U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
*Protecting People and the Environment*

## RIC 2011
# Emergent Topics in Consensus Standards

Carol Nove
NRC/NRR/DCI
March 8, 2011

1

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
*Protecting People and the Environment*

## A Regulatory Perspective on Nondestructive Examination (NDE)

Carol Nove
NRC/NRR/DCI
March 8, 2011

2

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
*Protecting People and the Environment*

## Introduction

- Appendix VIII Qualified Examination Techniques
  - 10 CFR 50.55a mandates the use of ASME Code, Section XI, Appendix VIII, Performance Demonstration for Ultrasonic Examination Systems.
  - Appendix VIII provides requirements for performance demonstration for ultrasonic examination procedures, equipment, and personnel to detect and size flaws.
  - The Performance Demonstration Initiative (PDI) was formed by U.S. utilities in 1991 to implement the performance demonstration requirements of Appendix VIII, and is implemented by the Electric Power Research Institute (EPRI)

3

## Introduction (cont.)

- Non-Appendix VIII Techniques
  - Many examination techniques beyond scope of PDI qualification program
    - Control Rod Drive Mechanism and Bottom-Mounted Instrumentation Nozzles examination qualifications mandated by 10 CFR 50.55a
    - New examination techniques such as guided wave ultrasonics still in development stage
    - Addressing emergent issues/new damage mechanisms

4

## Why Use Performance Demonstration?

- Eliminates prescriptive examinations
- Ensures that the technique applied can address the damage mechanism of interest in the configuration of interest
- Ensures techniques have sensitivity to detect flaws above the minimum acceptable dimensions and to size and locate those flaws to within acceptable tolerances
- Enables monitoring of changes in flaws over time even when different equipment and personnel are used
- Enables the application of fracture mechanics based acceptance standards

5

## "Performance Demonstration Initiative (PDI)"

- PDI Qualification Blocks have been developed to replicate field conditions and service-induced flaws
  - Mockup flaws are ID surface connected fatigue crack and "squeezed" notches simulating service induced degradation
  - Weld fabrication flaws not adequately addressed by PDI qualification program

- Qualified inspectors often lack experience to interpret examination results when weld fabrication flaws are detected in a field exam, particularly when manual ultrasonic techniques are employed
- Discrimination issues have resulted in misinterpretations of data

6

## Miscalls/False Positives

- "Miscalling" a fabrication flaw as a surface-connected flaw, though a conservative error, may result in several consequences including:
  - Analysis/mitigation methods called into question
  - Miscalls/False positives can be quite costly for the utility
  - Additional NDE personnel including EPRI personnel often called to the site
  - Unnecessary repairs are scheduled and may be initiated
- Recent "miscall" issues
  - More training and "blind" test sets needed to discriminate between surface-connected and fabrication flaws
  - Manual and encoded ultrasonics both qualified techniques
  - Encoded ultrasonics, though often more costly to implement, may be key to reducing miscalls

7

## Recent examples of Miscalls

- Pressurizer Safety Relief Nozzles implementing Appendix VIII qualified procedure
  - Retired pressurizer
  - Calvert Cliffs pressurizer
- Guided Wave (non-qualified) examination of buried piping

8

## Retired Pressurizer Examinations

- February 2008 – A retired pressurizer (St. Lucie) was donated to NRC Office of Research.
- EPRI performed initial NDE of pressurizer nozzles to screen for flaws or other features of potential interest/assess research value
- Manual phased-array ultrasonic inspection used – results showed indications that were consistent with significant, circumferentially-oriented stress corrosion cracking
- This initial flaw characterization was inconsistent with the advanced finite element analysis basis for pressurizer inspections
- Extensive resources brought in to perform additional inspections/ evaluations – NRC witnessed

9

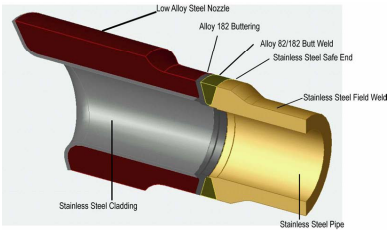
## Retired Pressurizer Examinations (cont.)

- Inspection results called into question the legitimacy of "bounding" analyses and bases for MRP-139 baseline examinations
- Results of additional encoded ultrasonic examinations concluded that the flaws were fabrication-induced and not structurally significant PWSCC in the welds

10

## Retired Pressurizer Examinations (cont.)

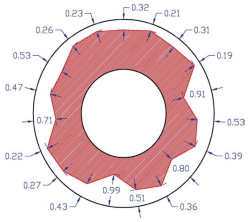
- CE Design PZR Safety/Relief Nozzle



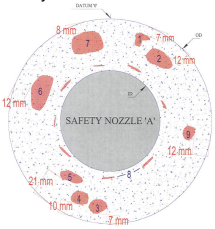

11

## Retired Pressurizer Examinations (cont.)

Retired Pressurizer UT Results for Nozzle "A"




Final Encoded Phased-Array UT Results




12

## Calvert Cliffs, Unit 1 Pressurizer Safety Relief Nozzle UT Examinations

- Same nozzle configuration as retired St. Lucie pressurizer nozzle "A"
- 2006 Manual UT identified approximately 8% through wall, 0.6" long, axial flaw in weld/butter region near top, dead center of nozzle – mechanical stress improvement process (MSIP) performed to arrest further flaw growth
- March 2010 – manual phased array identified new indication - 67% through wall and 1.4" long circumferential flaw adjacent to previously reported axial flaw

13

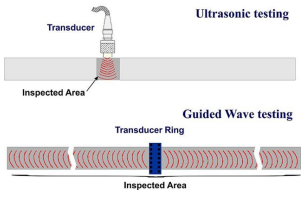
## Calvert Cliffs, Unit 1 Pressurizer Safety Relief Nozzle UT Examinations (cont.)

- Called into question the effectiveness of MSIP
- Further re-examination and characterization performed, construction radiographs reviewed – NRC witnessed/reviewed
- Concluded that there was no evidence of any ID-connected circumferential flaws, UT was seeing cluster of embedded fabrication flaws in the weld material

14

## Guided wave ultrasonics

- Technology with potential to provide 100% volumetric examination of a large section of piping with limited cleaning and excavation required
- Best used as screening tool – follow up required
- Used in other industries, but new to nuclear industry
- Many limitations, in particular when looking at buried piping




15

## Guided Wave (GW) Ultrasonics

- Used as a supplement exam (not required) for assessing the degradation of buried auxiliary feedwater piping at Salem – resulted in indications of pipe degradation
- Degradation much more extensive than GW results indicated

- NRC cautious…has many questions…
  - Want to understand the capabilities and limitations
  - How will the technique be used and results verified
  - What is plan for technique demonstration, and ultimately, qualification process

16

## Conclusion

- Every year, thousands of nondestructive examinations are successfully performed in nuclear power plants
- ASME Code, Section XI, Appendix VIII qualifications as implemented through the industry's PDI program have greatly improved the quality of the inspections performed on critical, pressure boundary welds
- Improvements still necessary regarding how NDE is applied
  - Refine/improve current techniques
  - Move from technique development to demonstration program to qualification program (i.e., CRDM examinations)
  - Address emergent issues (i.e., new failure mechanisms) and new examination methods
  - Address training deficiencies
  - Address long standing issues such as access/geometry limitations and inspection through cast austenitic stainless steel

17