Non-Destructive Examination of Nuclear Components

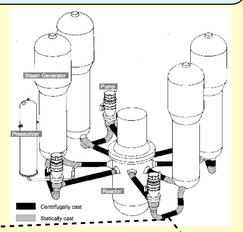
Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington DC, USA

The NRC Office of Nuclear Regulatory Research is investigating current non-destructive examination practices and evaluating advanced techniques to better understand the reliability of non-destructive examination techniques to be used in technical standards and regulatory positions.

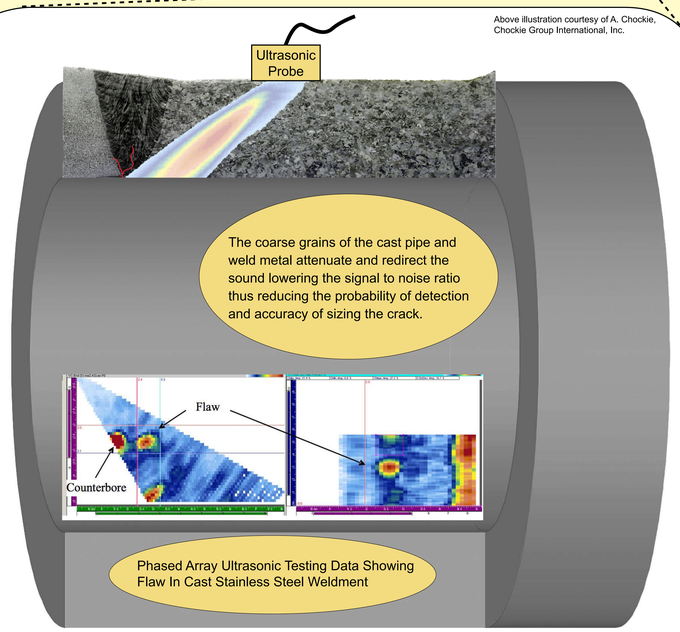
Example of Non-Destructive Examination Challenges:

Assessment of Crack Detection in Heavy-Walled Cast Stainless Steel Piping Welds Using Advanced Low-Frequency Ultrasonic Methods

Non-destructive testing is used to detect degradation of nuclear components such as cracking of primary loop piping as required by 10 CFR 50.55a.



Above illustration courtesy of A. Chockie, Chockie Group International, Inc.



The coarse grains of the cast pipe and weld metal attenuate and redirect the sound lowering the signal to noise ratio thus reducing the probability of detection and accuracy of sizing the crack.

Phased Array Ultrasonic Testing Data Showing Flaw In Cast Stainless Steel Weldment

Examples of Current Non-Destructive Examination Research Programs:

NRC-Industry Collaborative Program on Alloy 600 issues. Cracked control rod drive mechanism nozzles (CRDMs) were removed from the discarded North Anna 2 pressure vessel head. Under this collaborative program, research will be performed to:

(1) generate Alloy 600 crack growth data to disposition flaws;
(2) validate the results of field exams of CRDM damage mechanisms;
(3) determine the meaning of NDE signals from field examinations;
(4) determine impact of findings on susceptibility models;
(5) address PWR vessel head penetration inspection and repair.

Benchmark on Risk-Informed Inservice Inspection Methods (RISMET); The objective of the benchmark is to assess both the impact of RI-ISI methods on reactor safety, and how the differences between methods influence inspection programs.

NUREG/CRs to be Published in FY07:

A Study of Remote Visual Methods to Detect Cracking in Reactor Components

Fatigue Crack Flaw Tolerance in Nuclear Power Plant Piping — A Basis for Improvements to ASME Code Section XI Appendix L

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Assessment of Eddy Current Testing for the Detection of Cracks in Cast Stainless Steel Reactor Piping Components

Fabrication Flaw Density and Distribution in Repairs to Reactor Pressure Vessel and Piping Welds

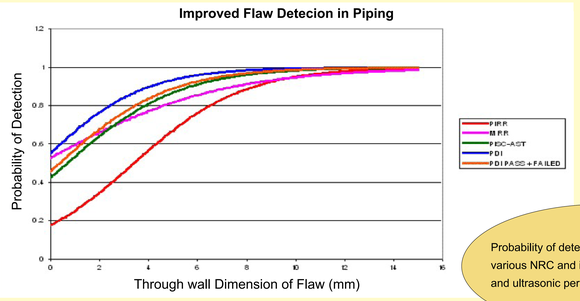
Evaluations of Structural Failure Probabilities and Candidate Inservice Inspection Programs

Example of International Program on NDE Reliability:

Program for the Inspection of Nickel Alloy Components (PINC)

Photo courtesy of JAPEIC

Data from comparative studies of non-destructive examination procedures from around the world yield probability of detection and accuracy of sizing of flaws in piping welds and vessel penetrations.



Probability of detection data were taken from various NRC and industry round robin studies and ultrasonic personnel qualifications

Doctor, S.R. and F.L. Becker. 2002. Two Decades of improvement in Austenic Stainless Steel Piping SIS, Porceedings of Joint EC-IAEA tech, Meeting on Improvements in In-Service Inspection Effectiveness, Petten, The Netherlands