

ADDENDUM
to
MEMORANDUM OF UNDERSTANDING
between
U.S. NUCLEAR REGULATORY COMMISSION
and
ELECTRIC POWER RESEARCH INSTITUTE, INC.
on
COOPERATIVE NUCLEAR SAFETY RESEARCH

xLPR Version 2 Code Documentation and Leak-Before-Break Applications

I. Introduction

This Addendum to the Memorandum of Understanding (the Addendum) is entered into by and between the U.S. Nuclear Regulatory Commission (NRC) and the Electric Power Research Institute, Inc. (EPRI) (collectively, the parties) effective as of the date of signature of the last of the parties to execute this Addendum (the Effective Date). The NRC and EPRI are parties to the Memorandum of Understanding on Cooperative Nuclear Safety Research signed on September 30, 2016 (the MOU). Pursuant to the MOU, the parties agreed to encourage cooperation in nuclear safety research, which provides benefits to the NRC, the nuclear power industry (the Industry), and the public.

This Addendum is authorized pursuant to Section 31 of the Atomic Energy Act and/or Section 205 of the Energy Reorganization Act. The roles, responsibilities, terms, and conditions of this Addendum should not be interpreted in a manner inconsistent with and shall not supersede applicable Federal laws and regulations.

This Addendum describes cooperative efforts to complete documentation concerning development of the xLPR Version 2 computer code (the Code) and apply the Code to leak-before-break problems. The parties have jointly developed the Code under a separate addendum to the MOU titled, "Extremely Low Probability of Rupture (xLPR) V2."

II. Objectives

The objectives of this Addendum are to:

- A. Complete project documentation that remains from the Code developmental effort;
- B. Broaden understanding of and gain experience using the Code through in-depth sensitivity studies and practical applications; and
- C. Investigate probabilistic leak-before-break methodologies for demonstrating compliance with the requirements of Criterion 4, "Environmental and Dynamic Effects Design Bases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the Code

of Federal Regulations, Part 50, "Domestic Licensing of Production and Utilization Facilities."

III. Scope and Plan

A. Projects

The key elements of the projects to be performed under this Addendum are described in the following paragraphs. Any modifications to the scope of this Addendum will require a revision in writing signed by the authorized representatives of the parties.

1. Code Documentation

Although the parties achieved technical completion of the Code in September 2016 following satisfactory verification and validation test results, several project documents remain unfinished. Under this task, the parties will complete the remaining Code development documentation. These documents include, but are not limited to, the user's manual, computational group report, uncertainty report, crack initiation calibration report, and a project summary report. Quality assurance requirements previously established for the code development phase will be followed as applicable to complete the documentation.

2. Leak-Before-Break Applications

a. Sensitivity Studies

Under this task, the parties will perform a variety of studies using the Code and other tools to identify which input variables contribute most significantly to uncertainty in the results for typical leak-before-break problems. Teams from each party will work together to first reach agreement on the scope of studies to be performed and the type of analysis techniques to be employed. As necessary, input parameters and distributions will also be developed and critiqued. The full scope of studies will then be divided and executed separately by the two teams. Afterwards, the teams will meet publicly to compare and discuss results and determine whether any additional studies are necessary. The parties will collaboratively develop a publicly available report to document the methodology and results of the effort.

b. Piping System Analyses

Under this task, the parties will use the Code to analyze sets of welds that are representative of one or two piping systems previously approved for leak-before-break. For each representative piping system, the effects of PWSCC on core damage frequency will be assessed by conducting the analyses both with and without consideration of the effects of PWSCC, and then comparing the results. The impacts of applicable PWSCC detection and mitigation techniques will also be considered. The acceptance criteria prepared during the Code developmental effort will be exercised for this task, and recommendations concerning their implementation will be made.

The initial thrust of the task will be for planning and data collection to gather sources for inputs to the Code. These activities will be a cooperative effort

between the two parties, although it is expected that EPRI will take the lead role in procuring the necessary source data. Data needs may include, but are not limited to, details on piping system configurations, loads, material properties, welding processes, inservice inspection, and operating conditions. The parties will also work together to develop guidelines to ensure that the breadth of coordinated analyses is appropriate.

The parties will independently select Code inputs from the gathered set of source information. The parties will then independently complete the agreed upon scope of piping system analyses, and meet publicly to compare and discuss results. Additional analyses, if needed, will be planned, performed, and discussed in a similar fashion. All inputs, results, and methodologies will be shared, but conclusions will be drawn independently.

c. **Generalization Study**

This is an optional task that may be conducted depending upon whether the piping system analysis results developed under paragraph III.A.2.b demonstrate adequately low probabilities of rupture. Under this task, the parties will develop categories of piping systems previously approved for leak-before-break. The parties will develop inputs to bound the piping systems within each category and then conduct analyses using the Code to quantify the effects of PWSCC on core damage frequency.

Similar to the piping system analysis, the initial thrust of this task will be for planning and data collection. These activities will be a cooperative effort between the two parties, although it is expected that EPRI will take the lead role in procuring the necessary sources for the data. The parties will work together to develop guidelines to ensure that the breadth of coordinated analyses is appropriate.

The parties will independently select Code inputs from the gathered set of source information. The parties will then independently complete the agreed upon scope of studies, and meet publicly to compare and discuss results. Additional analyses, if needed, will be planned, performed, and discussed in a similar fashion. All inputs, results, and methodologies will be shared, but conclusions will be drawn independently.

B. **Deliverables**

The key deliverables for each project are summarized in the following table:

Project	Deliverables
Code Documentation	Jointly-Developed Technical Reports, Culminating in a Project Summary Report
Sensitivity Studies	Jointly-Developed Technical Report
Piping System Analyses	Jointly-Developed Source Information for Inputs Independently-Developed Inputs, Results, and Methodologies for Completed Analyses

Generalization Study	Jointly-Developed Source Information for Inputs Independently-Developed Inputs, Results, and Methodologies for Completed Analyses
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IV. Project Direction and Coordination

Technical interactions will be managed through a designated point of contact for each party (the Project Contacts). Technical meetings to coordinate this effort and to discuss progress will be arranged through the respective Project Contacts. The Project Contacts are:

NRC	EPRI
Matthew Homiack, Materials Engineer Component Integrity Branch Division of Engineering Office of Nuclear Regulatory Research U.S. Nuclear Regulatory Commission Washington, DC 20555 301-415-2427 Matthew.Homiack@nrc.gov	Craig Harrington, Technical Leader, Principal Materials Reliability Program Electric Power Research Institute Las Colinas Tower I, 201 East John Carpenter Freeway, Suite 800 Irving, TX 75062 817-897-1433 charrington@EPRI.com

V. Period of Performance

The period of performance will be from the Effective Date through September 30, 2021, to be extended in writing if mutually agreeable to EPRI and the NRC Office of Nuclear Regulatory Research (RES).

VI. Costs and Schedule

A. Costs. EPRI and RES are responsible for their respective costs in implementing this Addendum. This Addendum does not create any binding obligation or enforceable right of action of any kind on either party. This Addendum does not obligate any funds and is subject to the availability of appropriated funds.

B. Schedule

Overall schedules for each project within the scope of this Addendum are described in the following paragraphs. Specific milestones will be mutually established by the Project Contacts as part of the planning phase for each task. The Project Contacts will provide the parties with periodic progress reports that will include updated schedules.

1. Code Documentation

The project described in paragraph III.A.1 is a continuation of efforts begun by the parties under the separate addendum to the MOU titled, "Extremely Low Probability of Rupture (xLPR) V2." The parties plan to complete the project by the second quarter of the 2018 calendar year.

2. Leak-Before-Break Applications

a. Sensitivity Studies

The project described in paragraph III.A.2.a will begin as soon as practical following the Effective Date. The parties plan to complete the project by the end of the 2018 calendar year.

b. Piping System Analyses

Planning and data collection for the project described in paragraph III.A.2.b will begin as soon as practical following the Effective Date. Final analyses will be run after the NRC Office of Nuclear Reactor Regulation accepts the Code. Contingent upon that acceptance being provided by the first quarter of the 2018 calendar year, the parties plan to complete the cooperative project activities by the third quarter of the 2018 calendar year.

c. Generalization Study

The parties will mutually decide whether to pursue the project described in paragraph III.A.2.c as soon as practical following review of the results developed under paragraph III.A.2.b. If pursued, the parties estimate that the project will begin in the third quarter of the 2019 calendar year and end by the third quarter of the 2020 calendar year.

VII. Dispute

If a dispute arises out of or relating to this Addendum or any breach thereof, the parties will first attempt to settle the dispute through direct negotiation between the Project Contacts. If the Project Contacts cannot settle such a dispute, the dispute shall be submitted to the Senior Management Contacts (as defined in the MOU) for resolution.

AGREEMENT

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Michael F. Weber
Director of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Neil Wilmshurst
Vice President of Nuclear
Electric Power Research Institute, Inc.

Date: 10 May 2017

Date: 16 May 2017