U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

ACRS MEETING WITH THE U.S. NUCLEAR REGULATORY COMMISSION

March 4, 2016

Overview

Dennis C. Bley

Accomplishments

Since our last meeting with the Commission on June 11, 2015, we issued 17 Reports

- **10 CFR 50.46c Rulemaking Activities**
- **Maximum Extended Load Line Limit Analysis Plus (MELLLA+) License Amendment Requests**
  - **Grand Gulf, NMP 2, Peach Bottom 2/3**
- **Fukushima: Plans for Resolving the NRC Near-Term Task Force Open Tier 2 and 3 Recommendations**

Reports

- **COLA: Duke Energy Carolinas, LLC, William States Lee III Nuclear Station, Units 1 and 2**
- **Construction Permit: SHINE Medical Technologies, Inc. Medical Isotope Production Facility**
- **Early Site Permit: PSEG site adjacent to Salem and Hope Creek on Artificial Island in New Jersey**

Reports

- **License Renewal Applications**
  - **Byron Station Units 1 and 2 and Braidwood Station Units 1 and 2**
  - **Davis-Besse Nuclear Power Station**
- **RMRF: Draft SECY Paper, Recommendations on Issues Related to Implementation of a Risk Management Regulatory Framework**

Reports

- **Fukushima: Draft Regulatory Basis for Containment Protection and Release Reduction for Mark I and Mark II Boiling Water Reactors**
- **Guidance and Bases**
  - **Interim Staff Guidance: DC/COL-ISG-028, "Assessing the Technical Adequacy of the Advanced Light-Water Reactor Probabilistic Risk Assessment for the Design Certification Application and Combined License Application"**

Reports

- Interim Staff Guidance, "Guidance for the Evaluation of Acute Chemical Exposures and Proposed Quantitative Standards"
- Reactor Oversight Process Enhancements
- Revised Fuel Cycle Oversight Process Cornerstones

- **ACRS Assessment of the Quality of Selected NRC Research Projects – FY2015**

Ongoing / Future Reviews

- **Fukushima**
  - **NRC Near-Term Task Force Fukushima Tier 2 and 3 Recommendations – Groups 2 & 3**
  - **Update to JLD-ISG-2012-05, "Guidance for Performing the Integrated Assessment for External Flooding"**
  - **Mitigation of Beyond-Design-Basis Events Rulemaking Update**

Ongoing / Future Reviews

- **New Plants**
  - **Subsequent COLAs for AP1000 (Levy & Turkey Point) and ESBWR (North Anna)**
  - **APR 1400**
- **Research and Test Reactor License Renewal Process Rulemaking**
- **Biennial Review and Evaluation of the NRC Safety Research Program**

Ongoing / Future Reviews

- **License Renewal**
  - **Fermi**
  - **Grand Gulf**
  - **LaSalle**
  - **Seabrook**
  - **South Texas Project**
- **Subsequent License Renewal**
- **Radiation Protection**
  - **10 CFR Part 61 Rulemaking**

Ongoing / Future Reviews

- **Digital I&C**
  - **SECY Paper on Cyber Security Control of Access**
  - **SECY Paper on Cyber Security for Fuel Cycle Facilities**
  - **SECY Paper on Digital I&C Diversity and Defense-in-Depth**
  - **Diablo Canyon Digital Replacement**

Ongoing / Future Reviews

- **Reliability and PRA**
  - **Level 3 PRA**
  - **Human Reliability Analysis Methods**
  - **Risk-Informed Resolution of GSI-191, "Assessment of Debris Accumulation on PWR Sump Performance"**
  - **NuScale Topical Report, "Risk Significance Determination – Use of RAW Importance Measure"**

Ongoing / Future Reviews

- **Metallurgy and Reactor Fuels**
  - **Spent Fuel Storage and Transportation**
  - **Dry Fuel Storage Generic Aging**
  - **Draft Regulatory Basis for 10 CFR Part 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements"**

Ongoing / Future Reviews

- **Thermal-Hydraulic Phenomenology**
  - **Westinghouse Realistic Full Spectrum LOCA Methodology**
  - **Supplement to Topical Report on BISON code**

Draft Final Rule for 10 CFR 50.46c, "Emergency Core Cooling System Performance During Loss-of-Coolant Accidents"

Ronald Ballinger

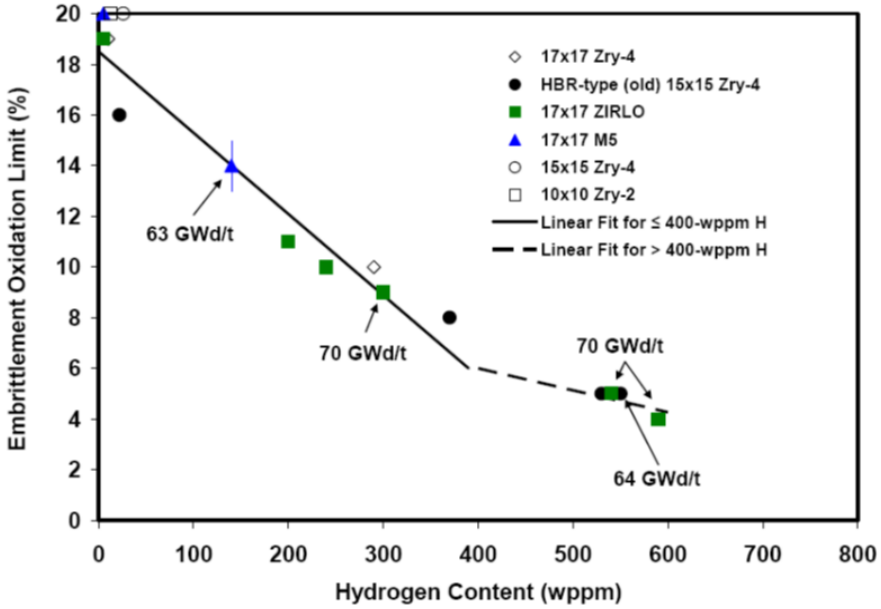
10 CFR 50.46c Rulemaking Goals

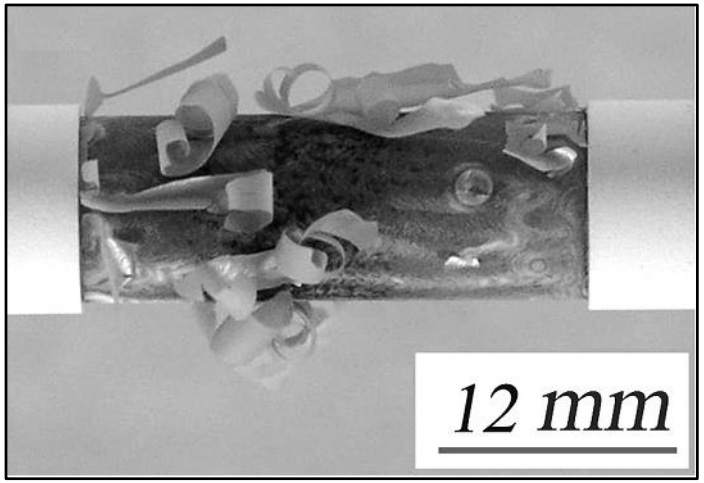
- **Revise ECCS acceptance criteria to reflect extensive research findings**
  - **High burnup effects on cladding ductility**
- **Replace prescriptive criteria with performance-based requirements***
- **Applicability to all fuel designs/cladding materials**
- **Allow an alternative risk-informed approach to evaluate the effects of debris on long-term cooling***

* **Response to Commission Directive**

LOCA Research and Testing Program Results

- **Significant reduction in cladding ductility at high burnup**
  - **Hydrogen absorption effect on ductility**
- **Breakaway oxidation during LOCA transient**
  - **Transition from adherent to non-adherent oxide-accelerated hydrogen absorption**





New 10 CFR 50.46c Rule

- **Maintains peak clad temperature and hydrogen limits**
  - **Peak clad temperature: 2200°F**
  - **Maximum cladding reacted: 1%**
- **Adjusts equivalent cladding oxidized to reflect burnup effect**
- **Requires analytical limits for peak cladding temperature and integral time-at-temperature to be developed that account for the effects of exposure.**
- **Requires accounting for breakaway oxidation**
- **Allows use of risk-informed methods for long-term cooling**

10 CFR 50.46c Related Regulatory Guides

- **Staff developed RGs 1.222, 1.223, and 1.224 to provide methods acceptable to meet the requirements for fuel performance.**
  - RG 1.222"Measuring Breakaway Oxidation Behavior"
  - RG 1.223, "Determining Post Quench Ductility"
  - RG 1.224, "Establishing Analytical Limits for Zirconium-Alloy Cladding Material"
- **Staff developed RG 1.229 to provide methods to meet requirements for long-term cooling**
  - RG 1.229 "Risk-informed Approach for Addressing the Effects of Debris on Post-accident Long-term Core Cooling"

10 CFR 50.46c Implementation Existing Fleet

- **Implementation plan six months after the effective date of the rule**
- **All license amendment requests for compliance must be submitted no later than 60 months after the effective date of the rule and must be completed no later than 84 months**

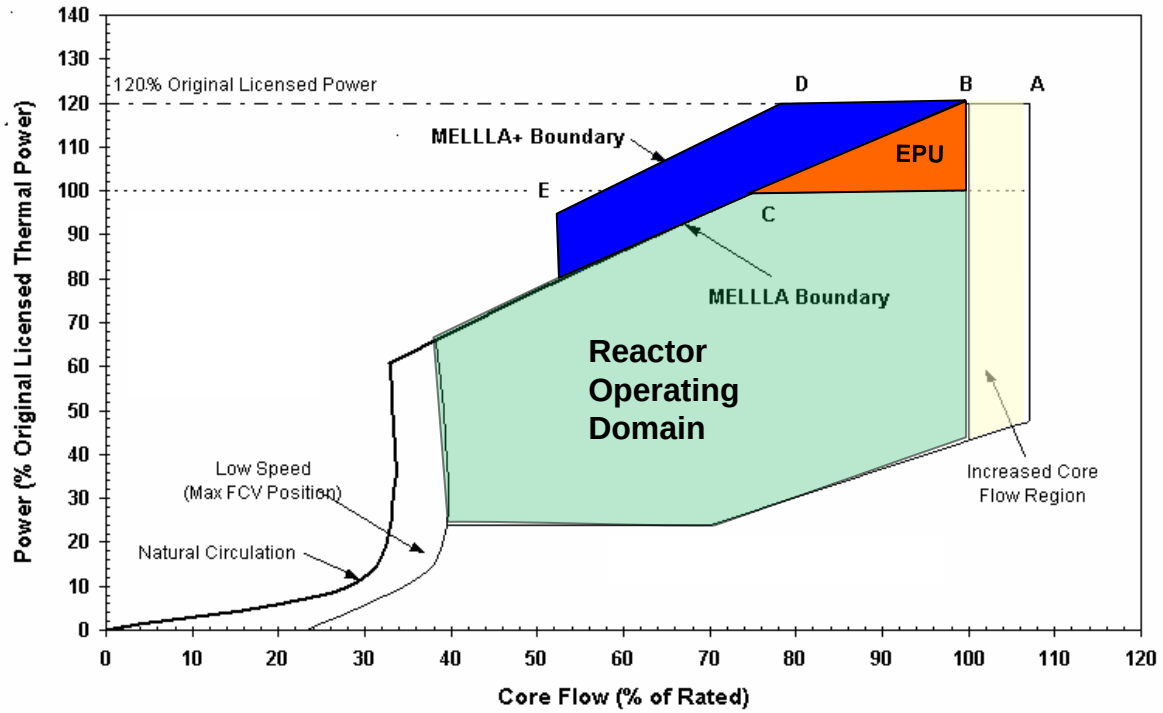
ACRS Recommendations

- **The draft final rule 10 CFR 50.46c and associated RGs 1.222, 1.223 and 1.224 should be issued**
- **RG 1.229 still in draft form should not be issued-further review in process**
  - **March 2016 Subcommittee**
  - **April 2016 Full Committee**

Maximum Extended Load Line Limit Analysis Plus (MELLLA+)

Joy L. Rempe

Simplified Power to Flow Map



MELLLA = Maximum Extended Load Line Limit
MELLLA+= Maximum Extended Load Line Limit Plus
EPU = Extended Power Uprate
ICU = Increased Core Flow

Graphic: NUREG/CR-7179

- **BWRs control power using two options: control rod movements and flow adjustments**
- **Expanded MELLLA+ flow window increases operational flexibility and safety**
- **Additional measures needed for maintaining margins to power and flow instabilities in MELLLA+**

ACRS MELLLA+ Reviews

- GE-Hitachi MELLLA+ licensing topical reports identify scope and provide generic analyses needed to meet safety and regulatory requirements
  - ACRS review focused on analytical uncertainties and limitations needed to preserve safety margin
- Four MELLLA+ license amendment requests
  - ACRS review emphasized uncertainties in plant-specific evaluations to assess safety margin

MELLLA+ Implementation

Parameter	Monticello	Peach Bottom Units 2 and 3	Nine Mile Point Unit 2	Grand Gulf Units 1 and 2
Type	BWR3	BWR4	BWR5	BWR6
Containment	Mark I	Mark I	Mark II	Mark III
Power (MWt)	2004	3951	3988	4408
M+ region lowest rated core flow	80%	83%	85%	80%
Fuel	GE14	GNF2	GE14	GNF2
Power Density (kW/liter)	~48	~58	~59	~62
Peak Power to Flow Ratio (MWt/Mlbm/hr)	~50	~55	~52	~57
Representative Compensating Measures	-Detect and Suppress Solution- Confirmation Density (DSS-CD) -No Feedwater Heater Out-of-Service (FWHOOS) -No Single Loop Operation (SLO) -Time Critical Actions	-DSS-CD - No FWHOOS - No SLO -Time Critical Actions -Limits on Safety-Relief Valves (SRVs) out-of-service (OOS) -Increased Standby Liquid Control System (SLCS) Boron-10 (B-10) enrichment	-DSS-CD - No FWHOOS - No SLO -Time Critical Actions -Limits on SRVs OOS -Automated actions to initiate feedwater flow reduction -Increased SLCS B-10 enrichment	-DSS-CD -No FWHOOS -No SLO -Time Critical Actions -Limits on SRVs OOS

Plant Response Evaluations

- Plant response evaluations consider normal operation and off-normal events
- Approval of GE-Hitachi MELLLA+ method contingent on limitations related to ATWS Instability:
  - Uncertainties in analytical models
  - Differences in plant design, operation, and selected compensating measures
  - Quantification of key “nominal” model input and associated uncertainties

Anticipated Future Activities

- Additional expanded flow operating domain submittals expected
  - Additional MELLLA+ license amendment requests
  - Other vendor licensing topical reports on extended flow operating domains
- Staff testing to reduce uncertainties in predicting instability phenomena

Plans for Resolving Fukushima Near-Term Task Force Tier 2 and 3 Recommendations

John W. Stetkar

Background

SECY-11-0137 priorities:

- **Tier 2 - need further technical assessment and alignment, depend on Tier 1 issues, or need critical skill sets**
- **Tier 3 - require further study for regulatory action, need completion of associated shorter-term action, depend on resolution of Recommendation 1, or need critical skill sets**

Background (cont.)

- **Some initial Tier 2 and 3 recommendations subsumed into Tier 1 activities (e.g., Mitigation of Beyond-Design-Basis Events rulemaking and related order)**
- **Need for expedited transfer of spent fuel to dry cask storage completed in May 2014**

SECY-15-0137 Group 1

- **Should be closed now**
- **Existing regulatory framework and requirements are adequate**
- **No further regulatory action is warranted**
  - **NTTF 3: Seismically-induced fires and floods**
  - **Staff: Emergency planning zone size and pre-staging of potassium iodide**
  - **NTTF 9.3: Maintain ERDS capability pending rulemaking**
  - **NTTF 10.3: ERDS enhancements**
  - **NTTF 11.2: Recovery and reentry insights**
  - **NTTF 11.4: Local community training**
  - **NTTF 12.1: Reactor Oversight Process consideration of defense-in-depth**
  - **NTTF 12.2: NRC staff and inspector training on severe accidents and SAMGs**

SECY-15-0137 Group 2

- **Should be closed**
- **No further regulatory action is warranted**
- **Interaction with ACRS or external stakeholders before final assessment**
- **Closure recommendations March 2016**
  - **NTTF 5.2: Reliable hardened vents for containments other than BWR Mark I and Mark II**
  - **NTTF 6: Hydrogen control and mitigation**
  - **ACRS: Enhanced instrumentation for beyond-design-basis conditions**

SECY-15-0137 Group 3

- **Assessment or documentation of basis for closure not yet completed**
- **Interaction with ACRS or external stakeholders before final assessment**
- **Closure recommendations December 2016**
  - **ACRS, Congress: Re-evaluations of natural external hazards other than seismic and flooding**
  - **NTTF 2.2: Periodic reconfirmation of external hazards**
  - **NTTF 11.3: Real-time radiation monitoring onsite and emergency planning zone**

ACRS Conclusions

- **November 16, 2015 letter report**
- **Assignments of open Tier 2 and 3 recommendations into the three resolution groups are appropriate**

ACRS Conclusions (cont.)

- **Existing regulatory framework and requirements are adequate, and no further regulatory action is warranted for the Group 1 recommendations**
- **ACRS will review staff evaluations and closure plans for the Group 2 and Group 3 recommendations**

Comments on Specific Issues

Seismically-induced fires and floods

- Agree no new regulatory requirements are needed
- Staff's conclusions about risk significance may overlook scenarios from compound effects
- Further investigate feasibility of PRA methods to evaluate these scenarios

Comments on Specific Issues (cont.)

Mitigation of hydrogen releases

- Examine other pathways for release into BWR Mark I and Mark II reactor buildings
- Sufficient release to pose a combustion hazard with containment pressure below level mandating vent activation
- Findings derived from staff reviews of international activities

Comments on Specific Issues (cont.)

Enhanced instrumentation

- Research on capability of instruments to withstand severe accident environments
- Use of available (reliable) instruments and supplemental calculation aids to support SAMG actions
- Identify instrumentation needed before, during, and after a severe accident

Abbreviations

ACRS	Advisory Committee on Reactor Safeguards
ATWS	Anticipated Transient Without Scram
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
COLA	Combined Operating License Application
ISG	Interim Staff Guidance
DSS-CD	Detect and Suppress Solution – Confirmation Density
ECCS	Emergency Core Cooling System
EPU	Extended Power Uprate
ESBWR	Economic Simplified Boiling Water Reactor
FWHOOS	Feedwater Heater Out-of-Service
GE	General Electric
GNF	Global Nuclear Fuel Americas, LLC
GSI	Generic Safety Issue
I&C	Instrumentation & Control
ICU	Increase Core Flow
LOCA	Loss of Coolant Accident
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
NMP2	Nine Mile Point Nuclear Station Unit 2
NRC	Nuclear Regulatory Commission
NTTF	Near-Term Task Force
PRA	Probabilistic Risk Assessment
PSEG	Public Service Electric & Gas Company
PWR	Pressurized Water Reactor
RAW	Risk Assessment Worth
RG	Regulatory Guide
RMRF	Risk Management Regulatory Framework
SAMG	Severe Accident Management Guidelines
SECY	Office of the Secretary
SHINE	SHINE Medical Technologies, Inc.
SLCS	Standby Liquid Control System
SLO	Single Loop Operation
SRV	Safety-Relief Valve