ISSUE STATEMENT

Regulators have identified non-conservative elements in current regulations for Loss of Coolant Accidents (LOCA) that will be addressed through the implementation of new or revised regulations. The proposed regulations could result in a reduction of the allowable Equivalent Cladding Reacted from 17% to 4% at end-of-life conditions, and an additional 50% reduction by the invocation of a fuel cladding double-sided oxidation requirement at some intermediate burn-up. Research can help inform the regulatory process so that new regulations have sound technical bases and are not unnecessarily conservative.

DRIVERS

Regulatory
Several key issues related to the U.S. Nuclear Regulatory Commission’s LOCA rulemaking remain unresolved and additional data are needed to assess alternative acceptance criteria or improvements in the acceptance criteria. How the rule is written can also be significant. A sound technical basis can ensure the appropriate level of conservatism is incorporated into the rulemaking. Many non-U.S. regulatory bodies monitor U.S. regulatory activities and may mirror NRC actions; so these efforts have global relevance.

Plant Performance and Cost
Regulatory changes impacting LOCA could result in nuclear plant operational changes to ensure compliance. Such changes could impact plant performance and production costs.

Need for Coordinated Approach
Since many stakeholders, including vendors, EPRI, owners groups, and individual utilities will need to contribute to some aspect of this work, a coordinated approach is very important in terms of efficiency and desired outcome. EPRI is in the best position to lead the technical aspects of this coordination.

RESULTS IMPLEMENTATION

• Research efforts will complement existing industry and/or regulator-sponsored programs to generate additional data to better understand the issues. As the issues are brought to closure it is expected that sufficient data will be generated to:
  – Clarify which issues are significant versus those that are essentially “non-issues”
  – Understand key phenomena and support development of models
  – Assess the level of conservatisms in new regulations
  – Identify and evaluate alternative acceptance criteria
  – Develop methodologies compliant with the new rule implementation guidance

• Research results will be made available to the regulators for use in developing the rule language so that:
  – New or revised rules consider increased flexibility and reasonable implementation as appropriate.
  – The rules are performance based with details in lower tier documents (to reduce the need for future rulemaking)
  – New or revised rules can be implemented on a reasonable schedule

PROJECT PLAN

Early research efforts were focused on increasing the fidelity of the three major U.S. NRC sponsored researching findings. Detailed investigations were conducted to evaluate the cladding ductility degradation at lower oxidation temperatures and under limited inner diameter oxygen source conditions. Potential causes for short breakaway oxidation incubation time is being investigated.

In a separate but coordinated effort, margins for the current fleet relative to the proposed criteria to confirm there is no immediate safety concern were assessed by the Owners Groups.

Alternative performance-based rule concepts were drafted for regulatory consideration. Tools needed to demonstrate compliance to the new rule are being discussed with industry stakeholders to identify potential implementation challenges. A coordinated and comprehensive response was
drafted to raise industry concerns with the proposed LOCA rulemaking package. LOCA implementation guidance and training materials have been prepared to make utilities aware of the issues and will be refined once the rule is finalized.

The NRC Commission has instructed the NRC staff to include fuel fragmentation, relocation and dispersal in the LOCA rulemaking. Preliminary evaluation suggests fuel rod burst is possible with high burn-up fuel and thus raises the possibility of fuel dispersal to outside of the fuel rod. Research efforts are focused on developing a better understanding of the fuel fragmentation process, fuel fragmentation burn-up threshold and fuel rod balloon/burst process. NRC staff has decided not to include fuel fragmentation in the current LOCA rulemaking but “…will continue multilateral research activities and interactions with stakeholders with the goal of developing a regulatory framework to address fuel fragmentation, if needed, in the next few years”.

RISKS

Risks associated with the research include:

• Research results indicate margins are less than anticipated
• Fuel fragmentation occurs at a relatively low burn-up (which has implications for coolability, fission gas release and extended burnups)
• The research results do not support a consensus view
• Regulators do not implement a performance-based LOCA rule and a future rulemaking will be needed for new classes of cladding materials

RECORD OF REVISION

This record of revision will provide a high level summary of the major changes in the document and identify the Roadmap Owner.

<table>
<thead>
<tr>
<th>REVISION</th>
<th>DESCRIPTION OF CHANGE</th>
</tr>
</thead>
</table>
| 0        | Original Issue: August 2011  
Roadmap Owner: Ken Yueh |
| 1        | Revision Issued: December 2011  
Roadmap Owner: Ken Yueh  
Changes: Minor edits and updates |
| 2        | Revision Issued: August 2012  
Roadmap Owner: Ken Yueh  
Changes: Flowchart modified to reflect new information on the LOCA rule process within the NRC and implementation schedule. Additional details added to fuel fragmentation as a result of recent NRC feedback and Reg-TAC planning progression. |
| 3        | Revision Issued: August 2013  
Roadmap Owner: Ken Yueh  
Changes: Project plan and rulemaking schedule update |
| 4        | Revision Date: December 2014  
Roadmap owner: Ken Yueh  
Changes: Added second LOCA Round Robin, IRSN PERFROI program |
| 5        | Revision Date: August 2016  
Roadmap owner: Ken Yueh  
Changes: Rule publication delayed by one year, added Owners Groups involvement |
Loss of Coolant Accident (LOCA) Regulation

Utilities

Develop Tools/Training for LOCA implementation

Owners Groups Develop Implementation Guidance and review standard

Implementation: Licensees have 180 days to file an implementation plan, all plants in compliance within 84 months

Fuel Regulatory Issues TAC (Reg-TAC)

Develop Response to Rulemaking

Comments Resolution Follow-up

Implementation Plan

Breakaway Oxidation Tests

Second LOCA Round Robin

Conduct Parametric Fuel Fragmentation Tests

Develop Fuel Fragmentation, Relocation and Dispersal Model

NRC

Draft Rule-making Package

Public Commenting

Comments Resolution

Issue Final Rule

LOCA Rule and Guides Finalized

NRC Evaluate and Approve LAR

Formulate Strategy to Address Fuel Fragmentation, Relocation and Dispersal

New Regulation Implementation

International Program

Halden, SCIP, PERFROI, NFIR and JAEA LOCA Testing

NEI

Coordinate Industry Response

Vendor

LOCA Methodology Development

Legend

Key Milestone

Funded Work

Potential NRC Direction

August 2016