

Nondestructive Evaluation Program (QA)

Program Overview

Program Description

Nuclear plant components and materials can undergo substantial changes in a nuclear environment. Plant owners must remain attuned to these changes to ensure steps can be taken if necessary to avoid unsafe operations or minimize mitigation costs. Nondestructive evaluation (NDE) is an important tool for assessing component condition, but depends on the availability of qualified technologies, personnel, and procedures.

The Nondestructive Evaluation Program develops technologies and procedures to quickly, accurately, and cost-effectively inspect and characterize nuclear component condition and guide strategic decisions on whether and when to replace, repair, or continue operation. Research results are used to inform regulatory actions related to pre-service and in-service inspections. The Program also supports industry efforts to expand and accelerate the supply of qualified NDE workers in the nuclear industry.

Research Value

Research results from the Nondestructive Evaluation Program enable the accurate deployment of advanced inspection technologies to the nuclear power industry. Program activities also support the use of performance-based and risk-informed methodologies to improve inspection reliability. Collectively, these activities increase the accuracy of information used to assess material condition, lower operating costs, lower radiation exposure to workers, and assist plant owners in meeting regulatory commitments. NDE Program participants gain access to the following:

- NDE technologies, training, and regulatory/code support that can shorten plant outages, leading to savings of \$1 million or more per plant per day saved
- Technical justification for the use of NDE diagnostic capabilities during extended plant operation, supporting regulatory approval of license renewal or extension
- Implementation support for inspection and evaluation guidelines promulgated through the Electric Power Research Institute (EPRI) and industry materials analysis programs
- Qualification process for NDE personnel, procedures, and equipment in accordance with American Society of Mechanical Engineers (ASME) Section XI, Appendix VIII
- Technical guidance supporting code changes that can lead to improved pre-service and in-service inspections
- Strengthened NDE workforce through industry-focused training and central qualification resources

Approach

The Nondestructive Evaluation Program develops and demonstrates cost-effective and reliable inspection methods and analysis programs that can be integrated with structural and lifetime evaluations of power plant components and systems. NDE results contribute to more accurate characterization of nuclear component condition and help inform decisions on whether to replace, repair, or continue operation.

- Develop new and improved NDE hardware, software, databases, methods, and delivery of NDE products to support nuclear plant inspection programs
- Provide NDE qualification programs addressing personnel, procedures, and equipment that enable nuclear plants to comply with regulatory and industry requirements
- Integrate NDE research and development with risk-informed technology and human performance research
- Provide technical basis to guide regulatory and code activities related to pre-service and in-service inspections

Accomplishments

EPRI's Nondestructive Evaluation Program supports nuclear industry efforts to address emergent material- and inspection-related issues through innovative NDE technologies, technical guidance, and qualification support.

- Published guidance for planning and executing efficient, effective examinations of dissimilar metal welds. Guidance was published publicly so that NDE vendors and utilities could collaborate to achieve greater success.
- Developed a buried piping NDE test facility. The test facility's first installation is a 220-foot run of 24-inch piping containing several elbows and controlled defects. It will be used both for technology development and for NDE vendor capability benchmarking.
- Completed the first qualification for ultrasonic examinations of pressurized water reactor (PWR) vessel head penetrations. Although the qualification process was difficult, it achieved its main objectives before the aggressive regulatory deadline.
- Successfully pilot-tested a risk-informed repair/replacement activity methodology (RI-RRA) and received regulatory approval from its use. The methodology allows plants to replace low safety-significant components with commercial components rather than N-stamp components. Because ASME Section XI requirements would no longer apply, cost reductions of 3-10X are expected.
- Evaluated the use of guided wave ultrasonics and alternating current field measurements for inspecting spent fuel pool liner welds. If undetected, leaks from these welds could lead to contamination of groundwater and surrounding soils.
- Developed qualified phased array ultrasonic procedures for fast, high-coverage examinations of reactor pressure vessel welds, austenitic and ferritic piping welds, dissimilar metal welds, and weld overlays. Phased array technology can examine a complex weld overlay configuration using only two scans, while a conventional approach would require as many as 20 scans.
- Developed 3D laser imaging and mathematical modeling tools for examining reactor vessel nozzles.
- Published initial guidance for NDE detection and measurement of gas accumulation in piping.
- Developed guidance for planning and executing effective examinations of dissimilar metal welds.

Current Year Activities

Nondestructive Evaluation Program research and development for 2011 will address a number of nuclear component materials issues where effective NDE is essential. Specific efforts will include the following:

- Identify and characterize best practices for examining buried piping
- Maintain qualification program for NDE of reactor pressure vessel head penetrations
- Convert risk-informed programs to applicable engineering code standards

Selected NDE program activities are conducted in whole or in part in accordance with Title 10, Code of Federal Regulations, Part 50, Domestic Licensing of Production and Utilization Facilities (10CFR50), Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, and may invoke Part 21, Reporting of Defects and Noncompliance (10CFR21). Additional NDE program activities may be conducted in accordance with 10CFR50 Appendix B and 10CFR21 at the discretion of the Nondestructive Evaluation Center, member utilities or EPRI, when such action is deemed appropriate.

Estimated 2011 Program Funding

\$10.3 million

Program Manager

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Summary of Projects

Project Number	Project Title	Description
P41.04.01.01	NDE Research and Development (base) (QA)	The base program conducts collaborative research and development of nondestructive evaluation technology (NDE) to address nuclear plant materials issues and characterize component degradation. Collaborative research and development of nondestructive evaluation technology to address nuclear plant materials issues and characterize component degradation.
P41.04.01.02	NDE Applications and Technology (QA) (supplemental)	The Nondestructive Evaluation Applications and Technology Transfer project develops products that support the demonstration, qualification, and technology transfer of NDE technology to field-usable products and services.
P41.04.01.03	NDE PDI Training and Qualification (QA) (supplemental)	This project provides general operation and maintenance support of the Performance Demonstration Initiative (PDI) program. Through the PDI program, utilities and their service providers, NDE personnel, NDE procedures, and equipment are qualified in accordance with ASME Section XI, Appendix VIII.

NDE Research and Development (base) (QA) (068030)

Key Research Question

The existing nuclear fleet has a proven track record of operating safely and effectively. Extending this track record will depend on continued, reliable insight into the condition of materials to assess and address aging and degradation. Nondestructive evaluation (NDE) plays a vital role in managing material aging issues. In recognition of this increasing role, EPRI conducts NDE research and development to develop NDE solutions that assist the nuclear power industry in safely operating and maintaining existing nuclear assets.

Approach

The Nondestructive Evaluation (NDE) research and development program focuses on developing more efficient and more accurate NDE devices and techniques. Staying ahead of materials issues requires sustained R&D. The program addresses NDE of all major plant components, including piping, vessels, balance-of-plant, and reactor internals. Emerging materials issues also are being tackled, including buried pipe, cast stainless steel, civil structures, and spent fuel. A wide range of NDE technologies are being evaluated, including ultrasonic guided-wave, low-frequency phased arrays, and laser-based technologies.

R&D activities employing the latest NDE techniques will address a variety of challenging materials inspection issues:

- Buried components
- Cast stainless steel
- Civil structures and materials
- Reactor vessel internal components
- Spent fuel pool and transfer canal liners

Impact

- Inspection strategies targeting existing and emerging degradation issues
- New inspection technologies for buried pipe, concrete, and cast stainless steel
- NDE approaches that facilitate life extension

How to Apply Results

The results of the NDE Program are primarily delivered as technical reports or guideline documents that are used by utilities and their inspection vendors to develop inspection strategies. Additionally, the results of the NDE Research & Development Program are often used as the technical basis for generic inspection strategies and procedures.

NDE Applications and Technology (QA) (supplemental) (068025)

Key Research Question

Nondestructive evaluation (NDE) capabilities address a number of nuclear power industry needs, including pre-service and periodic in-service inspection of components to satisfy regulatory requirements, inspection to characterize component condition, and inspection to guide strategic decisions on whether and when to replace, repair, or continue operation of components. The nuclear power industry must remain cognizant and receptive to the introduction of new technology while ensuring confidence in the overall reliability of the NDE processes employed. Often, the industry requires technical assistance to support the implementation and effective application of advanced NDE technologies.

Approach

The NDE Applications and Technology program provides the nuclear power industry with a collaborative "ready now" NDE resource focused on today's operations and emerging issues. A team of more than 40 EPRI NDE technical staff target nuclear power applications and enable NDE technology transfer through the following activities:

- Inspection strategies and application plans using the results from the EPRI NDE research and development program
- Regulatory and code support for pre-service and in-service inspections
- Evaluation of NDE technology to address aging plant and equipment reliability issues
- Resources to facilitate the supply of qualified NDE workers in the nuclear industry
- Supporting member utilities with independent assessments of NDE technology and results

Impact

NDE Applications and Technology Transfer program participants benefit from the development and application of NDE hardware, software, databases, and methods. These products include technical services support to participating nuclear units, as well as technical support to other EPRI Nuclear programs, including the Performance Demonstration Initiative (PDI), materials programs (Materials Reliability Program [MRP], Boiling Water Reactor Vessel and Internals Project [BWRVIP], Steam Generator Management Program [SGMP]), Low-Level Waste, Balance of Plant Corrosion, Advanced Nuclear Technology, and Fuel Reliability.

How to Apply Results

The results of the NDE Applications and Technology Transfer program are provided through EPRI technical reports and guidelines that member utilities directly apply. In some cases, program participants may elect to apply the results via service organizations that provide in-service inspection and other related inspection services. Participants also apply the results of the program through collaborative resources such as NDE mock-ups and generic procedures. Indirect methods of application also are used, including technical changes to inspection codes, NDE training materials for participants and their suppliers, and the release of good practice documents targeting increased public awareness and confidence in the reliability of NDE.

NDE PDI Training and Qualification (QA) (supplemental) (061738)

Key Research Question

Revisions to 10CFR50.55(a), initially published September 22, 1999, mandate the implementation of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Division 1, Appendix VIII, Performance Demonstration for Ultrasonic Examination Systems. Appendix VIII requires qualification of the procedures, personnel, and equipment used to detect and size flaws in certain piping, bolting, and reactor pressure vessel components.

Approach

This program includes the general operation and maintenance of the Performance Demonstration Initiative (PDI) program. This includes quality assurance (QA) activities, document control, and database maintenance.

Impact

The PDI program is administered by EPRI to address the requirements of the ASME Boiler and Pressure Vessel Code, Section XI, Division 1, Appendix VIII, in a collaborative, efficient, cost-effective, and technically sound manner.

How to Apply Results

Results of the PDI program may be applied by member utilities and organizations that provide in-service inspection services as defined in the PDI use agreement. Additional information on the application of the results is available at www.epriq.com.

2011 Products

Product Title & Description	Planned Completion Date	Product Type
<p>PDI Program 2011: For 2011 and the foreseeable future, maintaining the Performance Demonstration Initiative (PDI) Program as a collaborative program is expected to be the most efficient method for utilities to comply with the mandatory Performance Demonstration requirements within American Society of Mechanical Engineers (ASME) Section XI, Appendix VIII. The PDI Program includes the management, oversight, and implementation per the PDI quality program. This includes quality assurance (QA) activities, document control, and database maintenance. Through the PDI Program, utilities and their service providers, NDE personnel, NDE procedures, and equipment are qualified in accordance with ASME Section XI, Appendix VIII. The PDI Technical Advisory Committee provides oversight of PDI program operations and via the NDE Program integration Committee recommends policy and procedures to the NDE Action Plan Committee. The costs associated with conducting performance demonstrations are not included in this project; these are recovered from user fees.</p>	12/31/11	Technical Resource