ACRS MEETING WITH THE U.S. NUCLEAR REGULATORY COMMISSION

June 7, 2012

United States Nuclear Regulatory Commission

Protecting People and the Environment

Overview

Sam Armijo

Accomplishments

- **Since our last meeting with the Commission on November 29, 2011, we issued 21 Reports.**

- **Topics:**
  - **Spent Fuel Pool Scoping Study**
  - **Draft 10 CFR 50.54(f) Letter on Implementation of the Near-Term Task Force Recommendations from the Fukushima Daiichi Event**

- **Topics (cont.):**
  - **Response to February 27, 2012 Letter Regarding Final Disposition of Fukushima-Related ACRS Recommendations in Letters dated October 13, 2011 and November 8, 2011**
  - **ACRS Review of Proposed Orders in Response to Fukushima Lessons Learned (SECY-12-0025)**

- **Topics (cont.):**
  - **State-of-the-Art Reactor Consequence Analyses (SOARCA) Project**
  - **Review and Evaluation of the NRC Safety Research Program, NUREG-1635, Volume 10**
  - **Report on the Safety Aspects of the Progress Energy Florida, Inc. Combined License Application for Levy Nuclear Plant, Units 1 and 2**

- **Topics (cont.):**
  - **Response to the January 24, 2012, EDO Letter Regarding the Progress Energy Florida Combined License Application for Levy Nuclear Plant, Units 1 and 2**
  - **Chapters 6, 7, 15, and 18 of the Safety Evaluation Report with Open Items Associated with the Calvert Cliffs Nuclear Power Plant, Unit 3, Combined License Application**

- **Topics (cont.):**
  - **Chapters 3, 9, 14, and 19 of the Safety Evaluation Report with Open Items Associated with the U.S. EPR Design Certification Application**
  - **Chapters 6, 7, 11, 13, 15, 16, and 18 of the Safety Evaluation Report with Open Items Associated with the U.S. Evolutionary Power Reactor Design Certification Application**

- **Topics (cont.):**
  - **Final Safety Evaluation Report Associated with the Florida Power and Light Turkey Point Nuclear Plant, Units 3 and 4, License Amendment Request for an Extended Power Uprate**
  - **Report on the Safety Aspects of the License Renewal Application for the Columbia Generating Station**

- **Topics (cont.):**
  - **Proposed Draft Rule for 10 CFR 50.46c,"Emergency Core Cooling System Performance During Loss-of-Coolant Accidents"**
  - **Extremely Low Probability of Rupture Project**
  - **Draft Final NUREG-1921,"EPRI-NRC Fire Human Reliability Analysis Guidelines"**

- **Topics (cont.):**
  - **Proposed Requirements for ITAAC Maintenance and Draft Final Regulatory Guide 1.215,"Guidance for ITAAC Closure Under 10 CFR Part 52"**
  - **Revised Branch Technical Position on Concentration Averaging and Encapsulation of Low-Level Radioactive Waste**

- **Topics (cont.):**
  - **Draft Final Revision 1 to Regulatory Guide 1.93,"Availability of Electric Power Sources"**
  - **Draft Commission Paper,"Risk-Informed Regulatory Framework for New Reactors"**

- **Topics (cont.):**
  - **Response to the October 28, 2011, EDO Letter Regarding the ACRS Recommendations on Topical Report NEDC-33173P, Supplement 2, Parts 1, 2, and 3,"Analysis of Gamma Scan Data and Removal of Safety Limit Critical Power Ratio (SLMCPR) Margin"**

New Plant Activities

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

Future License Renewal Activities

- **Interim and final reviews to be performed for Seabrook, South Texas, Limerick, Davis Besse, Callaway, Diablo Canyon, and Crystal River**

Future Power Uprate Activities

- **Will review the Grand Gulf; St. Lucie 1 & 2; Crystal River 3; Browns Ferry 1, 2, & 3; and Monticello Extended Power Uprate Applications**

Other Ongoing/Future Activities

- Fukushima Longer-Term Reviews
- Uncertainties in PRA
- Watts Bar 2
- Fire Modeling Applications
- Extended Spent Fuel Storage and Transportation
- PWR Sump Strainer Blockage
- Revision to the Construction Reactor Oversight Process Assessment Program
- Revision of 10 CFR Part 20 Based on ICRP Recommendations
- Level 3 PRA
- NFPA 805 License Amendment Requests
- SMR Regulatory Guidance
- Other Emerging Technical Issues

Spent Fuel Pool Scoping Study (SFPSS)

Sam Armijo

Background

- **Spent fuel pool (SFP) safety addressed in prior NRC studies**
- **Frequency of events leading to significant damage to the pool and uncovery of the fuel is low**
- **Consequences would be large due to fuel overheating, failure, and uncontained release of fission products**

Background (cont.)

- **The SFPSS will update SFP beyond-design-basis accident (BDBA) consequence estimates**
- **Will reexamine the potential advantages associated with expedited transfer of older fuel stored in SFPs to dry cask storage**

Background (cont.)

- **Past SFP risk studies indicate that seismic hazard is the most prominent contributor to SFP fuel uncovery**
- **Two conditions to be considered:**
  - **high-density loading and a relatively full SFP**
  - **low-density loading following transfer of older fuel to a dry cask storage**

Background (cont.)

The study addresses key questions and provides insights on:

- **Accident progression**
- **Seismically induced station blackout scenarios**
- **Public health effects**
- **Post event mitigation**

ACRS Letter

- **The SFPSS:**
  - **Is organized, systematic, and is using modern NRC codes**
  - **Consists of a detailed deterministic analysis of the consequences of a severe seismic event on a BWR spent fuel pool**
  - **Will contribute to the technical basis for decision making regarding expedited transfer**

Supporting Observations

- **Elements of the study include:**
  - **Detailed assessments of pool and liner structural integrity following severe seismic events (up to six times the site SSE)**
  - **Analysis of reactor building dose rates using the SCALE code package**

Supporting Observations (cont.)

- Elements of the study include (cont.)
  - Accident progression analyses of fuel damage, fission product release and benefits of mitigation using the MELCOR code
  - Emergency planning assessment

Supporting Observations (cont.)

- **Elements of the study include (cont.)**
  - **Offsite consequence analyses of health effects and land contamination using the MACCS2 code**
  - **Probabilistic considerations**

Supporting Observations (cont.)

- **The SFPSS is capable of producing quantitative assessments of the benefits of low density fuel loading**
- **Overall safety benefit will not be quantified without comparable assessment of safety consequences associated with expedited loading, transfer, and long term dry storage**

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Implementation of Fukushima Recommendations

Stephen P. Schultz

Recent ACRS Reports on Fukushima

- February 15, 2012
  - Draft 10 CFR 50.54(f) Letter on Implementation of the NTTF Recommendations from the Fukushima Daiichi Event
- March 13, 2012
  - Response to February 27, 2012 Letter Regarding Final Disposition of Fukushima-Related ACRS Recommendations in Letters Dated October 13, 2011 and November 8, 2011

Recent ACRS Reports (cont.)

- **March 14, 2012**
  - **ACRS Review of Proposed Orders in Response to Fukushima Lessons Learned (SECY-12-0025)**

ACRS Letter – February 15, 2012

- **Item in Draft 10 CFR 50.54(f) letter affects the technical scope and consistency of the requested evaluations of seismic risk:**
  - **Requested information under NTTF Recommendation 2.1 referred to NUREG/CR-4334 and Part 10 of ASME/ANS RA-Sa-2009, as providing acceptable guidance for performance of a Seismic Margin Analysis (SMA)**

ACRS Letter – February 15, 2012

- **Inconsistent with requirement to use "current applicable Commission requirements and guidance" for the updated seismic hazard and vulnerability evaluations**

ACRS Letter – February 15, 2012

- Instead, should cite Part 5 of ASME/ANS RA-Sa-2009, as endorsed by ISG DC/COL-ISG-020, "ISG on Implementation of a PRA-Based SMA for New Reactors"
- In fact, this ISG specifically notes that methods described in Part 10 of ASME/ANS RA-Sa-2009 are not acceptable for performing a design-specific SMA for a new reactor

ACRS Letter – March 13, 2012

- **Response to staff's disposition of ACRS recommendations contained in October 13, and November 8, 2011 letters**
- **Staff's dispositions appropriate except for:**
  - **Tier 3 designation of additional hydrogen control and mitigation measures for Mark I and II plants is counter to intent as near-term defense-in-depth measures. It should be included in Tier 1 actions.**

ACRS Letter – March 13, 2012

- **Tier 3 designation of fire response procedures is inappropriate. It should be part of Recommendation 8 (Tier 1) since it presents similar challenges as those faced by integration of SAMGs and EDMGs with the EOPs**

ACRS Letter – March 14, 2012

- **Review of 3 proposed Orders (SECY-12-0025) regarding:**
  1) **Development of strategies to mitigate beyond design basis natural phenomena**
  2) **Installation of reliable hardened vents for BWRs with Mark I and II containments**
  3) **Installation of enhanced fuel pool instrumentation**

ACRS Letter – March 14, 2012

- **Recommendations:**
  - **Need clarification on technical basis for required venting capacity equivalent to 1% of licensed / rated thermal power**

ACRS Letter – March 14, 2012

- Containment venting systems should be treated in similar manner as other systems if seismic, flooding, and other natural external hazards reevaluations indicate an increase in hazard level
- Language not clear whether operating procedures must be modified to integrate use of instrumentation for response to abnormal spent fuel pool level conditions

ACRS Letter – March 14, 2012

- **FLEX approach appears responsive to mitigation strategies for beyond-design-basis external events. However, FLEX does not eliminate the potential for follow-up regulatory actions as a result of reevaluations of external hazards**
- **Future activities related to the NTTF Tier 1 Recommendation 8 on integration of onsite emergency response capabilities will impact procedures, guidance, and training requirements associated with these Orders**

STATE-OF-THE-ART REACTOR CONSEQUENCE ANALYSES (SOARCA) PROJECT

William J. Shack

ACRS Letter May 15, 2012

- **Recommendations & Conclusions**
  - **SOARCA work is a major step forward in developing more realistic, integral deterministic analyses**
  - **Highest priority future work should be development of a Surry uncertainty analysis and a MACCS2 best practices document**
  - **Best estimate and uncertainty analyses should be conducted in parallel rather than as "add-ons"**

ACRS Letter May 15, 2012

- SOARCA scenarios are important contributors to risk, but the fraction of the total risk captured is not known
- Uncertainty analysis includes parameter uncertainty, sensitivity studies; justification needed for selection or omission of parameters or effects of interest
- An ice condenser containment study would be valuable. However, completion of Level 3 PRA study has higher priority

ACRS Letter May 15, 2012

- **Discussion**
  - **SOARCA benefited greatly from Peer Review**
  - **SOARCA provides quantification of benefits of slower progression and smaller releases, potential benefits of SAMGs, and 10 CFR 50.54(hh)**

ACRS Letter May 15, 2012

- MACCS2 analyses included seismic effects on local infrastructure that would hamper evacuation
- Essentially no risk of early fatalities, even for the unmitigated scenarios
- For scenarios considered, latent health effects from any of dose-response models are small compared to NRC Safety Goal

ACRS Letter May 15, 2012

- SOARCA analyses provide important insights into the outcome of a scenario, but it is critical to understand the impact that uncertainties may have on the outcomes
- Formal methodology of uncertainty analysis appears rigorous; processes for choice of parameters to include or omit, ranges and distributions are less well developed

ACRS Letter May 15, 2012

- Not all uncertainties in physical processes of accident progression can be characterized by parameter uncertainty. Impact still needs to be characterized, e.g., through sensitivity analyses

ACRS Letter May 15, 2012

- SOARCA external event scenarios and the estimated frequencies of these scenarios were based on expert judgment
- Without more complete external events PRAs, it is not clear what fraction of the risk has been captured

ACRS Letter May 15, 2012

- Comparisons with earlier studies such as NUREG/CR-2239, should not be made without acknowledging differences and limitations in the analyses
- More complete documentation of technical work is needed including the uncertainty analysis for Surry and the MACCS2 best practices report

NRC SAFETY RESEARCH PROGRAM

Michael Corradini

Scope

- **The current safety research program organized by the Office of Nuclear Regulatory Research (RES)**
- **Safety research in the aftermath of events at Fukushima Daiichi**
- **Research on security and safeguards not addressed**

General Observations

- The current safety research program is very closely tied to needs of NRC line organizations (NRR, NRO, NMSS, NSIR, FSME)
- Research activities are delivering useful products to the line organizations in a timely manner.

Collaborations in the Conduct of Research

- **RES is taking advantage of opportunities to leverage its resources and expertise on issues of common interest to other Federal agencies, industrial institutions, and international partners (e.g., fire research, Fukushima analysis)**

Areas Deserving Attention in the Future

- There is a growing emphasis on the use of numerical simulation to resolve reactor safety issues; e.g., industry intent to use tools such as computational fluid dynamics (CFD) in TH safety analyses
- NRC needs to be in a position to evaluate products of computational simulations

Adequacy of Experimental Facilities

- **We must recognize our growing dependency upon experimental facilities in the rest of the world.**
- **It is important that these facilities remain available to NRC through formal as well as informal collaborations.**
- **NRC should continue to develop proactive strategies that ensure access to such facilities.**

Experimental Facilities (cont.)

- **In addition to maintain expertise and to train new hires in experimentation, NRC should consider assignments for promising younger staff at international experimental facilities.**

Safety Research Post-Fukushima

RES to develop an integrated plan to obtain the necessary technical basis for implementing the lessons learned with respect to:

- **protection from external hazards**
- **protection from severe accidents**

Safety Research Post-Fukushima (cont.)

- emergency response and severe accident management capabilities
- accident tolerant instrumentation to characterize plant response
- improved understanding of severe accident phenomena

Abbreviations

ABWR	Advanced Boiling Water Reactor
ACRS	Advisory Committee on Reactor Safeguards
ANS	American Nuclear Society
APWR	Advanced Pressurized Water Reactor
AP1000	Advanced Passive 1000
ASME	American Society of Mechanical Engineers
BDBA	Beyond Design Basis Accident
BWR	Boiling Water Reactor
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
COL	Combined License
COLA	Combined License Application
DC	Design Certification
EDO	Executive Director for Operations
EDMGs	Extensive Damage Mitigation Guidelines
EOPs	Emergency Operating Procedures
EPR	Evolutionary Power Reactor
EPRI	Electric Power Research Institute
ESBWR	Economic Simplified Boiling Water Reactor
FLEX	Diverse and Flexible Mitigation Capability
FSME	Office of Federal and State Materials and Environmental Management Programs
ISG	Interim Staff Guidance
ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
NFPA	National Fire Protection Association
NMSS	Office of Nuclear Material, Safety and Safeguards
NRC	Nuclear Regulatory Commission
NRO	Office of New Reactors
NRR	Office of Nuclear Reactor Regulation
NSIR	Office of Nuclear Security and Incident Response
NTTF	Near Term Task Force
PRA	Probabilistic Risk Assessment
PWR	Pressurized Water Reactor
SAMGs	Severe Accident Management Guidelines
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SFPSS	Spent Fuel Pool Scoping Study
SOARCA	State-of-the-Art Reactor Consequence Analyses
SMA	Seismic Margin Analysis
SMR	Small Modular Reactor
SSE	Safe Shutdown Earthquake
RES	Office of Nuclear Regulatory Research
TH	Thermal Hydraulics