



**NRC's NDE Research for
Vessels and Piping - Past,
Present, and Future Highlights**

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Past: 40 Years of NRC CASS* Research

- Final NUREG/CR entitled "NDE Reliability for the Examination of CASS Components" in review cycle – publication expected by end of FY18
- Key Attributes for Effective CASS Examinations
 - Adequate sound fields
 - Spatial encoding and volumetric image analysis
 - Understanding probe performance, sound field dimensions, propagation characteristics, and the material being examined
 - Effective training

*CASS – cast austenitic stainless steel

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Past: 40 Years of NRC CASS Research

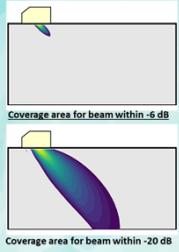
Key Conclusions

- Low frequency, Phased-Array ultrasonic testing (PAUT) necessary for detection in CASS
 - 500 kHz for wall thickness > 41 mm (1.6")
 - 800 kHz for wall thickness < 41 mm (1.6")
- For characterization, higher frequencies may be applied after a flaw is detected
- Inspection angles from 30° - 55° with increments no larger than 3° enhance flaw detection in CASS
- Spatial encoding coupled with off-line processing and imaging techniques important

Present: Ultrasonic Modeling & Simulation

Objective: Develop a technical basis for conducting, interpreting, and applying ultrasonic modeling to assess the effectiveness of inspections of nuclear power plant components

- Quantify the effectiveness of beam models
- Identify gaps in common simulation software tools
- Develop guidance for use and interpretation of simulation models for conveying information on effectiveness of inspections

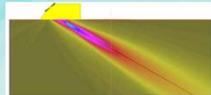


Recent publication: PNLL-26336 Validation of Ultrasonic Nondestructive Examination (NDE) Computational Models - Phase 1* (ML17082A190)

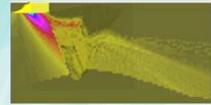
Present: Ultrasonic Modeling & Simulation

Key Takeaways to Date from Modeling & Simulation Studies

- Some software tools have limited ability to simulate beam propagation through complex materials
- Software tools evaluated for ultrasonic beam modeling show some differences in beam coverage estimates in isotropic materials
- Comparisons of simulation results and interpretation will require calibration of calculated ultrasonic flaw amplitudes
- Beam models show limited correlation with calculated and measured amplitudes from flaws



Simulated Ultrasonic Beam in Isotropic Material



Simulated Ultrasonic Beam Through a Weld

Future: Training and Practice

- Objective: Quantify the effects of training and practice on the performance of NDE personnel
- Areas to be examined include the effects of:
 - Directed laboratory training
 - Impact of hands-on practice with flawed specimens
 - The number of logged hours of experience
 - Hours of classroom training
 - Written test scores
- Initially, literature search to be conducted to identify important considerations related to the impact of training and practice on performance, and to define future work for this task

Future (> 5 years): Potential Research Topics

- Automated analysis of NDE data
- Artificial intelligence as applied to NDE
- Full matrix capture for ultrasonic testing
- NDE for new types of materials & structures
- Structural health monitoring