

MEMORANDUM TO: Michael E. Mayfield, Acting Director  
Division of Engineering Technology, RES

THRU: Edwin M Hackett, Acting Chief  
Materials Engineering Branch  
Division of Engineering Technology, RES

FROM: Wallace E. Norris, Project Manager  
Materials Engineering Branch  
Division of Engineering Technology, RES

SUBJECT: REQUEST TO INITIATE CONTRACT

I recommend that you approve the contractual action for Job Code Y6249, Analysis of BWR Vessel Metallic Samples. My recommendation is based on the following:

The NRC and EPRI have entered into an agreement to fund individual portions of a project to determine the weldability of highly irradiated BWR reactor vessel internals. In order to make a weldability determination, the boron and helium concentrations of the internals must be known. Metallic samples will be obtained from three BWR plants and shipped to Pacific Northwest National Laboratory (PNNL) for analysis. The NRC will fund the analysis of the samples because the cost for the analysis would double if performed under a private contract. The research is relevant to an important and risk-significant regulatory issue as explained in the Background section of the attached SOW.

The research results are expected to aid in the resolution of the regulatory issue explained in the Background section of the SOW by satisfactorily addressing the question(s) articulated in the Objective section of the attached SOW.

The estimated cost (which is estimated at \$100K) is justified by the knowledge to be gained, as evidenced by):

- providing data which can be used by NRR in reviewing the adequacy of welded repairs of BWR vessel internals.

The best people and contractors are being pursued, as evidenced by:

- few places have the capability for performing this kind of analysis. The international community routinely transmits their irradiated samples to PNNL for analysis due to PNNL's extensive hot cell capabilities and the quality of work.

The research results will be timely because:

- cracking of BWR vessel internals has been reported. To date, repairs were accomplished by mechanical means. Due to the cost of replacements, it is a only a matter of time before NRR receives a request to review and approve a welded repair of a highly irradiated vessel component.

An appropriate level of peer review has been incorporated into the planning of the project. More specifically:

- the BWR Vessel Internals Project members, the participating utilities, the Japanese BWR Owners Group, and the NRC staff have reviewed the overall project.

Applicable reviews related to the proposed procurement action have been completed as indicated:

- user office concurrence

Attachments:

Statement of Work  
NRC Form 367

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Approved: \_\_\_\_\_

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

Date: \_\_\_\_\_

**NOTE:** After approval - Original to Project Manager, copy to R. Hoskins, MA.

OFFICE OF NUCLEAR REGULATORY RESEARCH  
DIVISION OF ENGINEERING TECHNOLOGY  
STATEMENT OF WORK

PROJECT TITLE: ANALYSIS OF BWR VESSEL METALLIC SAMPLES

JOB CODE: Y6249  
CONTRACTOR: PNNL  
SITE: Hanford  
STATE: WA

NRC TECHNICAL MONITOR: Wallace E. Norris  
301-415-6796  
FAX: (301) 415-5074  
e-mail: wen@nrc.gov

PRINCIPAL INVESTIGATOR: Brian Oliver  
509-376-9228

BUDGET ACTIVITY: 6015110105

WORK PERIOD: February 1, 2000 to July 1, 2001

INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) and the Electric Power Research Institute (EPRI) have signed a Memorandum of Understanding (MOU) to permit and encourage cooperation in nuclear safety research which provides benefits for both NRC and the nuclear industry, such as technical information exchange and the sharing of costs, whenever such cooperation and cost sharing can be accomplished in a mutually beneficial manner. A program for determining the feasibility of underwater welding of highly irradiated in-vessel components of boiling-water reactors (BWRs) is being developed between NRC and EPRI. Under this program, technical information and overall program costs will be shared by the NRC and EPRI. Metallic samples will be obtained from reactor vessel components at three BWR plants. Analysis of the samples will be performed by Pacific Northwest National Laboratory (PNNL). The specific work to be performed under this contract will provide an element of NRC's participation in the overall program.

BACKGROUND

Environmentally assisted cracking of BWR core internals fabricated from stainless steel and high nickel alloys has been detected during examination. The industry will have to make decisions whether to repair or replace those components for which continued structural integrity cannot be assured, and the NRC will have to review repair or replacement strategies. Because of the scarcity of data pertaining to welding highly irradiated materials in an underwater environment, the level of activity in the commercial nuclear industry related to the generic

issues associated with the reactor vessels and internals, especially repair options, has been increasing. There are many complicated issues to be addressed in developing welding technology for use in repairing in-vessel components. For example, the thermal fluence at the vessel wall is not well benchmarked. Two problems specific to welding highly irradiated materials are: (1) cracking during the welding process as a result of helium entrapment in the material; and (2) cracking attributable to irradiation-damaged microstructure in the components. In addition, access to in-vessel components for inspection or repair typically is limited, and the high radiation levels usually require a remote repair approach or a well-shielded work environment.

The purpose of this research project is to analyze samples obtained from BWR reactor vessel components at several U.S. BWRs. This data will be used in the feasibility of underwater welding of highly irradiated BWR in-vessel components project to estimate the ranges of concentrations for the U.S. fleet, estimate thermal fluence, and determine the feasibility of using welding techniques to effect structural repairs.

### OBJECTIVE

The overall objective of the program is to analyze metallic BWR vessel component samples to determine the concentrations of various radionuclides and conduct radiometric counting. The BWR vessel samples will be obtained under the feasibility of underwater welding of highly irradiated BWR in-vessel components project and shipped to PNNL for analysis under this project.

### LEVEL OF EFFORT FOR PROJECT

The level of effort for the analysis of the samples is 0.32 staff year [\$89.4K (662 hours @ \$135/hr average rate)].

### WORK REQUIREMENTS

#### SCOPE OF WORK (TASKS)

Perform the following work for three (3) separate batches containing four (4) samples each: characterize the helium and boron concentrations; conduct compositional analysis by X-ray fluorescence; conduct radiometric counting to determine the activities of Co-60, Mn-54, Fe-55, Fe-59, Ni-59, and Ni-63; and use the radiometric data to determine the fast and thermal neutron fluence exposures. The use of equipment associated with the analyses is estimated to be \$1.1K. If the compositional analysis indicates sufficient Nb-93, the activity of Nb-93m will also be reported and used in the fluence determinations. Any additional radionuclides detected during the gamma analyses will also be reported. The samples are expected to be in the 2 to 10 mg size range (as requested). The anticipated shipping dates for the batches are January 14, 2000, October 30, 2000, and November 10, 2000. The contractor obtaining the samples will provide the shipping containers, and PNNL will be responsible for cost associated with shipping the samples to PNNL. It is estimated that the cost of shipping the containers is \$3.2K.

Personnel handling these samples should be advised that the samples will be obtained from the BWR jet pump riser brace pad, which is attached to the reactor vessel wall.

Unused sample material is to be discarded approximately 6 months after completing the various analyses.

### REPORTING REQUIREMENTS

- A monthly business letter report is to be submitted by the 20<sup>th</sup> of the month to the NRC project manager with a copy to Michael E. Mayfield, Division Director, Peggy Cross-Prather, Management Analysis, Edwin M Hackett, Branch Chief, and the Division of Contracts and Property Management (DCPM), Office of Administration. The reports will identify the title of the project, the Job Code, the Principal Investigator, the period of performance, and the reporting period and will contain information as shown in Exhibit 12. Any administrative or technical difficulties which may affect the schedule or costs of the project shall be immediately brought to the attention of the NRC project manager.
- Individual plant names are to be considered proprietary; i.e., not to be used in publicly available reports.

### MEETINGS AND TRAVEL REQUIREMENTS

No travel is anticipated.

### PUBLICATIONS

RES encourages the publication of the scientific results from RES-sponsored programs in refereed scientific and engineering journals, as appropriate. If the laboratory proposes to publish in the open literature or present the information at meetings in addition to submitting the required technical reports, approval of the proposed article or presentation should be obtained from the RES project manager. The RES project manager shall either approve the material as submitted, approve it subject to NRC-suggested revisions, or disapprove it. In any event, the RES project manager may disapprove or delay presentation or publication of papers on information that is subject to Commission approval that has not been ruled upon or that has been disapproved. (Additional information regarding the publication of NRC-sponsored research is contained in NRC Handbook 3.8).

If the presentation or paper is in addition to the required technical reports and the RES project manager determines that it will benefit the RES project, the project manager may authorize payment of travel and publishing costs, if any, from the project funds. If the project manager determines that the article or presentation would not benefit the RES project, the project manager can specify that the costs associated with the preparation, presentation, or publication will be borne by the contractor. For any publications or presentations falling into this category, the NRC reserves the right to require that such presentation or publication not identify the NRC's sponsorship of the work.

As requested by Battelle, the NRC will provide a copy of the publications and relevant reports in which the sample analyses data has been used.

### SUBCONTRACTOR INFORMATION

A portion of each sample batch will be shipped to the University of Missouri (PNNL has a service contract), which will provide radiation services. Prior to testing the samples for boron, the samples must be subjected to sufficient thermal neutrons. The university provides this service in their test reactor. The cost is estimated to be \$6.0K.

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An appropriate level of peer review has been incorporated into the planning of the project. More specifically:

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NRC Form 367

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

Date: \_\_\_\_\_

**NOTE:** After approval - Original to Project Manager, copy to R. Hoskins, MA.

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DATE	01/06/00	01/ /00					

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