MEC™ Pipe Seam Weld Inspection

Client:	**Client a**
Facility:	**Site b**
Items Inspected:	**12.75” OD - Steel Pipe**
Inspection Method:	**MEC P-19 Pipe Scanner**
Commencement Date:	**01st December 2015**
Completion Date:	**02nd December 2015**
Type of Report:	**Final Report**
Report Number:	**K-00x-1xxx**
Job Number:	**J-00x-1xxx**

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UKAS MANAGEMENT SYSTEMS 015

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MEC™ PIPE SEAM WELD INSPECTION REPORT (MEC-19)

Executive Summary

Innospection Ltd was requested by Client a, to perform a MEC™ (**M**agnetic **E**ddy **C**urrent) inspection on thirteen sections of seam welded carbon steel pipeline, with a 12.75" Ø and a wall thickness of 7.1mm, and coated with a 2.0mm epoxy layer.

The inspection was conducted on the premises of the Client's site on the 01st December 20xx and was completed on the 02nd December 20xx.

This inspection report documents in detail the specific inspection that has been conducted; the individual technique and equipment utilised, and the results, observations and conclusions (if applicable) obtained.

Inspection Details

(Long Seam Weld Inspection)			
Pipe Number	Length, Feet	Length, Meters	# of Tracks
1	16.71	5.09	40
2	21.85	6.66	52
3	18.54	5.65	44
4	12.25	3.73	29
5	29.17	8.89	70
6	26.58	8.10	64
7	29.42	8.97	71
8	32.00	9.75	75
9	24.13	7.35	58
10	24.54	7.48	59
11	42.38	12.92	102
12	38.13	11.62	92
13	30.67	9.35	74

The number of tracks identified in this chart, is for the number of transverse scans made for each section.

One remaining track is added to each section for a longitudinal scan.

The whole inspection did not highlight any discontinuities within the individual pipe sections examined, that was of interest to the client in respect to the defect observed during operational service.

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1. Test Object Data

Object Identification : 13 Pipe Sections (Numbered 1-13)

Location of Object : Client a, site b

Orientation of Scan : Longitudinal and Circumferential Scans Along a Seam Weld

Wall Thickness : Nominal 7.10mm

Material : API Specification 5L Grade X70M PSL Electric Welded Pipe.

Surface Condition: Smooth and Clean (with a flush and invisible seam weld to the external surface). Coated with a 2.0mm Layer of Epoxy.

2. Inspection Task

As requested by the Client a MEC™ (**M**agnetic **E**ddy **C**urrent) inspection was performed on 13 individual sections of varying 12" pipe lengths, from the 01st December 20xx to the 02nd December 20xx.

The inspection was performed with a MEC™ technology scanner, type MEC-P19.

MEC™ is regarded as a fast corrosion screening technique, for the detection of corrosion on either side of a pipe wall being inspected. This method of testing makes it practical to inspect the pipes from the external surface, whilst they are still in service and at operating temperatures.

The MEC™ inspection team consisted of qualified engineers from Innospection Ltd.

All areas described in Section 4 – Inspection Volume were inspected with the MEC™ scanner.

This inspection was carried out as a general screening of old pipeline, that was part of an original construction batch which had been subjected to a failure in a seam weld during operational service. The inspection was intended to ascertain if any defects were present in the pipe at manufacture, or indeed caused by conditions whilst in service.

3. Inspection Personnel

Inspection Supervisor : Technician a
PCN Level II Certificate No. 000000

Inspection Assistant : Assistant a

4. Inspection Volume

The MEC™ scans were taken both circumferentially and longitudinally, along the entire length of each section of pipe seam weld examined. This was done to ensure adequate overlapping of the scanners outer sensors, thus providing a complete coverage of the seam weld and associated heat affected zones.

(Long Seam Weld Inspection)			
Pipe Number	Length, Feet	Length, Meters	# of Tracks
1	16.71	5.09	40
2	21.85	6.66	52
3	18.54	5.65	44
4	12.25	3.73	29
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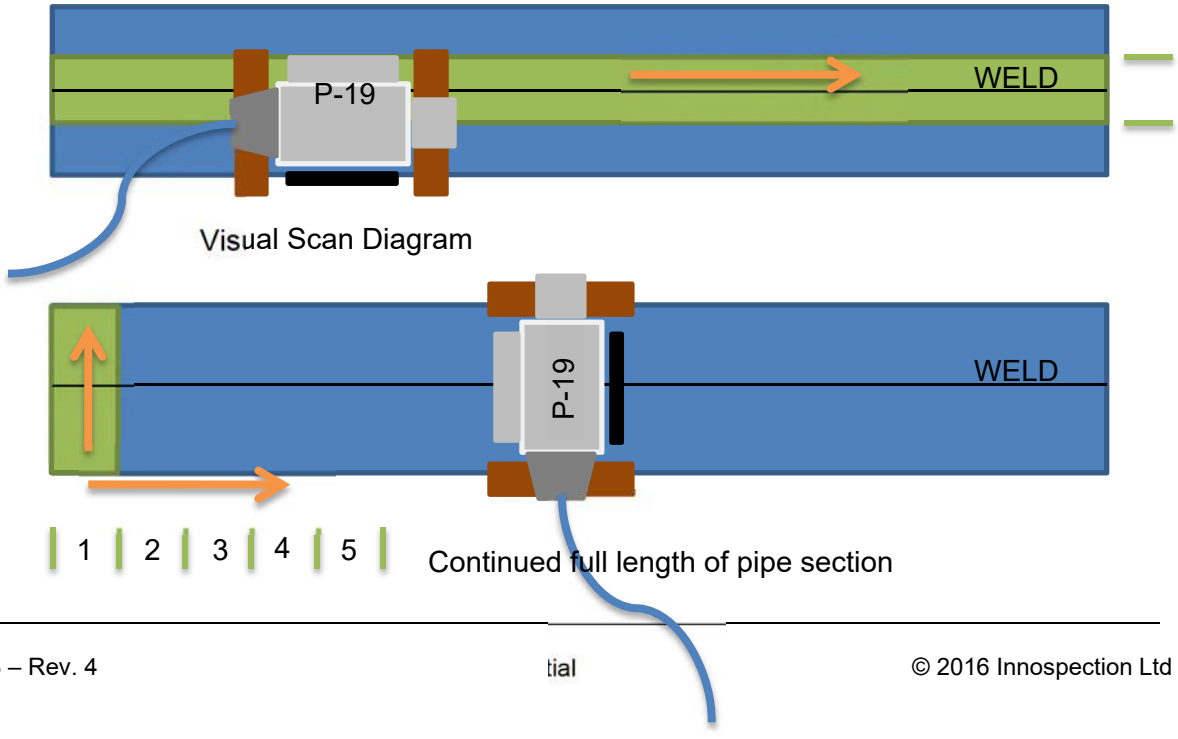
7	29.42	8.97	71
8	32.00	9.75	75
9	24.13	7.35	58
10	24.54	7.48	59
11	42.38	12.92	102
12	38.13	11.62	92
13	30.67	9.35	74

(**Figure 1**)



5. Inspection Equipment

5.1. MEC™ Equipment

The inspection system consisted of the following MEC™ equipment and accessories:

Scanner :	MEC™ P-19 Scanner (width 150mm)
Description of Scanner :	The MEC™ P-19 Scanner is a handheld system equipped with permanent magnets and multiplexed electronics. Eight (8) sensors each with a width of 18.75mm are located between the pole shoes. A trigger encoder is connected via a belt drive to one wheel. Two wheels at the front and two wheels at the rear which are adjustable in height for lift off.
Scanning Speed :	100% (approx. 24m/min)
Eddy Current Instrument :	IBM-AT-compatible (GETAC) computer linked to a single frequency eddy current electronic generator.
Eddy Current Sensors :	8 x EC-B-18.75 mm
Software Version :	Innospectit Software Version 2.6b
Cable :	30 metres of specific cable connection between the computer Eddy Current instrument and MEC™ P-19 Scanner
Reference Plate :	9.5mm Test Sample from Innospection, Serial No. 349
Reference Defect :	20%, 40%, 60%, 80% FBH

6. MEC™ Equipment Setting

In general, the MEC™ system is calibrated using sample test samples with artificial reference defects. The reference samples should be of the same material and thickness as the surface to be inspected.

In the case of a coating being present on the surface to be inspected, the average thickness of the coating (if applicable) should also be simulated on the reference sample for the calibration.

Typical reference defects that are used are flat bottom holes or conical bottom holes having a diameter of 5mm, 10mm and 20mm.

The depths of the artificial reference defects are typically 20%, 40%, 60%, 80% and 100%. Additional topside 20% deep defects for topside calibration.

For calibration, the MEC™ system is driven over the reference defects and the channels are set (one sensor per channel) to give a sufficient sensitivity level for the detection of internal and external corrosion defects.

The calibration is performed at the beginning of the inspection, and further checked after breaks, at the end of every shift and when significant changes are made to the settings of the equipment.

The calibration results and reference defect data from the calibration sample is always stored in the system.

The Eddy Current signal analysis is done online, i.e. at the time of the inspection. The computerised equipment and the software allow the analysis of the signal amplitude [in div.] and signal phase [in °].

7. MEC™ Equipment Calibration

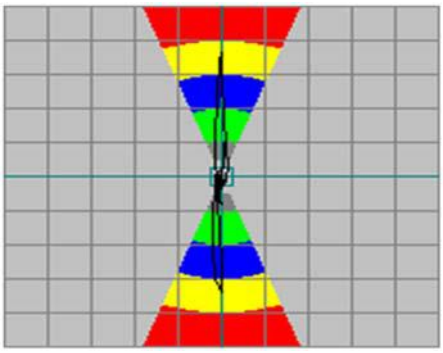
7.1. Equipment Calibration

For internal corrosion detection, a differential mode was used. The frequency setting used for Channel 1-8 (differential mode) was 80 - 100 kHz.

The amplitude of the signals was set so that the artificial reference defect (Ø 8mm 60% depth) was set to 8 screen divisions (full screen height). This is only classed as the initial pre-calibration setup and may then be further adjusted when the first true indication is detected and evaluated for depth, this by utilising the Ultrasonic pulse echo technique.

Optimum signal/noise ratio and signal phase separation between the internal defect indications and other indications were considered when selecting a suitable test frequency.

The differential channels of all the sensors were set so that internal defects were indicated in the vertical signal phase direction as shown in the diagram below. By moving the scanner in the positive forward direction, the internal defect signal would show the first peak down, followed by the second peak up.



Sample signal display of internal defect

7.2. Calibration Control

A general setting and calibration was performed at the beginning of the inspection and all the calibration data was stored digitally. Calibration controls were performed at the beginning and end of each working shift as well as after any other significant interruption (i.e. breaks or lunch). Re-calibration is also deemed necessary when significant changes are made to the settings of the equipment.

Calibration samples are used for the initial set-up and for the random check of operator’s settings. Accuracy of sensitivity settings can only be evaluated and achieved, when the first true indication found on the item undergoing the test is verified by an UT operator, with the corresponding depth of indication and MEC™ sensitivity being adjusted accordingly. With this setting, external corrosion defects would be detected and distinguished by phase separation from the internal defects.

7.3. Calibration Samples

The calibration samples are manufactured by Innospection Ltd in accordance to the setting standard requirements.

7.4. Change of Settings

In the event of any scanner adjustment, re-calibration is performed.

8. Inspection Procedures

The inspection was performed according to the following valid procedure:

MEC™ Pipe Inspection Procedure No’. InnoPSIoPIP-001-08 – Current Issue

9. Inspection Performance

9.1. Scanner Movement

The scanner assistant, who was in permanent communication with the MEC™ operator, was responsible for positioning and moving the scanner on the pipe surface. The MEC™ P-19 Scanner is marked clearly on the top with the FORWARD and BACKWARD directions so that all scan directions are made clear to the operator and assistant at all times. In addition, visual contact between the operator and assistant was established during the inspection.

The scanner was moved manually with the scanned tracks being overlapped at all times.

All scans for the inspection were recorded in the forward position.

9.2. Scan Track Positioning

The pipes were marked circumferentially into a number of equally spaced tracks. The longitudinal track was scanned with the weld in the centre of the scanner. The tracks were numbered accordingly. A visualisation of the track numbering is shown at the bottom of Page 5 (Figure 1).

9.3. Parameter Storage

The Eddy Current testing parameter was set during the calibration and digitally stored according to the scan direction and lift off.

10. Defect Analysis

All indications which showed a clear signal phase direction to that of the reference defects and which had signal amplitude equivalent to that of the test piece would have been subjected to analysis.

Signals that are clearly outside of the defect phase are considered to be indications that are not reported but would be investigated at the time of the inspection to determine its origin.

11. Comments to Inspection

This inspection was carried out using a standard Innospection calibration reference test sample and equipment set-up, in the absence of a truly representative pipe sample containing “like for like” defects. If such a true defective sample had been made available to Innospection, this would have significantly helped into understanding the type of signal response (definition) expected from such a defect.

With such a dedicated true resultant signal, it would also have been possible to make some further Eddy Current parameter and Magnetic changes, thus adapting better to suit the material being tested.

- Pipe samples were clean and free of debris
- The inspection was in a clean, quiet environment
- Some pipes were slightly bent with ovality.

12. Result Overview

This inspection did not highlight any discontinuities within the seam welds of the pipe sections examined, that were of interest to the client in respect to the type of defects observed within the pipe section that had failed during operational service.

12.1. Sensitivity Settings

The general overview of the inspected areas with the results is presented in the attached colour scan reports.

Note

Eddy Current inspection is an evaluation method of NDT; hence all results obtained are based upon the test piece used. Material and wall thickness of the test piece should be as near as reasonably practicable to the item under inspection. Artificial defects should be as near in size and shape as to the type sought.

Because MEC™ signal amplitudes are an indication of defect depth and volume, the defect depth analysis by signal amplitude is translated as a comparison with artificial reference defects within the provided test sample.

12.2. Result Overview

No significant indications observed.

13. Inspection Summary

A summary of the inspection findings in each of the scanned section is given below:

Of the thirteen sections of pipe tested and analysed, there was no evidence of defective indications within the seam welds.

The total length of weld analysed was 346.37ft (105.57m)

14. Documentation

The inspection result, parameters and data are stored in the Innospection Limited archive database system.

15. Signatures

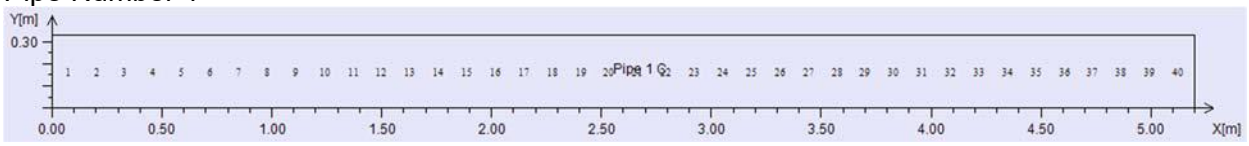
Name: Technician a
Title: Level II PCN Cert No 00000.
Innospection Limited

APPENDIX 01

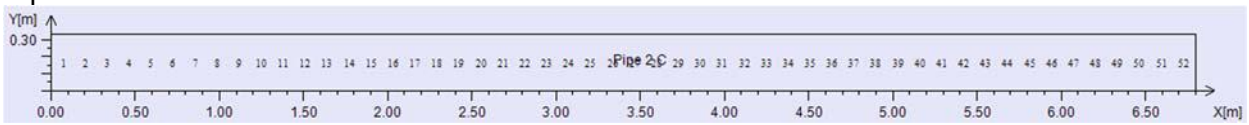
Transverse Weld Scan BMPs

Pipe Scan Indication Location BMP Images
Circumferencial / Transverse Scans

Pipe Number 1



Pipe Number 2



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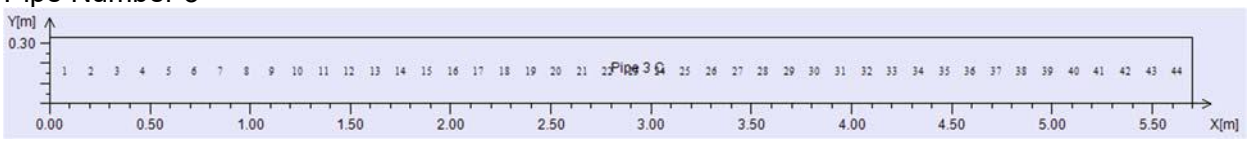

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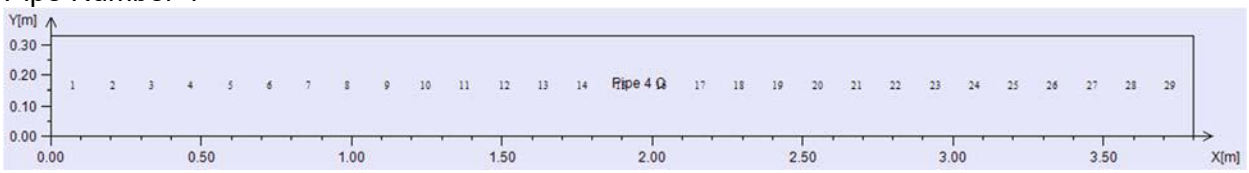

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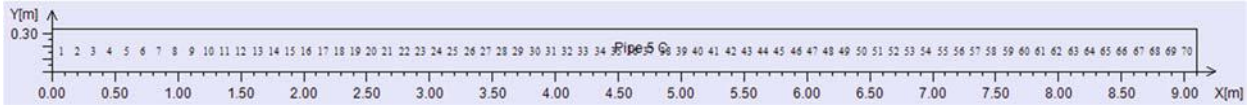

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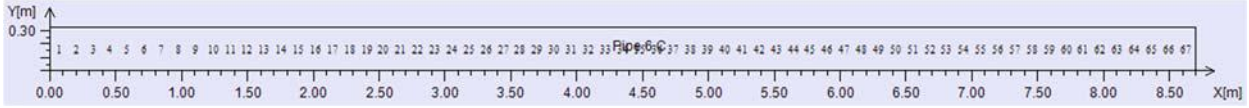
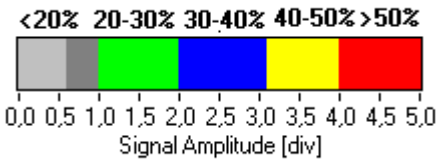
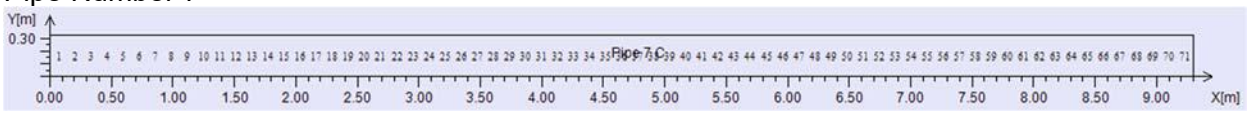


This colour palette indicates the amplitude and severity of indications by allocating a percentage and colour scale, that would be shown within the BMP images if a defect indication was present. The amplitude of a signal and its resulting colour can be seen in Appendix 3, at the end of this report.



Pipe Scan Indication Location BMP Images
Circumferencial / Transverse Scans

Pipe Number 7



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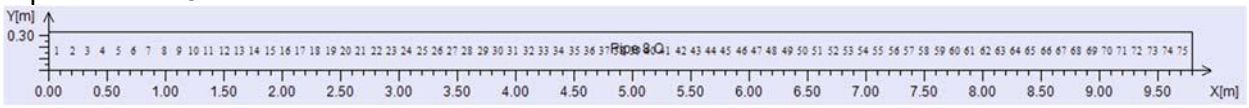

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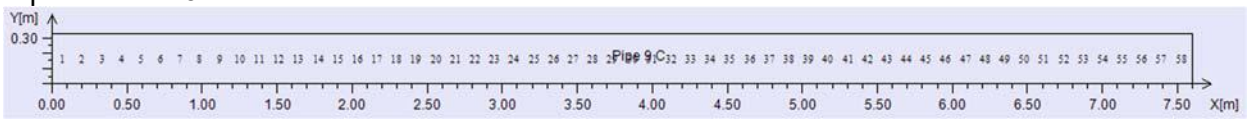

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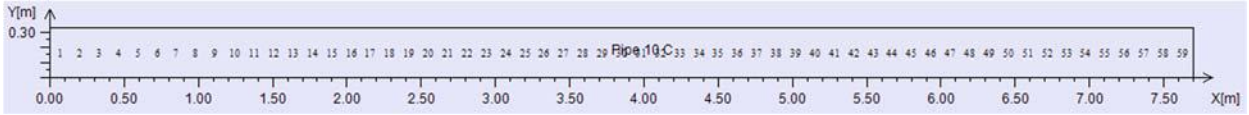

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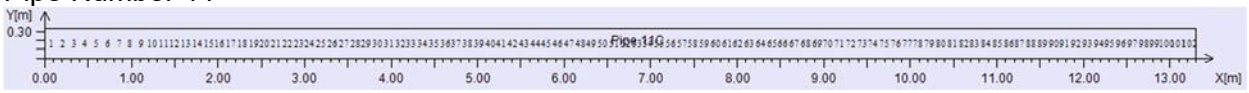

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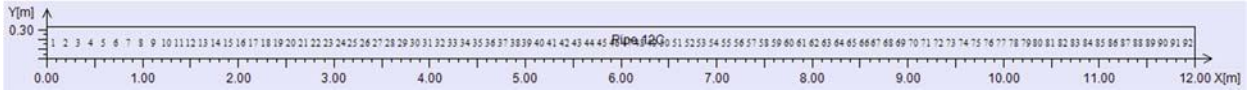

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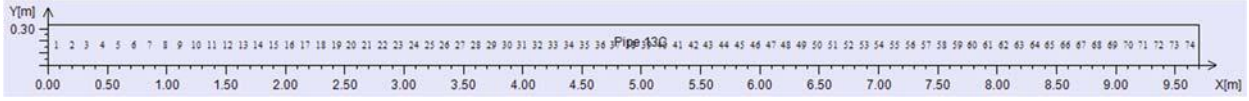

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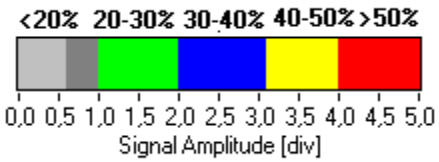

APPENDIX 02

Longitudinal Weld Scan BMPs

Pipe Scan Indication Location BMP Images
Longitudinal Scans

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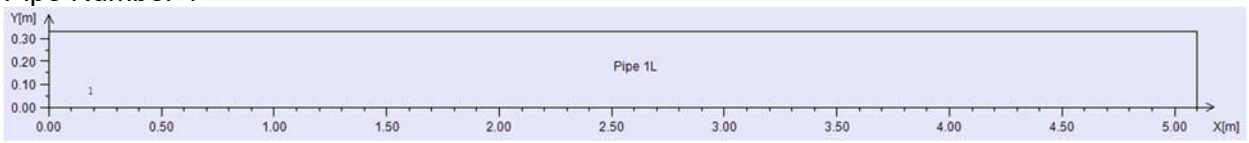

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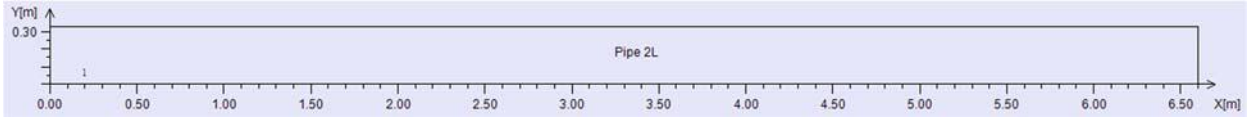

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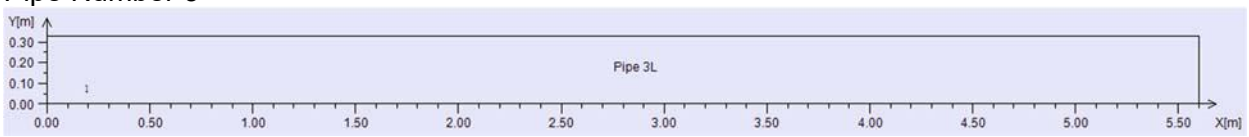

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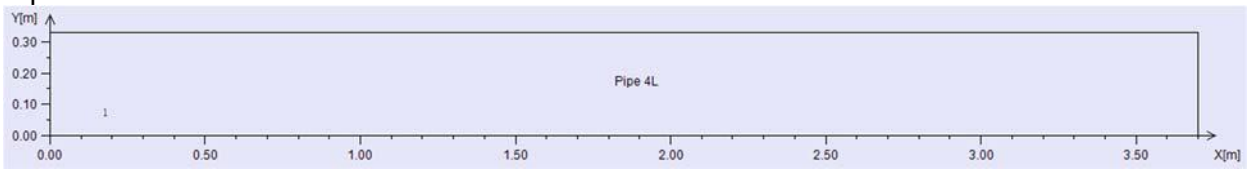

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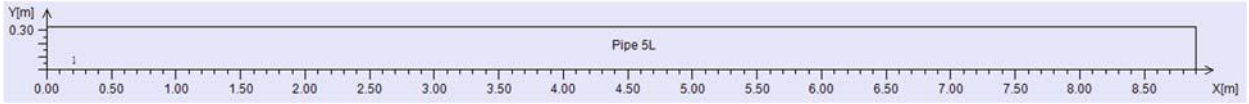

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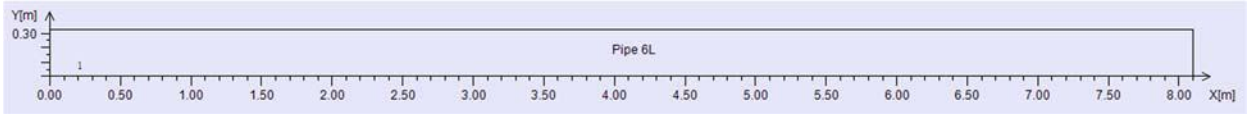

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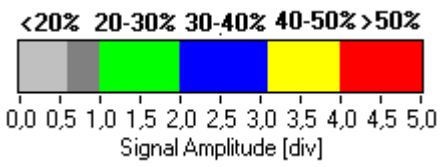
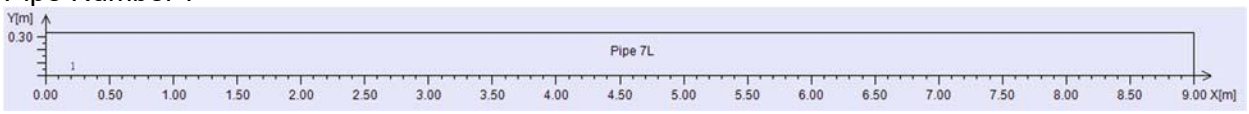


Pipe Scan Indication Location BMP Images
Longitudinal Scans

Pipe Number 7



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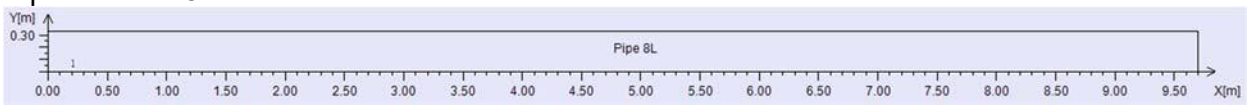

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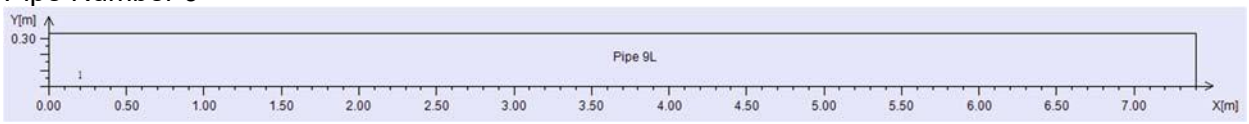

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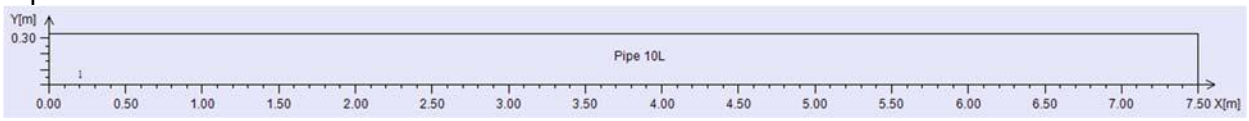
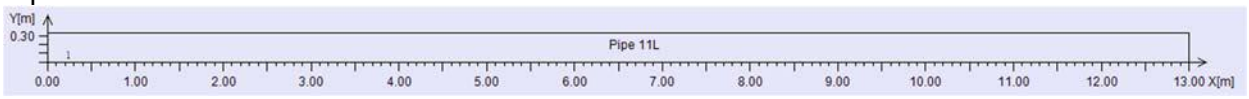


Pipe Number 11



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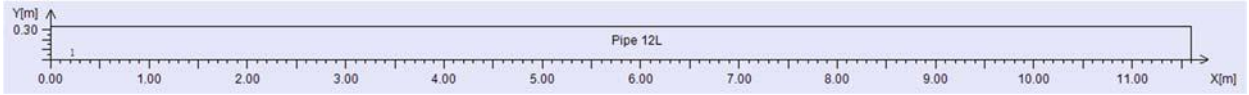

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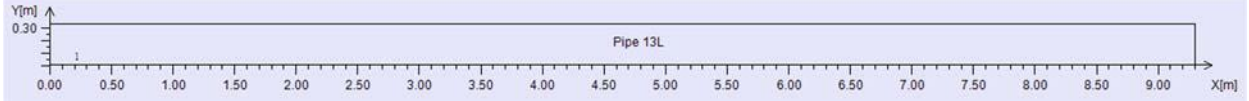

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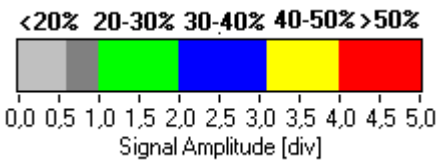
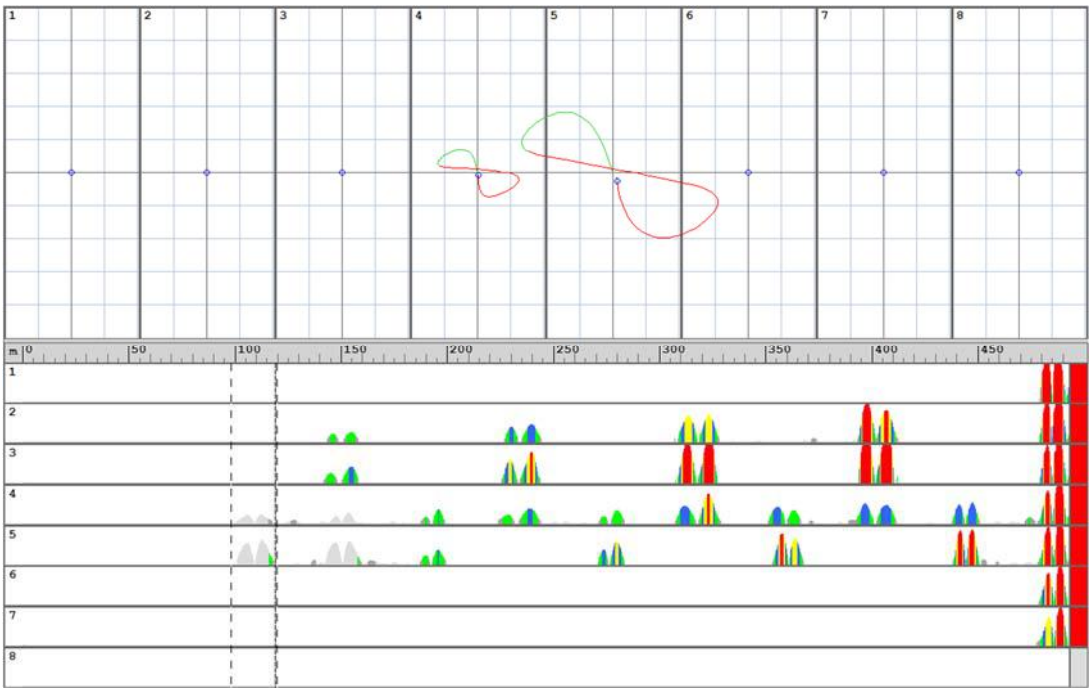


APPENDIX 03

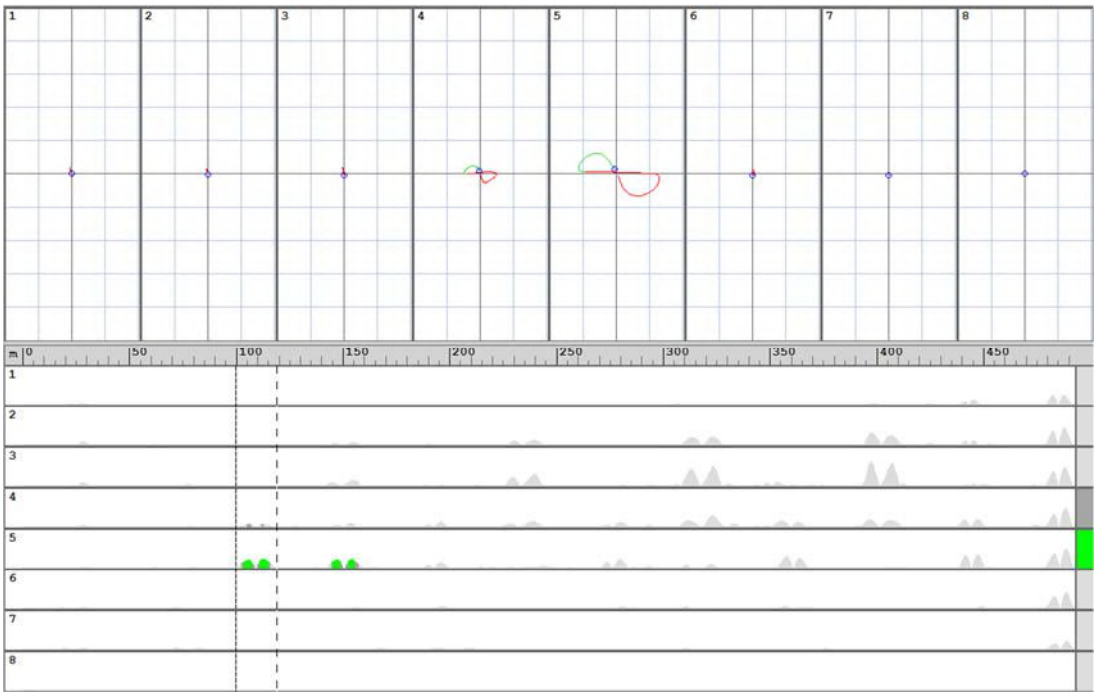
Calibration Scan BMPs

Calibration Indication BMPs

The calibration signal below depicts a 20% wall loss reference external surface indication, with the underside parameter settings active. A surface indication is distinguished clearly due to a horizontal shift in the (impedance) phase angle of approximately 90°, when compared to that of an internal (vertical) defect indication (page 17). Surface indications are the resultant of a true Eddy Current field disturbance/response(s).



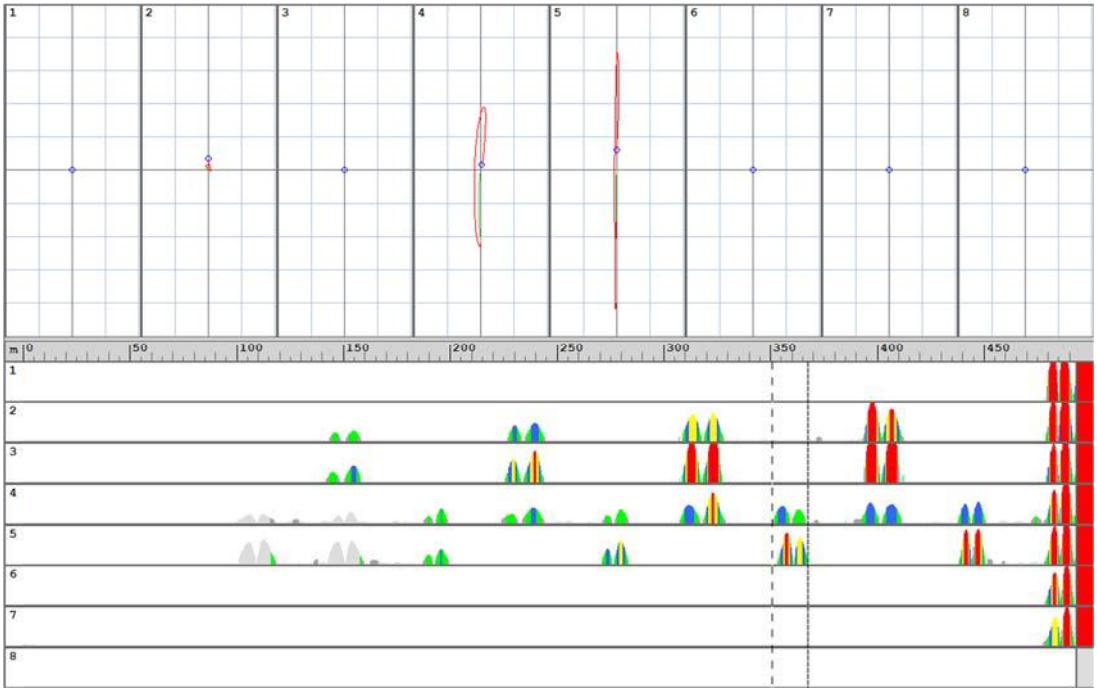
The calibration signal showing below is a 20% wall loss surface indication, with the topside parameter settings active



Calibration Indication BMPs

The calibration signal shown below is that of a 60% wall loss underside defect indication, with the underside parameter settings active. This indication is shown set vertically at 8 screen divisions, and is the main inspection sensitivity level.

MEC underside signal response(s) are achieved through the compression of magnetic flux field lines (that have been generated in a material by an electromagnet source), being disturbed by the presence of a defect. Such changes lead to localised permeability variations that are ultimately detected by Eddy Currents.



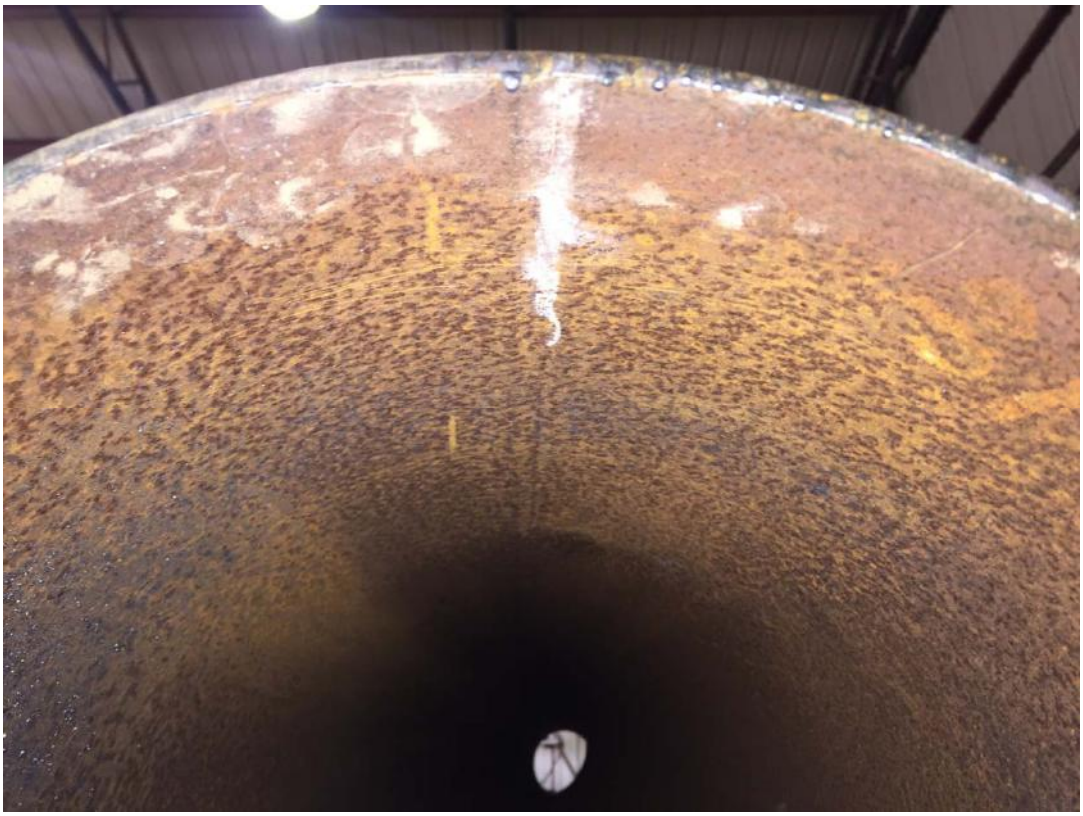
Pictures to the inspection

MEC™ P-19 Scanner with a circumferential wheel set and pole shoe.

Pipe section number 1, exhibits a slight bend giving rise to some minor pipe ovality which has the effect of raising and lowering lift off, (the distance between the sensor pole shoe and the inspected material) giving rise to gradual sensitivity variations.

Pictures to the inspection

This view shows the smooth profile of the weld from the internal surface



Weld Profile Diagram