

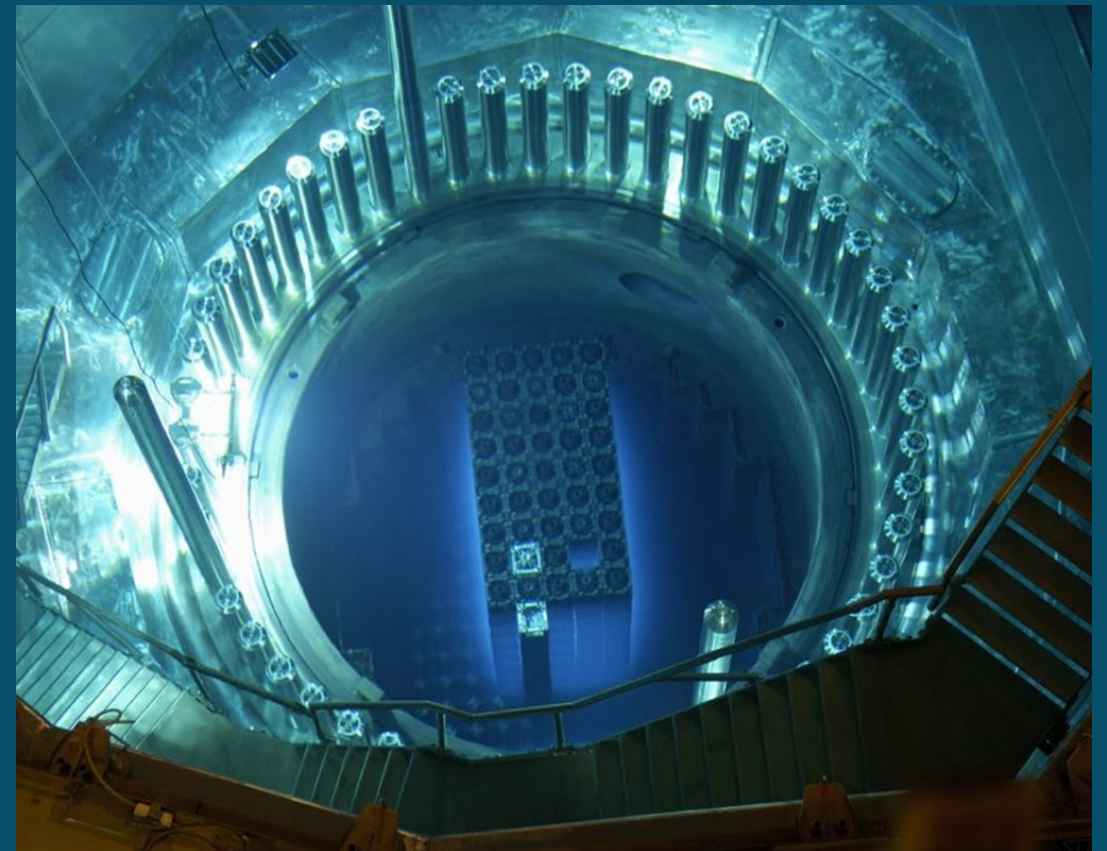
# Advisory Committee on Reactor Safeguards

## Advancing Reactor Safety Reviews for the Future

**Gregory H. Halnon**

*Chairman, ACRS*

U.S. Nuclear Regulatory Commission



# Agenda

- **Introduction and Overview**
  - Greg Halnon, Chairman
- **Insights From Recent Technical Reviews**
  - Dave Petti, Vice Chairman
- **Ongoing ACRS Reforms and Evolution of ACRS Processes**
  - Craig Harrington, Member-At-Large
- **Approach for Future Committee Operations and Engagements**
  - Greg Halnon, Chairman

# Overview

Greg Halnon



# ACRS Supports the NRC Mission

ACRS provides independent technical advice to the Commission on matters concerning reactor safety in support of the NRC's Mission to enable their safe use.

## NRC Mission Statement

*The NRC protects public health and safety and advances the nation's common defense and security by enabling the safe and secure use and deployment of civilian nuclear energy technologies and radioactive materials through efficient and reliable licensing, oversight, and regulation for the benefit of society and the environment. (January 2025)*

# ACRS Letter Reports

## Finalized Proposed Reactor Facilities

### Applications

- Kairos Hermes 2 CP
- NuScale SDA
- TerraPower Sodium Reactor at the Kemmerer Power Station CP

### In-Progress (active) Applications

- Clinch River BWRX-300 CP
- Long Mott X-energy CP

## Proposed Reactor Facilities

### Pre-Application

- TerraPower Sodium Topical Reports:
  - Principal Design Criteria
  - Fuel and Control Assembly Qualification
  - Emergency Planning Zone and Radiological Source Term Methodology
- Terrestrial Energy Principal Design Criteria Topical Report
- X-energy, LLC's, Xe-100 Mechanistic Source Term Topical Report

# ACRS Letter Reports (Cont.)

## Existing Reactor Facilities: Commission Referral to ACRS

- Safety Aspects Of The Reauthorization Of Power Operations For The Palisades Nuclear Plant
- Safety Aspects of the Alkali Silica Reaction Phenomenon at the Seabrook Nuclear Power Station

# ACRS Letter Reports (Cont.)

## Proposed Reactor Safety Standards

- Increased Enrichment Draft Proposed Rule Language
- Draft Safety Evaluation For Topical Report PWROG-18068-NP, “Use Of Direct Fracture Toughness For Evaluation Of Reactor Pressure Vessel Integrity”
- Electric Power Research Institute Topical Report, “Loss-of-Coolant-Accident-Induced Fuel Fragmentation, Relocation and Dispersal with Leak-Before-Break Credit: Alternative Licensing Strategy”
- Proposed Rulemaking on Licensing Requirements for Microreactors and Other Reactors with Comparable Risk Profiles (10 CFR Part 57)

# ACRS Letter Reports (Cont.)

## Other Letter Reports

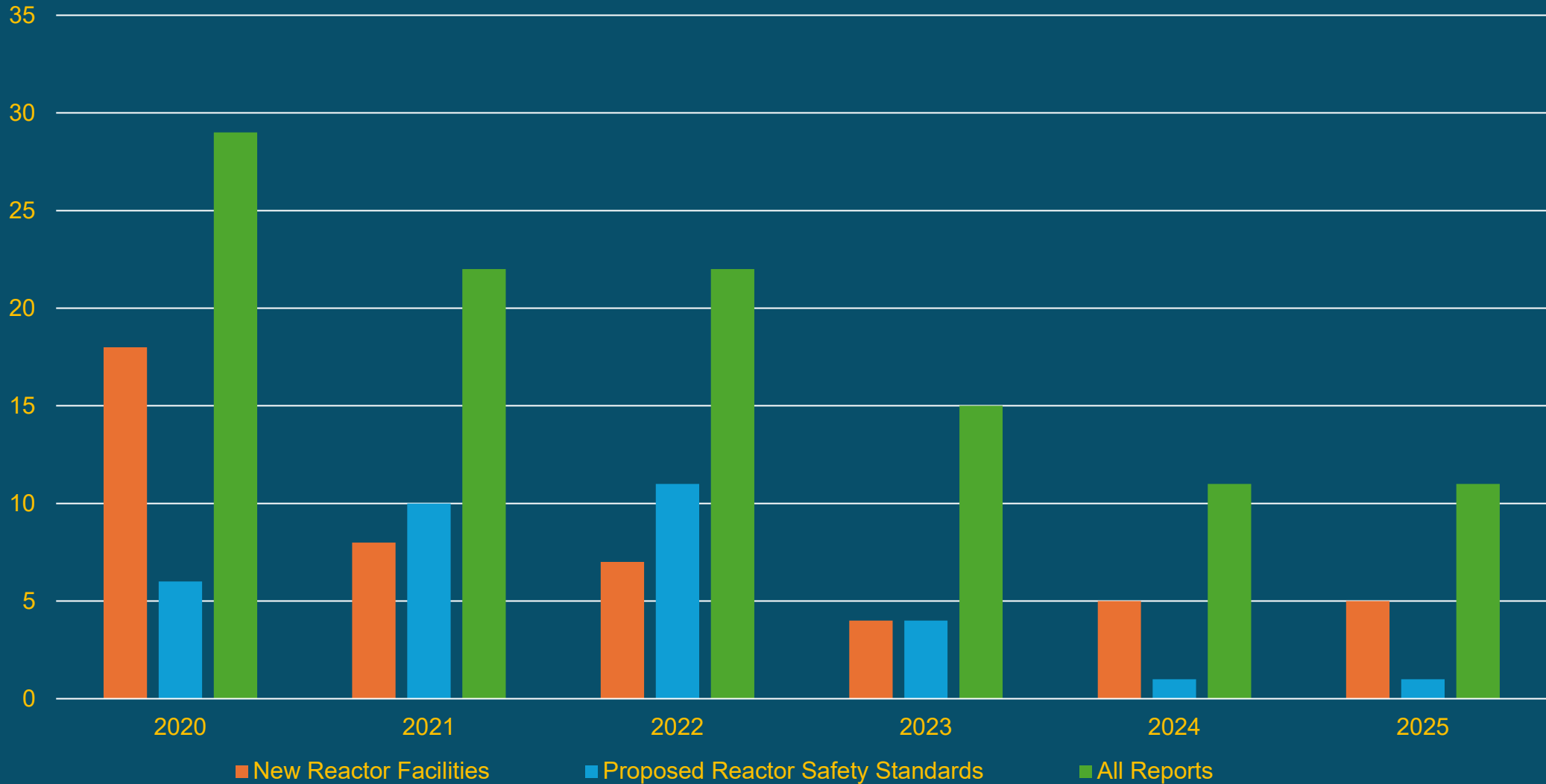
(Issued Prior to Executive Order (EO) 14300)

- Triennial Review and Evaluation of the Safety Research Program in the Office of Nuclear Regulatory Research
- V.C. Summer Subsequent License Renewal Application
- Regulatory Guide 3.78, Rev. 0, Acceptable ASME Section XI Inservice Inspection Code Cases for 10  
*Code of Federal Regulations Part 72*

# ACRS Continuous Improvement Culture

- Letter Report issued on Lessons Learned from ACRS Reviews of New Reactor Applications
  - Reinforcing a ***Culture of Continuous Improvement***
    - Developed New Reactor Design Center Review Guidance in 2024
    - Held numerous, self-reflective internal retreats
  - In 2025 – continued improvements, aligned with EO 14300
    - Expertise Matrix and Succession Plan for skillsets required for a complete Committee review
    - Reformed Subcommittee structure
    - Refined New Reactor Design Center Review Guidance
  - In 2026 – continued refinements in anticipation of high volume
    - Embraced EO 14300 platform as a “One-Team” effort of the Agency
    - Leadership Model to align on core vision and values
    - Reformatted Sharepoint site for efficiency

# ACRS Letter Reports



# ACRS Supports the NRC Mission

- Technical Lessons-Learned
  - Safety-Case
  - Licensing Review Process and Noteworthy Practices
  - Specific-Technical Impacts
- Process Lessons-Learned
  - Approach to New Reactor Reviews
  - Expectations for Members
    - Transparency for Applicant and Staff
  - Assessment of Effectiveness

# Insights From Recent Technical Reviews

Dave Petti



# Purpose

- Reflect on lessons learned from recent ACRS reviews of new reactor applications
- Ensure ACRS continues to meet its **statutory responsibilities**
- Enable **safe, timely, and efficient deployment** of nuclear energy
- Reinforce NRC's leadership and reputation in nuclear safety

# Context

- **Advanced Reactor Reviews**
  - **Completed reviews**
    - NuScale US600 DCA and US460 SDA
    - Kairos Hermes & Hermes 2 CPs
    - Kemmerer TerraPower Sodium CP
  - **Ongoing reviews**
    - Long Mott X-energy Xe-100 CP
    - Clinch River GVH BWRX-300 CP
    - **Pre-application topical reports** from additional vendors
- **Evolving Policy Direction**
  - ADVANCE Act
  - Executive Order 14300
  - Commission direction on review efficiency and focus

# Key Observations

ACRS reviews have become more **safety-focused, streamlined, and efficient**

Our integrated safety-case reviews complement staff compliance-based reviews

Parallel reviews enable **on-schedule or early completion**

Application quality strongly affects review efficiency

Detailed topical reports are critical for unique technologies

# Evolution of ACRS Review Approach

- **Continuous improvement since the NuScale DCA**
- **Accelerated by:**
  - ADVANCE Act
  - EO 14300
  - Commission direction
- **Increased focus on safety-significant features that are:**
  - Unique
  - Novel
  - Noteworthy

# Organization of Lessons Learned

- **Lessons are grouped into three areas:**
  - Safety Case Development
  - Licensing Review Process
  - Technology-Specific Impacts on Safety Review
- **Results presented generically without referencing a specific applicant or staff safety evaluation**

# Safety Case Development

- **Transparency and Safety Margins**
  - Safety case should be:
    - Clear
    - Complete
    - Transparent to reviewers and the public
  - Should explicitly identify:
    - Safety margins
    - Uncertainties
    - Compensatory measures for limited operating experience
- **Departures from Precedent**
  - Major departures from historical approaches require:
    - Early explanation
    - Strong technical justification
  - Early clarity improves overall licensing efficiency and reduces licensing risk

# Safety Case Development (cont.) (2)

- **Our Integrated Review Strategy**
  - Top-down safety function review
  - Bottom-up evaluation of:
    - New fuels, coolants and materials
    - New configurations
  - Enables:
    - Holistic safety assessment
    - Significant resource savings
    - Especially important for advanced reactors
- **Diverse Approach Complements Staff's Review**
- **Principal Design Criteria**
  - Inadequate justification for modifying or deleting Principal Design Criteria:
    - Weakens defense-in-depth
    - Increases accident risk
  - Particularly concerning for designs with limited data or experience

# Licensing Review Process

- **Construction Permit vs. Operating License**
  - CP applications may lack detailed analyses
  - Technical burden shifts to OL stage
  - First-of-a-Kind OL reviews:
    - More technically intense than CP reviews
    - May require more resources
- **Pre-Application Engagement**
  - Effective early engagement is essential
  - Reduces licensing risk
  - Technically complete topical reports add value
  - Concept-only or idea/plan-focused topical reports:
    - Lead to inefficiencies
    - Consume limited staff and ACRS resources

# Licensing Review Process (cont.)

- **TICAP / ARCAP Applications**
  - Applications should incorporate results from:
    - Hazards analyses
    - Accident analyses
  - Reliance on subsidiary documents:
    - Increases audit burden
    - Obscures safety margins
  - Timely access to audit results supports parallel ACRS review
- **Importance of Application Quality**
  - Significant variability in:
    - Technical depth
    - Completeness
  - High quality applications:
    - Enable streamlined reviews
  - Reduce burden on staff and ACRS

# Licensing Review Process: Noteworthy Practices

- **Risk-Informed Licensing Modernization Project Approach**
  - Focuses on risk-significant structures, systems and components
- **‘Delta’ Reviews – Nth-of-a-kind**
  - Efficient for evolutionary designs
- **Red-Line Preliminary Safety Analysis Report comparisons**
  - Rapid identification of safety impacts
- **Lines of Defense Methodology: A Structured Safety Approach**
  - Has the potential to support:
    - Adequacy of safety function integration
    - Defense-in-depth evaluation
    - Residual risk and cliff-edge assessment
    - PRA completeness confirmation

# Technology Specific Impacts

- **Need for Experimental Confirmation**
  - Computational tools alone are insufficient
  - CP documentation of required research and development is essential
  - Some safety attributes require:
    - Startup testing
    - Operational data
- **Technology Matters**
  - Different technologies have different safety concerns:
    - Liquid metal: reactivity and fire risks
    - Molten salts: REDOX control and freezing
    - Gas reactors: material performance
  - Direct application of light-water reactor guidance may be inefficient

# Technology Specific Impacts: Adapting Regulatory Guidance

- Applying the *Intent* of Guidance
  - Example: RG 1.203
    - Framework is useful
    - Details must be **adapted** not adopted
  - When establishing adequate protection determination focus should remain on:
    - Fundamental safety functions
    - Safety margins
    - Technology-specific risk drivers

# Final Thoughts

- **ACRS Commitment to You in Our Letter Reports**
  - Outline key safety issues
  - Timely, evidence-based recommendations
    - Thorough, technically sound explanations
    - Focused on safety, rigor and completeness of licensing action
  - Consensus and advice of experts
  - Clear, well-structured reports
- **Enduring Role of the ACRS**
  - Advanced reactors present new but familiar challenges
  - Safety remains our highest priority

# Ongoing ACRS Reforms and Evolution of ACRS Processes

Craig Harrington



# Ongoing ACRS Reforms

- Focusing on Statutory Obligations Regarding Safety

# Focus on Statutory Obligations Regarding Safety

## Actions Taken to Implement Commission Direction on EO 14300

- June 2025 refocused scope of ACRS reviews per EO direction
- Restructured Committee membership to maintain a balanced core expertise
- Revised ACRS Subcommittee structure
- Recently revised Bylaws
- 2026 ACRS Operating Plan
- Highlight refocused scope during all public meetings
- Updated web pages and developing online tools
- Issue Review Checklist – screening guidance
- Design Center Review Guidance - for ACRS meeting content
- **Pending Revisions in Fall 2026**
  - **ACRS Charter**
  - **ACRS-EDO MOU**

# Evolution of ACRS Processes

- Screening of Unique, Novel, or Noteworthy Issues (UNN)
- Diverse and Independent Reviews
- Progress on Design Center Reviews

# Screening of Unique, Novel, or Noteworthy Issues

- **Issue Review Checklist**
  - “Review/No Review” screening criteria for statutory obligations and then UNN elements
  - Flowchart link on webpage for external stakeholders
- **Screening Process**
  - Items considered for ACRS review
    - Licensing Actions, Topical Reports, Safety Standards
  - Review scope
  - Meeting planning – agenda topics
- **UNN Focus for Design Center reviews**
  - Design Center Review Guidance
  - Design-specific UNN assessment process

# Diverse and Independent Reviews

- Focus on **Safety Case** adequacy
  - Fundamental Safety Functions
    - Control of Heat Generation
    - Control of Heat Removal
    - Retention of Radionuclides
  - Defense In Depth
  - UNN elements emphasized
- Diverse approach from the structured aspects of staff review
- Consistent with statutory obligations focus
- Efficient use of ACRS, NRC staff and applicant time

# Progress on Design Center Reviews

- **Previous Reviews (through recent NuScale SDA)**
  - Reviewed each Preliminary Safety Analysis Report/Final Safety Analysis Report chapter
  - Involved multiple applicant/staff meetings to cover all chapters
  - Scheduled generally around availability of final SER with no open items
- **Current Reviews**
  - Review the Safety Case
    - Early identification of questions/safety issues
  - Focus on UNN elements thereof
  - Significant reduction in applicant and staff meetings
  - Parallel with Staff review

# Progress on Design Center Reviews

<b>Design</b>	<b>NuScale DCA 2016 – Final Letter 2020</b>	<b>NuScale SDA 2025 – Final Letter 2025</b>	<b>Kairos Hermes (1) – First-of-a-Kind for CP 2023</b>	<b>Kairos Hermes (2) – Nth-of-a-Kind Like for CP 2024</b>	<b>TerraPower Natrium Kemmerer – Final Letter 2025</b>
<b>Subcommittee</b>	20	11	12	3	5
<b>Full Committee</b>	20	1	7	1	1
<b>Total Meeting Days</b>	40	12	19	4	6
<b>Review Approach</b>	Chapter-by- Chapter	Chapters & Incremental	Chapter-by- Chapter	Incremental	Transition to “Safety Case”

## Recent Past Reactor Design Reviews

# Progress on Design Center Reviews

- **Elements of Current Process**

- *Design Center Review Guidance* posted
- Lead member initiates review in parallel with staff
- Design-specific UNN Assessment
- Early Staff Engagement - UNN List
- Applicant public meeting(s) - scheduling and content coordination
- Staff public meeting(s) - Safety Evaluation Report with No Open Items
- ACRS full committee meeting - finalize letter

# Summary

- **Documentation and process reforms focusing on statutory obligations regarding safety are nearing completion**
- **Broad revision of ACRS processes is complete**
- **Opportunities for further process improvement will continue to be explored**

# Approach for Future Committee Operations

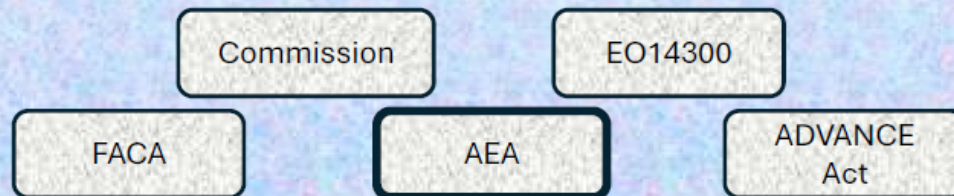
Greg Halnon



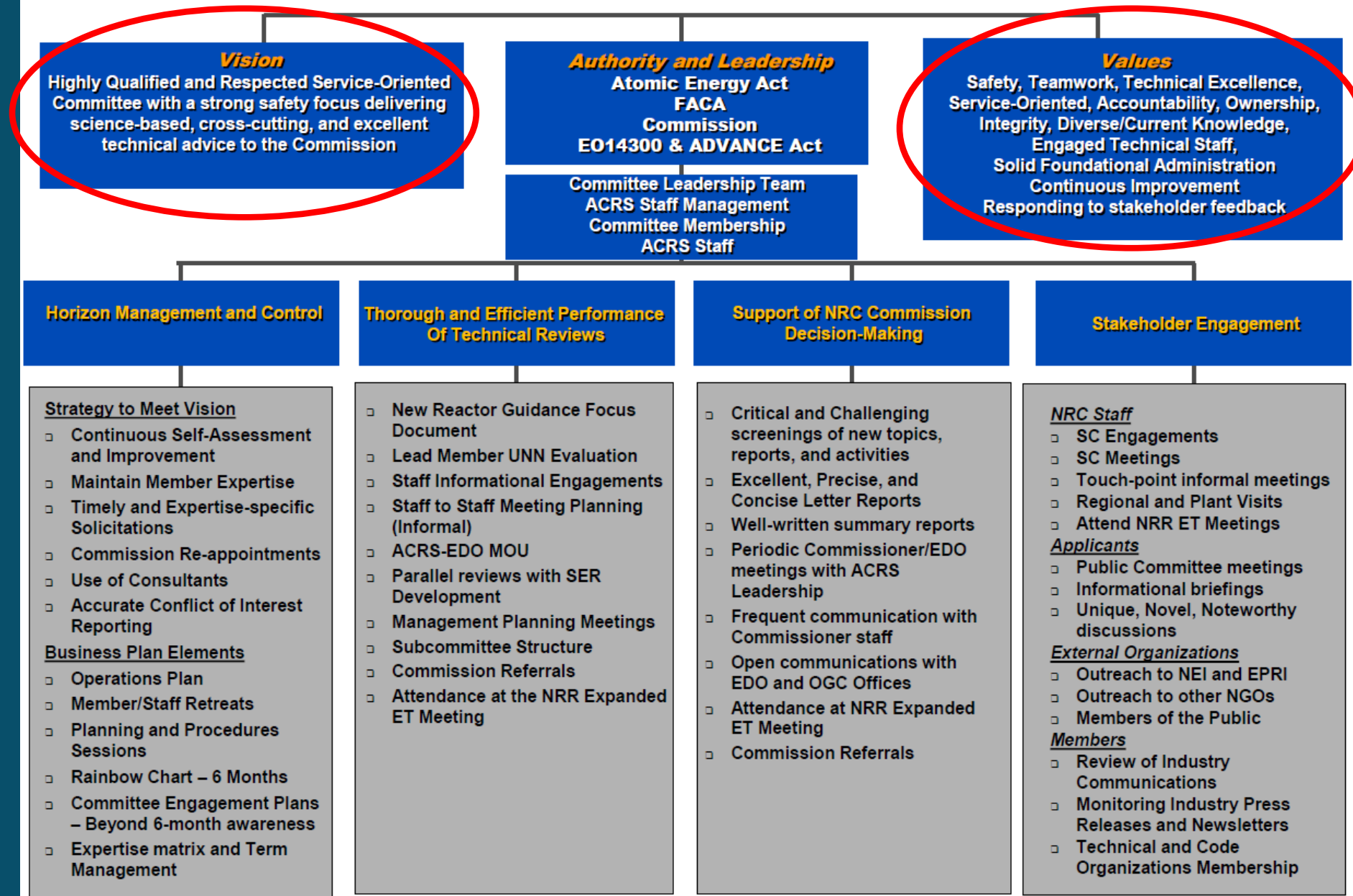
# ACRS Leadership Model



Advisory Committee On Reactor Safeguards



# ACRS Leadership Model



# Summary

- Focus on safety significant issues in applications and regulatory matters focused on unique, novel or noteworthy issues to enable safe, timely, and efficient deployment of nuclear energy
- ACRS Subcommittee structure and assignments aligned to statutory functions and anticipated workload
- Continue to adapt and stay prepared to conduct effective reviews of advanced reactor applications, proposed reactor safety standards and plant operations while keeping the public informed
- Objective is to provide efficient reviews and timely advice to the Commission with a “One-Team” result to support the NRC’s mission

## For More Information About ACRS



<https://www.nrc.gov/about-nrc/regulatory/advisory/acrs.html>

# List of Acronyms

ACRS	Advisory Committee on Reactor Safeguards	NGO	Non-Governmental Organization
AEA	Atomic Energy Act	NRC	Nuclear Regulatory Commission
ARCAP	Advanced Reactor Content of Application Project	MOU	Memorandum of Understanding
CP	Construction Permit	OGC	Office of General Counsel
DCA	Design Certification Application	OL	Operating License
EDO	Executive Director for Operations	PRA	Probabilistic Risk Assessment
EO	Executive Order	RG	Regulatory Guide
EPRI	Electric Power Research Institute	SC	Subcommittee
ET	Executive Team	SDA	Standard Design Approval
FACA	Federal Advisory Committee Act	SER	Safety Evaluation Report
GVH	GE Vernova Hitachi Nuclear Energy	TICAP	Technology-Inclusive Content of Application Project
LLC	Limited Liability Company	REDOX	Oxidation-Reduction Reactions
NEI	Nuclear Energy Institute	UNN	Unique, Novel, and Noteworthy