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

Primary Water Stress Corrosion Cracking - Crack Initiation Testing

## I. Introduction

This Addendum to the Memorandum of Understanding is entered into by and between the U.S. Nuclear Regulatory Commission (NRC) and the Electric Power Research Institute (EPRI) effective as of the date of signature of the last of the parties to execute this Memorandum (the Effective Date). The NRC and EPRI are parties to that Memorandum of Understanding on Cooperative Nuclear Safety Research (the MOU, found under Enclosure 1). Pursuant to the MOU, the parties agreed to encourage cooperation in nuclear safety research, which provides benefits for the NRC, the nuclear power industry (the Industry), and the public.

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

This Addendum describes a cooperative Primary Water Stress Corrosion Cracking (PWSCC) research and development (R&D) program between EPRI and the NRC's Office of Nuclear Regulatory Research (RES) in the area of crack initiation (CI) testing of nickel-based alloys.

## II. Objectives

The objective of the cooperative Primary Water Stress Corrosion Cracking - Crack Initiation (PWSCC-CI) R&D program is the development of data and technical information useful to the NRC and the Industry in the areas related to initiation of PWSCC.

This cooperative program has the following specific objectives:

1. Development of a mutually agreeable test plan. The test plan should reflect the research goals of both RES and EPRI. The materials of interest in this test plan are alloy 600/182/82 and alloy 690/152/52. The goal of this test plan includes, but is not limited to, acquiring some or all of the following data: crack characterization, time-to-initiation, surface analysis at crack tip, crack depth, and the quantitative effects of material variability on crack initiation.

2. Timely sharing of raw data, technical reports, and monthly status reports upon receipt.

3. Timely sharing of technical reports, documents, or other products resulting from independent review of the data by the NRC and EPRI.

III. Scope and Plan

This program is focused on the creation and execution of a research program to study crack initiation due to PWSCC in nickel-based alloys.

IV. Period of Performance

The period of performance will be from the effective date through September 30, 2021, from the agreement date signed in Section VIII below, to be extended in writing if mutually agreeable to NRC/RES and EPRI.

IV. Project Direction and Coordination

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

| **U.S. Nuclear Regulatory Commission** | **Electric Power Research Institute** |
|---|---|
| Primary: Eric Focht, Sr. Materials Engineer, RES | Primary: Paul Crooker, Principal Technical Leader, MRP |
| Alternate: Greg Oberson, Materials Engineer, RES | Alternate: Al Ahluwalia, Technical Executive, MRP |

All data and information generated during the tasks described in this addendum will be made publicly available in accordance with each party's policies and procedures. EPRI may have proprietary documents, data, materials, and/or information related to other projects outside the scope of this addendum, which may assist in carrying out the tasks associated with this addendum. Such documents, data, materials, and/or information will be submitted to RES under a general affidavit requesting that they be withheld from disclosure to the public under 10 CFR 2.390, as provided in Article 2, Section 2.4 of the MOU.

V. Costs and Schedules

EPRI and RES have agreed to fund participation for this research program implemented at Pacific Northwest National Laboratory (PNNL).

The cost allocation for this cooperative program will consist of cooperative projects where each party contracts separately for, manages, and conducts research and then shares the raw data with the other party. It is anticipated that each party will bear an equal share of the costs necessary to provide funding for this cooperative research program under each party's independent contract for research assistance. The chart below delineates the scope of

activities to be performed under the planned contracts and draft project completion target dates. This Addendum will not be used to obligate or commit funds or as a basis for the transfer of funds. EPRI and the NRC are responsible for their own respective costs in implementing this Addendum.

EPRI and RES will jointly develop the test program scope. The NRC will fund the first phase of the program, and EPRI will fund the second phase. The first phase will include purchase of equipment and the development of the test matrix. The first phase is estimated to cost about $1,000,000.

The second phase will cover testing, including the cost of materials, and will continue until EPRI's financial contributions to the program are equal to the financial contributions provided by the NRC. The second phase is expect to last about 24 months through December 31, 2018, (see table below). The total contribution by each of NRC and EPRI through the end of phase 2 shall be limited to about $1,400,000. A third phase of the program can be considered after phase 2. In the third phase, all project tasks and costs will be divided equally between EPRI and the NRC under mutually agreeable terms. The third phase is expected to last about 24 months, approximately through December 31, 2020.

Table 1: Scope of Activities to be Performed and Funding Responsibilities

| **Task** | **Funding Responsibility** | **Deliverables** | **Est. Completion Date** |
|---|---|---|---|
| 1. Test plan development | NRC, EPRI | Detailed plan including initial test matrix | Completed |
| 2. Develop testing and evaluation infrastructure | NRC | Manufacture of two 36-specimen test rigs, designed and built at PNNL<br><br>Report detailing the planned testing approach, technical basis, and verification and validation methods | Completed |
| 3. Alloy 600/82/182 CI testing | EPRI | Raw data, technical reports, and other information as it is developed<br><br>Monthly status reports | 12/31/2018 |
| 4. Alloy 690/52/152 CI testing | EPRI | Raw data, technical reports, and other information as it is developed<br><br>Monthly status reports | 12/31/2018 |

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|---|---|---|---|
| 5. (Optional) Alloy 690/52/152 and Alloy 600/82/182 | NRC and EPRI | Raw data, technical reports, and other information as it is developed<br><br>Monthly status reports | 12/31/2020 |
| 6. Expert Panel Review of Test Program | NRC and EPRI | Panel summary report | Annually |

**Additional Notes on Tasks**

*Task 1: Test plan development*: The NRC and EPRI shall jointly develop the testing matrix to provide mutually agreeable direction for the research in the interest of attaining the goals of both EPRI and RES. The test plan may be subject to modifications upon mutual agreement of both Parties. Modifications will likely be necessary over the course of research activities as data are produced and evaluated. The NRC will be responsible for initial test plan development funding. Subsequent funding for test plan modifications shall be the responsibility of EPRI until funding parity is met.

*Task 2: Phase 1 - Develop testing and evaluation infrastructure:* Completion of this task requires a shakedown and commissioning test to confirm that the testing systems are adequate and function as intended. Task 2 will compromise Phase 1 of the project. Proof of viability (as defined by reproducibility and the identification and/or establishment of accuracy, precision, and bias) of the testing systems requires confirmation that cell loading, instrumentation, and environmental controls of the system function as intended. Upon review and acceptance of the V&V letter report provided by PNNL, at the agreement of both Parties, the program shall proceed to Tasks 3 and 4.

*Task 3: Phase 2 - Alloy 600/182 CI testing:* Task 3 may occur concurrently with Task 4 during Phase 2 and is subject to modification upon mutual agreement of both Parties, consistent with Task 1. EPRI shall provide all funding for the experimental testing until RES and EPRI have both contributed equally to program costs at which point each party shall provide equal funding for subsequent costs upon agreement. All research efforts and testing shall be contingent on mutual agreement of both EPRI and the NRC. The administration of research efforts shall be the responsibility of both parties, and periodic re-assessment of current and future test plans shall be performed jointly. With respect to any data acquired in this task, the NRC and EPRI shall not draw joint conclusions. Any regulatory analysis of the data to determine applicability to and impact on existing or new regulation shall be done independently. At such time that the NRC and EPRI wish to present analyses or conclusions for further mutual discussion, this should, as appropriate, be done in a public meeting. PNNL will provide a report(s) that transmits the test data and other information required to interpret the test data in accordance with their contractual obligations.

*Task 4: Phase 2 - Alloy 690/52/152 CI testing:* Task 4 may occur concurrently with Task 3 during Phase 2 and is subject to modification upon mutual agreement of both Parties, consistent with Task 1. EPRI shall provide all funding for the experimental testing until RES and EPRI

have both contributed equally to program costs at which point each party shall provide equal funding for subsequent costs upon agreement. All research efforts and testing shall be contingent on mutual agreement of both EPRI and the NRC. The administration of research efforts shall be the responsibility of both parties, and periodic re-assessment of current and future test plans shall be performed jointly. With respect to any data acquired in this task, the NRC and EPRI shall not draw joint conclusions. Any regulatory analysis of the data to determine applicability to and impact on existing or new regulation shall be done independently. At such time that NRC and EPRI wish to present analyses or conclusions for further mutual discussion, this should, as appropriate, be done in a public meeting. PNNL will provide a report(s) that transmits the test data and other information required to interpret the test data in accordance with their contractual obligations.

*Task 5: (Optional) Phase 3 - Additional Alloy 600/182 and Alloy 690/52/152 Testing:* Following Phase 2, additional PWSCC initiation testing will be considered as part of Phase 3. If it is determined that Phase 3 will be conducted under this MOU Addendum, it shall be subject to modification upon mutual agreement of both Parties. In Phase 3, all project tasks and costs will be divided equally between EPRI and the NRC under mutually agreeable terms. All research efforts and testing shall be contingent on mutual agreement of both EPRI and the NRC. The administration of research efforts shall be the responsibility of both parties, and periodic re-assessment of current and future test plans shall be performed jointly. With respect to any data acquired in this task, the NRC and EPRI shall not draw joint conclusions. Any regulatory analysis of the data to determine applicability to and impact on existing or new regulation shall be done independently. At such time that NRC and EPRI wish to present analyses or conclusions for further mutual discussion, this should, as appropriate, be done in a public meeting. PNNL will provide a report(s) that transmits the test data and other information required to interpret the test data in accordance with their contractual obligations.

*Task 6: PWSCC Initiation Expert Review Panel:* The purpose of this Expert Review Panel is to provide independent review of program needs, goals, and design. Portions of this task are required to be performed prior to engagement of Tasks 3 and 4. The Expert Review Panel is expected to meet during the annual Alloy 690 Research Collaboration and Expert Panel Meeting. A selected subgroup of the panel shall assemble to evaluate the viability of the PWSCC crack initiation research program. This evaluation may include, but is not limited to, analysis of testing approach and variability and parameters associated therein, materials selection and applicability, specific definitions and means of analysis for the testing, and design of test matrix and programmatic direction. The advisement of this Expert Review Panel may or may not be implemented at the discretion of both EPRI and the NRC.

*Qualifications for PWSCC Initiation Expert Panel Members*

Panel members must have demonstrated expertise in reactor component materials and manufacture, corrosion and corrosion control, and additional experience in the design, operating requirements, and fabrication of plant components.

VI. Availability of Funds

The NRC and EPRI's ability to carry out the activities of this MOU Addendum is subject to the availability of funding. It is also understood that the terms herein agreed to represent feasible commitments according to the best understanding regarding resources and costs to the parties at the time of signature.

VII. Disputes

Cooperation of this Addendum shall be in accordance with the laws and regulations of the United States. Any questions other than those related to intellectual property concerning the interpretation or application of this Addendum arising during its term shall be settled by mutual agreement of the parties.

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.

VIII. Modification and Integration

No modification of this Addendum shall be valid unless written and signed by authorized representatives of both EPRI and the NRC. This Addendum contains the entire understanding between the parties, and no understandings exist that are not set forth or incorporated by reference herein.

IX. Entry into Force

This Addendum shall enter into force upon signature by both parties and shall remain in force through the end of the term of the MOU, or applicable MOU or extension renewal date.

AGREEMENT

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| **/RA/** | **9/28/16** |
| Michael F. Weber | Date |
| Director of Nuclear Regulatory Research | |
| U.S. Nuclear Regulatory Commission | |

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|---|---|
| **/RA/** | **9/30/16** |
| Neil Wilmshurst | Date |
| Vice President and Chief Nuclear Officer | |
| Electric Power Research Institute | |