

MEMORANDUM TO: Ashok C. Thadani, Director
Office of Nuclear Regulatory Research

FROM: Michael E. Mayfield, Acting Director
Division of Engineering Technology
Office of Nuclear Regulatory Research

SUBJECT: REVISED ADDENDUM TO EPRI MEMORANDUM OF
UNDERSTANDING

Attached for your signature is a revision to the addendum between the Electric Power Research Institute (EPRI) and the NRC addressing the feasibility of underwater welding of highly irradiated in-vessel components (two copies, an original for EPRI and an original for RES). NRC and EPRI signed the original addendum to the MOU on May 14, 1999. The addendum was structured to accommodate a sole source contract through the NRC. Based on an EPRI solicitation (U.S. and abroad) and an NRC Federal Register Notice, General Electric Corporation (GE) was the only company to respond favorably (GE had developed specialized tooling to perform this type of work in a BWR in Japan). The NRC was unable, however, to reach an agreement with GE and negotiations ended in August 1999.

Because of the continued industry need for this effort, EPRI initiated discussions in August 1999 with FTI, Inc., regarding interest in this effort. FTI began studying other possible techniques for obtaining the reactor vessel samples. On September 21, 1999, EPRI signed a letter of agreement authorizing FTI to fabricate tooling and test the tooling using a reactor component mockup. This effort proved successful, and FTI is under contract to obtain samples from a nuclear vessel in January 2000.

EPRI and NRC staff have revised the May 14, 1999, addendum to accommodate this new effort. The NRC will competitively bid its part of the effort, which has been taken into consideration in the revised addendum. OGC has reviewed the attached addendums and has no legal objection to its implementation.

Attachments: As stated

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Distribution:
B. Kildee, OGC
C. Ader, PMPDAS/RES
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MEB r/f

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DATE	01/06/00	01/06/00	/ /00	/ /00	/ /00				

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RES File Code:

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

Welding Highly Irradiated Materials To Repair Degraded BWR In-Vessel Components

Background

The U.S. Nuclear Regulatory Commission (NRC) and the Electric Power Research Institute (EPRI) signed a Memorandum of Understanding (MOU) on November 25, 1997, to allow and encourage cooperation in nuclear safety research which provides benefits for both NRC and industry. These benefits include technical information exchange and cost sharing, whenever such cooperation and cost sharing can be accomplished in a mutually beneficial manner.

On May 14, 1999, NRC and EPRI signed an addendum to the MOU. The addendum was structured to accommodate a sole source contract (a company which had developed the specialized tooling to perform this type of work) through the NRC. The NRC was unable, however, to reach an agreement with this company.

The NRC and EPRI have discussed the possibility of seeking other companies with experience in the nuclear industry willing to undertake this effort. Thus, this modification to the May 14, 1999, addendum provides a revised framework to do so. This Modified Addendum supercedes the May 14, 1999, Addendum in its entirety.

Purpose

Environmentally assisted cracking has been detected during examination of BWR and PWR core internals fabricated from stainless steel and high nickel alloys. The majority of cracks detected to date were at BWR facilities and thus, the plants to be chosen for sampling will be BWRs. However, the results of the research performed under this study will be applicable to all plants in the U.S.

In the near future, the industry will have to make decisions whether to repair or replace those components for which continued structural integrity cannot be assured. Mechanical repairs have been implemented for some components, such as the BWR core shroud. Other repair options, such as weld repairs, are being considered where mechanical repairs are not viable. However, a concern has been raised with regard to weld repair of highly irradiated core internals because of the potential for the helium in the steel to contaminate the weld, thereby possibly further reducing the component's integrity. There are many complicated issues to be addressed in developing welding technology for use in repairing in-vessel components. Some of the issues which will have to be addressed are: (1) determination of the helium concentration range for which weld repair is feasible; (2) determination of optimum welding parameters; (3) limited access to in-vessel components for inspection or repair; (4) high radiation levels which require a remote repair approach or a well-shielded environment; and (5) development of remote techniques to address the limited access and high radiation levels for in-vessel components.

Objective

This addendum addresses in-vessel sampling of BWR components. The objective of this effort is to better characterize the range of helium and boron concentrations expected in components considered for weld repair so that the feasibility of using standard welding techniques, as well as modified techniques, to affect the structural repair in these locations can be determined.

Period of Performance:

The parties commenced work under this addendum on September 21, 1999, and performance will continue through December 31, 2002.

Project Direction and Coordination:

Technical meetings to coordinate this effort and to assess progress will be arranged through the respective project managers for each organization. The project managers are:

Robert C. Thomas, EPRI
 Manager of Nuclear Operations
 & Asset Management Technology
 Energy Conversion
 3412 Hillview Avenue
 Palo Alto, CA 94304-1395

Wallace E. Norris
 Materials Engineering Branch
 Division of Engineering Technology
 M/S T-10E10
 Washington, DC 20555-0001

There are multiple activities to be performed under this project. The NRC or EPRI will be individually responsible (with the proper coordination) for certain activities, and none of the activities will be co-funded. To ensure that the overall effort is successfully completed, NRC and EPRI must coordinate proposed contract actions prior to either party entering into an agreements with others. To avoid confusion and maintain consistent project direction, the project managers will discuss matters related to project direction prior to the performance of the activities by the contractor. Following is a summary of the scope of activities and funding responsibilities to be performed under this Addendum (Attachment 1, Scope of Work, addresses the activities to be performed in further detail):

Scope

- (1) Four samples will be obtained from the BWR vessel Jet Pump Riser Brace Pad at three different plants. EPRI will be responsible for funding the effort at the first plant. NRC will be responsible for funding the effort at plants two and three.

The plants chosen shall meet the following criteria:

- (a) primary system configuration generally representative of those presently operating in the U.S.;
- (b) vessel with high thermal fluence levels;
- (c) planned outage consistent with the planned schedule; and
- (d) willingness to cooperate with all of the parties participating in this effort.

After the samples from each plant have been obtained and analyzed, a joint determination will be made by the respective project managers whether it is necessary and prudent to proceed with obtaining samples at each succeeding plant.

The project managers are Robert C. Thomas, EPRI, and Wallace E. Norris, USNRC.

- (2) The samples will be analyzed to measure the helium, boron, cobalt, magnesium, iron, nickel, and niobium content of each sample. This task will be funded by the NRC. This information will be made publicly available.
- (3) EPRI will negotiate with the Japanese to obtain data related to helium and boron concentration, estimated fluences, and the weldability of high fluence material. This task will be funded by EPRI.
- (4) NRC will be responsible for funding an effort to analytically predict thermal fluences based on the laboratory data (those plants which cannot provide information such as fuel inventory, fission products, structural components, moderator amount and density, and burnable poisons in fuel or moderator will not be included in this effort). At present, fluence calculations for these components are imprecise. Hence, there is a large uncertainty regarding component weldability. It is anticipated that refining fluence calculations will decrease this uncertainty and may permit a greater number of components to be welded rather than replaced. In addition to using a code which has been in wide use for some time, this task will include (for at least one plant) the use of a code based on the state-of-the-art technology, which has been developed recently. This comparison between the two techniques should advance the state of knowledge in radiation transport computation technology. The new code may be used in calculating fluences for the other two plants, pending the availability of funding, and the determination that it is technically beneficial.
- (5) The respective project managers will coordinate the technical information exchanges to be held between EPRI and the NRC.

EPRI Feasibility of Welding Reports

EPRI will provide to the NRC copies of final Boiling Water Reactors Vessel Inspection Project (BWRVIP) proprietary reports developed in support of determining the feasibility of welding highly irradiated BWR in-vessel components, which will be subject to the MOU addendum entitled, "Treatment of NRC Proprietary and EPRI Commercial Information." EPRI will also provide to the NRC a nonproprietary copy of these reports for public disclosure.

Funding

All NRC funding for work to be conducted in future fiscal years is subject to the availability of appropriated funds.

Dispute

If a dispute arises out of or relating to this Agreement, or any breach thereof, the parties will first attempt to settle the dispute through direct negotiation between the respective project managers. If such dispute cannot be settled by the respective project managers, the dispute

shall be submitted to the Director of the Office of Nuclear Regulatory Research, USNRC, and the Vice President, Science & Technology and Chief Nuclear Officer, EPRI.

Completion of Work Scope

The undersigned representatives of the funding parties or their designees shall review the data and other information resulting from each phase of the work and jointly determine whether the next phase of the work should be funded. If a joint determination cannot be made that it is necessary and prudent to proceed with obtaining samples at plant 2 or plant 3, either party has the express right to proceed with the project.

AGREEMENT

Ashok C. Thadani, Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Robin Jones, Vice President
Science & Technology
and Chief Nuclear Officer
Electric Power Research Institute

Date

Date

SCOPE OF WORK**Task 1:**

- (A) The objective is to obtain four metallic samples from the Jet Pump Riser Brace Pad Assembly in the reactor vessel at each of three plants. EPRI will be responsible for funding the sampling tool development, procedure development, technical justification, personnel training, and the sampling effort at the first plant. NRC will be responsible for funding the efforts at the second and third plants. To ensure that the program is successfully completed, the respective project managers will inform and coordinate prior to entering into any agreement with other parties.

Following are the estimated costs for each plant:

Estimated costs for Plant 1: \$200,000 - \$250,000	[EPRI]
Estimated costs for Plant 2: \$25,000 - \$50,000	[NRC]
Estimated costs for Plant 3: \$25,000 - \$50,000	[NRC]

The plants chosen shall meet the following criteria: (1) primary system configuration generally representative of those presently operating in the U.S.; (2) vessel with high thermal fluence levels; (3) planned outage consistent with the schedule contained in the section entitled "Schedule" below; and (4) willingness to cooperate with all of the parties participating in this effort.

- (B) After the samples from each plant have been obtained and analyzed, a joint determination will be made by the respective project managers whether it is necessary and prudent to proceed with obtaining samples at each succeeding plant.
- (C) The contractor performing the sampling at each plant will separately issue a no-cost agreement with each utility for removal of the samples. However, the contractor should discuss in its proposal to EPRI and NRC issues related to the removal of the samples such as location on the jet pump riser brace pad assembly, orientation, and QA/QC (e.g., measures to ensure that the samples are not overheated; controls for tracking individual samples; decontamination of removal equipment).
- (D) The contractor will be responsible for specifying and procuring encapsulation containers suitable for shipping the samples to the laboratory for analysis. The NRC will be responsible for transmitting the samples to the laboratory.

Task 2:

The NRC will issue a work order under the NRC interagency agreement with DOE for PNNL to analyze the samples for the relative concentrations of helium, boron, cobalt, magnesium, iron, nickel, and niobium. This information will be made publicly available by the NRC. The NRC will be responsible for the costs of this contract. The laboratory will be responsible for disposal of the samples.

Following are the estimated costs for sample analysis:

Estimated costs for Plant 1: \$34,000
Estimated costs for Plant 2: \$34,000
Estimated costs for Plant 3: \$34,000

Task 3:

EPRI, on behalf of the Boiling Water Reactors Vessel Inspection Project (BWRVIP) utilities, is currently negotiating with the Japanese Owners Group (JOG) to obtain proprietary data on environmental assisted cracking in Japanese BWRs, including data on the helium and boron content in vessel materials, estimated fluences, and the weldability of high fluence materials. EPRI's rights to use the JOG proprietary data will include the U.S. utility BWRVIP; the transfer of rights to a wholly owned EPRI subsidiary; EPRI consulting services; and furnishing copies to the NRC. EPRI estimates that it will pay JOG over \$1.6 M to obtain the rights to use its proprietary data for these purposes.

EPRI will provide RES a copy of all final reports transmitted to the BWRVIP members with regard to the feasibility of underwater welding of highly irradiated in-vessel components.

EPRI will provide to RES five (5) nonproprietary copies of the above EPRI developed final reports; a copy will be placed in the NRC Public Document Room.

The estimated costs for the development of these reports is \$110,000.

Task 4:

NRC will be responsible for funding an effort to analytically predict thermal fluences based on the PNNL data (those plants which cannot provide information such as fuel inventory, fission products, structural components, moderator amount and density, and burnable poisons in fuel or moderator will not be included in this effort). At present, fluence calculations for these components are imprecise. Hence, there is a large uncertainty regarding component weldability. Refining fluence calculations will decrease this uncertainty may permit a greater number of components to be welded rather than replaced. In addition to using a code which has been in wide use for some time, this task will include (for at least one plant) the use of a code based on the state-of-the-art technology, which has been developed recently. This comparison between the two techniques will advance the state of knowledge in radiation transport computation technology. The new code may be used in calculating fluences for the other two plants, pending the availability of funding, and the determination that it is technically beneficial. The estimated cost for the one plant is \$500,000.

Schedule:

Presuming the candidate plants noted below are confirmed for sampling, then it is expected that sampling will be performed during the outages currently projected to begin on or about the times indicated:

Plant 1	1/11/00
Plant 2	9/10/00
Plant 3	10/7/00