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 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 could 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”
- Identify and evaluate alternative acceptance criteria
- Develop methodologies compliant with the new rule implementation guidance
- Support development of high temperature clad embrittlement models and Post Quench Ductility test methodologies
- Assess the level of conservatisms in new regulations

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

EPRI research projects are geared toward increasing the fidelity of the three major NRC sponsored research findings. High-temperature oxidation tests at lower temperatures (below 1200°C) are being conducted to evaluate alternative alloy temperature-specific acceptance criteria that are representative of nuclear plant operating conditions. Tests with controlled fuel rod internal oxygen sources are being conducted to assess the reasonableness of uniformly imposing two-sided oxidation. Breakaway oxidation tests are being conducted to assess the materials and processing factors that can lead to short breakaway times, which in turn will assist the regulators and vendors in determining the appropriate triggers and frequency for testing during the manufacturing process.

In a separate but coordinated effort, the owners groups are assessing margins for the current fleet relative to the proposed criteria to confirm there is no immediate safety concern.

Alternative performance-based rule concepts are being 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 response is being drafted to raise
industry concerns with the proposed LOCA rulemaking package. LOCA implementation guidance and training materials are being prepared.

Preliminary evaluations to determine high burnup fuel rod burst potential and development of alternative representative/lower cost methods to evaluate fuel fragmentation are planned. Fuel fragmentation is currently not part of the LOCA rulemaking and future course of action will depend on the results of the burst potential evaluation and regulatory needs once defined. The research plan also will include an assessment of fuel performance in beyond design basis conditions.

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 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>
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| 0        | Original Issue: August 2011  
Roadmap Owner: Ken Yueh |
| 1        | Revision Date: December 2011  
Roadmap Owner: Ken Yueh  
Changes: Minor edits and updates |
| 2        | Revision Date: 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. |
Loss of Coolant Accident (LOCA)

Utilities
- Track 1 LAR Application
- Track 2 LAR Application
- Track 3 LAR Application

Fuel Reliability Program (FRP)
- Develop Tools/Training for LOCA Implementation
- Develop Response to Rulemaking Package
- Conduct Preliminary Fuel Fragmentation Testing
- Conduct Parametric Fuel Fragmentation Testing Using New Heating Method
- Develop Fuel Fragmentation, Relocation, and Dispersal Model

NRC
- Draft Rulemaking Package
- Commission Vote
- Comments Resolution
- Issue Final Rule
- LOCA Rule and Guides Finalized
- NRC Evaluate and Approve LAR
- New Regulation Implementation
- Formulate Strategy to Address Fuel Fragmentation, Relocation, and Dispersal

International Program
- Halden and NSRR LOCA Testing

NEI
- Coordinate Industry Response

Vendor
- LOCA Methodology Development

Legend:
- Key Milestone
- Funded Work
- Potential NRC Direction