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PEC INSPECTION REPORT

UTILISING SUBSEA PEC TECHNIQUE

CLIENT

Final Report: Kxxx-xx

Rev	Document	Author		Checked		Approved By		Date
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0	Issued to Client	Reporting Engineer		Group Leader		Group Leader		

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1. GENERAL INFORMATION

1.1 General Technique

The PEC probe magnetises a certain volume of the object under inspection. During the measurement, eddy currents will flow from surface till back wall in area approximately determined by the probe's footprint. The PEC technique derives a wall thickness estimate from the secondary electro-magnetic field generated by these eddy currents and hence, will be a function of **volume** rather than wall thickness.

Consequently, the PEC reading will be proportional to the average wall thickness. For defects in the order of smaller than the probe's footprint, the wall loss will be **underestimated**. PEC is therefore suitable for **general** wall loss, isolated pits or small diameter holes cannot be detected.

The PEC readings depend on the electromagnetic **properties** of the material, which may differ for individual segment of e.g. a caisson. Variations in these will influence the PEC wall thickness readings.

The geometry of the test object should be simple; i.e. straight sections of pipe and vessels. Wall thickness readings are affected by nearby nozzles, welds, internals, and support structures.

ROV (Subsea) specific issues:

Without proper calibration, readings obtained with the PEC technique – unlike e.g. ultrasound (UT) – are of *relative* value only. The main issue with subsea PEC inspection remains the difficulty to calibrate the relative result on the actual object.

The current procedure attempts to deduce nominal thickness from readings obtained by a systematic scan over an area, large enough to include material, which has none or minimal corrosion damage and hence approximates the nominal thickness for the inspected object. This method requires an accurate probe deployment tool.

Results are presented in 2D and 3D colour plots for convenience only. In general, no quotes can be made as to the absolute accuracy, readings are of qualitative value only.

1.2 Work Timing

- Start measurements: 21st, December 2013, @11:50 at the bottom of the pipe (6'o clock position)
- End measurements: 21st, December 2013, @15:20

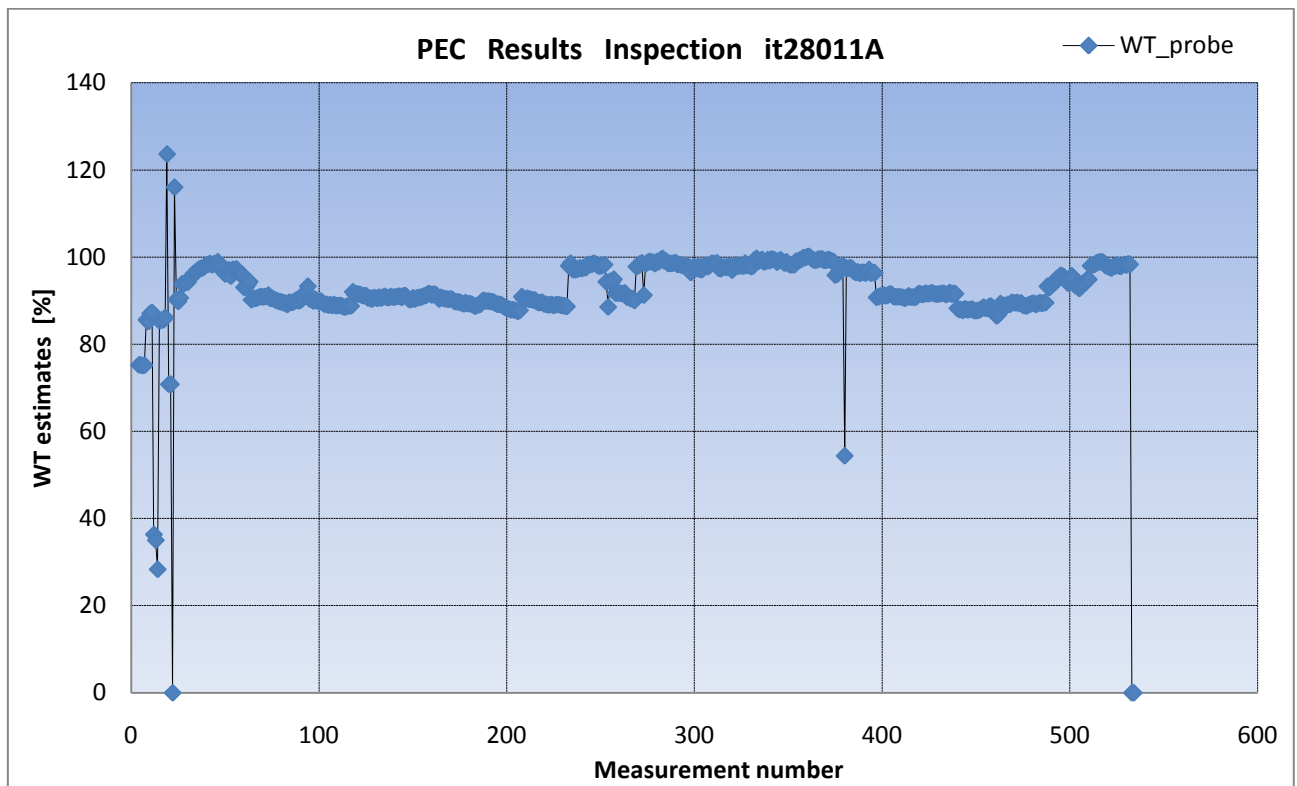
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1.3 Measurements Features

- Total number of measures: 533 measures
- Number of wrong measures: 10%
- Reason of wrong measures:
The repeated measures did depend from an earlier probe lifting from the properly position and/or from small vibrations by the divers. NOTE: every wrong measure did be repeated until to obtain the properly result.

The graph below indicates all the measures of the Project.



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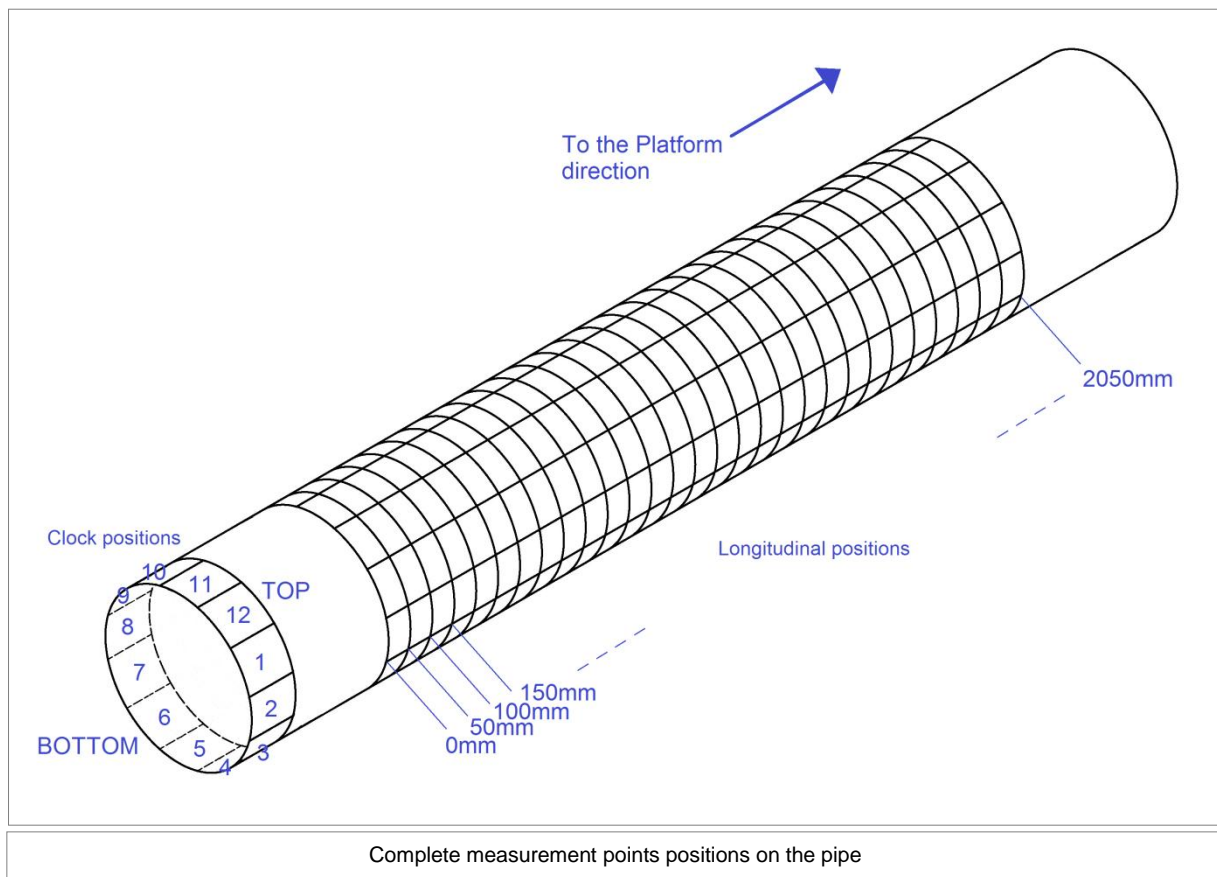


2. MEASUREMENT DESCRIPTION

2.1 Measurements positions and orientation

The measurement points have been defined by the clock positions around the pipe, with the bottom corresponding at 6'o clock and the top of the pipe corresponding at 12'o clock. The longitudinal positions are defined at every 50mm, starting from 0mm value, increasing with the platform nearing.

The picture below shows the orientation and the measurement points positioning.



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2.2 Work sequence

The inspection has started from 6'o clock position around the pipe (bottom of the pipe) and from 0mm to 1000mm longitudinal position, with 50mm between every measure. The second section has started from 6'o clock position around the pipe, from 1050mm to 2050mm longitudinal position.

In every position the probe was kept still 10 seconds for the data acquisition.

The table below shows the timing for the measurements sequence.

TIME	CLOCK POSITION AROUND THE PIPE	LONGITUDINAL POSITIONS ON THE PIPE [mm]																			
FIRST MEASUREMENTS SERIES																					
11:50	6	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
12:00	7	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
12:10	5	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
12:20	4	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
12:30	3	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
12:40	2	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
12:50	1	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
13:00	11	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
13:10	10	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
13:20	9	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
13:30	8	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	1000
SECOND MEASUREMENTS SERIES																					
13:45	6	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
13:57	7	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
14:07	5	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
14:16	4	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
14:25	3	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
14:35	2	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
14:43	1	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
14:51	11	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
15:00	10	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
15:10	9	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050
15:20	8	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2050

3. COLOUR PLOT RESULTS

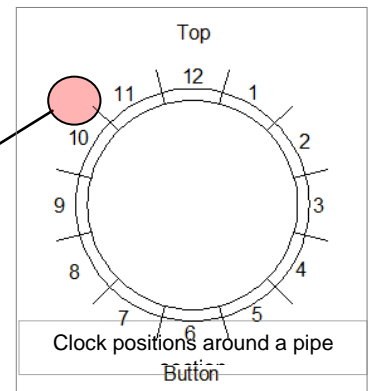
The table below indicates the measures obtained from the calibration and the pipe inspection. The values define the average wall thickness percentage, referred to the 100% value from the test pipe calibration.

3.1 Table result description

Columns

The columns indicate the clock positions around the pipe: the measurement step is one hour, so this means in total twelve measures every pipe section.

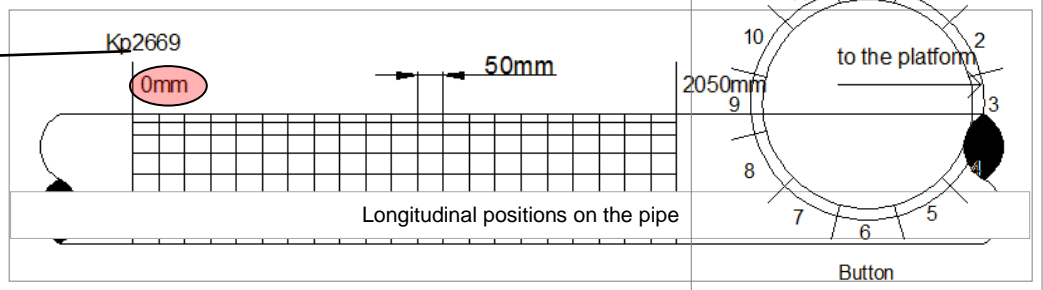
Clock Position [hr]											
12	1	2	3	4	5	6	7	8	9	10	11
87.4	89.7	90.8	91.8	89.9	90.4	90.1	97.3	91.6	97.5	90.8	89.3
87.5	90.0	90.9	91.0	89.7	90.4	92.5	97.5	91.7	98.2	90.3	89.4



Rows

The rows define the longitudinal position on the pipe, starting from 0mm to 2050mm, with 50mm between every step.

Longitudinal Position [mm]
0
50
100
150
200
250
...
1800
1850
1900
1950
2000
2050



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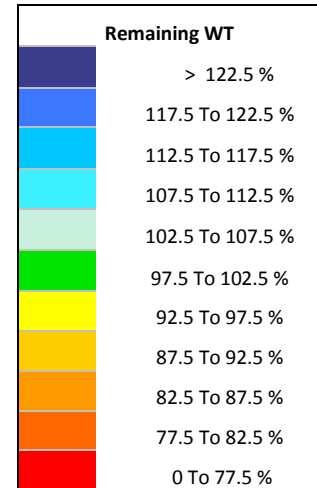


3.2 Calibration results

The calibration value is obtained by a specific measures catching procedure on the test pipe.

The calibration results are showed in the table below.

Vertical Position [mm]	Horizontal Position [mm]					
	0	50	100	150	200	250
0	98.6	99.7	99.2	100.1	100.2	100.3
50	99.0	99.2	98.9	99.7	99.0	100.1
100	98.1	98.0	99.5	100.8	101.0	100.4
150	97.9	98.2	100.8	101.1	100.7	100.0
200	99.0	99.2	98.9	99.8	100.6	101.8
250	97.8	98.6	98.7	99.3	99.8	100.5



The values inside the red square are used to define if the PEC system is properly calibrated: the maximum error is within +/-5%: this means the properly calibration on the test pipe.

The average value of the measures inside the red square is used as the final calibration value, corresponding to the absolute wall thickness result by UT system on the test pipe.

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3.3 2D Colour plot results

The table shows the perceptual of remaining wall thickness on the inspected pipeline.

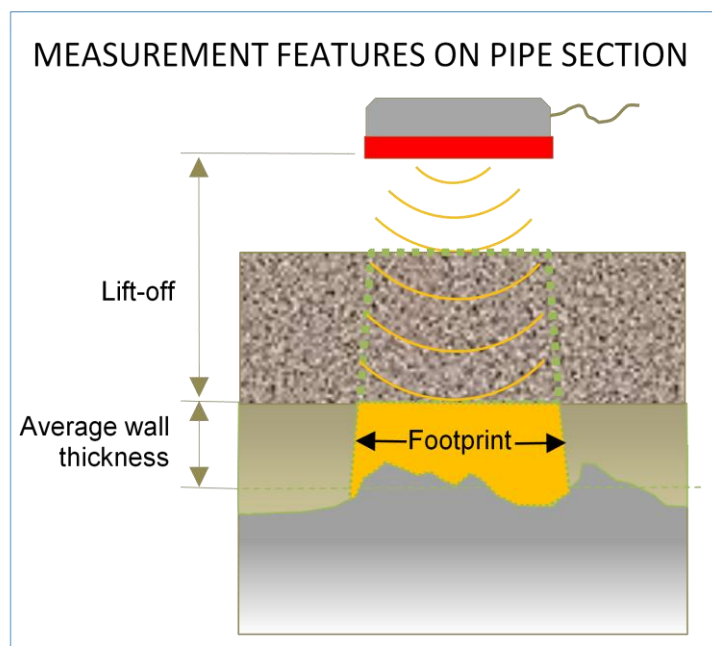
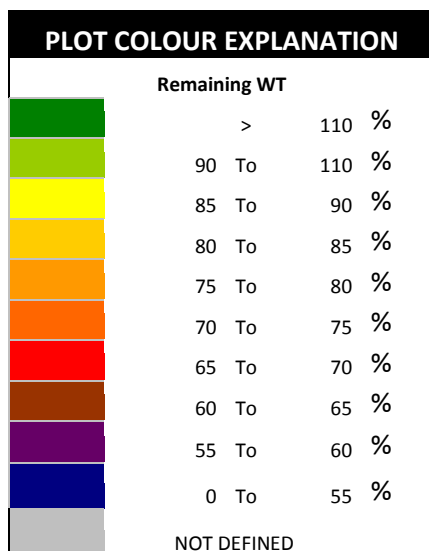
Longitudinal Position [mm]	Clock Position [hr]											
	12	1	2	3	4	5	6	7	8	9	10	11
0	87.4	89.7	90.8	91.8	89.9	90.4	90.1	97.3	91.6	97.5	90.8	89.3
50	87.5	90.0	90.9	91.0	89.7	90.4	92.5	97.5	91.7	98.2	90.3	89.4
100	87.8	89.8	91.0	91.1	89.9	90.2	93.5	97.1	91.6	96.7	90.5	89.2
150	87.6	89.7	90.7	91.1	89.4	90.0	93.5	96.7	91.6	96.6	90.2	89.2
200	87.6	89.7	91.1	91.0	89.3	89.9	93.9	97.2	91.7	96.8	90.2	89.2
250	87.4	89.7	91.2	90.8	89.5	89.7	93.8	97.0	90.9	96.9	90.0	89.0
300	87.0	89.2	90.7	90.7	89.0	89.7	94.6	96.7	90.8	97.2	90.0	88.9
350	86.7	89.1	90.2	90.7	88.8	89.4	95.0	96.2	90.5	97.0	89.6	88.5
400	86.5	89.1	90.4	90.2	88.9	89.4	95.8	92.8	90.5	97.4	89.5	88.3
450	86.4	89.0	90.7	90.2	88.7	89.0	96.0	92.8	90.2	97.5	89.2	88.4
500	86.0	88.8	90.7	90.0	88.9	89.5	97.0	93.4	97.7	98.2	89.1	88.3
550	85.8	88.6	90.8	90.4	88.7	89.4	97.1	94.0	98.3	98.1	89.0	88.1
600	85.7	88.9	91.0	90.3	89.0	89.5	97.3	90.2	98.5	98.4	88.8	87.8
650	85.5	88.7	91.2	90.2	88.7	89.7	97.6	90.6	98.2	98.4	88.9	87.6
700	85.4	88.6	91.2	90.5	88.7	90.0	98.0	90.7	98.5	98.1	88.7	87.4
750	85.4	88.5	91.6	90.2	88.7	89.8	98.1	90.9	98.7	97.8	88.9	87.2
800	85.4	88.3	91.5	90.7	88.7	89.9	98.3	90.9	98.6	97.8	89.0	87.3
850	85.1	88.0	91.2	90.5	88.4	90.2	97.9	90.9	98.5	97.9	89.0	87.2
900	86.2	88.2	91.4	90.4	88.4	90.8	98.2	90.9	98.1	94.0	88.9	87.0
950	86.0	88.4	91.4	90.7	88.7	91.8	98.3	90.9	98.6	94.6	88.8	86.8
1000	86.3	88.6	90.9	90.6	88.6	93.0	98.7	91.3	98.5	94.1	88.7	87.1
1050	87.1	91.4	90.8	95.5	98.8	99.1	99.5	98.0	97.8	92.7	88.7	88.0
1100	86.9	91.5	90.9	95.7	98.8	99.4	98.9	98.4	98.1	93.1	88.9	87.5
1150	86.6	91.3	91.1	96.4	99.1	98.7	98.9	98.5	98.2	93.7	89.2	87.4
1200	86.3	91.4	91.0	97.1	99.3	99.2	98.3	98.1	98.5	93.8	89.1	87.2
1250	86.3	91.6	91.2	97.8	99.7	98.8	98.2	97.3	98.7	94.7	89.5	87.5
1300	86.2	91.5	91.0	97.0	99.6	98.8	98.3	97.2	98.7	94.8	89.5	87.2
1350	86.1	91.5	91.2	97.1	99.9	99.2	98.4	97.6	98.7	95.4	89.6	87.3
1400	86.4	91.7	91.5	97.2	99.9	99.0	98.4	97.6	98.5	95.2	89.5	87.3
1450	86.1	91.6	91.4	96.9	99.5	99.4	98.0	97.4	97.8	95.0	89.0	87.0
1500	86.2	91.4	90.9	96.2	99.1	99.2	98.1	97.8	97.5	94.4	88.8	87.0
1550	86.4	91.4	90.8	96.0	99.0	99.1	98.1	97.6	97.3	93.6	88.8	87.1
1600	86.3	91.4	90.8	96.1	99.0	98.5	97.8	97.9	97.6	94.6	89.1	87.2
1650	86.4	91.5	90.8	95.7	99.3	99.0	97.5	98.1	97.8	95.3	89.2	87.6
1700	87.2	91.6	90.8	96.0	99.3	99.2	96.4	97.7	98.0	93.1	89.4	88.0
1750	87.0	91.6	90.7	96.0	99.3	98.7	97.4	97.8	97.8	92.9	89.4	87.6

1800	86.9	91.3	90.5	95.9	99.0	98.2	97.5	97.8	97.7	92.4	89.1	87.5
1850	87.2	91.5	90.7	96.0	99.0	98.7	97.7	98.5	97.9	92.9	89.4	88.1
1900	87.2	91.8	91.1	96.7	99.3	98.2	97.1	97.9	98.1	93.6	89.5	88.1
1950	86.2	91.4	90.7	95.8	99.1	97.9	98.0	98.0	98.0	93.6	89.4	86.4
2000	85.5	91.6	90.7	96.0	98.9	97.9	97.8	97.7	98.3	94.5	89.5	85.1
2050	85.7	91.5	90.8	95.9	98.8	98.0	97.5	97.7	98.1	94.5	89.5	85.6

Remarks:

1. The 4" piggybacked pipeline has not permitted to measure the values on 12'o clock position: the present values on the table are calculate by a mathematic algorithmic from the near measures, only to have an estimation of the average wall thickness pipe corrosion.

2. The results indicate an average wall thickness value, with 100mm of footprint diameter.



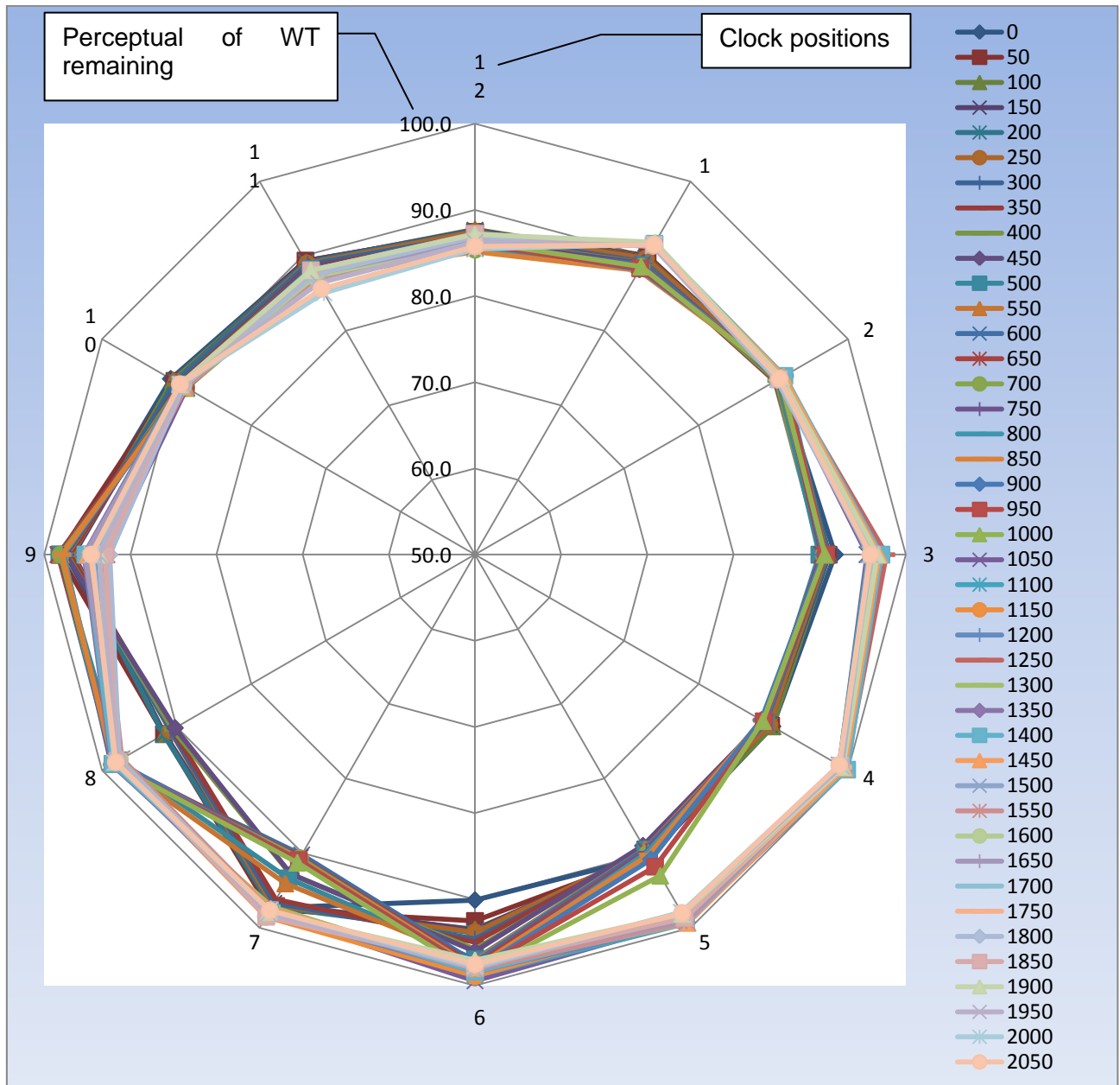
- The results are 10% of accuracy, so the values are relevant when less than 90%.
- The 10% of accuracy means the values greater than 110% are not wrong results because less than the error range.
- If the result is greater than 110% can mean a greater wall thickness of the declared value or very different magnetic pipe proprieties (or a wrong calibration value).

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3.4 Pipe section wall thickness remaining

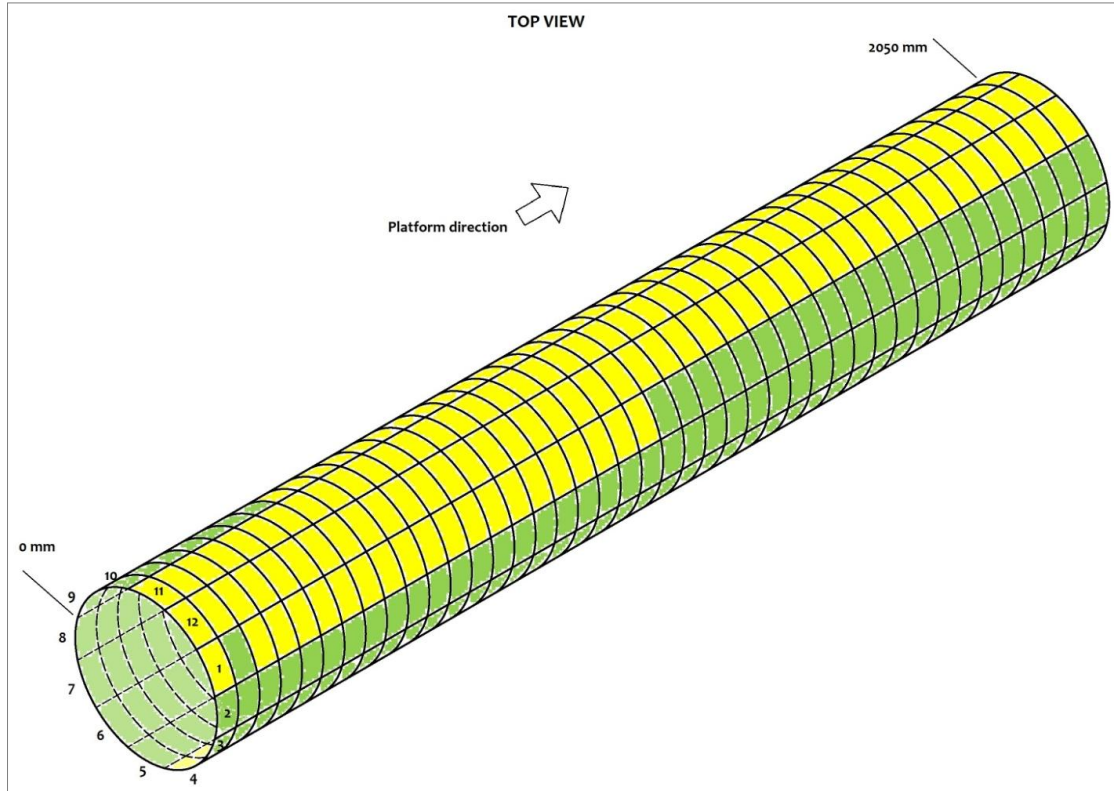
Average wall thickness pipe section from 0mm to 2050mm on the longitudinal position.



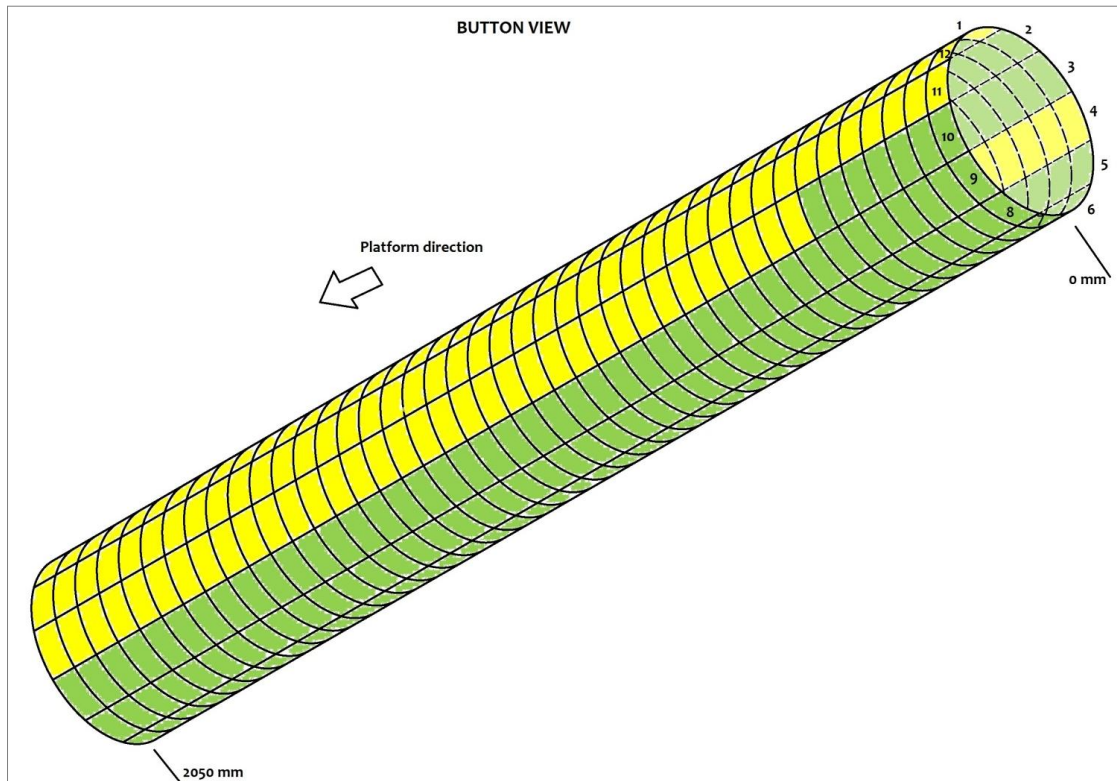
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3.5 3D pipe model colour plot results



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3.6 Scan Results

The exhaustive data analysis and processing is showing the integrity of the pipe, with a general wall loss at the top of the pipe, between 10'o clock and 2'o clock positions. The corrosion value is between 10 to 15% of the original wall thickness, with an increasing corrosion with the upper clock positions.

Is present a corroded well from 0 to 1000mm of the scanned section at 4 and 5'o clock positions (the yellow area on the 2D colour plot at the relevant coordinates), but not greater than 12% of wall loss.