
Assessment of Corrosion under Insulation and Engineered Composite Wraps using Pulsed Eddy Current Techniques.
trac
Service • Safety • Quality • Innovation

Presentation Outline

- Introductions
- Brief overview of TRAC Oil & Gas Ltd.
- Factors affecting Probability of Detection - Review
- Perceived current challenges
- NDT methods to be verified – Overview and work carried out to date:
- Radiography,
- Pulsed Eddy-Current (PEC)

Established in 1999:

Incorporated in Scotland,
based initially in Aberdeen.
10 years of growth & diversification.
2009 creation of group & subsidiary companies.

Group turnover circa £50m.

Steady state and controlled growth for initial 10 years, accelerated growth following 2009 reorganisation.

TRAC Oil & Gas:

Turnover circa £15m

Services

- Rope Access
- Engineering Support
- Inspection & Testing
- Remote Inspection
- Marine Class Survey & Repair
- Mechanical & Electrical Trades
- Rigging & Lifting
- Fabric Maintenance
- Fire Protection Systems
- Training

Accreditations & Approvals

trac

Accreditations

ISO 9001: 2008

ISO 14001: 2004

ISO 18001: 2007

ISO 17020:2012

Class Approvals & Hull Thickness Measurement Approvals

402a

402b

Memberships & Affiliations

Full Member

Perceived Current Challenges

In-Service Inspection relative to:

- Corrosion Under Insulation (CUI)
- Evaluation of Remaining Wall Thickness under Blisters/Surface Scabs
- Inspection of and through Composite Engineered Wraps

Factors Affecting Probability of Detection (POD)

- Competency of the Company & Personnel
- Well developed and verified procedures
- Appropriate Acceptance Criteria
- Effective scanning of the component -
- Area of the reflecting surface
- Orientation of the defect
- Shape of the defect

Who Decides What to Use?

Compliance Responsibility - Roles & Responsibilities

The **Owner / End User** is the responsible party irrespective of any construction / maintenance / consultancy contracts etc. that might be in force)

The **Owner / End User** verifies that the **NDT Contractor (Employer)** is competent to carry out the contractual requirements.

The **Employer** is responsible for ensuring Inspection Personnel meet the competency requirements of the contract.

Inspection Bodies

Companies accredited in accordance with: ISO/IEC 17020:2012

The inspection body should demonstrate that it has management control over the following stages in order to demonstrate that it has the personnel necessary to undertake the range of inspection activities covered by its scope of accreditation:

- Identify the range of inspection activities,
- Identify the competence required for each activity,
- Train & assess against the competence criteria,
- Authorise persons for activities under appropriate supervision,
- Monitor performance of persons to re-assess competence

What are we looking for & how do we know we will find it?

This is the pre-requisite for all Inspection / NDT activities.

Identify what the degradation process is likely to be and apply the most appropriate method/technique to find and quantify it.

Verify the procedure under site conditions – coating / surface condition, real degradation – not artificial flaws or verify that the artificial flaws truly represent the expected degradation.

NDT personnel competent to carry out the activities?

Certification is not a measure of competence

Project Outline

Project consists of:

- Market survey and evaluation of Pulsed Eddy-Current equipment available.
- Source relevant in-service samples with typical and varied degradation
- In-House research to be verified by competent Third Parties
- Research and source suitable additional and/or alternatives to Pulsed Eddy-current techniques
- Research and trial suggested innovative methods

Market survey and evaluation of Pulsed Eddy-Current equipment available.

In total three (3) Pulsed Eddy-Current systems were evaluated.

Two systems were found to be relevant to our project.

These were Eddyfi Lyft and Maxwell PECT

Eddyfi LYFT Instrument

- **Materials**:

  Carbon steel

- **Lift-off range:**

  up to 300mm (12”)

- **Wall thickness:**

  up to 100mm (4”)

- **Weather jackets:**

Aluminium, stainless steel, galvanised steel

- **Probe**:

PEC-089-G2-HT05S

Footprint 95.2 mm

Circumferential Footprint 124.5mm

MAXWELL PECT Instrument

- **Materials**:

  Carbon steel and low-alloyed steel

- **Lift-off range:**

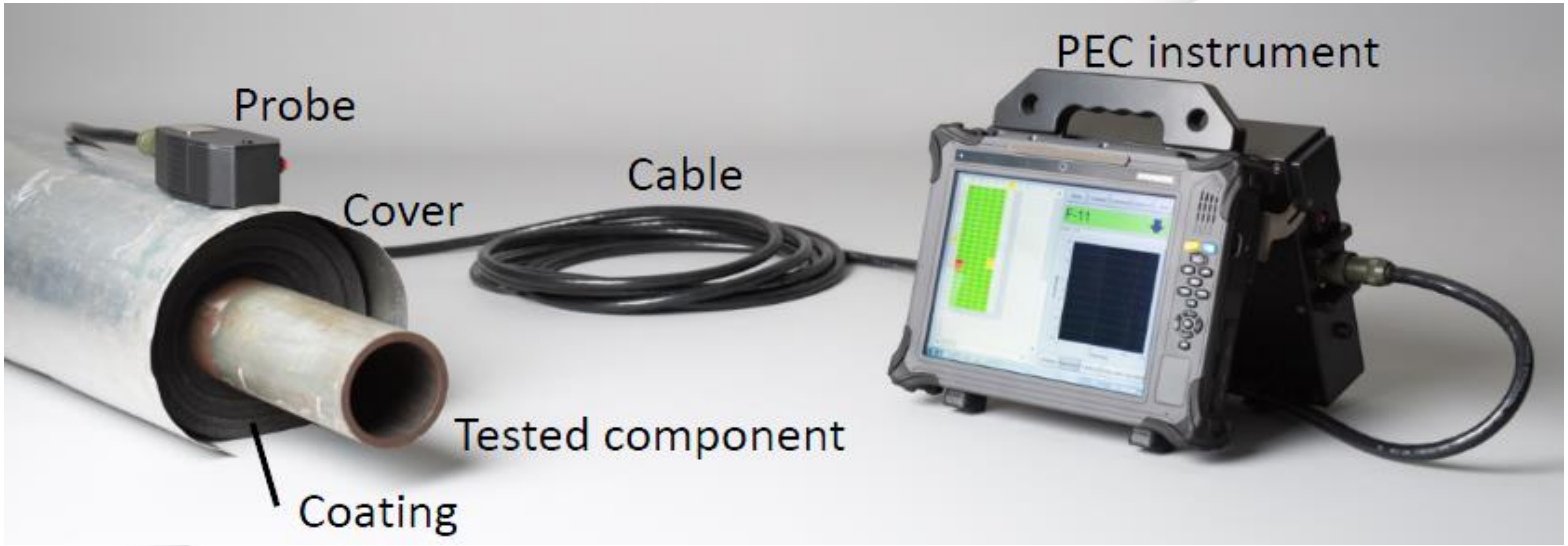
  0 – 250 mm (0-10”)

- **Wall thickness range:**

  3 – 50 mm (0.12”-2”)

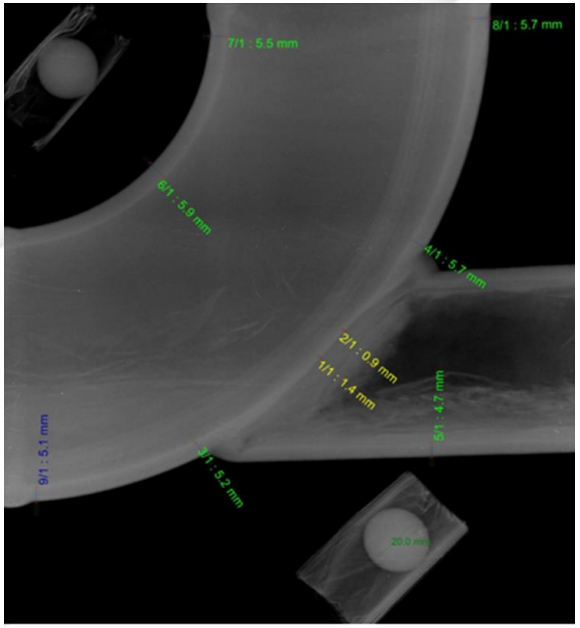
- **Insulation covers:**

Non metal, aluminium and stainless insulation covers; limited galvanised weather sheeting

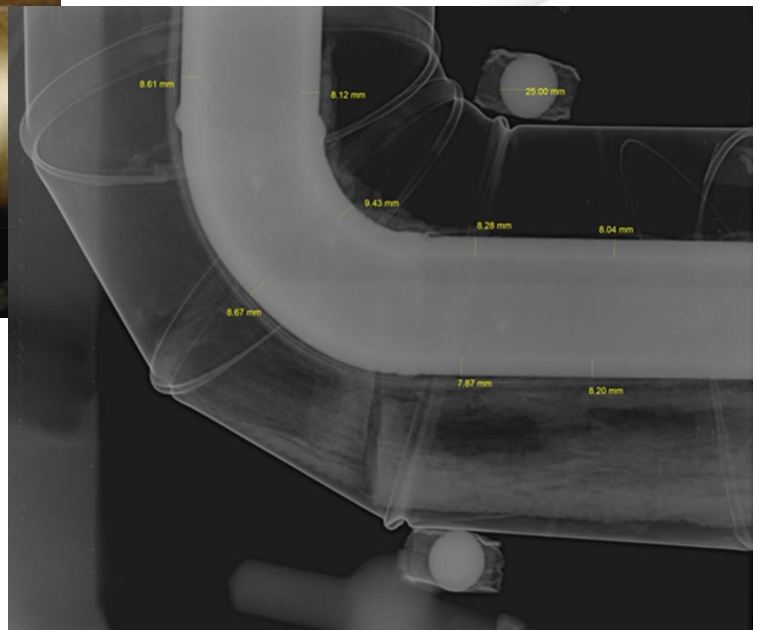


Radiography

Due to our positive experiences offshore using radiographic techniques we introduced this method to the project. Examples below:



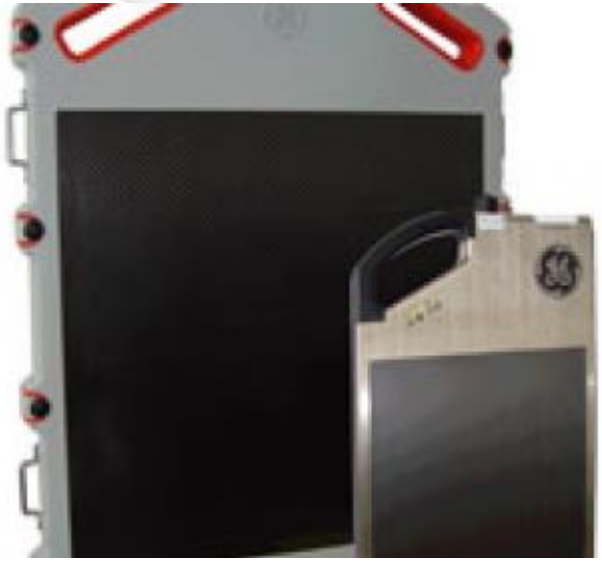
Radiography



Radiography

Initial trials with Sentinel QSA Global Open Vision equipment.

Radiography



Two Digital Detector Array (DDA) systems were evaluated

Little or no difference in technical performance

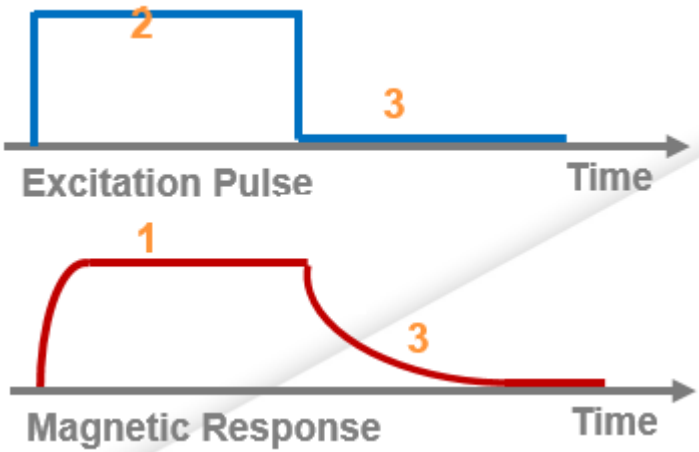
The project continued combining Pulsed Eddy-Current & Digital Radiography

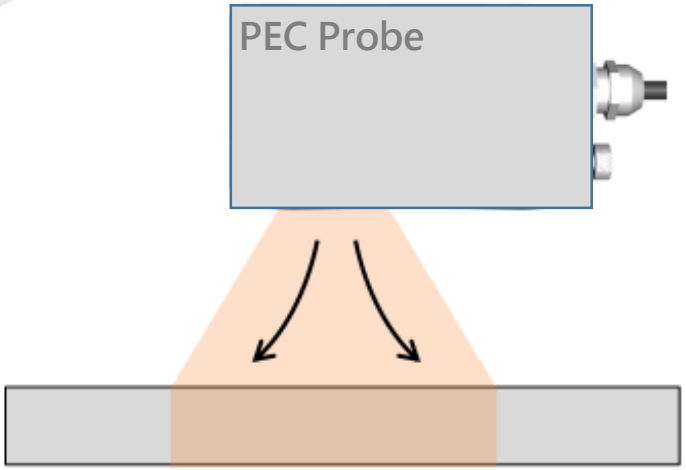
Principles PEC

Phase 1 The emission phase (the pulse) during which the probe injects magnetic fields that penetrate and stabilize in the component thickness

Phase 2 The cut-off phase which induces strong eddy currents into the component When the magnetic field emission is stopped abruptly

Phase 3 The reception phase during which magnetic sensors measure the decay of the eddy currents as they diffuse into the material thickness

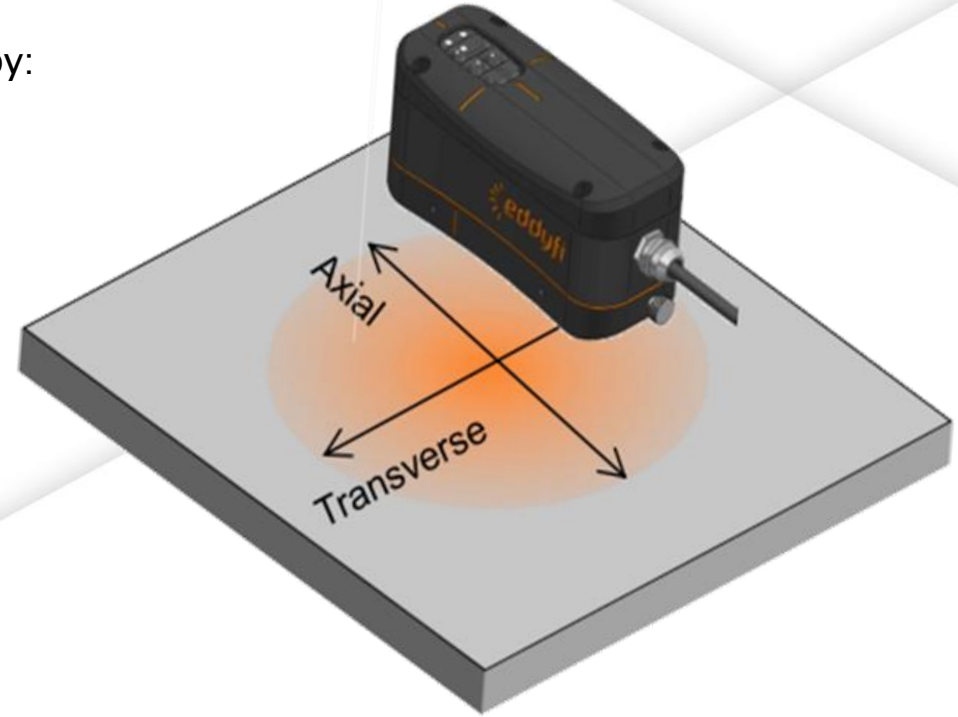




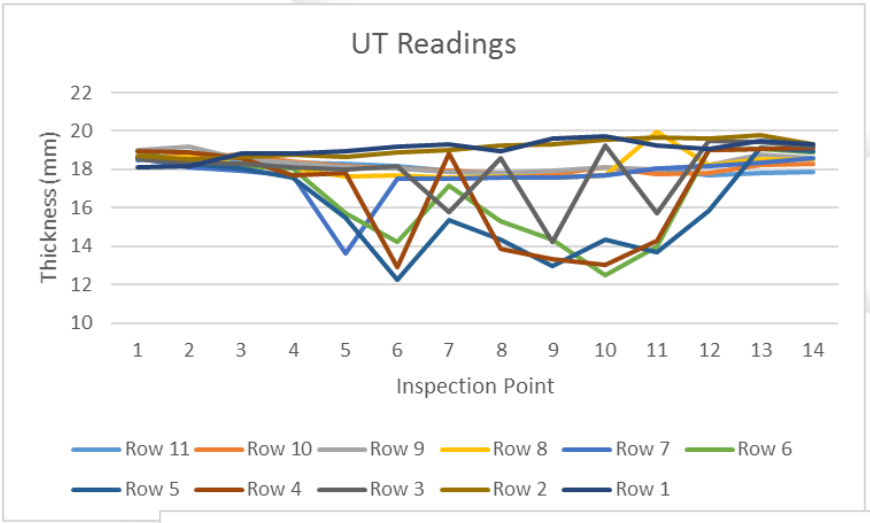
Footprint Definition

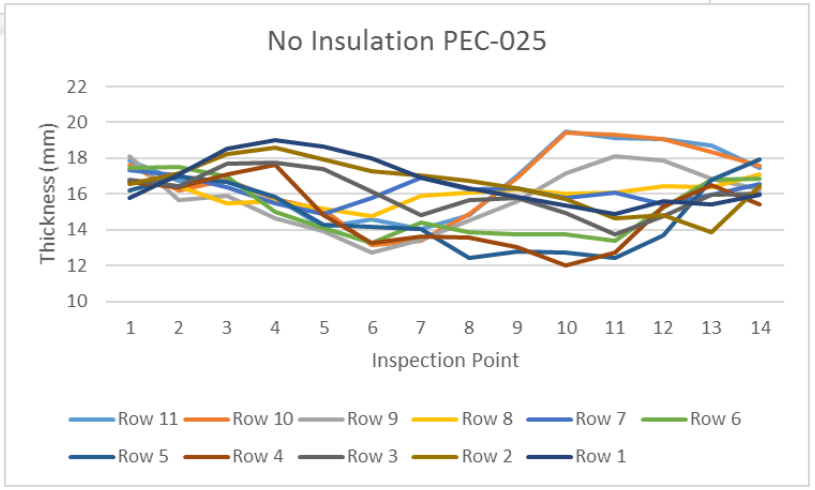
- The footprint is the sensitivity area of the probe on the inspected component.

- The size of the footprint is affected by:
  - The probe size and configuration
  - The coating\insulation thickness
  - The jacket material
  - The WT of the component



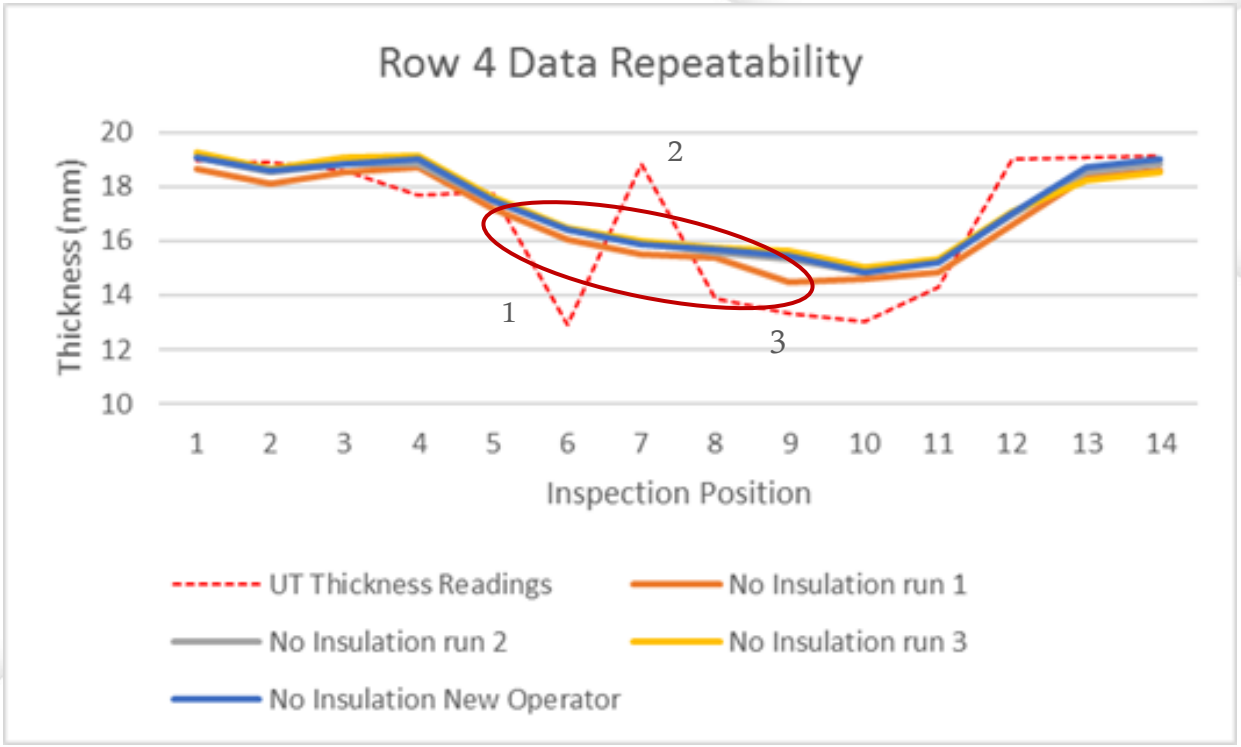
PEC v UT


UT Readings
Thickness (mm)
22
20
18
16
14
12
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Inspection Point
Row 11 Row 10 Row 9 Row 8 Row 7 Row 6
Row 5 Row 4 Row 3 Row 2 Row 1


No Insulation PEC-025
Thickness (mm)
22
20
18
16
14
12
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Inspection Point
Row 11 Row 10 Row 9 Row 8 Row 7 Row 6
Row 5 Row 4 Row 3 Row 2 Row 1

PEC v UT

- Averaging Effect
- Point 1 a Dip
- Point 2 A Peak
- Point 3 PEC Averaging



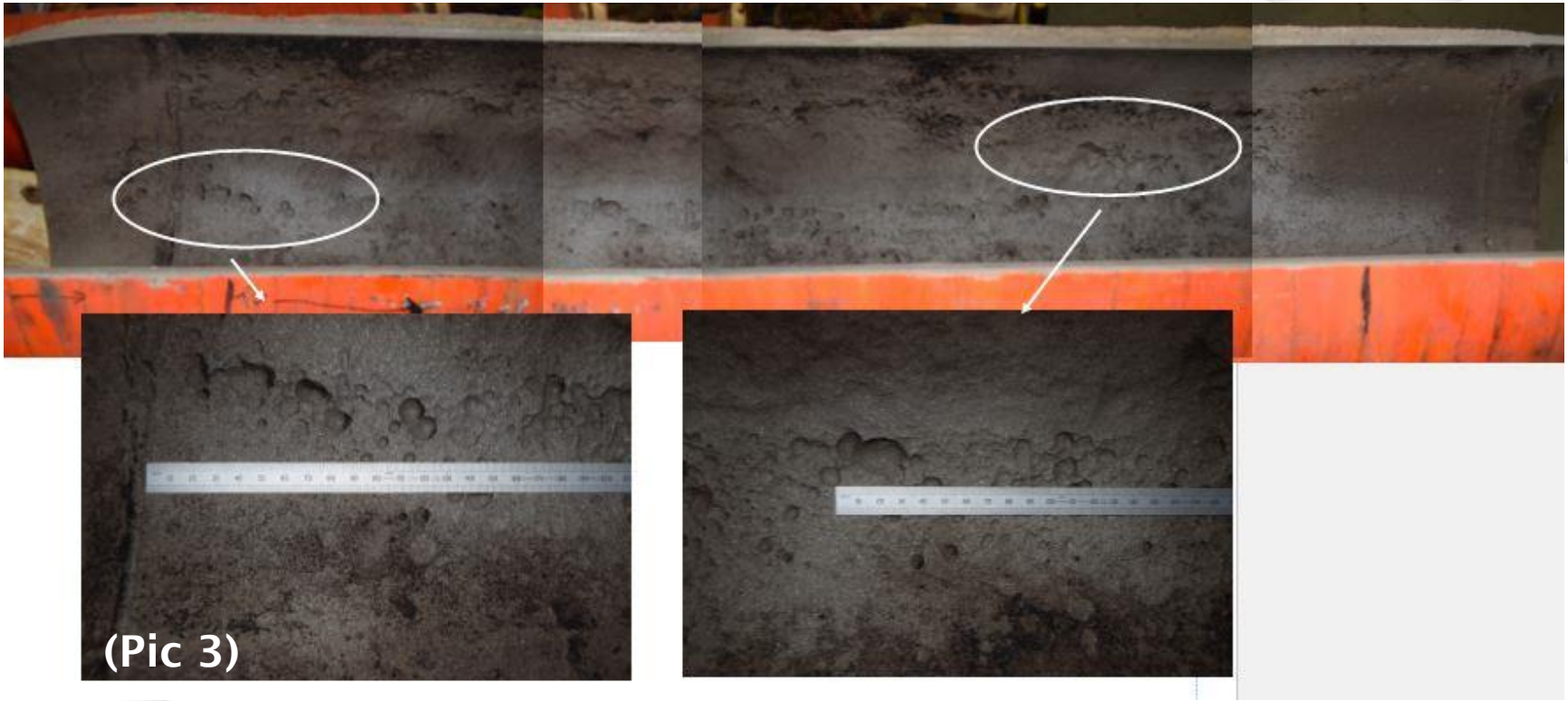
Initial Work

Sample : Pipe OD 323mm
Thickness: 8.3mm
Length 1200mm
Engineered Composite Wrap 9mm

- Sample inspected after being removed from service (picture 1)
- After inspection a section of pipe was cut and the ID exposed to reveal a large scabbed area after initial cleaning. (picture 2)

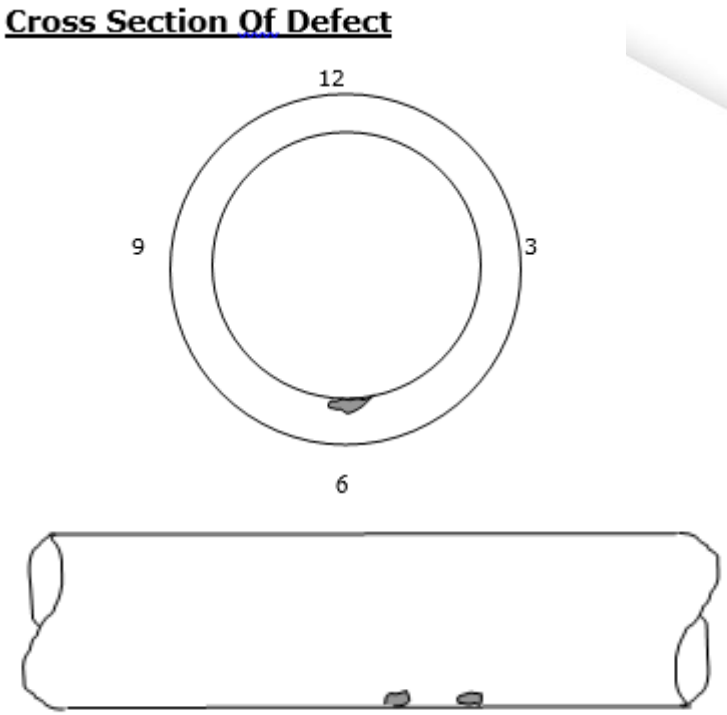
Initial Work

- The Pipe was sent for cleaning and on return reviled the sever corrosion on the ID at what was the 6 O'clock position (picture 3)



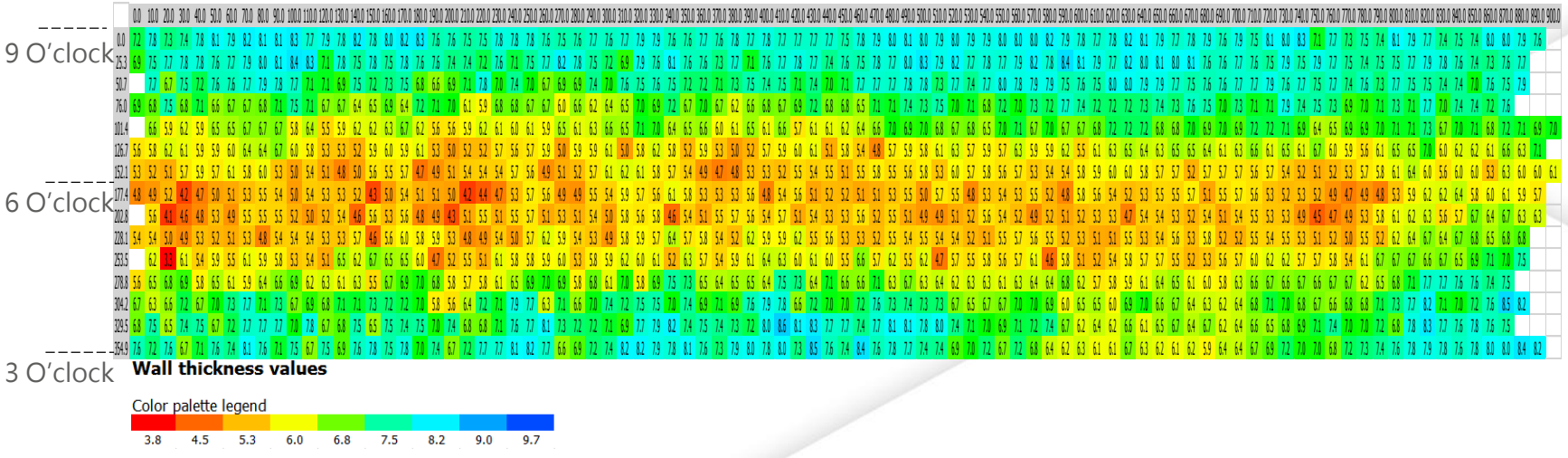
Initial Work – Anomaly Report

- The original anomaly report identified two areas
- Area of anomaly A 80mm x 30mm 6 o'clock position 5.2mm minimum
- Area of anomaly B 20mm x 30mm 6 o'clock position 4.9mm minimum



Initial Work – PEC Results

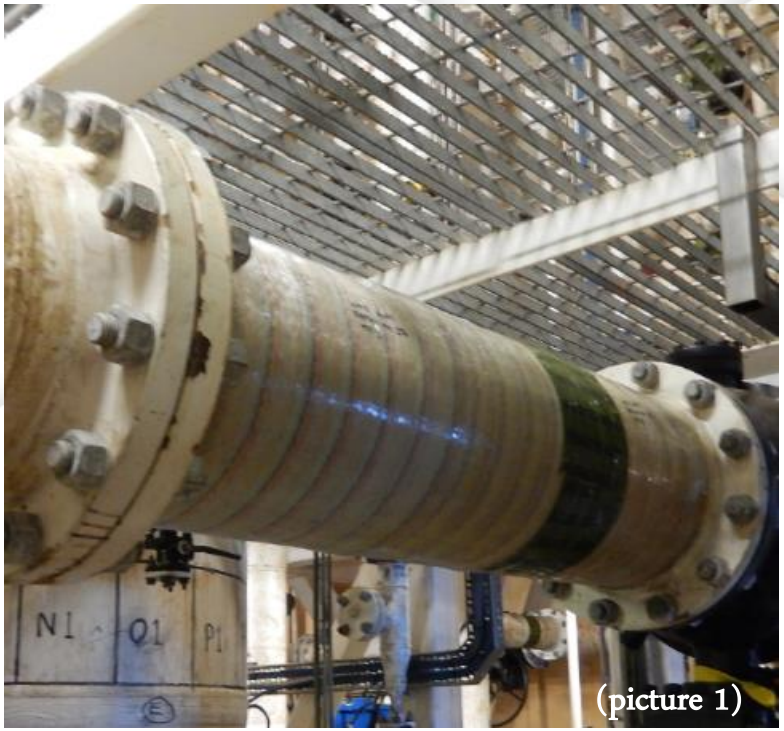
- PEC Results show large area of general wall loss containing deep pitting along the length. The minimum reading recorded by the PEC 4.2mm.



Example 1

Inspection carried out on off-shore facility
Sample : Pipe OD 798mm
Thickness: 6.35mm
Length 750mm
Engineered Composite Wrap 9mm

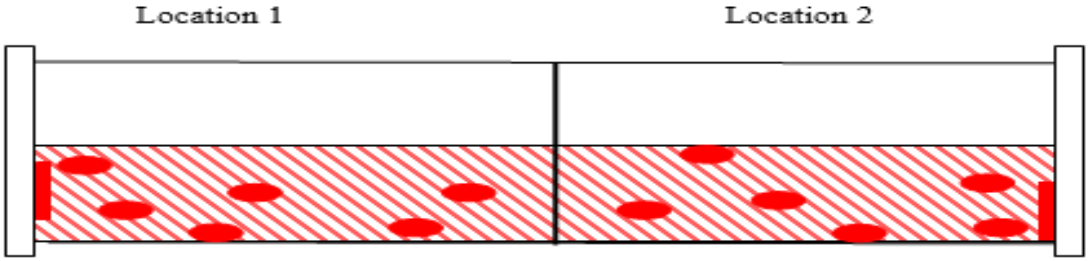
- Sample inspected off shore still in service. (picture 1)

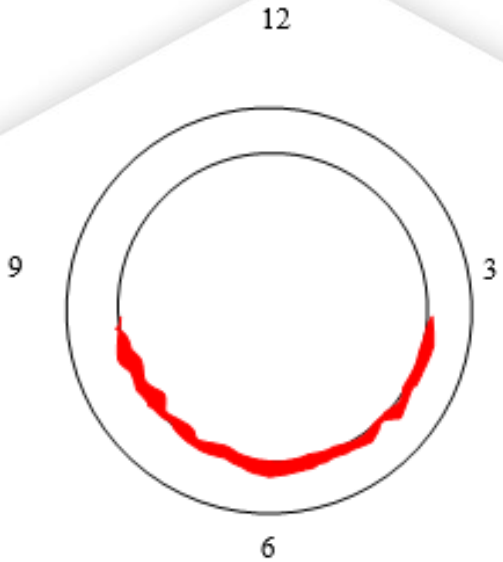


(picture 1)

Example 1

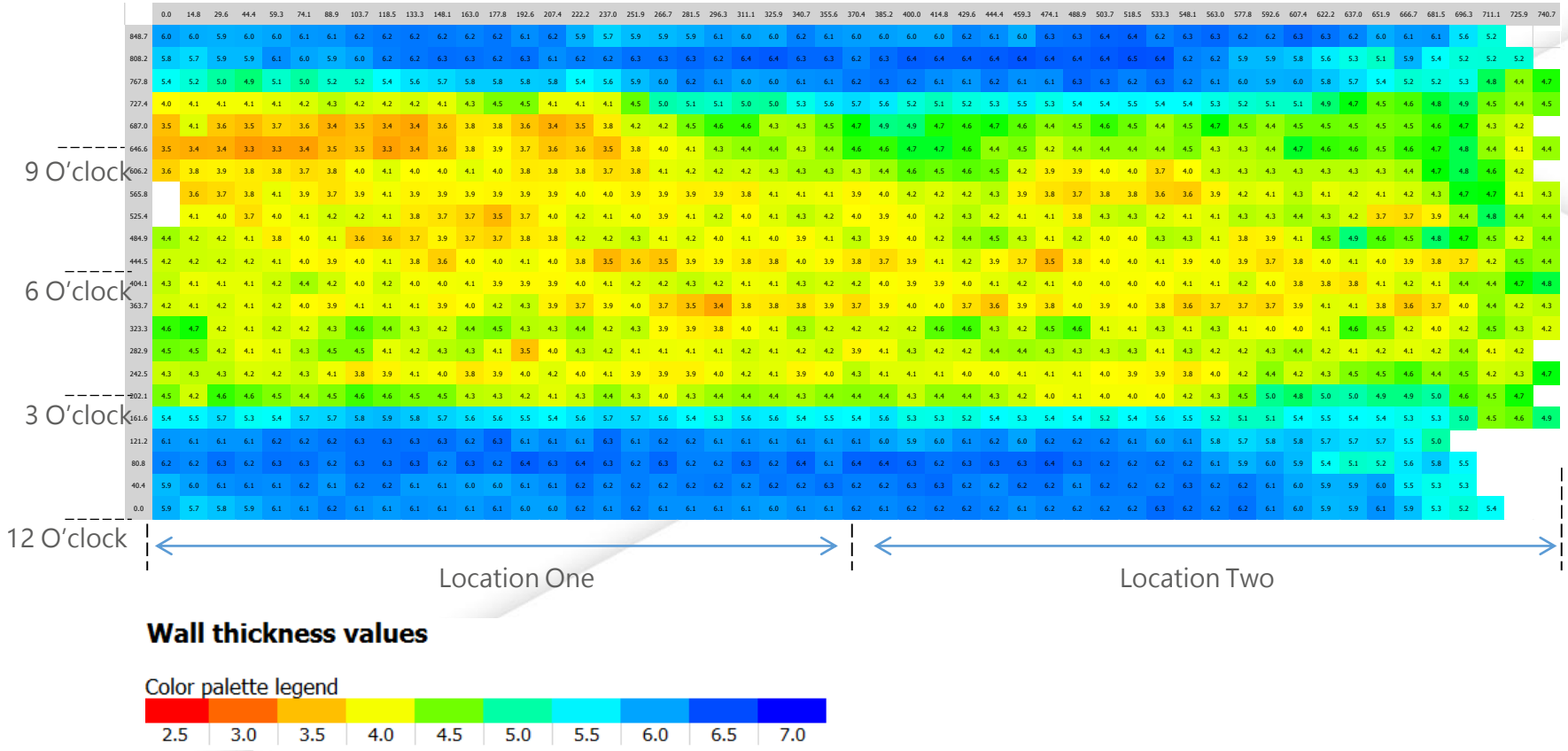
- The original anomaly report identified many areas of wall loss
- All anomaly's predominantly between 3-9 O'clock positions
- Minimum reading Location 1 3.8mm
- Minimum Reading Location 2 3,6mm





Example 1

- PEC Results show large area of general wall loss containing deep pitting along the length. The minimum reading recorded by the PEC 4.2mm.

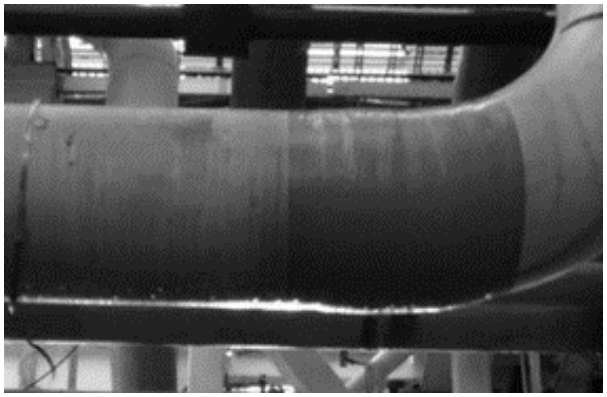


UT & PEC Comparisons

Line ID Test Point	Nom	Min Reading		Difference	Indication Position	
	(mm)	UT (mm)	PEC (mm)	(mm)	UT	PEC
2" Test Point 12	3.9	2.4	2.7	-0.3	6 o'clock	5-10 o'clock
2" Test Point 2	3.9	2	2.9	-0.9	not identified	4-10 o'clock
2" Test Point 3	3.9	2	2.7	-0.7	not identified	4-10 o'clock
3" Test Point 45	5.5	2.3	3.7	-1.4	6 o'clock	1-11 o'clock
4" Test Point 19	6.02	2	3.6	-1.6	8 o'clock	4-8 o'clock
4" Test Point 21	6.02	2.8	3.7	-0.9	4 o'clock	4-8 o'clock
8" Test Point 8	8.2	2.8	4.2	-1.4	3 o'clock	3-6 o'clock
8" Test Point 11	8.2	3.5	3.5	0	6 o'clock	5-8 o'clock
10" Test Point 6	6.35	3.7	3.3	0.4	3-6 o'clock	full circ
10" Test Point 1	6.35	3.8	3.4	0.4	3-9 o'clock	2-10 o'clock
10" Test Point 2	6.35	3.6	3.5	0.1	3-9 o'clock	2-10 o'clock
10" Test Point 11	6.35	3	3.9	-0.9	1-5 o'clock, 8-11 o'clock	full circ
12" Test Point 48	8.38	1	3.3	-2.3	6 o'clock	6 o'clock
12" Test Point 49	8.38	1	3.5	-2.5	6 o'clock	6 o'clock

Table shows 14 test point inspected off shore in service.

Example 2

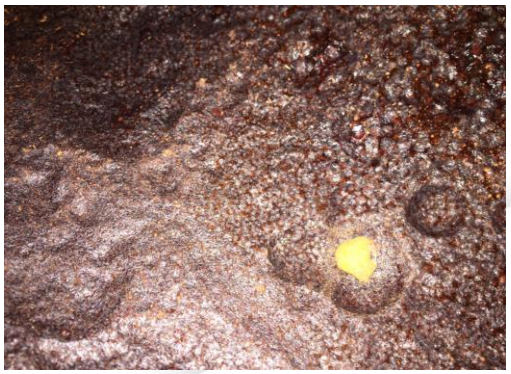


- Nominal 7.92mm
- PEC (48% Remaining) 3,8mm
- Measured remaining before wrap applied 3mm

	B	C	D	E	F	G	H	I	J
1	61	63	66	86	93	96	98	100	
2	61	62	64	83	90	93	95	99	
3	61	61	61	81	88	91	93	96	
4	60	59	58	80	88	92	94	94	
5	60	58	56	74	88	93	97	94	
6	60	58	52	60	86	94	101	98	
7	61	59	48	50	93	99	102	101	
8	61	60	50	65	97	99	104	103	
9	63	61	60	73	95	103	105	103	
10	64	62	64	81	96	104	106	105	
11	64	64	65	83	95	103	107	107	
12	64	65	66	88	93	101	105	108	
13	63	65	66	90	92	99	101	106	
14	63	65	67	94	93	98	101	101	
1									

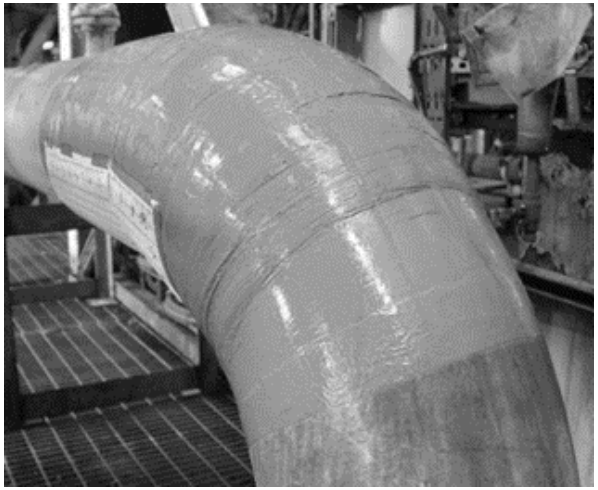
Example 3

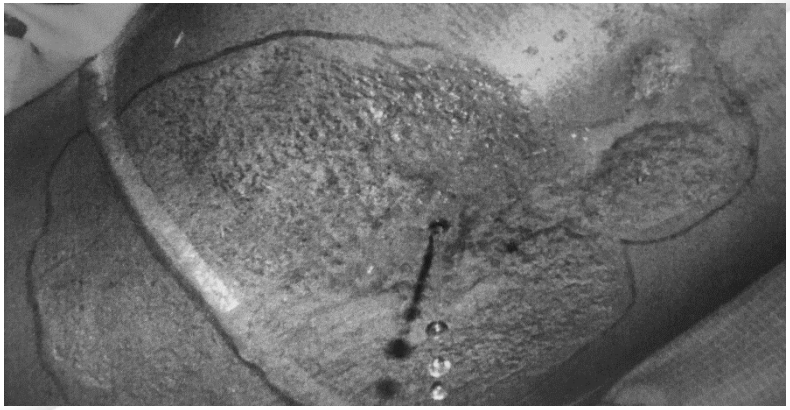
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	3
A	79	93	91	96	103	100	96	97	101	99	100	98	99	92	92	94	91	93	89	94	94	88	86	85	85	82	80	81	82	87	90	94	93	91	
B	75	92	91	89	99	99	98	100	102	99	91	85	86	86	91	93	88	94	94	94	90	94	88	87	86	84	81	80	87	88	93	97	98	97	
C	75	91	90	87	95	100	100	101	101	100	89	88	86	92	93	94	92	96	99	96	101	95	91	92	90	95	88	92	90	93	96	103	101	96	
D	75	83	86	90	94	99	98	96	97	90	92	93	94	92	93	87	88	87	95	96	94	93	79	88	85	97	96	93	90	82	86	88	88	92	
E	75	79	84	92	92	89	94	89	88	81	88	92	94	94	90	74	75	85	84	82	86	74	82	83	88	84	87	87	74	77	76	79	82	80	
F	78	84	86	89	93	85	89	86	89	84	83	86	87	88	87	81	73	70	73	77	81	75	77	71	77	78	72	77	79	70	72	70	74	79	
G	81	94	92	92	91	79	76	84	79	72	80	83	81	86	84	72	68	69	68	74	71	77	67	77	76	74	71	74	75	71	68	70	75	76	
H	83	97	95	95	92	77	73	86	86	74	81	86	78	87	85	81	75	71	73	79	79	80	72	80	80	75	75	77	78	76	68	72	70	75	
I	79	98	105	97	94	90	81	83	87	91	92	92	90	91	86	85	84	81	84	84	91	87	82	86	84	83	84	89	89	78	83	69	75	70	
J	81	97	106	104	98	89	85	83	88	92	96	97	95	90	89	88	87	88	93	79	93	99	88	90	83	84	84	88	90	87	81	79	75	69	
K																																			



- Pitting with leak path through to wrap PEC detected 68% remaining (pit approx. 10 mm diameter hole approx. 5mm)

Example 4

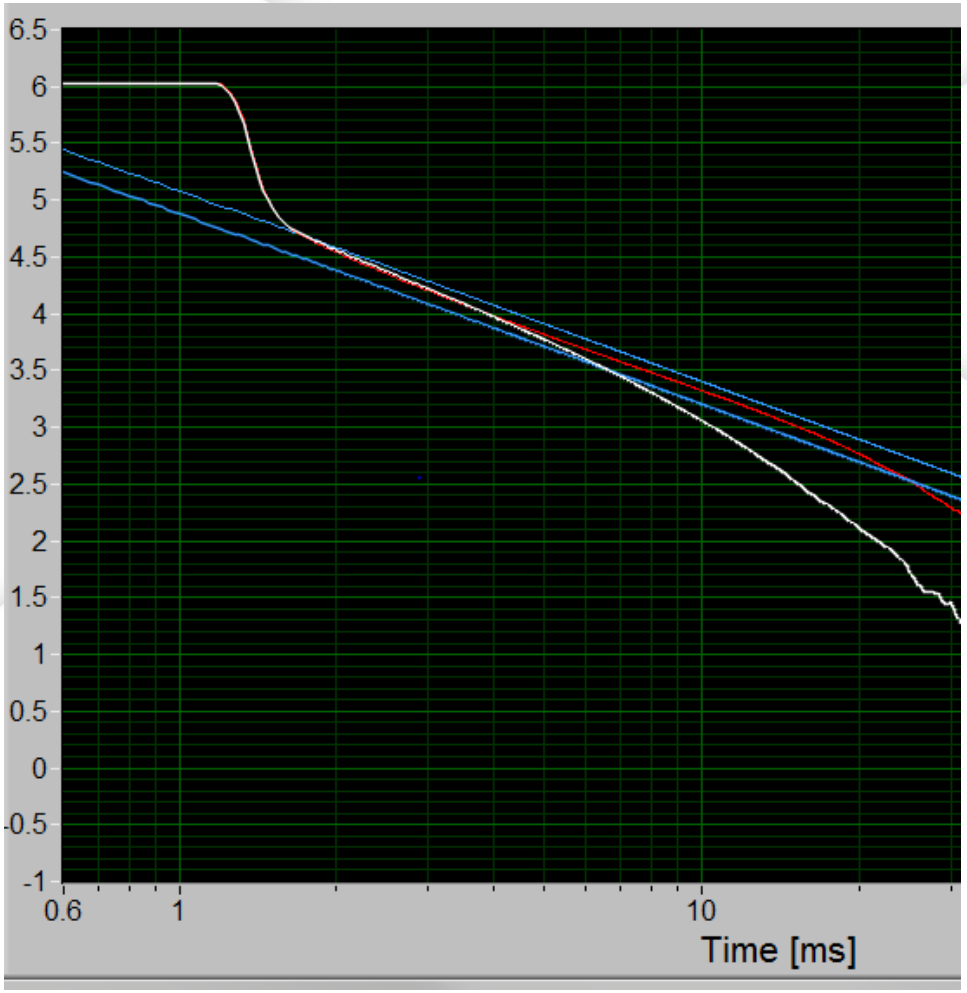




	A	B	C	D	E	F	G	H	I	J	K	L	M
1	81	78	76	77	84	79	76	90	91	91	92	92	
2	95	89	90	79	83	89	91	91	91	92	92	92	
3	96	90	88	77	81	85	87	90	90	91	91	92	
4	97	91	86	75	77	80	82	87	89	89	90	90	
5	97	92	87	73	73	70	76	84	86	89	90	88	
6	97	94	87	68	58	51	63	77	81	83	85	80	
7	99	92	84	64	54	50	61	78	81	82	83	81	
8	100	92	80	60	53	50	64	80	82	82	82	84	
9	98	90	71	60	51	50	65	81	82	83	83	83	
10	95	87	74	59	53	54	72	81	83	84	84	85	
11	94	86	77	64	60	64	77	82	84	85	85	86	
12	93	90	86	72	70	73	79	83	84	86	85	85	
13	95	95	92	80	75	79	83	84	84	86	86	84	
14	95	95	94	81	75	83	84	86	86	88	87	84	
15	94	92	87	78	75	80	83	87	87	88	87	85	
16													

Example 4

	A	B	C	D	E	F	G	H	I	J	K	L
1	81	78	76	77	84	79	76	90	91	91	92	92
2	95	89	90	79	83	89	91	91	91	92	92	92
3	96	90	88	77	81	85	87	90	90	91	91	92
4	97	91	86	75	77	80	82	87	89	89	90	90
5	97	92	87	73	73	70	76	84	86	89	90	88
6	97	94	87	68	58	51	63	77	81	83	85	80
7	99	92	84	64	54	50	61	78	81	82	83	81
8	100	92	80	60	53	50	64	80	82	82	82	84
9	98	90	71	60	51	50	65	81	82	83	83	83
10	95	87	74	59	53	54	72	81	83	84	84	85
11	94	86	77	64	60	64	77	82	84	85	85	86
12	93	90	86	72	70	73	79	83	84	86	85	85
13	95	95	92	80	75	79	83	84	84	86	86	84
14	95	95	94	81	75	83	84	86	86	88	87	84
15	94	92	87	78	75	80	83	87	87	88	87	85
16												

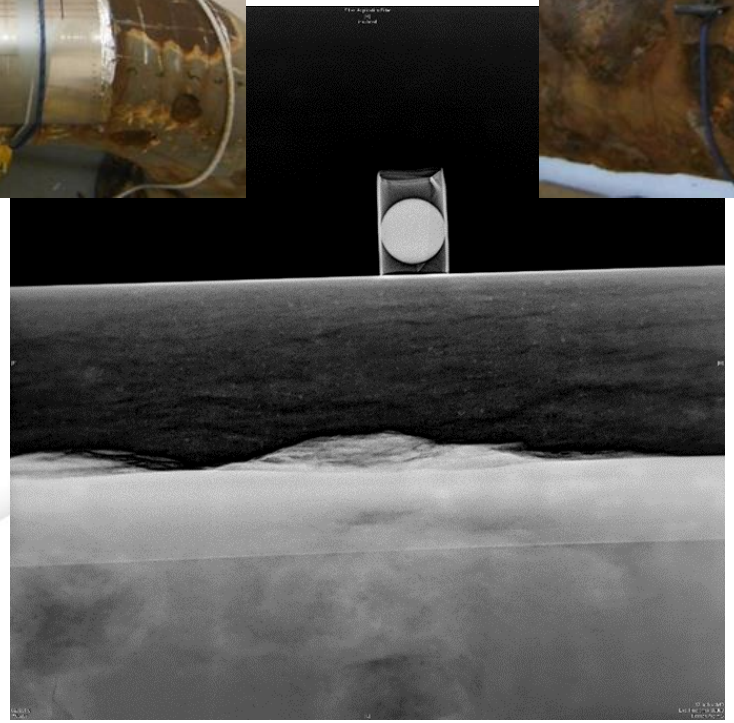


- A-scan for Position E9
- Red line calibration White Line the A-scan for the reading Notice they follow the same path until the white A-scan falls off 4ms

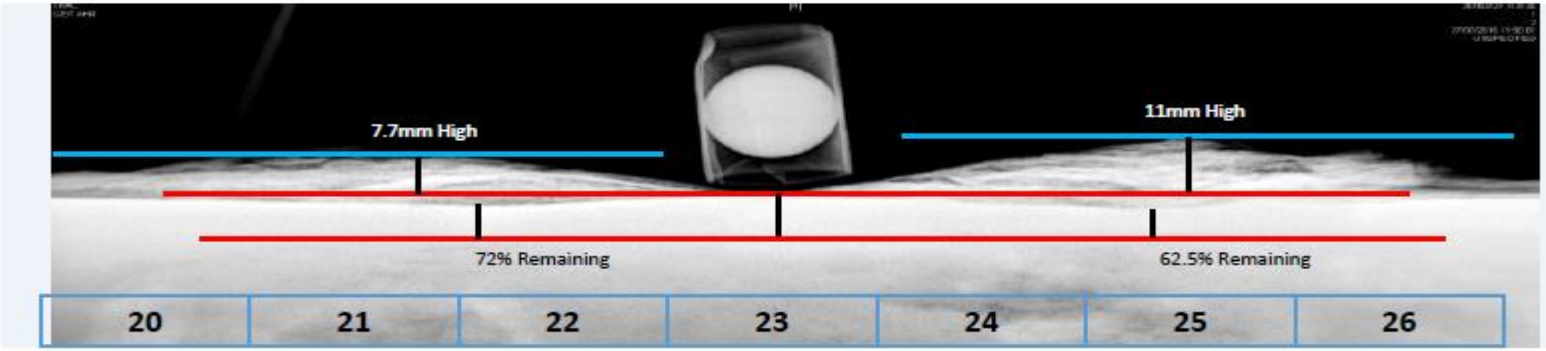
Example 5

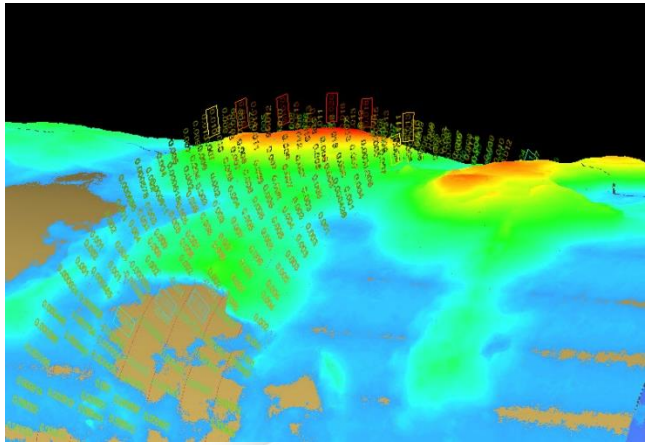
10.5	10.3	10.2	10.2	10.3	10.4	10.4	10.7	10.9	10.6	
10.2	10.1	10.0	10.0	10.3	10.4	10.7	10.9	10.7	10.9	
9.9	9.8	9.8	9.8	10.1	10.3	10.7	10.9	10.9	12.1	
9.5	9.4	9.5	9.7	9.9	10.2	10.4	10.7	11.9	12.0	
9.4	9.2	9.4	9.5	9.7	10.0	10.1	10.6	11.6	12.0	
9.2	9.2	9.3	9.5	9.6	9.7	10.0	10.2	11.5	12.1	
9.2	9.1	9.3	9.3	9.2	9.4	9.7	10.2	11.6	12.1	
9.1	9.1	9.2	9.1	9.0	9.1	9.3	9.6	11.5	12.0	
9.0	9.0	8.9	8.8	8.7	8.6	9.2	9.3	11.3	12.0	
8.7	8.7	8.6	8.5	8.7	8.4	8.6	8.9	11.3	11.9	
8.6	8.4	8.2	8.1	8.1	8.2	8.7	8.9	11.3	11.9	
8.5	8.2	7.8	7.8	7.7	8.0	8.5	8.9	11.3	11.9	
8.5	8.5	7.4	7.4	7.4	7.8	8.3	8.8	11.3	11.9	
8.5	7.8	7.2	7.4	7.3	7.7	8.1	8.8	11.3	11.9	
8.8	8.2	7.6	7.4	7.7	8.0	8.3	9.4	11.3	11.9	
8.5	7.7	7.3	7.2	7.6	7.8	8.2	8.9	11.3	11.9	
9.3	8.7	8.0	8.1	8.2	8.9	9.3	9.9	11.3	11.9	
9.8	9.3	9.0	8.8	9.6	9.6	10.1	10.3	11.3	11.9	
10.4	10.1	9.9	9.8	10.1	10.6	10.9	10.9	11.3	11.9	
11.0	10.8	10.7	10.8	11.4	11.3	11.6	11.6	11.3	11.9	
11.3	11.4	11.2	11.5	11.5	11.5	11.9	11.9	11.3	11.9	
11.5	11.6	11.7	11.8	11.8	11.9	12.0	12.1	11.3	11.9	
11.5	11.5	11.6	11.8	11.8	11.8	11.9	12.1	11.3	11.9	
11.3	11.4	11.5	11.6	11.6	11.8	11.9	12.0	11.3	11.9	
11.3	11.3	11.3	11.2	11.5	11.6	11.8	12.0	11.3	11.9	
11.3	11.3	11.3	11.3	11.5	11.6	11.8	12.0	11.3	11.9	

- Remaining wall measured through blister then blister removed.
- PEC measured 7.2 remaining
- UT measured 6.8



PEC, Radiography & Scanning



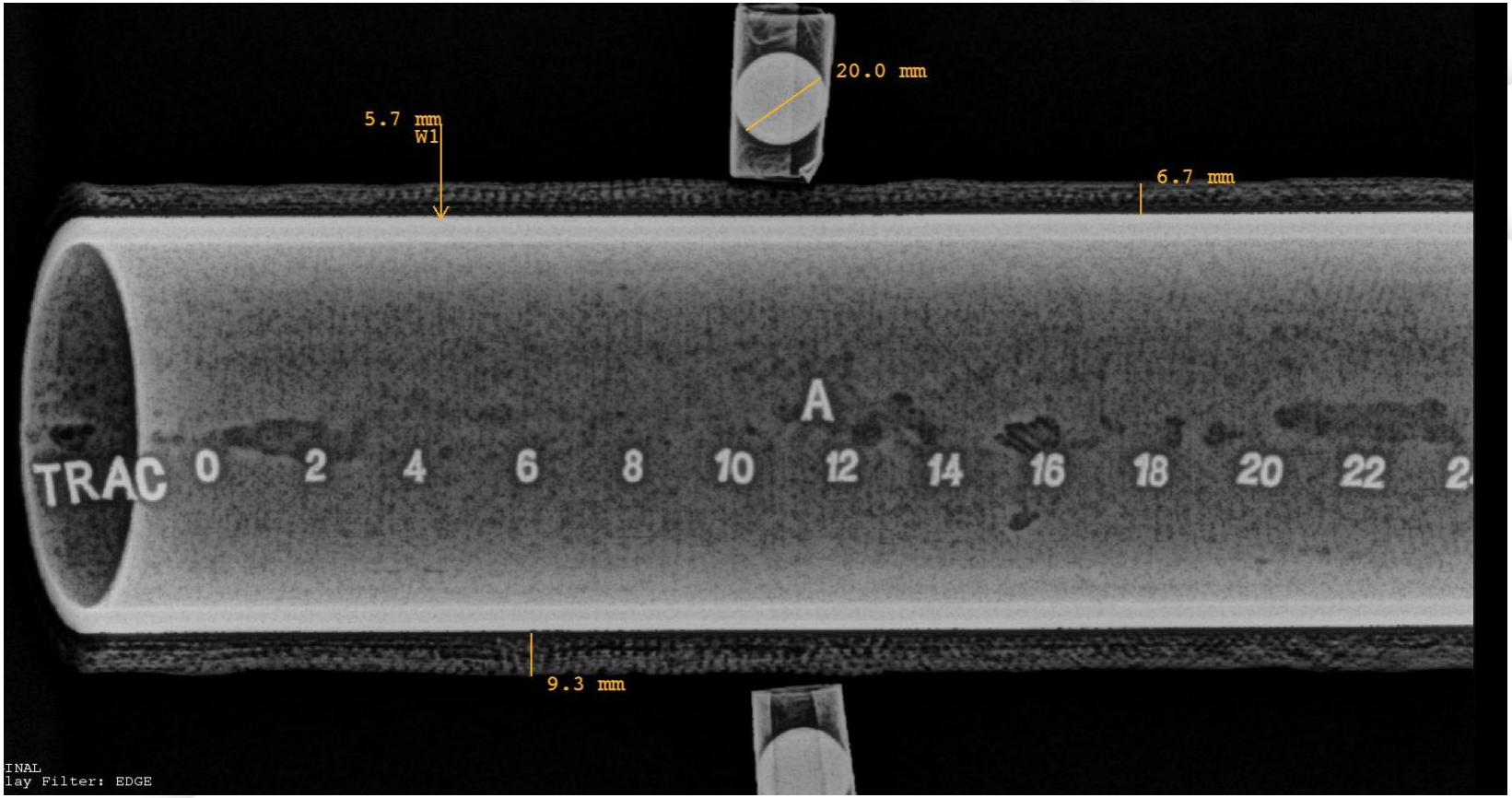


20	21	22	23	24	25	26
9.7	8.5	8.4	8.3	7.4	6.1	7.4
10.6	9.7	8.7	9.3	8.3	8.0	9.6
10.8	9.9	9.6	9.9	8.0	9.4	10.3

Example 6

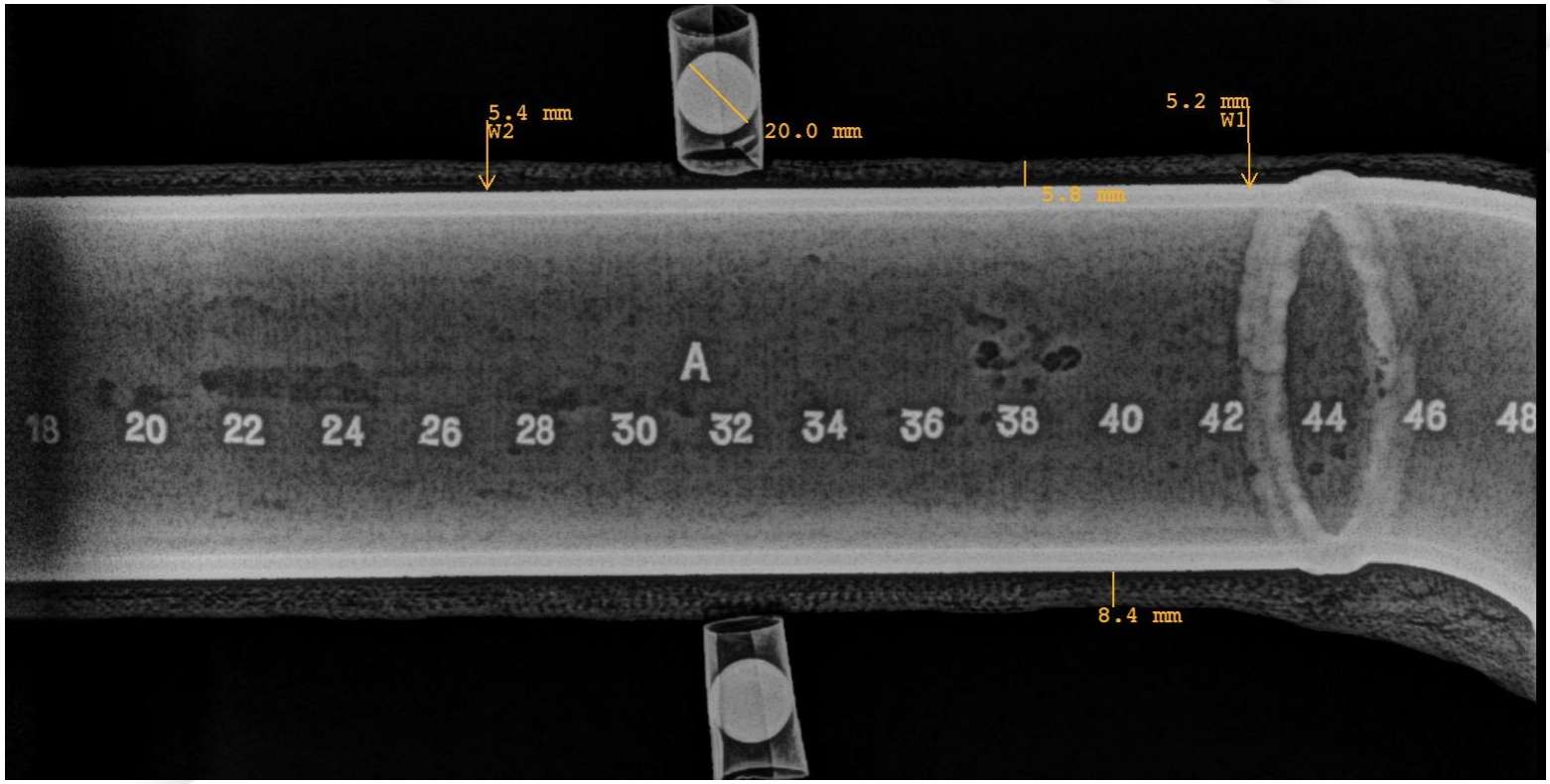
Example 6

Section 0-24



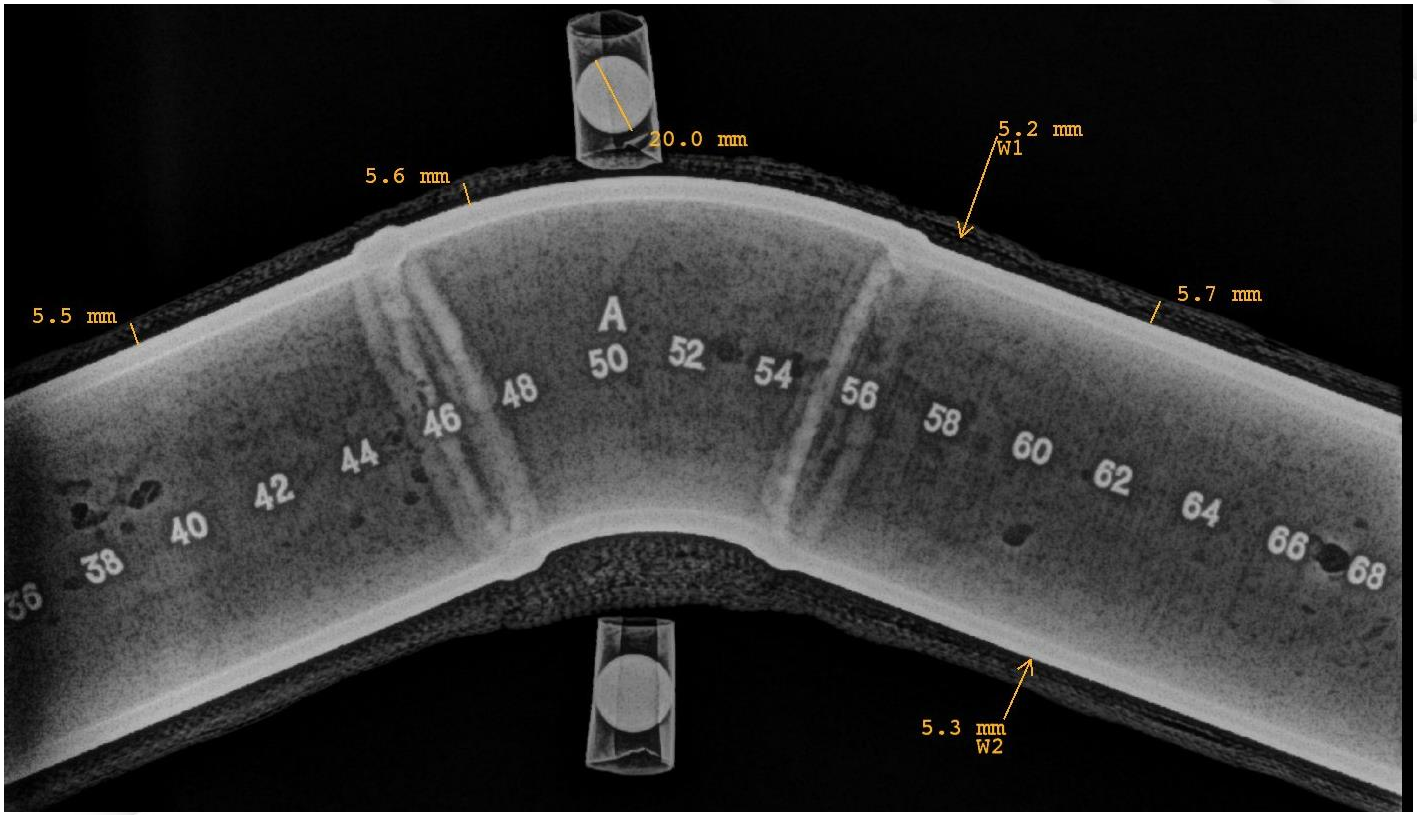
Example 6

Section 18-48



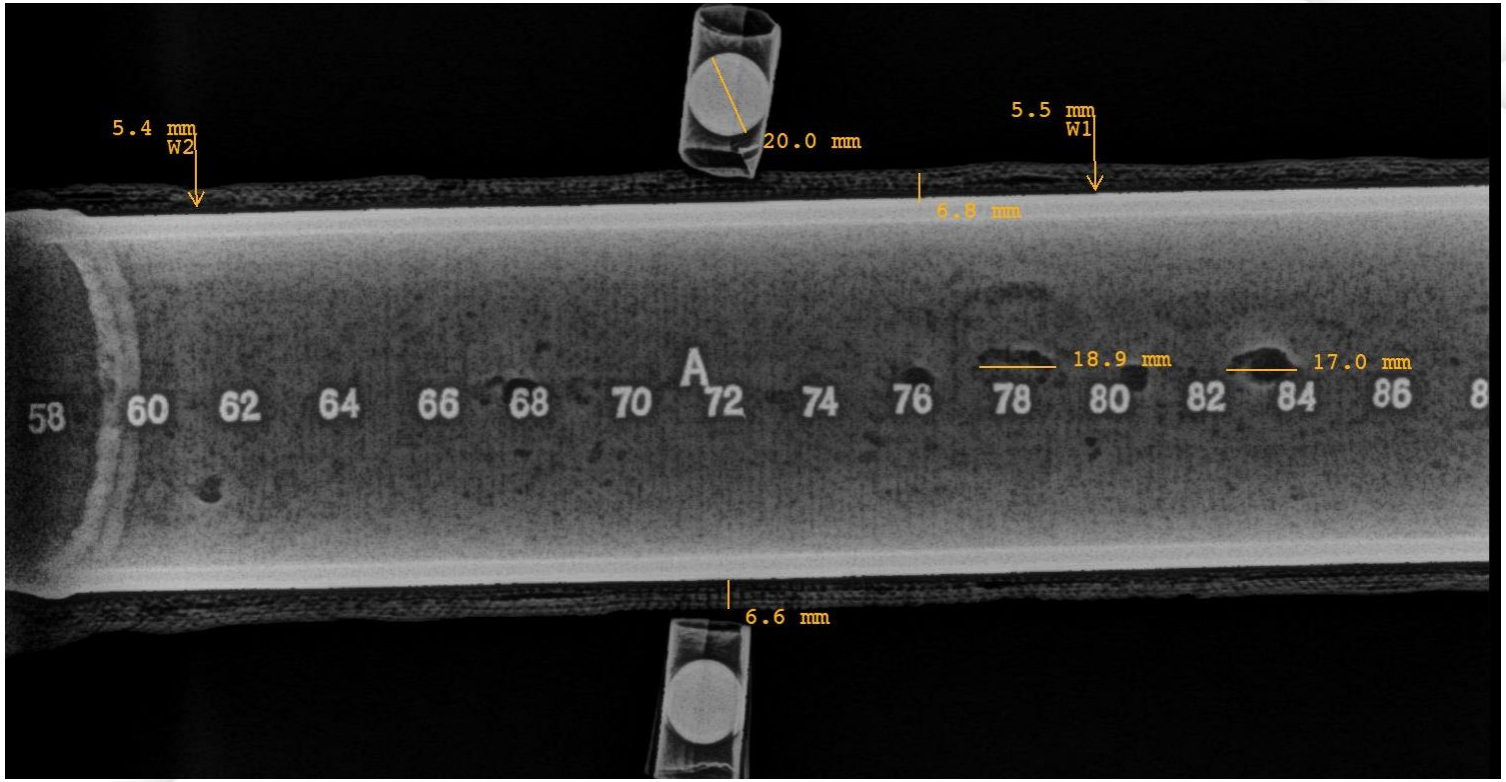
Example 6

Section 36-68



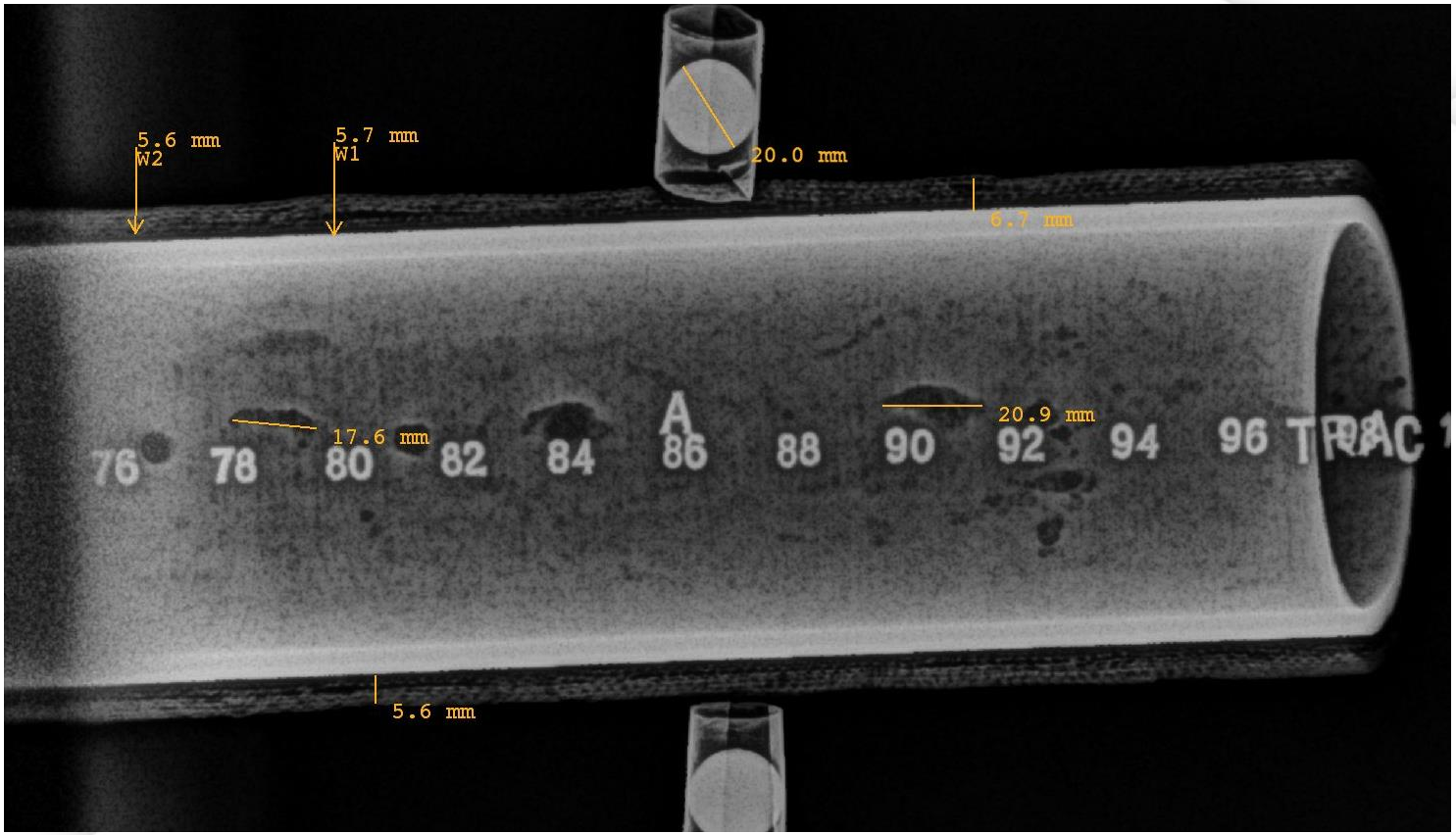
Example 6

Section 58-88



Example 6

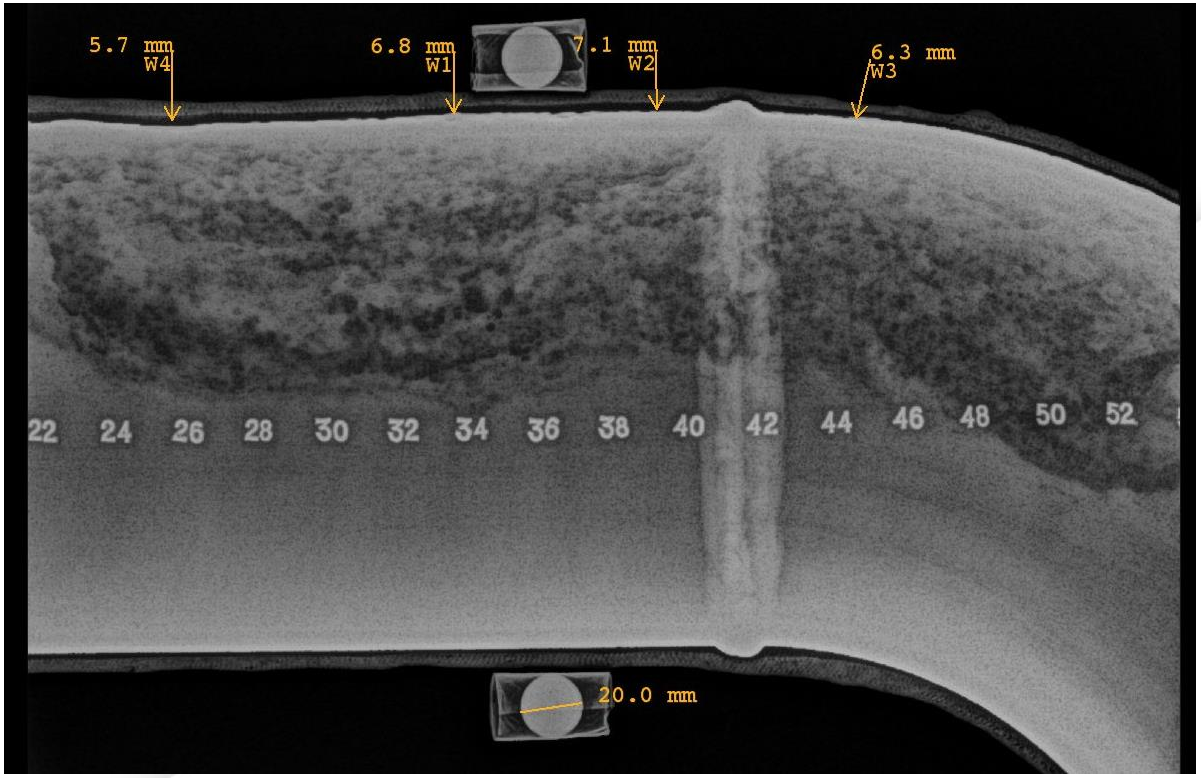
Section 74-100



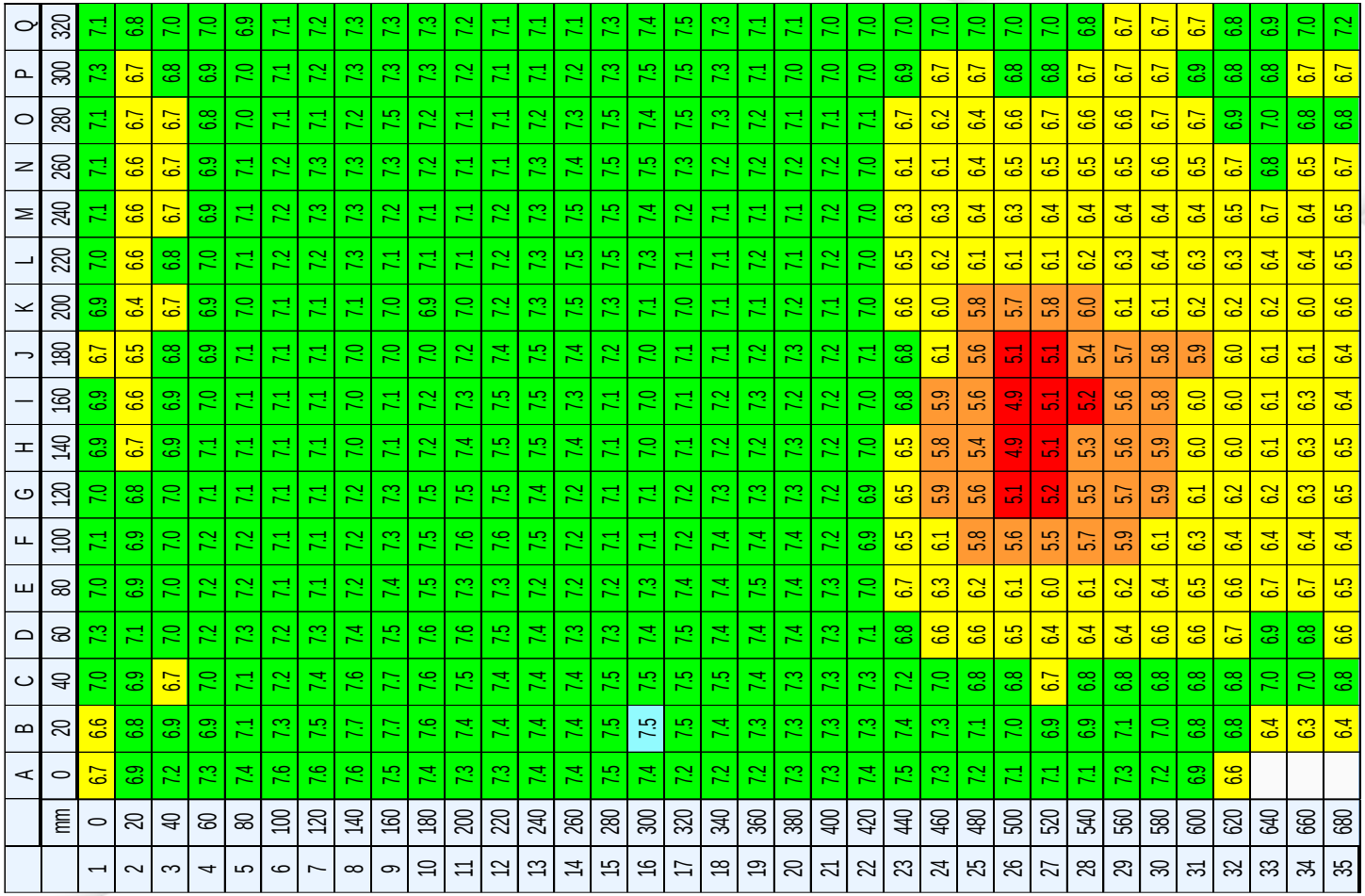
Example 7

Example 7

Section 22-54



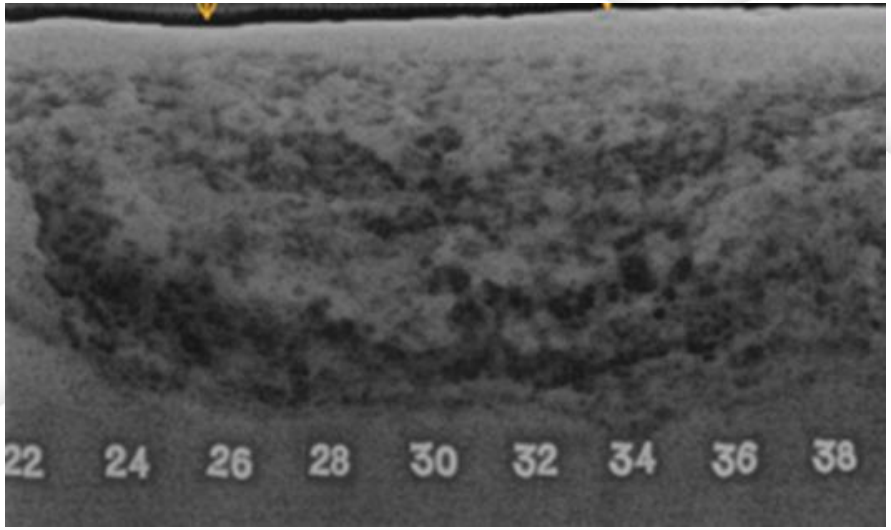
Example 7 - PEC Results



		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
	mm	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
1	0	6.7	6.6	7.0	7.3	7.0	7.1	7.0	6.9	6.9	6.7	6.9	7.0	7.1	7.1	7.1	7.3	7.1
2	20	6.9	6.8	6.9	7.1	6.9	6.9	6.8	6.7	6.6	6.5	6.4	6.6	6.6	6.6	6.7	6.7	6.8
3	40	7.2	6.9	6.7	7.0	7.0	7.0	7.0	6.9	6.9	6.8	6.7	6.8	6.7	6.7	6.7	6.8	7.0
4	60	7.3	6.9	7.0	7.2	7.2	7.2	7.1	7.1	7.0	6.9	6.9	7.0	6.9	6.9	6.8	6.9	7.0
5	80	7.4	7.1	7.1	7.3	7.2	7.2	7.1	7.1	7.1	7.1	7.0	7.1	7.1	7.1	7.0	7.0	6.9
6	100	7.6	7.3	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.2	7.2	7.2	7.1	7.1	7.1
7	120	7.6	7.5	7.4	7.3	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.2	7.3	7.3	7.1	7.2	7.2
8	140	7.6	7.7	7.6	7.4	7.2	7.2	7.2	7.0	7.0	7.0	7.1	7.3	7.3	7.3	7.2	7.3	7.3
9	160	7.5	7.7	7.7	7.5	7.4	7.3	7.3	7.1	7.1	7.0	7.0	7.1	7.2	7.3	7.5	7.3	7.3
10	180	7.4	7.6	7.6	7.6	7.5	7.5	7.5	7.2	7.2	7.0	6.9	7.1	7.1	7.2	7.2	7.3	7.3
11	200	7.3	7.4	7.5	7.6	7.3	7.6	7.5	7.4	7.3	7.2	7.0	7.1	7.1	7.2	7.1	7.2	7.2
12	220	7.3	7.4	7.4	7.5	7.3	7.6	7.5	7.5	7.5	7.4	7.2	7.2	7.2	7.1	7.1	7.1	7.1
13	240	7.4	7.4	7.4	7.4	7.2	7.5	7.4	7.5	7.5	7.5	7.3	7.3	7.3	7.3	7.2	7.1	7.1
14	260	7.4	7.4	7.4	7.3	7.2	7.2	7.2	7.4	7.3	7.4	7.5	7.5	7.4	7.4	7.3	7.2	7.1
15	280	7.5	7.5	7.5	7.3	7.2	7.1	7.1	7.1	7.1	7.2	7.3	7.5	7.5	7.5	7.5	7.3	7.3
16	300	7.4	7.5	7.5	7.4	7.3	7.1	7.1	7.0	7.0	7.0	7.1	7.3	7.4	7.5	7.4	7.5	7.4
17	320	7.2	7.5	7.5	7.5	7.4	7.2	7.2	7.1	7.1	7.1	7.0	7.1	7.2	7.3	7.5	7.5	7.5
18	340	7.2	7.4	7.5	7.4	7.4	7.4	7.3	7.2	7.2	7.1	7.1	7.1	7.1	7.2	7.3	7.3	7.3
19	360	7.2	7.3	7.4	7.4	7.5	7.4	7.3	7.2	7.3	7.2	7.1	7.2	7.1	7.2	7.2	7.1	7.1
20	380	7.3	7.3	7.3	7.4	7.4	7.4	7.3	7.3	7.2	7.3	7.2	7.1	7.1	7.2	7.1	7.0	7.1
21	400	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2	7.1	7.2	7.2	7.2	7.1	7.0	7.0
22	420	7.4	7.3	7.3	7.1	7.0	6.9	6.9	7.0	7.0	7.1	7.0	7.0	7.0	7.0	7.1	7.0	7.0
23	440	7.5	7.4	7.2	6.8	6.7	6.5	6.5	6.5	6.8	6.8	6.6	6.5	6.3	6.1	6.7	6.9	7.0
24	460	7.3	7.3	7.0	6.6	6.3	6.1	5.9	5.8	5.9	6.1	6.0	6.2	6.3	6.1	6.2	6.7	7.0
25	480	7.2	7.1	6.8	6.6	6.2	5.8	5.6	5.4	5.6	5.6	5.8	6.1	6.4	6.4	6.4	6.7	7.0
26	500	7.1	7.0	6.8	6.5	6.1	5.6	5.1	4.9	4.9	5.1	5.7	6.1	6.3	6.5	6.6	6.8	7.0
27	520	7.1	6.9	6.7	6.4	6.0	5.5	5.2	5.1	5.1	5.1	5.8	6.1	6.4	6.5	6.7	6.8	7.0
28	540	7.1	6.9	6.8	6.4	6.1	5.7	5.5	5.3	5.2	5.4	6.0	6.2	6.4	6.5	6.6	6.7	6.8
29	560	7.3	7.1	6.8	6.4	6.2	5.9	5.7	5.6	5.6	5.7	6.1	6.3	6.4	6.5	6.6	6.7	6.7
30	580	7.2	7.0	6.8	6.6	6.4	6.1	5.9	5.9	5.8	5.8	6.1	6.4	6.4	6.6	6.7	6.7	6.7
31	600	6.9	6.8	6.8	6.6	6.5	6.3	6.1	6.0	6.0	5.9	6.2	6.3	6.4	6.5	6.7	6.9	6.7
32	620	6.6	6.8	6.8	6.7	6.6	6.4	6.2	6.0	6.0	6.0	6.2	6.3	6.5	6.7	6.9	6.8	6.8
33	640		6.4	7.0	6.9	6.7	6.4	6.2	6.1	6.1	6.1	6.2	6.4	6.7	6.8	7.0	6.8	6.9
34	660		6.3	7.0	6.8	6.7	6.4	6.3	6.3	6.3	6.1	6.0	6.4	6.4	6.5	6.8	6.7	7.0
35	680		6.4	6.8	6.6	6.5	6.4	6.5	6.5	6.4	6.4	6.6	6.5	6.5	6.7	6.8	6.7	7.2

Example 7 - PEC Results

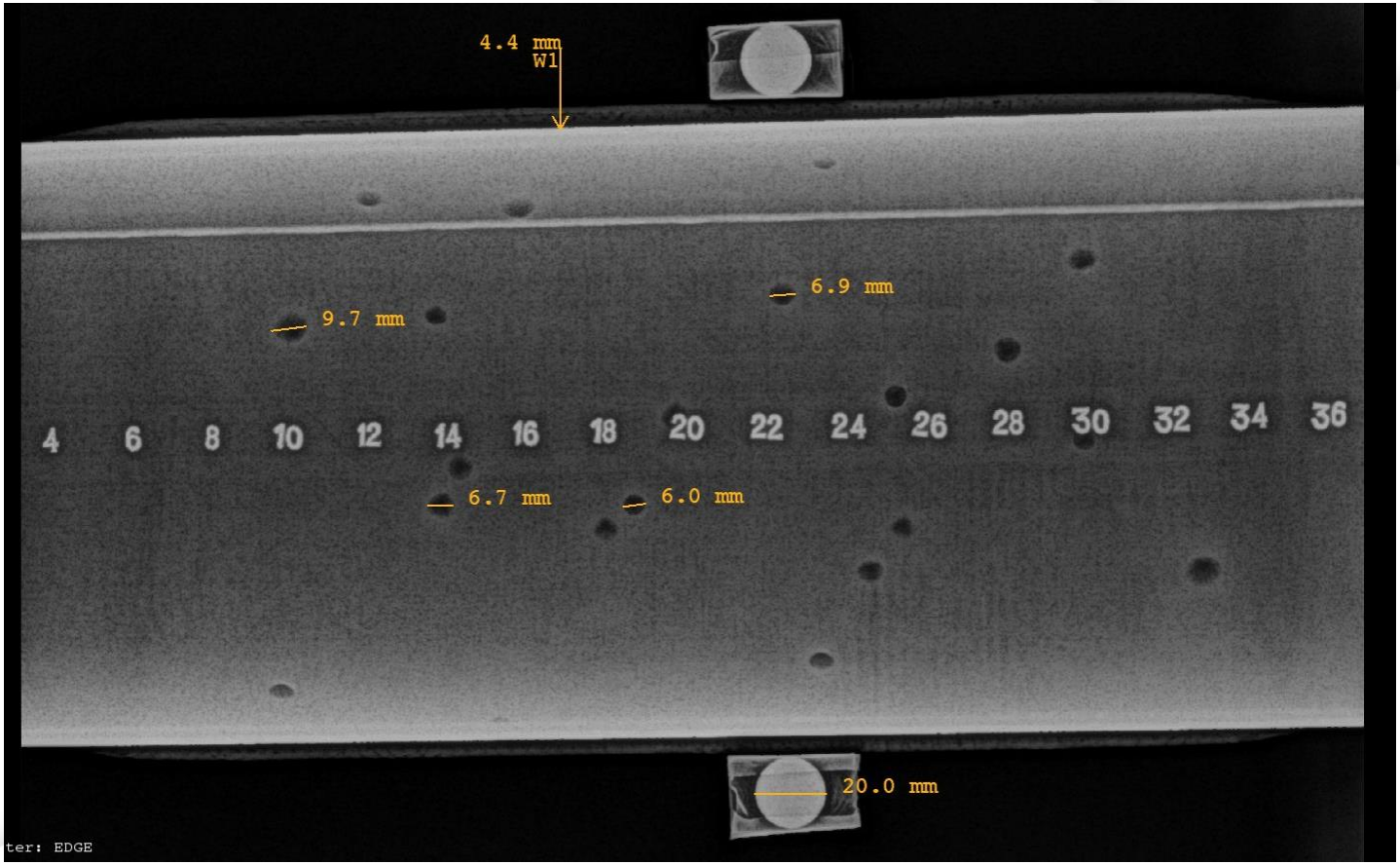
7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.8	6.7	6.7	6.7	6.8	6.9	7.0	7.2
7.0	7.0	6.9	6.7	6.7	6.8	6.8	6.7	6.7	6.7	6.9	6.8	6.8	6.7	6.7
7.1	7.1	6.7	6.2	6.4	6.6	6.7	6.6	6.6	6.7	6.7	6.9	7.0	6.8	6.8
7.2	7.0	6.1	6.1	6.4	6.5	6.5	6.5	6.5	6.6	6.5	6.7	6.8	6.5	6.7
7.2	7.0	6.3	6.3	6.4	6.3	6.4	6.4	6.4	6.4	6.4	6.5	6.7	6.4	6.5
7.2	7.0	6.5	6.2	6.1	6.1	6.1	6.2	6.3	6.4	6.3	6.3	6.4	6.4	6.5
7.1	7.0	6.6	6.0	5.8	5.7	5.8	6.0	6.1	6.1	6.2	6.2	6.2	6.0	6.6
7.2	7.1	6.8	6.1	5.6	5.1	5.1	5.4	5.7	5.8	5.9	6.0	6.1	6.1	6.4
7.2	7.0	6.8	5.9	5.6	4.9	5.1	5.2	5.6	5.8	6.0	6.0	6.1	6.3	6.4
7.2	7.0	6.5	5.8	5.4	4.9	5.1	5.3	5.6	5.9	6.0	6.0	6.1	6.3	6.5
7.2	6.9	6.5	5.9	5.6	5.1	5.2	5.5	5.7	5.9	6.1	6.2	6.2	6.3	6.5
7.2	6.9	6.5	6.1	5.8	5.6	5.5	5.7	5.9	6.1	6.3	6.4	6.4	6.4	6.4
7.3	7.0	6.7	6.3	6.2	6.1	6.0	6.1	6.2	6.4	6.5	6.6	6.7	6.7	6.5
7.3	7.1	6.8	6.6	6.6	6.5	6.4	6.4	6.4	6.6	6.6	6.7	6.9	6.8	6.6
7.3	7.3	7.2	7.0	6.8	6.8	6.7	6.8	6.8	6.8	6.8	6.8	7.0	7.0	6.8
7.3	7.3	7.4	7.3	7.1	7.0	6.9	6.9	7.1	7.0	6.8	6.8	6.4	6.3	6.4
7.3	7.4	7.5	7.3	7.2	7.1	7.1	7.1	7.3	7.2	6.9	6.6			



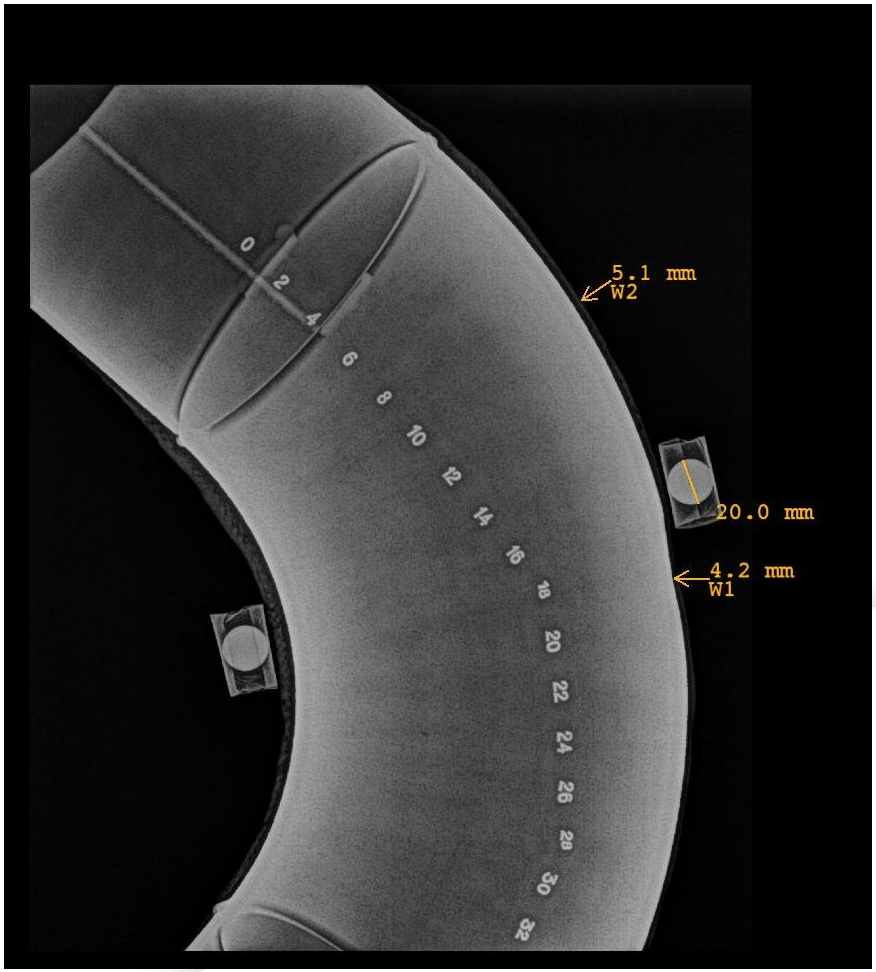
Example 8

Example 8

Section 4-36



Example 8 - RAD & PEC of Elbow



	A	B	C	D	E	F	G	H
1	74.5	74.5	73.5	72.4	72.6	72.9	72.4	72.3
2	74.3	74.9	73.7	72.5	73.0	72.5	71.4	71.9
3	74.2	75.1	73.9	72.6	72.5	72.2	71.3	72.4
4	73.8	74.9	74.9	73.6	73.3	73.0	73.3	73.3
5	80.8	72.5	71.4	72.8	74.6	71.8	72.6	72.5
6	81.4	82.6	82.0	81.5	84.8	88.7	88.0	86.2
7	89.1	86.4	86.6	88.9	91.4	91.9	91.6	92.3
8	93.2	90.6	92.5	93.3	94.7	96.0	93.8	94.3
9	95.1	93.7	96.8	97.9	97.5	96.5	95.3	96.7
10	93.4	95.1	98.8	99.7	98.8	96.8	96.1	98.7
11	92.8	96.1	99.7	100.0	99.0	97.3	96.7	99.7
12	92.0	95.4	99.7	100.0	99.1	97.6	97.6	100.4
13	92.0	95.7	99.2	99.5	98.7	96.8	98.0	100.0
14	93.3	94.5	97.5	99.0	97.8	98.7	99.7	101.0
15	94.3	94.3	95.8	98.3	96.8	96.1	97.9	100.9
16	95.5	93.3	93.2	97.4	96.1	93.5	93.8	99.7
17	96.1	93.4	89.5	92.1	91.2	90.8	94.4	101.7
18	96.0	93.8	87.6	84.1	87.1	89.6	96.0	100.3
19	96.1	94.1	88.3	85.6	88.6	88.7	95.3	99.1
20	95.2	94.6	92.4	93.6	94.0	92.7	95.8	98.4
21	96.1	96.0	95.5	98.0	98.6	96.9	97.8	97.7
22	96.0	96.6	97.7	98.2	98.6	98.9	98.9	99.2
23	96.1	97.6	98.5	97.8	99.9	100.0	98.7	96.6
24	95.2	96.1	98.3	98.3	99.1	101.0	98.9	97.6
25	94.6	95.5	96.8	96.5	98.3	98.1	97.3	95.4
26	92.1	93.2	94.3	94.3	94.1	93.2	93.4	90.0
27	79.4	81.2	83.8	83.6	78.3	77.0	76.8	72.5
28	75.2	74.4	74.3	74.6	73.8	73.1	73.5	73.8

Different Schedule

Weld Area

Detected Defect

Weld Area

Different Schedule

Example 9