



# **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

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