BOREAL

E-line

Well Integrity Log Interpretation

(Magnetic Thickness Detector and 56-Arm Multi-Finger Caliper)

Company:	
Well:	
Field:	
Province:	Alberta
Country:	Canada
License:	
UWI:	
Logging Date:	21-Mar-2015
Report Date:	21-Mar-2015
Reference:	
Analyst:	

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1. Objective and Conclusions

1.1. Introduction

A Magnetic Thickness Detector (MTD) and a 56-Arm Multi-Finger Caliper Tool (MFC56) were logged in the **** well on 21-Mar-2015.This interpretation is based on the main pass of the above mentioned well.

1.2. Objectives

The objective of the job was to inspect the 244.5 mm, 59.5 kg/m production casing using GOWell 56 Finger Caliper Tool (MFC56) and Magnetic Thickness Detector (MTD).

1.3. Job Details

Ground Level (GL) elevation is 621.4 m. KB to GL distance is 5.0 m. No correlation log provided. Log zeroed at Ground Level/CF instead of KB. Magnetic Thickness Detector (MTD) and 56 Arm Multi-Finger Caliper Tool (MFC56) were deployed directly through the 244.5 mm production casing via e-line (free fall).A total of 2 passes were recorded during the job. The main pass was recorded from 542.4 mKB to Surface. The repeat pass was recorded from 542.4 mKB to 460.0 mKB.Well details are as per log header information provided by the client.

1.4. Conclusions

244.5 mm Casing Condition from Magnetic Thickness Detector and 56 Arm Multi-Finger Caliper:

Good casing condition was observed through most of the logged interval 4.5 m - 538.0 m. Both MFC56 & MTD showed breach/Possibly parted casing around 90 m in the vicinity of a collar. The temperature ranged from 21°C near surface to 97°C at 538.0 m. Temperature changes were observed around the breach area and 217.0 m – 300.0 m.

56-Arm Multi-Finger Caliper (MFC56):

Casing breach/Possibly Parted casing was observed around 90.12 m. 100% penetration and 100% wall loss was recorded at this depth. The breach is occurring in the vicinity of collar. The vertical height of the breach is around 0.05 m

Apart from the breach around 90.12 m, the MFC56 run in the 244.5 mm production casing mostly showed very light (Less than 10%) to light (10% - 25%) penetration **Figure.1a.**

The casing joints showed penetration from 5.4% - 31.7%. MFC56 recorded a maximum penetration of 31.7%at 171.40 m The MFC56 penetration joints are detailed in **Table 1.1.**

The MFC56 run in the 244.5 mm production casing showed very light (Less than 12%) wall loss.

Casing joints showed wall loss from 0.1%-8.9%.MFC56 recorded a maximum of 8.9% wall loss at 171.4 m. MFC joints with the wall loss are detailed in **Table 1.1.**

Higher pipe ovality/deformation was observed at 171.4 m. Penetration of 31.7% and wall loss of 8.9% was observed at this interval.

The Intervals 153.46 m-191.92 m and 489.16 m-538.0 m showed slightly higher penetration (16%-31.7%) and wall loss (5.1%-8.9%) as compared to the other casing joints.

Magnetic Thickness Detector (MTD):

MTD also detected the breach around 90.18 m. The breach/parted casing signature was pronounced on the BB, B and C Channels and the ANoise.

Apart from the breach around 90.18 m The MTD showed very light (Less than 12%) wall loss in the 244.5 mm production casing **Figure.5a**.

Most of the joints showed wall losses from 1.8%-8.4%.MTD recorded a maximum of 8.4% wall loss at 537.5 m Casing joints (244.5 mm) with wall loss determined from the MTD are detailed in **Table 1.2**.

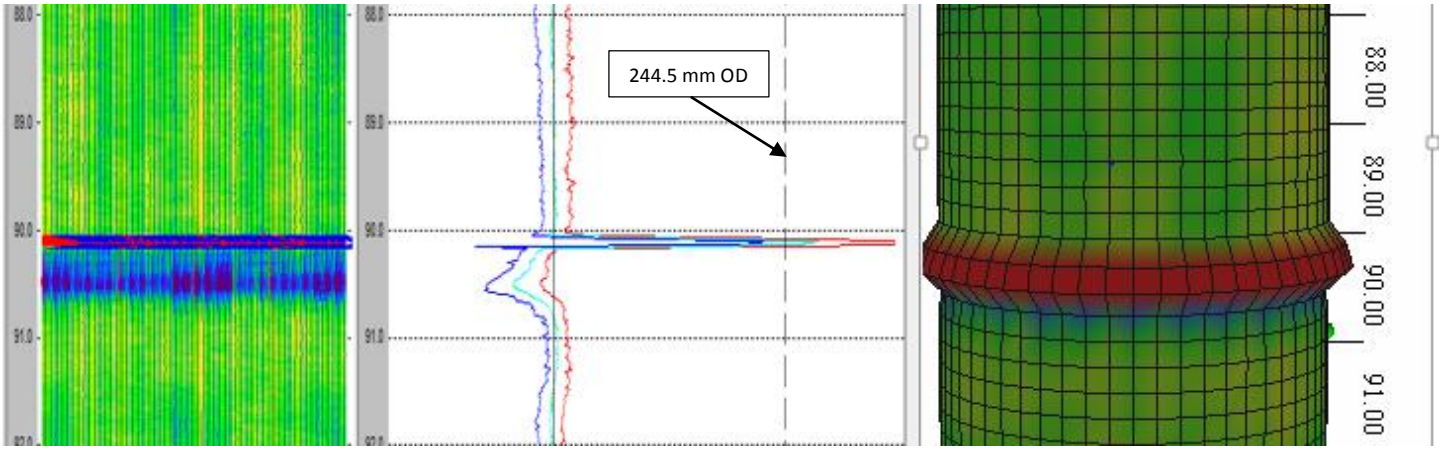
The Interval 489.16 m-538.0 m showed slightly higher wall loss (6.4%-8.4%) as compared to the other casing joints.

Breach/Possibly Parted Casing Confirmed by MFC56 & MTD

In order to investigate the breach/Parted Casing in the vicinity of a collar around 90 m, statistical analysis was run over this area. For this purpose casing body length of 26 m (Approximately) was assumed.

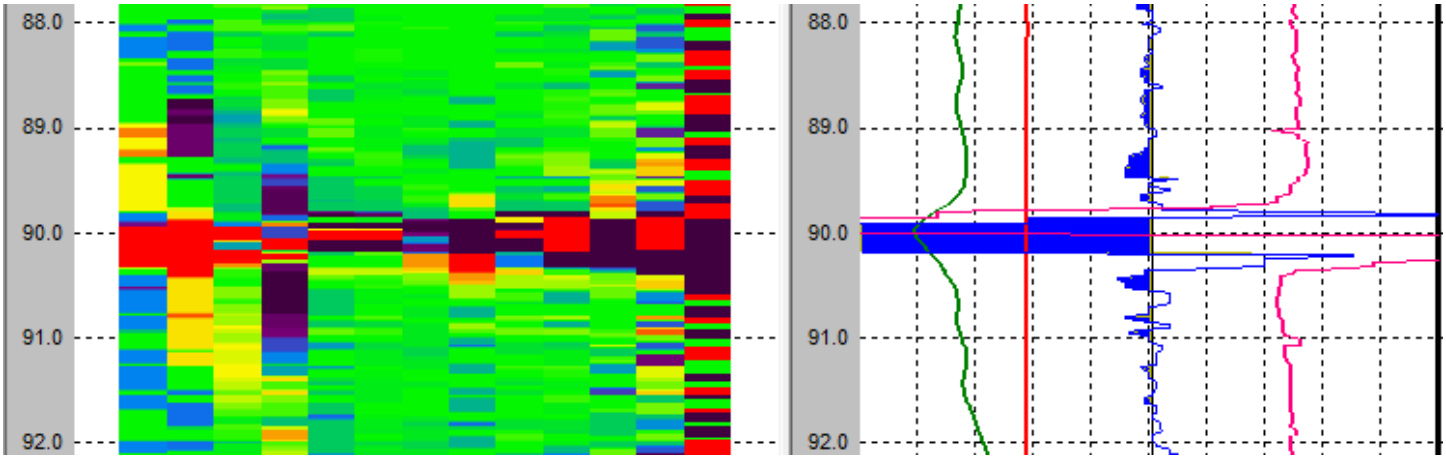
MFC56 Analysis: MFC56 showed 100% penetration and 100% wall loss around 90.12 m

Top Body(m)	Bottom Body(m)	Body Length(m)	Max Pen Depth(m)	Max Pen (mm)	Max Pen (%)	Max Loss Depth(m)	Max Loss (%)	Min Diam Depth(m)	Min Diam (mm)
77.34	103.42	26.08	90.12	254.1	100.0	90.11	100.0	90.53	219.0



MTD Analysis: MTD showed 100% wall loss around 90.18 m

Top Body(m)	Bottom Body(m)	Body Length(m)	Nom Thk (mm)	Min Thk (mm)	Max Loss Depth(m)	Max Loss (%)
77.41	103.09	25.68	10.030	0.000	90.18	100.0

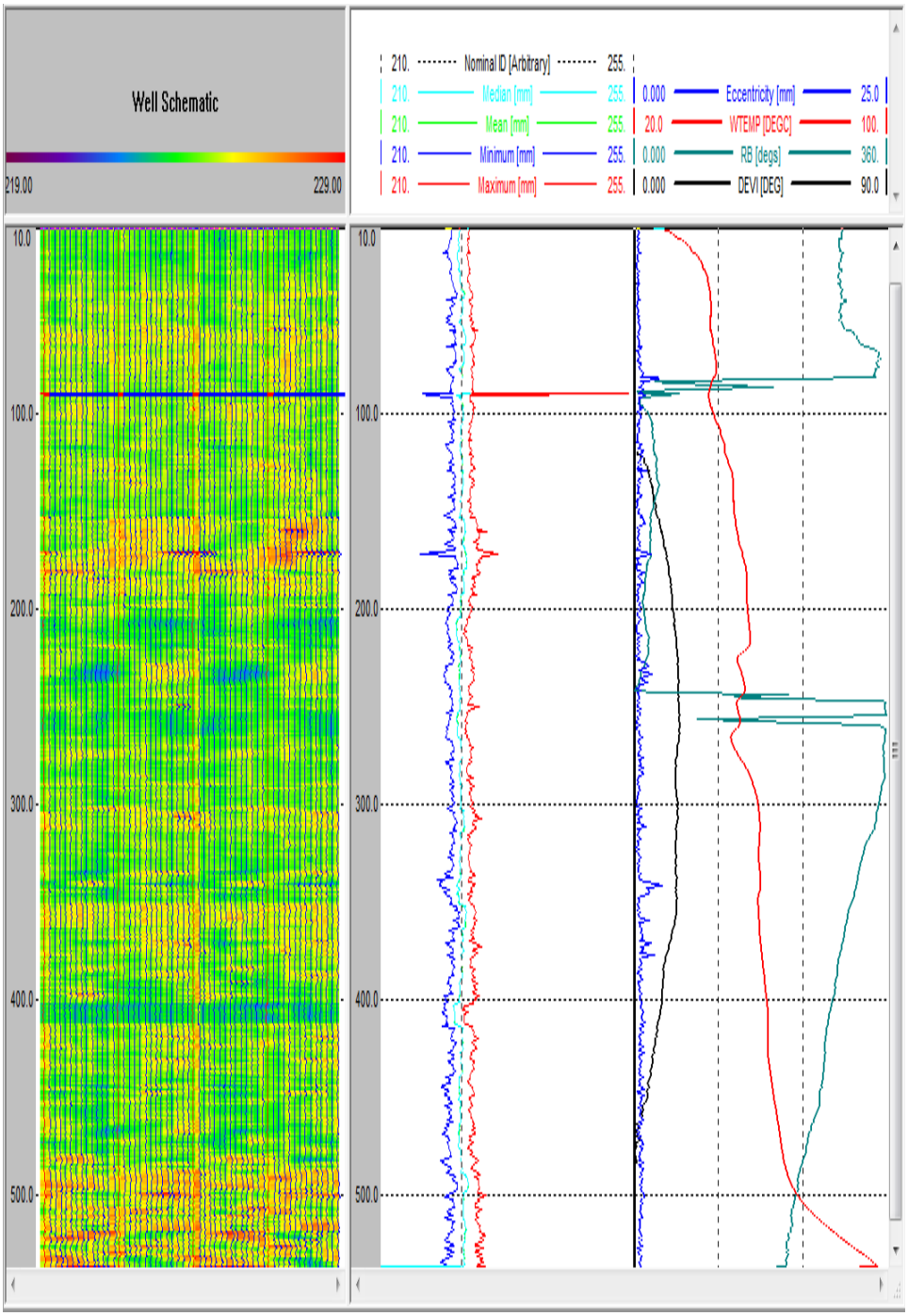

88.0
89.0
90.0
91.0
92.0
88.0
89.0
90.0
91.0
92.0

1.5. Log Quality Control

Table 1 – MFC56 Log Quality Control	
LQC Area	**Result**
[1]Are all fingers in contact with inner pipe wall (raw data)?	**Yes**
[2]Before and after calibrations performed and within specification?	**Yes**
[3]Excentralization correction applied?	**Yes**
[4]Is tool excentralization acceptable?	**Yes**
[5]Does average radius approximate theoretical nominal radius (in good pipe)?	**Yes**
[6]Are inner wall manufacturing patterns clearly visible (in good pipe)?	**Yes**
[7]Any sticking/reconstructed fingers?	**No**
[8]Connections/collars identifiable on all finger traces?	**Yes**
[9]Is the level of tool rotation acceptable?	**Yes**
[10]Has the correct master calibration (MTC) been applied?	**Yes**
[11]Does the repeat pass correlate with the main pass?	**Yes**
LQC Comments	
1	
2	
3	
4	
5	
6	
7	
8 Collars/Connections were difficult to identify	
9	
10	
11	
Additional Comments	
A good level of repeatability exists between the main log and repeat section	

Table 2 – MTD Log Quality Control	
LQC Area	**Result**
[1]Are all MTD curves free from abnormal noise	**Yes**
[2]Is the AI curve reading above 300 throughout the log and free from sudden spurious jumps?	**Yes**
[3]Is the Anoise curve centred at 2000 and free from intervals of noise?	**Yes**
[4]Do the raw curves (particular A channels) respond consistently with the well schematic?	**Yes**
[5]Is the wellbore temperature curve showing typical geothermal trend and free from noise?	**Yes**
[6]Is the depth of major well schematic features consistent with the MTD log responses?	**Yes**
[7]Are inner and outer pipe collars clearly identified in the raw A & C curves?	**Yes**
[8]Is the correct logging speed maintained and consistent throughout the log?	**Yes**
Specific LQC Comments above	
1	
2	
3 Yes, however a sharp jump in ANoise was observed due to the breach around 90 m	
4	
5	
6	
7	
8	
Additional LQC Comments	
A good level of repeatability exists between the main log and repeat section.	

Supporting Well Information			
Required	**Received?**	**Optional**	**Received?**
LAS File	**Yes**	Well History	**Yes**
Field Print	**Yes**	Production History	**No**
Job Log	**Yes**	Well Status	**No**
Well Diagram	**Yes**	GR Log	**No**
Completion Diagram	**Yes**	Cement Evaluation Log	**No**
Toolstring Diagram	**Yes**	Borehole Fluid Type	**Yes**
Logging Program	**Yes**	Well Trajectory Survey	**Yes**
Job Objectives	**Yes**	DB File	**Yes**



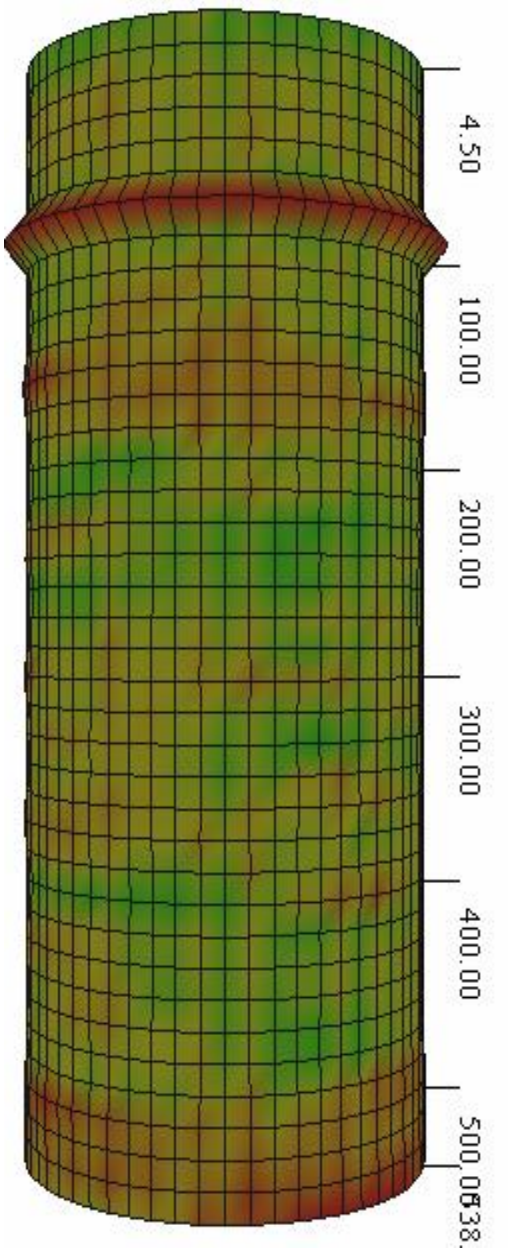


Figure.1a (MFC56) Full Logged Interval.

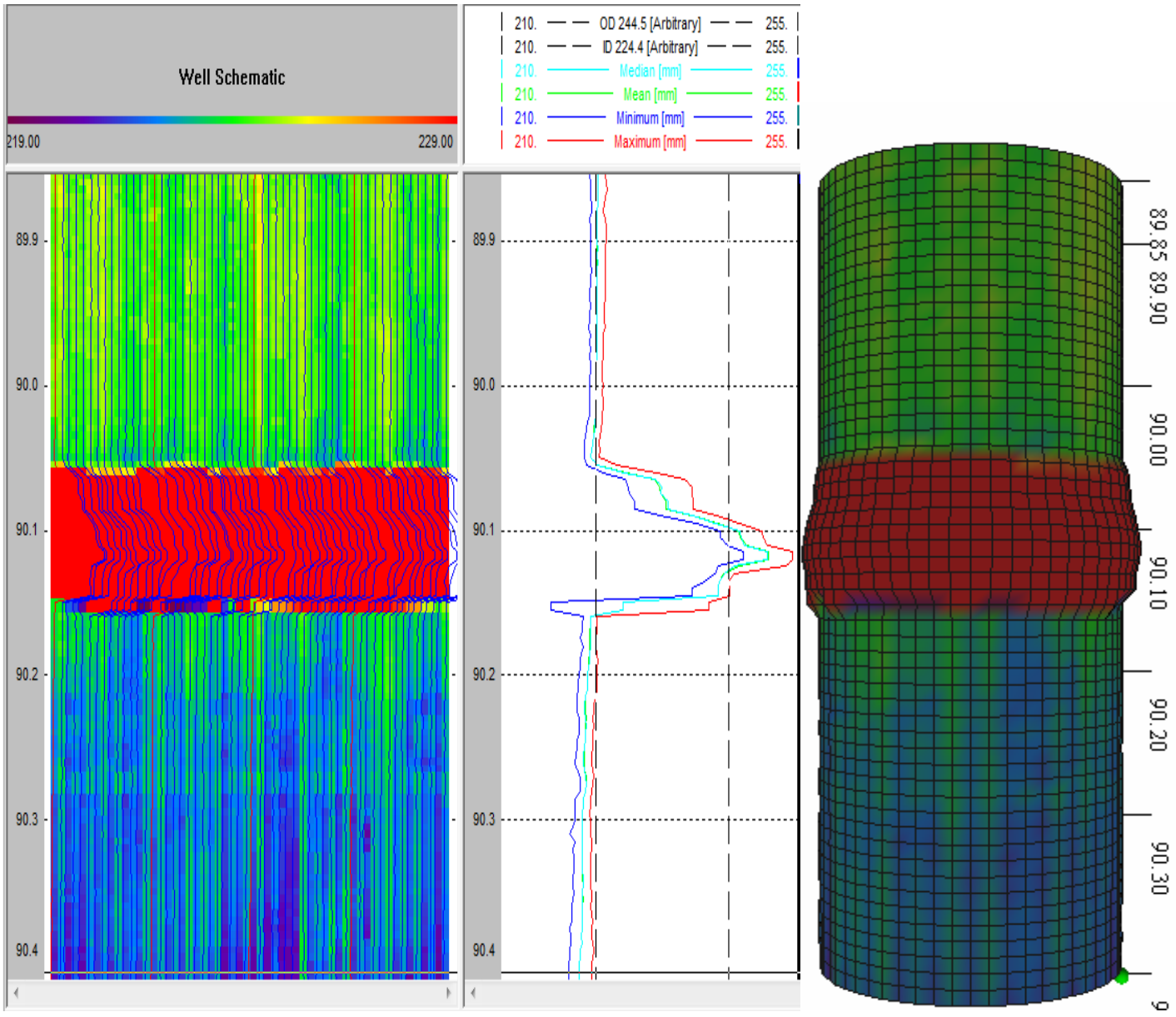


Figure2a Breach Detected at 90.12 m

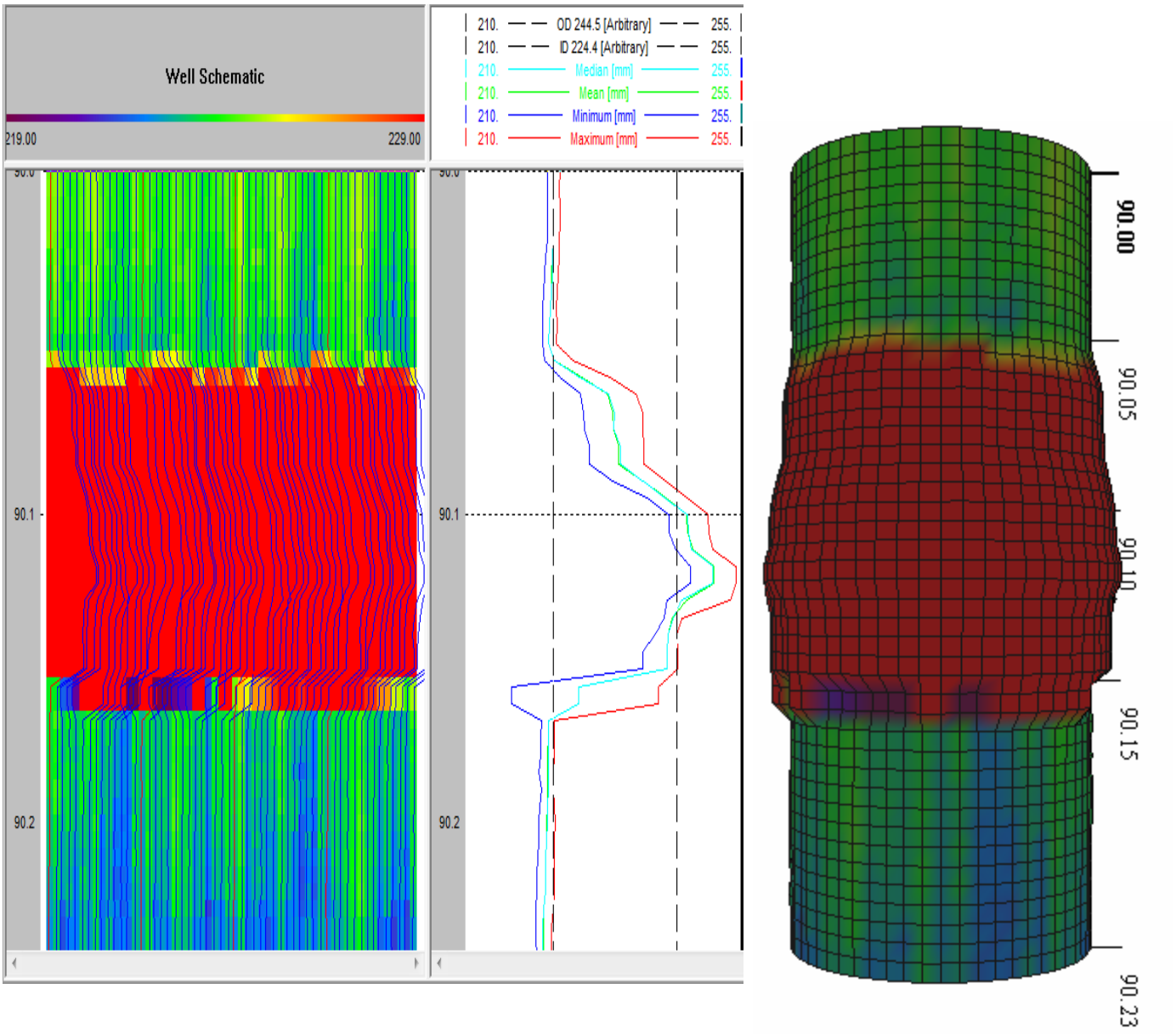


Figure.2b Breach detected at 90.12 m (zoomed-in)

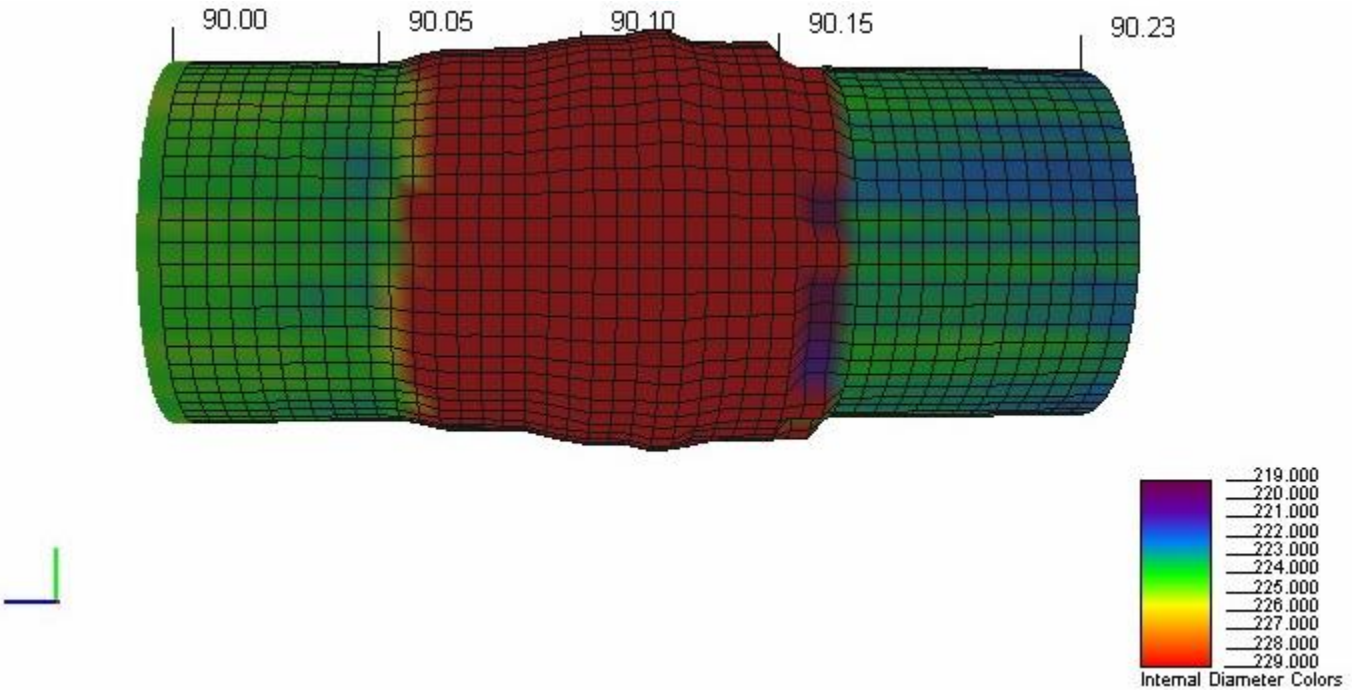


Figure.2c 3D Side View of Breach detected at 90.12 m

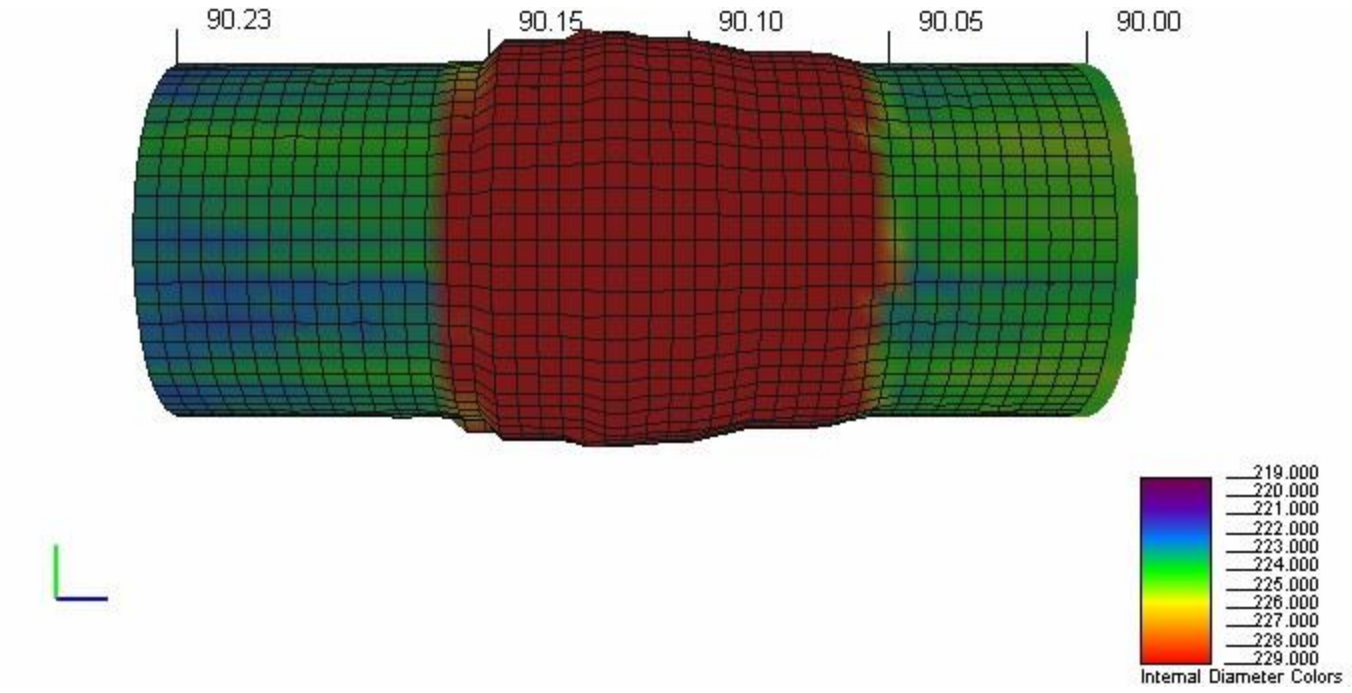


Figure.2d 3D Side View of Breach detected at 90.12 m

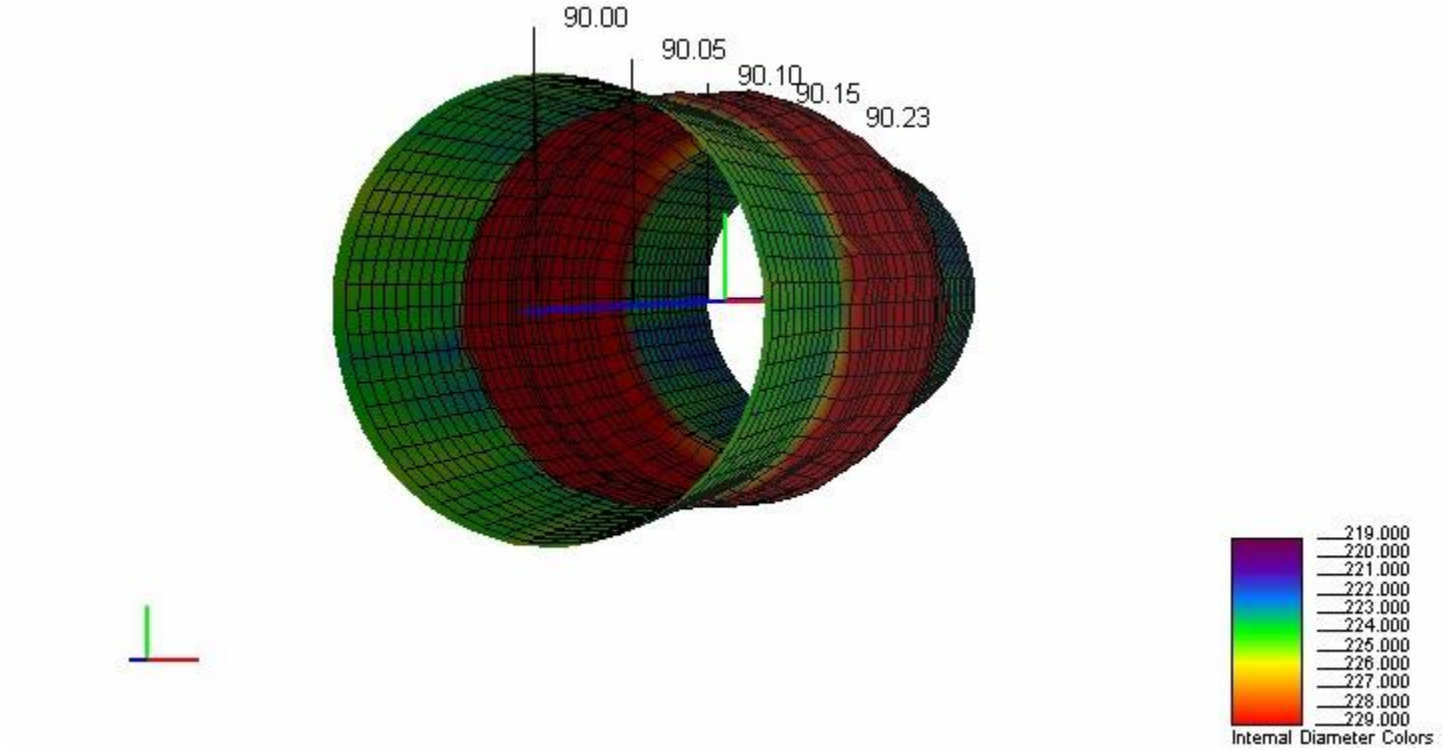


Figure.2e 3D Slanted View of Breach detected at 90.12 m

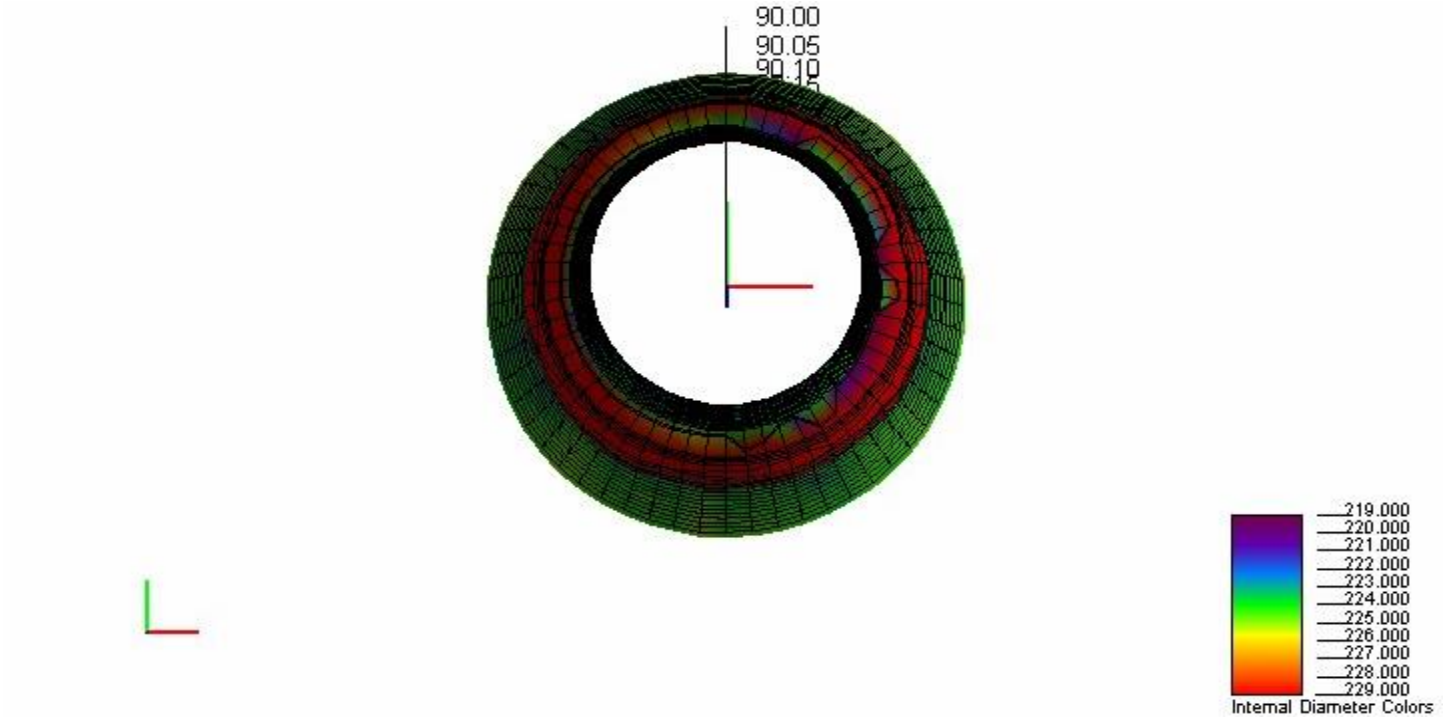


Figure.2f 3D Fly Down View of Breach detected at 90.12 m

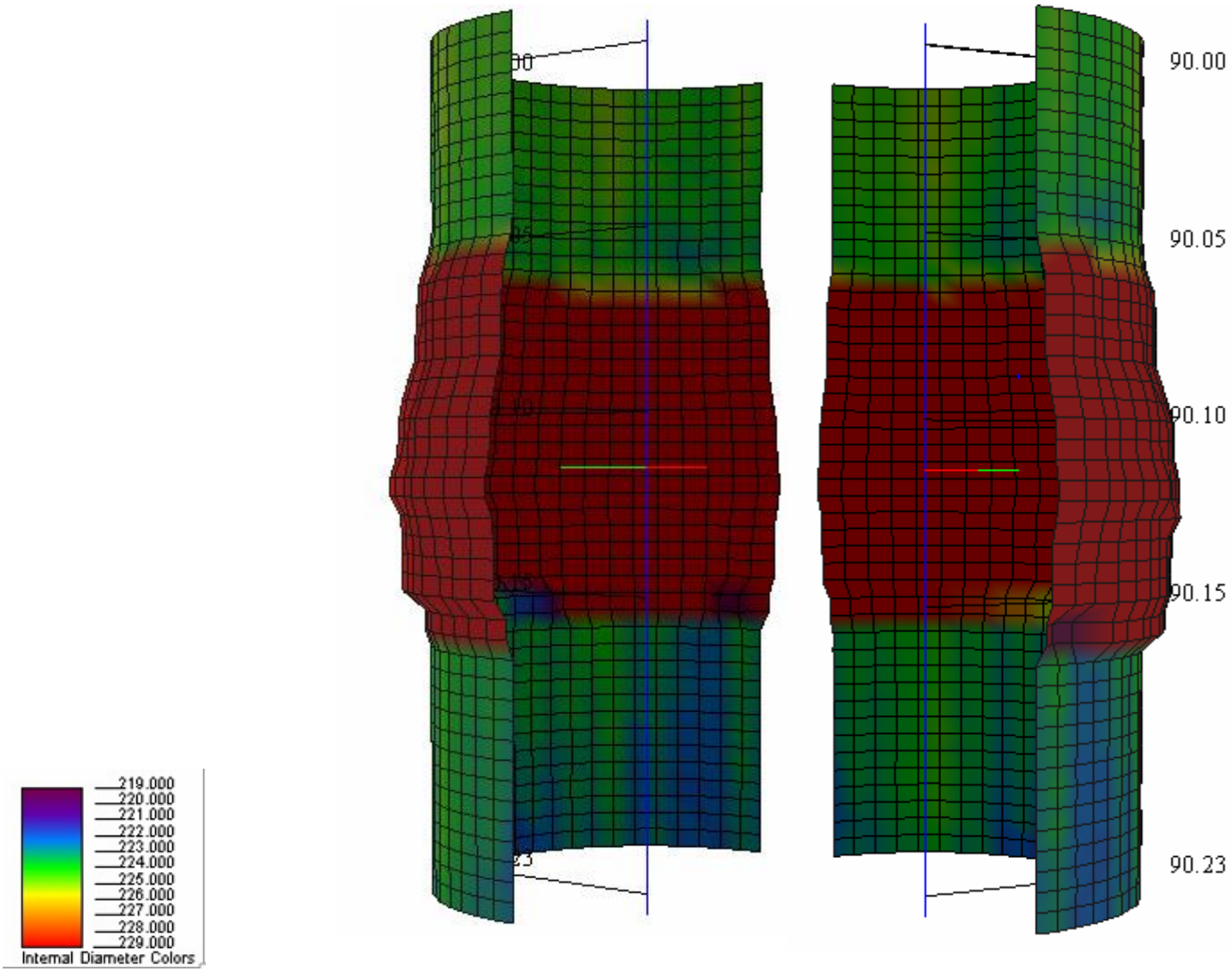


Figure.2g 3D Cut Away View of Breach detected at 90.12 m

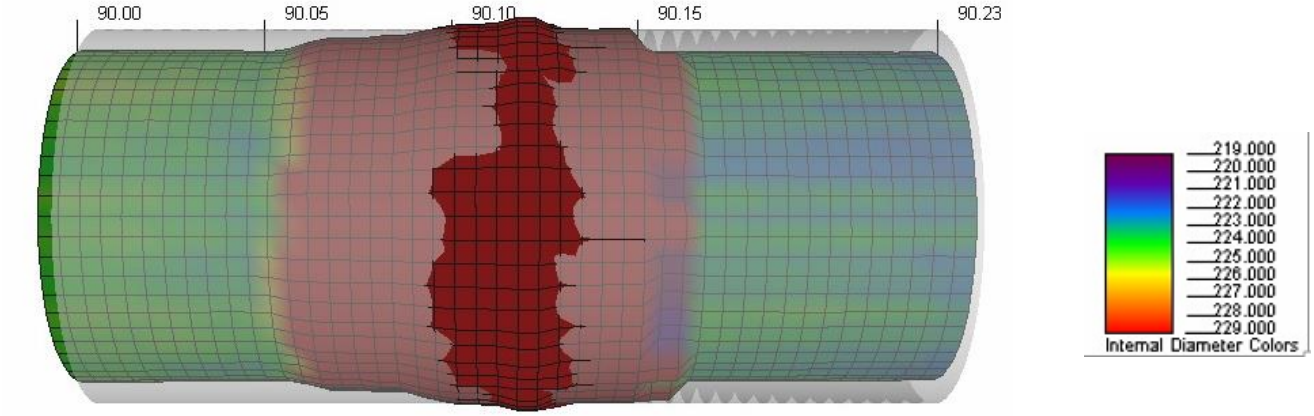


Figure.2h 3D Side View of Breach detected at 90.12 m with masked OD

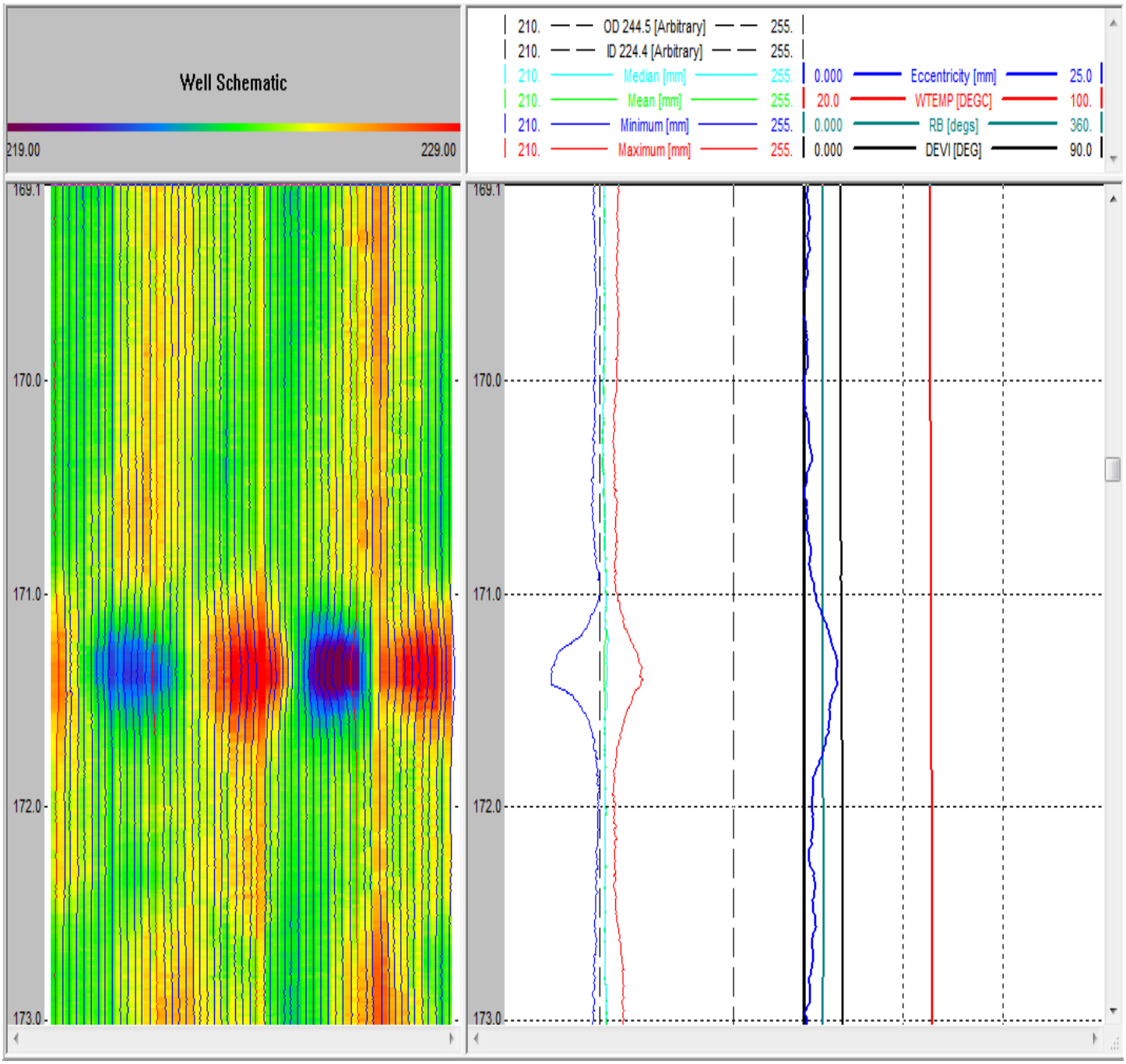


Figure.3a Ovality observed around 171.4 m

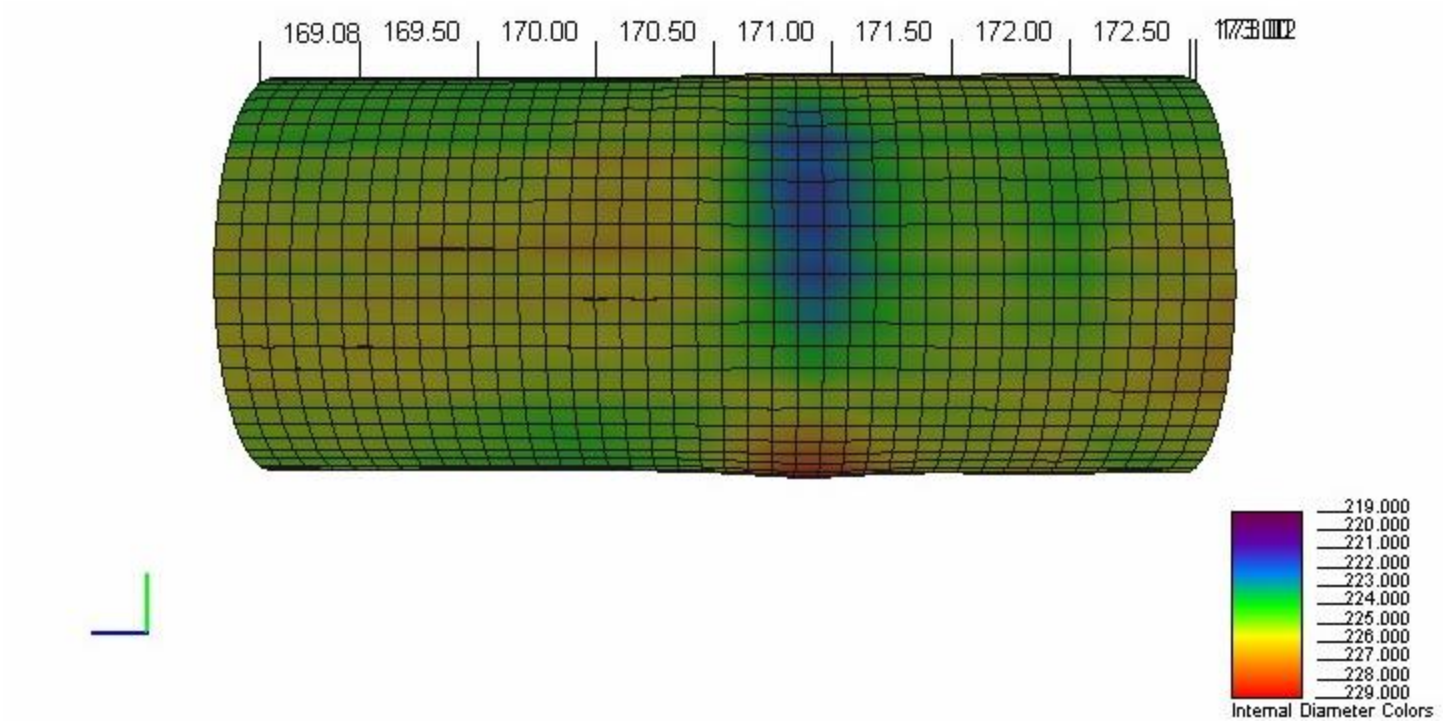


Figure.3b 3D Side View of Ovality observed around 171.4 m

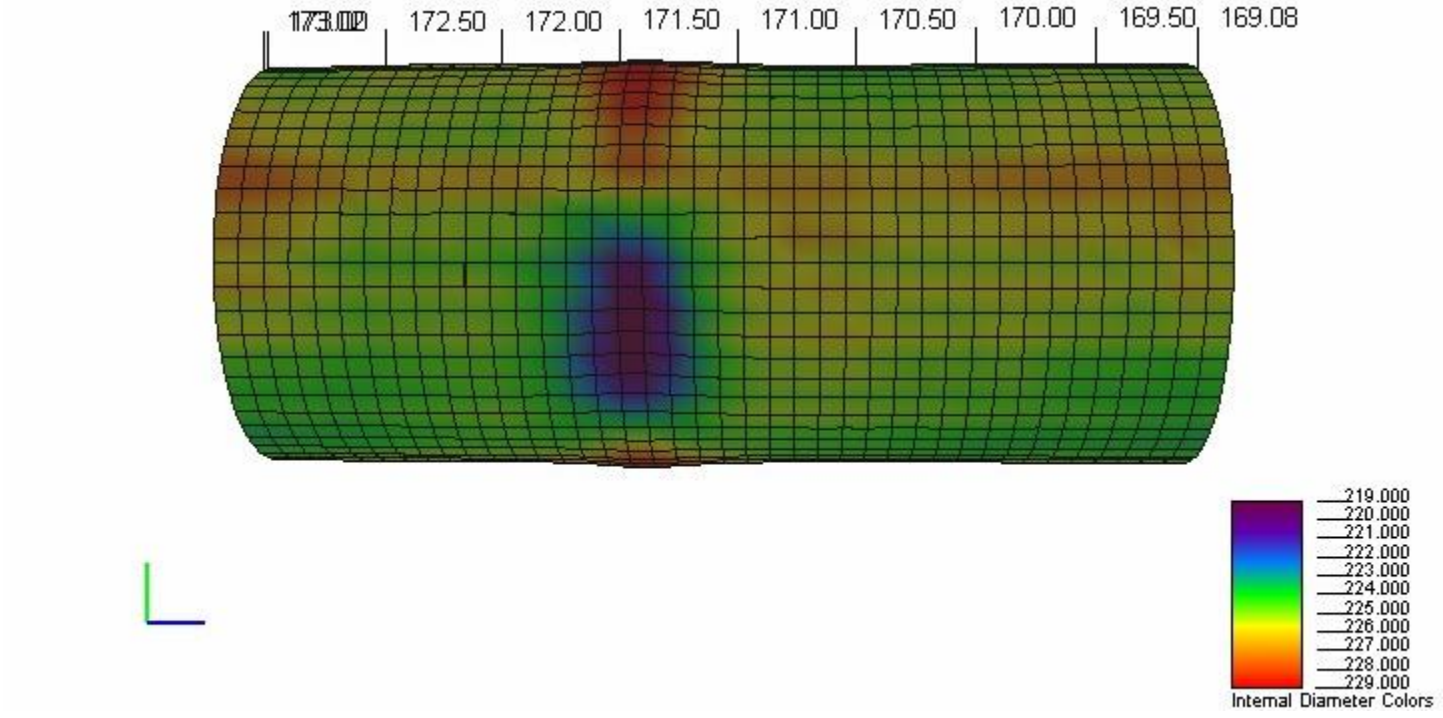


Figure.3c 3D Side View of Ovality observed around 171.4 m

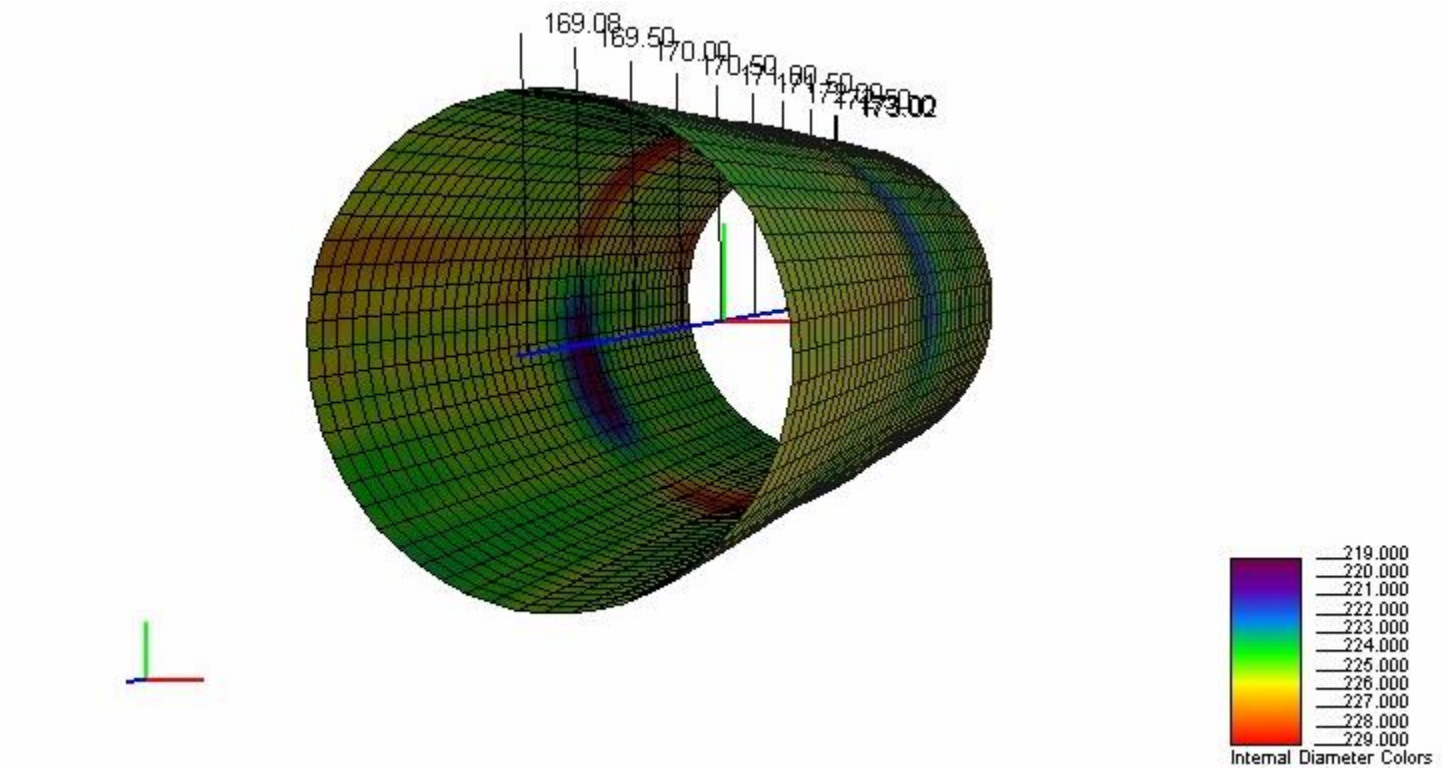


Figure.3d 3D Slanted View of Ovality observed around 171.4 m

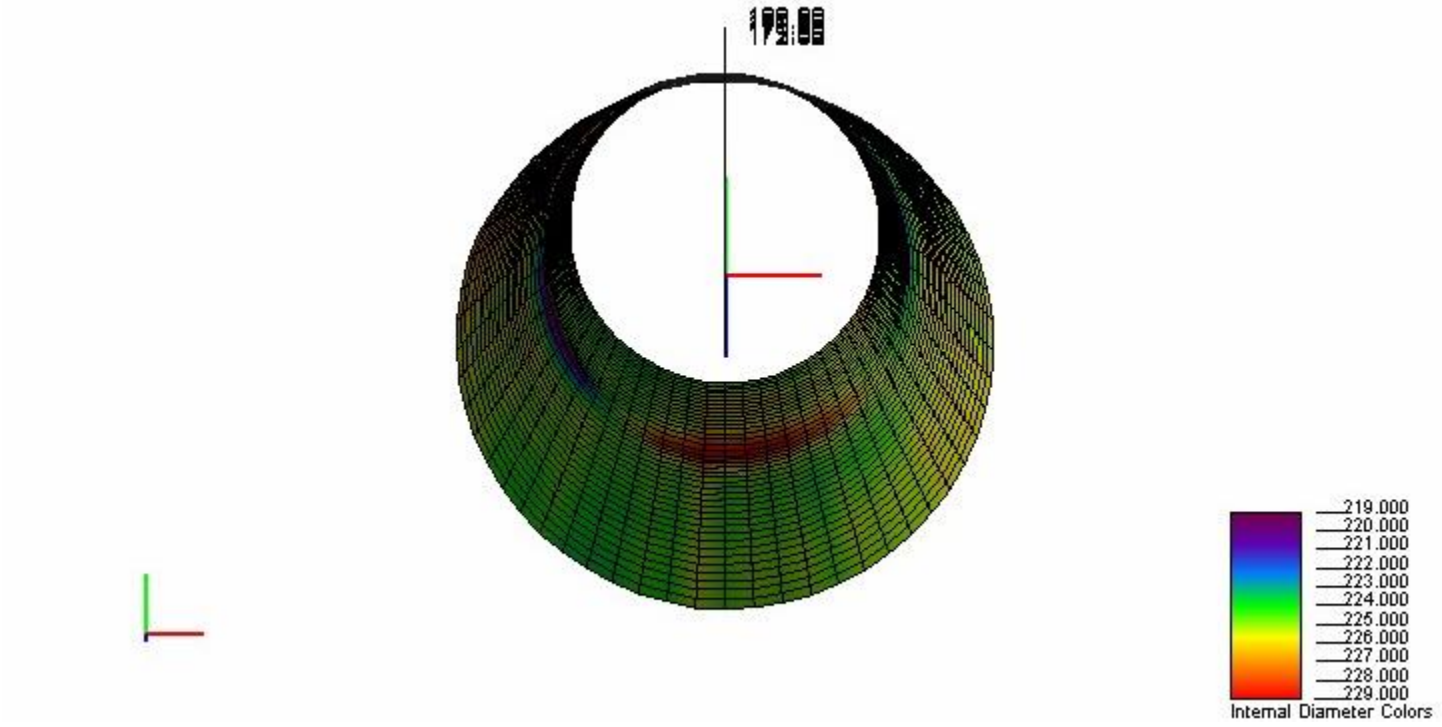
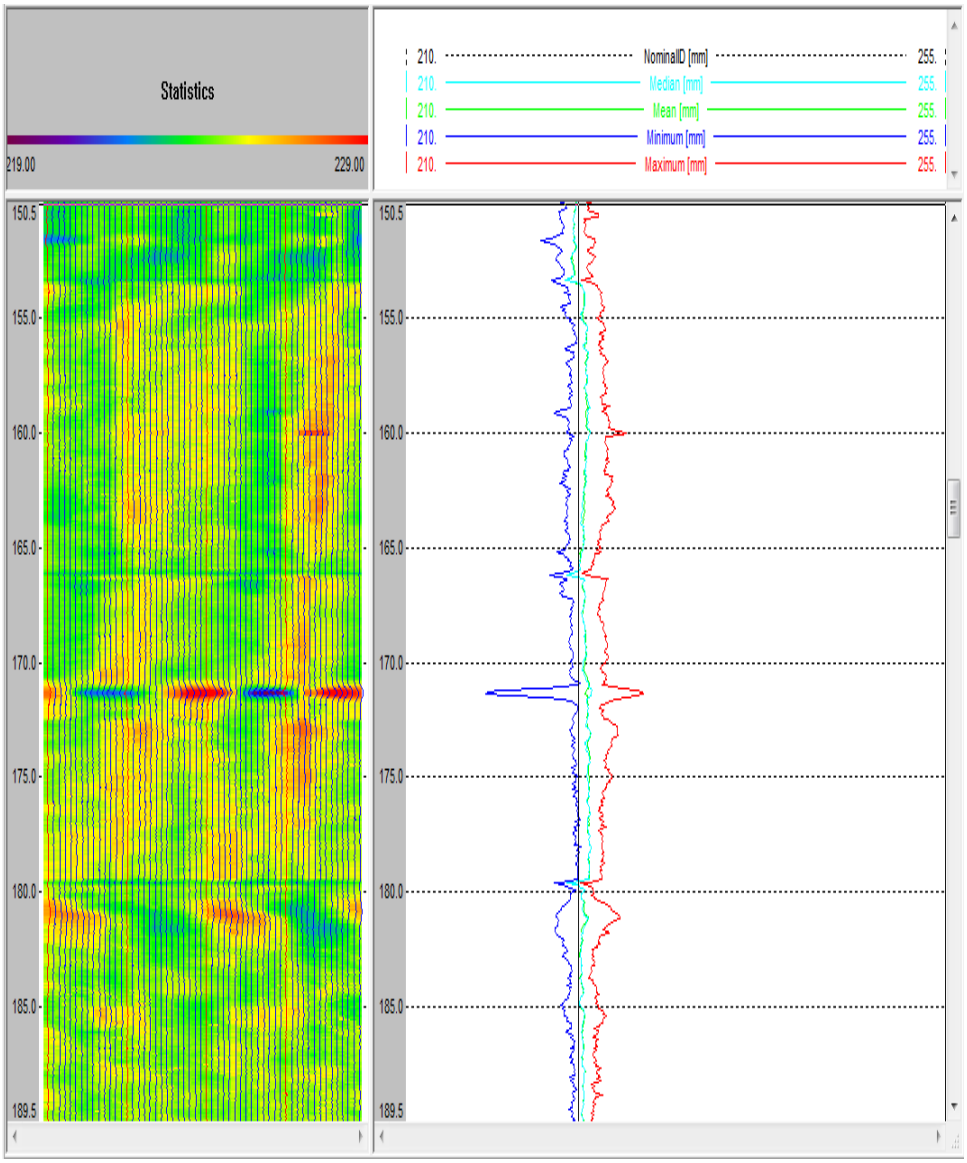


Figure.3e 3D Fly Down View of Ovality observed around 171.4 m



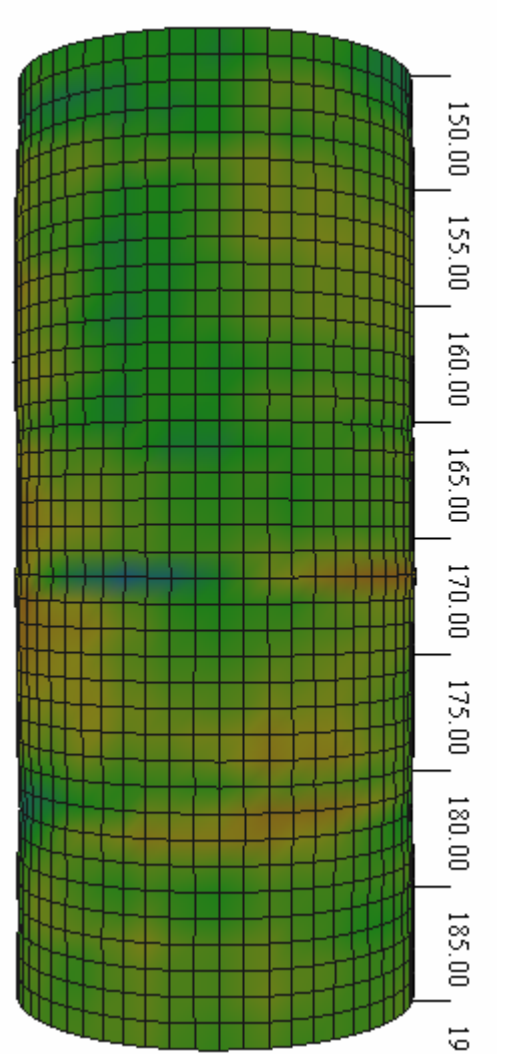


Figure.4a Logged interval 153.46 m-191.92 (Ovality)

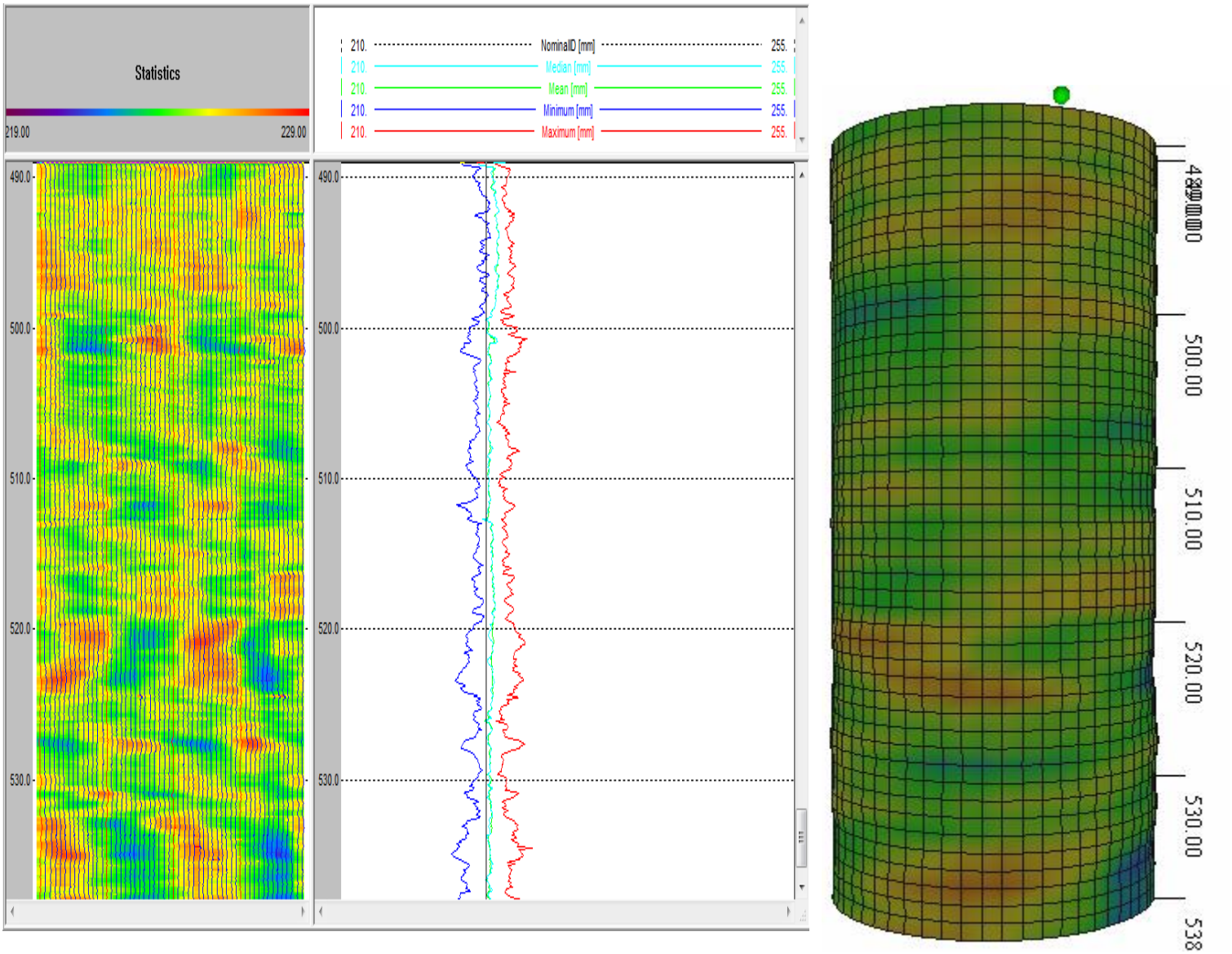


Figure.4b Logged interval 489.16 m-538.0 m (Ovality)

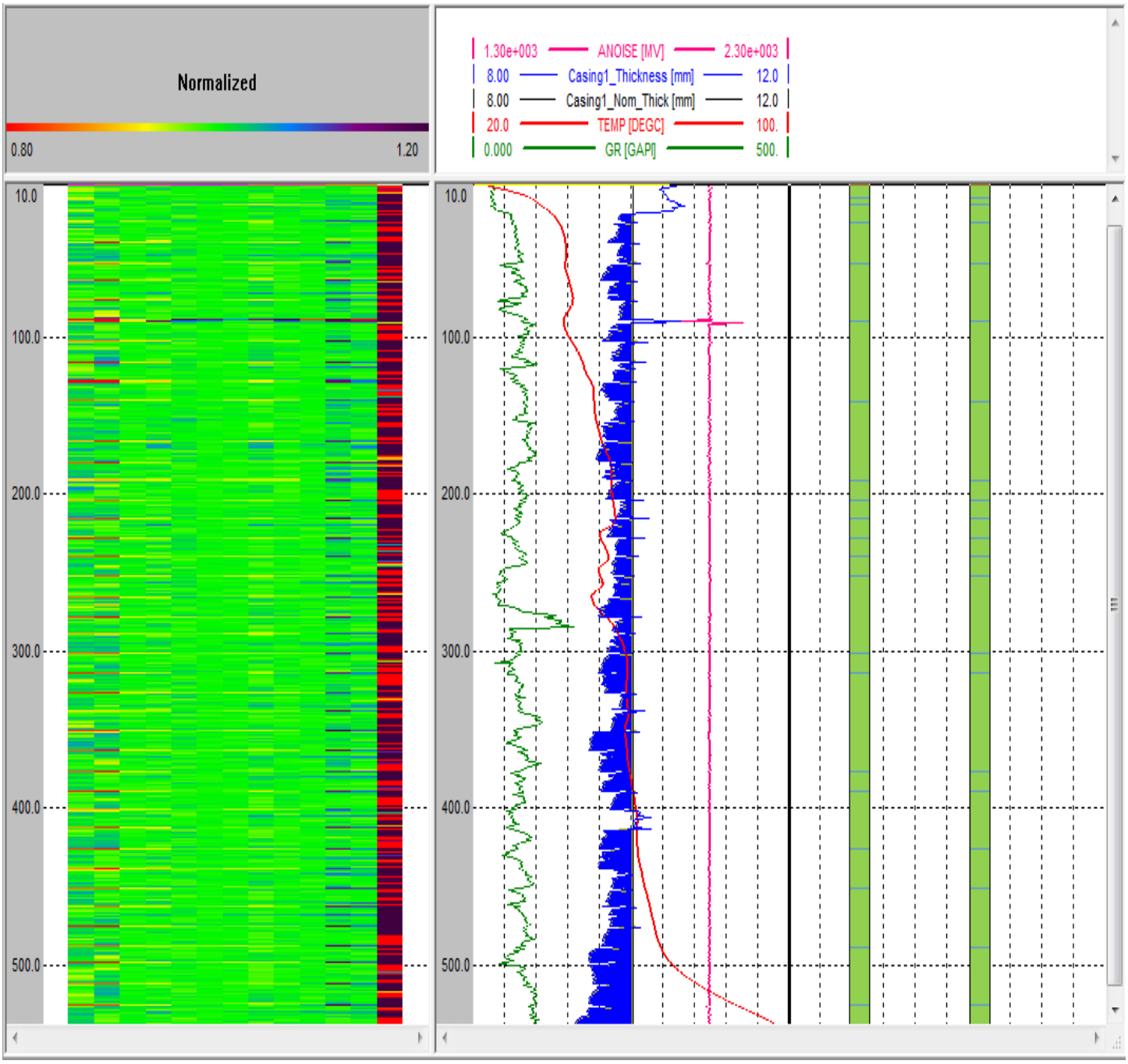


Figure.5a (MTD) Full Logged Interval

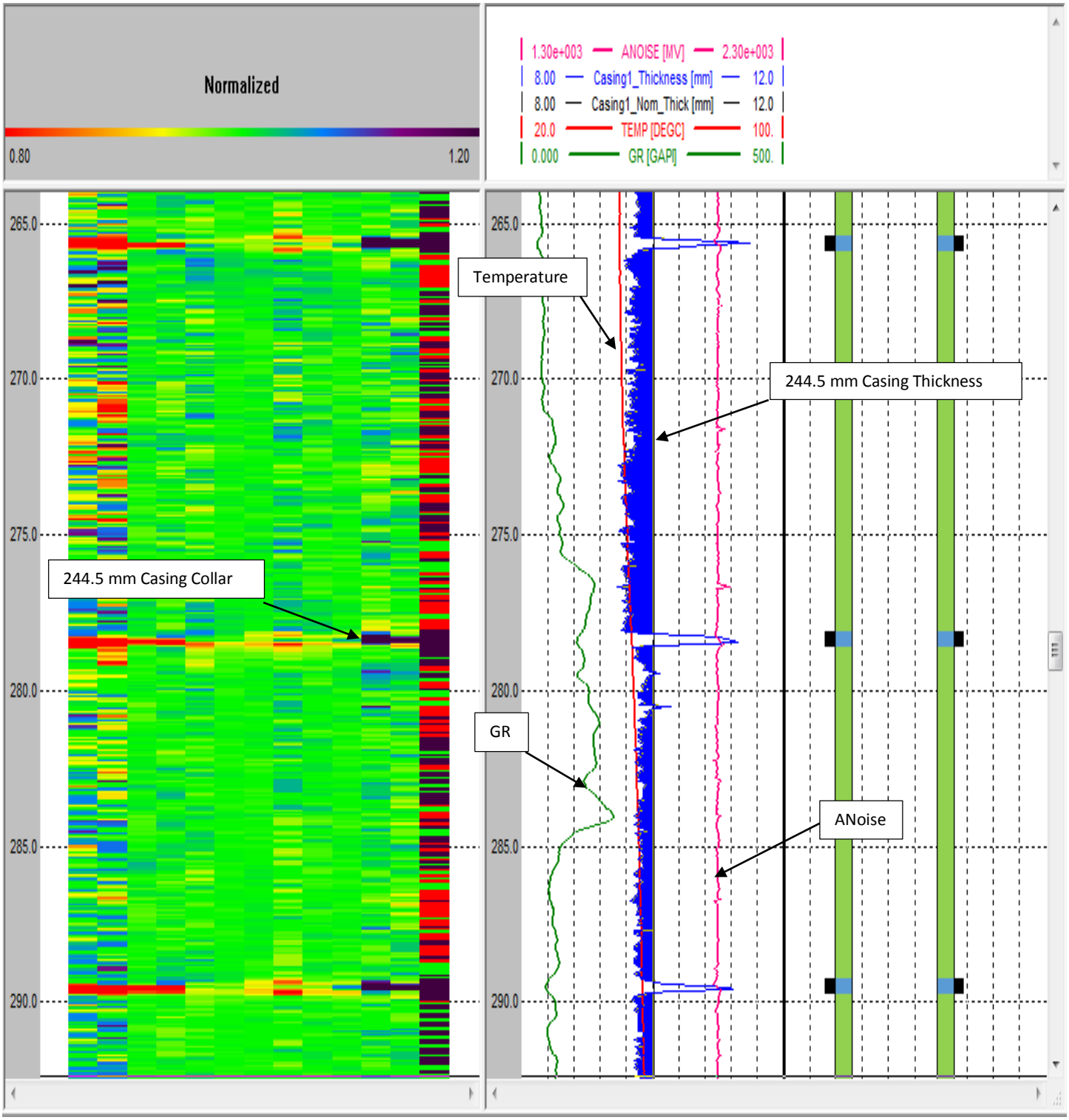


Figure.5b MTD Logged interval (zoomed-in)

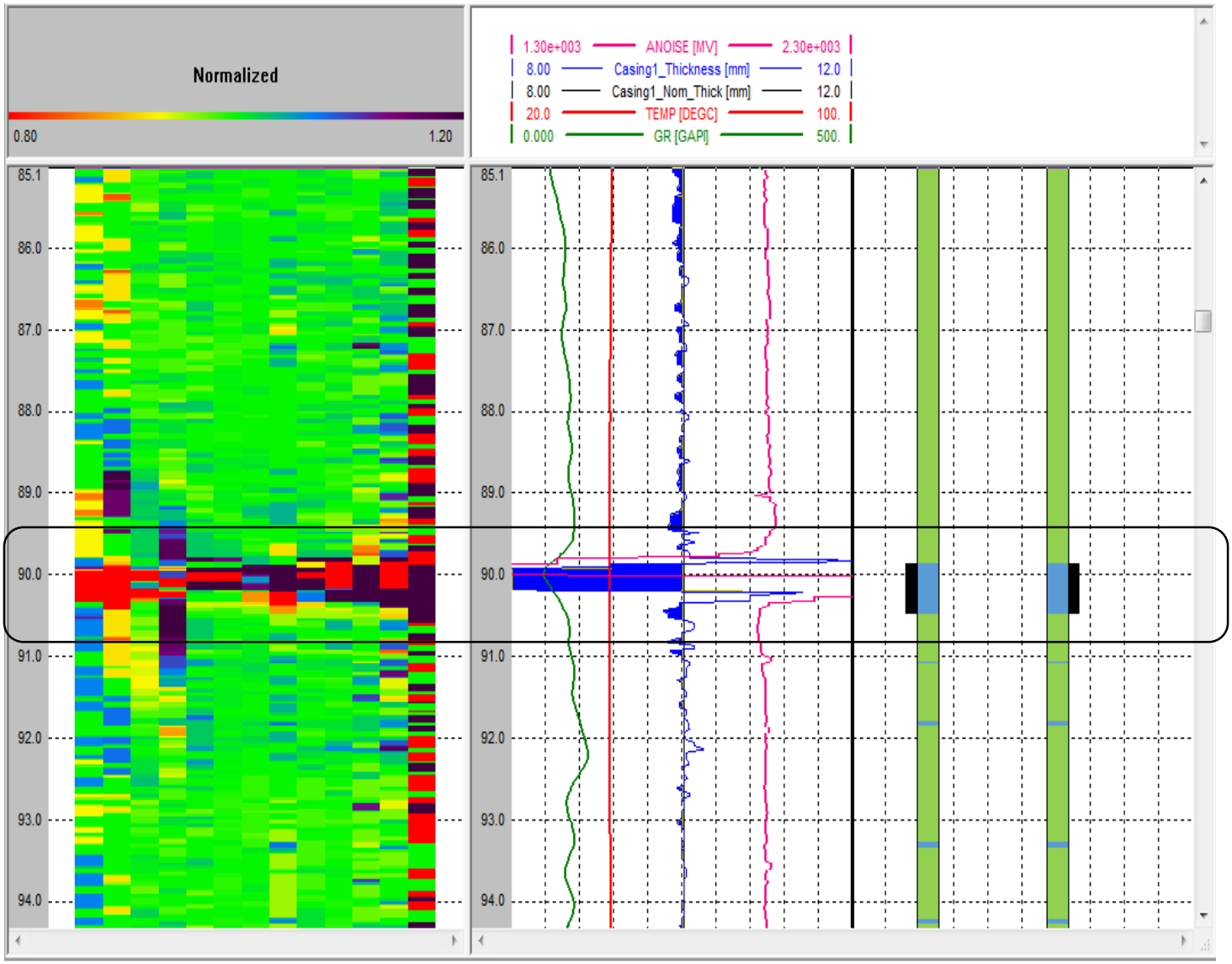
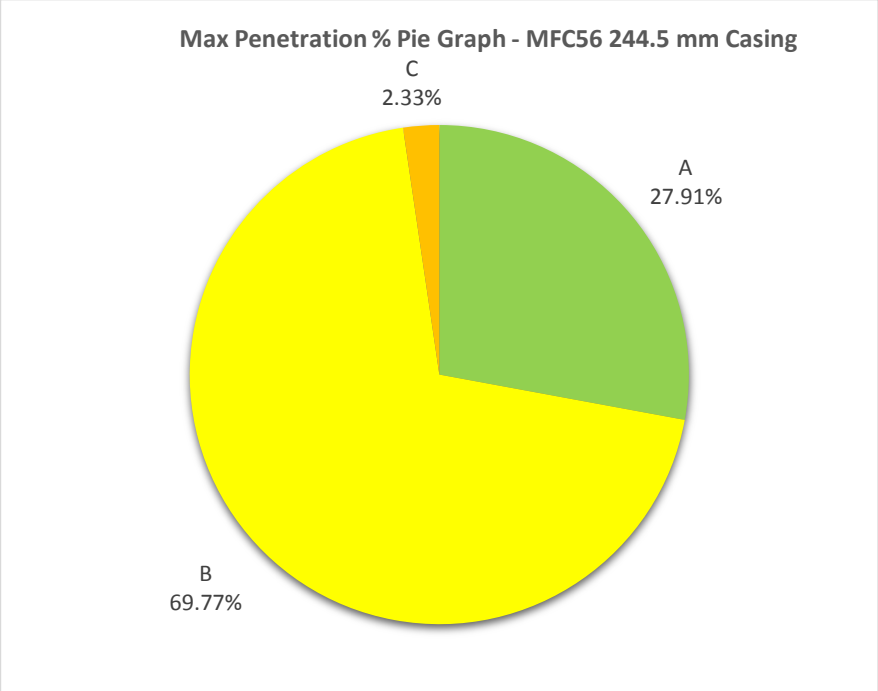


Figure.5c Breach/Possibly Parted casing observed at 90.18 m

1.6. Log Interpretation



Grade Color	Penetration %	Comment
A	<10%	Very Light
B	10>-25%	Light
C	25>-50%	Moderate
D	50>-75%	Significant
E	>75%	Intensive
R	<0%	< Nominal IR

Grade	Joints
A	12
B	30
C	1
D	0
E	0
R	0

Figure.6

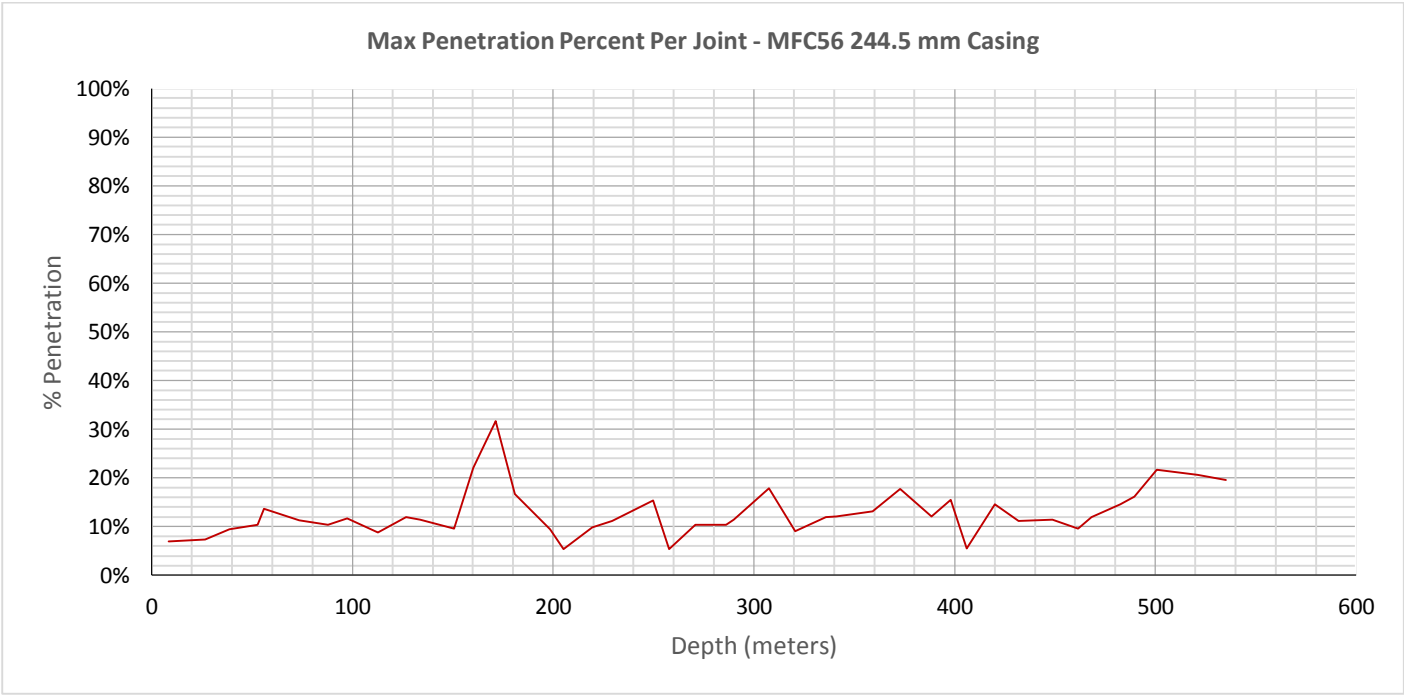
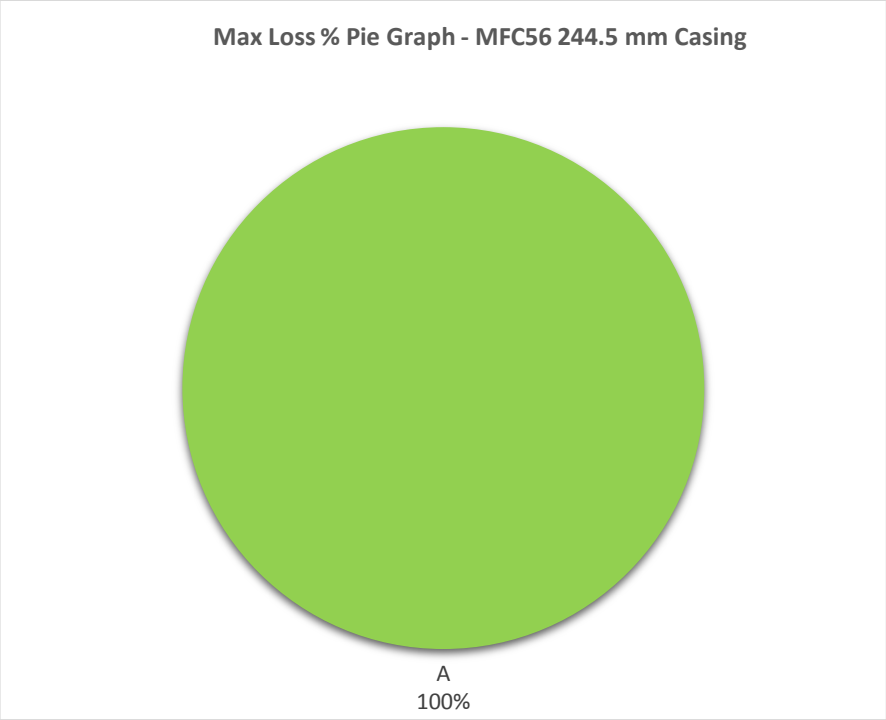


Figure.7



Grade Color	Wall Loss %	Comment
A	<12%	Very Light
B	12>-20%	Light
C	20>-30%	Moderate
D	30>-40%	Significant
E	>40%	Intensive
G	<Nominal	Undergauge

Grade	Joints
A	43
B	0
C	0
D	0
E	0
G	0

Figure. 8

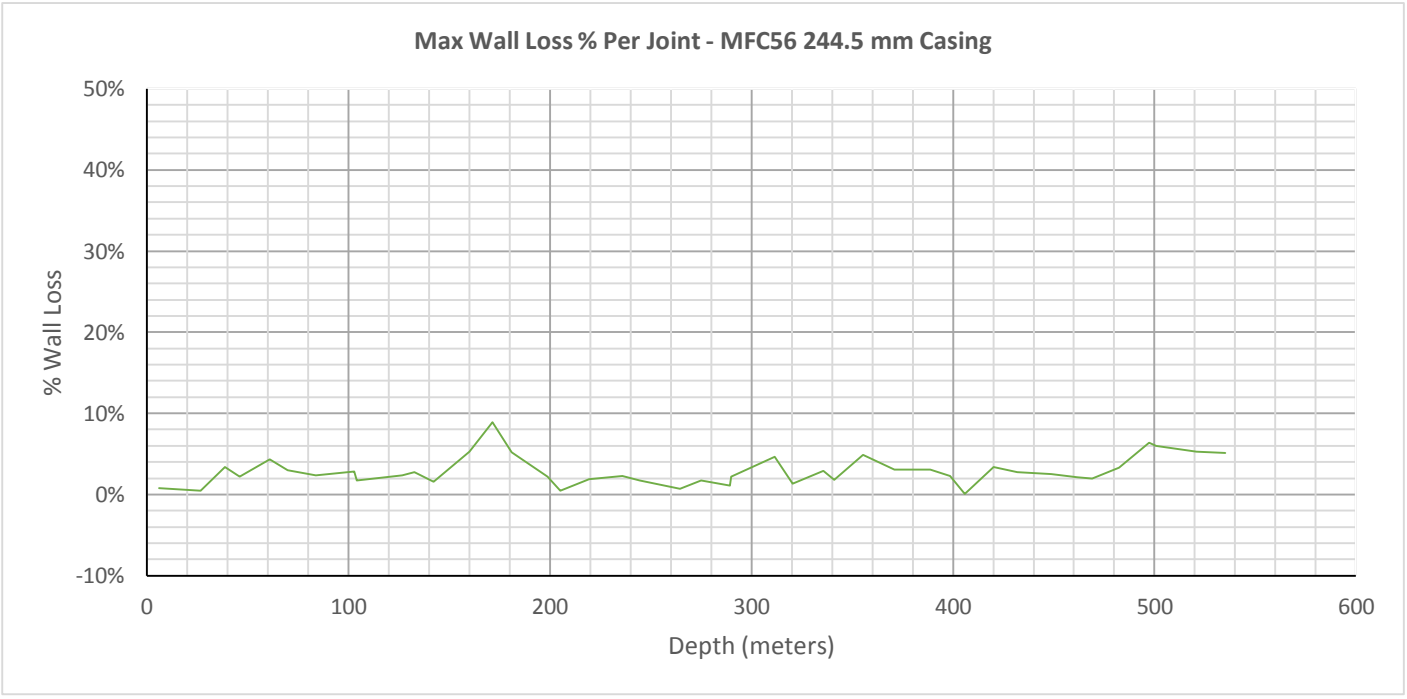


Figure.9

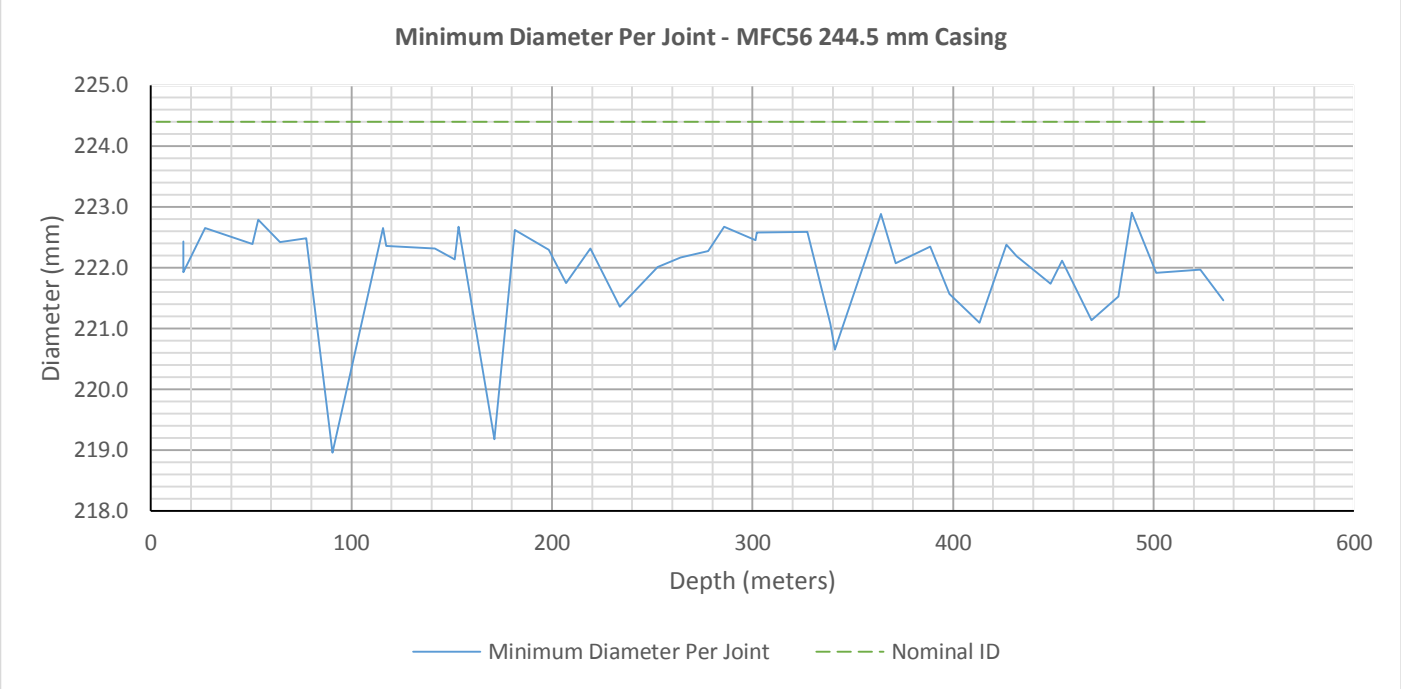


Figure.10

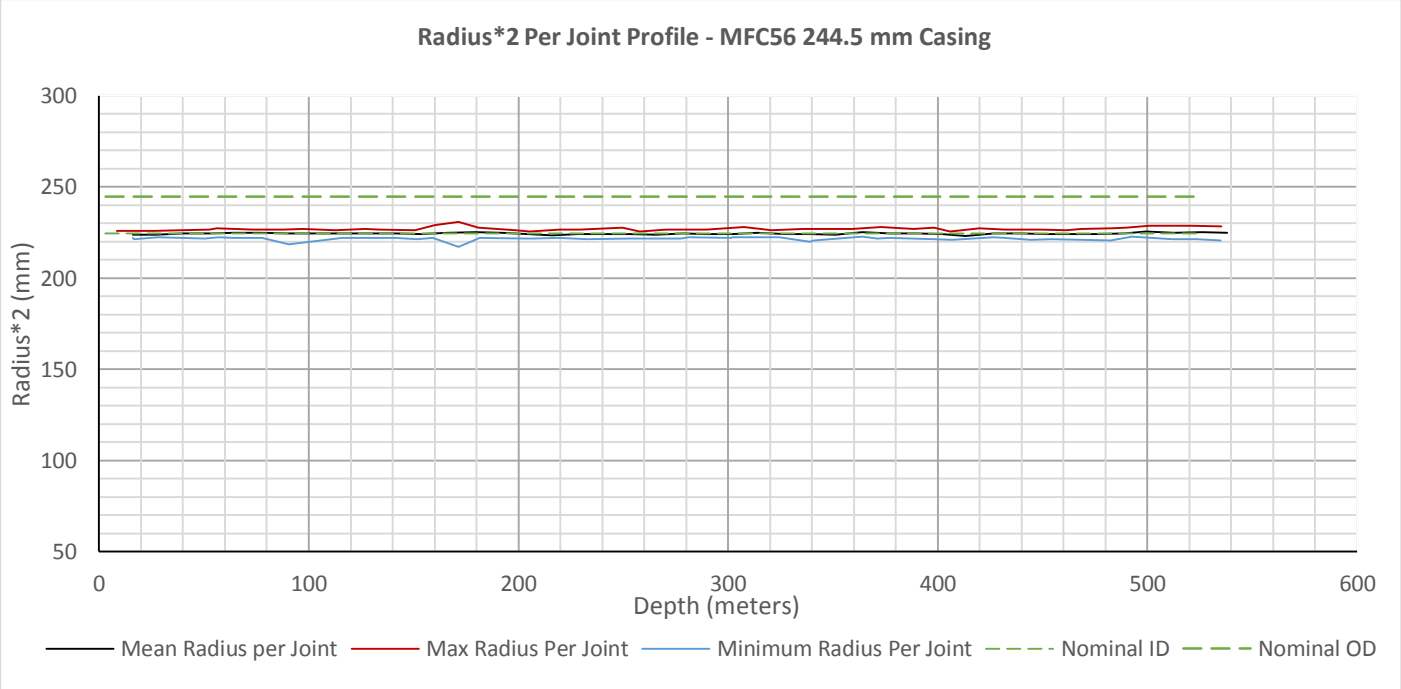
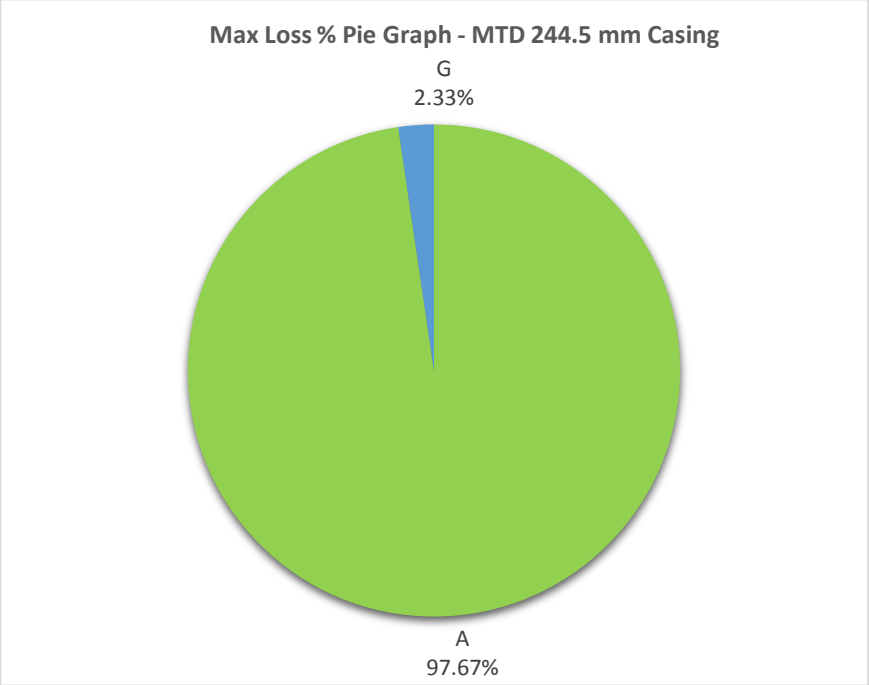


Figure.11



Grade Color	Wall Loss %	Comment
A	<12%	Very Light
B	12>-20%	Light
C	20>-30%	Moderate
D	30>-40%	Significant
E	>40%	Intensive
G	<Nominal	Undergauge

GRADE	JOINTS
A	42
B	0
C	0
D	0
E	0
G	1

Figure.12

Figure.13

244.5 mm Casing Joint Table from MFC56

Table 1.1

Top Body(m)	Bottom Body(m)	Body Length(m)	Max Pen Depth(m)	Max Pen (mm)	Max Pen (%)	Max Loss Depth(m)	Max Loss (%)	Min Diam Depth(m)	Min Diam (mm)
2.94	16.15	13.21	8.30	225.8	7.0	5.92	0.8	16.15	222.4
16.25	27.04	10.79	26.42	225.9	7.3	26.72	0.4	16.25	221.9
27.16	40.26	13.09	38.83	226.3	9.5	38.60	3.4	27.20	222.6
40.39	53.36	12.97	52.63	226.5	10.4	45.87	2.2	50.67	222.4
53.49	64.13	10.64	56.01	227.2	13.7	61.07	4.3	53.49	222.8
64.26	77.19	12.93	73.46	226.7	11.3	69.75	3.0	64.27	222.4
77.34	90.05	12.71	87.68	226.5	10.4	83.86	2.3	77.57	222.5
90.16	103.45	13.29	97.33	226.8	11.7	102.71	2.8	90.53	219.0
103.57	115.90	12.33	112.74	226.2	8.9	104.26	1.8	115.90	222.6
116.02	128.34	12.32	126.82	226.8	11.9	126.65	2.3	117.36	222.4
128.44	141.53	13.09	133.74	226.7	11.5	132.85	2.8	141.51	222.3
141.64	153.36	11.72	150.57	226.3	9.6	142.38	1.6	151.68	222.1
153.46	166.14	12.68	160.03	228.8	22.0	160.04	5.3	153.46	222.7
166.25	179.57	13.32	171.40	230.8	31.7	171.41	8.9	171.38	219.2
179.68	191.92	12.24	181.05	227.8	16.7	181.10	5.2	181.60	222.6
192.04	204.27	12.23	198.53	226.3	9.5	198.63	2.2	198.40	222.3
204.39	215.97	11.59	205.21	225.5	5.4	205.26	0.5	206.96	221.7
216.09	228.38	12.30	219.57	226.4	9.9	219.38	1.9	219.32	222.3
228.49	240.03	11.54	229.38	226.6	11.2	235.95	2.3	234.01	221.4
240.17	252.75	12.58	249.72	227.5	15.3	244.62	1.7	252.73	222.0
252.88	265.70	12.82	257.73	225.5	5.4	264.39	0.7	264.11	222.2
265.81	278.45	12.64	270.79	226.5	10.4	274.96	1.7	277.77	222.3
278.58	289.58	11.00	286.06	226.5	10.4	289.34	1.1	285.99	222.7
289.71	301.97	12.27	289.97	226.7	11.5	289.85	2.2	301.39	222.5
302.08	314.07	11.98	307.43	228.0	17.9	311.40	4.6	302.08	222.6
314.19	327.28	13.09	320.55	226.2	9.1	320.39	1.3	327.28	222.6
327.40	338.96	11.56	335.80	226.8	11.9	335.70	2.9	338.90	221.1
339.07	351.30	12.23	340.97	226.8	12.1	340.98	1.8	341.02	220.7
351.41	364.04	12.64	359.22	227.0	13.1	355.22	4.9	364.05	222.9
364.16	377.09	12.93	372.77	228.0	17.7	370.85	3.1	371.27	222.1
377.22	389.86	12.65	388.56	226.8	12.1	388.63	3.0	388.77	222.3
389.97	401.94	11.97	398.15	227.5	15.4	398.43	2.3	398.23	221.6

Top Body(m)	Bottom Body(m)	Body Length(m)	Max Pen Depth(m)	Max Pen (mm)	Max Pen (%)	Max Loss Depth(m)	Max Loss (%)	Min Diam Depth(m)	Min Diam (mm)
402.06	413.28	11.21	405.96	225.5	5.5	405.96	0.1	413.27	221.10
413.39	426.78	13.38	420.05	227.3	14.5	420.00	3.4	426.77	222.38
426.89	439.72	12.83	431.74	226.7	11.2	431.80	2.8	431.88	222.19
439.83	451.47	11.64	448.88	226.7	11.4	448.60	2.5	448.82	221.74
451.59	463.83	12.24	461.43	226.3	9.6	461.89	2.1	454.52	222.11
463.97	475.93	11.96	468.30	226.8	12.0	469.07	2.0	469.02	221.14
476.05	489.03	12.98	482.60	227.3	14.6	482.43	3.3	482.48	221.53
489.16	499.35	10.20	489.70	227.7	16.2	497.32	6.4	489.15	222.91
499.44	512.70	13.26	500.79	228.8	21.7	500.79	6.0	501.47	221.91
512.84	526.05	13.21	521.01	228.6	20.7	520.80	5.3	523.43	221.97
526.18	538.00	11.82	535.16	228.3	19.5	535.05	5.1	534.94	221.47

244.5 mm Casing Joint Table from MTD

Table 1.2

Top Body(m)	Bottom Body(m)	Body Length(m)	Nom Thk (mm)	Min Thk (mm)	Max Loss Depth(m)	Max Loss (%)
3.15	15.83	12.68	10.030	10.311	7.35	-2.8
16.22	26.80	10.58	10.030	9.653	26.58	3.8
27.20	40.01	12.82	10.030	9.587	39.89	4.4
40.43	53.07	12.64	10.030	9.719	52.62	3.1
53.56	63.89	10.33	10.030	9.521	63.79	5.1
64.41	76.94	12.54	10.030	9.587	76.94	4.4
77.41	89.87	12.46	10.030	9.390	89.78	6.4
90.49	103.21	12.72	10.030	9.521	102.88	5.1
103.68	115.65	11.98	10.030	9.653	115.61	3.8
116.15	128.07	11.93	10.030	9.653	128.00	3.8
128.62	141.23	12.62	10.030	9.521	130.98	5.1
141.78	153.12	11.34	10.030	9.653	152.69	3.8
153.51	165.87	12.36	10.030	9.456	164.22	5.7
166.31	179.31	13.00	10.030	9.456	179.08	5.7
179.77	191.55	11.78	10.030	9.521	190.23	5.1
192.19	203.94	11.75	10.030	9.521	201.51	5.1
204.49	215.63	11.14	10.030	9.719	215.23	3.1
216.25	228.10	11.85	10.030	9.587	227.32	4.4
228.59	239.81	11.22	10.030	9.719	238.85	3.1
240.28	252.46	12.18	10.030	9.653	251.98	3.8
253.03	265.44	12.41	10.030	9.653	265.19	3.8
265.93	278.13	12.21	10.030	9.456	276.72	5.7
278.63	289.29	10.66	10.030	9.653	286.83	3.8
289.78	301.68	11.90	10.030	9.587	301.68	4.4
302.18	313.80	11.62	10.030	9.521	313.70	5.1
314.19	327.03	12.84	10.030	9.521	320.87	5.1
327.44	338.64	11.20	10.030	9.653	337.15	3.8
339.13	350.93	11.80	10.030	9.653	350.89	3.8
351.52	363.76	12.24	10.030	9.324	363.72	7.0
364.20	376.79	12.59	10.030	9.456	372.86	5.7
377.28	389.59	12.31	10.030	9.521	389.55	5.1

Top Body(m)	Bottom Body(m)	Body Length(m)	Nom Thk (mm)	Min Thk (mm)	Max Loss Depth(m)	Max Loss (%)
390.06	401.70	11.65	10.030	9.653	401.64	3.8
402.10	413.01	10.92	10.030	9.850	412.89	1.8
413.48	426.47	13.00	10.030	9.521	426.35	5.1
426.94	439.45	12.51	10.030	9.521	439.41	5.1
439.87	451.05	11.19	10.030	9.653	449.03	3.8
451.68	463.53	11.85	10.030	9.587	463.53	4.4
464.07	475.60	11.52	10.030	9.653	475.55	3.8
476.19	488.75	12.56	10.030	9.521	483.12	5.1
489.19	499.01	9.82	10.030	9.324	496.66	7.0
499.58	512.38	12.80	10.030	9.390	502.88	6.4
512.84	525.81	12.97	10.030	9.390	525.49	6.4
526.28	538.03	11.75	10.030	9.192	537.50	8.4

2. Appendix B: Tool Specification

2.1. MFC Tool Specifications & Logging Modes

Type	MFC24C	MFC40C	MFC56C
O.D.	43 mm (1 11/16")	73mm（2 7/8"）	90mm（3 1/2")
Working Temperature	-20- 175℃(-40-350℉)		
Working Pressure	≤100MPa (15,000 PSI)		
Working Voltage	90V±2		
Working Current	37mA±3		
Measurement Range	45-180mm (1 3/4"-7 1/12")	80-210mm (3 1/8"-8 1/4"）	100-245mm (3 15/16"- 9 13/20") 100-350mm (3 15/16"-13 4/5" with extension fingers)
Measurement Accuracy	±0.5mm (±0.02")		
Resolution	0.1mm(0.004")		
Deviation Range	0-180º		
Deviation Accuracy	±5º		
Deviation Sensitivity	0.1º		
Relative Azimuth Range	0-360º		
Relative Azimuth Accuracy	±5º		
Relative Azimuth Sensitivity	0.1º		
Transmission Mode	Mono-conductor		
Speed	≦600 m/h (1968ft/h)		
	(Vertical Resolution =8mm or 5/16")		

2.2. MTD Tool Specifications & Logging Modes

General	
Working Temperature	0℃~175℃(32℉~347℉)/2hr
Working Pressure	≤100MPa(14,503psi)
Working Voltage	90VDC±10%
Working Current	60mA~130mA
OD	φ43mm(1.69")
Shipping Length	2253.5mm (88.72")
Make-up Length	2088.5mm(82.22")
Weight	9kg
Max. Logging Speed	300 m/h (16 ft/min)
Pipe String Measuring Range	60mm~324mm (2.362"~12.756")
Single Pipe Measurement	
Pipe Wall Thickness	≤12mm(0.4724")
Measurement Error	±0.5mm(0.0197")
Resolution	0.15mm(0.0059")
Double Pipe Measurement	
Pipe Wall Thickness	≤25mm (0.984")
Measurement Error	±1.5mm(0.059")
Resolution	0.3mm(0.0118")
Temperature Measurement	
Measurement Range	0~175℃
Sensitivity	0.01℃
Accuracy	±1℃

2.3. Tool String Diagram

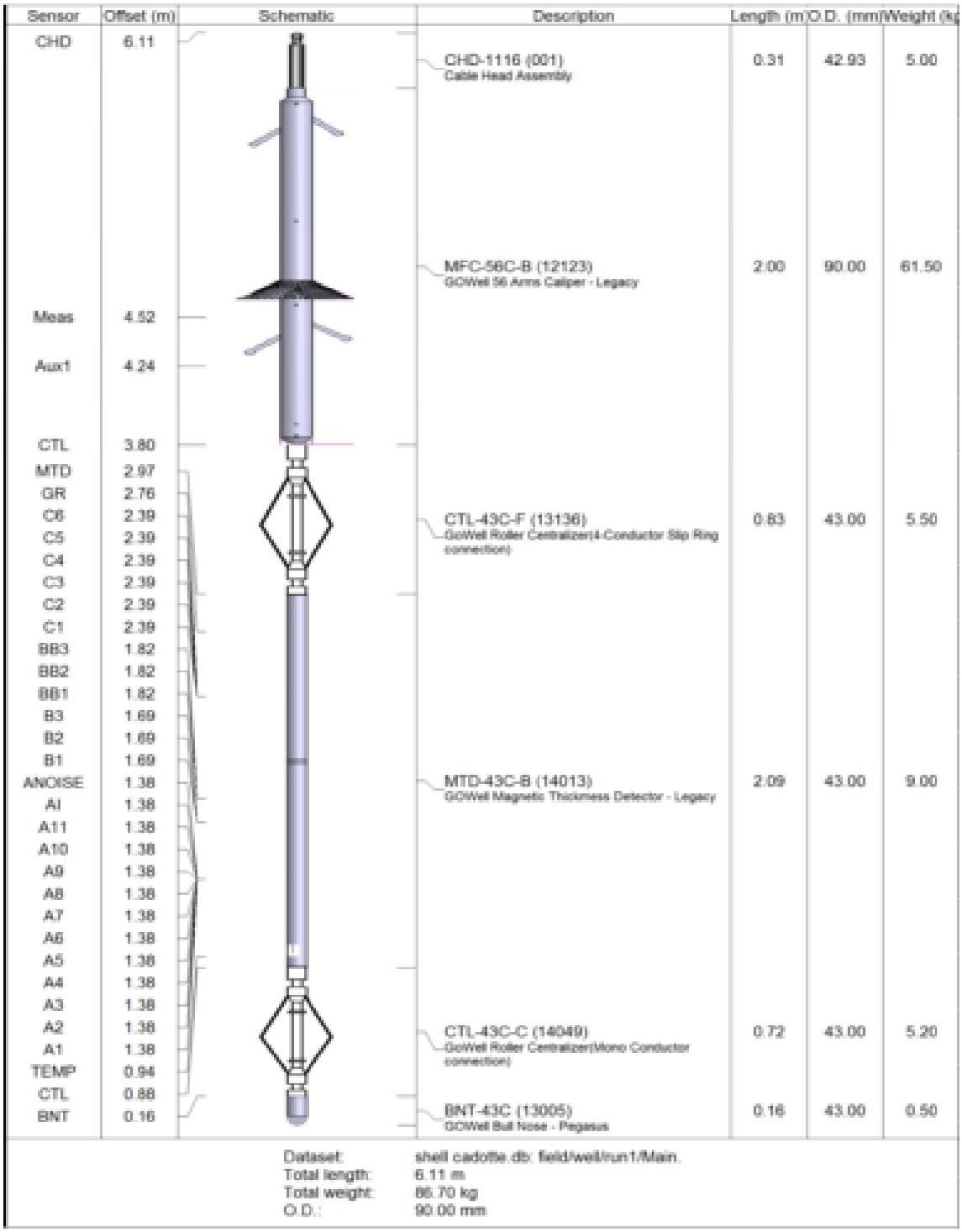
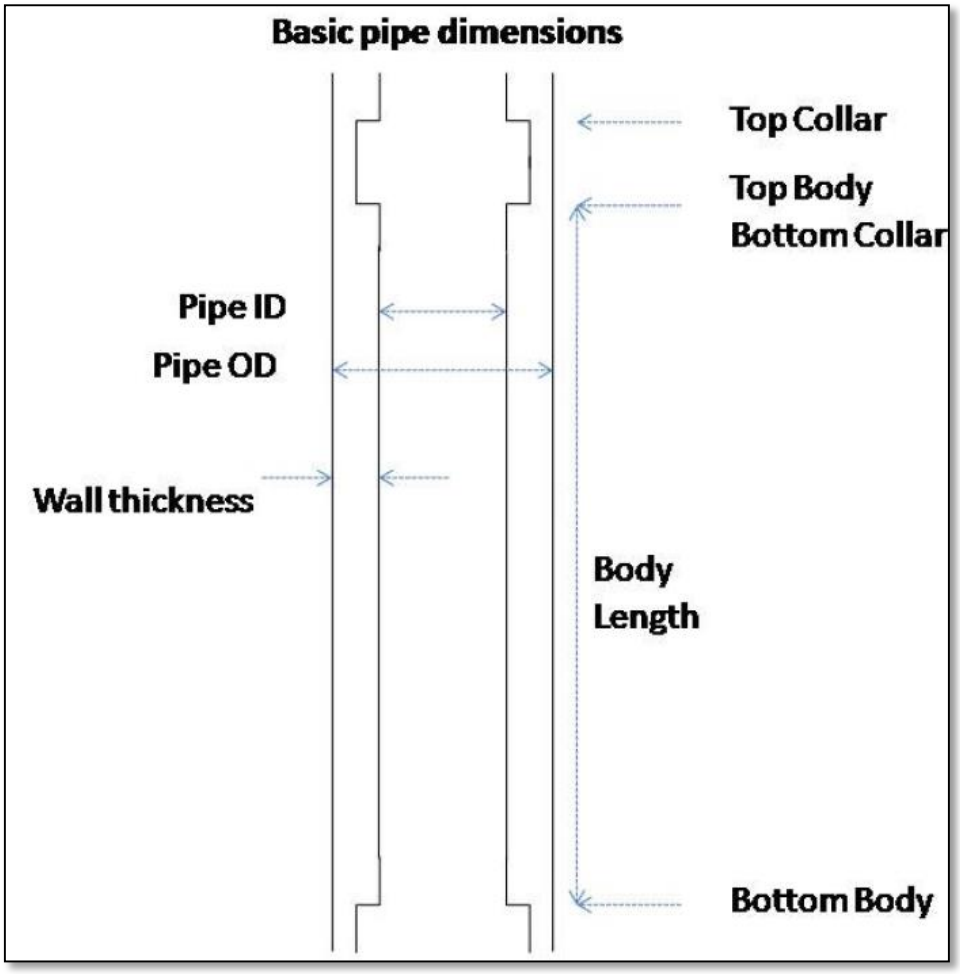


Figure.14

3. Appendix C: Definition of Terms in Pipe Analysis Report

Here listed all the definitions in the MFC56 interpretation result. Not all the terms are included in this report since the limitation of the page.

3.1. Pipe Dimensions



Top Body (ft/m)

Processed measured depth in m/ft of top of the pipe section.

Body Length (ft/m)

Length in m/ft of the pipe section.

Mean mean diameter [Mean Mean (ins/mm)]

The mean average value of the mean diameter in ins/mm over the pipe length.

Mean median diameter [Mean median (ins/mm)]

The mean average value of the median diameter in ins/mm over the pipe length.

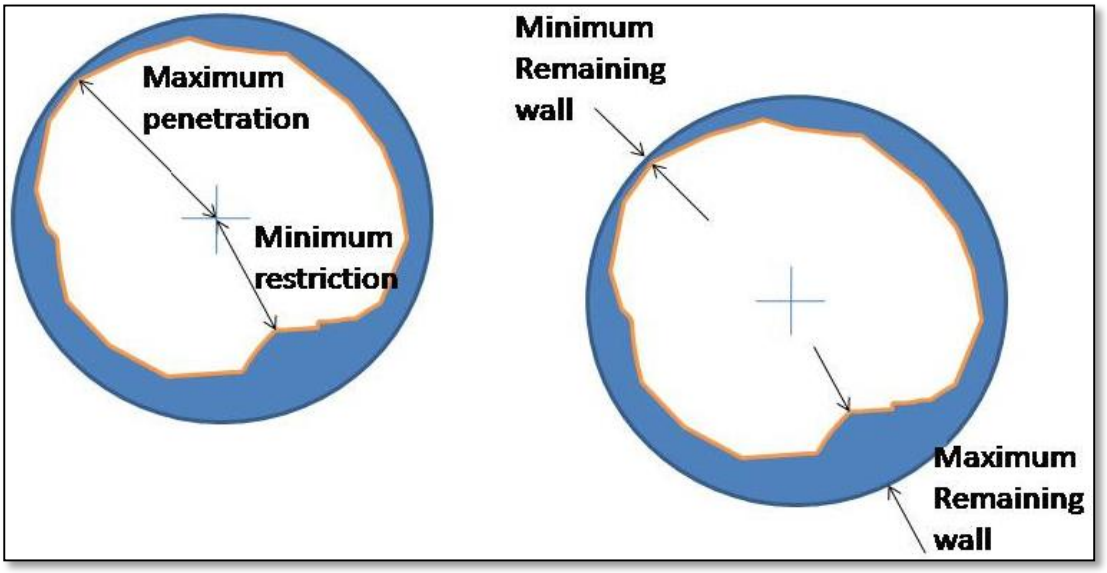
Mean remaining wall [Mean wall (ins/mm)]

The average remaining wall thickness in ins/mm of this pipe length.

Mean remaining wall [Mean wall (%)]

The average remaining wall thickness in % of nominal thickness of this pipe length.

3.2. Maximum Penetration



Maximum penetration [Max.Pen] (ins/mm)

Twice radius in inches or mm at maximum penetration of the pipe wall in the pipe section.(Expressed as a diameter - twice radius - for comparison with Nominal and Drift IDs).

Maximum penetration % [Max.Pen (%)]

Maximum penetration of the wall in the pipe section, expressed as a percentage relative to the difference between Nominal thickness at the maximum penetration point.

Maximum penetration depth [Max.Pen depth]

Depth in m/ft of the maximum wall penetration in the pipe section.

Maximum penetration arm [Max.Pen arm (no.)]

Arm number with maximum wall penetration in the pipe section.

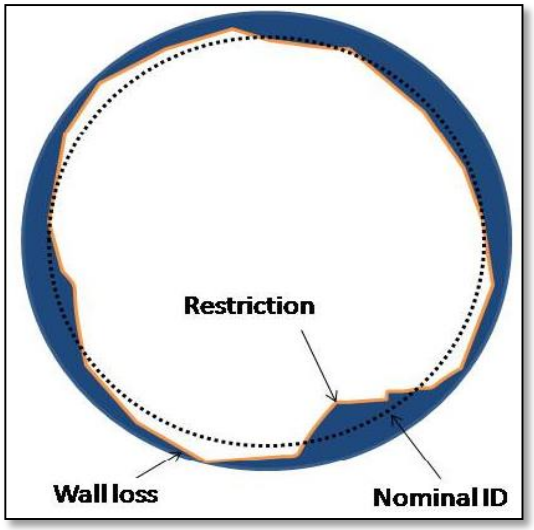
Minimum remaining wall [Min Wall (ins/mm)]

Minimum wall thickness in the pipe section in inches or mm. Negative value implies wall is fully penetrated.

Minimum remaining wall % [Min Wall (%)]

Minimum wall thickness in the pipe section as % of wall thickness at maximum penetration point. Negative value implies wall is fully penetrated.

3.3. Wall Loss



Maximum loss [Max.Loss (ins2 or mm**2)]**

The maximum value of metal loss in this pipe section, expressed as the areal loss of wall relative to the outer diameter and nominal diameters. For each sampled depth in the pipe the metal loss is calculated as:

Absolute wall loss = $(\pi/4n)\Sigma(Si^2 - ID^2)$, where n is the number of caliper arms, Si is twice the radius measured by caliper arm i, ID is the Nominal ID of the pipe.

The joint analysis module reports the maximum of the wall loss in the pipe section independent of the maximum penetration.

Maximum loss % [Max.Loss (%)]

The maximum value of metal loss in the pipe, expressed as the percentage areal loss of wall relative to the outer diameter and nominal diameters. For each sampled depth in the pipe the loss is calculated as:

Percentage wall loss = $(100/n)\ \Sigma(Si^2-ID^2)/(OD^2-ID^2)$, where n is the number of caliper arms, Si is twice the radius measured by caliper arm i, ID is the Nominal ID of the pipe.

Maximum Loss depth [Max.Loss Depth]

Depth in m/ft of maximum metal loss in the pipe.

Mean Wall Loss [Mean Loss (%)]

The mean average value of the areal wall loss wrt inner and outer nominal diameters over the pipe length (%).

Restriction volume (ins3 or m*3)**

The integrated restriction in cubic inches or mm or cubic metres of the borehole over this pipe length.

Restriction volume (%)

The integrated restriction of the borehole as a %age of the bore volume over this pipe length Restrictions.

Minimum radial restriction [Min Res (ins/mm)]

Smallest arm reading in inches or mm in the pipe section, (expressed as twice radius for comparison with Nominal and Drift IDs).

Minimum radial restriction % [Min Res (%)]

Smallest arm reading in the pipe section, expressed as a percentage relative to the Nominal ID and Outer diameters. If a negative percentage is reported, the minimum radius is smaller than the Nominal Inside Radius of the pipe.

Minimum radial restriction depth [Min Res. Depth]

Depth in m/ft of smallest arm reading in the pipe section.

Minimum radial restriction arm [Min. Res. arm]

Arm number showing minimum radial restriction in the pipe section.

Minimum radial restriction orientation [Min. Res. dirn]

Orientation in degrees of arm with minimum radial restriction in the pipe section. *Tool upside curve required in input .mip1 data file.

Maximum wall thickness [Max Wall (Ins/mm)]

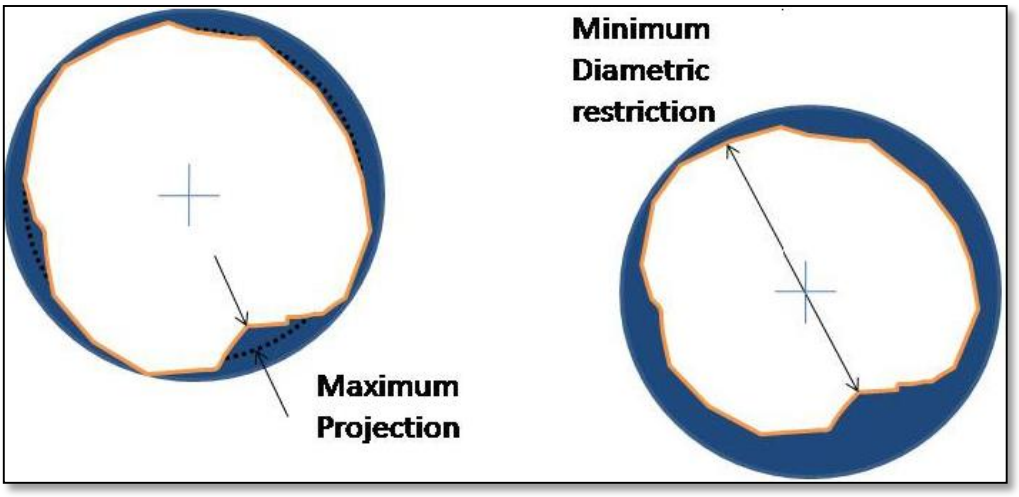
Maximum wall thickness in the pipe section in inches or mm.

Maximum remaining wall % [Max Wall (%)]

Maximum wall thickness in the pipe section as %age of wall thickness at minimum restriction point.

Maximum projection [Max Proj (ins/mm)].

Largest projection into the well bore from the pipe wall in ins/mm based on Nominal IR.



Maximum projection % [Max Proj (%)].

Largest projection into the well bore from the pipe wall as a %age of Nominal IR.

Minimum diametric restriction [Min Diam. (ins/mm)]

Smallest diameter in inches or mm of the pipe section measured on opposing arms.

Minimum diametric restriction % [Min Diam. (%)]

Smallest diameter in the pipe section measured on opposing arms as a %age of Nominal ID.

Minimum diametric restriction depth [Min Diam. Depth]

Depth of smallest diameter in the pipe section measured on opposing arms

Minimum diametric restriction arm [Min Diam. arm]

First arm with smallest diameter in the pipe section measured on opposing arms

Minimum diametric restriction orientation [Min Diam. dirn]

Orientation in degrees of first arm with smallest diameter in the pipe section measured on opposing arms. *Tool upside curve required in input .mip1 data file.

4. Appendix D: Data Processing/Data Display

4.1. Data Processing

MTD and MFC56 data were processed through program MIPS

1) MTD processing workflow

Loading raw data into MIPS software is the first step for MTD interpretation. Then the data might be pre-processed including depth correction and abnormal value editing that are optional steps and not must be done. Collar detection is then used for the processed data from MIPS to locate the top and bottom depths for each joint. The next step is thickness calculation and right curves should be selected. And then make annotation for well schematic and pipe defect according to thickness calculation results. The last is outputting joints analysis tables for different pipes and result LAS file.

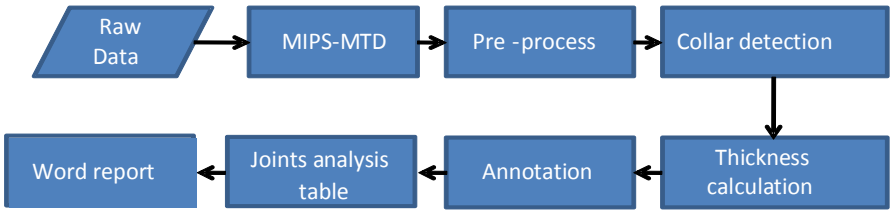


Figure 1 - MTD processing workflow

2) MFC56 processing workflow

Loading raw data into MIPS software is the first step of MFC interpretation. Then the data should be pre-processed including depth correction and abnormal value editing that are optional steps and not must be done, If necessary it also need to be centralized. Collar detection is then used for the processed data from MIPS to locate the top and bottom depths for each joint. And the average, minimum, and maximum radius are determined along with body loss for each joint. The results are stored in csv file for corrosion rating. Finally, MIPS can generate the 3D image of damaged interval.

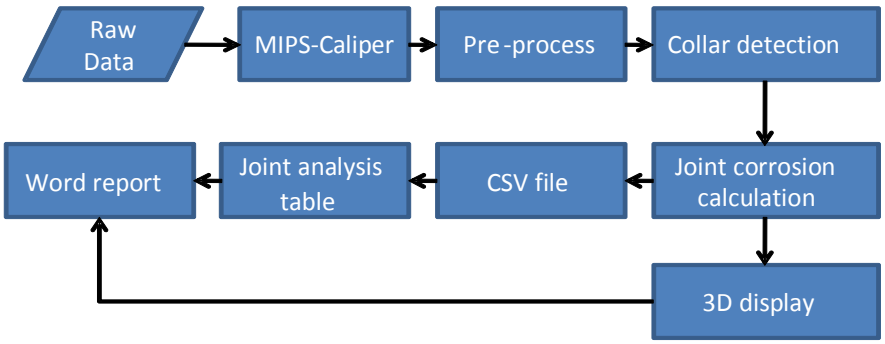


Figure 2 - MFC processing workflow

4.2. Description of Post Processed Presentation

1) MTD result plot

Multi-arm track: Normalization curves and color VDL, i.e B1_n, BB1_n, B2_n, BB2_n, C1_n, C2_n, A1_n, A2_n, C3_n, C4_n, A3_n, A4_n, C5_n, A5_n, A6_n, A7_n, A8_n, A9_n, A10_n, A11_n.

Panel 1: GR, green; TEMP, brown; Tubing_Nom_Thick, black; Tubing_Thickness, green; Casing 1_Nom_Thick, black; Casing 1_Thickness, red; Casing 2_Nom_Thick, black; Casing 2_Thickness, blue; shading between Tubing_Nom_Thick and Tubing_Thickness, green; shading between Casing 1_Nom_Thick and Casing 1_Thickness, red; shading between Casing 2_Nom_Thick and Casing 2_Thickness, blue.

Panel 2: Well schematic and defect

2) MFC result plot

Multi-arm track: Multi-finger curves and color VDL.

Panel 1: Maximum, red; Minimum, blue; Mean, green; Median, light blue; shading between Maximum and Mean, red; shading between Mean and Minimum, blue.

4.3. Media & Listing of Files

Files delivered by GoWell are:

1. Final word report;

2. Joint by joint summary table, which lists all the joints wall loss or penetration condition;