Advanced NDT - Supporting Asset Integrity Management

John Everton, Principal Corrosion Engineer
ALS Industrial – Asset Care
Fact: Serious Plant Failures do Occur!

They include:

- Pressure vessels
- Heat Exchangers
- Storage Tanks
- Piping
- Pump
- Many others
Advanced Inspection – What is It?

• Not defined in API Codes?
• Not defined by training organizations?
• NDT methods developed since my initial training in the 1970’s?
• NDT methods characterized by:
  • The use of physics not previously applied to NDT
  • More sophisticated technology in the use of sensors and in data processing
  • Highly trained technicians
  • Principals and capabilities not fully understood by the market
Advanced Inspection – What it is Not

Traditional NDT technology such as:

• Visual inspection
• Manual Ultrasonic Inspection (UT)
• Radiography - using film (RT)
• Eddy Current Testing – manual (ET)
• Magnetic Particle Inspection (MT)
• Dye penetrant Inspection (PT)
Advanced Inspection in the Context of Asset Integrity

• Asset integrity is the ability of an asset to perform its required function effectively and efficiently within guidelines of safety, environment and design life. It involves the engineering management of risk.

• Inspection is a risk mitigation strategy which reduces the uncertainty of risk, making performance more predictable.

• The process of selection of inspection methodology should involve the following steps
  • Understanding the damage mechanisms (type and rate)
  • Short list of inspection methods which have an acceptable probability of detection (POD) of the damage
  • Selection of inspection method(s) based upon:
    • POD
    • Cost
    • Convenience
  • Advanced Inspection is usually not chosen but there are specific circumstances where it offers great advantage
The Wrong Process

Selection of a particular advanced inspection method as the first step in inspection planning, rather than selection after a rational process of understanding the damage mechanisms and the evaluation of alternatives.

People can become infatuated with new technology without consideration of proven POD, convenience and cost effectiveness.
Common Advanced Inspection Methods

- Phased Array UT
- TOFD
- Corrosion Mapping
- SLOFEC
- Eddy Current & IRIS tube testing
- Acoustic Emission
- Guided Wave Testing (LRUT)

Why are these methods used?

- They suit an integrated Asset Care Strategy
- They deliver what industry needs
- Effective outcome for in service inspections
- Results are repeatable
- Reliable with high POD
- Data Storage
- Proven in field applications
- Reasonable numbers of technicians available
Every inspection requires the following steps:

• Select the appropriate technique

• The calibration/procedure process - optimise calibration, prepare test samples, develop scan plans if required, develop procedure, ensure trained operator for technique selected, performance demonstration.

• Data acquisition onsite (inspection strategy)

• Data & Signal analysis – offline

• Interim Report issued

• Final reporting
Some Practical Examples
Flange Face Corrosion

- Very difficult inspection
- Needs a lot of preparation
- Reduce safety risk
- Maintain integrity
- Targeted approach

Applied to ANSI 150, 100 and 80 NB 1500 lb flange seal faces.
In-Situ Bolt Inspection

Example - Well Head Cap Screw

Trials with Bolt removed

Bolt in-situ

Phased Array sensor in position
Phased Array UT - Heavy Wall Weld Inspection
TOFD – heavy wall weld scanning

Confirming Phased Array Results

External Surface

Back Wall
### TOFD

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**Area 1**

**Area 2**

**Area 3**

**Area 4**

**Area 5**

**Area 6**

**Ground Level**

**Maximum Reach of the Cherrypicker**

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<th>South</th>
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**Manway**

**Nozzle**

**Nozzle**

**Nozzle**

**C1**

**C2**

**C3**

**C4**

**C5**

**C6**

**V1**

**V2**

**V3**

**V5**

**V6**

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**Firewater Storage Tank**

**Thin Material – 6.0mm**

**Weld root erosion**
TOFD – Water Pipe Butt weld – 80 year old pipe

- Manual UT inconclusive
- Many original weld defects
- “dirty plate”
- Previous failures had occurred
- RT not an option
Eddy Current Tube Testing – MS5800

Advantage of pulling a tube?
Eddy Current Tube Testing - Reporting

- Raw data analysed
- Defective tubes presented - Colour palette, based on severity
- Type of defect stated i.e. pit, baffle wear, wall loss etc...
- Percentage of nominal w/t per tube
- Plugging threshold
- List of tubes not tested
- List of tubes with internal restrictions
- Test parameters stated
Eddy Current Tube Testing

Chemical Plant
Eddy Current Tube Testing - Magnetic Bias

Carbon Steel Tubes

Plant in WA
IRIS Tube Testing

Power Plant
Corrosion Mapping

- Quantitative measurement
- Repeatable
- Encoded

A Scan

B Scan

C Scan

- Vessels
- Tanks
- Piping
- Pipelines

“Thickness Measurement”
## Corrosion Mapping - Piping

### Typical w/t result

#### Thickness Measurement Survey

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Corrosion Mapping – Piping

“Defect Detection”

- Conventional UT slow
- Low POD
- Defect geometry limitations
SLOFEC – Pipe Screening – Fire Water Piping
Acoustic Emission (AE)

- Steel Storage Tanks
- Composite tanks & vessels
- Piping
- HDPE material

Multi-Channel Equipment
Guided Wave Testing (LRUT)

- CUI programs
- Under pipe supports
- Buried piping
- Offshore risers
In Conclusion, to get the best from Advanced NDT...

• Communication is vital – treat your NDT provider as part of the team

• Ask for more than raw results. The Inspection Service company should be able to provide:
  • A statement of “fitness for service”
  • A review of results Vs expected damage
  • An explanation of the root cause of damage
  • A prediction of future damage e.g. corrosion rates
  • Recommendations for repair/damage mitigation
  • Future Inspection schedules
  • Residual life

• Price should not be the only factor. Consider the value for money. POD and interpretation of results are critical.

• Shop around before you decide who you want on your site. Consider competence, experience and reputation.
Thank You for your time...

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