



ACRS MEETING WITH THE U.S. NUCLEAR REGULATORY COMMISSION

June 6, 2011



Overview

Said Abdel-Khalik

Events at Fukushima

- **ACRS has been actively engaged on event follow-up and discussion of lessons-learned and recommendations for appropriate follow-up actions for NRC**
- **ACRS Fukushima Subcommittee has been formed**

Events at Fukushima (cont.)

- **ACRS has received briefings from NRC staff and other stakeholders and plans to hold additional Subcommittee meetings**
 - **Overview on April 7, 2011**
 - **Near term review on May 26, 2011**
 - **Additional briefings to be scheduled**
- **ACRS report to the Commission on staff's Lessons-Learned report**
 - **Prior to February 28, 2012**

Accomplishments

- **Since our last meeting with the Commission on November 5, 2010, we issued 32 Reports:**
- **Topics:**
 - **Current State of Licensee Efforts to Transition to NFPA-805**
 - **Comparison of ISA and PRA for Fuel Cycle Facilities**
 - **Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews**

- **Topics (cont.):**
 - **AP1000**
 - **Design Certification Amendment Application**
 - **Long-Term Core Cooling**
 - **Aircraft Impact Assessment**
 - **Vogtle Units 3 & 4 Reference COLA**
 - **VC Summer Unit 2 &3 Subsequent COLA**

- **Topics (cont.):**
 - **Use of CAP in Analyzing ECCS and Containment Heat Removal System Pump Performance in Postulated Accidents**
 - **Emergency Planning Rule and Related Regulatory Guidance**
 - **Safety Culture Policy Statement**
 - **SRP for Renewal of Spent Fuel Dry Cask Storage Licenses and Certificates of Compliance**

- **Topics (cont.):**
 - **Point Beach Extended Power Uprate**
 - **RAMONA5-FA Code for Use in BWR Stability Calculations**
 - **Revisions to Generic License Renewal Guidance Documents**
 - **Final SERs Associated with the License Renewal Applications for:**
 - **Palo Verde Nuclear Station**
 - **Kewaunee Power Station**
 - **Salem Nuclear Generating Station**

- **Topics (cont.):**
 - **SER Related to the Calvert Cliffs COLA Referencing the EPR Design**
 - **Response to EDO Regarding Closure of DAC for New Reactors**
 - **Quality Assessment of Selected NRC Research Projects**
 - **Advanced Reactor Research Plan**
 - **Groundwater Protection Task Force Efforts**
 - **Human Factors Considerations Associated with Emerging Technologies**

- **Topics (Cont.):**
 - **Regulatory Guides**
 - **RG 1.174, An Approach for Using PRA in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis**
 - **RG 1.177, An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications**
 - **RG 1.152, Criteria for the Use of Computers in Safety Systems of Nuclear Power Plants**

- **Topics (Cont.):**
 - **Regulatory Guides**
 - **RG 1.34, Control of Electroslag Weld Properties**
 - **RG 1.43, Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components**
 - **RG 1.44, Control of the Processing and Use of Stainless Steel**
 - **RG 1.50, Control of Preheat Temperature for Welding of Low-Alloy Steel**

New Plant Activities

- **Reviewing:**
 - **DC applications and SERs associated with the U.S. EPR and U.S. APWR designs**
 - **Adequacy of Long-Term Core Cooling Approach for the ABWR**
 - **Reference COLAs for ABWR, ESBWR, U.S.-APWR, and U.S. EPR**
 - **Subsequent COLAs for AP1000**
- **Continuing to complete reviews of available material promptly**

License Renewal

- **Interim reviews performed for Diablo Canyon and Crystal River**
- **Will perform interim reviews of Seabrook and Columbia in CY 2011**

Power Upgrades

- **Will review the Turkey Point, Nine Mile Point, Grand Gulf, and Monticello Extended Power Upgrade Applications**
- **Will review Supplements to NEDC-33173P-A, “Applicability of GE Methods to Extended Operating Domains”**

Other Ongoing/Future Activities

- **SOARCA**
- **Watts Bar 2**
- **Digital I&C**
- **10 CFR 50.46(b)**
- **Small Modular Reactors**
- **Revision to the Construction Reactor Oversight Process Assessment Program**
- **Blending of Low-Level Radioactive Waste**
- **Emerging technical issues**



**Current State of Licensee
Efforts to Transition to
National Fire Protection
Association (NFPA)
Standard 805**

John W. Stetkar

10 CFR 50.48(c)

- **Issued in 2004, allows licensees to adopt and maintain a risk-informed, performance-based Fire Protection Program that meets the requirements of NFPA Standard 805 (2001 Edition)**
- **Alternative to 10 CFR 50.48(b) or the plant-specific fire protection license conditions**

June 25, 2010 SRM

- **The ACRS should conduct a review and report back to the Commission on the current state of licensee efforts to transition to NFPA Standard 805**
- **The review should include methodological and other issues that may be impeding the transition process, lessons learned from the pilot projects, and recommendations to address any issues identified**

June 25, 2010 SRM

- **The review should determine whether the level of conservatism of the methodology is appropriate and whether any adjustments should be considered**

Pilot Plant License Amendments

- **Shearon Harris request submitted May 2008; final safety evaluation issued June 2010**
- **Oconee request submitted May 2008, revised April 2010; final safety evaluation issued December 2010**

ACRS Review of Transition

- **Consultant interviewed industry fire PRA practitioners and NRC staff**
- **Reliability and PRA Subcommittee met in November and December 2010**
- **Committee completed review during February 2011 meeting**
- **February 17, 2011 report**

NUREG/CR-6850; EPRI 1011989

- **Provides a sound technical basis for the development of fire PRA models and analyses to support the transition to NFPA 805**
- **Focused departures from general guidance will be necessary to address some plant-specific issues**
- **Staff has accepted departures with adequate technical justification**

Baseline Fire PRA for Transition

- **Simplified models and bounding values often used for screening**
- **Best estimate models and values used for refinements**
- **Supports determination of assurance that overall safety will be maintained under risk-informed framework**
- **Baseline fire PRA may retain conservative simplifications and assumptions**

Post-Transition Applications

- **Excessive PRA conservatism may affect quality of decisions for post-transition risk-informed applications**
- **Especially important for licensee self-approved changes**
- **Further refinements of models and data needed for more realistic estimates of absolute risk and relative contributors**

Analytical Conservatism Sources

- **Arbitrary unilateral decisions and inflexible guidance: not evident from our reviews**
- **Maturity of current state-of-the-practice methods: enhanced methods in NUREG/CR-6850; all PRA methods continue to evolve**
- **Analysts' choices regarding applied PRA refinements: plant-specific decisions**

Numerical Conservatism

Sources

- **Systematic bias in parametric values: conservatism may be introduced by interpretation and application of limited test data**
- **Large uncertainties: do not represent "conservatism" if the uncertainties accurately account for our current state of knowledge**

Quantification of Uncertainties

- **Uncertainties are not quantified in the pilot plant PRAs or in-progress "mature" studies**
- **Uncertainties should be quantified consistently with current methods and guidance**
- **Understanding of perceived conservatism and its sources**
- **Characterization of post-transition risk-informed changes**

Overall Plant Risk Profile

- **Fire and internal events PRA results should be combined**
- **Understanding of contributors to overall plant risk profile**
- **Post-transition analyses should compare changes to risk from fires and internal events**
- **Risk-informed decisions should consider context of proposed change and PRA analyses**

Sequential Submittal Schedule

- **The staff should consider a firm schedule for sequential submittals of license amendment requests for transition consistent with the industry target of June 2012**
 - **Fully incorporate lessons learned from pilot projects**
 - **Time for industry peer reviews and issue resolutions**
 - **Improved technical quality of subsequent submittals**
 - **Improved staff reviews of plant-specific technical issues**

Departures from NUREG/CR-6850

- **Industry peer reviews are effective, but schedules are limited by number of technically qualified independent experts**
- **Encourage active engagement of industry senior technical review group**
- **Timely staff communications of technical positions with generic applicability**

Fire Events Database

- **Careful treatment of most recent operating experience**
- **Explicitly account for plant-to-plant variability as a contributor to uncertainties**
- **Expedite data for "component-level" fire frequencies**
- **Caution that supplemental data may not significantly reduce overall fire risk estimates**

Electrical Cabinet Fires

- **Typically most important contribution to fire risk**
- **Propagation to nearby cables**
- **Risk is determined by location-specific fire hazards, geometry, cables, and circuits**
- **Realistic analyses of fire ignition, growth, detection, and suppression are complex**

Electrical Cabinet Fires

- **NUREG/CR-6850 defines one general category of "electrical cabinets"**
- **Approach is retained in near-term research activities**
- **Cabinets should be divided into functional subgroups**
- **Facilitate improved treatment of fire ignition frequencies, potential fire severities, and risk from plant-specific locations**

Interesting Observations

- **Limited use of fire models for post-ignition growth, severity, and propagation**
- **Reliance on parametric values in NUREG/CR-6850 and simplified empirical correlations**
- **Limited test data to support more detailed analyses (e.g., heat release rates)**
- **Limited location-specific details**

Interesting Observations

- **Multiple spurious operations ("hot shorts") are often important to risk, but were not identified as a significant impediment to NFPA 805 transition**
- **Comparable effort is required for cable identification and circuit analysis for compliance with 10 CFR 50.48(b)**



AP1000 Design Certification Amendment, Reference COLA, and Subsequent COLA

Harold B. Ray

ACRS Reports Issued

- **AP1000 Design Certification Amendment (DCA) – December 2010**
- **AP1000 Long-Term Core Cooling – December 2010**
- **AP1000 Aircraft Impact Assessment – January 2011**
- **Vogtle Units 3&4 Reference COLA – January 2011**
- **V. C. Summer Units 2&3 Subsequent COLA – February 2011**

18-Month Review Period

- **Both staff and applicants committed to supportive and responsive interaction with ACRS**
- **Reference COLA initially Bellefonte – Revised to Vogtle by design center during review**
- **Initially parallel review process changed to priority-based review**
- **Scheduling flexibility by all concerned essential to success**

DCA Review Process

- **Definition of changes is vital to effective ACRS review**
- **Chapter-by-chapter review of text revisions makes change definition very difficult where many changes are being made**
- **Late-submitted changes were reviewed individually- not as chapter-by-chapter text revisions**
- **Chapter-by-chapter staff reviews and ACRS review of individual changes would require more time**

Parallel DCA and COLA Reviews

- **ACRS established review priorities placing DCA ahead of Reference COLA and then Subsequent COLA**
- **The design center greatly facilitated management of reviews during the evolving process**
- **COLAs required revisions following ACRS review to reflect finalized DCA**

Conclusions

- **Changes to certified designs should be presented to ACRS as individual changes, rather than revisions to affected text on a chapter-by-chapter basis**
- **COLAs referencing an amended certified design should be reviewed after the DCA review is completed**



Comparison of ISA and PRA for Fuel Cycle Facilities

Michael T. Ryan

May 12, 2010 SRM

- **Directed the staff to prepare a paper that compares ISAs for FCFs to PRA methods used for power reactors**
- **Directed that the staff provide a copy to the ACRS for review**



ACRS/ACNW Reports

- **January 14, 2002, ACNW recommended that NRC move the ISA process in the direction of quantitative risk assessment**
- **February 22, 2010, ACRS recommended that the staff continue to move FCF reviews in the direction of risk-informed regulations consistent with other Agency applications**

ISA/PRA Comparison Paper

- **Transmitted to the ACRS for review on December 15, 2010**
- **Concluded that ISAs were acceptable for meeting 10 CFR Part 70, but may need PRA approach to determine risk significance of inspection findings**

Comparison of ISA and PRA

ISA:

- **Used extensively in the chemical industry**
- **Conservative analysis**
- **Identifies:**
 - **Accident sequences**
 - **High and intermediate consequence events**
 - **Items Relied On For Safety**
 - **Management measures**

Comparison of ISA and PRA

(cont.)

PRA:

- **Used extensively by the reactor industry**
- **Realistic assessment**
- **PRA also analyzes:**
 - **Human reliability**
 - **Dependencies**
 - **Relative risk importance of contributors**

Comparison of ISA and PRA

(cont.)

Advantages of PRA:

- **Ability to rank IROFS in terms of risk importance**
- **More rigorous treatment of dependencies and human error**
- **Ability to analyze complex facilities**
- **Provides an integrated risk perspective**

Conclusions

- **Staff's comparison paper provided an exposition of the advantages and disadvantages of the use of ISA and PRA methods**
- **ISAs, in combination with practices required by current regulations, are adequate for licensing FCFs under 10 CFR Part 70**
- **PRA is advantageous because it provides a basis for prioritization of safety systems and maintenance activities**

Recommendation

- **The staff should continue to develop and test the use of focused PRA-like analyses to help assess the risk significance of inspection findings in FCFs**

Path Forward

- **Move ISA towards PRA for complex facilities with high consequences**
- **ACRS will continue to interact with the staff on cornerstones for the Fuel Cycle Oversight Process and choice of analytic methods for implementation**



Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews

Dennis C. Bley

Background

- **August 31, 2010 SRM**
 - **Integrate risk insights and develop risk-informed (R-I) licensing review plans for SMRs**
 - **Build on SMR and NGNP review insights and NUREG-1860 to develop a new R-I licensing framework for the longer term**
 - **Identify resolution strategies for policy issues**
- **SECY-11-0024 Risk Insights in SMR reviews**
 - **R-I framework for iPWR reviews**
 - **R-I design-specific review plans for each iPWR**
 - **New R-I regulatory framework**

Proposed Staff Approach-iPWRs

- **Developed R-I review framework for near-term iPWR designs**
- **Develop design-specific review plans**
 - **SRP tailored to each iPWR design**



Proposed Staff Approach

- **Develop a longer term R-I performance-based (P-B) regulatory framework**
 - **pilot review iPWR design application**
 - **compare and contrast the proposed NGNP approach with NUREG-1860 principles**
 - **Compare and contrast proposed Liquid Metal Reactor (LMR) approaches with NUREG-1860 principles**
 - **Consolidate insights for R-I, P-B framework recommendation**

March 16, 2011 ACRS Letter

- **Draft framework is appropriate**
- **Design-specific iPWR review plans is crucial step**
- **Consider PIRT-like processes to guide development**
- **Longer-term approach for license review of non-LWR SMRs is the logical extension of NUREG-1860**
- **Proposed pilot studies essential**

Additional Considerations

- **Lessons learned from recent design certification reviews**
- **Risk-informed aspects of anticipated SMR applications require more complete PRAs**
- **Bound the external events for potential sites**
- **Application in remote and harsh environments could require specialization of data and design assumptions**

Going Forward

- **Implementation of new frameworks**
- **Novel designs of some SMRs highlight need for criteria defining when experimental demonstration of predicted plant performance is needed to provide confidence in complex computer models**

Abbreviations

ABWR	Advanced Boiling Water Reactor	IROFs	Items Relied on for Safety
ACNW	Advisory Committee on Nuclear Waste	ISA	Integrated Safety Analysis
ACRS	Advisory Committee on Reactor Safeguards	I&C	Instrumentation & Control
APWR	Advanced Pressurized-water Reactor	LMR	Liquid Metal Cooled Reactor
AP1000	Advanced Passive 1000	LWR	Light Water Reactor
BWR	Boiling Water Reactor	NFPA	National Fire Protection Association
CAP	Containment Accident Pressure	NGNP	Next Generation Nuclear Plant
CFR	Code of Federal Regulations	NRC	Nuclear Regulatory Commission
COLA	Combined License Application	NUREG/CR	NUREG Contractor report
CY	Calendar Year	PB	Performance based
DAC	Design Acceptance Criteria	PIRT	Phenomena Identification and Ranking Tables
DC	Design Certification	PRA	Probabilistic Risk Assessment
DCA	Design Certification Amendment	RG	Regulatory Guide
ECCS	Emergency Core Cooling System	R-I	Risk Informed
EDO	Executive Director for Operations	SECY	Secretary of Commission
EPR	Evolutionary Power Reactor	SER	Safety Evaluation Report
EPRI	Electric Power Research Institute	SMR	Small Modular Reactor
ESBWR	Economic Simplified Boiling Water Reactor	SOARCA	State-of-the-Art Reactor Consequence Analyses
FCFs	Fuel Cycle Facilities	SRM	Staff Requirements Memorandum/Memoranda
GE	General Electric	SRP	Standard Review Plan
iPWR	Integrated Pressurized Water Reactors		