



EPRI

ELECTRIC POWER
RESEARCH INSTITUTE



Inspection of cast austenitic stainless steel



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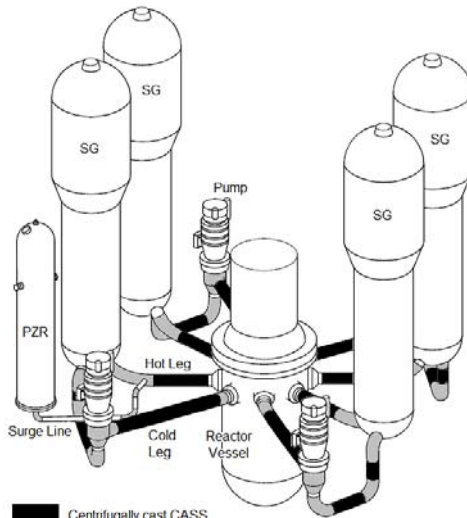
- Summary of EPRI NDE projects involving CASS material
 - Completed Projects (4)
 - Ongoing Projects (4)
 - New Projects (2)

Completed Projects

Flaw Tolerance Evaluation of Thermally Aged CASS (Deterministic Approach)

- Objective

- Determine critical flaw size for CASS material throughout the industry
- Develop suitable flaw acceptance criteria for ASME Sect.XI



- Method

- Calculations based on fracture mechanics and flaw growth analysis
- Using a range of material properties and operating conditions that encompass the industry
- Include a safety margin that follows the current ASME methodology

- Results

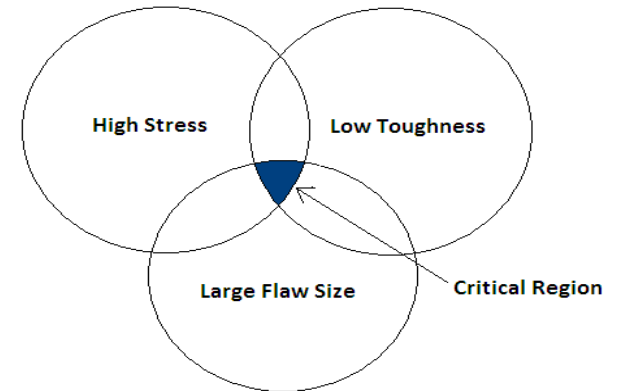
- Large variations in the essential variables were noted throughout the industry
- Most likely not the appropriate solution for industry wide critical flaw size determination
- Results published in Report 1019128

Completed Projects

Probabilistic Model for the Reliability of Thermally Aged CASS (Phase I)

- Objective

- Predict failure probability vs. time at temp with respect to ranges of critical flaw sizes
- Bypasses the need for conservative bounding values
- Used to predict thermal embrittlement
- Results used to determine critical flaw sizes in CASS



- Method

- Generate computer model similar to PRAISE Code for probabilistic evaluation of degraded piping
- Estimate the distributions of random variables
- Define and run example problem

- Results

- The results of Phase 1 are currently being reviewed
- A draft report has been generated and is expected to be published later in 2011

Completed Projects

Guidelines for the Inspectability of New Components (Including CASS)

- Objective

- Provide guidelines for fabrication and design of new nuclear systems
- Necessary steps for effective preservice and inservice NDE
- Prevent known problems that the existing nuclear fleet is experiencing
- Provide a document that aids the newest generation of engineers in the development of nuclear components

- Method

- Compile information pertaining to NDE problems and solutions experienced throughout the industry
- Tap “aging resources” to prevent the loss of important knowledge

- Results

- A large amount of information was obtained and documented
- The 2010 report includes a section dedicated to CASS components
- Results published in Report 1021160 (Considered a must read for 2011)

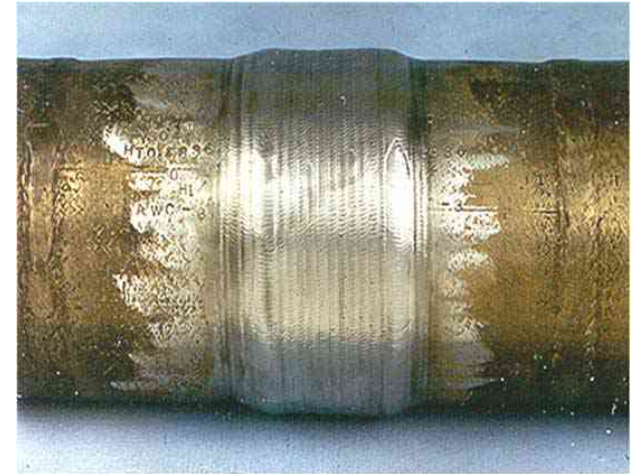


Completed Projects

Low Frequency UT for WOL on CASS Base Material

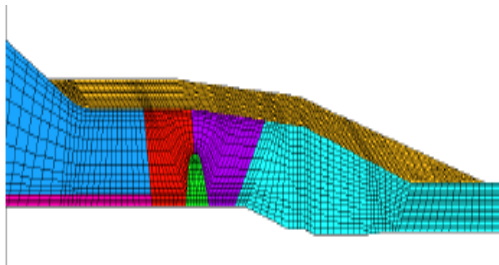
- Objective

- Investigate the effectiveness of low frequency UT on WOL specimens with CASS base material
- Compare low frequency UT techniques and traditional higher frequency techniques
- Determine current limitations of CASS base material examinations through WOL material



Method

- Utilize mockups recently manufactured for the PDI WOL program
- Mockups have a limited number of indications in the CASS base material that were intended for research only
- Inspect the mockups with various low frequency instruments and search units



- Results

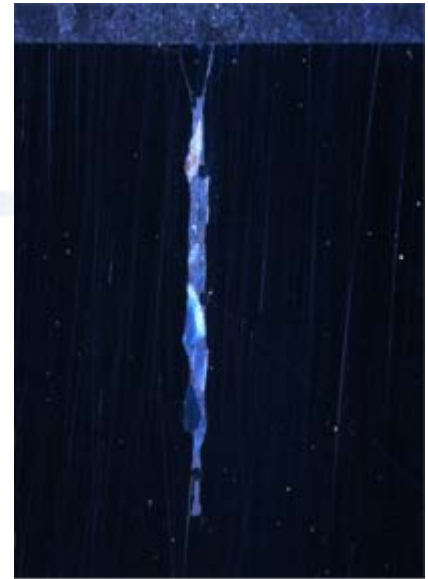
- Improvement noted over standard higher frequency techniques
- Some flaws could not be detected and others were difficult to fully characterize
- Results from this study suggest that current low frequency techniques could result in an increased level of false calls – note of caution
- Results published in Report 1021145

Ongoing Projects

Flaw Fabrication in CASS Components

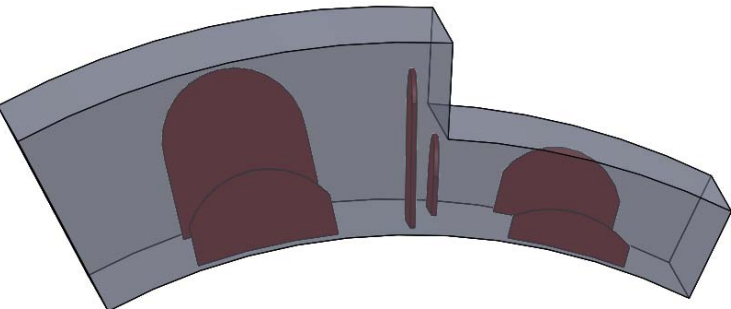
- Objective

- Supply the industry with an open set of flawed mockups that provide realistic NDE responses
- Discover a way to implant flaws into CASS base material without disturbing the unique grain structure



Method

- Determine the limitations of current flaw making technology
- Work with mockup manufacturers to develop new flaw making techniques
- Test flawed mockups with the latest NDE technology to determine if the response is realistic (no tell tale signs)



- Results

- 500 kHz 45°/60°L conventional UT data collected on both the thick and thin sides
 - 45°L focused at the inside surface provided better signal-to-noise ratios.
 - 60°L focused near the notch tip yielded improved depth sizing results.
- PNNL has requested to collect ultrasonic phased array data on this specimen.
- Currently discussing alternative flaw fabrication techniques with domestic and international companies
- Results to date are published in Report 1021146



Ongoing Projects

Acquisition and Analysis of CASS Material

- Objective

- Identify sources for non-contaminated vintage CASS material
- Negotiate the purchase or donation of vintage CASS material
- Identify a reliable source for additional material



- Method

- Scour the earth for leads to sources for material
- Work with foundries to manufacture new “old” material
- Perform grain structure analysis on the material and catalog the results



- Results

- Obtained four statically cast main loop elbows and a centrifugally cast surge line pipe from two US utilities
- Recently took receipt of the first simulated vintage CASS material and awaiting results of the grain structure analysis
- Results to date are published in Report 1021146

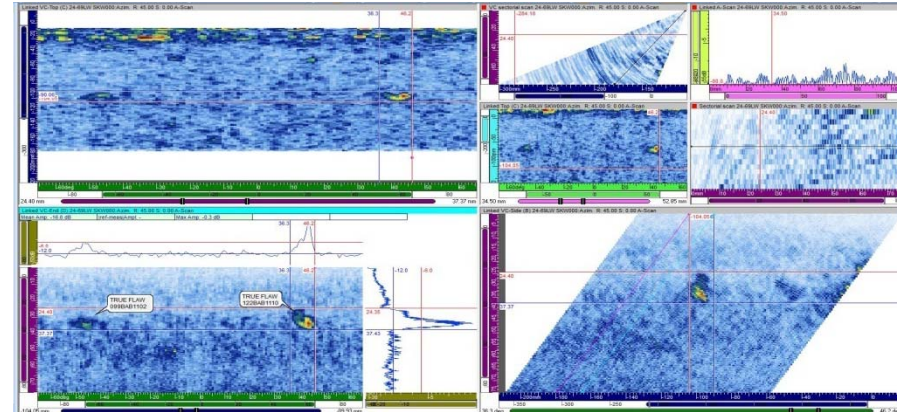
Ongoing Projects

Inspection Results on CASS Less than 2" Thick

- Objective
 - Determine if current NDE techniques are capable of reliably detecting and characterizing flaws in CASS material less than 2" thick
 - Aid in the development of a code case for the inspection of CASS components less than 2" thick
- Method
 - Obtain as many vintage CASS specimens as possible and expose them to currently qualified UT techniques
 - Perform and catalog the grain structure analysis for as many of the specimens as possible
 - Utilize both conventional and phased array UT techniques
- PNNL Cast Elbow Data Acquired by EPRI (Next Slide)
 - TruFlaw Thermal Fatigue Crack Dimensions:
 - 19.3 mm by 3.4 mm
 - 25.3 mm by 6.0 mm

Ongoing Projects

Inspection Results on CASS Less than 2" Thick PNNL Cast Elbow Data (True Flaws)



- Results

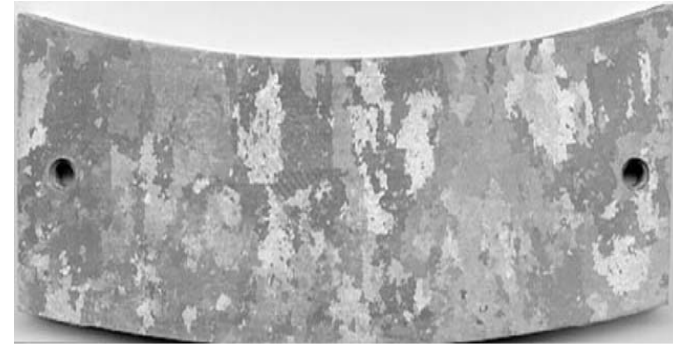
- Small reflectors (10% to 20%) are difficult to detect in some CASS material
- Precise length and depth sizing is difficult and in some instances unobtainable
- Some CASS material affects the UT propagation more than others (beam bending, attenuation, and reduced sensitivity)
- The ultrasonic instrument characteristics impacted results (pulse voltage, pulse width, bandwidth, etc.)
- The scanning direction may influence results.
- The ultrasonic phased array data was generally better than the conventional data (by as much as 5 dB).
- This study included a very limited number of specimens and reflectors

Ongoing Projects

Evaluation of Inside Surface Examination Techniques for CASS

- Objective

- Evaluate and develop UT and ET techniques deployable from the ID surface of CASS components
- Determine if ID connected flaws can be reliably detected from the inside surface of a CASS component



- Method

- Investigate new technologies and procedures for ET techniques
- Evaluate and possibly expand currently qualified ID UT inspection procedures

- Results

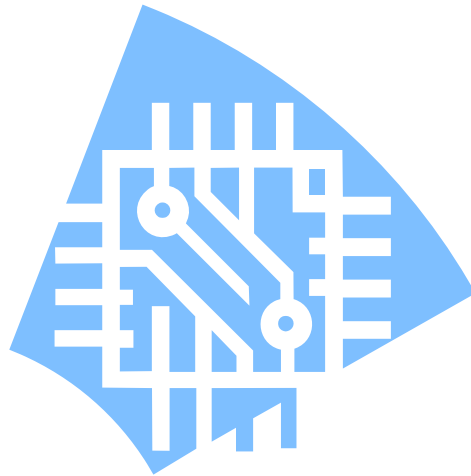
- An inspection vendor has finished scanning one set of the ID samples
- Other vendors have expressed an interest in working on this project
- Report will be published in 2011 describing the preliminary results of this project

New Projects

Signal Processing Advancements for CASS UT Examinations

- Objective

- Develop signal processing algorithms for more reliable flaw detection during UT inspections of CASS
- Increase signal to noise ratio by eliminating some of the material noise while amplifying the signal response from indications



- Method

- Develop the software and hardware necessary to perform the advanced signal processing
- Test the signal processing routines on specimens with known reflectors

- Results

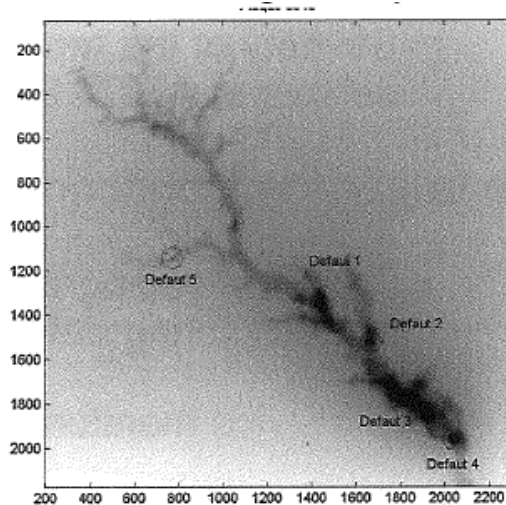
- The results of this project will be published in an annual report

New Projects

Probabilistic Model for the Reliability of Thermally Aged CASS (Phase II)

- Objective

- Develop final code for model
- Develop detection probability and crack size distribution statistics



- Method

- Refine model developed in Phase I
- Document final input assumptions
- Consider additional variable such as pore sharpening
- Continue research on inspection capabilities
- Characterize load inputs



- Results

- The results of this project will be summarized in a report to be published in early 2012
- Preliminary results will be published in the 2011 annual CASS Study report

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