STATEMENT OF WORK
HIGH DENSITY POLYETHYLENE PIPING
ADDITION to the ADDENDUM of MEMORANDUM OF UNDERSTANDING
between
U.S. NUCLEAR REGULATORY COMMISSION
and
ELECTRIC POWER RESEARCH INSTITUTE
on
COOPERATIVE NUCLEAR SAFETY RESEARCH

Memorandum of Understanding for Nondestructive Examination

Background

On March 14, 2007, the U.S. Nuclear Regulatory Commission (NRC) and the Electric Power Research Institute (EPRI) signed a Memorandum of Understanding (MOU) to allow and encourage cooperation in nuclear safety research that 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. The MOU 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 MOU should not be interpreted in a manner inconsistent with, and shall not supersede, applicable laws and regulations.

The EPRI NDE Center and the Office of Nuclear Regulatory Research (RES) signed an Addendum to the NRC/EPRI Memorandum of Understanding on March 22, 2011, which allows and encourages cooperation in nuclear safety research that provides benefits for both NRC and industry. Specific areas of collaboration were identified in Attachments 1 through 5 to the Addendum (1. visual testing, 2. cast austenitic stainless steel, 3. ultrasonic testing in lieu of radiographic testing for repairs, replacements, and modifications, 4. documentation of the basis for ASME Section XI, Appendix VIII, and 5. root mean square error – inner diameter pipe examinations depth sizing). This statement of work (SOW) addressing high density polyethylene (HDPE) piping adds a sixth area for collaboration.

The NDE Addendum to the NRC/EPRI MOU acknowledges that emerging degradation issues at existing plants or issues regarding new plant designs related to the areas of nondestructive examination (NDE) and inservice inspection (ISI) will be of interest to both organizations and therefore candidates for future inclusion under the Addendum. Further, the Addendum states "… additional SOWs may be added to this Addendum without having to revise the Addendum provided: i) the provisions of the Addendum are not modified; ii) new SOWs are subjected to the same organizational approval process as the original Addendum; and iii) new SOWs are signed by the designated officials.

Purpose

Recent excavations at several nuclear power plants (NPPs) have found instances of significant wall thinning in carbon steel piping systems. The tasks described in Attachment 6 to the NDE Addendum to the NRC/EPRI MOU address issues related to the use of HDPE in buried piping systems.

Addendum to the NRC/EPRI MOU address issues related to the use of HDPE in buried piping systems.

The SOW in Attachment 6 does not modify the objectives, period of performance, project managers, or other provisions of the March 22, 2011, NDE Addendum.

AGREEMENT

Brian W. Sheron, Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

10/26/11
Date

Neil Wilmshurst, Vice President
Nuclear Sector
Electric Power Research Institute

11-2-2011
Date

ATTACHMENT 6

Table 6. Scope of Activities to be Performed and Funding Responsibilities

Task	Responsibility	Deliverables
HDPE		
1) Effectiveness and Reliability of UT and Microwave	EPRI: investigate effectiveness and reliability of UT, RT, NMR and possibly microwave to detect and characterize flaws	Submit technical paper to NRC
	NRC: investigate effectiveness and reliability of UT and microwave to detect and characterize flaws	Publish final report[1] that includes results of EPRI and NRC assessments
2) Detection and Characterization of Flaws	EPRI: work with NRC to develop test matrix and obtain samples	—
	NRC: work with EPRI to develop test matrix and obtain samples	—
	EPRI: conduct study in accordance with plan on detection and characterization of flaws	Submit technical paper to NRC
	NRC: conduct study in accordance with plan on detection and characterization of flaws	Publish final report that includes results of EPRI and NRC assessments
3) Acceptance Criteria	EPRI: assess Code Case N-755 acceptance criteria and develop improved acceptance criteria with a technical basis.	Submit technical paper to NRC and ASME
	NRC: assess Code Case N-755 acceptance criteria	Publish final report that includes results of EPRI and NRC assessments

[1] There will be one final report that includes assessments of the four tasks.

4) Code Case N-755-X, Volumetric and Visual Methods; Implementation of Code Case	EPRI: develop training materials and tests for HDPE V T personnel	Submit technical paper to NRC
	NRC: assess the interchangeability of these methods	Publish final report that includes results of EPRI training and NRC assessments

SCOPE OF WORK
High Density Polyethylene (HDPE) Piping

Background:

Recent incidents at several nuclear stations, including Braidwood Generating Station, Oyster Creek Generating Station, Oconee Nuclear Station, and Vermont Yankee Nuclear Power Station, involving radioactive contamination of groundwater wells and soil have caused NRC licensees and the NRC to take actions to address the source of the radioactive material (e.g., buried piping leaks) and to communicate the impact of such incidents to the public and other external stakeholders. Although the NRC actions in each incident have been adequate to prevent off-site releases in excess of Federal limits, the incidents raise questions about (1) the completeness of NRC actions to date, and (2) whether those actions need to be augmented.

Degradation in buried piping has occurred in safety-related and non-safety-related piping at nuclear power plants. The piping degradation referred to above has not affected the operability of safety systems, and the type and amount of radioactive material or chemicals released to the environment have been a small fraction of the regulatory limits. However, there has been at least one situation where bio-fouling led to severely restricted flow. In addition, the leakages and subsequent contamination has resulted in heightened public scrutiny.

Recent excavations at several nuclear power plants (NPPs) have found instances of significant wall thinning in carbon steel piping systems. The primary cause of degradation is that the metal surface of these systems was exposed to the elements when the coating was damaged during installation or degraded over time through wear and tear.

Nuclear industry representatives have been working with representatives from the gas transmission, mining, and plastic pipe manufacturers to develop American Society of Mechanical Engineers (ASME) Code requirements for the use of high density polyethylene (HDPE) piping at NPPs. Specifically, the representatives have been working on Code Case N-755, “Use of Polyethylene (PE) Plastic Pipe, Sections III, Division I, and XI.”

Several industry organizations are investigating NDE methods that can be applied to HDPE materials; ultrasonic techniques primarily, but there is at least one organization investigating the use of microwave technology for determining the structural integrity of joints. The ability of these techniques to detect and characterize flaws with air gaps caused by contamination has been demonstrated but not for voids and cold fusion (kissing bonds) .

Given that the Code Case proposes to allow HDPE materials to be used at or above the design temperatures for certain periods, it should be demonstrated that the requirements for HDPE addressing procedures, equipment, and personnel qualifications provide the necessary rigor. EPRI has developed a training program for the visual inspection of HDPE piping. The development of a demonstration program addressing performance would be a logical outgrowth of the training program.

A robust program is required to better understand the issues that have been raised and potential problems of for using HDPE in nuclear applications. It is believed that the range of

conditions can be assessed by testing the smallest diameter pipe (and thinnest wall thickness) and largest diameter (and thickness wall) projected to be used. An intermediate diameter may be required if warranted by early test results. With regard to Task 4, fracture mechanics experts will have to be engaged so that the critical flaw size is determined to guide the selection of flaw sizes and flaw types to include in the studies for the other tasks, i.e., understand how precise NDE has to be. Given the time that may be required to develop the critical flaw sizes, it may be necessary to make some assumptions regarding the smallest flaw sizes to be included in the studies so as to not delay important NDE work.

Task 1:

Various nuclear industry organizations are currently investigating the effectiveness and reliability of ultrasonic, RT and microwave technologies, for example, to detect flaws in HDPE joints. The NRC will be initiating a study to determine the effectiveness and reliability of visual and volumetric examination methods to detect and characterize surface breaking flaws and embedded flaws that are located at various through-wall depths and in various shapes. It is anticipated that the NRC's and EPRI's focus will be on phased array and time of flight diffraction (TOFD). EPRI conducted a preliminary study to assess the capabilities of microwave. The NRC will be assessing industry results relative to microwave (e.g., EPRI, Evisive). Under this agreement, EPRI will focus on the effectiveness and reliability of UT, RT, NMR and microwave technologies to detect flaws in HDPE joints. EPRI will develop and provide to NRC a technical paper providing its assessment of their investigation. NRC will develop a final technical report describing the findings of the research regarding the effectiveness and reliability of ultrasonic and microwave technologies for the examination of HDPE.

Task 2:

NRC and EPRI will determine an appropriate matrix of samples to assess the effectiveness associated with detection and characterization of flaws for visual and volumetric examination methods. Industry organizations are procuring HDPE specimens to conduct various investigations, and some of these specimens may be available for inclusion in this task. NRC and EPRI will develop a joint plan to obtain or procure samples in accordance with the matrix and conduct detection/characterization research.

Task 3:

The industry is working through the ASME to develop a technical basis regarding flaw sizes and acceptance criteria. NRC and EPRI will independently assess the acceptance criteria developed for the different NDE methods. The industry is also working through the ASME to determine the critical flaw sizes for different wall-thicknesses/diameters and the effects on critical flaw size with regard to effects from aging, temperature, and pressure. EPRI will develop and provide to NRC a technical paper providing the results of its assessment. NRC will develop a final technical report with its assessment of the acceptance criteria.

Task 4:

Future revisions of Code Case N-755 may allow the use of volumetric and visual methods. The industry would need to develop acceptance criteria for the chosen volumetric method(s). The NRC will investigate these criteria in its assessment of the interchangeability of NDE methods. The NRC will include the results of the assessment in the final technical report.