Update of Nondestructive Examination Projects Funded by NRC at PNNL

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Presented at
NRC/EPRI/PDI Meeting
Dana Point, CA
December 6-7, 2011

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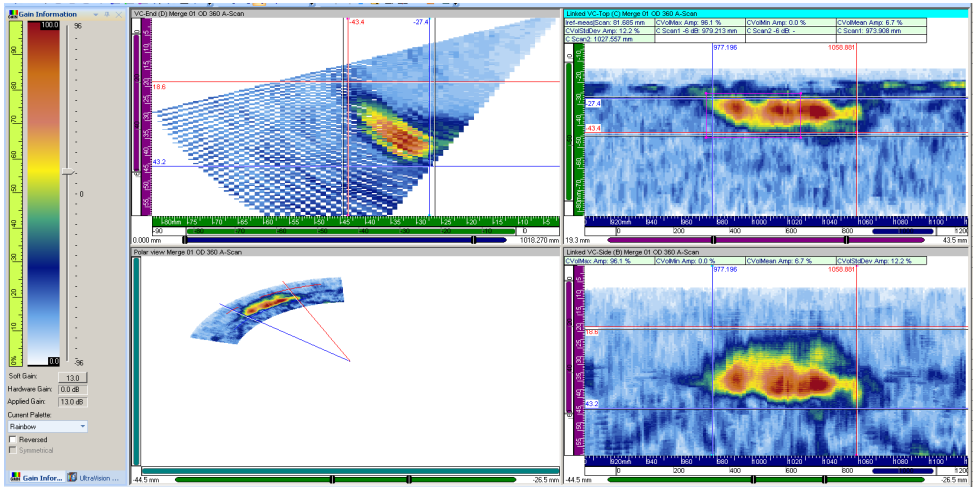
Primary NDE Research Project: JCN-N6398

- JCN-N6398, “Reliability of Nondestructive Examination (NDE) for Nuclear Power Plant (NPP) Inservice Inspection (ISI)”
  - Project Objectives:
    - Evaluate accuracy and reliability of NDE methods used for ISI
    - Provide information to NRC staff to assess adequacy of proposed industry changes to ISI programs
    - Provide recommendations to NRC staff to improve NDE methods
    - Evaluate effectiveness of ISI techniques for detecting service degradation
    - Provide technical assistance on NDE and related issues to NRC program offices on as-needed basis
- Wallace Norris, RES Project Manager
- Mike Anderson, PNNL Project Manager

Examination of CASS Piping JCN-N6398

- **NUREG/CR for phased array work on several CASS PZR line specimens being finalized by NRC**
  - Includes work by PNNL and ISI supplier (Supplement10 procedure) on implanted and in-situ grown thermal fatigue cracks in CASS surge line
    - ISI supplier and PNNL results almost identical
    - All flaws are easily detected; some tips available for depth sizing
    - Good S/N ratios for implanted and in-situ grown flaws
  - Axial and circumferential UT beam redirection measured and reported
  - ASME moving forward with Code Case for new Appendix III, Supplement 2



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Examination of CASS Piping JCN-N6398

- Continue to evaluate CASS materials
  - Examined CASS calibration blocks, on-loan from EPRI
    - Easily detected all machined reflectors in these blocks

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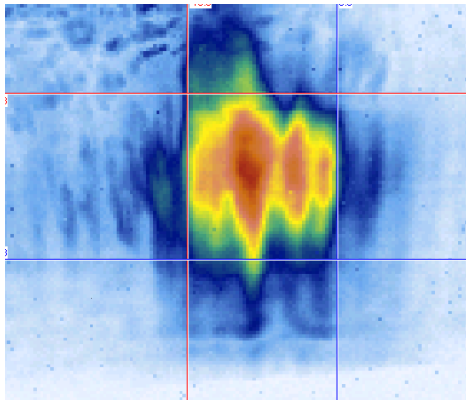
Examination of CASS Piping JCN-N6398

- UT beam mapping in thick section CASS
  - Data acquisition complete; analysis recently begun



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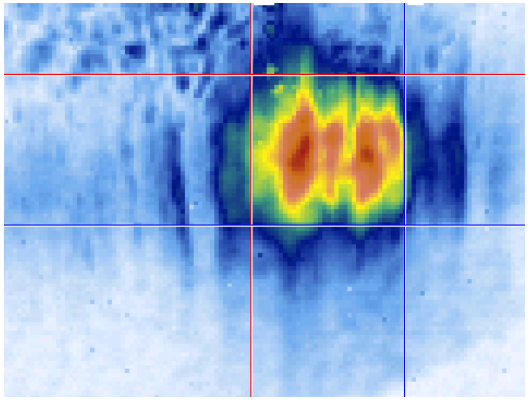

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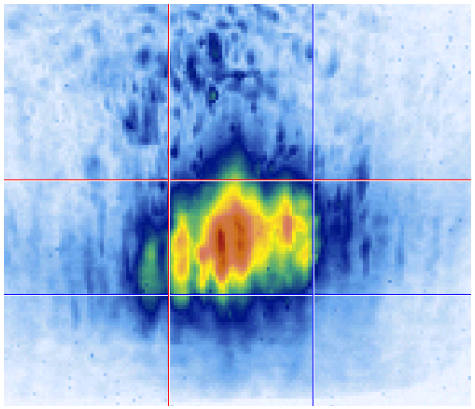
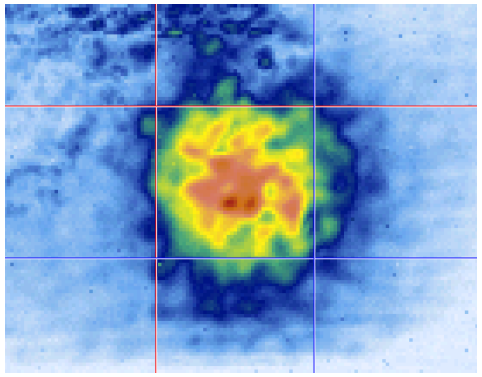
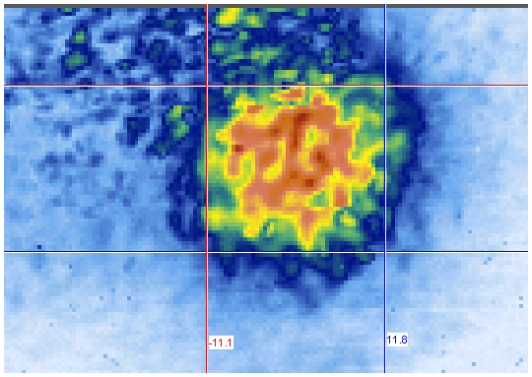
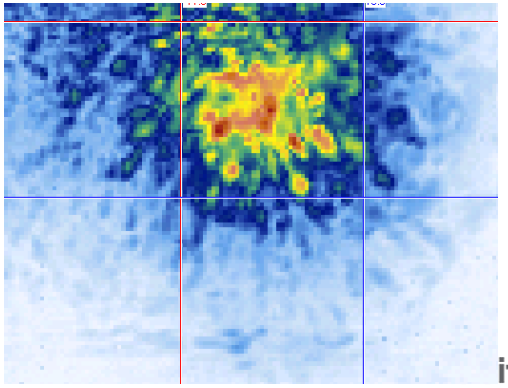


1 MHz

Columnar grains







Equiaxed grains

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DMW Examinations
JCN-N6398

- UT of specimens representing PZR surge, shut-down cooling and safety injection DMWs, TLR to NRC (PNNL-19018)
- Acquired UT data on RCP DMW – FPL specimen at EPRI
  - Data is yet to be analyzed
- Working with EPRI to access “practice” large-bore DMW specimens

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Remote VT Activities JCN-N6398

- Remote Visual Examinations
  - Assess capabilities and limitations of remote visual examination to detect cracking in RPV internal components
    - Parameters affecting reliable examinations
      - Crack opening dimension (COD) and length
      - Camera resolution, magnification, lighting effects and VT scanning speed
      - System calibration (resolution) standards
      - Others?
  - **Conduct round-robin (RR) exercises** to evaluate current industry application and assess new technologies
  - Phase I testing at the EPRI NDE Center completed in **August 2010**
    - Parametric study to refine specific parameters impacting remote visual examinations underway
      - Expected completion in December 2011
  - Planning for phase II RR continuing in collaboration with EPRI
    - Specimen design in progress
    - Recruitment of NDE vendors for Phase II complete; information gathering from participating vendors underway
    - Phase II RR currently planned for Summer 2012

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HDPE Activities
JCN-V6230

- High Density Polyethylene Piping
  - Industry thrust to use HDPE for non-safety system applications
  - NRC concerns about **lack of fusion flaws** being created in butt fusion joints
  - Conducted program to **assess NDE technologies** for performing volumetric inspections of butt fusion joints using laboratory techniques and commercially available technology
    - Ultrasonic testing with phased arrays and time-of-flight diffraction
    - Microwaves
    - Visual examination
  - Draft NUREG/CR report documenting all work has been submitted for NRC publication (December 2011)
  - Concluded initial scoping studies under JCN-N6398
  - New program started November 2011 under JCN-V6230
    - Pursuing more fundamental and systematic approach to explore the science of HDPE fusion and NDE inspections

Other Related Work

- **Assessing UT of full structural overlays on small-bore dissimilar metal welds**
  - Full WOL specimens examined
  - Data analyses; TLR being drafted
  - Appears that original flaws are easily detected through overlay
- **Evaluated EPRI POD DMW report** (MRP-262)
  - Compares POD with recent round robin exercises
  - Draft report awaiting more EPRI comments
    - Carl Latiolais provided only comments thus far
- **Evaluated UT responses from cracks, pre- and post-MSIP**
  - TLR on using MSIP as a PWSCC mitigation being internally reviewed
    - Includes NDE and strain measurement results, and assesses Code Case N-770-1 implementation re: MSIP

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Other Related Work

- NRC-EPRI NDE Collaborative Program
  - Currently includes several cooperative areas:
    - Examining CASS piping and welds
    - Remote visual testing
    - Using UT in lieu of RT; digital RT
    - Documenting technical basis for UT performance demonstration through Appendix VIII
    - Flaw-depth-sizing of DMWs examined from ID
  - Future potential collaborative areas:
    - Assessing technical issues for use of HDPE piping
    - Addressing NDE training/qualification issues

Technical Bases for Appendix VIII

- Objective: Document the rationale behind the current version of Section XI, Appendix VIII
- Steven Doctor and Tom Taylor initially went through Appendix VIII requirements and produced an annotated version containing technical basis, or rationale, as best remembered
  - Mike Gothard provided some comments on an early draft
  - More recently, EPRI NDE Center provided input and comments on draft technical basis report
    - Included Larry Becker in this review
    - PNNL has incorporated these comments – there are many good comments, but several others not related to goal of the report
    - Trying to identify and resolve some EPRI referenced documents
- Draft NUREG/CR is at the NRC undergoing NRO and NRR review

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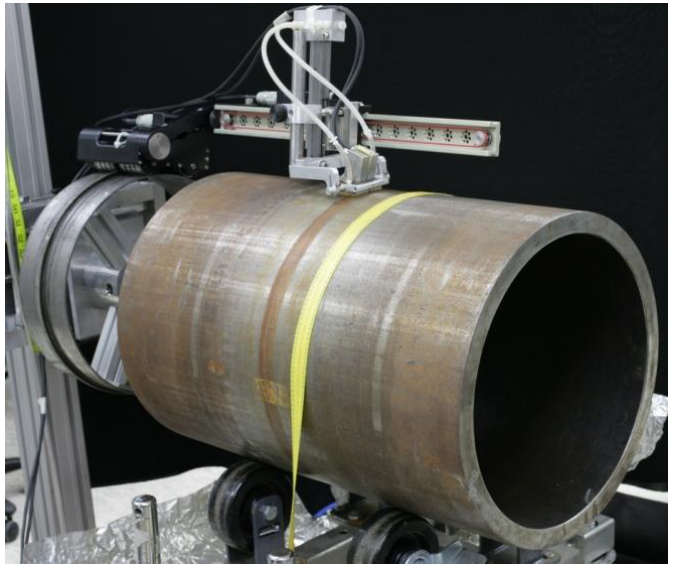
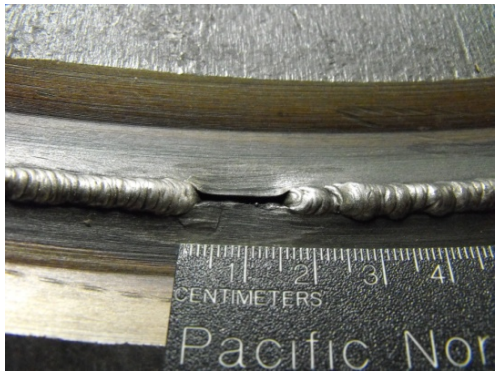
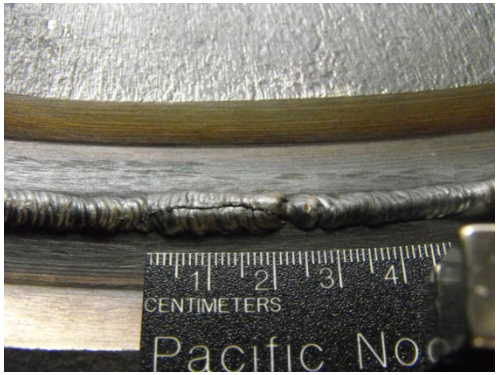
NDE-Related Research Projects – Carol Nove NRC Project Manager Al Pardini PNNL Project Manager

- JCN-V6097, Effectiveness and Reliability of UT and RT for NDE
  - Follow-on to gap analysis performed in 2010
  - Evaluating limitations and capabilities of UT and RT
  - Status: Current work aimed at assessing the capability of UT to detect, locate and characterize welding fabrication flaws in ferritic piping
    - Provide input to ASME Code actions
    - RT being used as a “true state” benchmark







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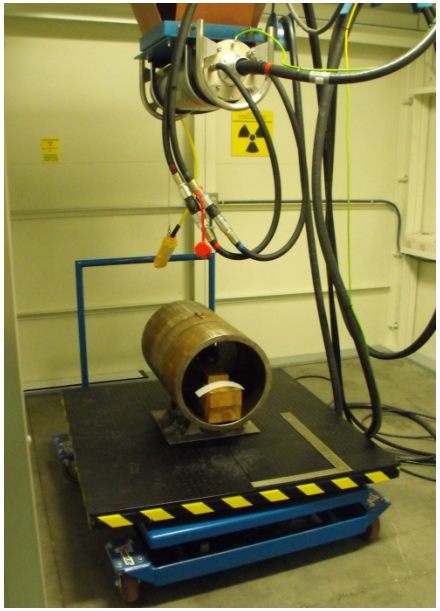
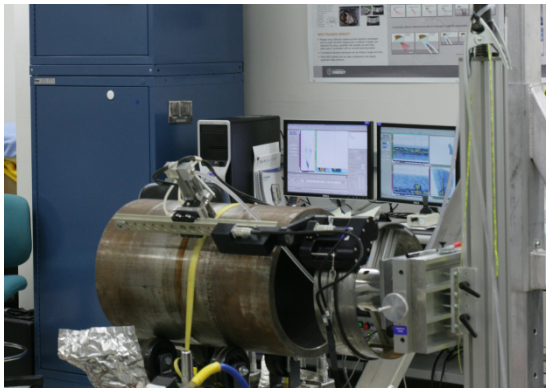
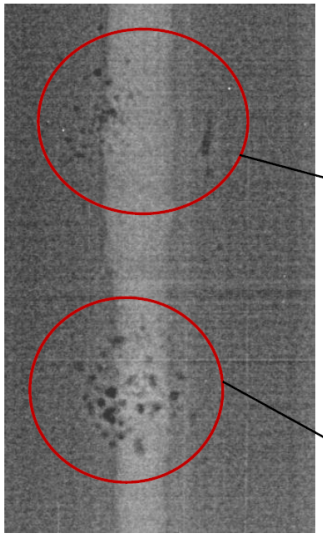
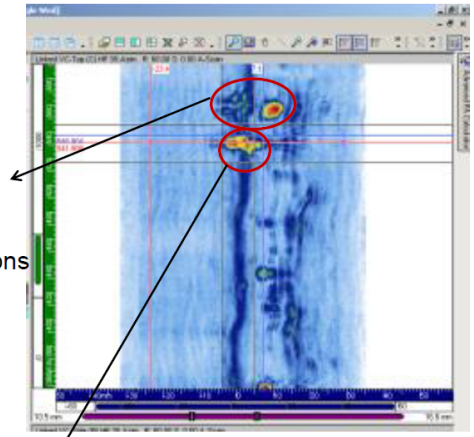
NDE-Related Research Projects – JCN-V6097 (cont'd.)

- PNNL is performing phased array UT and X-ray of each specimen.









Other "Bonus" indications

Flaw 7

Top View (C-Scan)

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Assess Emerging NDE for Dissimilar Metal Welds JCN-N6593

- The NRC Project Manager - Iouri Prokofiev
- PNNL Project Manager – Brett Braatz
- Project consists of following tasks:
  - **Program for the Inspection of Nickel Alloy Components (PINC)** - A cooperative international program to provide experimental data and correlations for assessing integrity of DMWs and BMIs – **Complete**
    - **NUREG/CR-7019** "Results of the Program for the Inspection of Nickel Alloy Components," published August 2010
  - **Program to Assess the Reliability of Emerging Nondestructive Techniques (PARENT)** – An international program to evaluate current and emerging NDE methods

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PARENT Program

- PARENT is currently underway, and is being supported by multilateral international agreements
  - Scope of work was cooperatively developed with international committee at the PARENT-1 meeting in June 2010
  - Bottom mounted instrumentation (BMI) nozzles and dissimilar metal weld (DMW) large and small bore piping to be included in open and blind testing phases
    - Open testing to assess emerging (new) NDE methods
    - Blind testing for field deployable technology as applied by qualified inspectors.
    - One blind test underway with other blind and non-blind to start in 2012
    - Data to provide insights on:
      - DMW POD for use on xLPR
      - Flaw sizing (RMSE) from ID with optimum UT inspection conditions
  - Closure on international agreements is expected in late 2011

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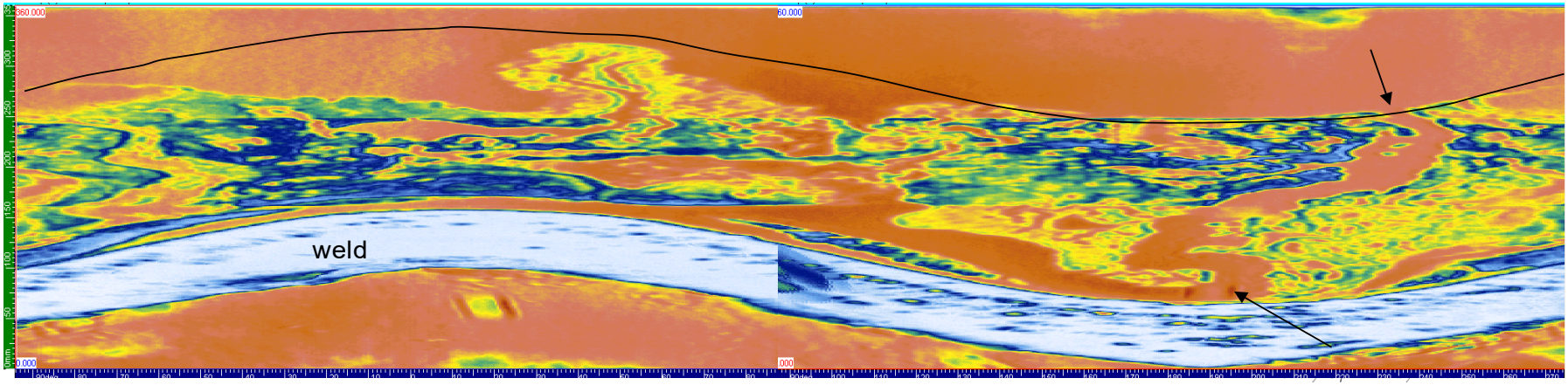
NDE-Related Research Projects – Properties of CRDM Welds - JCN N6783

- Greg Oberson – NRC Project Manager
- Brady Hanson – PNNL Project Manager
- Objectives – Assess the leak path on North Anna Unit 2, Nozzle 63
  - Ultrasonically examine the interference fit (region between penetration tube and low alloy steel) for wastage and boric acid deposits
  - Destructively evaluate (DE) the leak path – keeping the J-groove weld intact for possible future testing
- Status
  - Suspected leak path ultrasonically examined
  - DE work planned for completion in December



Questions?

Comments?

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