



COMMISSION MEETING WITH THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

December 6, 2019



Agenda

- Pete Riccardella, Chairman, ACRS
 - Overview and Transformation
- Walter Kirchner, Member, ACRS
 - NuScale Design Certification Application Review
- Dennis Bley, Member, ACRS
 - Advanced Reactor Siting; Technology-inclusive, Risk-informed, and Performance-based Approach; Advanced Reactor Computer Codes
- Joy Rempe, Member-at-Large, ACRS
 - Assessment of the Quality of Selected NRC Research Projects

Accomplishments

Issued 31 reports since the last meeting with the Commission in December 2018:

- NuScale Design Certification Application (DCA)
 - Safety Evaluation Reports (SERs) with Open Items (8)
 - NuScale Topical Reports (2)
 - Focus Area Review Approach (1)
- ACRS Activities to Support NRC Transformation

Accomplishments (Cont'd)

- Advanced Reactor Topics (3)
- License and Design Certification Renewals (5)
- Vendor Topical Reports (4)
- Other Topics
 - 10 CFR 50.59 for DI&C
 - Expanded Power-to-Flow Domain Application Reviews
 - Non-power, Production, or Utilization Facility (NPUF) Rulemaking
 - TVA Clinch River Early Site Permit
 - Reactor Vessel Embrittlement Technical Letter Report (Re: Regulatory Guide 1.99)
 - Quality Review of Selected RES Projects

ACRS Transformation

Committee engaged in several activities to assess ACRS role in a transformed agency:

- Briefed by senior NRC staff
- Conducted ACRS retreats and discussed at Committee meetings
- Solicited input from the EDO, current and past Commissioners
- Reviewed relevant agency transformation documents

Conclusions and Proposed Actions

- ACRS reviews provide integrating perspective and increase quality and rigor
- Moving forward
 - Prioritize reviews based on risk significance and agency transformation priorities
 - Stay abreast of staff transformation initiatives and continue to contribute
 - Improve operational efficiency
- No need for rule changes to implement these actions

Actions Already Underway

- Established prioritization criteria for Committee review topics
- Developed (with staff) a more effective process for NuScale DCA Phase 5 review
 - Focused on risk-significant, cross-cutting issues instead of another chapter-by-chapter review
- Eliminated reviews of some routine, low priority items
- Implemented process improvements to enhance operational efficiency

Summary

- ACRS performs independent, integrated, multi-discipline reviews
- Prioritization of future reviews will focus on those with the most impact and value to the Commission
- Membership with expertise covering the breadth of risk-significant issues is mission-critical

NuScale Design Certification Application (DCA) Review

Walter Kirchner, Chair, ACRS NuScale
Subcommittee

NuScale DCA

- NuScale Power Modules (NPM)
 - Small modular, natural circulation PWR
 - 160 MWt/50 MWe per module
 - Each NPM composed of reactor core, pressurizer, and two helical steam generators integral to a reactor vessel and enclosed in a high-strength steel containment vessel

NuScale DCA (Cont'd)

- Core contains 37 ~half-length 17 x 17 PWR fuel assemblies
- Each NPM has a dedicated, passive emergency core cooling system (ECCS) and decay heat removal system (DHRS), not reliant on electrical power

NuScale DCA (Cont'd)

- Reactor Building
 - NPMs largely immersed in common pool of water
 - Pool serves as passive ultimate heat sink for cooling during design basis events (DBEs) and beyond DBEs (BDBEs)
 - Common pool for refueling and spent fuel storage

NuScale Review Status

- Met Phase 3 milestone of August 27, 2019
- Issued 7 Interim Chapter Letter Reports (for 21 Chapters)
- Issued 8 Topical Letter Reports
- Four Topical Reports remain to be reviewed

Phase 5 Review

- Cross-cutting “Areas of Focus” review proposed for Phase 5 based on lessons learned from past DCA reviews
- Consistent with NRC’s strategy for transforming to more risk-informed, performance-based, safety-focused reviews
- In-depth review of matters that are inherently cross-cutting regarding integrated system safety performance

Phase 5 Review (Cont'd)

- ACRS chapter lead will perform detailed chapter review and document for completeness
- Lead for chapter will make recommendation to Full Committee if briefing is needed, or to include items in a focus area review

Phase 5 Review (Cont'd)

- The currently identified focus area reviews include:
 - ECCS and Valve Performance
 - Helical-Tube Steam Generator Design
 - Boron Dilution and Return to Criticality
 - Source Term
 - Probabilistic Risk Assessment

Phase 5 Review (Cont'd)

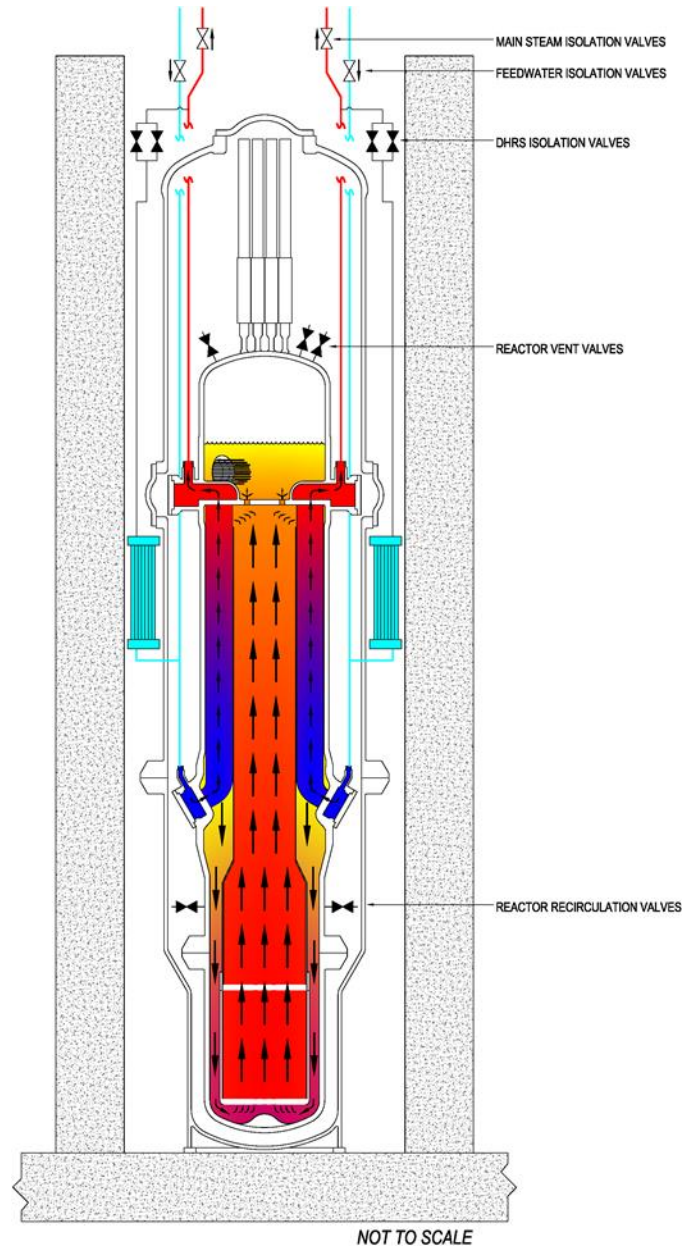
- This is a departure from past reviews of design certification applications (chapter by chapter)
- Less resource intensive for staff and applicant; more effective safety focus
- EDO and staff expressed favorable feedback

Phase 5 Review Status

- All SERs with no open items due on December 12, 2019
- Six SER chapters have been reviewed by chapter leads and determined not to require a briefing
- Chapter 15 SER briefing scheduled for February/March 2020
- Focus area briefing schedule being negotiated with staff for early 2020
- Working with staff to meet June 23, 2020 target milestone

NuScale Backup Slides

NuScale Power Module



NuScale Reactor Building

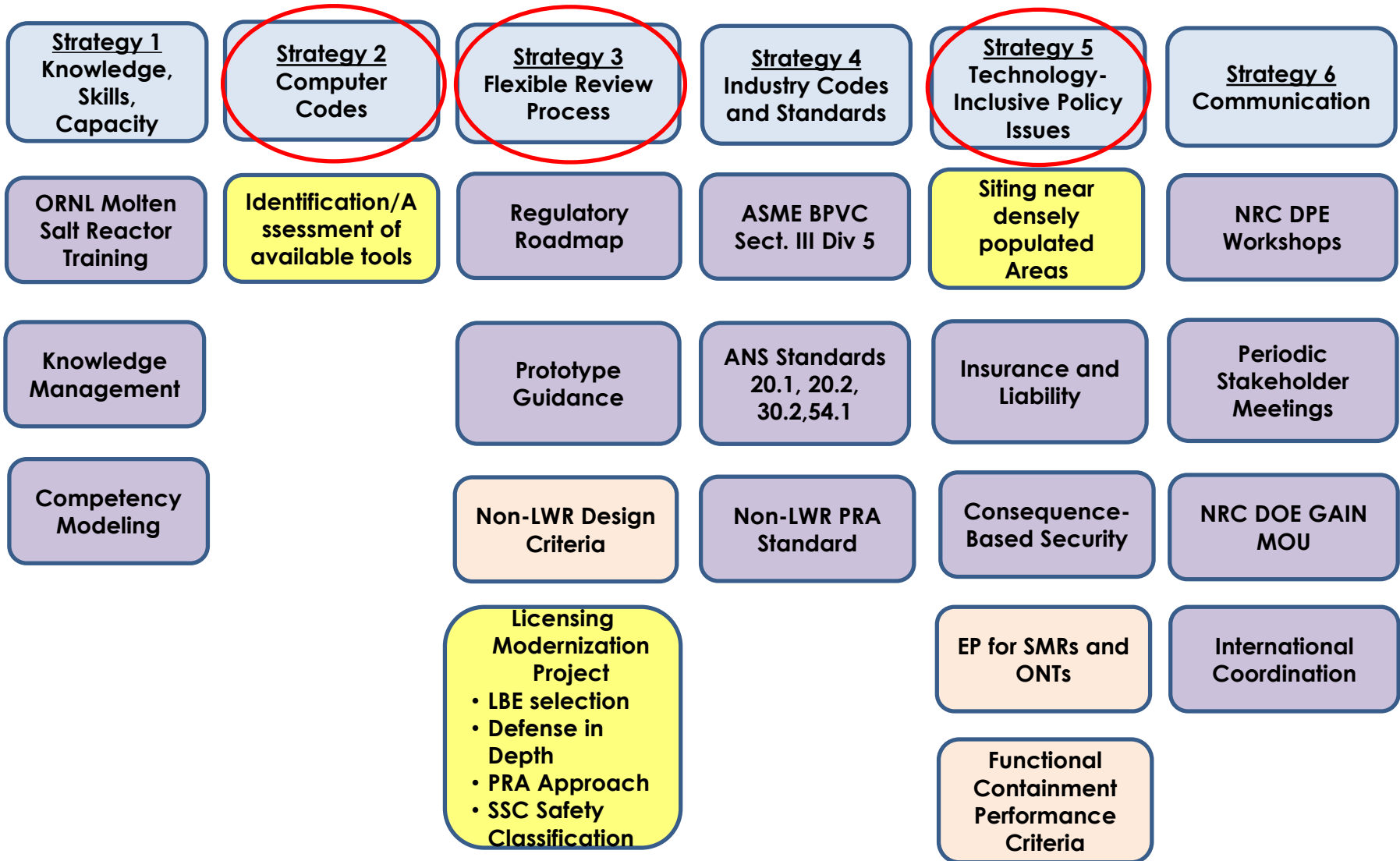


Three Reports on the Staff's Vision and Strategy for Review of Non-LWR Applications

Dennis Bley, Chair

ACRS Future Plant Designs Subcommittee

Near-Term Implementation Action Plan



Licensing Modernization Project (LMP)

- LMP: Technology-inclusive, risk-informed, and performance-based approach to inform the content of applications for licenses, certifications, and approvals for non-LWR reactors – gathered in NEI 18-04
- DG-1353 endorses with clarifications, principles and methodology of NEI 18-04
- Proposed approach neither exempts any design from existing regulations nor addresses all regulations applicable to nuclear power plants

Objectives – LBEs, SSCs, DID

- Identify Licensing Basis Events (LBEs)
 - Defined by scenarios developed in the PRA
 - Tested against frequency-consequence goals in NEI 18-04
 - Total integrated risk must meet integrated goals
 - Includes AOOs, DBEs, BDBEs now defined objectively by PRA frequency results

Objectives (Cont'd)

- Classify Structures, Systems, and Components (SSCs)
 - Paper extends and makes operational concepts expressed earlier
 - SSCs selected from important risk contributors in PRA
 - Special treatment assigned based on importance to risk
- Defense in Depth (DID)
 - Operational structure for evaluation of DID
 - Uses techniques to evaluate plant capabilities and programmatic controls
 - No reliance on a single element of design/program

ACRS Findings and Recommendations

1. Next evolution of a licensing approach in development for thirty years
2. Three objectives: select LBEs, classify SSCs, assess adequacy of DID
3. Recommend adoption of approach
4. Guidance in DG-1353 is adequate to support implementation, except source term
5. DG-1353 should be issued for comment

Population-Related Siting Considerations

Existing Regulatory Framework

- Exclusion area (EA), low population zone (LPZ), and population center distance (PCD)
- EA and LPZ boundaries set by dose limits of 25 Rem (2 hours/entire cloud)
- PCD 1.33 times the radius of the LPZ from boundary of any densely populated center >25,000 people

Existing Regulatory Framework

RG 4.17 written for large LWRs:

- A reactor should be located so, at the time of initial plant approval and within about 5 years thereafter, the population density, over any radial distance out to 20 miles does not exceed 500 persons per square mile (ppsm)
- A reactor should not be located at a site where the population density is well in excess of this value

Options Evaluated

- Option 1 – Status quo
- Option 2 – Scaling source term with power
- Option 3 – Dose-based
- Option 4 – Develop societal risk measure

Option 3 Dose-Based

New guidance in RG 4.17 for small modular reactors (SMRs) and microreactors

- Density of 500 ppsm assessed to distance equal to twice the distance at which a hypothetical individual could receive 1 rem over 1 month after hypothetical design accident
- Recommended

ACRS Findings and Recommendations

1. ACRS agrees that Option 3 is reasonable, however paper is short on implementation details
2. These details should be provided in RG 4.17 with illustrative examples

Advanced Computer Code Evaluations

We have reviewed available volumes of the Strategy 2 Report on Codes for:

- DBE Analysis (systems analysis)
- Fuel Performance Analysis
- Severe Accident Progression, Source Term, and Consequence Analysis

ACRS Findings and Recommendations

1. Approach supports readiness of NRC staff to review non-LWR reactor applications and can help staff understand new designs
2. Tools for staff confirmatory analysis should be as independent as practical and validated
3. Staff needs to become familiar with applicant codes to support timely reviews

ACRS Findings and Recommendations (Cont'd)

4. The overview report should be revised to better explain how the approach integrates the evaluations using a coherent strategy
 - Four principles should underlie the strategy: simplicity, completeness, working the problem backwards starting with source term (ST), and scaling down the level of effort as hazard decreases
5. The staff should perform pilot studies using relatively mature designs to illustrate how the analysis should proceed

Assessment of the Quality of Selected NRC Research Projects

Joy Rempe, Chair
ACRS Safety Research Subcommittee

Background

- Throughout its history, an essential ACRS activity is reviewing NRC-sponsored research
- This activity includes reviews of:
 - Research conducted in support of specific regulatory activities
 - Important ongoing agency research
 - NRC safety research program
 - The quality of specific research projects

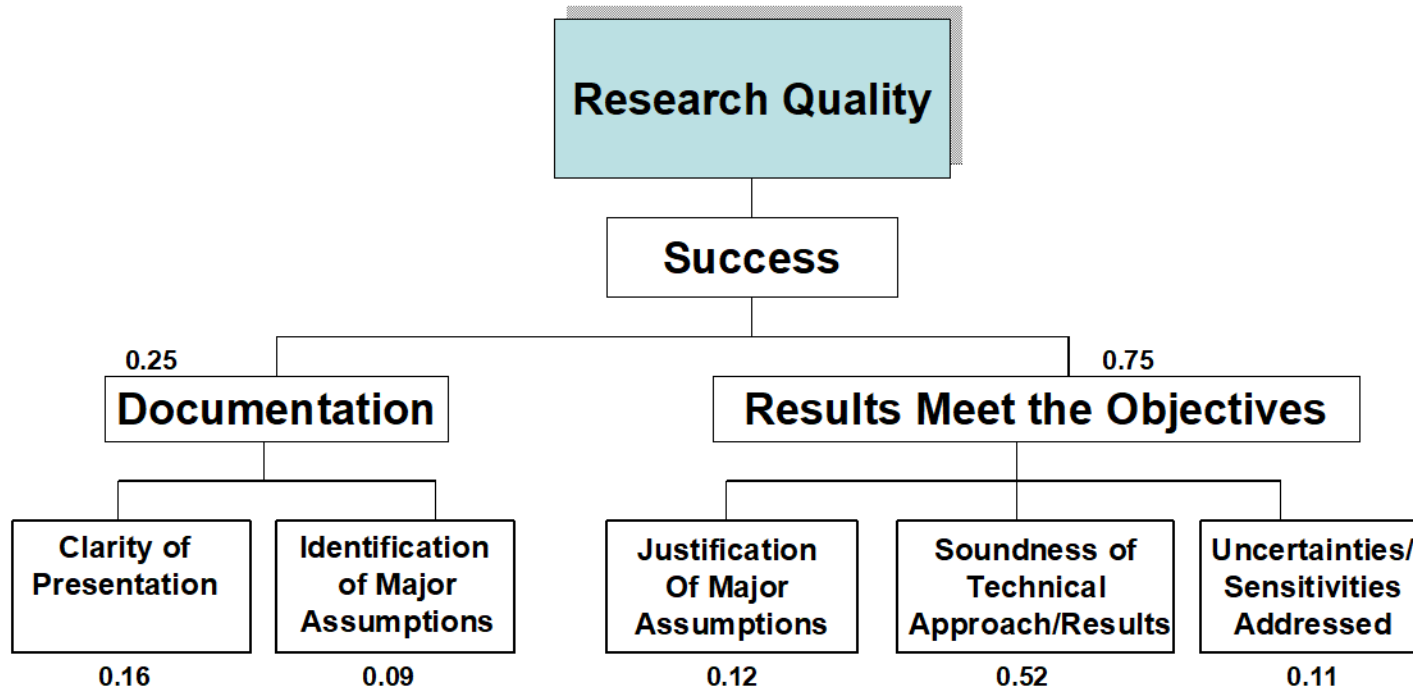
Quality Review Motivation

- Independent evaluation of quality and utility of research projects
- Conforms with Government Performance and Results Act (GPRA)

Quality Review Process

- ACRS typically selects two or three projects proposed by RES
- Three members assigned to each project to complete review
 - RES and sponsoring program office meeting
 - Present report to Full Committee
- Quality rating finalized by Full Committee

Evaluation Criteria and Scoring



- Evaluation emphasizes results meeting project objectives
- Scoring encourages improvement (e.g., “5” is satisfactory)

Quality Review Status

- 2018 review completed
 - NUREG-2218, “An International PIRT Expert Elicitation Exercise for HEAFs”
 - NUREG/CR-7237, “Correlation of Seismic Performance in Similar SSCs”
- 2019 review underway
- Alternate 2020 activity under consideration to provide more strategic input

Research Biennial Review

- 2020 Biennial Research Review underway
- Review continues to emphasize 1997 Commission direction
 - Need, scope, and balance of reactor safety research program
 - Progress of ongoing activities
 - How well RES anticipates research needs and is positioned for changing environment

Research Biennial Review (cont'd)

- Updated 2018 process provides succinct report, also emphasizing:
 - Prioritization and identification of user needs
 - Long-term planning
- Letter report to be issued in March 2020

Thank You!

Acronyms

- ACRS – Advisory Committee on Reactor Safeguards
- AOO – Anticipated Operational Occurrences
- BDBE – Beyond Design Basis Events
- DBE – Design Basis Event
- DCA – Design Certification Application
- DG – Draft Guide
- DHRS – Decay Heat Removal System
- DI&C – Digital Instrumentation and Control
- DID – Defense in Depth
- EA – Exclusion Area
- ECCS – Emergency Core Cooling System
- EDO – Executive Director for Operations
- GPRA – Government Performance and Results Act
- HEAF – High Energy Arc Fault
- LBE – Licensing Basis Event
- LMP – Licensing Modernization Project
- LPZ – Low Population Zone
- MWe – Megawatt (electric)
- MWt – Megawatt (thermal)
- NEI – Nuclear Energy Institute
- NPM – NuScale Power Module
- NPUF – Non-production and Utilization Facility
- NRC – U.S. Nuclear Regulatory Commission
- PCD – Population Center Distance
- PIRT – Phenomenon Identification and Ranking Table
- PRA – Probabilistic Risk Assessment
- PWR – Pressurized Water Reactor
- RES – Office of Nuclear Regulatory Research
- RG – Regulatory Guide
- SER – Safety Evaluation Report
- SMR – Small Modular Reactor
- SSC – Structure, System, or Component
- ST – Source Term
- TVA – Tennessee Valley Authority