

## **Enclosure 6**

Memo from Donald G. Naujock to  
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PDI/NRC Meeting



## **Inspection & Mitigation of Alloy 82/182 Butt Welds**

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**Demonstration**

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# Inspection & Mitigation of Alloy 82/182 Butt Welds

## Scope

- **This project builds on the previously funded (MRP) work allowing the application of economically feasible pre-emptive weld overlays to large (greater than 27 inch diameter) Alloy 600 components which allow utilities to meet MRP-139 commitments**
- **Expand currently qualified procedures to address application of full structural overlays on main loop components**
- **Close inspection gaps present on smaller diameter complex Alloy 600 welds , including pressurizer nozzles and drain lines**
- **This project also evaluates techniques required to examine overlays that are applied over Alloy 600 welds that contain cast materials**

# Inspection & Mitigation of Alloy 82/182 Butt Welds

## Project Description

- **Fabricate samples to support the following tasks**
  - **Develop procedures and techniques to examine cast base material under weld overlays**
  - **Develop procedures and techniques to examine beyond the outer 25% of the original base material in order to reduce the size of the overlay for large diameter thick components**
  - **Develop code criteria in order to qualify the techniques developed**
  - **Expand currently qualified procedure thickness ranges**
  - **Obtain mitigation data to support the application of PWOL on large diameter components**

# Inspection & Mitigation of Alloy 82/182 Butt Welds

## Tasks & Deliverables

- MRP Funded Portion
  - Smaller Diameter Configurations
    - All have cast safe-ends
    - Surge Line Mock-ups have flaws at 50% and 75% of the original weld and base material thickness
    - In the cast and in weld
    - Delivered in January of 07
      - Development work underway



# Inspection & Mitigation of Alloy 82/182 Butt Welds

## • Tasks & Deliverables

- MEOG/NDEC Projects
  - Design and fabricate large diameter thick test samples (RCS)
    - February 2008 *(Complete, data collection underway)*
    - Document Mitigation Design Data April 2008 *(Underway)*
  - Complete Relief Request Template
    - November 2008 *(Working with Pilot Plant)*
  - Characterize samples and evaluate techniques
    - December 2008 *(Data Collection and Analysis Underway)*
  - If successful, qualify techniques
    - December 2008
- (First Application for Preemptive Overlay Targeted for September 08, if techniques are successful)*

# Inspection & Mitigation of Alloy 82/182 Butt Welds

## Benefits

- If successful this project will;
  - Allow the application of economically feasible pre-emptive weld overlays to large (greater than 27 inch diameter) Alloy 600 components
  - Expand current procedure thickness ranges to address application of full structural overlay on main loop piping configurations
  - Close several inspection gaps present on smaller diameter complex Alloy 600 welds , including pressurizer nozzles and drain lines
  - Develop and qualify techniques required to examine overlays that are applied over Alloy 600 welds that contain cast materials

# Inspection & Mitigation of Alloy 82/182 Butt Welds

- **Other Related Projects**

- “*Indication Evaluation & Disposition for Weld Overlays*”
  - Funded by EPRI NDE
  - Addresses sizing of embedded planar flaws and laminar flaws
    - Report completed “***Proposed Code Case Criteria for Technical Basis of Weld Overlay Indication Evaluation and Disposition Based on Advanced Technology Assessments 1015148***”
- Project includes development of code cases and relief requests in order to get criteria accepted by NRC and Code where needed
- Working with RRAC on preliminary evaluations of MIG overlay processes
  - Not presently funded under NDE program



# Overlays Over Cast Base Material (Thin wall)

- 4 samples delivered
  - (2) Pressurizer Safety Relief
  - (1) Pressurizer Surge
  - (1) Mainloop (RCP)
  - Axial and circumferential flaws
  - All flaws implanted with no tilt so they are equally challenging from both directions
    - No favorable side
- Some flaws in cast material propagate into overlay material

# Examination Overlays Over Cast Base Material (Thin Wall)

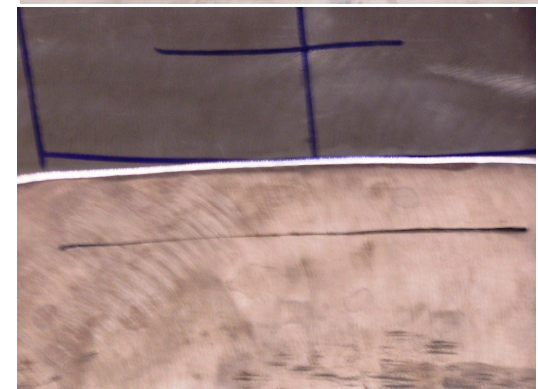
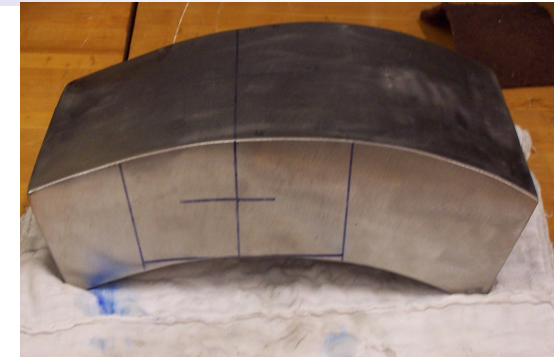
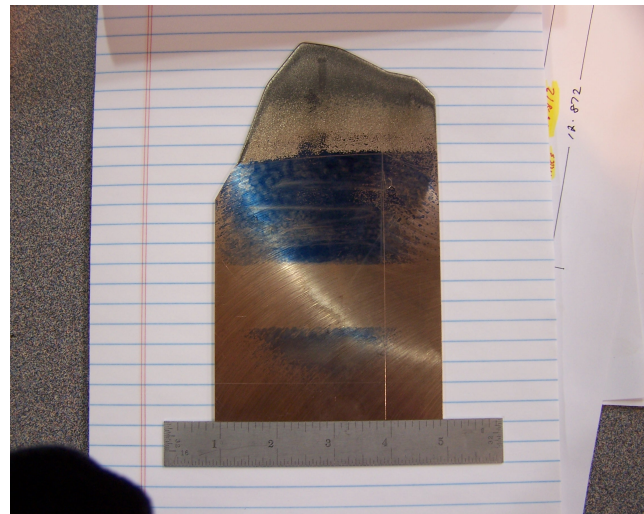
- Examination Thin Wall Overlays Over Cast Base Material with Conventional Techniques (1.5 MHz Search Units)
  - All flaws in weld and ferritic base material readily detected and sized
  - Portion of flaws in cast material that have propagated into overlay material are readily detected
  - Flaws in cast base material have not been detected to date with currently qualified conventional and phased array techniques

# Examination Overlays Over Cast Base Material (Thin Wall)

- Examination Thin Wall Overlays Over Cast Base Material with Low Frequency Techniques (500 KHz Search Units)
  - Initial evaluations with 500 KHz were successful in detecting all flaws in cast material, but depth sizing requires refinement
  - Responses from flaws in weld and base material poor
- Future Work
  - Ordered additional 500 KHz phased array search units (**Complete should receive May 2008**)
  - Searching for commercially available instrument capable of supporting these low frequencies
    - **Purchased new system capable of handling lower frequencies**
    - **System is new and has no existing qualifications to expand upon**

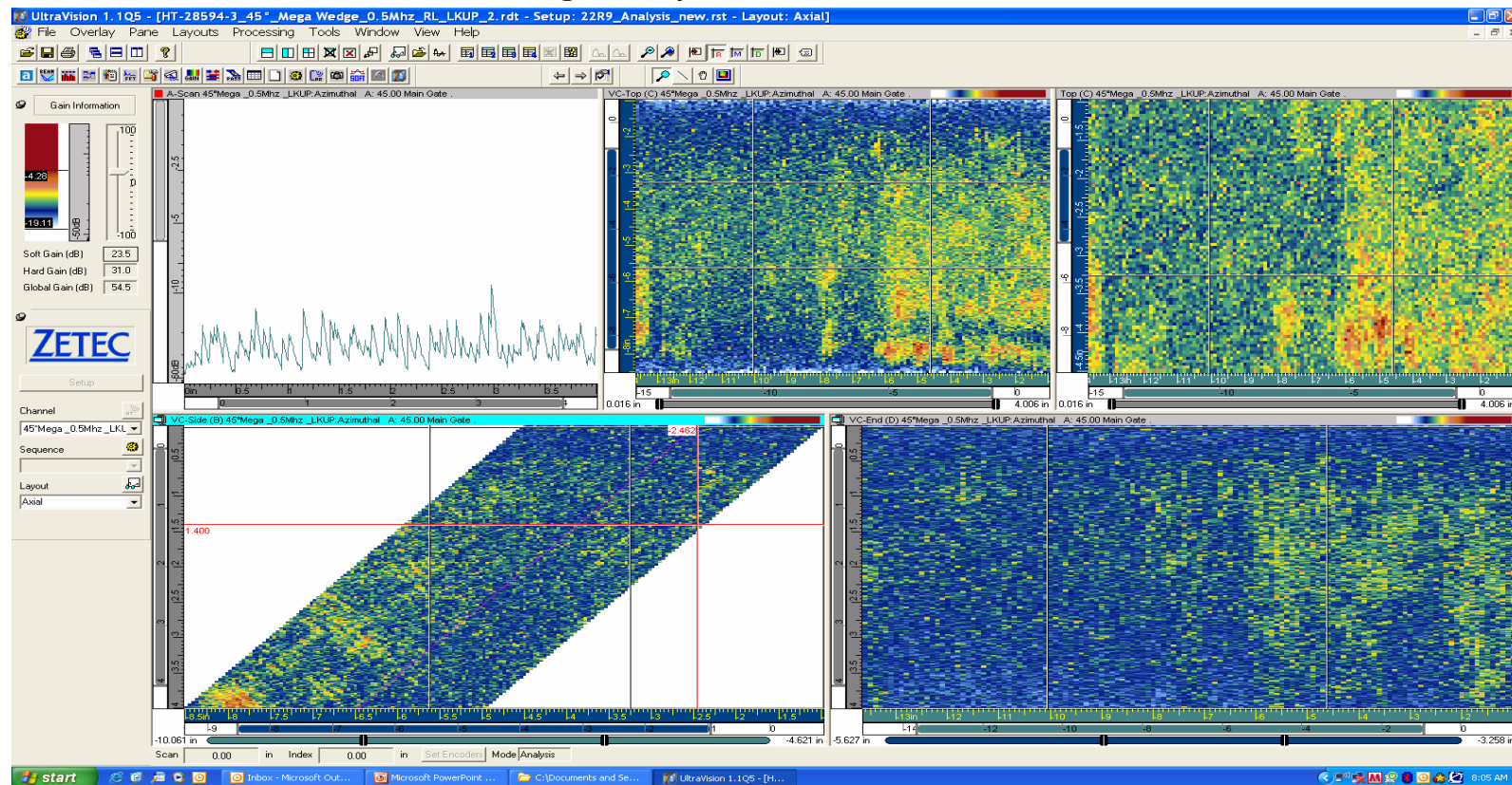
# Examination Overlays Over Cast Base Material (Heavy Wall)

- Main Loop Piping Sample
  - ~3.5" thick
  - Non-Overlaid
  - Statically cast
  - Large flaws



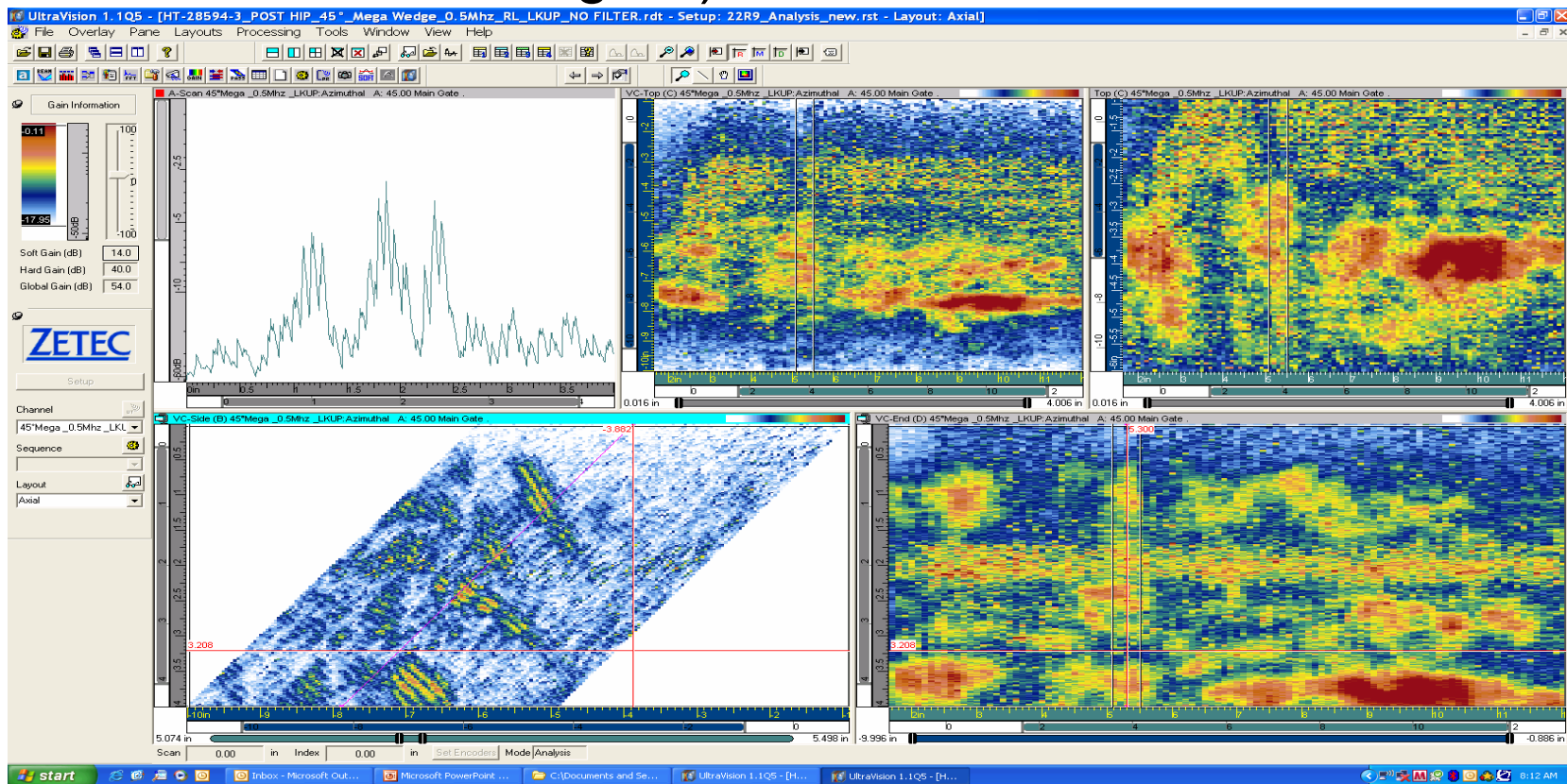
# Examination Overlays Over Cast Base Material (Heavy Wall)

- Response from flaw with conventional system (1.5 MHz Conventional 45 Degree)



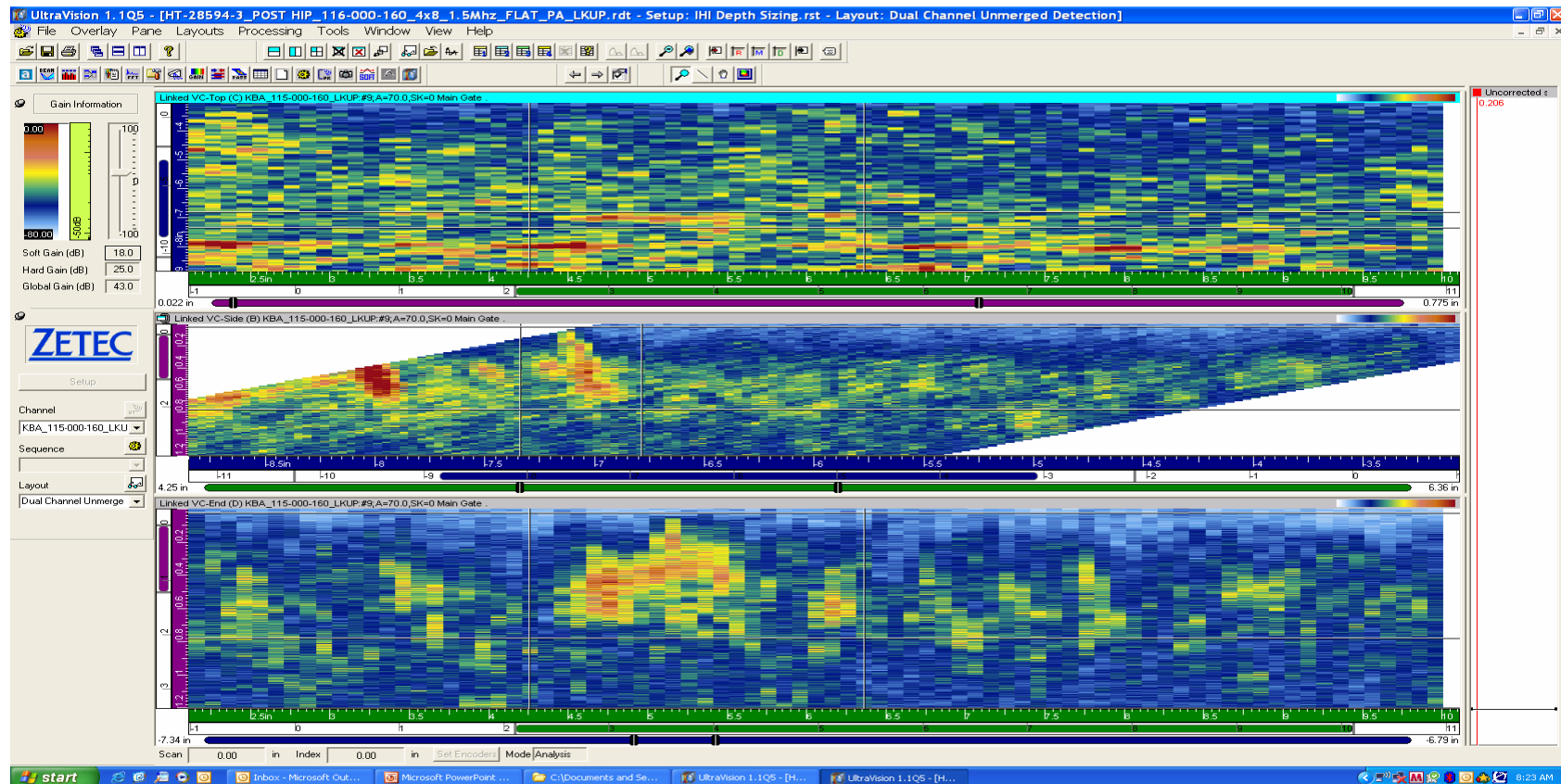
# Examination Overlays Over Cast Base Material (Heavy Wall)

- Response from flaw with modified system (500 KHz Conventional 45 degree)



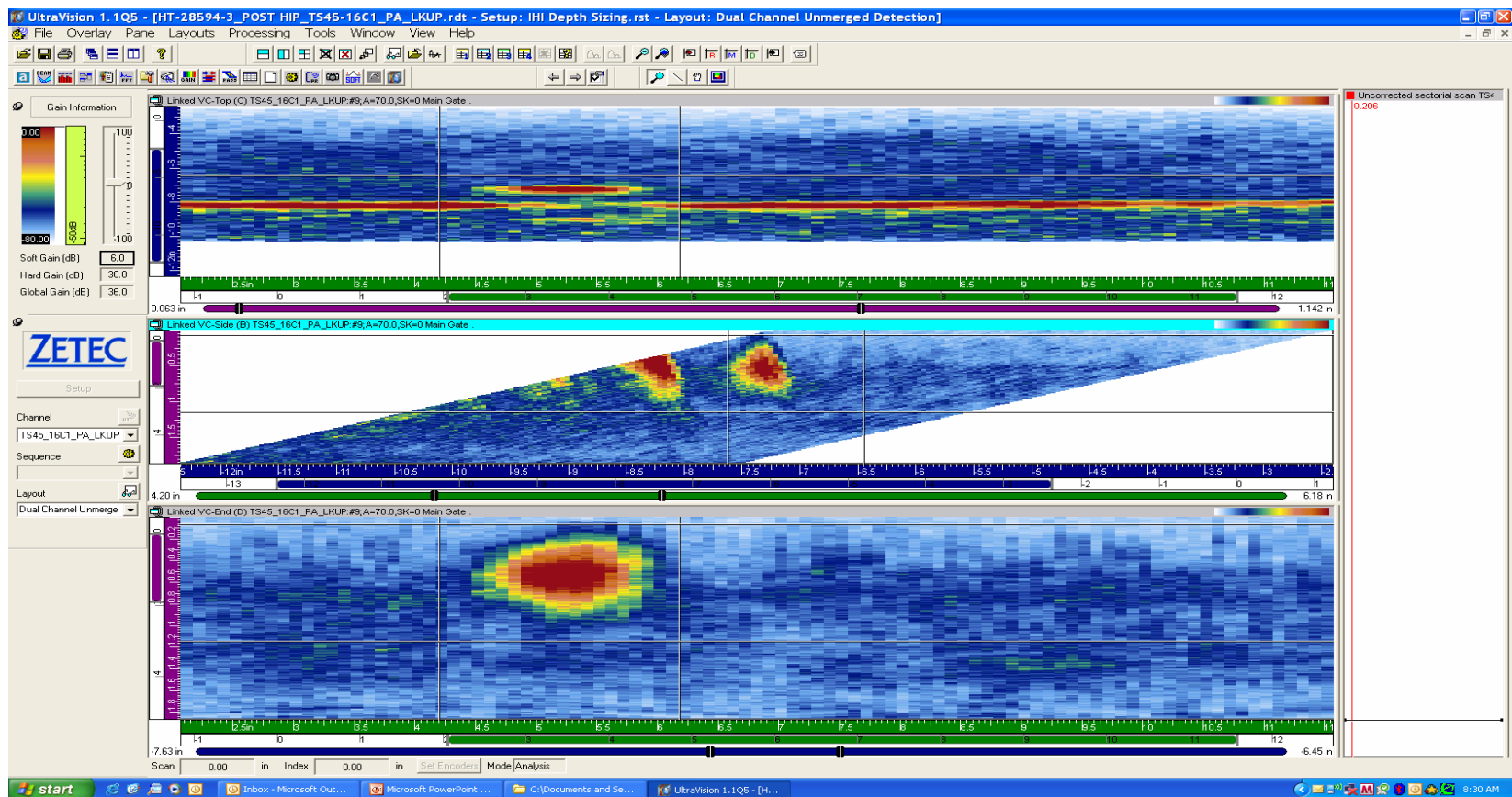
# Examination Overlays Over Cast Base Material (Heavy Wall)

- High Angle Response from 1.5 KHz Phased Array Search Unit



# Examination Overlays Over Cast Base Material (Heavy Wall)

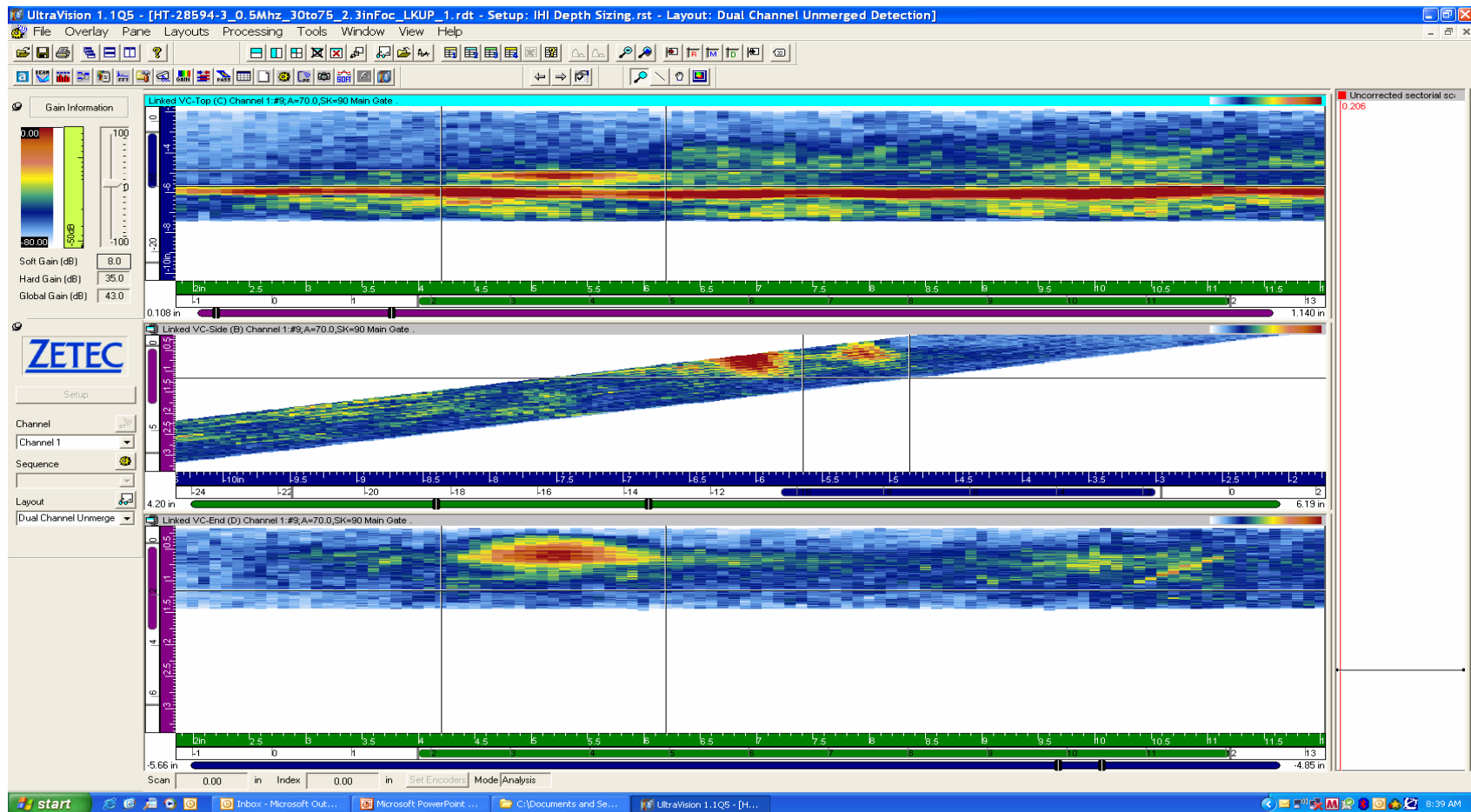
- High Angle Response 750 KHz Phased Array Search Unit





# Examination Overlays Over Cast Base Material (Heavy Wall)

- High Angle Response 500 KHz Phased Array Search Unit



# Examination Overlays Over Cast Base Material (Heavy Wall)

- Main Loop Overlay Sample Delivered
  - Purpose
    - Expand thickness range of current procedure
    - Evaluate and qualify procedures and people for examination of the outer 50% of the original base material below overlay
    - Evaluate and qualify techniques for the examination of the cast base material below the overlay

Note: Non-overlaid sample also purchased (Same Configuration)



# Expansion of Examination Volume

- Expansion of examination volume beyond upper 25%
  - Samples
    - Pressurizer Surge
    - Shutdown Cooling
    - Main Loop RCP
      - Axial and Circumferential flaws included
        - Implanted in the following areas
        - Weld and base material of nozzle to safe end weld (dissimilar metal weld)
        - Base material heat affected zone of safe-end to pipe weld (Similar metal weld)

# Expansion of Examination Volume

- Expansion of examination volume beyond upper 25% (Conti.)
  - Conventional Techniques Applied
    - Promising results achieved for flaws in the 40% to 71% range on smaller diameter thinner overlays
    - Refining depth sizing capabilities
    - Assessing limitations
  - Additional work underway to improve on results
    - Application of specialized conventional search units and Phased Array
    - Extensive work underway on main loop configuration

# Expansion of Thickness Range

- Expansion of currently qualified procedures to address application of full structural overlays on main loop components (Limited to examination of the outer 25% of original base material)
  - Sample delivered
  - Scanning and analysis underway
  - Expansion work scheduled for summer 2008
    - Manual Conventional
    - Manual Phased Array

Note: Does not require code changes

# Actions Underway

- Ongoing work
  - Designing and purchasing conventional 500 KHz search units  
(COMPLETE)
  - Borrowing modified instrument capable of collecting 500Khz data  
(COMPLETE)
  - Evaluating techniques on large main loop overlaid mock-up
    - Detection and sizing of flaws in outer 50% if base material
    - Detection and sizing of flaws in cast base material
    - Evaluating current techniques on thicker overlay
  - Preliminary conclusions
    - Non-Spectral reflections from face of flaws reduced or eliminated in cast material with (> 750 KHz) conventional and phased array techniques
    - 500 to 750 KHz search units have shown some promising results on deeper flaws in non- overlaid cast material
    - Work underway evaluating techniques on overlaid cast components

## Future Work (2008 and 2009)

- Continue with research and development activities
- Document and demonstrate capabilities
- Work with pilot plant and NRC with development of relief requests for application of optimized overlay in fall 2008
- Start Code process

# Summary

- Significant activity underway to expand current capabilities
- Success will require close coordination between utilities, vendors and NRC