The field deployable digital X-Ray solution for weld inspection in O&G

Imagination at work.

Haitham Ibrahim,
Hanley Thomas,
Steven Wissels
7th MENDT Conference
Bahrain
Agenda

Field inspection
• Actual weld inspection
• Challenges of the actual workflow

Opportunities
• Time for a change?
• Alternative equipment
• Calculation

Platform and Tools

Conclusion
Field inspection
Actual weld inspection

Actual weld inspection in Oil&Gas (workshop and refinery) traditionally performed with Gamma (Ir 192, Se75, Co60) in combination with Industrial Film:

Reason:

- Good enough images to cover Standard
- Convenient (small and portable equipment)
- Tradition (certain level of conservatism wrt. changing workflow & technology)
- Cheaper

A better, cheaper and safer alternative available?
Challenges of the actual workflow (I)

1. Drawbacks of using Isotopes
   - **HAZARD**: Constant, no “switch off”
   - Risk of capsules/wire failure with the following alarm to authorities, investigations, ...
   - Limited Service Life:
     - Extra costs & labour for transport to factory (re-energizing)
     - Maintenance costs camera
     - Recurring investment every 6-8 months
   - Half-life value:
     - Ir192: 74 days
     - Se75: 120 days
Challenges of the actual workflow (II)

- Rules, regulations, paperwork and costs for ownership and usage
- Larger safety perimeter (e.g. inspecting small bore with a higher Ci vs. XR)
- More shielding needed (Half Value Layer Ir192 is ±4,8mmPb, for 300kV is ±1,5mmPb)
2. **Image quality**
   - Both energy and intensity level unadjusted
   - Lower image contrast
   - SNR (image quality) & BSR (sharpness) negatively influenced by spectral noise
   - Because of FocalSpot of Gamma, minimum ffd will be larger (Ug) and therefore the exposure time will be much longer compared to XR with smaller FS

(example Fe-weld SWSI WT30mm:
- Ir192, 40Ci, 3mmFS, 465mm fdd (EN Class B), D5 OD 2,5 ➔ 4,1 minutes
- IV Mob 160 MM2 HP, 1mmFS, 175mm fdd, 10mA, D5 OD 2,5 ➔ 42 seconds)
Opportunities
Time for a change?

With some workflow adaptation, alternative technology is available and proven to perform safer, better, cheaper.

- Portable X-Ray generators
- Mobile HV generators
- CR (Computed Radiography) and DDA (Digital Detector Array) covering weld inspection as well as profile radiography, CUI, FAC, ...
Portable X-Ray generators

Reliable, lightweight and portable
Directional and panoramic tubes
HF CP Technology
Different energies: 160, 200 and 300kV
With 3mm and 1mm (!) focal spot

Ideal contrast as energy is optimised for the thickness

BUT, power source required
Mobile HV Generator: Isovolt Mobile 160

Offering you:
- Industrial radiography, but mobile
- Short exposure times (1600W (!) and 10mA)
- 100% duty cycle (autonomous cooling unit)
- Power mode and dual focus operation
- Image quality covering most stringent EN standards (HF CP technology)
- Safe working conditions (20m HV cables)
- Wide range of weld solutions (HP, Mini Focus, panoramic (100mmD) and very small diameter tubes available)
Isovolt Mobile 160: Typical setup
Overview ISOVOLT mobile 160

High Voltage Cables
- 5 m
- 10 m
- 15 m
- 20 m

Additional tubes pre-programmed and fully compatible:
- IV 160MM2/HP FS 0.4 & 1mm, Ø 110mm
- IV 160M2/0.4-0.4 FS 1mm, Ø 110mm
- IV 160M1/10-30 FS 1 & 3mm, Ø 105mm
- IV 160M2/0.4-0.4HP FS 0.4 & 0.4mm, Ø 110mm
- IV 160M2/0.4-1.5 FS 0.4 & 1.5mm, Ø 110mm
- IV 160MC2 Panoramic, Ø 100mm
- MCR120A25 Panoramic, Ø 70mm
- MCD 100 H3 FS 3mm, Ø 70mm

High Power / Mini Focus

High Power / extra robust

Panoramic

Standard Directional Tubes

Special Purpose
Financial calculation

Modest 3 year calculation for 1 system:

Ir192: 90-120k USD (container, Isotope, shipments, necessary administration for permits, shipments, usage)

IV Mobile 160: ±65k USD

Eresco 65 MF4: ±46k USD
Time for a change, results

Benefits of this new technology:
- Increased safety (no power = no radiation)
- No transport challenges
- Increased image quality
- Faster results
- In 3 yrs.: X-Ray half the investment instead of Gamma
- Smaller safety zones, easier operation in plants.

Drawbacks:
- Physically limited in energy.
Platform and Tools
One Software platform: the Rhythm Spider

- FS50b
- CRxFlex
- CRxVision
- CRx25P
- Static DDA´s
- Portable DDA´s
- Rhythm Archive
- X-ray controller
- Rhythm RT
- Rhythm Review
The "Digital Age" of NDT—"Adopt to Optimize"

**AQUIRE SOLUTIONS**
- RT - Radiography
- UT - Ultrasonic
- CT - Computed Tomography
- RT - Remote visual inspection
- EM - Electromagnetic
- TM - Testing machines
- Data management software

**REVIEW SOLUTIONS**
- QA/QC
- Level II or Level III
- Remote Collaboration

**SHARE SOLUTIONS**
- Remote Collaboration
- Automated Workflow
- Convert data into actionable information
- Measure the health of the asset by product, region and channel
- Find growth opportunities via data mining

**ARCHIVE - REPORT SOLUTIONS**
- 100 % DICONDE/ASME CODE - Non Propriety Data Format
- Measure the health of the asset
- Find quality and verification opportunities via data mining
- Traceability
- Data Integrity/Data Management

**DICONDE Standard** Turning information into intelligence
DICOM/DICONDE compliant:
• Ensures customers not to be “locked in” to propriety form.
• Eliminates data conversion issues customers face today
• Simplifies integration NDT information into other systems
• Ensures data integrity (NO manipulation of raw data)

TIFF represents just an image: a small header + image pixel values. It does not typically inform the user
• of where the image was taken,
• who took the image,
• from which modality it is, etc.

DICONDE is much more than an image:
• Extra info like all Technique data, all Component data, ...
• **The image is a complete report in itself**
• An International Standard that providing a common platform for users when dealing with NDT images.

Interoperability of the DICONDE platform enables data-sharing between systems, locations, and/or customers.
Flash! filter

A unique image enhancement software tool based upon innovative technology bringing NDT inspection to an advanced level.

Why:

- A raw image is not optimal for reading and interpretation
- Image processing visualizes the essential information which is embedded in the raw image without creating/hiding indications!

Benefits:

- Higher productivity with more reading comfort
- Faster & consistent results
- Less retakes & shorter exposure times, lower labor cost / job
Example: 6” pipe, WT 10.8mm, DWSI, 150kV, 3mA, 500SFD, 8 minute exposure.

W7 visible

W8 visible
Example: 4” Pipe, WT 5 mm, 140kV, 5.0mA, 1030FDD, 6x6s, IQI-Source Side
Example: DWDI, 140kV, 5mA, 6x6s, 1160FDD IQI
Source Side

W6 fully visible

W7 partial visible
Advanced Report Generator for Weld

Radiographic Examination Report

<table>
<thead>
<tr>
<th>Customer</th>
<th>Radiograph Specific Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client 1</td>
<td>ISO Drawing #</td>
</tr>
<tr>
<td>14878-13</td>
<td>Line number</td>
</tr>
<tr>
<td>458868838</td>
<td>Position/Test Point</td>
</tr>
<tr>
<td>1234</td>
<td>1 of 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weld Info</th>
<th>Radiography Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding Technique</td>
<td>Source</td>
</tr>
<tr>
<td>Y1G 608822-6</td>
<td>63</td>
</tr>
<tr>
<td>EN 1435</td>
<td>57</td>
</tr>
<tr>
<td>L3</td>
<td>500</td>
</tr>
<tr>
<td>EN FE 10 - 16</td>
<td>125</td>
</tr>
<tr>
<td>04</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Joint # &amp; Image #</th>
<th>Writer</th>
<th>Position on plate</th>
<th>OK</th>
<th>Failed</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>0686822-1</td>
<td>12</td>
<td>0 - 30</td>
<td>34</td>
<td>x</td>
<td>5</td>
</tr>
<tr>
<td>0686822-2</td>
<td>12</td>
<td>25 - 55</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0686822-3</td>
<td>12</td>
<td>50 - 80</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0686822-4</td>
<td>12</td>
<td>75 - 105</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0686822-5</td>
<td>27</td>
<td>100 - 130</td>
<td>34</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>0686822-6</td>
<td>12</td>
<td>115 - 160</td>
<td>34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prüfbericht Durchstrahlungsprüfung ASME
Radiographic Test Report ASME
The use of CR and DDA for Profile Radiography (I)

As a bonus, the same portable X-Ray source can be used in the field for erosion/corrosion inspection, combined with either DDA or CR.

Automated measuring software (patented mathematical algorithm) for pipe wall inspection & reporting.

The visible edge is an optical illusion thus not exact, so a mathematical determination of the outer wall is needed.

Computer based evaluation algorithms:
  - Higher precision of measurement on RAW image (DICONDE)
  - Faster and Consistent results, operator independent
  - Higher productivity
  - Digital archiving, direct export into weld reports
  - Import & export measurements into pipe data managing system (e.g. Pipecad)
The use of CR and DDA for Profile Radiography (II)

Flash! applied on RAW image ➔ no effect on results
Conclusion
Conclusion

If NDT service companies can reduce their dependency on Gamma sources by converting to mobile X-Ray technology, while adapting from Film to CR/DDA technology, for ±40% of their RT needs they would be able to:

- **Reduce** impact of the strict Governmental legislation on isotopes
- **Improve** H&S track record for the (service) company
- **Reduce** their operational cost structure
- **Optimize** their assets to deliver consistent results to end-customers
- **Increase** image quality and working throughput
Questions?