API RP-586 Part 3
Contact Point Corrosion

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1.0 Introduction

1.1 Contact point corrosion (CPC) may occur between two materials of similar or different corrosion resistance that are in intimate contact with of an electrolyte potential. CPC at pipe supports is an example of CPC loss of primary containment events where localized, external pipe damage occurs at the pipe-to-pipe support interface. Access difficulties and the inherent limitations of common NDE methods such as visual inspection require specialized techniques for the detection, sizing, and monitoring of. This document provides information on commercially available NDT methods and techniques that supplement visual inspection and prevention strategies for specific pipe support designs and inspection conditions. Inspection methods for both qualitative or quantitative detection and measurement of extent and remaining pipe integrity within the crevice zone are discussed in detail.

Note: The accumulation of water can occur at locations remote from the point of intrusion, especially in services where the surface temperature does not cause the water to evaporate. For example, this can occur on a horizontal line in the middle of a span between pipe supports where the insulation is missing at the supports or there is a leak spot due to lack of sealing. Yet evaporated water may also travel through the insulated system and condense in areas with a lower surface temperature.

2.0 Scope

2.1 This document covers NDT methods and techniques for CPC support designs which include structural I-beam with or without a stabilizing U-bolts, saddle clamps, welded supports and other designs for piping. See section 6.0 for a list and description of pipe support designs.

2.2 The NDT methods and techniques in this document intended for, but not limited to external localized metal loss of carbon steel, alloys, stainless steel and aluminum. NDT methods for external surface chloride stress corrosion cracking of Austenitic and Duplex stainless steels are also provided.

Note: Some NDT methods may be used for soil to air interface corrosion.

2.3 CPC detection, monitoring and sizing are highly dependent on critical variables including, but not limited to component diameter, wall thickness, temperature, insulation (if applicable), insulation type and physical access.

2.4 It is recommended that the operator and service provider utilize an understand of the critical variables and limitations of each NDT CPC method on a case by case basis.

3.0 References

API RP-570, In-Service Inspection, Rating, Repair and Alteration of Piping Systems
API RP-571, Damage Mechanisms Affecting Fixed Equipment in the Refining Industry
API-572 Inspection Practices for Pressure Vessels
API-574, Inspection Practices for Piping System Components
API RP-583, Corrosion at Insulation and Fireproofing
ASTM E1774-17: Standard Guide for Electromagnetic Acoustic Transducers (EMATs)
ASTM E1816-18: Standard Practice for Ultrasonic Testing Using Electromagnetic Acoustic Transducer (EMAT) Techniques

4.0 Abbreviations

CHIME: Creeping Head wave Inspection Method
CPS: Contact Point Corrosion
EMAT: Electromagnetic Acoustic Transducer (or Transduction)
GWT: Guided Wave Testing
IOW: Integrity Operating Window

SRUT: Short Range Ultrasonic Testing

LRUT: Long Range Ultrasonic Testing

MRUT: Medium Range Ultrasonic Testing

MsS: Magnetostrictive Sensor Technique

OES: Optical Emission Spectrometry Material Identification

PC: Pitch-Catch

PE: Pulse-Echo

PEC: Pulsed Eddy Current

RT: Radiographic Testing

SH: Shear Horizontal

UT: Ultrasonic Testing

WL: Wall Loss

WT: Wall Thickness

XRF: X-Ray Fluorescence Material Identification

5.0 Definitions

Atmospheric corrosion: Corrosion that occurs from moisture associated with atmospheric conditions. Marine environments and moist, polluted industrial environments with airborne contaminants are the most severe.

Creeping head wave inspection method: A medium range ultrasonic screening technique which provides full volume coverage between the transmitting and receiving probes which can be separated by up to 2 m operating in through-transmission.

Direct Visual Inspection: Visual inspection performed without the use of remote visual aids and meeting the requirements of ASME Section V, Article 9.

Fluoroscopy: Real time X-ray system based on the principle of fluorescing screens.

Guided wave Ultrasonics: An ultrasonic technique that projects sound waves along pipe walls to detect corrosion or other damage.

Localized corrosion: Deterioration, e.g., corrosion that is confined to a limited area of the metal surface. See API RP 510.

Multi-Skip Techniques: Ultrasonic Pitch/Catch or Pulse/Echo methods.

Procedures: A document that specifies or describes how an activity is to be performed on a piping system. NOTE A procedure may include methods to be employed, equipment or materials to be used, qualifications of personnel involved, and sequence of work. Edit for NDT procedures and move to Intro scope.

Profile Radiography: A radiograph of a small section of the pipe wall that represents a cross-sectional view of top and/or bottom "horizon" of the pipe.

Pulsed eddy current examination: An eddy current examination method that uses a stepped or pulsed input signals greater penetration depth of penetration than conventional eddy current techniques.

Remote Visual Inspection: Visual inspection performed with the use of visual aids, including optical and remote visual tools, cameras, or fiber optic imaging. See ASME Section V, Article 9.

Scanning: NDT techniques that are used in motion sensors to screen, estimate or measure the thinnest thickness measurement within a defined inspection area. See guidance contained in API 574.

6.0 Pipe Support Designs

6.1 Rod and hanger pipe support:

A hanger is a vertical pipe support containing a supporting rod. These hangers can be rigid, variable spring, or constant support hangers. See figure 1.

Figure 1: Hanger Pipe Support

Note: A hanger pipe support joint creates a 360-degree crevice corrosion area with a relatively small crevice width.

6.2 U-Bolt to I-Beam:

A U-bolt is a bolt in the shape of the letter U with screw threads on both ends. U-bolts have primarily been used to support pipework. See figure 2 below.

Figure 2: U-Bolt to I-Beam

U-bolt to I-Beam supports create a 360-degree crevice area with a relatively large inaccessible area at the base if the pipe (depending on the width of the I-Beam) and a small area around the U-bolt.
Note: Coated U-Bolts and non-metallic spacers between the pipe and the I-Beam can reduce or eliminate crevice corrosion initiation.

6.3 Pipe Shoes:

Single upright pipe shoe made either from a split beam or from flat bar/plate. This variety of shoe is welded to the pipe. Frequently provided with a galvanized surface and it is welded to the pipe.
The shoe rides on top of structural steel support member of a pier. See Figure 3 below.

Figure 3: Single Upright Shoe Support

Single upright pipe shoe supports allow easy access to the pipe to support shoe weld. No significant crevice corrosion results from this design

6.3.1 A double upright pipe shoe made from either flat bar or plate.
This variety of shoe is welded to the pipe. Frequently provided with a galvanized surface and is welded to the pipe.
The shoe rides on top of structural steel support member of a pier. See Figure 4 below:

Figure 4: Double Upright Shoe Support

A double upright shoe support provides a difficult access space between the two upright support welds and the supported pipe. No significant crevice corrosion results from this design.

6.3.2 Single upright pipe shoe made either from a split beam or from flat bar/plate with a U-Bolt-On shoe has a partial clamp welded to the upright. The pipe is placed in the partial clamp and a U-Bolt is placed over the pipe and through holes in the partial clamp. See Figure 5 below:

Figure 5: Single upright pipe shoe with a U-Bolt-On shoe

Upright pipe shoe supports with U-Bolts have similar 360-degree crevice areas with susceptible water entrapment at the base and top of the U-Bolts.
Note: This design may also include a double upright pipe shoe with U-Bolt

Upright pipe shoes with U-Bolts can have non-metallic contact surfaces to reduce or eliminate crevice corrosion. Examples include partially lined clamps with a non-metallic liner wear pad (fiberglass), or an elastomeric bearing, or PTFE (Teflon), or PVC or Neoprene. Further, the U-Bolt can have a plain, painted or galvanized finish or can be Stainless Steel. The U-Bolt can also be coated with neoprene or a PVC shrink tube.

6.4 Sliding Supports

A slide plate is used to produce a low-coefficient of friction between stationary support elements and moving components to decrease the forces/friction that is caused by pipe deflections. Slide plates can be constructed using a variety of materials depending upon their use – including graphite, PTFE, 25% glass filled, stainless steel, and bronzphite. See Figure 6 below.

Figure 6: Sliding pipe support

6.5 Insulated Pipe Support

An insulated pipe support (also called pre-insulated pipe support) is a load-bearing member and minimizes energy dissipation. Insulated pipe supports can be designed for vertical, axial and/or lateral loading combinations in both low and high temperature applications. See Figure 7 below.

Figure 7: Insulated Pipe Support

Note: Insulated pipe supports significantly reduce the likelihood of water entrapment due to the pipe support. Corrosion of fully insulated pipes is considered CUI. See RP-583.

6.6 Pipe Saddle

A pipe saddle is a structure consisting of a saddle and integral base that is used to support the pipe by transmitting the load or forces to the adjacent structure. See figure 8 below.

Figure 8: Pipe Saddle

Pipe saddle supports can have significant crevice corrosion surface area dependent on the size of the pipe and saddle support. Saddle supports can include mounting straps that result in 360 degree crevice corrosion bands.

6.7 Welded Pipe Saddle

A welded pipe saddle is permanently attached to the supported pipe by a full-length fillet weld. See figure 9 below.

Figure 9: Welded Pipe Saddle

Welded pipe saddle supports are usually considered a low risk for water entrapment between the pipe and the saddle support.

6.8 Welded Trunnion Pipe

A welded trunnion pipe is a piece of piping welded to the back of a bend or elbow in a piping system and is attached to the nearest primary pipe support. While the trunnion (dummy) support pipe does not conduct the flow of anything it can be vital for keeping an entire section of the system in place without sagging or adding stress to the other piping sections. See figures 10 and 11 below.

Figure 10: Vertical Trunnion Pipe Support

Figure 11: Horizontal Trunnion Pipe Support

Welded trunnion supports can mask external atmospheric or water entrapment corrosion on the outside sweep of the supported pipe elbow. See figure 12 below.

Figure 12: External Corrosion Hidden by a Trunnion Elbow Support

Note: CPC inspection methods should also be considered for pipe areas beneath trunnions and dummy legs.

6.9 Other Pipe Support Components

6.9.1 Rolling Pipe Support:

A roller bearing support to allow for pipe movement. See figure 13 below.

Figure 13: Roller Bearing Pipe Support

6.9.2 Pipe Support Clamp:

Pipe clamps use contoured plates and bolts to hold pipes onto a supporting structure.

Figure 14: Pipe support clamp

6.9.3 Pipe Restraints

Axial restraints are designed to restrict the movement down the centerline of the pipe. These are generally used for horizontal pipes.

Lateral restraints are designed to restrict movement of pipe in the direction perpendicular to the pipe axis.

A limit stop allows a defined movement in any direction before acting as a rigid restraint. See figures 15-17 below.

Figure 15: Sway Struts

Figure 16: Lateral Restraint

Figure 17: Pipe Lift Stop

Note: CPC interfaces may contain non-metallic spacers that can help inhibit or mitigate crevice corrosion at the CPC interface. Some spacer designs may affect the selection and use of CPC NDT methods.

7.0 General Guidance for Selecting NDT Methods and Techniques for Contact Point Corrosion (see API 570, 574)

7.1 Contact Point Corrosion (CPC)

CPC can be a highly localized, accelerated material degradation that may not be detectable by visual inspection alone. External water sources or even moisture from pipe sweating is considered a primary driver of CPC. Other contributing factors may include the following.

For CPC in marine environments, chlorides can initiate pitting and cracking of austenitic stainless steels and aluminum alloys. When cracking is suspected in non-ferritic metals, surface eddy current, liquid dye penetrant, ultrasonic or radiographic methods may be used to detect and/or size surface cracking.

7.2 Operating Temperature Ranges (at support):

Ambient to High Temperature Piping may increase CPC corrosion rates over that of the general corrosion under insulation (CUI) rates for the same piping system. Higher temperatures and temperature cycling can also increase CPC over that of general CUI for the piping system. These factors should be considered for both NDT method selection and inspection intervals.

Note: Removal of insulation while the piping or equipment is in service may cause hot or cold spots, leading to a potential increase in internal corrosion or process issues.

7.3 Environmental Conditions:

Environmental conditions should be considered in the plan and execution of CPC inspections. Specifically, the ability to remove insulation for CPC inspection while the equipment/piping is in service without adversely affecting process control, product quality, and safety.

7.4 Pipe Diameter and Wall Thickness:

The pipe diameter and type of pipe support determine the amount of concealed pipe area that is subject to crevice corrosion as well as accessibility to these areas by NDT CUPS methods. Larger pipe diameters may prevent use of a preferred CUPS NDT method for the type of support due a loss of accessibility. The operator should consider the applicability and limitations of CPS NDE methods on a case-by-case basis.

8.0 NDE Methods and Techniques for Contact Point Corrosion

8.1 Visual Inspection (see API 574, ASME Section V, Article 9)

Direct Visual Inspection
In-Direct Visual Inspection (Remote Viewing)
Drone Inspection

8.2 Ultrasonic Methods

Ultrasonic Phased Array
Ultrasonic Shear Wave
Ultrasonic Multi-Skip and CHIME
Long Range Guided Wave UT (see RP-583, 7.3.4.2)
Short Range Ultrasonic Guided Wave Testing Shear Horizontal
Short Range Ultrasonic Guided Wave Testing -MsS
Circumferential EMAT (Electromagnetic Acoustic Transducer)

Axial EMAT

8.3 Radiographic Methods

Profile Radiography: Film, CR, DR

Contact RT for density

9.0 Preparing for Contact Point Corrosion Inspections

Each NDT method can have unique access, surface preparation, pipe temperature and permitting requirements. The time, difficulty and safety risks of CPC inspections can subsequently be a factor in the selection of NDT methods and techniques.

Note: CPC NDT method and techniques should not disturb loose surface corrosion and/or scale.

9.1 Insulation Removal (if applicable)

Pipe supports for insulated piping can have various levels of access between the insulation jacketing, insulating materials and the inspection area of interest. Insulation modifications may be required for inspection, or an inspection method that does not require insulation removal may be used if appropriate. Examples are included in figures 18-20 below.

Figure 18: Insulation Jacket Remove and Repair

Figure 19: Insulation Remove and Repair

Figure 20: Difficult Access for all NDT Methods

9.2 Surface Preparation for NDT CPC Inspections

Adequate surface preparation is important for proper visual examination and for the satisfactory application of most examination methods. The type of surface preparation required depends on the individual circumstances and NDE technique. Wire brushing, blasting, chipping, grinding, or a combination of these preparations may be required.

Advice from NDE specialists may be needed to select and apply the proper surface preparation for each individual NDE technique.

9.3 Coating Removal:

Thick, loose, or peeling coatings may have to be removed for some CPC NDT methods. See Appendix A for NDT method surface preparation details.

9.4 Scale Removal:

Rust scale can typically mask the area of inspection and prevent proper application of CPC NDT inspection methods. Some methods such as radiography can tolerate or even measure levels of iron oxide scale. Site safety policies should address the risks of disturbing or removing iron oxide scale on live piping.

9.5 Support Modification (if applicable):

Some NDT methods may require removal or partial removal of pipe supports or pipe support components. Site safety policies should address the risks of temporary or permanent modifications of pipe supports or adjacent structural components.

Notes:

A risk assessment and detailed plan should be developed prior to modifying pipe supports or lifting pipe while they are in-service or may contain hazardous materials.

Physical access limitations should be considered when planning CPC inspections in densely populated pipe racks and/or pipes with limited spacing or in contact with the ground.

10.0 NDT Technician Qualification (by NDT Method)

NDT technicians who perform CPC NDT inspections and analyze data shall be trained and certified to ASNT-TC1A Level II or III or equivalent international training and certification program.

NDT technicians who perform CUPS NDT methods that are not yet covered by ASNT-TC1A or other international training and certification schemes shall be through a training and certification program provided by the NDT equipment manufacturer.

11.0 NDT of Contact Point Corrosion Reporting

The following items may be included in the examination report and archived for future reference:

1. Owner, location, type, and serial number of components examined.
2. Size, material type and grade, and configuration of the pipe support areas examined.
3. Pipe circuit ID and support P&ID location.
4. Extent of examination, for example, areas of interest, complete or partial coverage
5. Personnel performing the examination and their qualifications.
6. Models, types, and serial numbers of the components of the CUPS inspection system, including probes and calibration blocks if applicable.
7. An NDT procedure number and list of all relevant instrument settings and parameters used. Probe speed if applicable.
8. Where possible, indicate factors that may have limited sensitivity.
11. Indication evaluation and reporting criteria.
12. Complementary examination methods (if applicable) that were used to validate results of the primary inspection method.
13. NDT technician signature, certification level and contact information.
14. Date and time of inspection.

APPENDIX A: CPC NDE Method Definitions and Detailed Descriptions

A1 Visual Inspection

A1.1 Direct Visual Inspection

Direct visual inspection may be the most reliable method to detect CPC on carbon and low alloy steel systems is to physically remove the insulation or fireproofing and visually inspect the surface for damage.

Direct visual inspection is usually performed by direct eye vision at a distance no greater than 24 inches, a viewing angle of greater than 30 degrees off of the inspection surface and adequate lighting.

A1.2 Indirect Visual Inspection

Indirect visual inspection methods can be classified as semi quantitative methods that do not meet the requirements of a direct visual inspection and attempt to estimate the relative degree of surface corrosion damage present or as qualitative methods that attempt to look for the impact that surface corrosion damage.

Indirect visual inspection methods often involve the use of optical aids and/or remote visual imaging technologies such as CCD cameras, fiber optic cameras, boroscopes, or thermal imaging.

Remote visual imaging technologies typically deploy a mechanical delivery system such as a crawler, miniaturized articulating or non-articulating umbilical cables, or drones.

Note: Indirect visual inspection techniques may be less effective than direct visual inspection techniques for characterizing, and sizing CPC damage. It may also be less effective at detecting general corrosion.

A2 CHIME (Creeping Head wave Inspection Method)

PRINCIPLES OF THE TECHNIQUE:

CHIME is a medium range ultrasonic screening technique which provides full volume coverage between the transmitting and receiving probes which can be separated by up to 2 m operating in through-transmission. The system employs a combination of ultrasonic head-waves and creeping waves: CHIME can be used as a screening method for some pipes and plates including vessels, tanks etc and clamps, saddles and pipe supports. The system is suitable for wall thicknesses greater than 3 mm with pipe diameters from 4”.

The geometry of corroded surfaces affects the amplitude and characteristic pattern of the received signals. The effects become more pronounced with increasing depth of corrosion and it has been possible to apply a qualitative ranking of signals into the categories of <10% corrosion, 10% to 40% and >40%.

The technique has been shown to be effective in meeting the requirements as a screening technique for the inspection of certain types of pressure equipment.

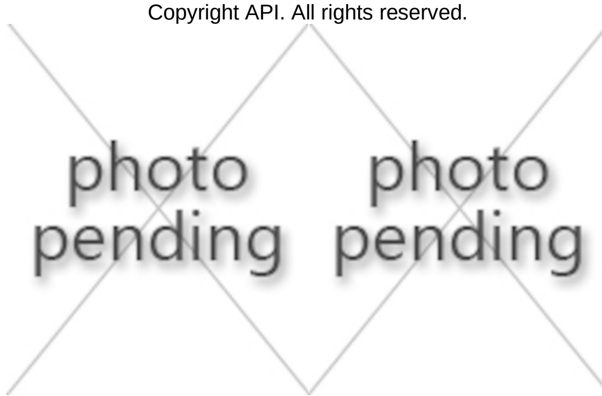

Figure A2-1: CHIME tool set- up and data image

Defect classification

The CHIME signals provide an indication of defect severity. The signal responses can provide an indication of any changes in the vessel wall (either external or internal) and, based on current experience; the responses are divided into three categories that correspond to the following defect extent:

A Nominal wall thickness to < 10% (approximately) of through wall extent for any defect present

B Defect present has a through wall extent which is likely to lie between ~10% and 30/40%

C Defect present that has a through wall extent which is likely to be greater than 30/40%

Indeterminate) No conclusion can be drawn due to a lack of reliable data (i.e. probe coupling difficulties)

Advantages

- Screening tool which reduces the need for expensive shutdowns and provides information to indicate areas of corrosion and aid in the lifetime prediction of assets.
- Sensitive to both internal and external surfaces.
- Suitable for pipe diameters from 100 mm (4 inches).
- Suitable for inaccessible geometries such as inspecting under clamps and saddles, pipe and vessel supports.
- Validated through HOIS blind trials.
- Capable of detecting internal and external corrosion.
- The CHIME signals provide an indication of defect severity.
- Tolerant to typical field surface conditions and thin coatings.
- Has been used on assets up to 150°C, however, at elevated temperatures (above 70°C) application details need to be considered and high temperature equipment in the form of suitable probes, leads and equipment are required.

Disadvantages

- Doesn't provide a quantitative through-wall sizing.
- As with all ultrasonics, surface conditions can be detrimental to the collection of good data, and this can be a limiting factor in carrying out examinations.
- For extruded pipe, thickness variations caused by the manufacturing process can interfere with interpretation.
- Longitudinal and spiral welds can also interfere with interpretation.

A3 Ultrasonic Multiskip Pulse Echo:

Multiskip can be used on both pipes and plate, and is suitable for inaccessible geometries such as clamps, saddles and pipe support. This eliminates the need for expensive shutdown and lifting of equipment by providing information that allows integrity decisions to be made.

The Multiskip and CHIME techniques use a similar setup and can be deployed as complimentary techniques.

The Multiskip technique uses angled shear waves with two transducers in a pitch-catch mode. The transmitter and receiver can be separated by up to 2 m with full investigation of the material condition between the probes. The data can be collected while scanning at reasonably high speeds, allowing for rapid coverage of large areas.

The transmitting ultrasonic probe injects ultrasound into the material. This sound then 'skips' through the material to be received by the second ultrasonic probe. The arrival time for each of the skips depends on the distance between the ultrasonic probes and the thickness of the material. The technique can be employed with either an axial beam (circumferential scanning) or a circumferential beam (axial scanning).

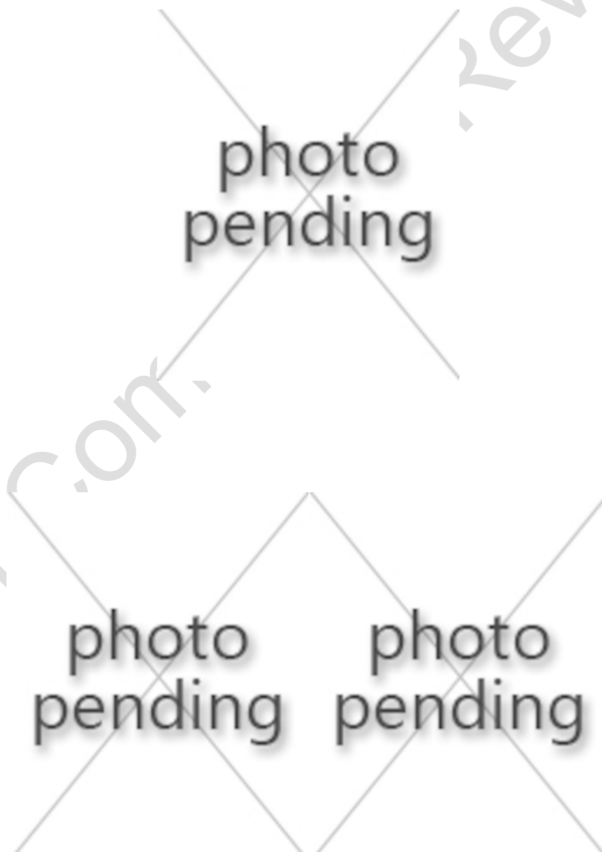

Figure A3-1: Multiskip image and Multiskip equipment set- up

Any degradation present along the beam path affects the arrival times for the signals. The characteristics of the data are readily visible in the b-scans generated as the data is collected. Review of the b-scans allows clear identification of the presence of degradation. The technique is also capable of identifying areas of more general wall loss.

In the case of localized degradation, the data is analyzed to estimate the depth of flaws. In the case of general degradation the data is analyzed to estimate the average remaining wall thickness.

Advantages

- Large area, single pass corrosion detection.
- Depth sizing capability for corrosion.
- Probe separation up to 2 m.
- 100% coverage of material between the probes.
- Suitable for steel pipes and plate.
- Sensitive to both internal and external surface degradation.
- Ability to inspect material thickness between 3 mm and 100 mm.
- A number of independent trials have been performed (CHRIS, GSP 235 and HOIS).
- Has been used on assets up to 150°C, however, at elevated temperatures (above 70°C) application details need to be considered and high temperature equipment in the form of suitable probes, leads and equipment are required.

Disadvatages

- Surface preparation.
- For areas where there are multiple areas of degradation between the probes, the sizing capability will be compromised but the technique can still be used for detection.
- As with all ultrasonics, surface conditions can be detrimental to the collection of good data, and this can be a limiting factor in carrying out examinations.

A4 Guided Wave Ultrasonics (Long Range GWT)

Figure A4-1: Long Range Guided Wave UT System, Data Presention

A5 Electromagnetic Transducer (EMAT)

The Principles of the EMAT Technique

Unlike standard piezoelectric probes, Electro-Magnetic Acoustic Transducers (EMATs) are non-contact ultrasonic probes (shown schematically below). EMATs consist of a magnet and an electric coil; the configuration of these components dictates the type of wave produced and the frequencies at which the probe will be most efficient.

Figure A5-1: Schematic comparison between a piezoelectric probe and an EMAT.

EMATs rely on the Lorentz force and magnetostriction in order to produce ultrasound within a specimen. The EMAT produces an eddy current on the surface of the specimen, this current in the magnetic field (also produced by the EMAT) results in a Lorentz force which creates ultrasound within the material. If the specimen is ferromagnetic, it will also experience magnetostriction, this is a dimensional change due to the external magnetic field introduced by the EMAT. When scanning ferromagnetic materials, the dominant effect is caused by magnetostriction.

EMATs can be constructed to generate Shear – Horizontal (SH) or Lamb waves. EMATs can be used on pipes with diameter from 4 to 28inch. In general SH EMATs are used for pipes with wall thickness below 15mm and coating thicknesses up to 0.5 mm. Lamb Wave EMATs can be used for pipes up to 25mm wall thickness and coatings up to 2 mm in thickness.

One of the key benefits of producing ultrasound using EMAT technology is that direct contact with the specimen is not required. EMATs are also less sensitive to surface conditions than piezoelectric probes and do not require any couplant between the transducer and the material under inspection.

In order to scan the circumference of a pipe, the EMAT probes can be placed at the same axial position with the transmitting and receiving sides of the probes aligned. The waves travel circumferentially, in both clockwise and anticlockwise directions (as shown schematically below).

The signals that are received when using SH and Lamb waves are based on the velocities of the modes that have been generated within the sample. Unlike conventional ultrasonics, there is no backwall signal and defects can affect the velocity of the signals.

Figure A5-2: Circumferential positioning of EMATs on a pipe

Any degradation that is present on a sample will disrupt the transmitted signals. Variation in the EMAT signals can be interpreted and used as an indication of wall loss at pipe supports. The priority for each of the supports can be determined by the classification key given dependent on pipe thickness (<10% wall Loss, 10-40% wall loss, >40% wall loss).

Figure A5-3: EMAT Tool Set up and a typical scan from a circumferential setup

Advantages

- Lamb Wave EMAT can be used with thicker pipe up to 25mm.
- SH EMAT can be used for pipes with thickness up to 15 mm.
- Screening tool capable to inspect large areas of pipe over short period of time and identify suspected areas which require a follow- up.
- No external power needed.
- No coating removal.
- EMAT tool is intended to be used for detection of general corrosion.
- Easy to adjust to different pipe sizes.
- Capable of detecting internal and external corrosion.
- The severity of results can be categorised.
- Validated through HOIS blind trials.
- Has been used on assets up to 150°C, however, at elevated temperatures (above 70°C) application details need to be considered and high temperature equipment in the form of suitable probes, leads and equipment are required.

Disadvantages

- Semi-quantitative inspection technique
- Any flaking paint or blistered parent material must be removed prior to inspection.
- Directionality of defects may impact detectability

A5.1 Quantitative EMAT

An EMAT system that provides quantified remaining ligament measurements for local CUPS wall loss less than 50% of the pipe wall thickness and qualitative wall loss estimations with wall loss greater than 50%. See Figure X:

Figure A5-4: Mechanized EMAT with qualitative thickness measurement

Figure A5-5: EMAT Sound Path

Applications:
Horizontal pipes only
Non-insulated pipes only
8-24 inch diameter pipe
0.25-.050 inch wall thicknesses
Coatings <.039 inch thick

Advantages: Motorized Pipe Crawler

A6 Ultrasonic Phased Array:

Figure A6.1: UT Phased Array System, Data Presentations

Figure A6.2: FMC/TFM (Full Matrix Capture/Total Focusing Method Phased Array UT)

A7 Short Range Guided Wave UT

Figure A7-1: Short Range Guided Wave System, Data Presentation

A8 Radiographic Techniques

A8.1 Compton Backscatter Technique

Figure A8-1 Compton Backscatter System, Data Presentation