

# Light Water Reactor Sustainability Program

## FY13 Status Update for EPRI - RISMIC Collaboration

**Curtis Smith**

September 2013



The INL is a U.S. Department of Energy National Laboratory  
operated by Battelle Energy Alliance

# **Light Water Reactor Sustainability Program**

## **FY13 Status Update for EPRI - RISMC Collaboration**

**Curtis Smith**

**September 2013**

**Idaho National Laboratory  
Idaho Falls, Idaho 83415**

**<http://www.inl.gov/lwrs>**

**Prepared for the  
U.S. Department of Energy  
Office of Nuclear Energy  
Under DOE Idaho Operations Office  
Contract DE-AC07-05ID14517**

**DISCLAIMER**

This information was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness, of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. References herein to any specific commercial product, process, or service by trade name, trade mark, manufacturer, or otherwise, do not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

## **EXECUTIVE SUMMARY**

The purpose of the Risk Informed Safety Margin Characterization (RISMC) Pathway research and development (R&D) is to support plant decisions for risk-informed margins management with the aim to improve economics, reliability, and sustain safety of current NPPs. Goals of the RISMC Pathway are twofold: (1) Develop and demonstrate a risk-assessment method coupled to safety margin quantification that can be used by NPP decision makers as part of their margin recovery strategies. (2) Create an advanced “RISMC toolkit” that enables more accurate representation of NPP safety margin. In order to carry out the R&D needed for the Pathway, the Idaho National Laboratory (INL) is collaborating with the Electric Power Research Institute (EPRI) in order to focus on applications of interest to the U.S. nuclear power industry. This report documents the collaboration activities performed between INL and EPRI during FY2013.

# CONTENTS

EXECUTIVE SUMMARY .....	ii
1. BACKGROUND .....	5
1.1 RISM Pathway Background .....	5
1.2 Collaboration with EPRI .....	6



# FY13 Status Update for EPRI - RISMC Collaboration

## 1. BACKGROUND

### 1.1 RISMC Pathway Background

Safety is central to the design, licensing, operation, and economics of nuclear power plants (NPPs). As the current light water reactor (LWR) NPPs age beyond 60 years, there are possibilities for increased frequency of systems, structures, and components (SSC) degradations or failures that initiate safety-significant events, reduce existing accident mitigation capabilities, or create new failure modes. Plant designers commonly “over-design” portions of NPPs and provide robustness in the form of redundant and diverse engineered safety features to ensure that, even in the case of well-beyond design basis scenarios, public health and safety will be protected with a very high degree of assurance. This form of defense-in-depth is a reasoned response to uncertainties and is often referred to generically as “safety margin.” Historically, specific safety margin provisions have been formulated primarily based on engineering judgment backed by a set of conservative engineering calculations.

The ability to better characterize and quantify safety margin holds the key to improved decision making about LWR design, operation, and plant life extension. In a sense, contemplation of LWR operation beyond 60 years does represent a kind of “beyond design basis” operation. A systematic approach to characterization of safety margin and the subsequent margin management options represents a vital input to the licensee and regulatory analysis and decision making that will be involved. In addition, as research and development (R&D) in the LWR Sustainability (LWRS) Program and other collaborative efforts yield new data, sensors, and improved scientific understanding of physical processes that govern the aging and degradation of plant SSCs (and concurrently support technological advances in nuclear reactor fuels and plant instrumentation and control systems) needs and opportunities to better optimize plant safety and performance will become known. This interaction of degradation understanding and potential impacts to plant margins is shown in Figure 1-1. To support decision making related to economics, readability, and safety, the RISMC Pathway provides methods and tools that enable mitigation options known as margins management strategies.

The purpose of the RISMC Pathway R&D is to support plant decisions for risk-informed margin management with the aim to improve economics, reliability, and sustain safety of current NPPs. As the lead Department of Energy (DOE) Laboratory for this Pathway, the Idaho National Laboratory (INL) is tasked with developing and deploying methods and tools that support the quantification and management of safety margin and uncertainty.

Goals of the RISMC Pathway are twofold:

1. Develop and demonstrate a risk-assessment method coupled to safety margin quantification that can be used by NPP decision makers as part of their margin recovery strategies.
2. Create an advanced “RISMC toolkit” that enables more accurate representation of NPP safety margin.

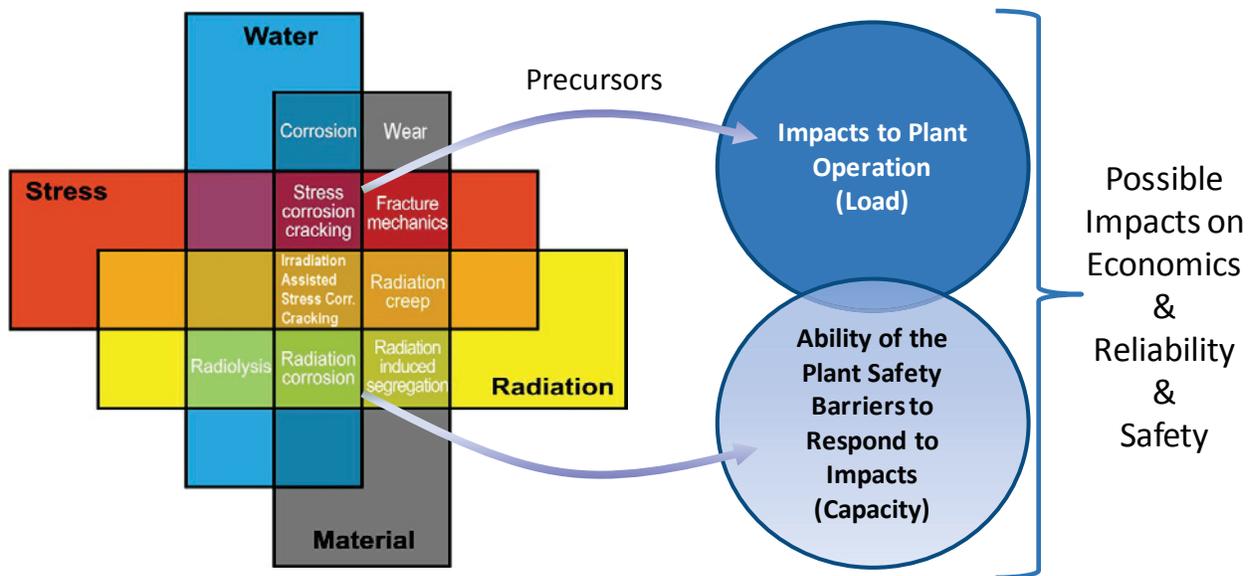


Figure 1-1. Representation of the interaction of degradation mechanisms that may impact plant operations and safety barriers if left unmitigated.

One of the primary items inherent in the goals of the Pathway is the ability to propose and evaluate margin recovery strategies (i.e., proposed changes to SSCs or plant procedures that work to mitigate margin degradation due to aging or plant modifications). If a margin such as a plant safety is degraded, the RISMC methods and tools will serve to model, measure, and maintain margins for active and passive SSCs for normal and off-normal conditions. Moving beyond current limitations in safety analysis, the Pathway will develop techniques to conduct analysis using simulation-based studies of safety margins where “margin” go beyond the typical engineering margins concept. For example, licensing margins as a part of the plant’s design basis are not the only ones protecting the public; plant safety depends on margins that are not necessarily analyzed in licensing.

In order to carry out the research and development needed for the RISMC Pathway, INL, along with the Electric Power Research Institute (EPRI), has proposed a series of case studies that will explore methods- and tools-development issues. This report documents the collaboration activities INL has performed with EPRI during FY2013.

## 1.2 Collaboration with EPRI

A variety of collaboration activities were performed during FY2013 between INL and EPRI. The types of activities includes:

- Technical and program status meetings
- Interactions and reviews of ongoing case studies

A summary of the FY2013 activities are listed chronologically below:

### **November 2012**

Performed technical reviews of the EPRI report 1025291, *Pilot Application of Risk Informed Safety Margins to Support Nuclear Plant Long Term Operation Decisions, Impacts on Safety Margins of Power Uprates for Loss of Main Feedwater Events*. This report was published in December 2012, with the INL contributions acknowledged in the report.

### **February 2013**

A technical exchange meeting was held at the INL over the course of three days. Topics that were covered were:

- Presentation of EPRI analysis of BWR SBO event and impact of EPU on plant safety margins
- EPRI EOOS Configuration Risk Management software demonstration
- Presentation of EPRI's recommendation for assessment of RELAP-7 for generic and BWR analysis
- Current status of RELAP-7 code development
- Discussion of RELAP-7 development 2013 goals / objectives / plans / staffing / schedule and any changes since last meeting
- Status of RAVEN development
- Status / plans of coupling RELAP-7 to any other codes through MOOSE / RAVEN
- Discussion of RISMC plans including EPRI TAG formation, development of RISMC / RIMM guidance and SBO test case schedule with data accessibility for INL use in RELAP-7
- Discussion of RELAP-7 development topics
- Planning for next engagements (ANS M&C Conference / EPRI MAAP-UG Meeting / other) Thursday 14 February 2013

### **May 2013**

A status meeting was held with EPRI at the M&C 2013 Conference. Discussions were held on the overall project status and the Significance Determination Process case study that was being initiated at EPRI. Planning for FY14 activities took place during the meeting.

### **June 2013**

Performed technical reviews of the EPRI report 3002000573, *Pilot Application of Risk Informed Safety Margins to Support Nuclear Plant Long Term Operation Decisions Impacts on Safety Margins of Extended Power Uprates for BWR Station Blackout Events*.

### **July 2013**

A technical exchange meeting was held at the INL over the course of three days. In addition to the EPRI representatives, attendees from GE Nuclear and Westinghouse participated. Topics that were covered were:

- Review of RISMC Pathway
- Review / status of action items from previous meetings
- Final update of the EPRI report on BWR extended SBO w/ impact of EPU
- ELAP-7 validation plans and schedule.
- Update on INL SBO analysis
- RELAP-7 code development status and work plan
- RAVEN code development status and work plan
- Grizzly overview and current status
- Update on identification of available T-H validation data
- Brief update on status of EPRI SDP “retrospective” analysis
- Presentation of the LTIAC comments and resolution
- Plans for development of integrated RIMM process
- Discussion of a RELAP-7 and RAVEN user community

### **August 2013**

Collaborated on the development of a “RELAP-7 Attributes” table and writeup to be used to provide the RELAP-7 software to industry. Also, held discussions with EPRI to finalize the RISMC cost-sharing information that was provided to DOE.

### **September 2013**

Collaborated on a joint article related to risk informed margins management approaches as part of RISMC. This paper will be submitted to the PSAM12 conference in 2014.