical information and discussion on the following is recommended:
  - Is D_{50} established from a fragility analysis alone or fragility analysis in combination with the seismic hazard and a target MAFE? (Section 3.7.2 and Section 3.3)
  - What is the intent of the sentence in Section 3.7.2 stating a dynamic analysis of a 3D finite element model of the isolated building shall be performed for DB and TPG shaking?
    - For the calculation of D_{50} only the lumped building reactive mass above the basemat is used in Section 5.2.2
      - Is a verification of D_{50} expected after the building design is more detailed?
    - Is it for the calculation of axial forces on the isolators?
  - Why is ACI 318-19 proposed for the design of the isolators' pedestals? (Section 3.7.3)
  - Justification for use of precast concrete pedestals (Section 3.7.5)

Performance Expectations (Section 3.3)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

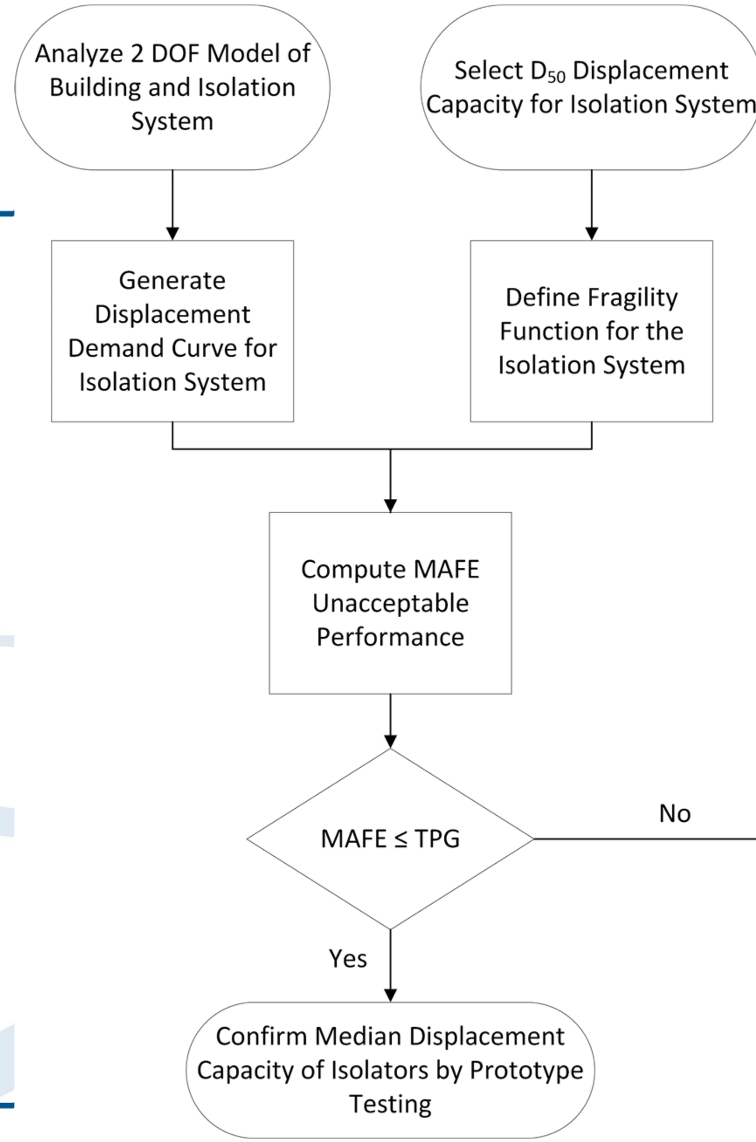
	Design Basis Shaking	At Target Performance Goal
Use	Production testing of isolators and dampers	Prototype testing of isolators and dampers
Isolator and Damper Displacement	Mean maximum	D_{50} from fragility analysis
Damper Velocity	Mean maximum	Mean maximum from TPG shaking
Acceptance Criteria	Production testing of each isolator for mean maximum horizontal displacements and corresponding axial force	Prototype testing of three isolators of each type and size for D_{50} displacement and TPG axial force
	Production testing of each damper for mean maximum displacement and corresponding maximum velocity	Prototype testing of three dampers of each type and size for D_{50} displacement and TPG velocity
	No damage to isolators	Isolator damage is acceptable but load-carrying capacity for gravity loading is maintained
	No damage to dampers	No damage to dampers

From Table 3.1 in the Draft Report

Performance Expectations (Section 3.3)

- Consider adding discussion on how and why performance expectations vary from ASCE 4 Table 12-1.
- Expand on meaning and clarification of terms in table,
  - Mean maximum displacements (DB) and their use
  - TPG axial force (TPG)
  - TPG velocity (TPG)
  - E.g., terms denoting response demands, viscous dampers demands and terms referring to isolators' capacities

Performance Based Design (Section 5)



Performance-Based Design of a Seismic Isolation System (Section 5, Appendix D)

- Separation between guidelines and example calculations
  - Listing of guidelines and then their illustration with the examples
  - For example, can the guideline for establishing D_{50} be written as the median fragility displacement capacity corresponding to a MAFE equal to the TPG MAFE?
- Define the building reactive mass at the level of the basemat (Section 5.2.2)
- Comparison of the proposed fragility analysis Section 5.2.3) and displacement hazard approach (Section 5.2.4) with the traditional approach where the original hazard curve is convolved with a fragility curve which is a function of spectral acceleration in the hazard curve.
- Is the approach in Section 5 one way to determine D_{50} for the target MAFE and other approaches are acceptable provided prototype testing per Section 6 confirms D_{50}?
  - E.g., traditional fragility analysis approach and convolution of fragility analysis with the original hazard curve
  - How would the logarithmic standard deviations for fragility analysis change with different approaches such as the traditional fragility analysis methodology?
  - How would the median fragility change?

Qualification, Prototype, and Production Test (Section 6)

- Qualification Tests: Demonstrate basic performance characteristics independent of project application for qualification of vendors/isolators/dampers
- Prototype Tests: Performed on limited number of devices to confirm the isolators D_{50} capacity and the dampers requirements
- Production Tests: Performed on all devices at the DB seismic loads

Qualification, Prototype, and Production Test (Section 6)

- Approach for qualification tests is comprehensive with detailed information and uses parameters in the performance expectation table (Table 3.1)
- Identify and justify how the testing protocols were derived from ASCE 4-16 (Chapter 12), ASCE 43-19 (Chapter 9) and ASCE 7-22 (Chapters 17 an 18)
  - What was used or not from each code and what has been added and why
  - Justification and sources for the acceptance criteria, especially the deviations from the target values (e.g., force-displacement relations, stiffness)
- Testing protocols are per isolator and damping types to address different behaviors
  - Feasibility of expressing protocols in terms of behavior and response characteristics of isolators and dampers rather than type
- Qualification testing: can exemptions for qualification testing be related to specification and performance requirements rather than through a list of specific vendors?
- Is there an intent to also validate the isolators and dampers mathematical models using the testing results (Section 3.6.3 models)?

Specifications for the Supply of Isolators and Viscous Damping Devices (Section 7)

- Draft specifications for supply of 2D isolators and 1D fluid viscous dampers.
- 3D isolation systems are not addressed
- Gamma and Neutron radiation resistance are not addressed
- Clarify that the Section 7 specification are not related for technical plant specifications in Appendix E
- Part II.4 Design Calculations
  - The only seismic demands considered are D_{50}
  - Axial loads at TPG shaking
    - Is this the shaking characterized by the uniform hazard spectra at the TPG MAFE?
- Are any design calculations at the DB shaking needed?
- Why is the AISC 360 chosen for the mounting plates as opposed to the AISC N690?
- Level of detail recommended for the SSCs above the isolation interface to calculate the demands in the load combinations?

Commercial Grade Dedication of Seismic Isolators and Dampers (Section 8)

- Section 8 provides a template for the technical evaluation tasks required by 10CFR21 and 10CFR50 Appendix B and follows the process in Section 4 of EPRI TR-102260 (Plant engineering: guideline for the acceptance of commercial-grade items in nuclear safety-related applications)
  - Identify deviations from RG 1.164
  - Recognizes that the entirety of the supplier CGD is out of scope for Section 8
- Address if CGD of isolators is anticipated for most designs
  - Section 8 would be reviewed by staff specialized in CGD regulations, guidance and processes

Other Items

- Appendix E – Considerations for ITAAC
  - Endorsement of Appendix E is not requested and observations on Appendix E are outside of the scope of these observations including the assertion in Section E.3 that a seismic isolation system and associated components need not be explicitly addressed in a plant's Technical Specifications

Summary

- Guidance document is limited to isolation system design and does not address design of structures, systems, and components supported by base isolators and viscous dampers
- Additional technical justification and discussion is recommended for some sections of the report to facilitate a safety evaluation review

Acronyms

ACI: American Concrete Institute

AISC: American Institute of Steel Construction

ASCE: American Society of Civil Engineers

CFR: Code of Federal Regulations

CGD: Commercial Grade Dedication

DB: Design Basis

D_{50}: Median displacement from fragility curve

ITAAC: Inspections, tests, analyses, and acceptance criteria

MAFE: Mean annual frequency of exceedance

PSD: Power spectral density

RG: Regulatory Guide

TPG: Target performance goal, frequency of unacceptable performance

SSC: Structures, Systems, or Components

SDC: Seismic design category

SF: Scale factor applied to the TPG hazard curve to develop the design response spectrum

LUNCH BREAK

Meeting will resume at 1:00 pm EDT

Microsoft Teams Meeting

Bridgeline: 301-576-2978

Conference ID: 590 049 732#

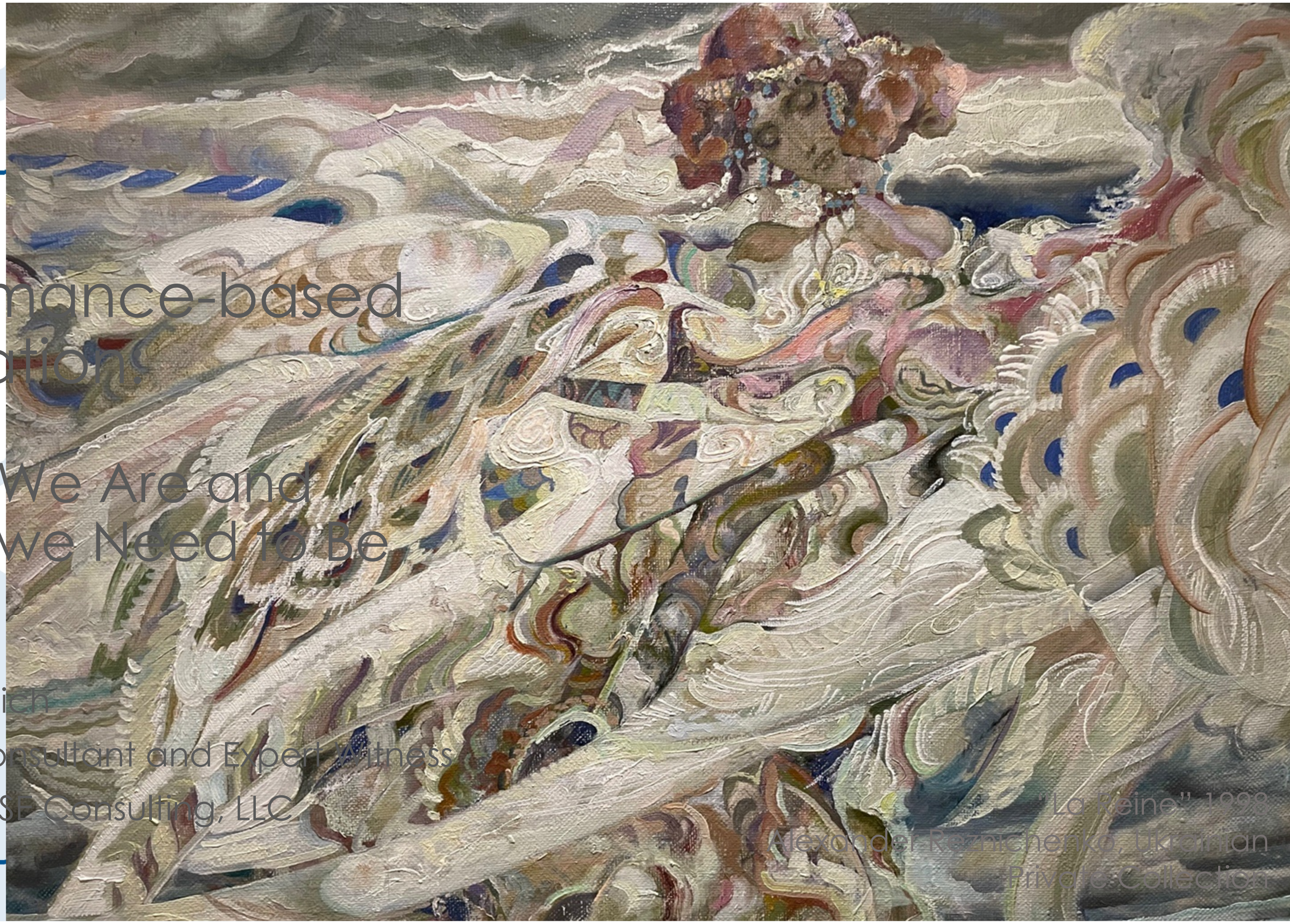
Performance-based Regulation

Where We Are and Where we Need to Be

Rani Franovich

Principal Consultant and Expert Witness

Nuclear ROSE Consulting, LLC



"La Reine" 1998
Alexander Reznichenko, Ukrainian
Private Collection

Where We Have Been

- Commission Direction re Modernization (1999)
  - Risk-informed (RI) and Performance-based (PB) approaches
  - Terms defined by the Commission in SRM-SECY-98-144
  - RIPB approach to oversight (Reactor Oversight Process, ROP)
- Nuclear Energy Innovation and Modernization Act (2019)
  - 10 CFR Part 53
- Focus on RI Reviews using Licensing Modernization Project (LMP 2021)
- Conflation of terms during NRC public meeting on Framework B (June 16, 2022)
- NRC public meeting to align on terminology (June 30, 2022)
- NRC public meeting to discuss NEIMA concepts and confirm alignment on terminology (July 28, 2022)

Technology Inclusive and Risk-Informed Reviews for Advanced Reactors:
Comparing the US Licensing Modernization Project with the Canadian Regulatory Approach

More Recent Developments

- 10 CFR Part 53 Submitted to Commission (March 2023)
- Commission Directed Staff to Revise Rule (March 2024)
- Continued Lack of Coherence Around PB Methods
  - NRC's Regulatory Information Conference (RIC), March 2024
    - Question about whether NRC really is performance-based and risk-informed
    - Responses focused almost exclusively on RI concepts, not PB methods
  - Advanced Reactor Stakeholder Meetings (March 27 and May 23, 2024)
    - More focus on RI and LMP
    - Stakeholder requests for further discussion of PB approaches
  - Advanced Reactor Construction Oversight Process Workshops (Feb-Jul, 2024)
    - Focus on enforcement of compliance, not performance
    - Not pursuing performance indicators because data do not exist
- Passage of the Accelerating Deployment of Versatile Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act, July 9, 2024)

Where We Are

- July 18, 2024 – NRC Risk Metrics Workshop
  - Stakeholders (particularly small reactor developers) struggle with implementing LMP
  - DOE Lab contrasted "margin-based" and "probability-based" assessment of structure, system and component (SSC) performance
    - "Probability-based" assessment of SSC monitoring system and decision process based on plant CDF and LERF
    - "Margin-based" assessment of SSC health based on monitoring performance data
- Margin-based Performance Monitoring Represents a PB Approach
  - Provides for assessment of SSC health during reactor demonstration
  - Facilitates seamless transition to continuous performance monitoring of data during commercial operation
  - Affords efficient, effective regulatory oversight of RI safety parameters using performance indicators

Where We Need to Be

More Attention to PB Solutions

- Observable parameters (quantitative, qualitative, or combination) directly related to outcomes are developed
  - Margin-based approaches to SSC performance (use demonstration data for FOAK and operational data for oversight and performance monitoring)
- Objective acceptance criteria for each parameter is developed.
  - Margin-based approaches to SSC performance (compare actual performance to objective performance criteria)
- A decision-making framework is developed for evaluating and assessing physical and temporal margins.
  - Structured hierarchy with high-level performance objectives
- Flexibility is afforded to the licensee to show that the margins are being employed to improve outcomes.
  - Prescription is minimized in regulations, guidance and industry standards
  - Applicants propose means for demonstrating how high-level performance objectives are met

Advantages of PB Approaches

- Achieve high levels of safety performance without undue regulatory burden
- Key to satisfying NEIMA mandate for technology-inclusive frameworks
  - Offer flexibility for innovation
  - High-level performance objectives are technology-neutral
  - Incorporate risk insights
- Data-driven vice theoretical
  - Utilize actual reactor demonstration and operational data
  - Offer seamless transition to PB oversight during plant operation
  - Save time and costs to license first-of-a-kind reactors (FOAK)
  - Support rapid deployment of n^{th}-of-a-kind reactors (NOAK)
- Can leverage advances in digital technology for continuous monitoring
- Facilitate international harmonization

Summary, Conclusion & Next Steps

Summary:

Most stakeholders agree that regulatory modernization is necessary to keep pace with innovation, incentivize improved safety outcomes, and mitigate enterprise risk to the industry.

Conclusion:

It is not clear how NRC and stakeholders define "modernization," particularly as it pertains to PB approaches.

Next Steps:

A workshop is needed to establish a shared understanding of what PB means and how it will be applied to satisfy 1999 Commission direction, NEIMA, and the ADVANCE Act.

DG-1290, Revision 1 – Proposed Revision 3 to Regulatory Guide 1.59 Appendix K - Consideration for Applying Guidance to Advanced Reactors and Small Modular Reactors

Presentation to Advanced Reactor Stakeholder's Meeting

July 24, 2024

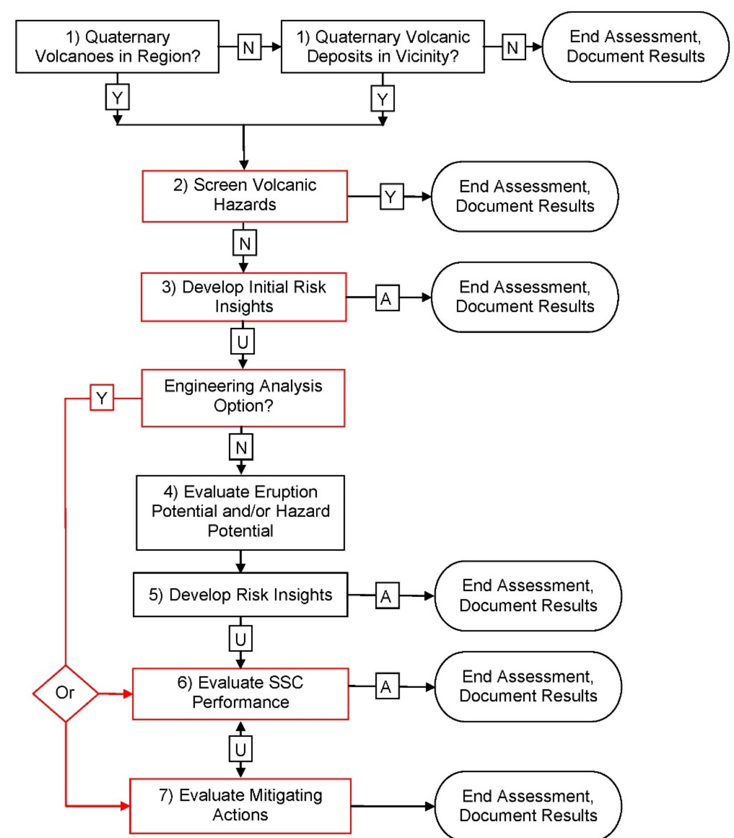
Jenise Thompson

NRR - Division of Engineering and External Hazards

Overview

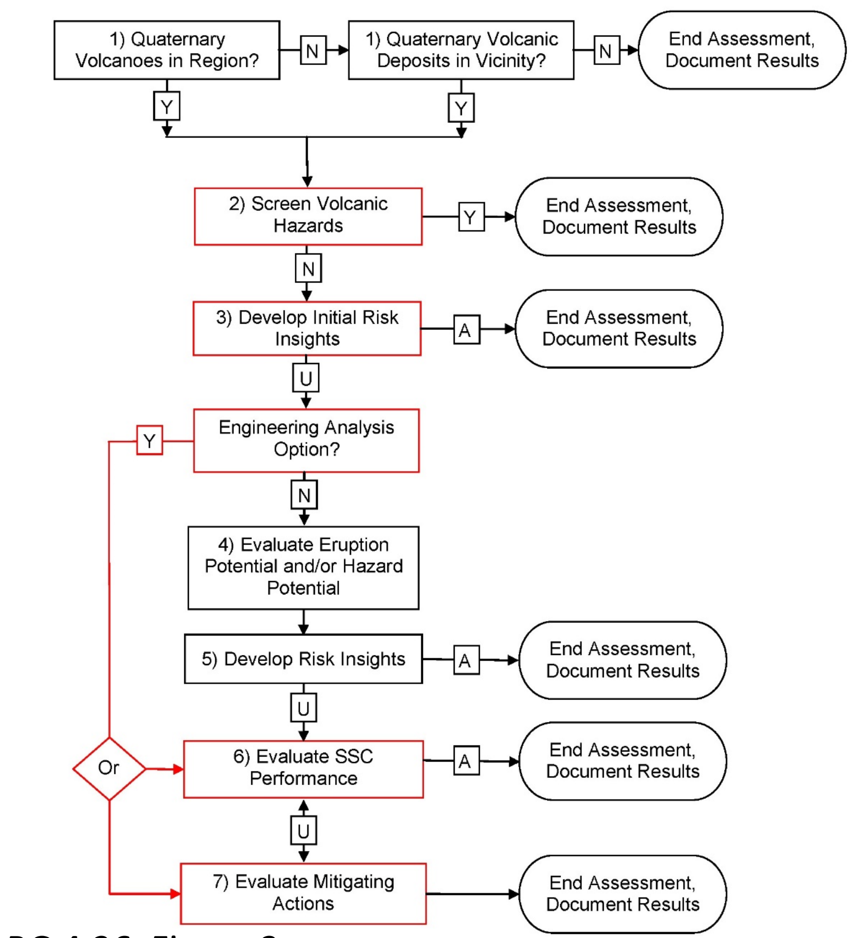
- RG 1.59, Revision 2, issued in 1977
- Revision 3 initially issued for public comment as DG-1290 in 2022, reissued for public comments July 15, 2024
- Appendix K adapts methodology from RG 4.26 to use a flexible stepwise approach to leverage PRA and site characteristics in flood evaluations for advanced reactors and SMRs

Adapting from RG 4.26

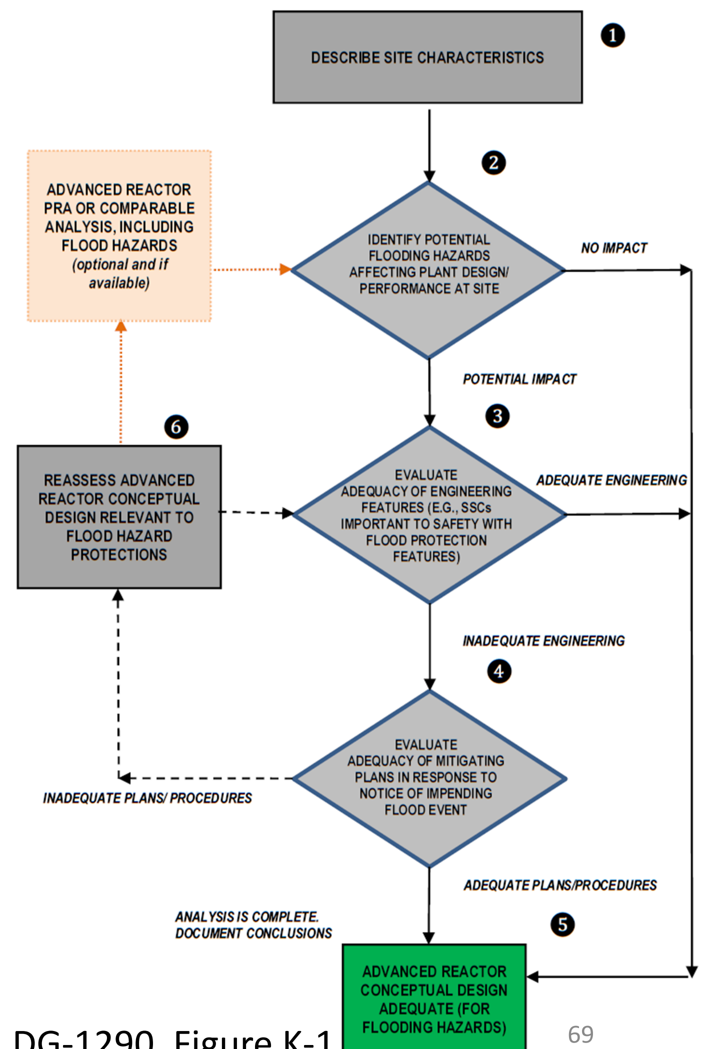


RG 4.26, Figure 3

- Leverage existing site characterization information
- Screen hazards and consider risk insights
- Allow for evaluation of SSC performance and mitigating actions in addition to or in place of detailed hazard analysis



RG 4.26, Figure 3



DG-1290, Figure K-1

Appendix K Flowchart

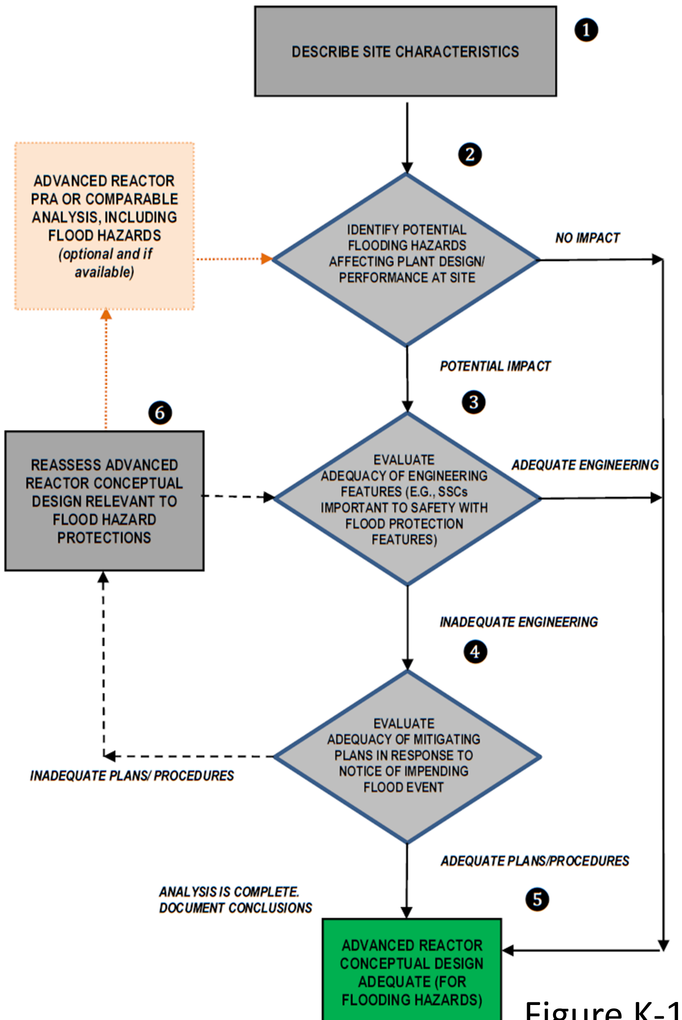


Figure K-1, DG-1290, Rev. 1

- Step 1 – leverage site characterization information
- Step 2 – determine which, if any, flood-causing mechanisms affect plant performance
- Step 3 – determine if there is adequate engineering for SSCs to withstand the hazard

Appendix K Flowchart

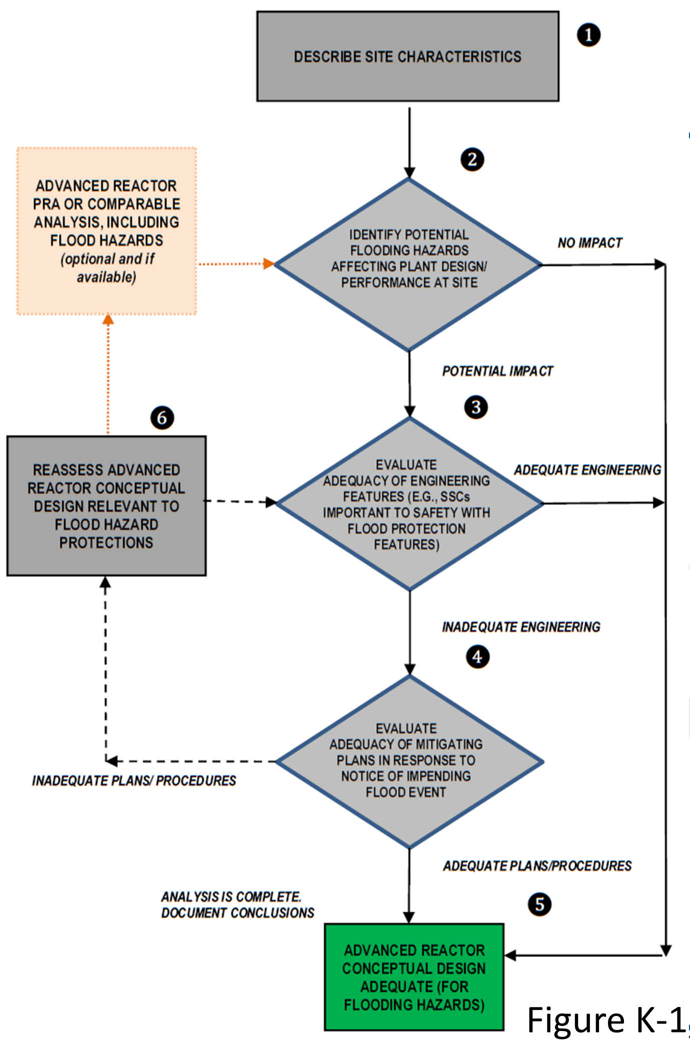


Figure K-1, DG-1290, Rev. 1

- Step 4 – evaluate mitigating actions for adequacy
- Step 6 – reassess design features and/or consider PRA
- Step 5 – assessment is complete and results are documented

Appendix K Summary

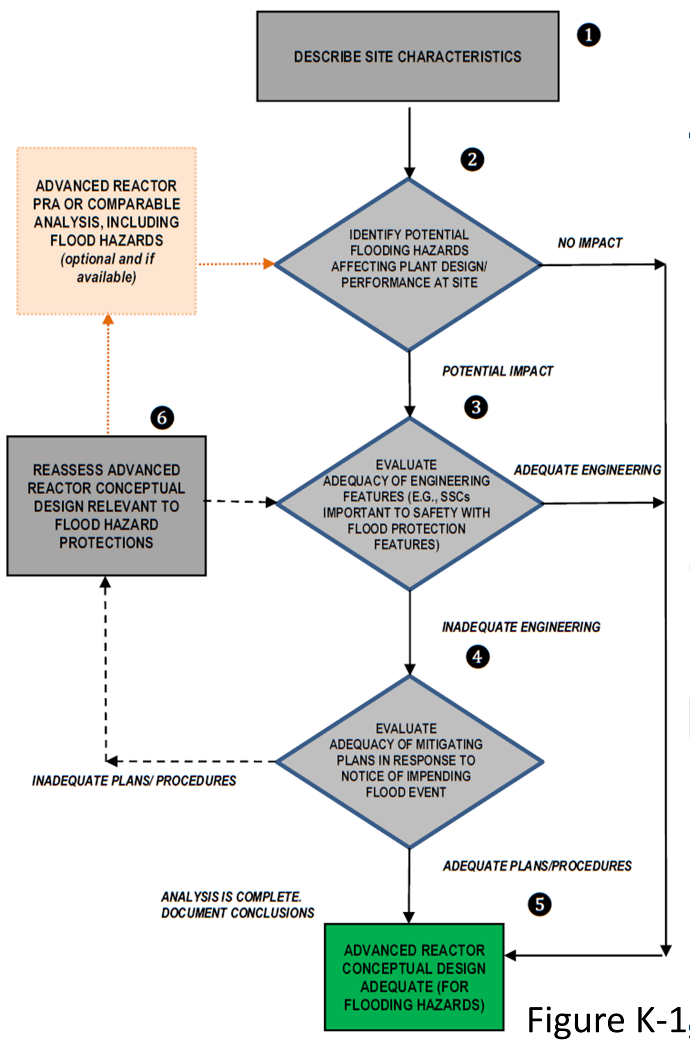


Figure K-1, DG-1290, Rev. 1

- Focus on flood causing mechanisms of importance to the design
- End the flood evaluation at the earliest possible point in the process.
- Consider PRA or comparable analysis
- Iterate between evaluation of SSCs performance and mitigating actions and design reassessment to achieve satisfactory result.

Next Steps

- DG-1290, Revision 1, public comment period open.

References

- Disposition of first set of public comments – ML23320A026
- DG-1290, Revision 1 – ML23320A025

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Licensing and Deployment Considerations for Nth-of-a-Kind Micro-Reactors

Advanced Reactor Stakeholders Meeting

July 24, 2024

William Kennedy, Advanced Reactor Policy Branch
Jackie Harvey, Advanced Reactor Policy Branch
Peyton Doub, Environmental Tech Review Branch 1
U.S. Nuclear Regulatory Commission

ADVANCED REACTOR READY

https://www.nrc.gov/reactors/new-reactors/advanced.html

Contents

- Goals of this presentation
- Background
- Regulatory approaches for standardized operational programs
- Alternative approaches for environmental reviews
- Other licensing and deployment topics
- Next steps

Goals of this Presentation

- Inform stakeholders about regulatory approaches the NRC staff is developing, for Commission consideration, regarding standardized operational programs and alternative environmental reviews
- Inform stakeholders about other licensing and deployment topics, potential near-term strategies, and next steps the NRC staff is considering.
- Engender a dialogue with stakeholders

Background

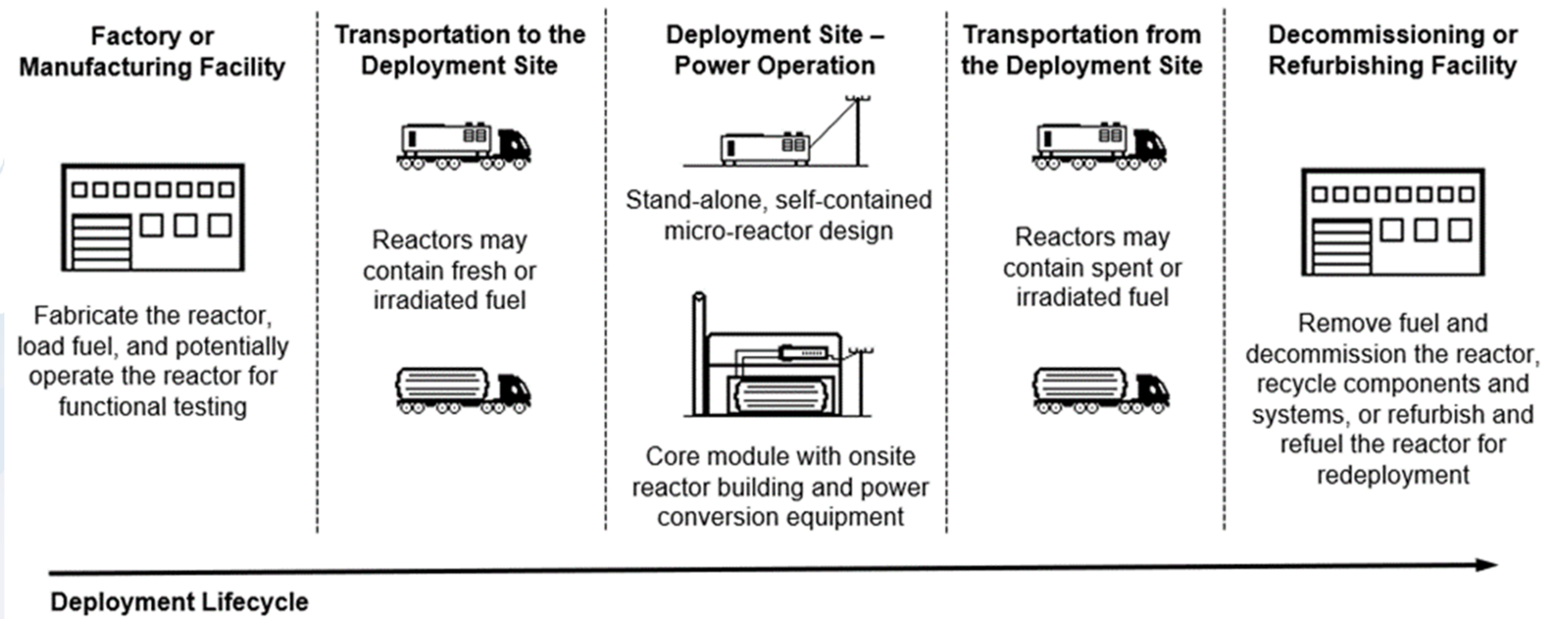
- For licensing purposes, micro-reactors are commercial power reactors licensed under Section 103 of the AEA.
- Micro-reactors typically use non-light-water reactor technologies, are expected to have power levels on the order of tens of megawatts thermal, small site footprints, low potential consequences in terms of radiological releases, and may have increased reliance on passive systems and inherent characteristics to control power and heat removal.
- Factory-fabricated micro-reactors are a subset of micro-reactors that would rely heavily on standardization and mass production to simplify licensing and deployment.*

* See SECY-24-0008, “Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory,” dated January 24, 2024 (ML23207A252).

Background

- For the purposes of this presentation, the term “Nth-of-a-Kind” (NOAK) micro-reactor generally means a micro-reactor of a standard common design that has been previously approved by the NRC through, a design certification, manufacturing license, or final safety analysis report for a first-of-a-kind (FOAK) combined license or operating license.
- Nth-of-a-Kind micro-reactor licensing refers to licensing micro-reactors of a standard common design for operation as power reactors at fixed sites.

Conceptual Deployment Model for Factory-Fabricated Transportable Micro-Reactors



An approach by which a robust up-front approval of a standard design enables efficient, predictable licensing of "Nth-of-a-Kind" reactors

Up-Front Approval of the Standard Plant

- Standard design approved in a manufacturing license, design certification, construction permit and operating license, or combined operating license
- Technical issues resolved
- Standardized operational programs
- Generic environmental review (to the extent practicable)
- Hearings covering the standard design and environmental review

Nth-of-a-Kind Licensing

- Streamlined administrative processes
- Confirmation of site suitability for the standard design
- Site-specific environmental review (applying the generic environmental review, as appropriate)
- Closure of ITAAC/license conditions
- Confirmatory site-specific inspection
- Site-specific hearing
- Operating decision

Regulatory Approaches for Standardizing Operational Programs

- The NRC staff is exploring approaches to review operational matters at the design approval stage (ML or DC) for a standard micro-reactor design considering two general groups of operational programs:
  - Group 1: Design-related (e.g., technical specifications (TS), design quality assurance, and portions of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME BPV) in-service inspection and in-service testing programs)
  - Group 2: Site specific/operational (e.g., operator training, security programs, emergency preparedness, etc.) developed in the operating license or combined license under current processes

Regulatory Approaches for Environmental Reviews

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- The current regulatory process is to perform an environmental impact statement (EIS) for nuclear power reactors*
- The NRC staff is considering alternative approaches for environmental reviews for micro-reactors of a common design
- Any EIS, generic environmental impact statement (GEIS), or environmental assessment (EA) under any alternative may be tiered from the New Reactor GEIS

Alternative	Environmental Review for First-of-a-Kind	Environmental Review for Nth-of-a-Kind
Design-Specific GEIS	• GEIS or • Generic EA w/ Exemptions	• Supplemental EA tiered from FOAK GEIS or EA
Environmental reviews associated with a design approved in a ML or DC	• EIS or • EA with Exemptions	• Supplemental EA tiered from FOAK EIS or EA
Micro-Reactor Online Environmental Review Portal	• EIS or • EA with Exemptions • Develop Design-Specific Portal	• Applicant supplies site-specific data into Portal • NRC develops EA tiered from First-of-a-kind EIS/EA or from New Reactor GEIS based on applicant submission on Portal
Design-Specific Categorical Exclusions (CATEX)	• EIS or • EA with Exemptions • Develop CATEX and Checklist	• Applicant supplies site-specific data using Checklist • NRC determines if CATEX applies

* See SECY-24-0046, "Implementation of the Fiscal Responsibility Act of 2023 National Environmental Policy Act Amendments" (https://www.nrc.gov/docs/ML2407/ML24078A013.html), for discussion of the current process for environmental reviews and potential changes related to the Fiscal Responsibility Act of 2023.

Other Licensing and Deployment Topics

Maximal design standardization

- The regulations in 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” provide several regulatory pathways for design standardization, including manufacturing licenses, design certifications, and standard design approvals, under which most safety issues would be resolved.
- Maximal standardization would involve approval of a standardized micro-reactor design and subsequent deployment under a combined license or construction permit and operating license without any significant deviations or departures from the standardized design.
- Maximal design standardization could allow micro-reactors of a common design to be deployed to most sites in the U.S. with minimal need for site-specific features or the associated additional NRC reviews and approvals.

Other Licensing and Deployment Topics

Grading the level of site characterization

- A standardized design for a micro-reactor could establish bounding parameters for site characteristics that are important to the safety review so that micro-reactors of the standard design could be deployed at suitable sites throughout the U.S.
- The NRC staff is considering approaches for grading the level of site characterization for NOAK micro-reactors of a standard design based on the applicable hazards for the specific micro-reactor design, the amount of margin included in the design for each bounding site parameter, and the amount of margin to appropriate dose reference values.
- A graded approach could focus on how a construction permit or combined license applicant can provide the required site characterization information and demonstrate that the bounding parameters are met for the candidate site.

Other Licensing and Deployment Topics

Deployment site security

- The existing requirements for security apply to licensing micro-reactors of a common design, including various regulations in 10 CFR Part 73, "Physical Protection of Plants and Materials."
- The NRC has ongoing activities that would apply to micro-reactors, such as those associated with SECY-22-0072, "Proposed Rule: Alternative Physical Security Requirements for Advanced Reactors" (https://www.nrc.gov/docs/ML2133/ML21334A003.html), and SECY-23-0021, "Proposed Rule: Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors" (https://www.nrc.gov/docs/ML2116/ML21162A093.html).
- The NRC staff is considering additional approaches for streamlining the review of security for licensing "Nth-of-a-Kind" micro-reactors, including the possibility to standardize operational aspects of security, to the extent practical.

Other Licensing and Deployment Topics

Deployment site emergency preparedness

- The existing regulations for emergency preparedness in 10 CFR Part 50, “Domestic licensing of production and utilization facilities,” apply to licensing micro-reactors of a common design.
- The NRC staff is exploring approaches for streamlining the review of emergency preparedness for licensing NOAK micro-reactors based on considerations such as the possibility that potential accidents would result in low doses at the site boundary and, under certain circumstances, might not require extensive off-site response.

Other Licensing and Deployment Topics

Streamlined processing of license applications and licensing documents

- Licensing applications referencing an approved micro-reactor design that leverages maximal design standardization will likely be nearly identical, with some possible minor variations related to licensee-specific or site-specific information.
- NRC-generated licensing documents, such as the NRC staff safety evaluation, environmental review, license, and required Federal Register notices, will likely be very similar for licensing each individual micro-reactor of a common design.
- The NRC staff is considering approaches for using electronic licensing forms, licensing document templates, and automation to streamline processing and review of micro-reactor applications to reduce the timeframes for acceptance review, docketing, safety review, environmental review, concurrence, license issuance, and other steps.

Other Licensing and Deployment Topics

Construction inspection

- Micro-reactors of a common design might be “self-contained” in that they would be almost entirely fabricated at a factory and require minimal site preparation or construction activities at the deployment site, or they might consist of a “core module” that is fabricated in a factory and then incorporated into or connected to permanent structures and systems constructed at the deployment site, such as a reactor building and power conversion equipment.
- In either case, it will be necessary for the NRC staff to verify completion of ITAAC in support of a finding for authorization to operate under 10 CFR 52.103(g) or to verify substantial completion of construction for issuance of an operating license under 10 CFR 50.56 and 50.57(a)(1).
- As discussed in SECY-23-0048*, the NRC staff is considering approaches for risk-informed and performance-based inspections at both the fabrication facility and deployment site that can be completed within the expected timeframes for licensing and deployment of Nth-of-a-Kind micro-reactors.

*SECY-23-0048, "Vision for the Nuclear Regulatory Commission's Advanced Reactor Construction Oversight Program" (ML23061A086)

Next Steps

- Publish a draft white paper, expected in Fall 2024, to further stakeholder engagement
- Develop a Commission paper on licensing and deployment considerations for Nth-of-a-kind micro-reactors:
  - Request Commission direction on regulatory approaches for standardizing operational programs and alternate environmental reviews
  - Provide information on other topics, including the NRC staff’s related near-term strategies and potential next steps

Discussion Items

- Are there other approaches that the NRC staff should consider for NOAK micro-reactor licensing and deployment?
- Are there additional strategies the NRC staff should consider for the other identified topics?
- Other feedback or questions for the NRC staff?

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Closing Remarks

- September 18, 2024, Periodic Advanced Reactor Stakeholder Public Meeting
- October 30, 2024, Periodic Advanced Reactor Stakeholder Public Meeting

Advanced Reactor Program