The HOIS recommended practice for the inspection of weld corrosion

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Dr Stephen F Burch,
ESR Technology, Oxfordshire, UK
steve.burch@esrtechnology.com
HOIS Joint Industry Project (JIP)

• HOIS is a well established JIP & forum for improved NDE in the oil and gas industry
  – Focus on upstream applications
• Members comprise:
  – Oil and Gas producers
  – NDT service companies
  – NDT equipment vendors
  – A regulatory authority (UK HSE)
• Managed by ESR Technology
• Now has 39 members
• More information from www.hois2000.com
Introduction

- Preferential attack associated with welds (corrosion or erosion)
  - Is a relatively common issue within the oil and gas industry
  - A number of leaks and other incidents have been caused by this form of degradation

- Need to address lack of well defined inspection methodologies
  - Different approaches and inspection methods in use

- Note: Use term “weld corrosion” to refer to all forms of preferential attack associated with welds
Inspection of weld corrosion

- Inspection is not straightforward because the region of greatest wall loss is usually underneath the weld cap
- Reliable detection and accurate sizing may require combination of more than one different inspection technique
Inputs to HOIS recommended practice

• Many years experience from HOIS members of in-service of weld corrosion
  – Inspection service providers
  – Operators

• Initial evaluation trials to assess sizing capability of different techniques, including
  – Manual angled beam pulse-echo UT
  – Angled beam PA
  – TOFD
  – Tangential computed radiography

• Blind trials of manual UT and advanced/novels techniques
Overview of HOIS weld corrosion RP

- **Scope**
  - Covers detection & sizing of weld corrosion
  - Assumes that weld cap is present
  - Carbon steel only
  - Monitoring not addressed

- **Information on corrosion mechanisms**

- **Provides recommendations on technique selection**

- **Generic procedures for techniques**

- **Comprehensive – 140+ pages**
Inspection issues for weld corrosion (1)

- Attack can be centred on weld or offset
- Variable morphology
  - Broad groove
  - Narrower and sharper associated with weld HAZ
Inspection issues for weld corrosion (2)

• Variable circumferential profile
  – Need to identify min ligament position
Inspection techniques considered

• Main techniques
  – TOFD
  – Tangential radiography
  – Double wall radiography
  – Manual pulse-echo UT
  – Angled beam Phased Array (PA)

• Developmental/advanced techniques
  – Corrosion mapping using 0° stand-off probe scanned over weld cap
  – 0° phased array probes straddling the weld cap
  – Flexible 0° probes
  – SCEXY (build up weld cap with epoxy to give flat surface)
Overall recommendations

• All techniques to be applied by suitably trained and competent personnel

• Two preferred techniques:
  – TOFD, supplemented by 0° pulse-echo scanning on both sides of weld cap
  – Combined double wall/tangential radiography
    • Double wall double image radiography (DWDI) to detect weld corrosion and locate deepest point around weld circumference
    • Tangential radiography with deepest point aligned at the tangent position

• Other techniques to consider if above not appropriate
  – Manual pulse-echo for initial detection. Sizing likely to be of limited accuracy.
  – Double wall radiography (qualitative sizing only)
  – Advanced/developmental techniques

• Beneficial to use more than one technique for confirmation
TOFD for weld corrosion inspection

- Probes straddle weld cap
- Scan probes along weld
- Grey-scale B-scans to show resulting data
- Use information from mode converted signals if available
- Consider scans perpendicular to weld for offset corrosion
- Wall thickness > 6-8 mm
- Min. ligament ≈3 mm
TOFD for weld corrosion inspection (cont)

• Modelling to verify coverage recommended when geometry is more complex than flat plate:

• May need to apply corrections to measured depths:
  – If corrosion is offset from weld centre line
  – If one probe on flange taper or other geometry effects (mis-match)
Supplementary 0° pulse-echo for use with TOFD

- To measure the uncorroded wall thickness on both sides of the weld.
- To detect and measure the remaining ligament for any weld corrosion that is sufficiently offset to emerge from underneath the weld cap
Radiography for weld corrosion

- Film or computed radiography
- Double wall double image radiography (DWDI) as search/location technique
- Follow-up with tangential radiography if found (need to rotate source/detector to align with deepest point on corrosion)
- Provides direct image of corrosion
- Very limited angular coverage of tangential technique
- Restricted to smaller diameter, thinner wall pipes
  - Max tangential path for Ir 192 in range 65mm – 80 mm
Manual pulse-echo UT

- Front-line inspection technique provided by “core crew” onshore/offshore
- Blind trials to assess detection reliability. High reliability on available test specimens for:
  - Combined angled beam from sides of weld cap; small 0° “button” probe to inspect through the weld cap
  - Suitably trained and competent technicians
  - Working to inspection procedures specifically for weld corrosion inspection
- Recognised that sizing accuracy is limited
  - If corrosion found or suspected, need to follow-up with a second technique for confirmation and more accurate sizing
- There may be some geometries & corrosion morphologies for which detection reliability is reduced
Sections on individual inspection techniques

- Each of main techniques covered in a separate section
- Range of applicability (wall thickness, pipe diameter etc)
- Advantages and limitations
- Detailed generic procedure for optimum inspection of weld corrosion
Complete RP contents

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Summary

- A substantive RP has been developed covering the in-service inspection of weld corrosion in carbon steel pipes
- Based on inputs from HOIS members and two sets of trials
- Clear recommendations given for preferred inspection techniques for different component geometries
- Advantages and limitations of each identified
- Available for download from www.hoispublications.com
- Current version to be superseded shortly by Issue 2
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  – Provision of ex-service specimens
Thank you for your attention

Any questions?