ASME Codes and Standards for Boiler Inspections

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18th World Conference on Nondestructive Testing, 16-20 April 2012, Durban, South Africa
Presentation Outline

• ASME Section V and it’s role
• Two new PA Mandatory Appendices
• Three new AUT Mandatory Appendices
• Other ASME activities: guided waves, calibration blocks, interpretation manual etc
• Other code and related activities
• Summary
ASME Section V and its role

- American Society of Mechanical Engineers (ASME) wrote original Boiler & Pressure Vessel Code 125 years ago
- Now globally used BPV Code
- Impacts almost all countries due to global scope
- Also impacts on in-service inspections as these often require ASME calibration.
ASME Impact on AUT

- Impact on AUT (Automated Ultrasonic Testing) is large
- Three new (2010) Mandatory Appendices more or less complete
- Includes TOFD as Mandatory App III
- Now includes rewrite of Code Case 2235 (App VI-VIII)
- And includes Mandatory Appendices on phased arrays (App IV-V)
Manual Phased Array Mandatory App IV

• Essentially a rewrite of Section V Article 4
• Includes “Essential Variables”, plus:
  – Calibration for all beams
  – Description of array (element width, length etc)
  – Description of wedge (wedge angle, height etc)
  – Scanning procedure
  – Scanning technique
• Requires maximum scanning speed, etc.
• Must raster for manual PA
Calibration

AutoTCG function on OmniScan
Encoded Linear Scanning with PA’s

- Very different philosophy – linear scanning
- Re-packaged from original Code Cases
- Uses single pass to cover full weld
- Requires full coverage using either E-scans (linear electronic scans) or S-scans
- Requires Scan Plan
- Big question: How many S-scans do we need from the same array to get “full” coverage?
- Modeled and experimented to get solution.
Switching from raster scanning (left) to linear scanning (right) saves a lot of time, and makes AUT commercially viable under many conditions.
5 Degree BVI

Requires three separate S-scans per side for 15 mm weld

15mm 30° bevel
70° beam OK for root
55-65° only OK for lower half
Needs 2 scan offsets total 23mm
10 Degree BVI

- Requires only two S-scans per side for 15 mm weld

- 15mm 30° bevel
- 70° beam OK for root
- 50-70° only OK for lower half
- Needs second scan offset 15mm

15mm wall

15 mm

+/-10°
10 Degree BVI on thicker wall

Still only needs two S-scans for 30 mm weld; scaleable for simple weld geometries.
Ray tracing using advanced ESBeam with sample Bevel Incidence Angles (arrowed) calculated on 25 mm wall double-V weld.

Angles not “appropriate”? 
Experimental Results on BVI

Results on notches – quite clear
Experimental Results on BVI

Results on artificial defects – not so clear!

Modified PA Mandatory Appendix to require “appropriate angles”.

(Moles, Kruzic and Ginzel, Mat Eval)
Encoded Linear Scanning PA Appendix V

• Published in 2010
• Talks about “using appropriate angles”
• All the same Essential Variables as per manual raster scanning, plus extra conditions.
### Essential Variables for Mandatory App V

<table>
<thead>
<tr>
<th>Requirements (As Applicable)</th>
<th>Essential Variable</th>
<th>Nonessential Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search unit(s)</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>(element pitch, size, number, and gap dimensions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focal range(s)</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>(identify plane, depth, or sound path as applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual aperture size(s)</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>(number of elements, element width, and effective height) [Note (1)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wedge natural refracted angle</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>Scan plan</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>Weld axis reference point marking</td>
<td>...</td>
<td>X</td>
</tr>
</tbody>
</table>

#### Additional E-scan requirements:

<table>
<thead>
<tr>
<th>Requirement(s)</th>
<th>Essential Variable</th>
<th>Nonessential Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rastering angle(s)</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>Aperture start and stop element numbers</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>Aperture incremental change(s)</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>(number of elements stepped)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Additional S-scan requirements:

<table>
<thead>
<tr>
<th>Requirement(s)</th>
<th>Essential Variable</th>
<th>Nonessential Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweep angular range(s)</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>Angular sweep increment</td>
<td>X</td>
<td>...</td>
</tr>
<tr>
<td>(incremental angle change, deg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aperture element numbers (first and last)</td>
<td>X</td>
<td>...</td>
</tr>
</tbody>
</table>
AUT Mandatory Appendices

- Three new Appendices to replace CC 2235
  - Workmanship criteria (Mandatory App VI)
  - Fracture Mechanics (ECA) criteria (VII)
  - Procedure Qualification for flaw sizing and categorization (VIII)
- Published in 2010
- **NO** acceptance criteria – these come from another Referencing Section (e.g. Sections I, VIII, XII etc)
- Acceptance criteria not normal in Section
AUT Mandatory Appendices

• Main difference: MUCH easier to read and written in plain English
• Hopefully, there will be fewer abuses of the Code
• Also, greater freedom on demonstration block dimensions:
  – Diameter now 0.9 to 1.5 times actual
  – Wall thickness ± 25%
• Permits EDM notches as substitute for cracks for construction applications
AUT Mandatory Appendices - Benefits

• Overall, should be major improvement on CC 2235
• Fewer calibration/demonstration blocks
• Fewer misinterpretations and queries
Conclusions on ASME Today

- ASME published five new Mandatory Appendices (IV-VIII) in July 2010
- The phased array Appendices are a modification of the original Code Cases
- The AUT Appendices are a re-write of CC 2235, and should be much clearer
- The Procedure Qualification Appendix allows greater flexibility in both diameter and wall thickness -> reduced cal blocks.
On-Going ASME Projects

Guided Waves
PA Calibration Blocks
PA Interpretation Manual
HDPE Tests
Re-write of AUT into Article 3
Guided Waves

- New Article 18
- Draft document written by GUL, TWI and SwRI
- Essentially approved, and ready for publishing from November 2012.
Phased Array Calibration Block

- On-going project for a few years
- No real decisions made, but iterating towards a solution
- However, a lot of “flak” coming from various committee members
- May be based on the NAVSEA block, with additions/variations
Sample PA Cal Block
PA Interpretation Manual

• Original drafted some time ago
• Edited version submitted to ASME UT Working Group some months ago
• Main problem with new version is ASME only prints in B&W, not colour
• Recommended: ASNT and Materials Evaluation, or Photoshop
• ASNT needs copyright approval “to go”.
High Density Polyethylene Pipes

Welds

- Power Gen particularly interested in inspecting HDPE welds due to NRC
- Task Group set up, but only one meeting and “no samples” yet
- So, nothing to report yet
Re-write of AUT into Article 3

• Master plan is to coalesce all the AUT Appendices in Article 4 into Article 3
• Project has been “on the agenda” for a while, but no serious action (yet).
Summary

• ASME is the global leader in codifying AUT and phased arrays
• Currently have three AUT Mandatory Appendices, which effectively replace Code Case 2235
• Two PA Mandatory Appendices published
• One TOFD Mandatory Appendix also published, with Interpretation Manual and Set-up Guide.
Thank you

Any questions?