wellsafe

Government of South Australia
Department for Energy and Mining

Department for Energy and Mining

Caroline-1 Tubing and Casing

Report

August 2019

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1. Executive Summary

Caroline-1 was a CO_2 producing well that was in operation from 1967 until 2018, when it was successfully plugged and abandoned.

During this time, no major servicing was completed on the well and none of the production tubing or casing was replaced. Given this, and the logged condition of the tubing and casing, selected joints from depths of interest were put aside for potential further analysis.

In total, 50 joints of 2-3/8” Tubing and 18 joints of 5-1/2” Casing were retained from Caroline-1. These samples were transported to Adelaide, cut into small pieces and palletised, and stored on site at TAFE SA Tonsley Campus.

The following report describes the process and delves into the reasons of interest that led to retaining each joint of casing and tubing. The log data corresponding to each joint can be found in the Appendices below.

The tubing and casing is available for industry inspection, on site at TAFE SA Tonsley Campus.

2. Introduction

Caroline-1 was spudded by Alliance Oil Development Australia N.L. in September 1966 and reached a total depth of 3371m in January 1967. The well was completed in February 1967 as a CO_2 producer.

In September 2018, Caroline-1 well was decommissioned, after Air Liquide Australia (ALA) had contracted Wellsafe to manage the operation. The decommissioning activities were completed on 22 September 2018, without any major incidents occurring.

Analysis of the Multi-Finger Calliper (MFC) and Magnetic Thickness Detector (MTD) logs run prior to well decommissioning showed the condition of the casing and tubing after the well had produced CO_2 for around 50 years at the time, and no recompletion programs had been run over that time.

As such the Department for Energy and Mining (DEM), in co-operation with Wellsafe and Air Liquide, selected certain zones of interest in the tubing and casing joints to store for industry to use for further study. These joints were put aside on site at Caroline-1 and sent to Adelaide upon completion of decommissioning operations.

3. Well Information

The following section provides the well information available at the time of decommissioning.

Well Description

The Caroline-1 well was drilled by ODE Rig No.1 and completed as a Carbon Dioxide Producer. Operations at the Caroline-1 Well were conducted in accordance with the requirements of the South Australian *Petroleum Act 1940* which has now been replaced with the South Australian *Petroleum and Geothermal Energy Act 2000*.

The Caroline-1 well was spudded by Alliance Oil Development Australia N.L. in September 1966 and reached a total depth of 3371m in January 1967. The well was completed in February 1967 as a CO_2 producer. The deepest formation penetrated was the Eumeralla Formation of the Otway Group. After a series of drill stem tests, the well was completed in two upper units of the Otway Group. The Waarre Formation, and a transition unit between the Waarre and Eumeralla Formations. Production from the well since February 1968 had shown that the clear majority of the CO_2 had come from two small perforated intervals in the Waarre Formation.

The well was a single completion, producing through a 2-3/8" tubing string with a packer set in the 5-1/2" production casing at 2475m. The total depth of the well was 3371m and was plugged back to 2865m prior to running production casing. A diesel cap was placed in the annulus between production casing and tubing, and above drilling mud. This was evidenced during decommissioning operations whereby drilling mud had coated the production tubing and well logging operations had identified a hang up at approximately 500m depth. The diesel levels in the annulus were monitored over the course of well life as part of ongoing integrity monitoring activities, and the levels were reported to be unchanged during the productive life of the well.

Apart from intermittent production during 1968, the well had produced CO_2 almost continuously at an average rate of 1.25million SCFPD (65t per day). The maximum continuous rate was approximately 1.9million SCFPD (100t per day). The estimated production in 2014 was 6,950t

compared to 7,737t produced in 2013. The reduction in production output was due to depletion of the resource and the well was ultimately shut-in in January 2017, and decommissioned in September 2018.

Well Data

3.1.1 Basic Well Data

Table 1: Caroline-1 Well Data Card

General Data		
Permit Holder	Air Liquide (as at August 2019)	
Well Name	Caroline 1	
Well Type	Onshore Carbon Dioxide Well	
Permit	PPL 21	
Drilling Contractor/Rig	ODE # 1	
Well drilled	September 1966 to February 1967	
TD original	3,371mKB (11,061ft)	
Location, Depths and Reference System		
Surface Location (Lat, Long)	37 ° 56 ' 30" S, 140 ° 54 ' 30" E	
Surface Location (Grid)	677379.42mE; 5728374.14mN	
Grid Reference	UTM Zone 54S Australian Datum 1984	
Surface casing	13-3/8" H40 48ppf BTC	225.5mKB MD (740ft)
Intermediate Casing	9 -5/8" J55 36ppf	959.5mKB MD (3,148ft)
Production Casing	5-1/2" N80/J55 17ppf LTC/STC	2,860mKB MD (9,385.4ft)
Tubing (existing)	2-3/8" J55 4.7ppf	2,455mKB MD (8,055ft)
Perforations	8,204 – 8,210ft (6ft) 8,214 – 8,230ft (16ft)	8,820 – 8,830ft (10ft) 8,870 – 8,880ft (10ft)
Tubing Head adaptor / Xmas Tree	7-1/16" 3M x 3-1/8" 3M / 3-1/8" 3M m/vs x 2-1/16" 3/5M w/v	
Reservoir Details		
Pressure	Current SITHP ~ 800psi	PC and IC Annuli zero psi
Temperature	Normal Geothermal gradient	

3.1.2 Hole Design

Table 2: Caroline-1 Hole Design

Size	Top Depth (ft)	Bottom Depth (ft)
22"	16	165
18"	165	510
17-1/2"	510	761
12-1/4"	761	3150
8-3/8"	3150	11061

3.1.3 Casing and Cementing

Table 3: Caroline-1 Casing

Casing Size	Grade	Weight (lb/ft)	Coupling	Collapse PSI	Burst PSI	Drift ID (API)	Coupling OD (“)
13-3/8”	H40	48	BTC	740	1730	12.559”	14.375
9-5/8”	J55	36	TBC	2020	3520	8.675”	10.62
5-1/2”	N80	17	LTC	6290	7740	4.767”	6.050
5-1/2”	J55	17	STC / LTC	4910	5320	4.767”	6.050

Table 4: Caroline-1 Cementing

Outer Casing	Inner Casing	Annular Capacity	Cement Logs
13-3/8” 48lb/ft	9-5/8” 36lb/ft	0.06706bbl/ft	CBL dated 1 December 1966
9-5/8” 36lb/ft	5-1/2” 17lb/ft	0.04793bbl/ft	CBL dated 20 September 2018
5-1/2” 17lb/ft	2-3/8” 4.6lb/ft	0.01777bbl/ft	CBL dated 14 February 1967 CBL dated 29 March 2001

3.1.4 Stratigraphy

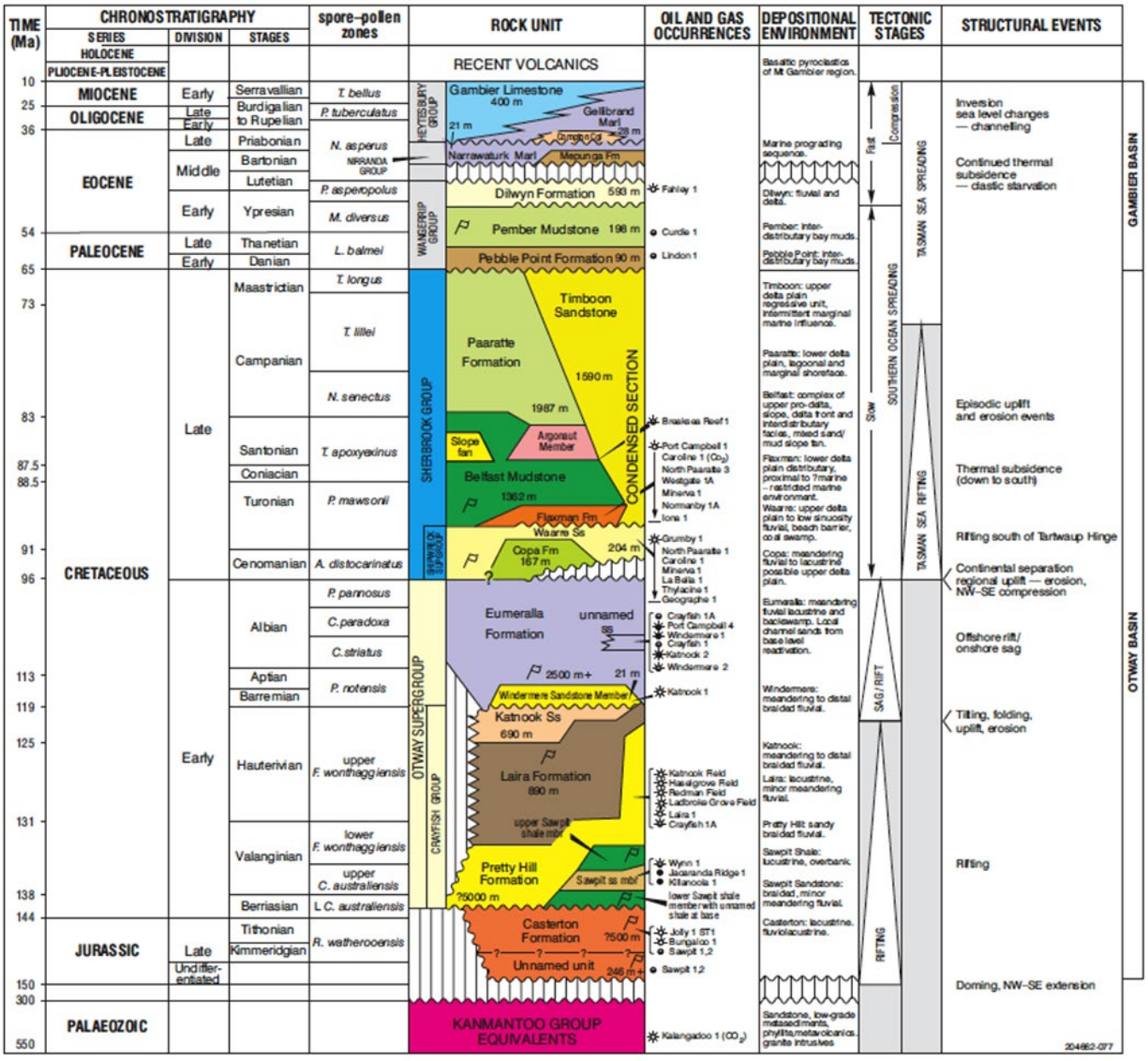


Figure 1: Caroline-1 Stratigraphy

4. Well Diagrams

4.1.1 Well Status at Time of Decommissioning

Caroline 1 was shut-in with SITHP of ~800psi.

4.1.2 Downhole Diagrams Prior to Decommissioning

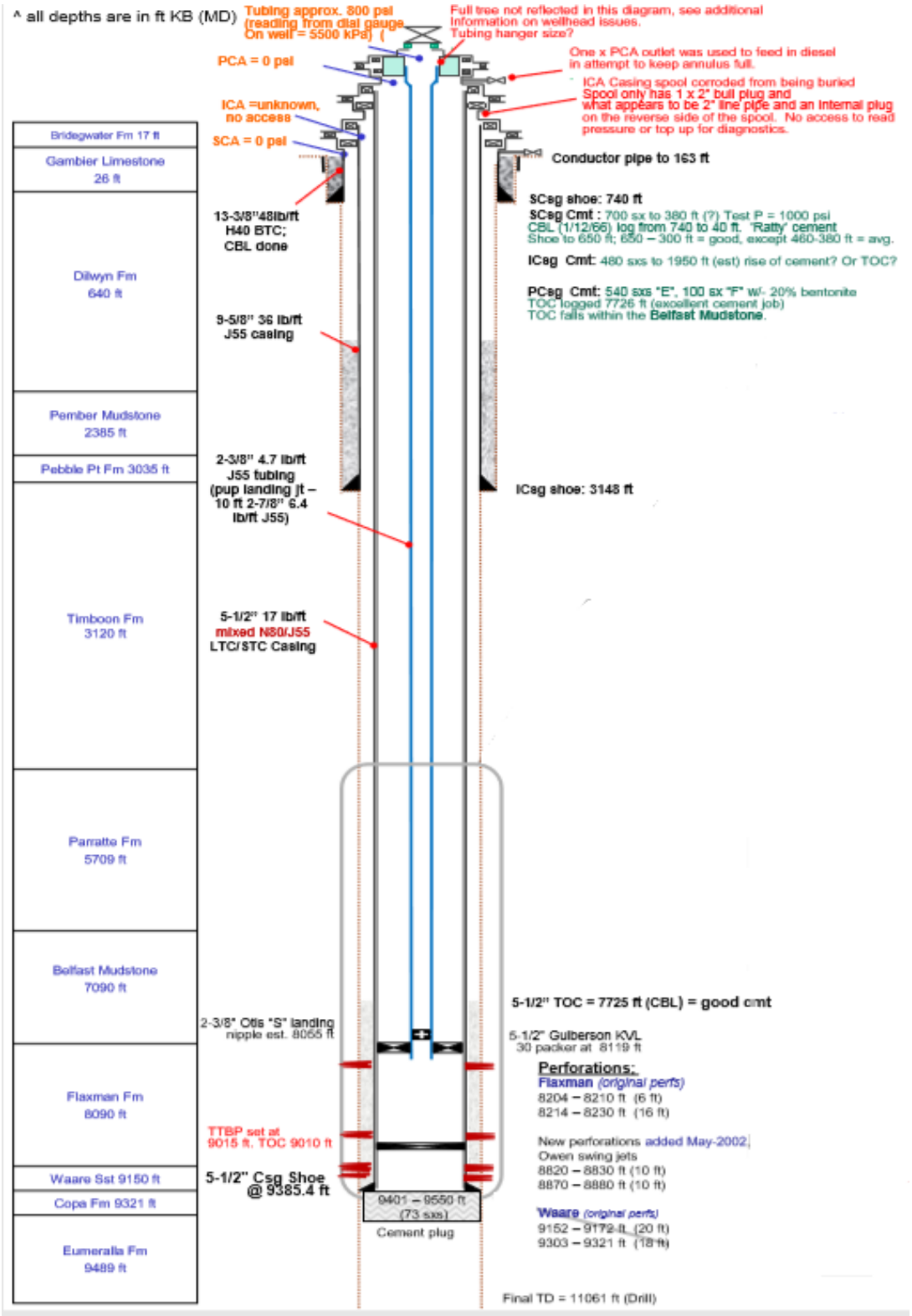


Figure 3: Caroline-1 Downhole Diagram

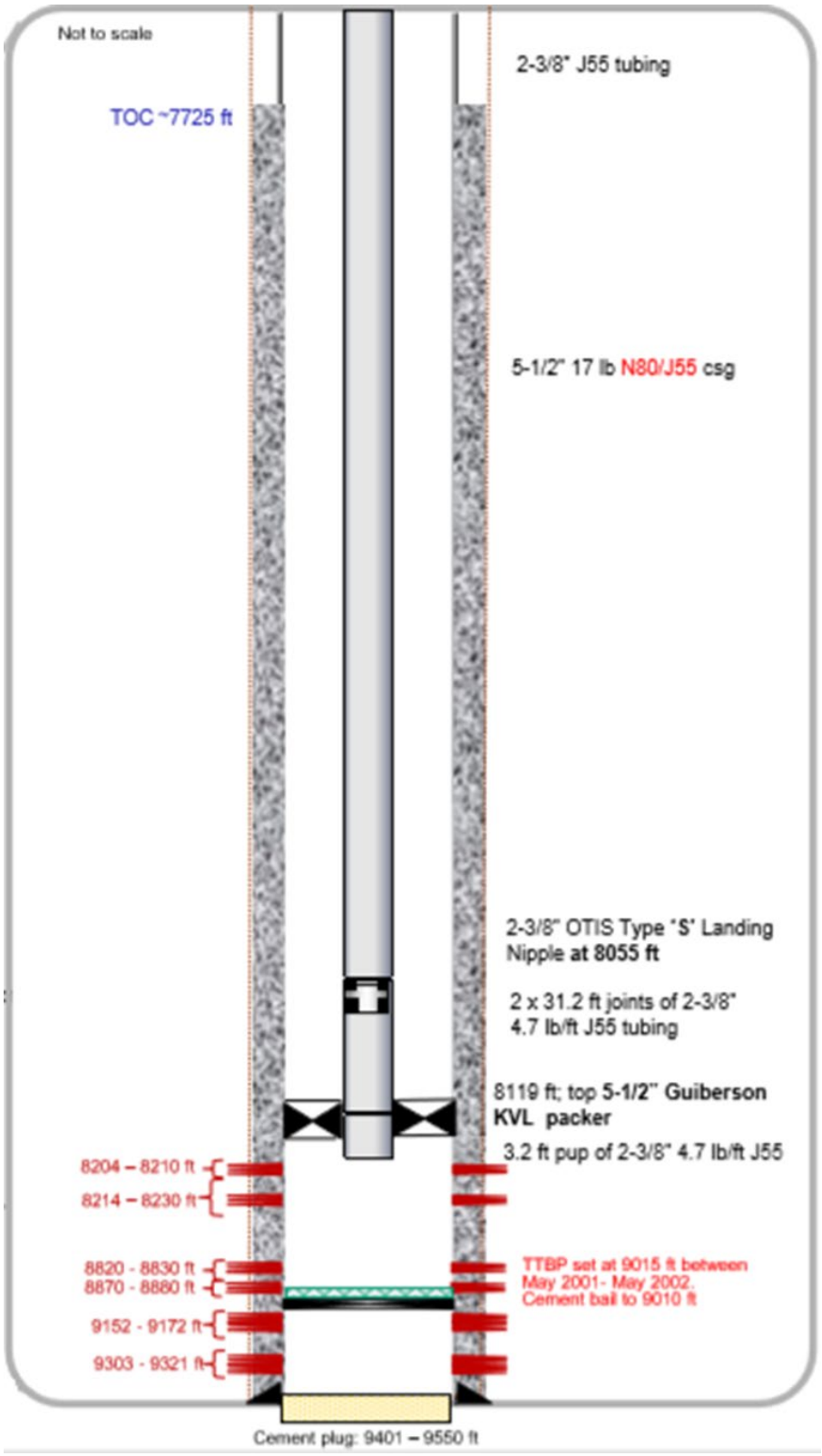
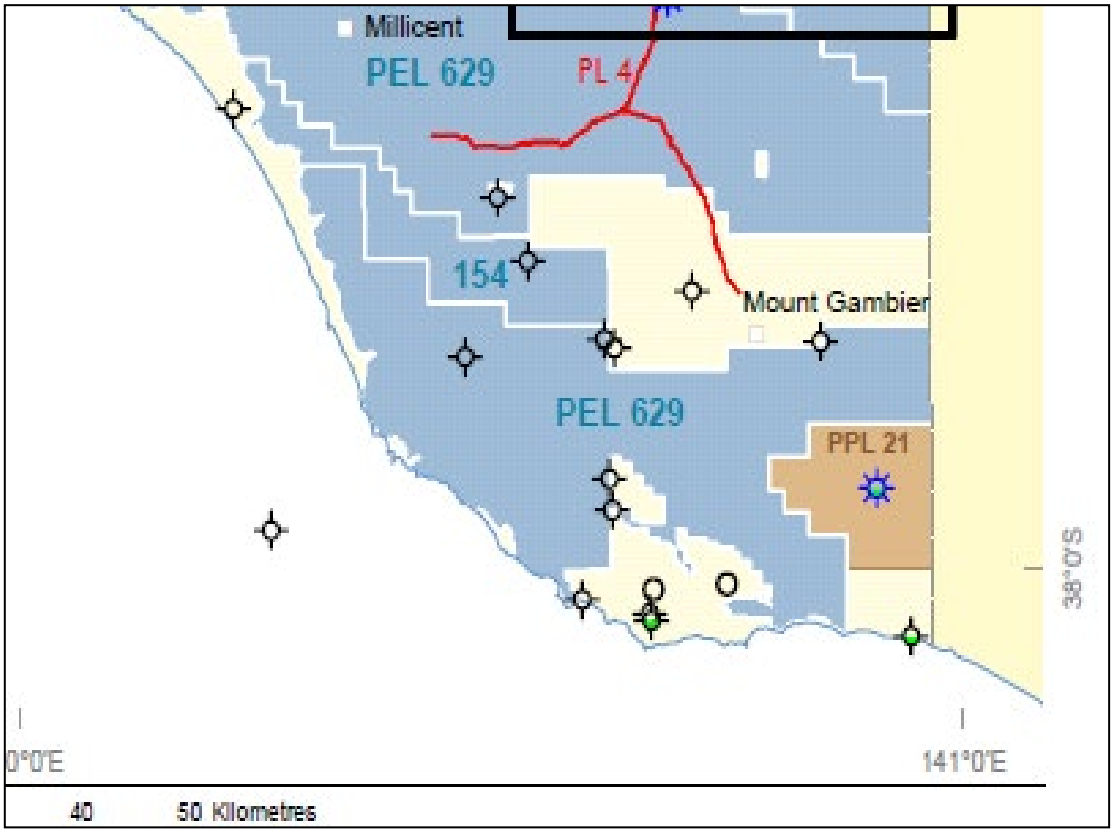


Figure 4: Caroline-1 Downhole Diagram Inset

5. Well Location

The Air Liquide Caroline-1 CO_2 well is located in PPL 21 in the Otway Basin at 640 Carba Road, Caroline, South Australia, 22km South East of Mount Gambier.

Figure 5: Caroline-1 Well Location



6. Well Logs

The following section provides the well log information available at the time of the decommissioning.

6.1.1 Reservoir Temperature Data

SGS

GAUGE REPORT SUMMARY
Caroline 1

AIR LIQUIDE

Date	May 22, 2015
Test	Static Gradient Survey to determine fluid level
Formation	Multiple formations, un-named in programme
Perf's	8204-8830
WL Operator	B. Arthur
Note	**Bottom gauge data used to generate Gradient report.**

Date dd/mm/yy	Time on Depth hh:mm:ss	Time off Depth hh:mm:ss	Pressure psia	Temp degC	Depth KB	Gradient psi/ft	Comments
22/05/2015	15:02:30	15:04:30	3053.12	92.16	8800	0	On Depth
22/05/2015	15:06:30	15:08:30	2926.57	89.66	8500	0.422	
22/05/2015	15:10:30	15:12:30	2808.41	84.63	8200	0.394	
22/05/2015	15:14:40	15:16:40	2739.21	82.37	7900	0.231	
22/05/2015	15:18:30	15:20:30	2669.67	80.10	7600	0.232	
22/05/2015	15:22:30	15:24:30	2599.64	77.78	7300	0.233	
22/05/2015	15:26:20	15:26:20	2529.87	75.47	7000	0.233	
22/05/2015	15:34:10	15:36:10	2297.52	68.53	6000	0.232	
22/05/2015	15:42:00	15:44:00	2065.07	61.41	5000	0.232	
22/05/2015	15:49:50	15:51:50	1833.89	54.07	4000	0.231	
22/05/2015	15:57:30	15:59:30	1600.69	46.42	3000	0.233	
22/05/2015	16:05:30	16:07:30	1348.53	36.35	2000	0.252	
22/05/2015	16:09:20	16:11:20	1265.78	33.71	1700	0.276	
22/05/2015	16:13:20	16:15:20	1185.59	31.02	1400	0.267	
22/05/2015	16:17:20	16:19:20	1100.60	28.57	1100	0.283	
22/05/2015	16:21:20	16:23:20	1014.62	25.93	800	0.287	
22/05/2015	16:25:20	16:27:20	923.37	22.61	500	0.304	
22/05/2015	16:29:20	16:31:20	825.92	18.95	200	0.325	
22/05/2015	16:34:00	16:39:00	757.03	15.24	0	0.344	Lubricator

Figure 2: Caroline-1 Reservoir Temperature Data

6.1.2 Corrosion logs – MTD/ MFC

MFC identified some high penetration rates intervals in the 2-3/8" tubing with the highest penetration rates up to 41.1%. These high penetrated intervals corresponding to pitting damage depths.

MTD tool did not detect severe damage at the corresponding pitting damage depths, most likely due to circumferentially average nature of electromagnetic response signal and thus reduced directivity of wall loss estimation.

No severe localized damages can be revealed in 2-3/8" tubing, according to MFC.

2-3/8" tubing corrosion evaluation from MTD shows wall loss mostly less than 12% and some joints with wall loss up to 17.1%. No severe localized damages in 2-3/8" tubing according to MTD.

With respect to corrosive damage, indication of damage is recorded in most of the 2-3/8" tubing joints in the forms of isolated pits, scattered pits, areas of corrosion and roughness of the casing I.D.

The tubing was also analysed for any possible mechanical damage, such as deformations. No tubing deformations were evident in the recordings.

5-1⁄2" casing corrosion evaluation from MTD shows wall loss mostly less than 12% and some joints with wall loss up to 14.8%. No severe localized damages in 5-1⁄2" casing according to MTD.

The temperature log mostly tends to follow normal geothermal gradient and did not show any significant changes within the logged interval.

7. Selection, Cutting and Storage Process

The MTD and MFC logs run on Caroline-1 in 2015 were analysed and particular areas of interest were identified. These areas of interest were used with estimated depths of tubing and casing to determine which joints would correlate to these areas. This correlation process can be seen in Appendix A (tubing) and Appendix B (casing), and shows estimations of what condition each section of each joint is in.

All joints of tubing and casing that were pulled from the well during the decommissioning operations were marked sequentially. After the process was complete the rig crew identified the joints that were required by DEM. These joint numbers and the reasoning each joint was selected can be found in Section 6.1 and Section 6.2 below, along with other critical information about them.

The joints were transported from Caroline-1 to Tonsley TAFE, Adelaide, where they are currently stored. In order to safely and easily store the tubing and casing, each joint was cut into smaller sections and palletised. The pallet each joint is stacked on can be found in Section 6.1 and Section 6.2 below.

Each length of 2-3/8" tubing was cut into two sections, in order to: fit them on the pallets, not be too long for transporting, and reduce the weight to a more manageable amount. This was done onsite at Tonsley TAFE, using a 9" drop saw. This ensured the tubing integrity was not impacted and areas of interest were maintained in largely undisturbed condition.

As the 5-1/2" casing was much larger and heavier, each joint was cut into 4 sections. This once again ensured the sections would: fit on the pallets, not be too long for transporting and reduce the weight to a more reasonable amount.

Given the greater thickness and material strength, a contractor was called into Tonsley TAFE to cut the casing. This process involved using an oxy-fuel cutter to get through the casing with a flame.

Markings were made prior to the contractor's arrival, positioning the cuts at equal lengths where possible. However, in order to ensure any area of particular interest was conserved, a 1m buffer zone was left around that point. This created some small differences in section length.

The contractor then drilled a small hole along the cut line to use as a pilot hole, took the oxy flame to the hole and cut around the perimeter of the casing. This process created clean cuts, which removed less casing than the width of the drill bit. The heat from the flame impacted on the casing either side of the cut, however this impact is considered negligible. As can be seen in Figures 6 and 7 below, the heat from the flame affected at most 2cm either side of the cut and thus left the casing in good condition for further analysis.

All pallets are now stored and can be viewed on request at Tonsley TAFE, Adelaide.

Figure 6: Caroline-1 5-1/2" Casing Cut with Oxy Cutter

Figure 7: Caroline-1 5-1/2" Casing Cut with Oxy Cutter

7.1.1 Palletised 2-3/8" Tubing

Table 5: 2-3/8" Tubing Data

Joint #	Section	Section Length (m)	Est. Length (m)	Measured Joint Length (m)	Difference (m)	Est. Depth (m)	Est. Depth (ft)	Feature / Importance
1	A	4.780	9.540	9.630	0.09	9.54	31.3	Near surface
	B	4.850						
2	A	4.800	9.540	9.640	0.10	19.08	62.6	Near surface
	B	4.840						
3	A	4.760	9.540	9.520	-0.02	28.62	93.9	Near surface
	B	4.760						
11	A	4.840	9.540	9.620	0.08	104.94	344.3	High pitting
	B	4.780						
12	A	4.820	9.540	9.650	0.11	114.48	375.6	High pitting
	B	4.830						
13	A	4.800	9.540	9.530	-0.01	124.02	406.9	High pitting
	B	4.730						
15	A	4.840	9.540	9.640	0.10	143.10	469.5	Damaged pipe
	B	4.800						
32	A	4.810	9.540	9.650	0.11	305.28	1001.6	Sample point
	B	4.840						
51	A	4.800	9.540	9.630	0.09	486.54	1596.3	High pitting
	B	4.830						
52	A	4.770	9.540	9.590	0.05	496.08	1627.6	High pitting
	B	4.820						
53	A	4.680	9.540	9.360	-0.18	505.62	1658.9	High pitting
	B	4.680						
55	A	4.770	9.540	9.540	0.00	524.70	1721.5	Odd calliper response
	B	4.770						
63	A	4.850	9.540	9.650	0.11	601.02	1971.9	Scale build-up
	B	4.800						
75	A	4.820	9.540	9.640	0.10	715.50	2347.4	Scale build-up
	B	4.820						
76	A	4.810	9.540	9.650	0.11	725.04	2378.7	Scale build-up
	B	4.840						
82	A	4.810	9.540	9.640	0.10	782.28	2566.5	Scale build-up
	B	4.830						
85	A	4.840	9.540	9.650	0.11	810.90	2660.4	Low wall thickness / high pitting
	B	4.810						

Joint #	Section	Section Length (m)	Est. Length (m)	Measured Joint Length (m)	Difference (m)	Est. Depth (m)	Est. Depth (ft)	Feature / Importance
86	A	4.830	9.540	9.660	0.12	820.44	2691.7	Low wall thickness / high pitting
	B	4.830						
87	A	4.830	9.540	9.620	0.08	829.98	2723.0	Low wall thickness / high pitting
	B	4.790						
92	A	4.820	9.540	9.650	0.11	877.68	2879.5	Damaged pipe
	B	4.830						
113	A	4.830	9.540	9.650	0.11	1,078.02	3536.8	Good pipe
	B	4.820						
123	A	4.840	9.540	9.660	0.12	1,173.42	3849.8	Good pipe
	B	4.820						
124	A	4.840	9.540	9.610	0.07	1,182.96	3881.1	Good pipe
	B	4.770						
129	A	4.850	9.540	9.670	0.13	1,230.66	4037.6	High pitting
	B	4.820						
130	A	4.830	9.540	9.640	0.10	1,240.20	4068.9	High pitting
	B	4.810						
141	A	4.800	9.540	9.650	0.11	1,345.14	4413.2	High pitting
	B	4.850						
142	A	4.710	9.540	9.620	0.08	1,354.68	4444.5	High pitting
	B	4.910						
143	A	4.800	9.540	9.660	0.12	1,364.22	4475.8	High pitting
	B	4.860						
145	A	4.820	9.540	9.650	0.11	1,383.30	4538.4	High pipe damage
	B	4.830						
146	A	4.830	9.540	9.650	0.11	1,392.84	4569.7	High pipe damage
	B	4.820						
147	A	4.765	9.540	9.640	0.10	1,402.38	4601.0	Good pipe
	B	4.875						
149	A	4.800	9.540	9.660	0.12	1,421.46	4663.6	High pitting
	B	4.860						
155	A	4.820	9.540	9.640	0.10	1,478.70	4851.4	Damaged pipe
	B	4.820						
156	A	4.810	9.540	9.650	0.11	1,488.24	4882.7	Damaged pipe
	B	4.840						
174	A	4.790	9.540	9.600	0.06	1,659.96	5446.1	High pitting
	B	4.810						
175	A	4.810	9.540	9.650	0.11	1,669.50	5477.4	High pitting
	B	4.840						
176	A	4.820	9.540	9.620	0.08	1,679.04	5508.7	High pitting
	B	4.800						

Joint #	Section	Section Length (m)	Est. Length (m)	Measured Joint Length (m)	Difference (m)	Est. Depth (m)	Est. Depth (ft)	Feature / Importance
192	A	4.880	9.540	9.690	0.15	1,831.68	6009.4	Sample point
	B	4.810						
215	A	4.500	9.540	9.130	-0.41	2,051.10	6729.3	Scale build-up
	B	4.630						
216	A	4.830	9.540	9.670	0.13	2,060.64	6760.6	Scale build-up
	B	4.840						
244	A	4.890	9.540	9.650	0.11	2,327.76	7637.0	
	B	4.760						
245	A	4.870	9.540	9.630	0.09	2,337.30	7668.3	
	B	4.760						
246	A	4.800	9.540	9.550	0.01	2,346.84	7699.6	Scale build-up
	B	4.750						
247	A	4.520	9.540	9.000	-0.54	2,356.38	7730.9	Scale build-up
	B	4.480						
248	A	4.760	9.540	9.540	0.00	2,365.92	7762.2	Scale build-up
	B	4.780						
249	A	4.640	9.540	9.230	-0.31	2,375.46	7793.5	Damaged pipe
	B	4.590						
250	A	3.830	9.540	7.730	-1.81	2,385.00	7824.8	Damaged pipe
	B	3.900						
Top of fish	NA	4.310	NA	NA	NA			Top of fish
Wireline cut	NA	4.240	NA	NA				Wireline cut

Table 6: Pallet Catalogue for 2-3/8" Tubing Stored at Tonsley TAFE

Pallet	Joint #	Pallet	Joint #	Pallet	Joint #
1	76	3	123	5	15
	142		246		12
	143		247		55
	145		250		52
	147		244		85
	149		248		92
	156		113		1
2	141		245	6	13
	146		129		53
	155		124		75
	192		51		63
	215		Top of fish		11
	174		Wireline cut		
	176	4	87		
	175		32		
	176		86		
	216		3		
			130		
			82		
			249		
			2		

7.1.2 Palletised 5-1/2" Casing

Table 7: 5-1/2" Casing Data

Joint #	Section	Section Length (m)	Est. Joint Length (m)	Measured Joint Length (m)	Difference (m)	Est. Depth (m)	Est. Depth (ft)	Feature / Importance
1	A	2.50	10.00	10.11	0.11	10.00	32.81	
	B	2.50						
	C	2.50						
	D	2.61						
2	A	2.50	10.00	10.31	0.31	20.00	65.62	Near Surface
	B	2.50						
	C	2.50						
	D	2.81						
3	A	2.50	10.00	10.04	0.04	30.00	98.43	
	B	2.50						
	C	2.50						
	D	2.54						
13	A	2.50	10.00	10.06	0.06	130.00	426.51	
	B	2.50						
	C	2.50						
	D	2.56						
14	A	2.50	10.00	10.04	0.04	140.00	459.32	Scaling / Eccentricity
	B	2.50						
	C	2.50						
	D	2.54						
16	A	2.50	10.00	9.61	-0.39	160.00	524.93	
	B	2.50						
	C	2.50						
	D	2.11						
17	A	2.50	10.00	10.01	0.01	170.00	557.74	Maximum Wall Loss
	B	2.50						
	C	2.50						
	D	2.51						
23	A	2.50	10.00	10.16	0.16	230.00	754.59	
	B	2.50						
	C	3.00						
	D	2.16						
24	A	2.50	10.00	10.21	0.21	240.00	787.40	Anomaly in MTD 2015
	B	2.50						
	C	2.50						
	D	2.71						

Joint #	Section	Section Length (m)	Est. Joint Length (m)	Measured Joint Length (m)	Difference (m)	Est. Depth (m)	Est. Depth (ft)	Feature / Importance
34	A	2.50	10.00	10.3	0.30	340.00	1115.49	J55/N80 Crossover
	B	2.50						
	C	2.50						
	D	2.80						
35	A	2.50	10.00	9.9	-0.10	350.00	1148.29	
	B	2.50						
	C	2.50						
	D	2.40						
36	A	2.80	10.00	8.4	-1.60	360.00	1181.10	
	B	2.80						
	C	2.80						
37	A	2.50	10.00	10.24	0.24	370.00	1213.91	
	B	2.50						
	C	2.50						
	D	2.74						
90	A	2.50	10.00	10.35	0.35	900.00	2952.76	Scaling to Wall Loss
	B	2.50						
	C	2.50						
	D	2.85						
91	A	2.00	10.00	10.35	0.35	910.00	2985.56	
	B	2.00						
	C	3.00						
	D	3.35						
96	A	2.50	10.00	10.25	0.25	960.00	3149.61	Last Joints
	B	2.50						
	C	2.50						
	D	2.75						
97	A	2.50	10.00	10.26	0.26	970.00	3182.41	
	B	2.50						
	C	2.50						
	D	2.76						
98 (Cut Off)	A	2.40	6.00	4.77	-10.77	976.00	3202.10	
	B	2.37						

Table 8: Pallet Catalogue for 5-1/2" Casing Stored at Tonsley TAFE

Pallet	Joint #	Pallet	Joint #	Pallet	Joint #
1	2	3	1	5	14
	36		3		17
	90		97		98
2	16	4	13	6	23
	24		35		34
	91		96		37

8. Appendices

Appendix A – 2-3/8" Tubing MFC and MTD Logs

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
1 - 3	Surface – 28.62 (0 – 94)	Near surface

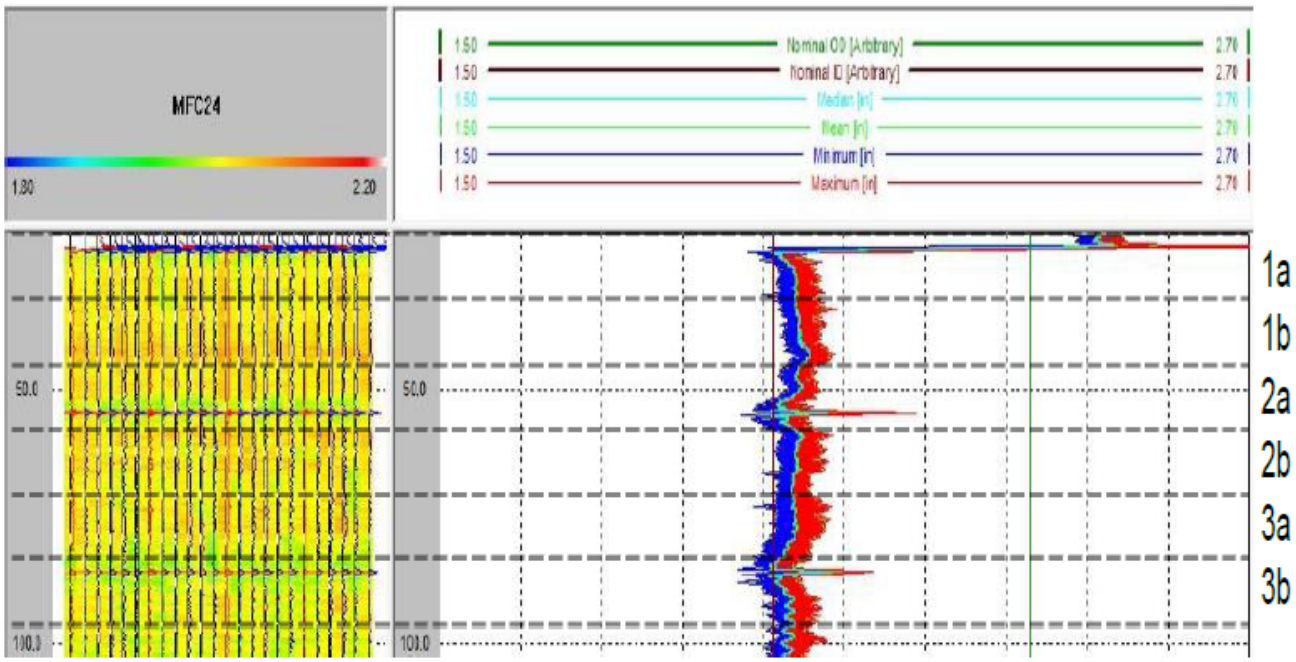


Figure 8: Joints 1-3 MFC log

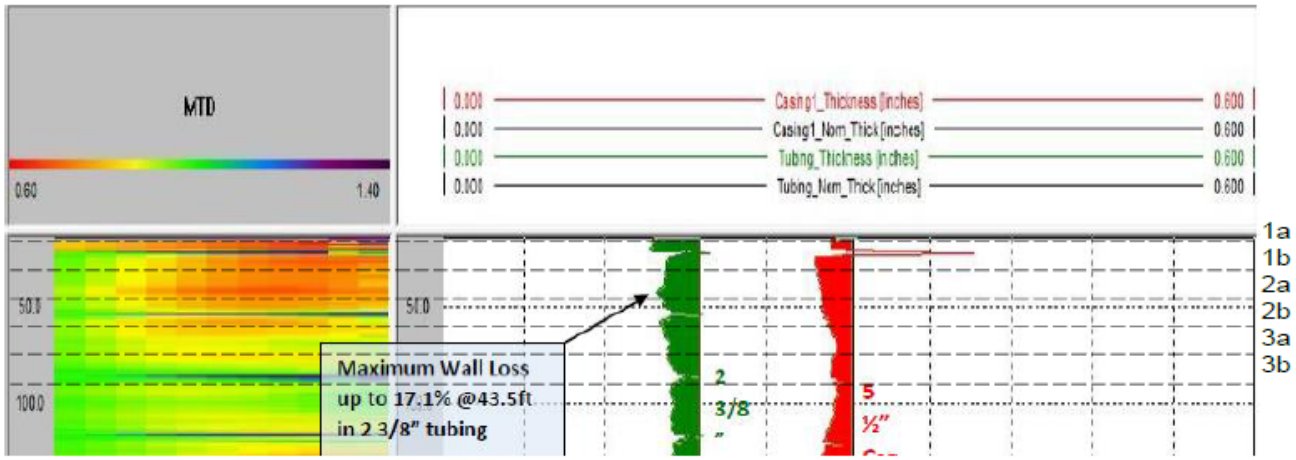


Figure 9: Joints 1-3 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
11 - 13	95.40 – 124.02 (313 – 407)	High pitting

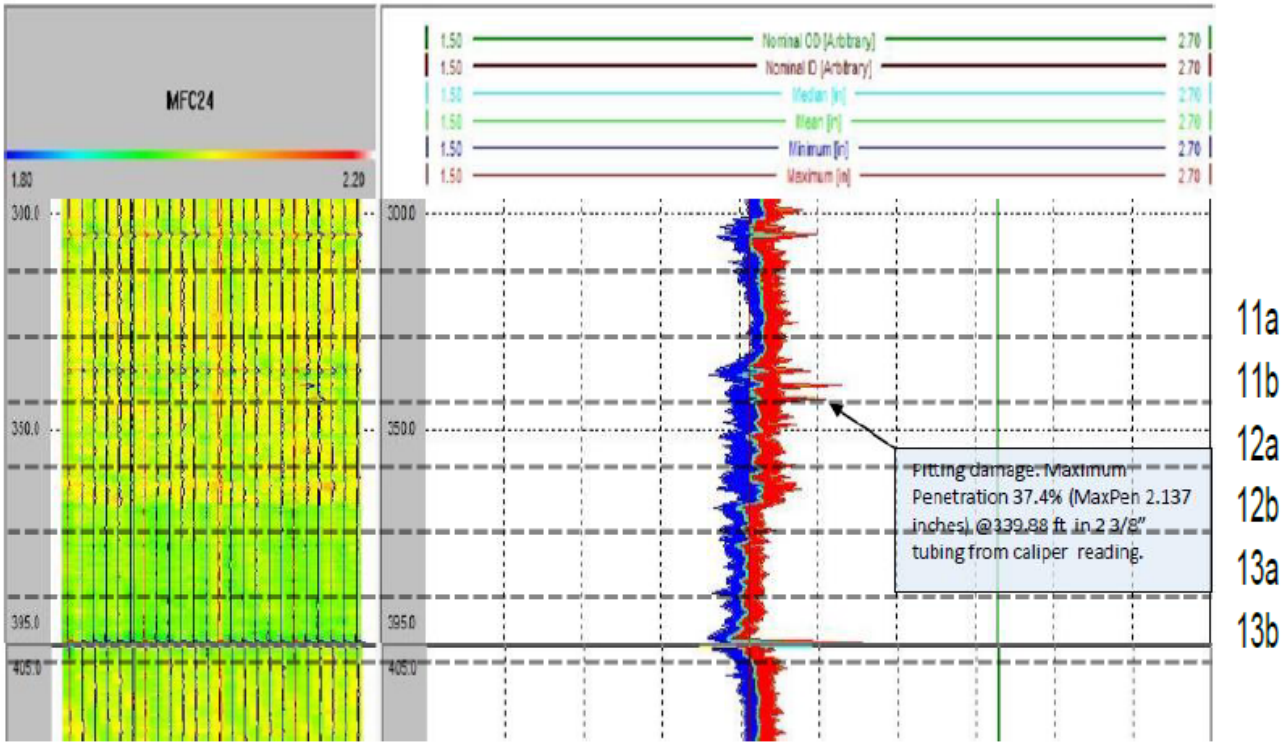


Figure 10: Joints 11-13 MFC Log

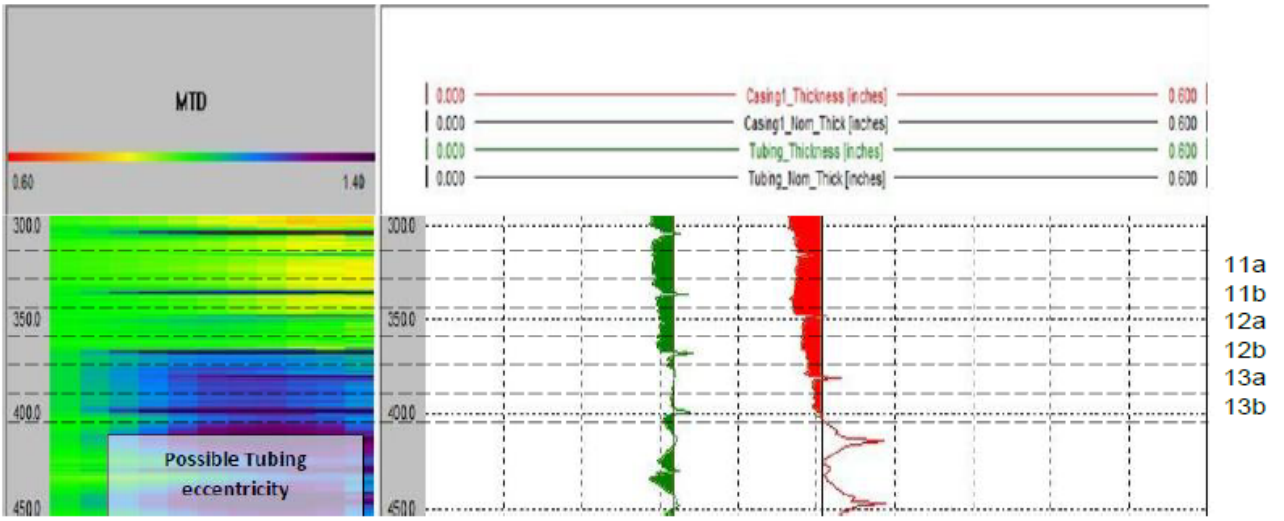


Figure 11: Joints 11-13 MTD Log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
15	133.56 – 143.10 (438 – 469)	Damaged pipe

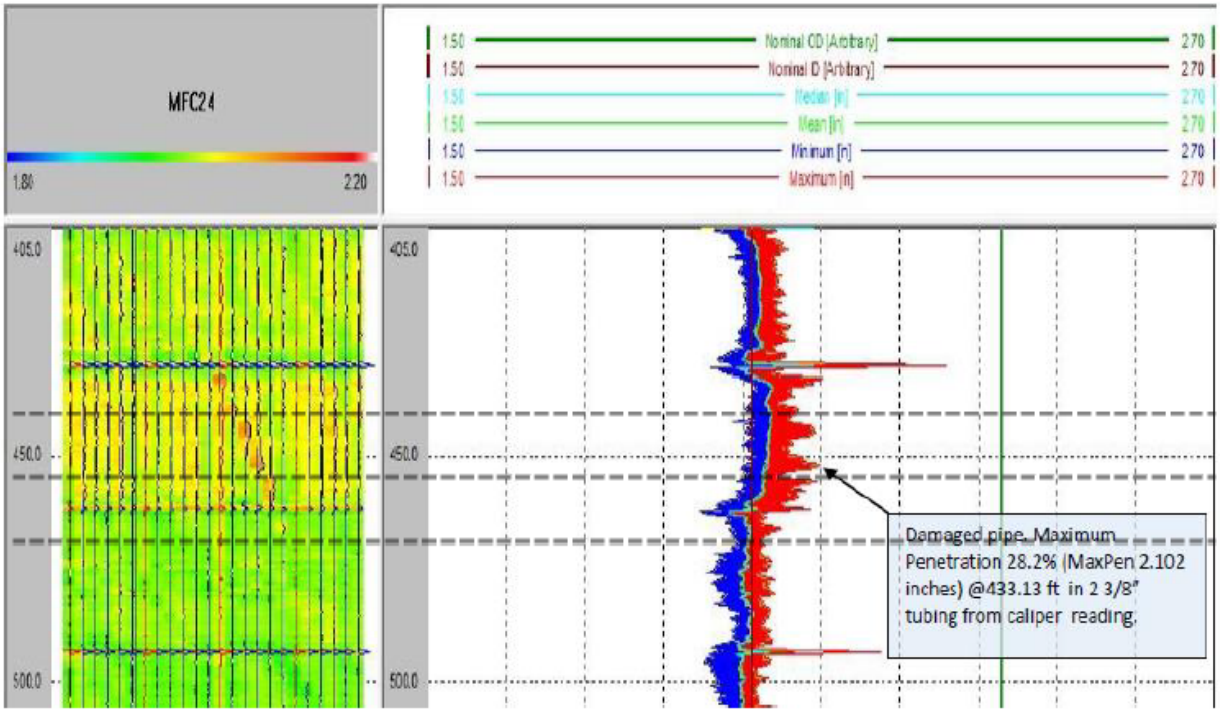


Figure 12: Joint 15 MFC log

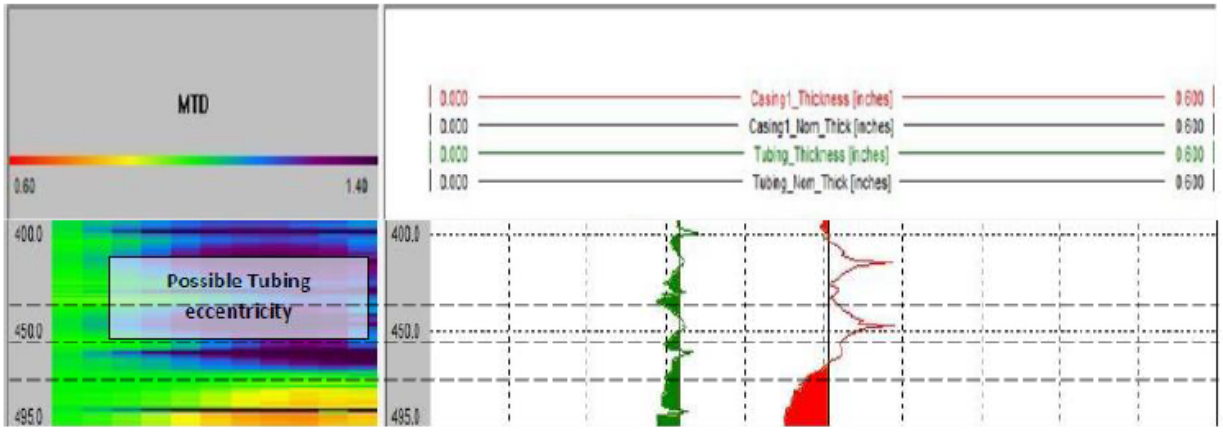


Figure 13: Joint 15 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
32	295.74 – 305.28 (970 – 1002)	Sample point

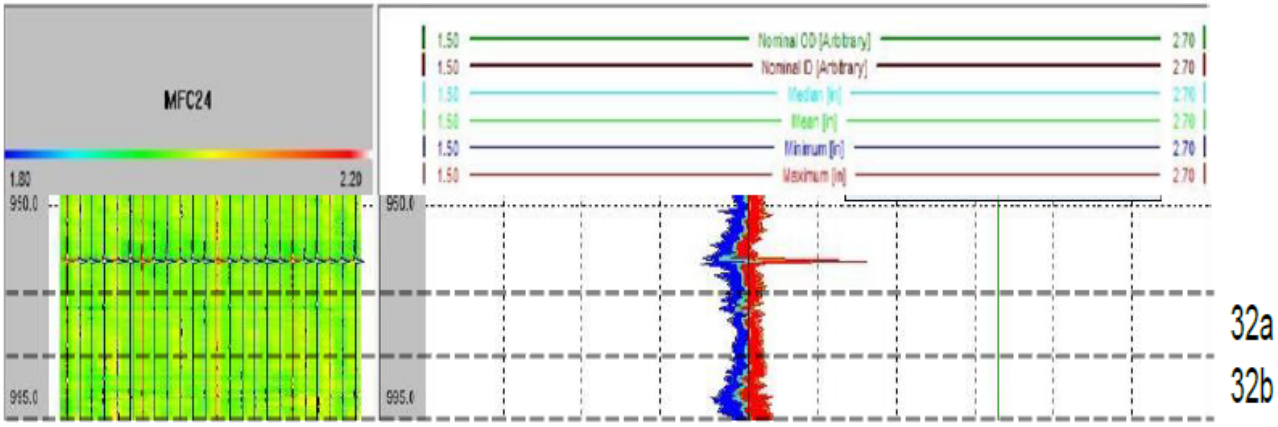


Figure 14: Joint 32 MFC Log

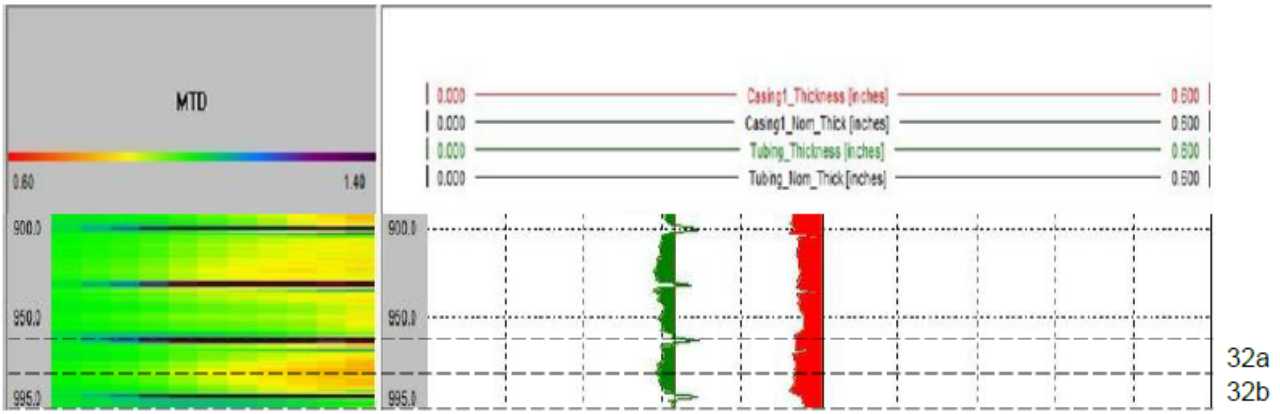


Figure 15: Joint 32 MTD Log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
51 - 53	477.0 – 505.62 (1565 – 1659)	High pitting

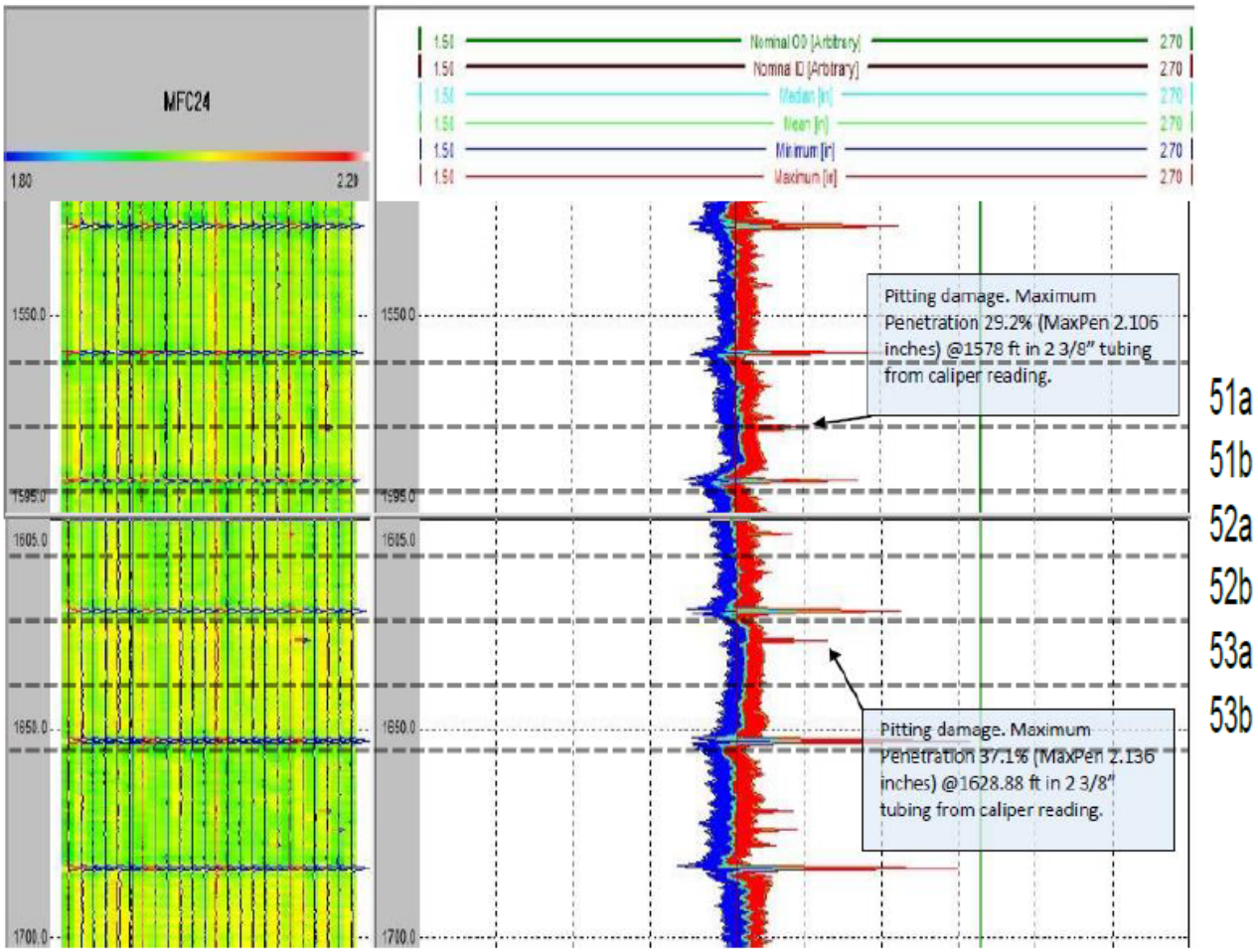


Figure 16: Joints 51-53 MFC log

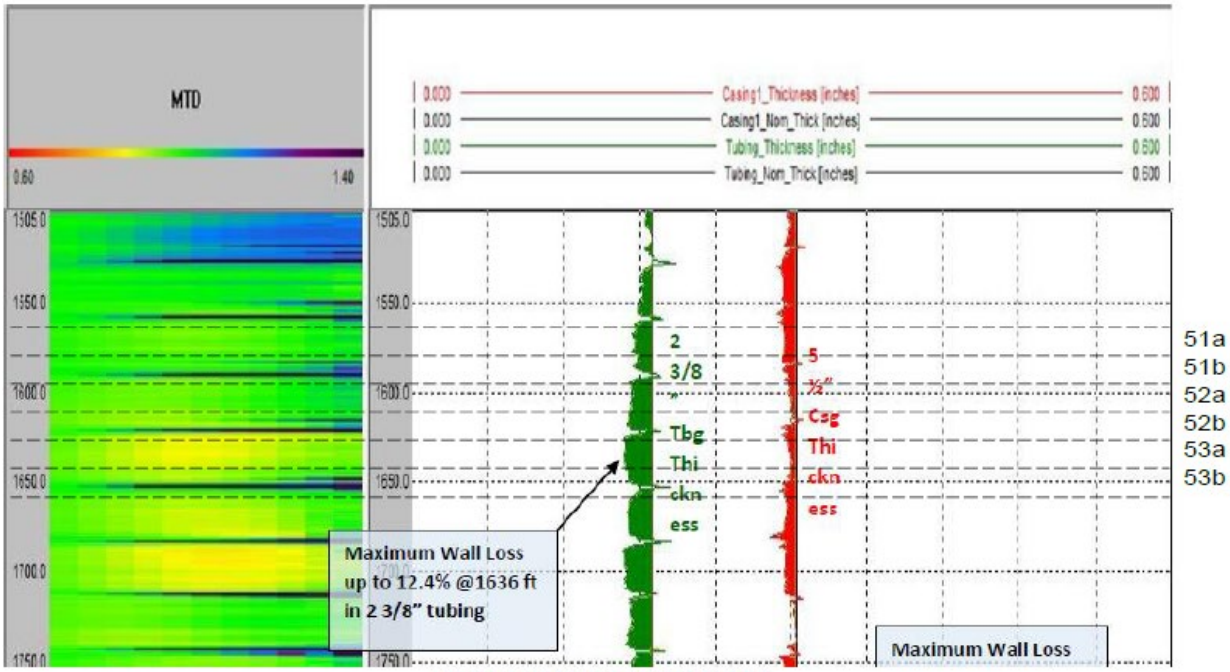


Figure 17: Joints 51-53 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
55	515.16 – 524.70 (1690 – 1721)	Odd calliper response

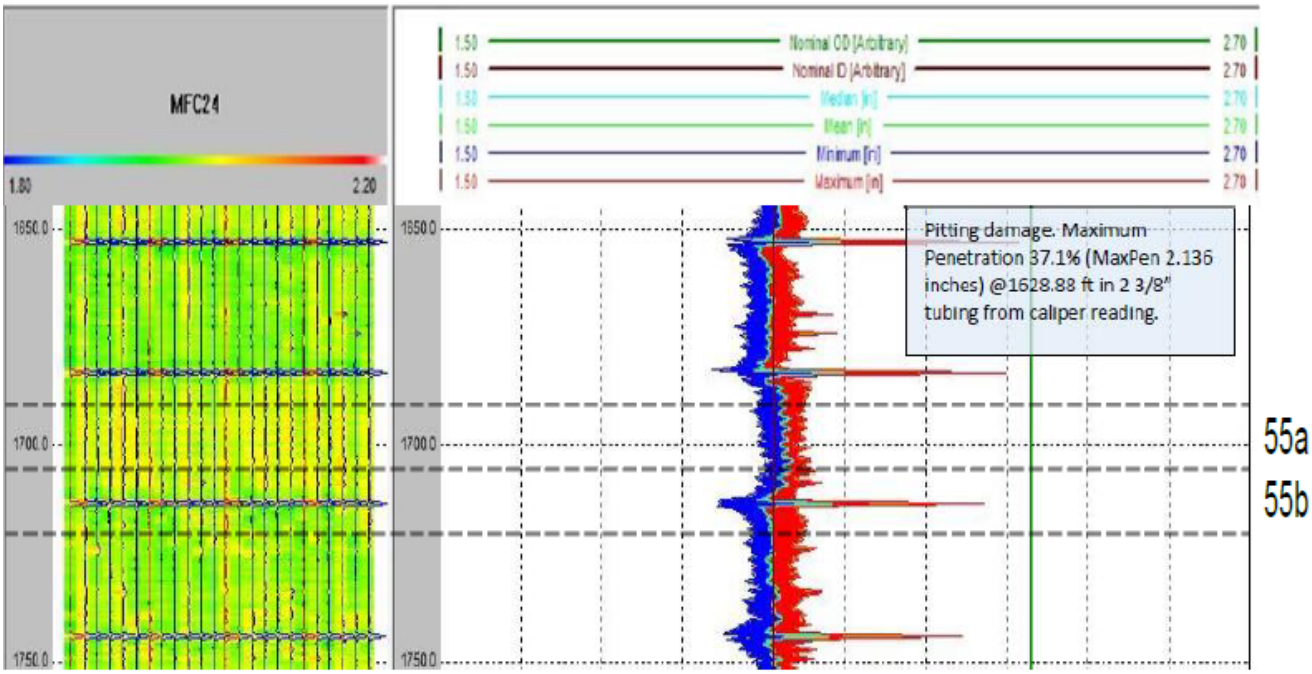


Figure 18: Joint 55 MFC log

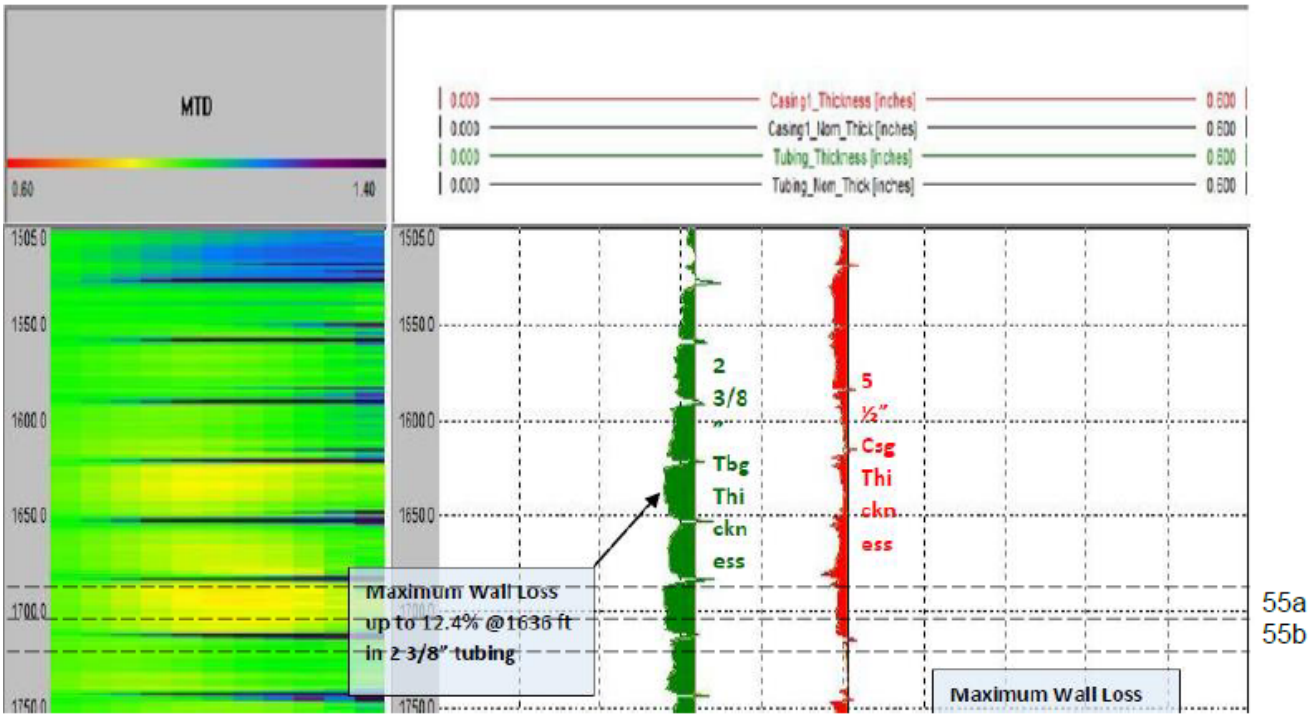


Figure 19: Joint 55 MTD log

Joint Range	Est. Depth Range (m)	Reason for Interest
63	591.48 – 601.02 (1941 – 1972)	Scale build-up

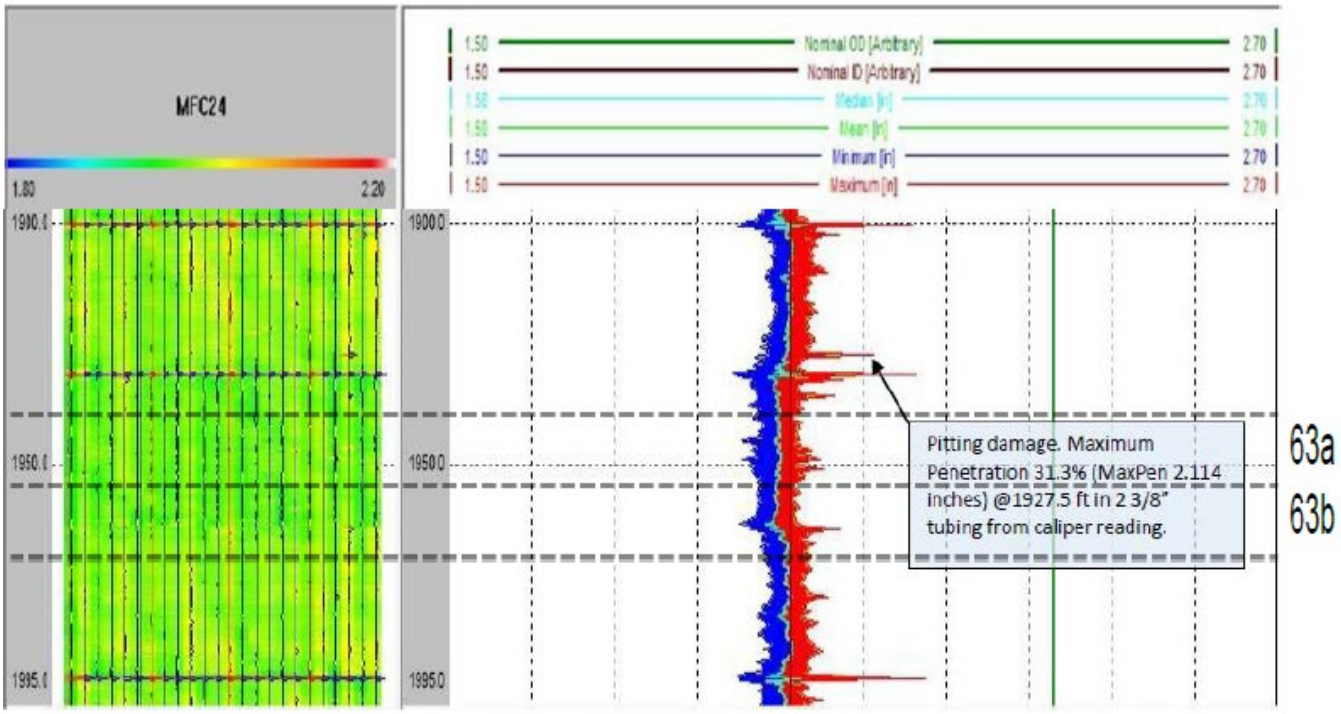


Figure 20: Joint 63 MFC log

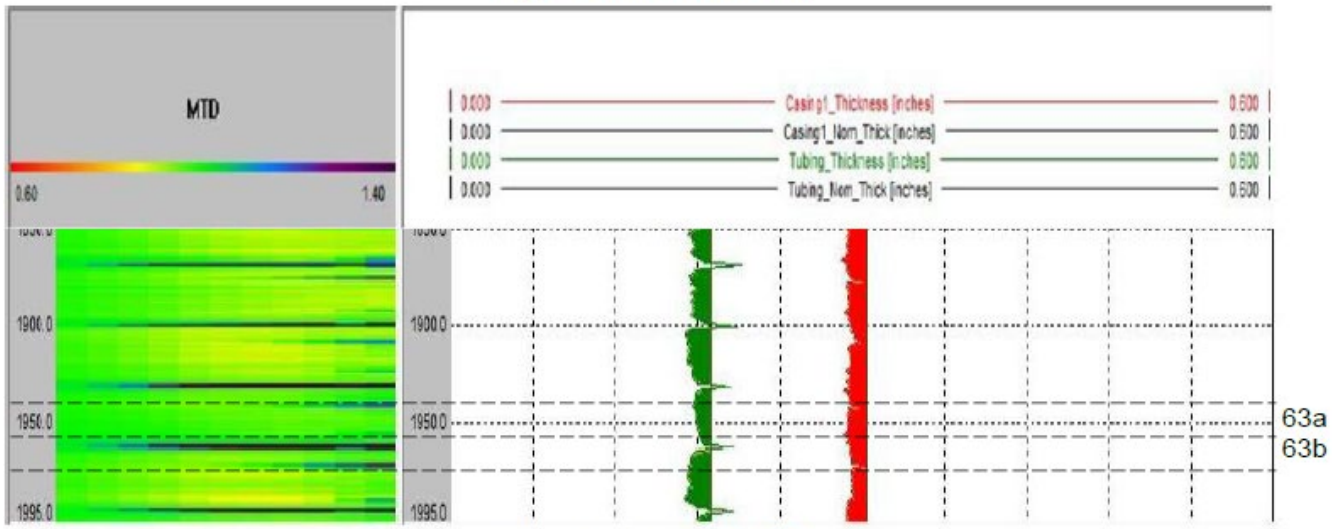


Figure 21: Joint 63 MTD log

Joint Range	Est. Depth Range (m)	Reason for Interest
75 -76	705.96 – 725.04 (2316 – 2379)	Scale build-up

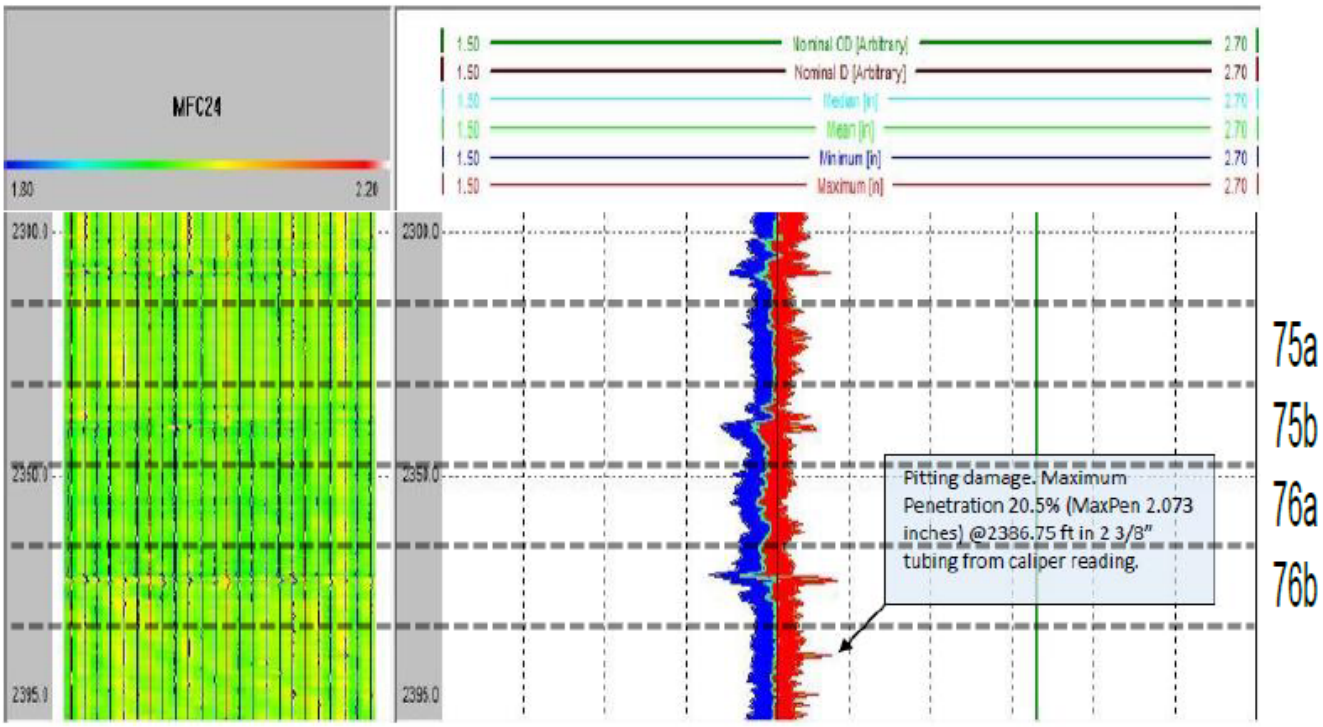


Figure 22: Joints 75-76 MFC log

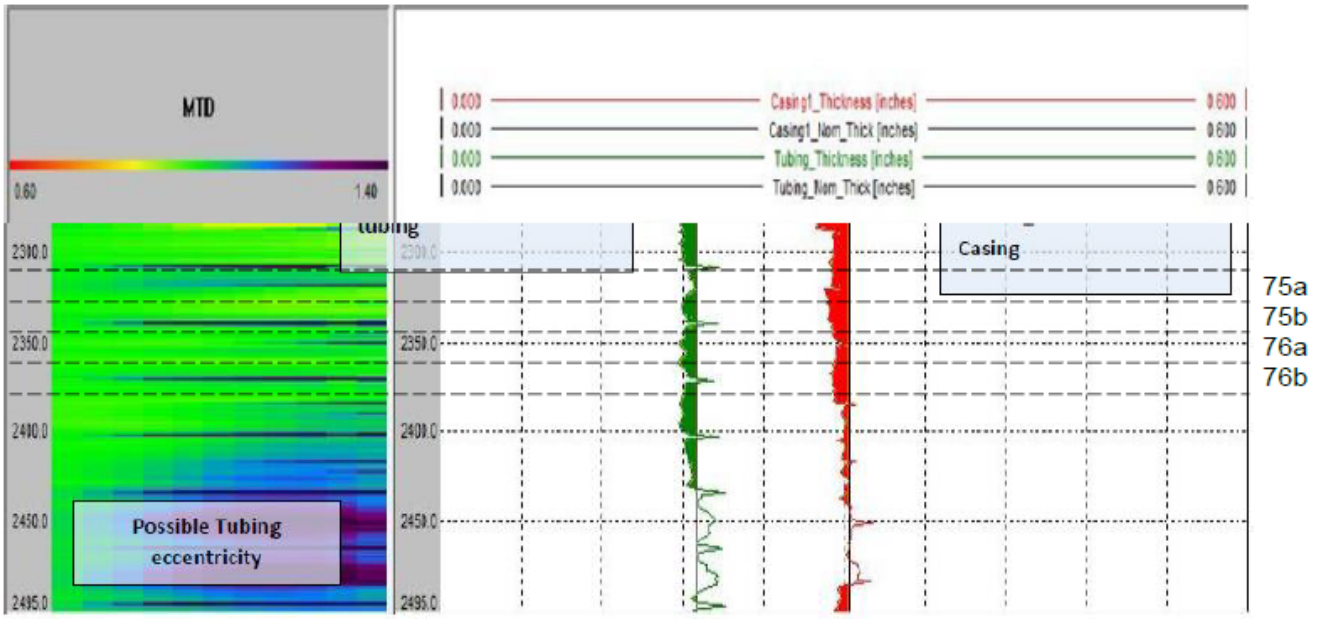


Figure 23: Joints 75-76 MTD log

Joint Range	Est. Depth Range (m)	Reason for Interest
82	772.74 – 782.28 (2535 – 2567)	Scale build-up

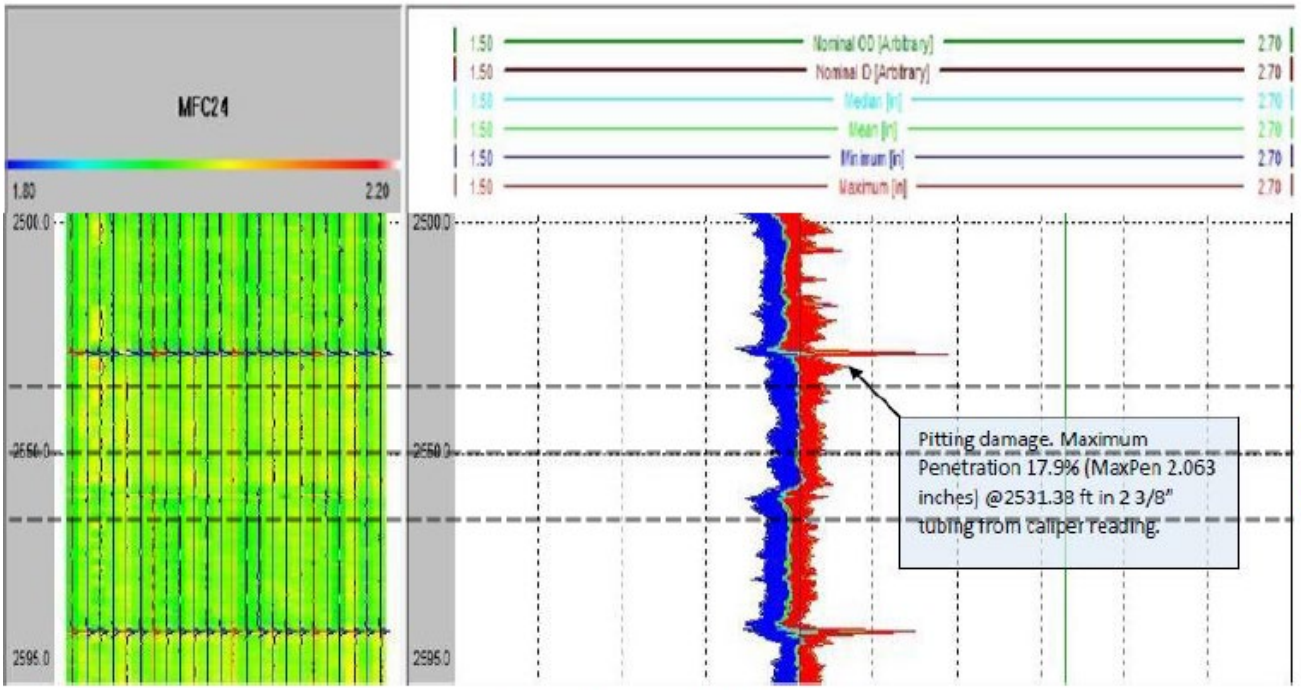


Figure 24: Joint 82 MFC log

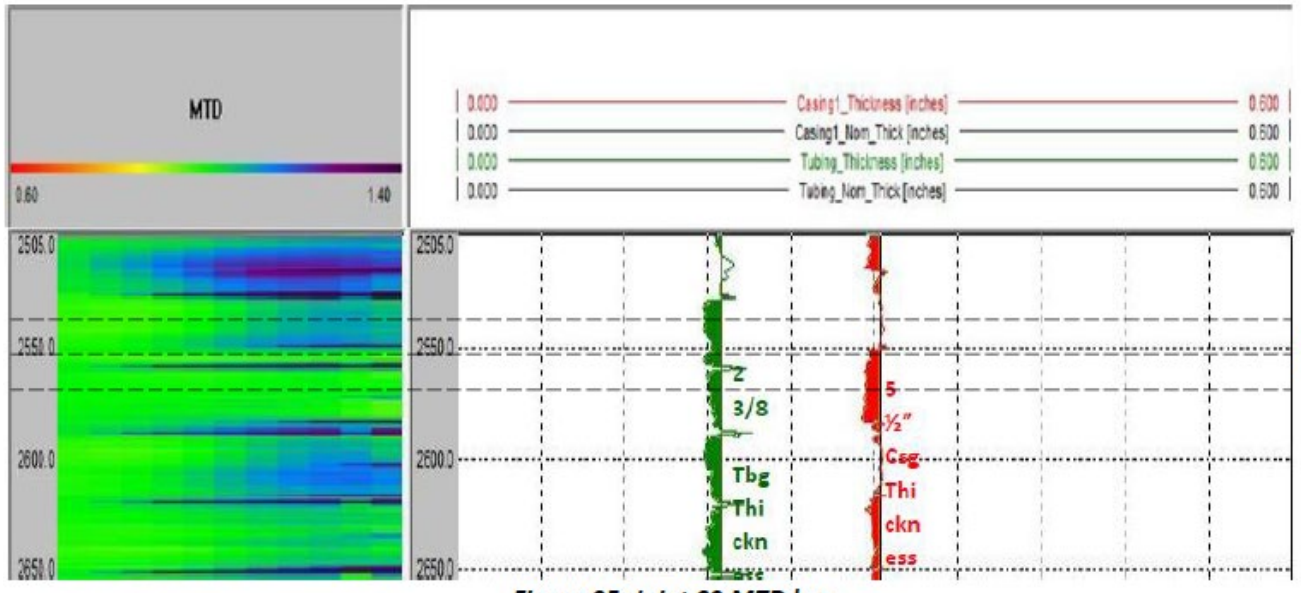


Figure 25: Joint 82 MTD log

Joint Range	Est. Depth Range (m)	Reason for Interest
85 - 87	801.36 – 829.98 (2629 – 2723)	Low wall thickness / high pitting

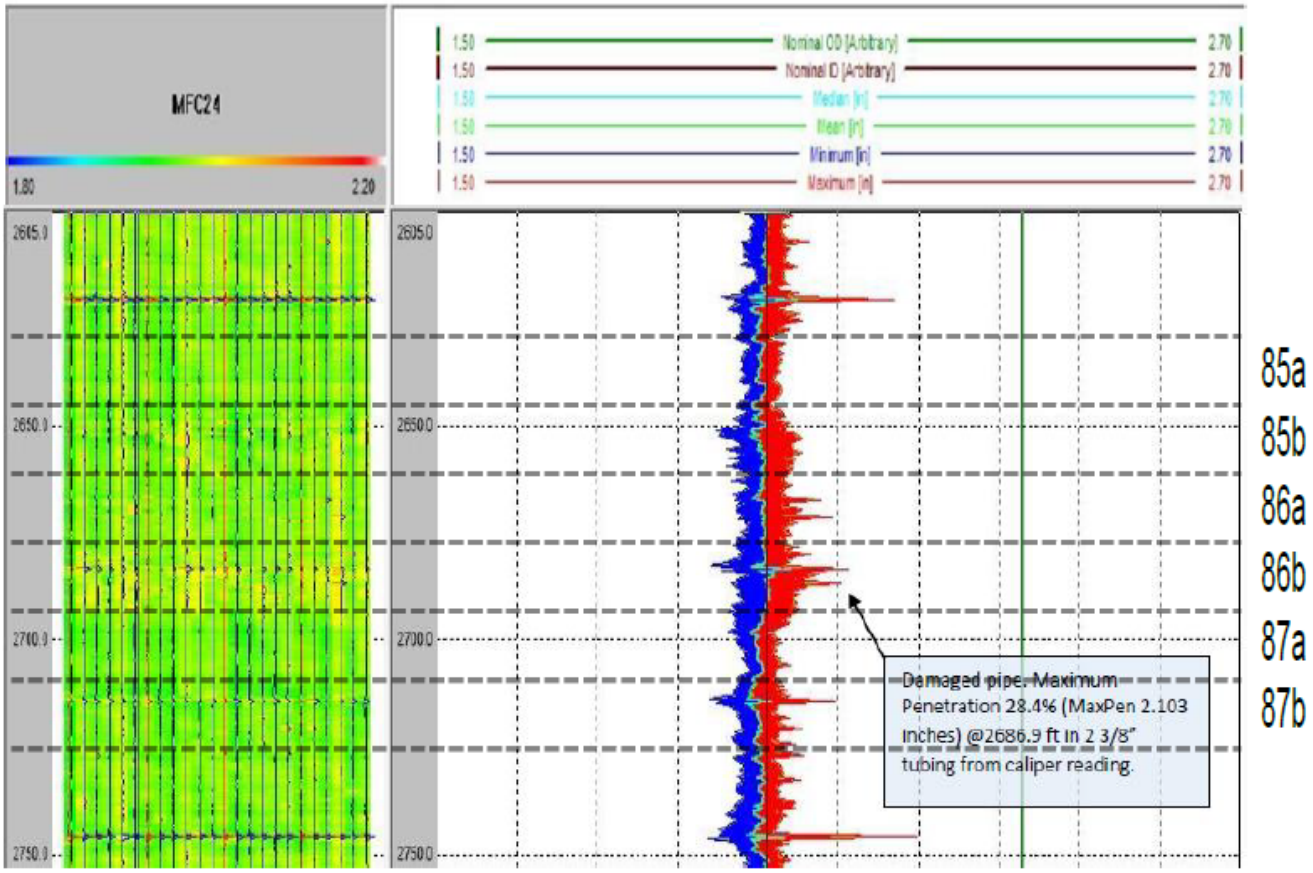


Figure 26: Joints 85-87 MFC log

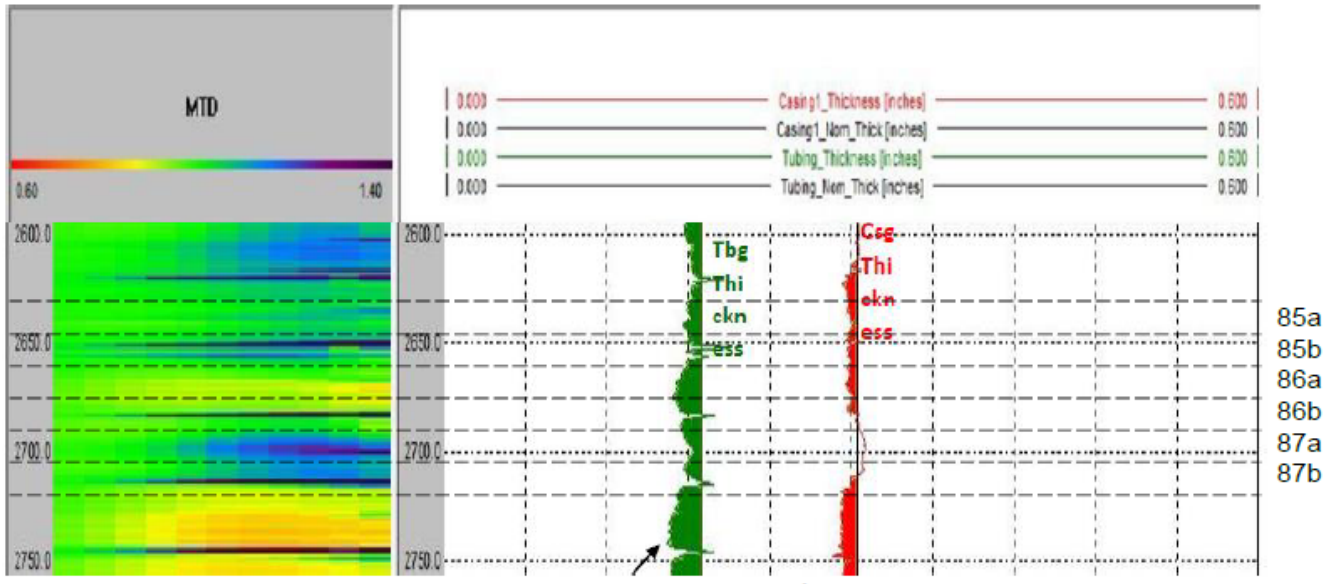


Figure 27: Joints 85-87 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
92	868.14 – 877.68 (2848 - 2880)	Damaged pipe

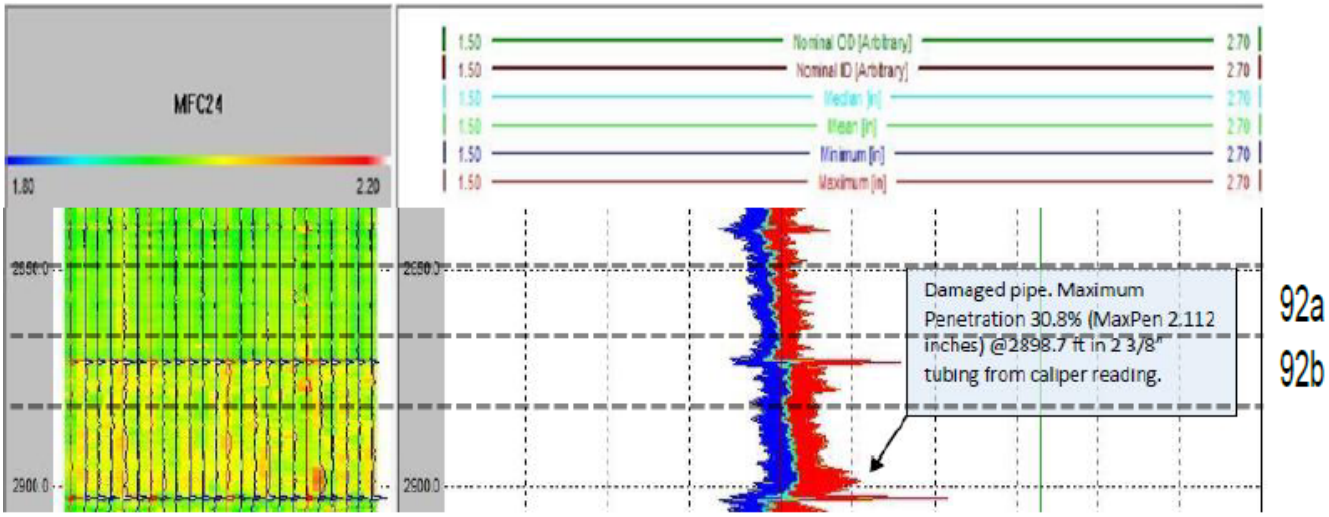


Figure 28: Joint 92 MFC log

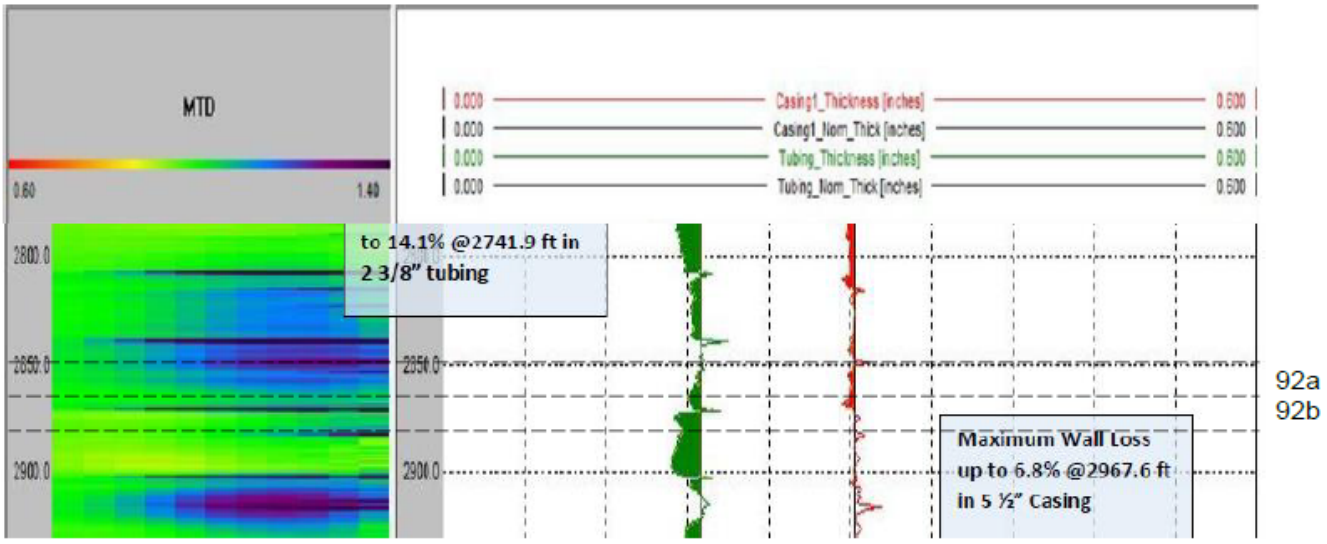


Figure 29: Joint 92 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
113	1068.48 – 1078.02 (3506 – 3537)	Good pipe

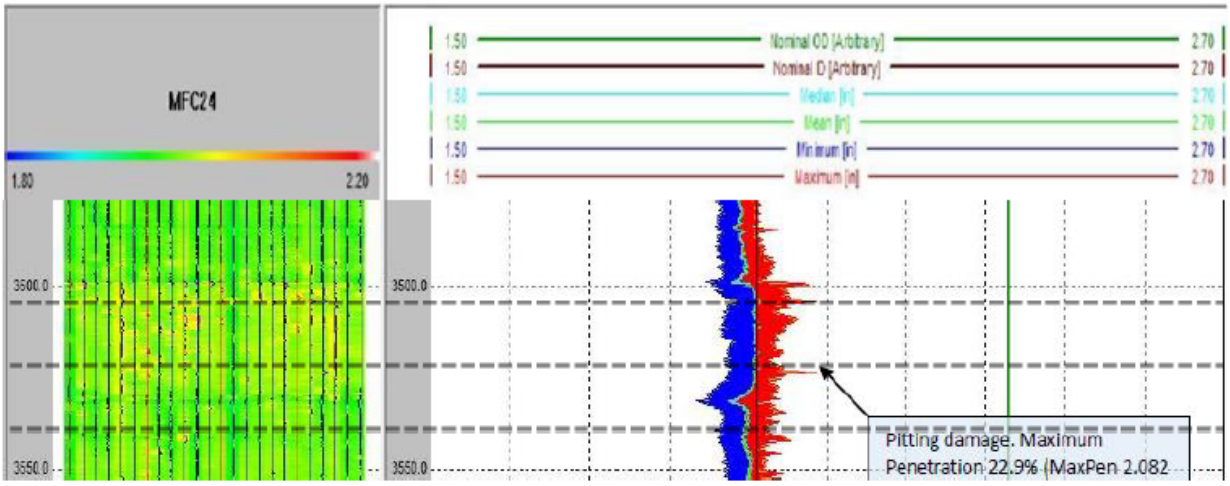


Figure 30: Joint 113 MFC log

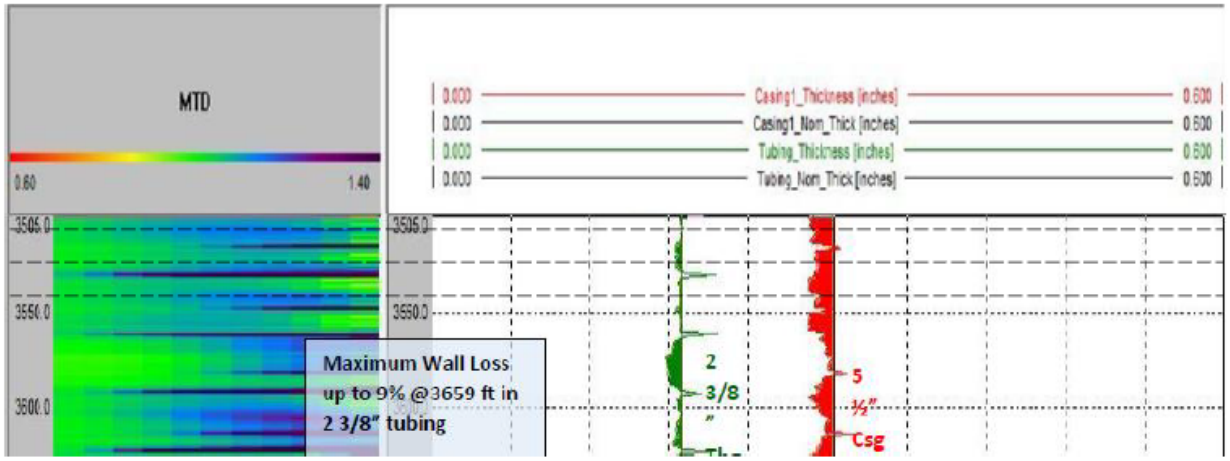


Figure 31: Joint 113 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
123 - 124	1163.88 – 1182.96 (3819 – 3881)	Good pipe

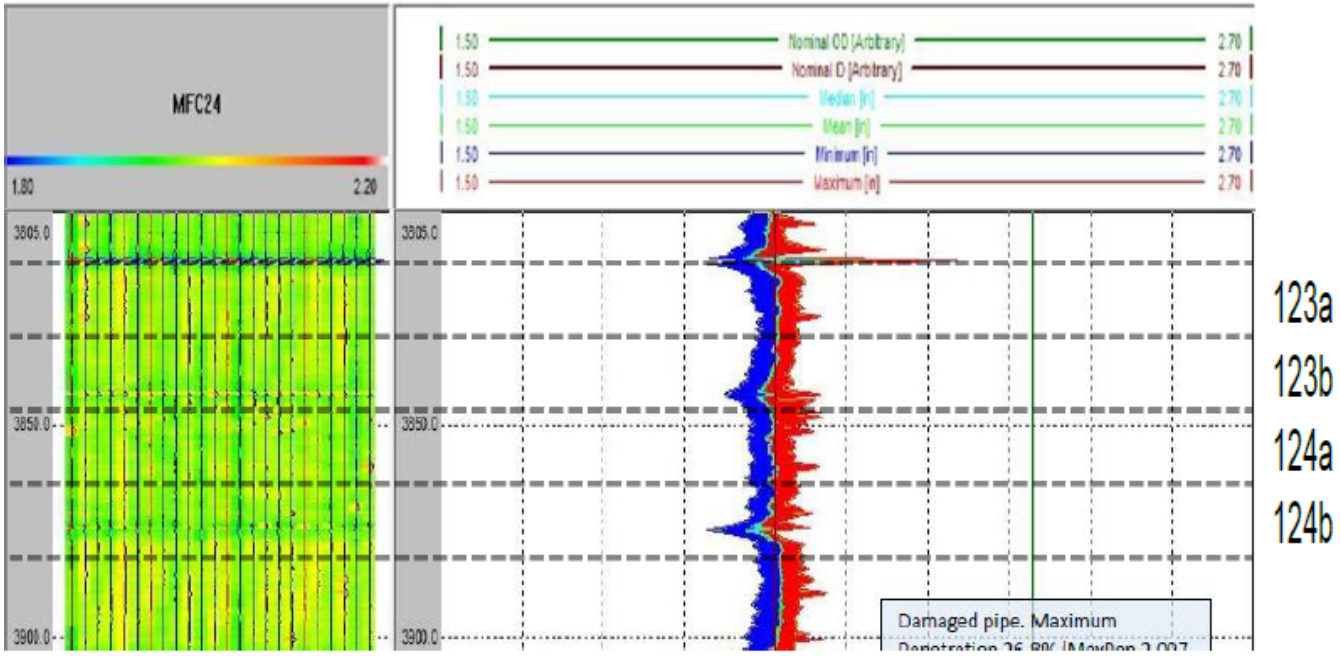


Figure 32: Joints 123-124 MFC log

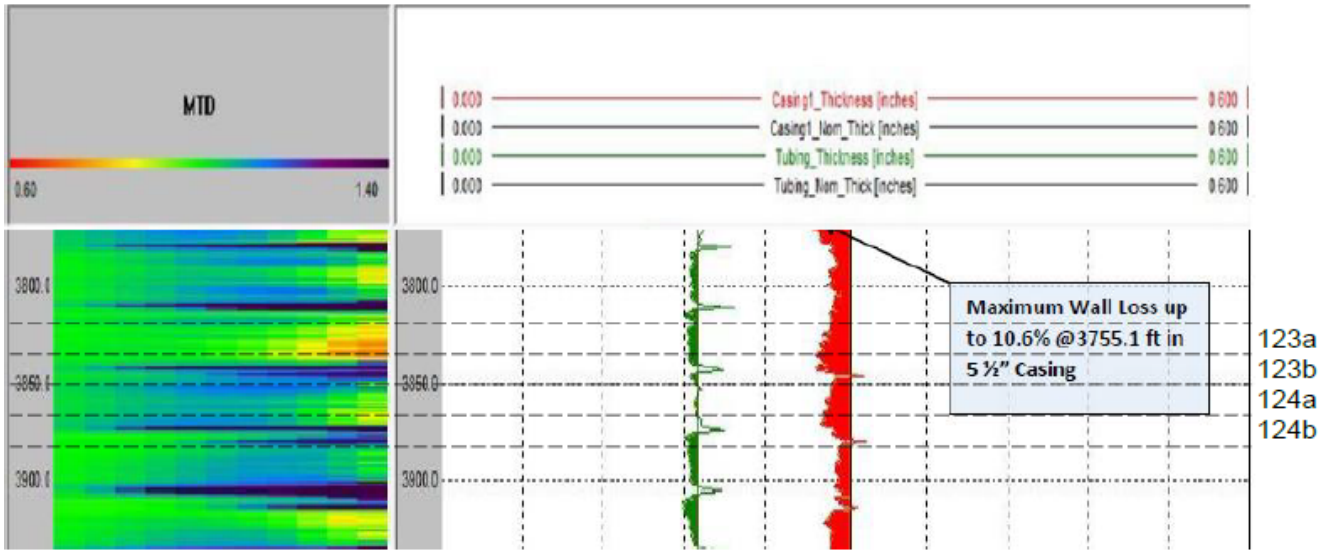


Figure 33: Joints 123-124 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
129 - 130	1221.12 – 1240.20 (4006 – 4069)	High pitting

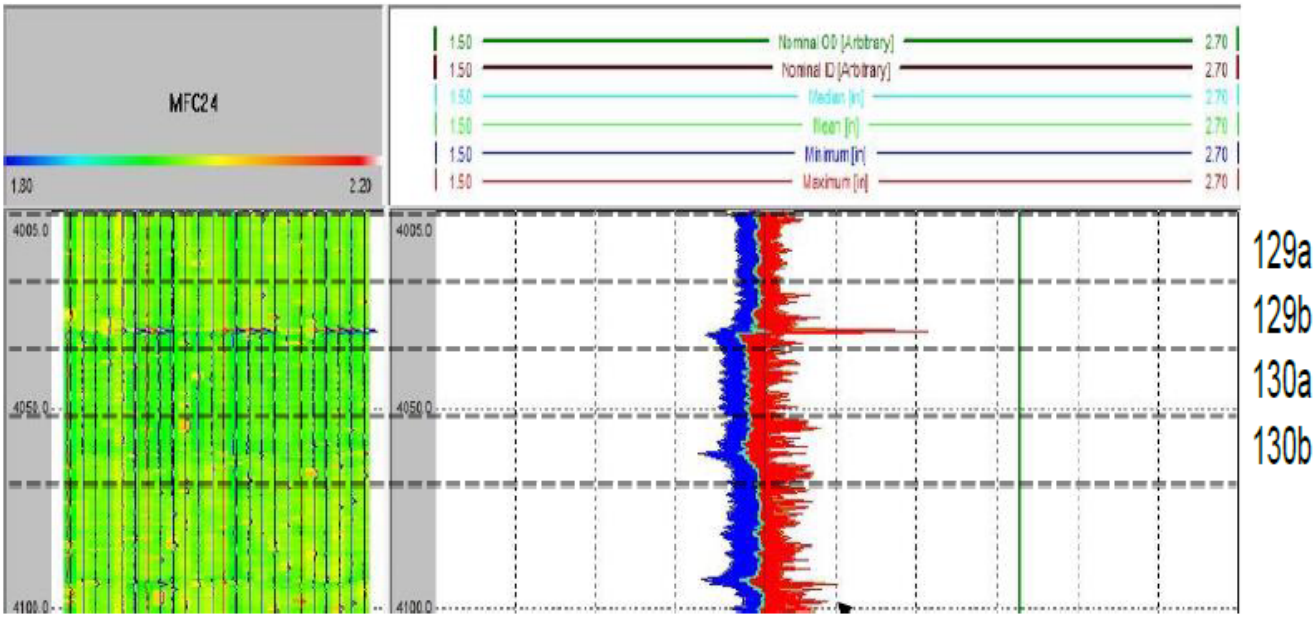


Figure 34: Joints 129-130 MFC log

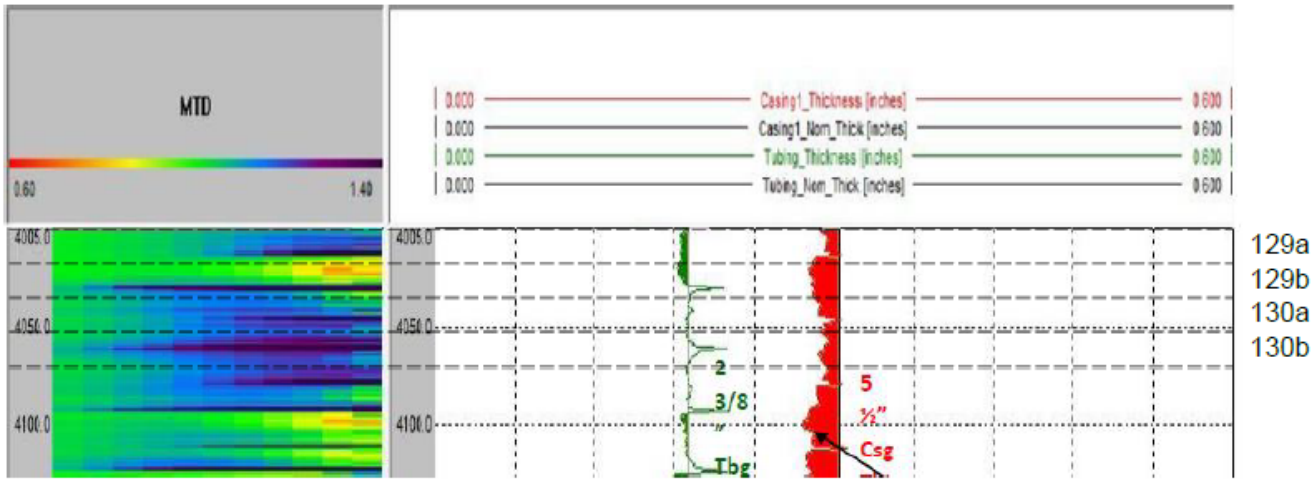


Figure 35: Joints 129-130 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
141 - 143	1335.60 – 1364.22 (4382 – 4476)	High pitting

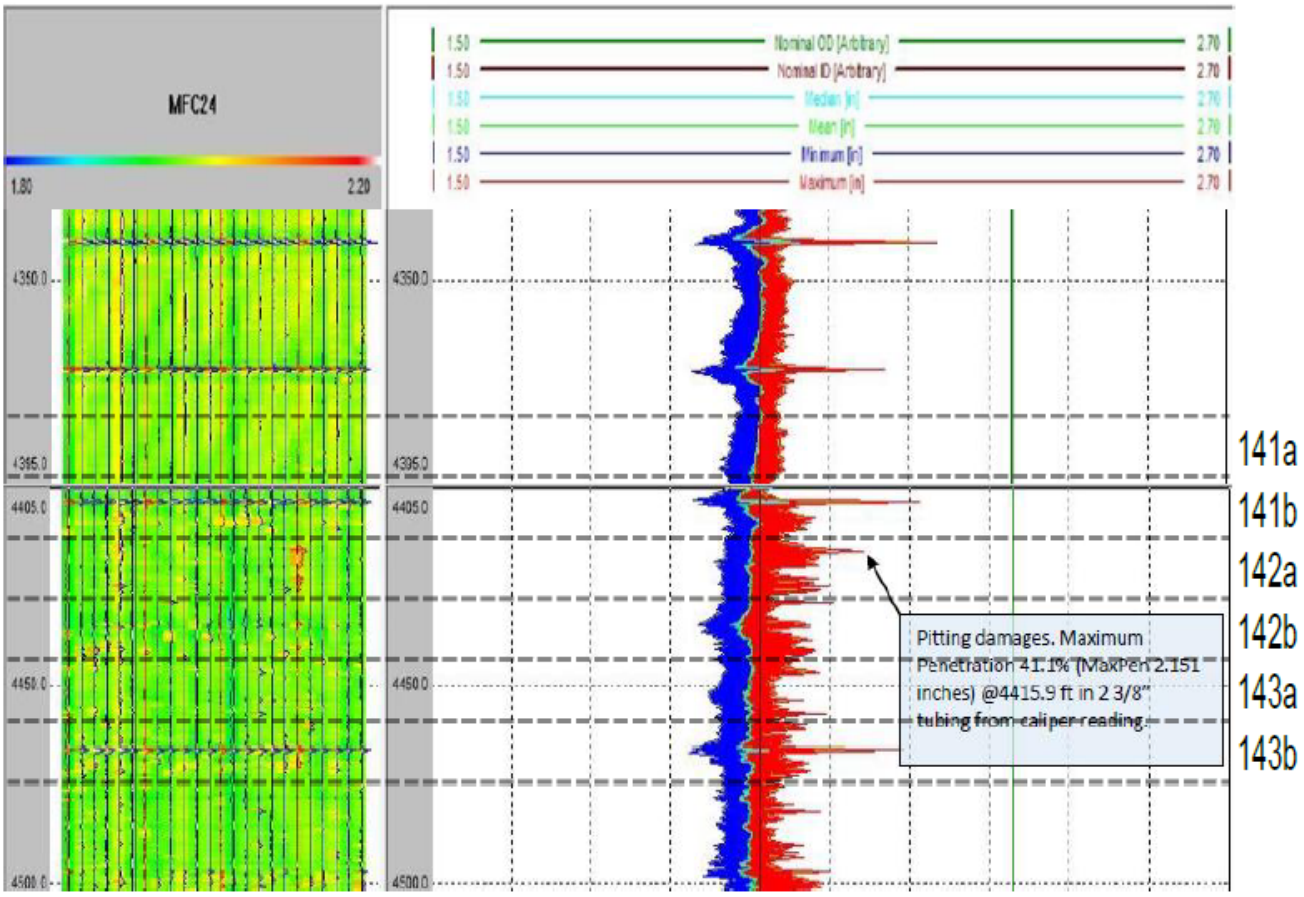


Figure 36: Joints 141-143 MFC log

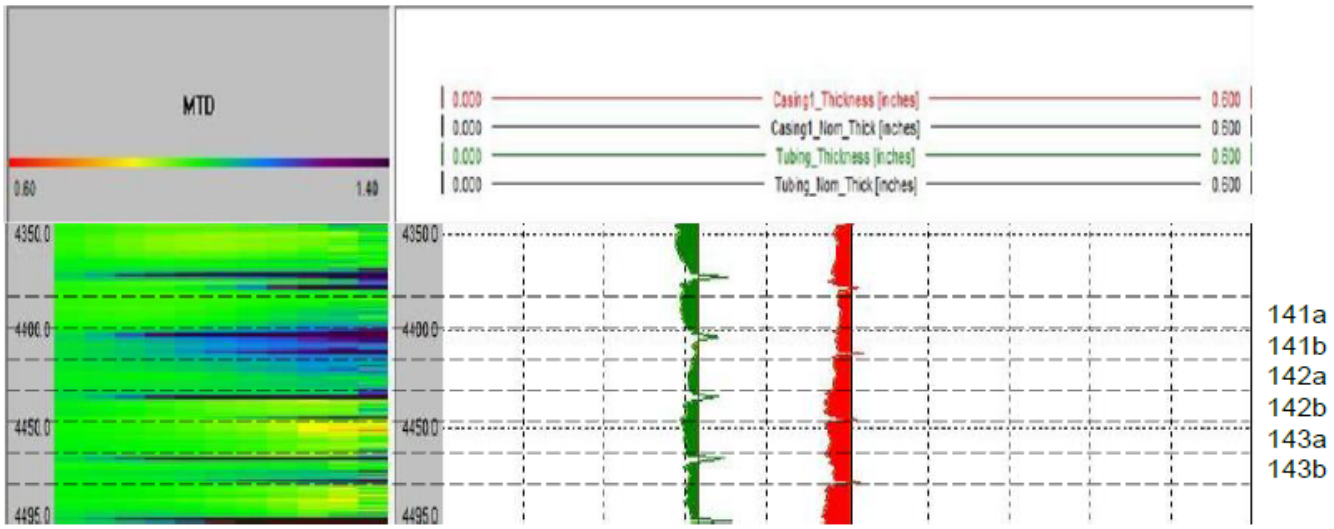


Figure 37: Joints 141-143 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
145 - 147	1373.76 – 1402.38 (4507 – 4601)	High pipe damage / Good pipe jt. 147?

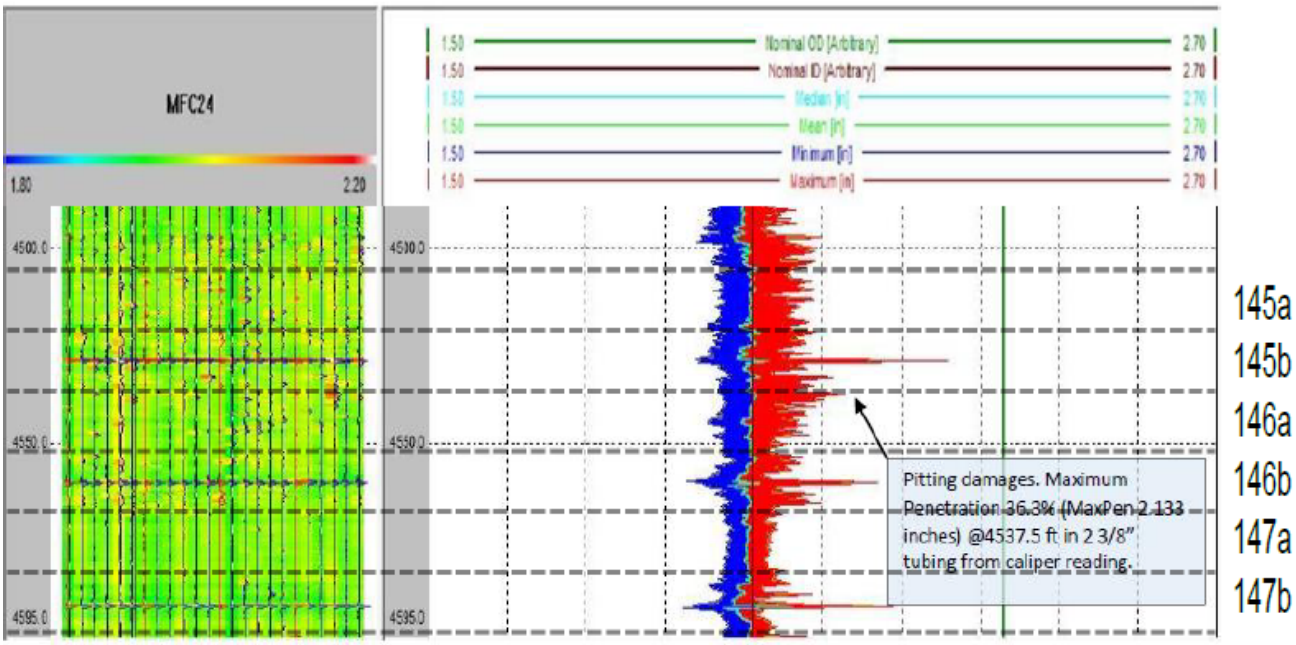


Figure 38: Joints 145-147 MFC log

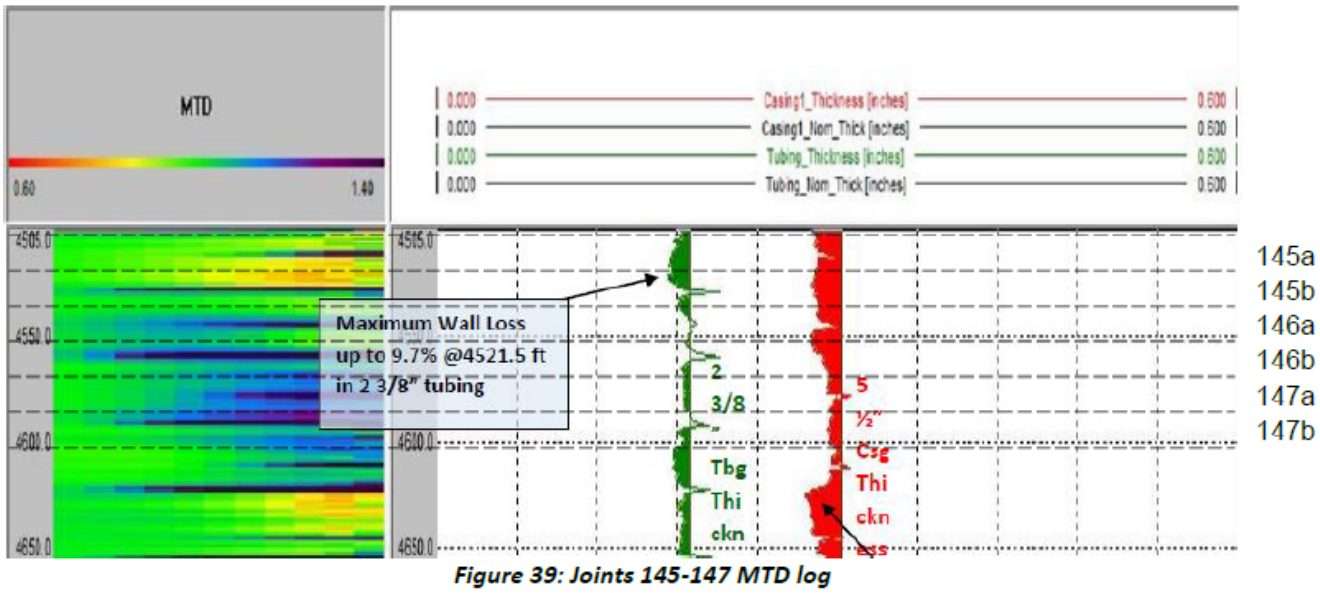


Figure 39: Joints 145-147 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
149	1411.92 – 1421.46 (4632 – 4665)	High pitting

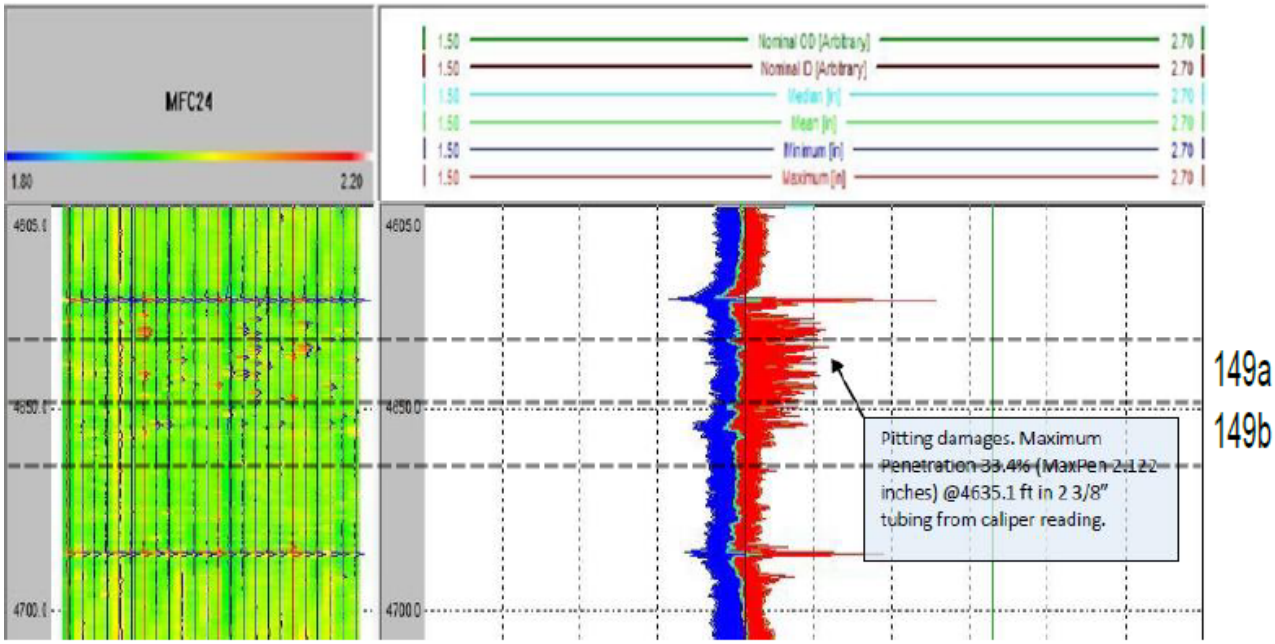


Figure 40: Joint 149 MFC log

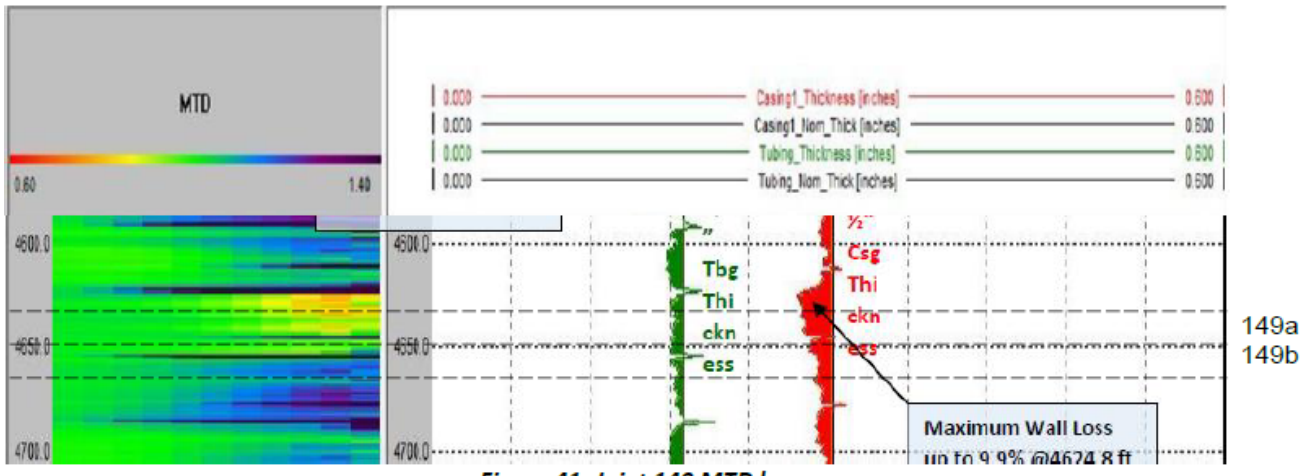


Figure 41: Joint 149 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
155 - 156	1469.16 – 1488.24 (4820 – 4883)	Damaged pipe

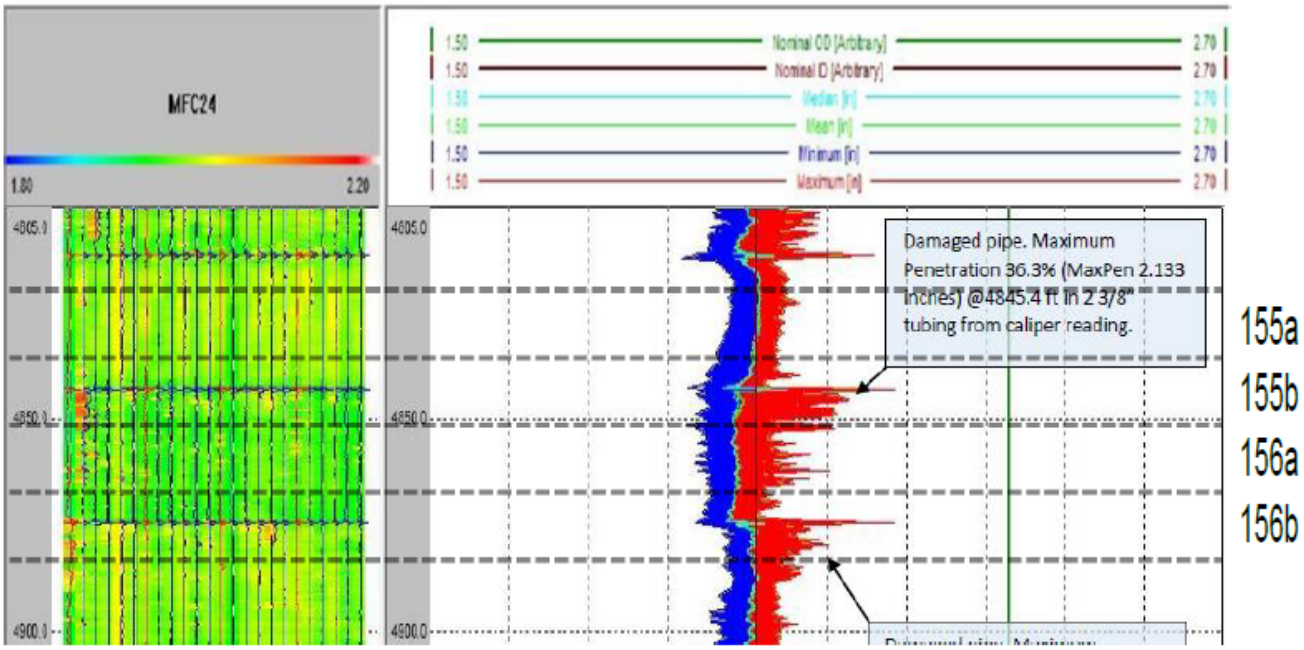


Figure 42: Joints 155-156 MFC log

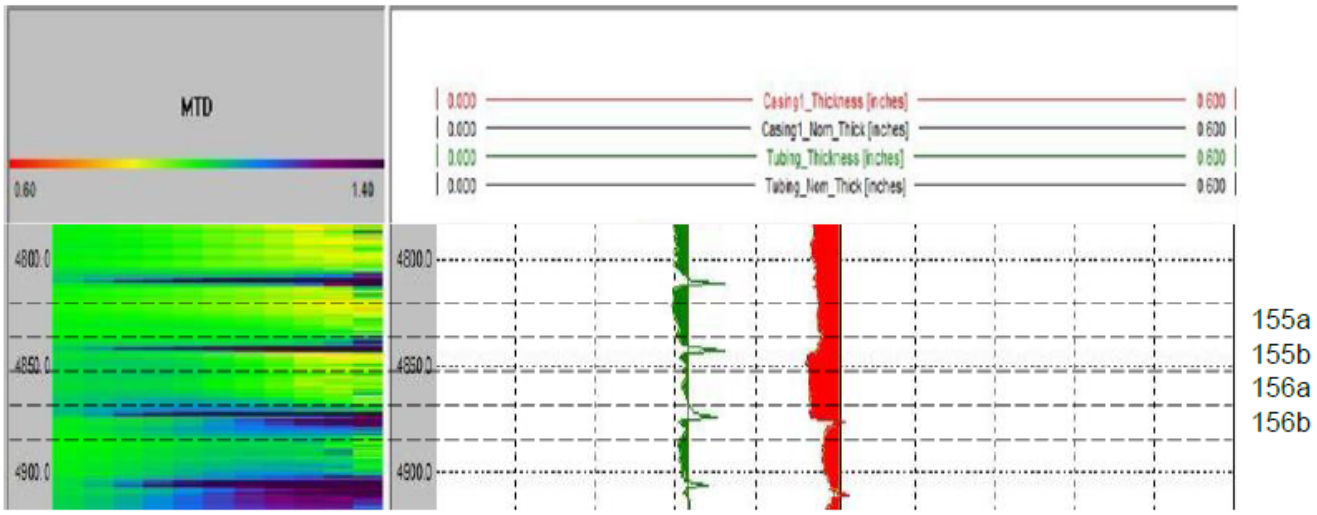


Figure 43: Joints 155-156 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
174 - 176	1650.42 – 1679.04 (5414 – 5509)	High pitting

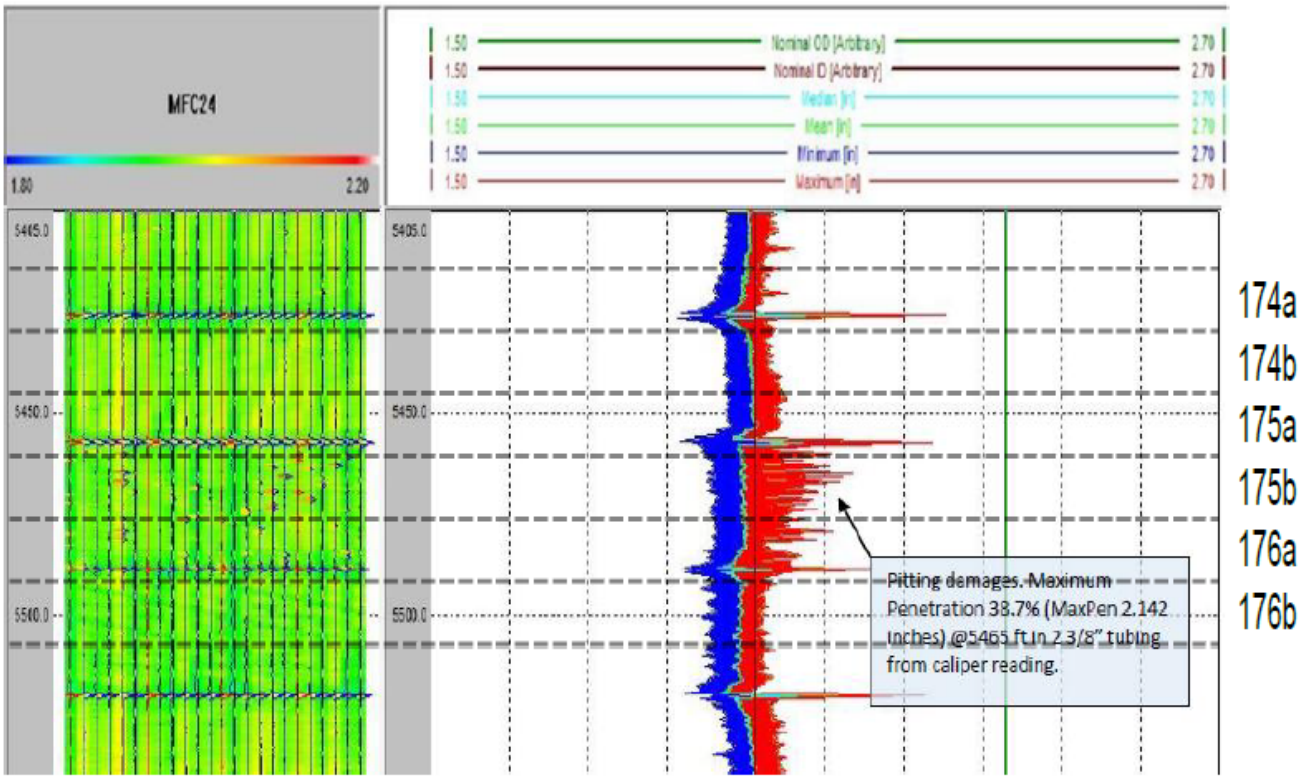


Figure 44: Joints 174-176 MFC log

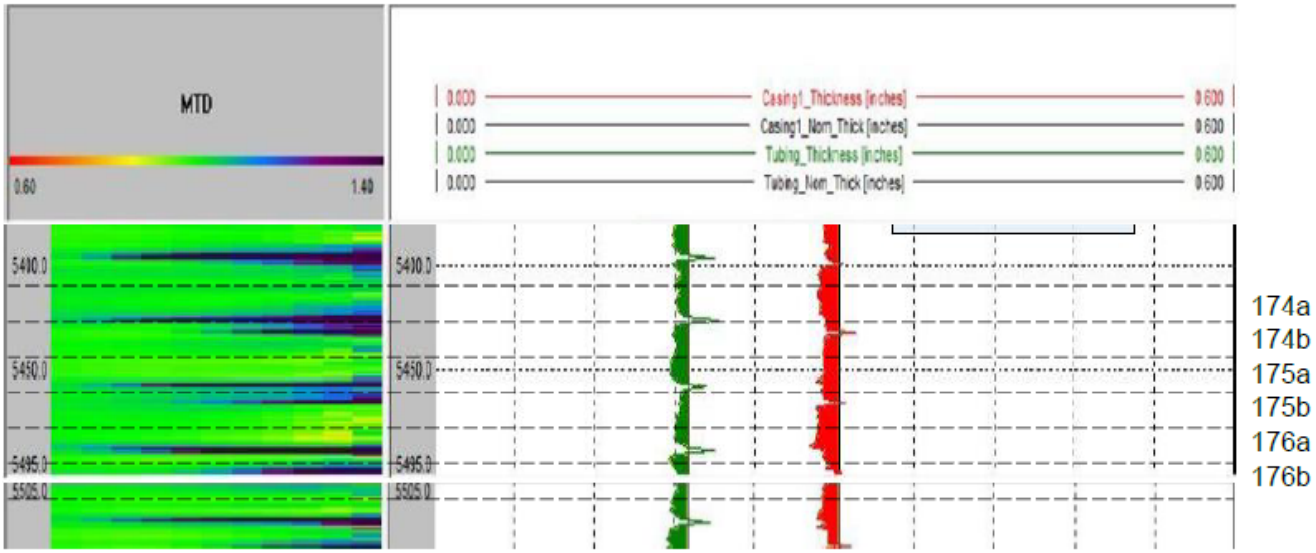


Figure 45: Joints 174-176 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
192	1822.14 – 1831.68 (5978 – 6009)	Sample point

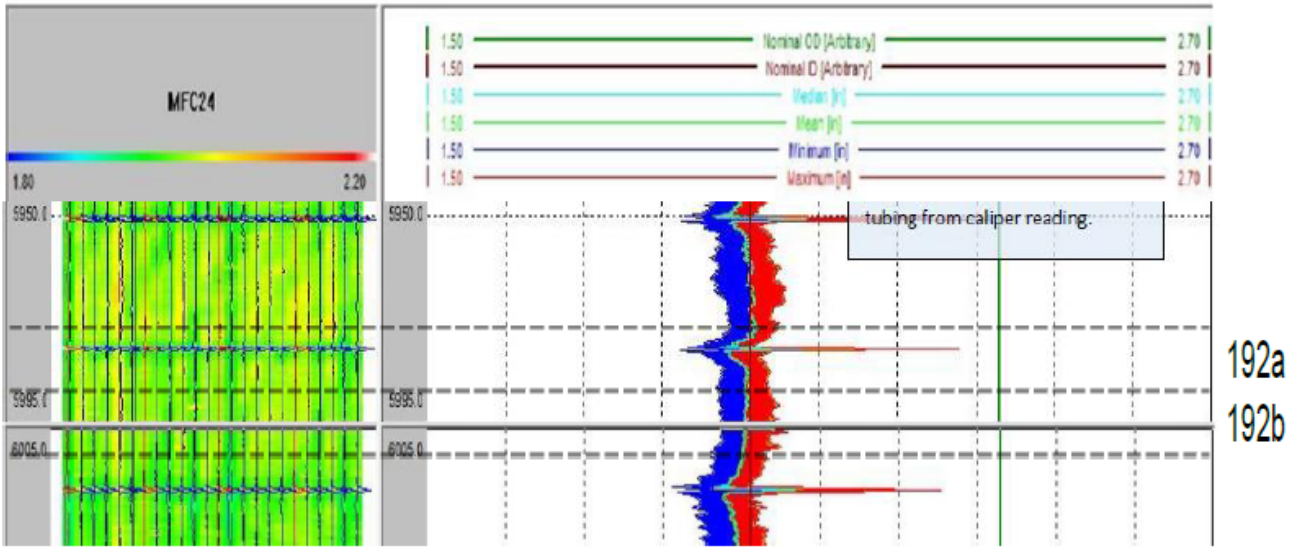


Figure 46: Joint 192 MFC log

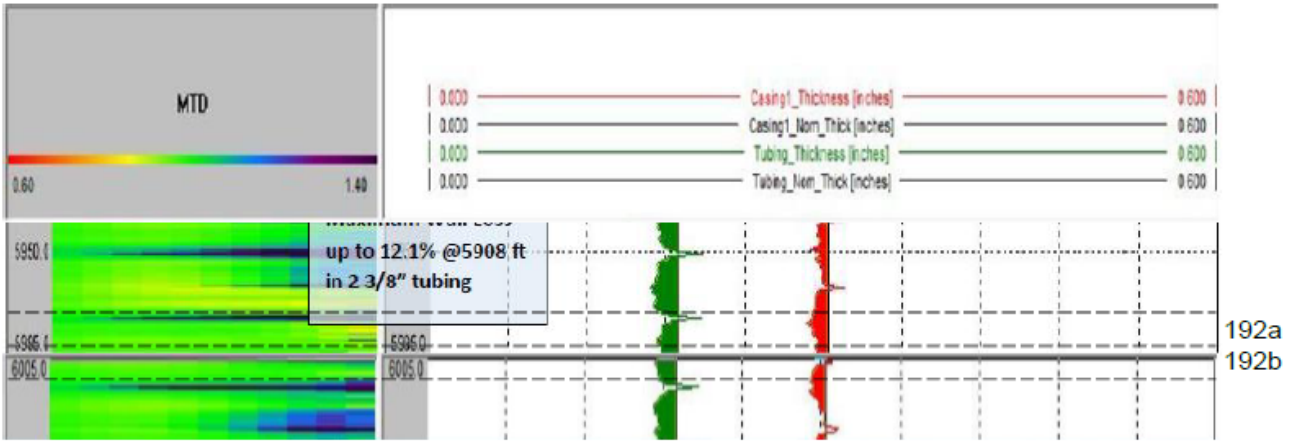


Figure 47: Joint 192 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
215 - 216	2041.56 – 2060.64 (6698 – 6761)	Scale build-up

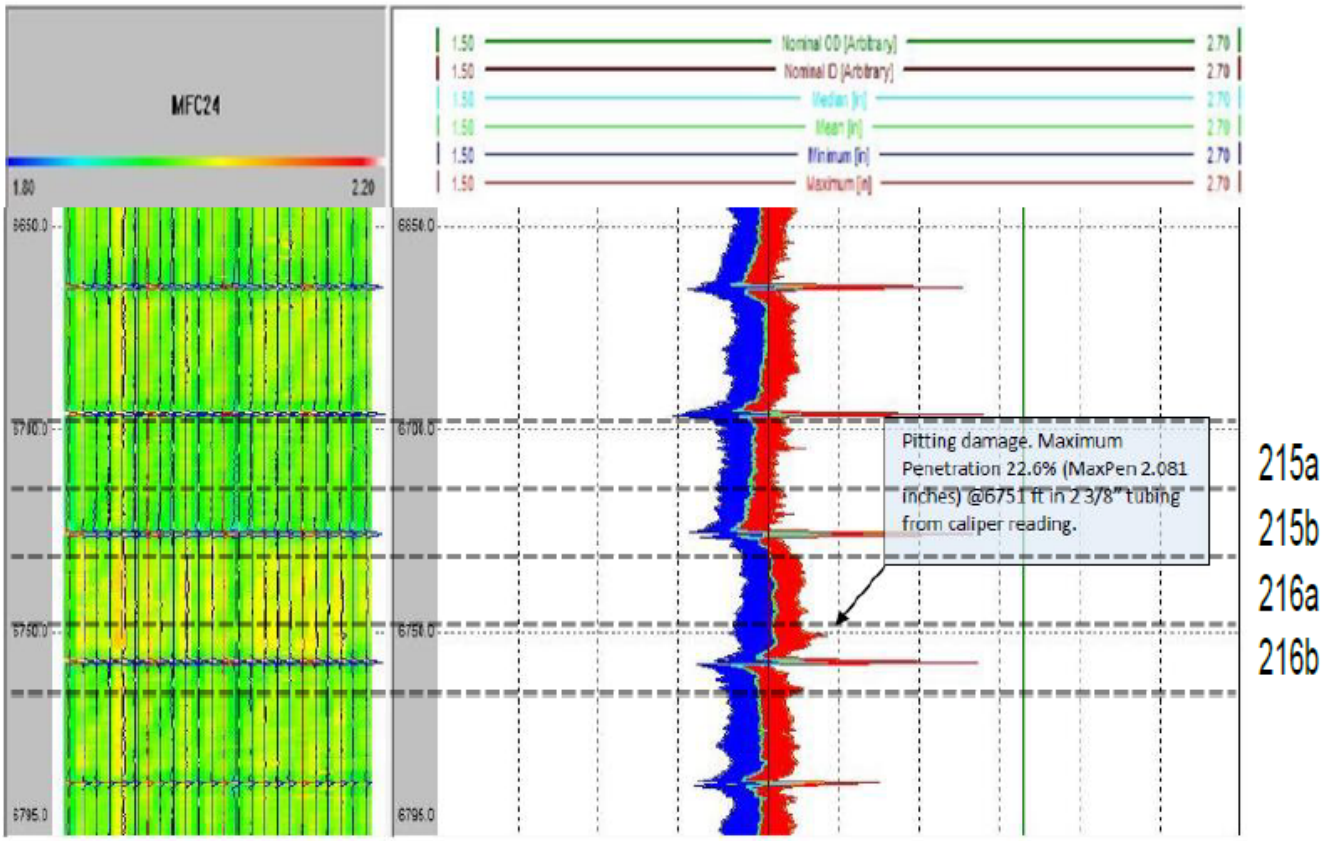


Figure 48: Joints 215-216 MFC log

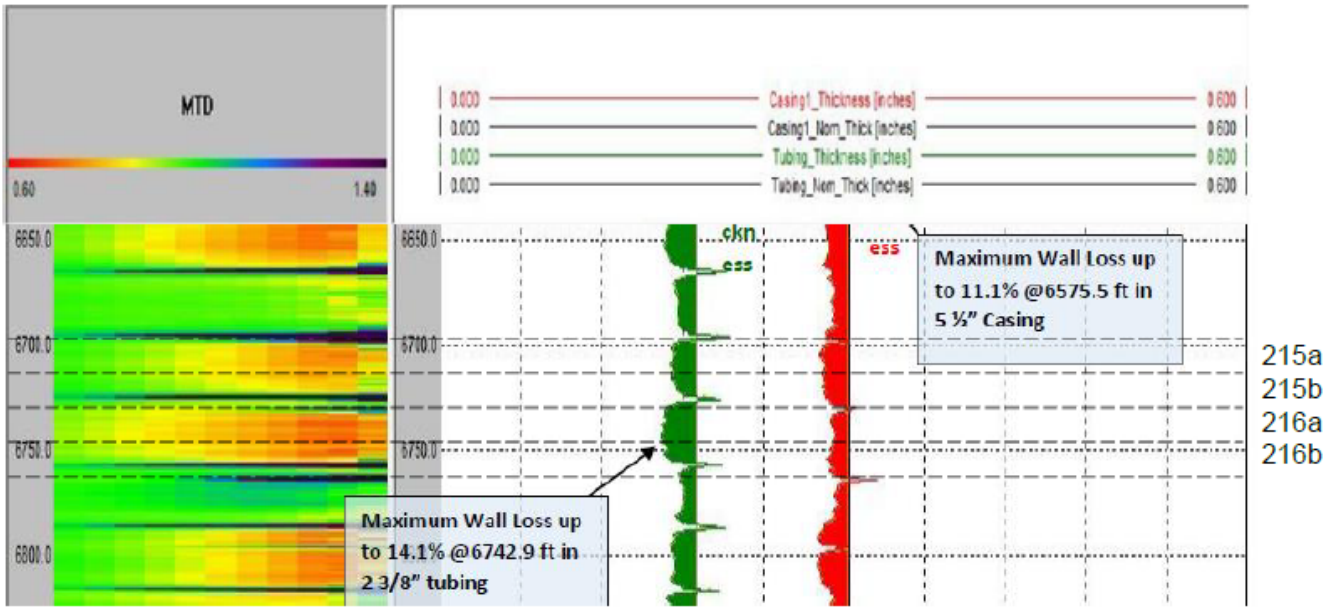


Figure 49: Joints 215-216 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
244 - 245	2318.22 – 2337.30 (7606 – 7668)	?
246 - 248	2337.30 – 2365.92 (7668 – 7762)	Scale build-up
249 - 250	2365.92 – 2385.00 (7762 – 7825)	Damaged pipe / Last joints

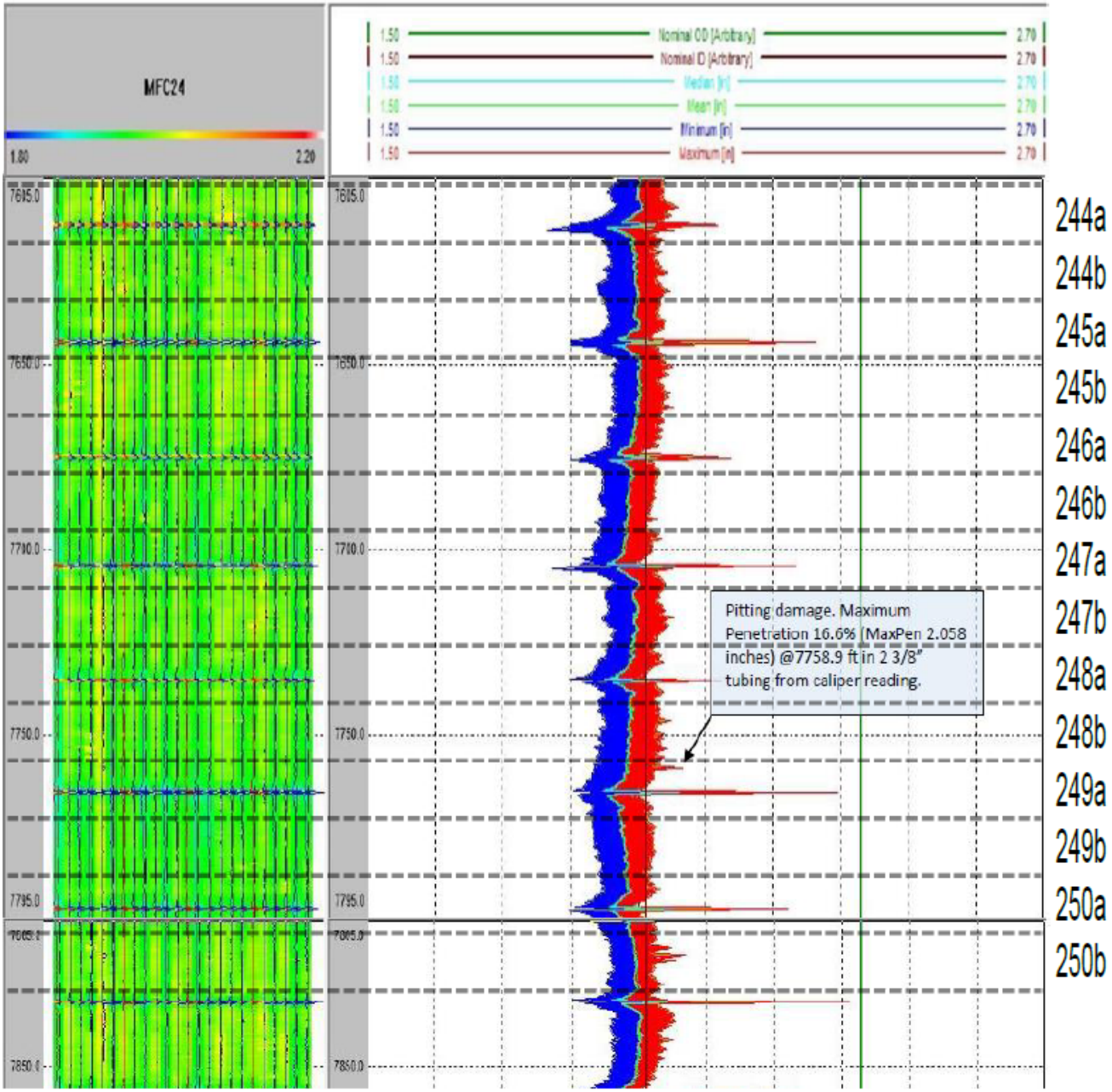


Figure 50: Joints 244-250 MFC log

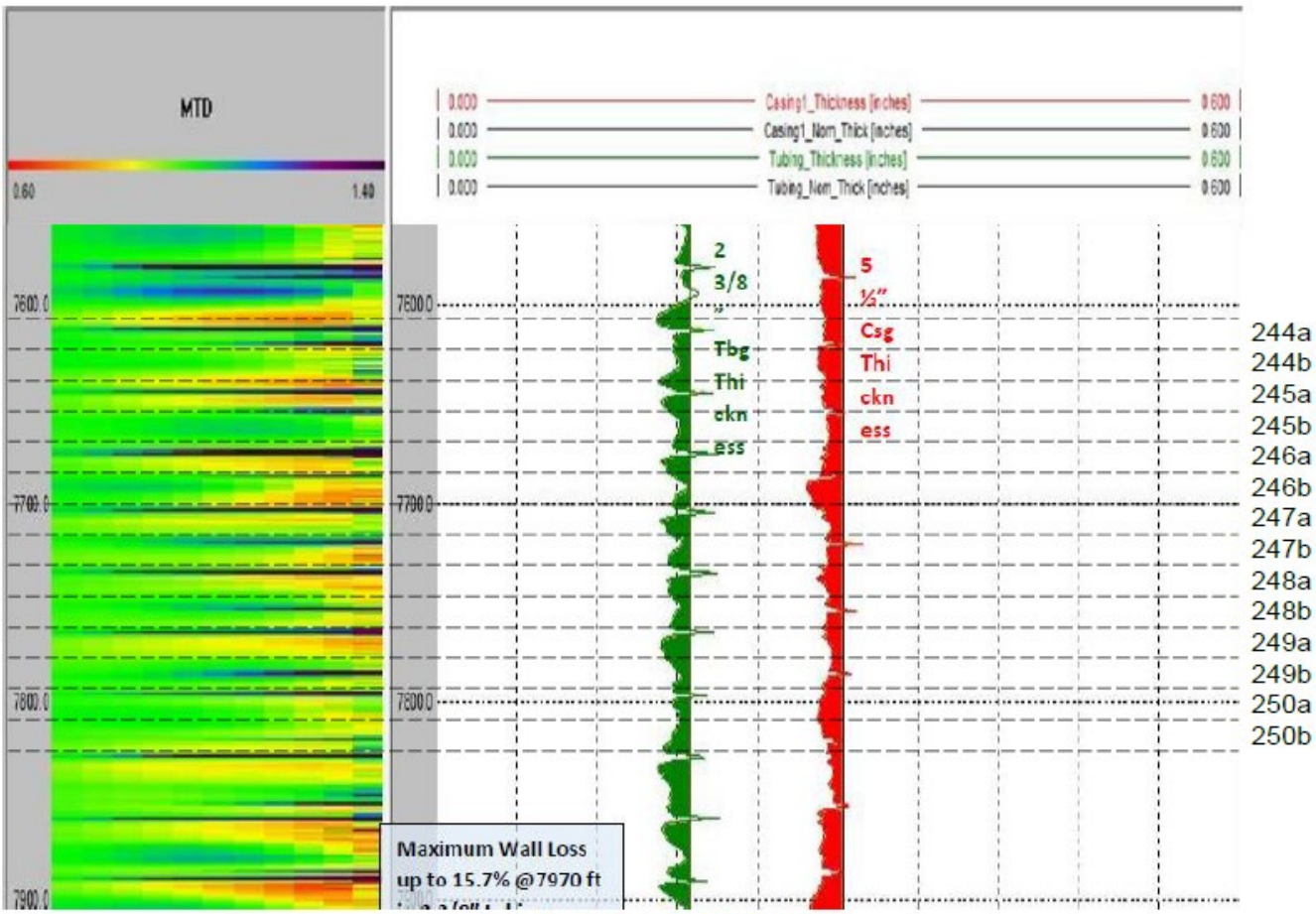


Figure 51: Joints 244-250 MTD log

Appendix B – 5-1/2" Casing MTD Log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
1 - 3	Surface – 30.0 (0 – 98)	Near Surface

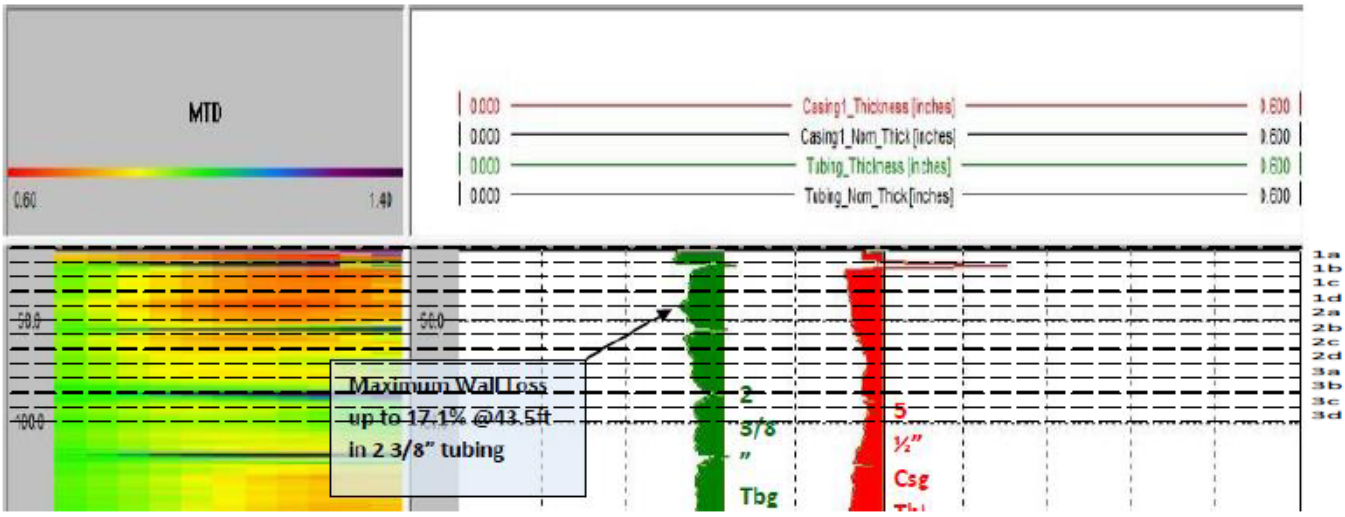


Figure 52: Joints 1-3 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
13 - 14	120.0 – 140.0 (394 – 459)	Scale / eccentricity

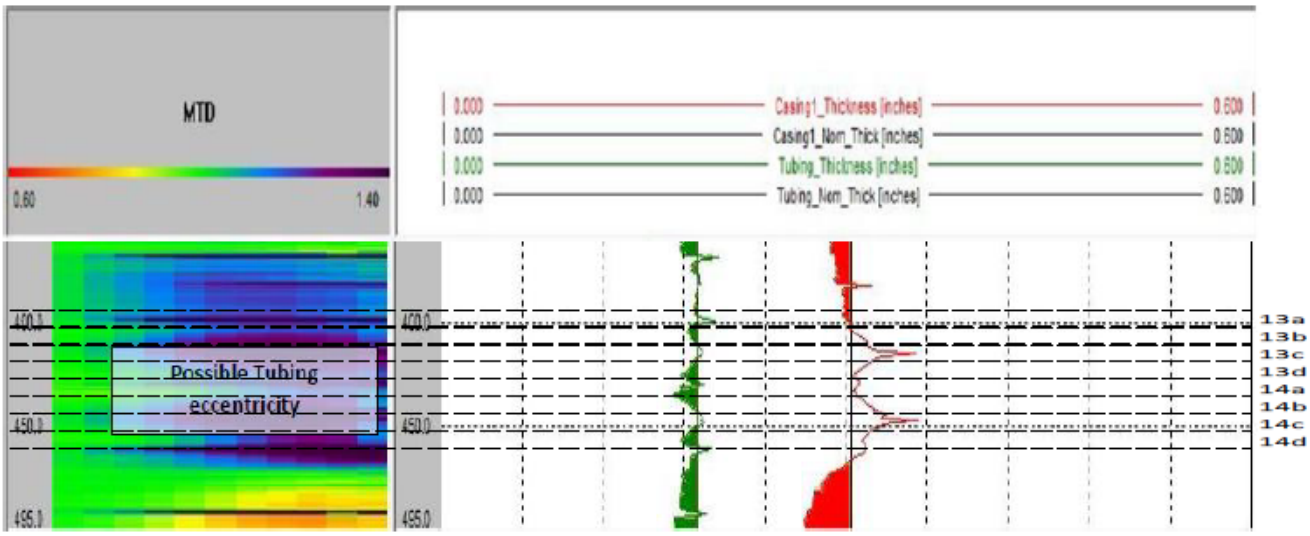


Figure 53: Joints 13-14 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
16 - 17	150.0 – 170.0 (492 – 558)	Maximum wall loss

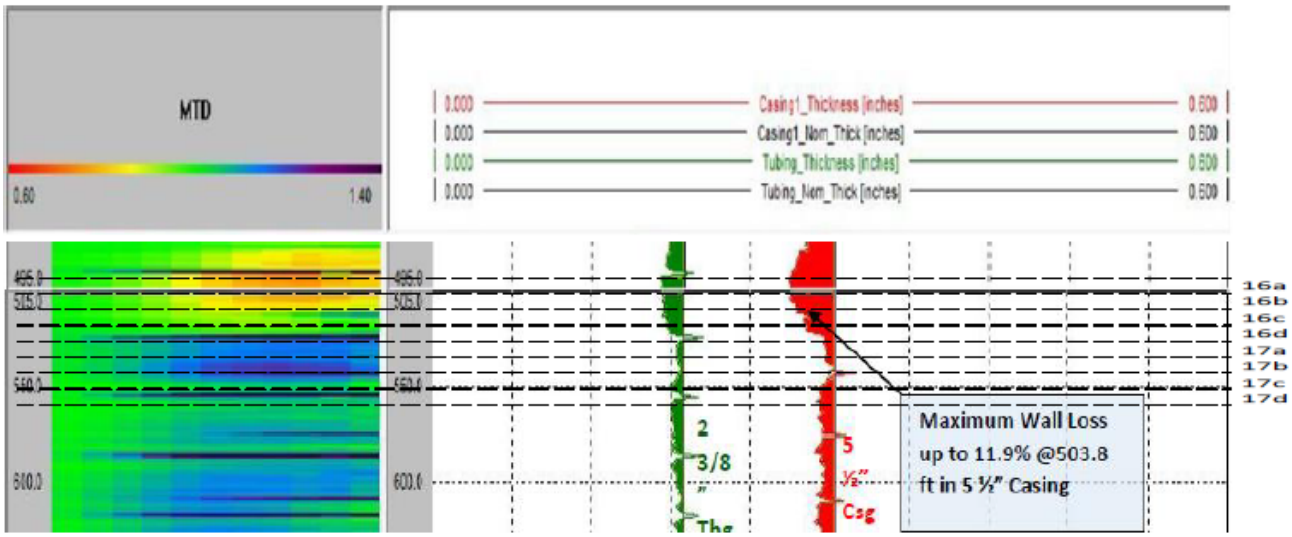


Figure 54: Joints 16-17 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
23 - 24	220.0 – 240.0 (722 – 787)	Anomaly in MTD 2015

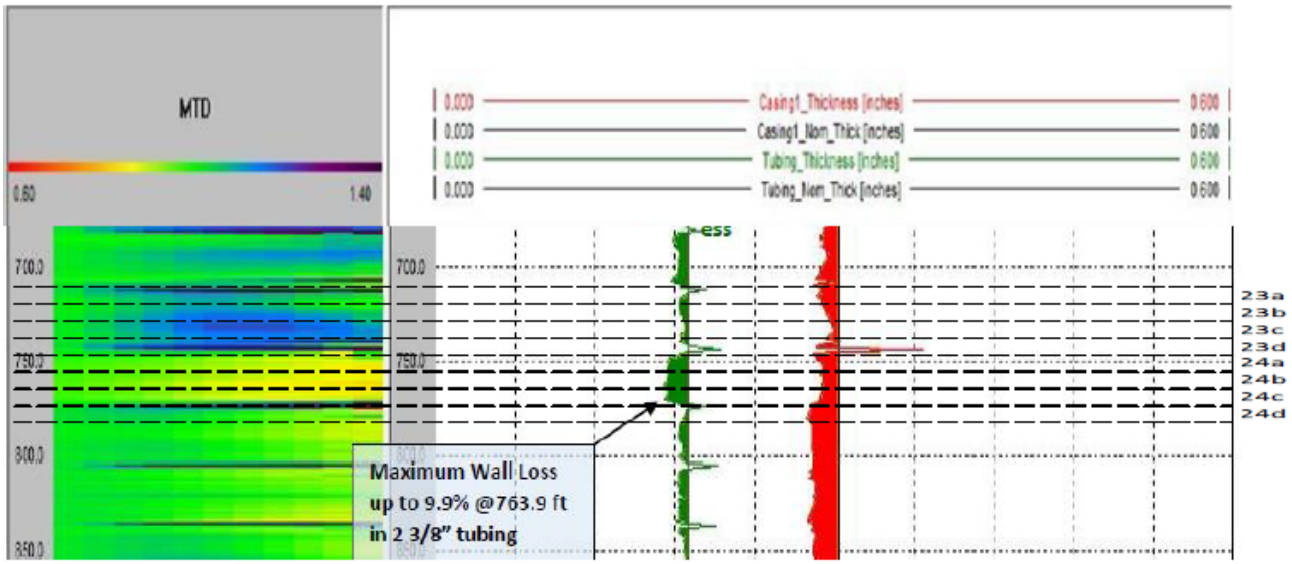


Figure 55: Joints 23-24 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
34 - 37	330.0 – 370.0 (1083 – 1214)	J55/N80 crossover

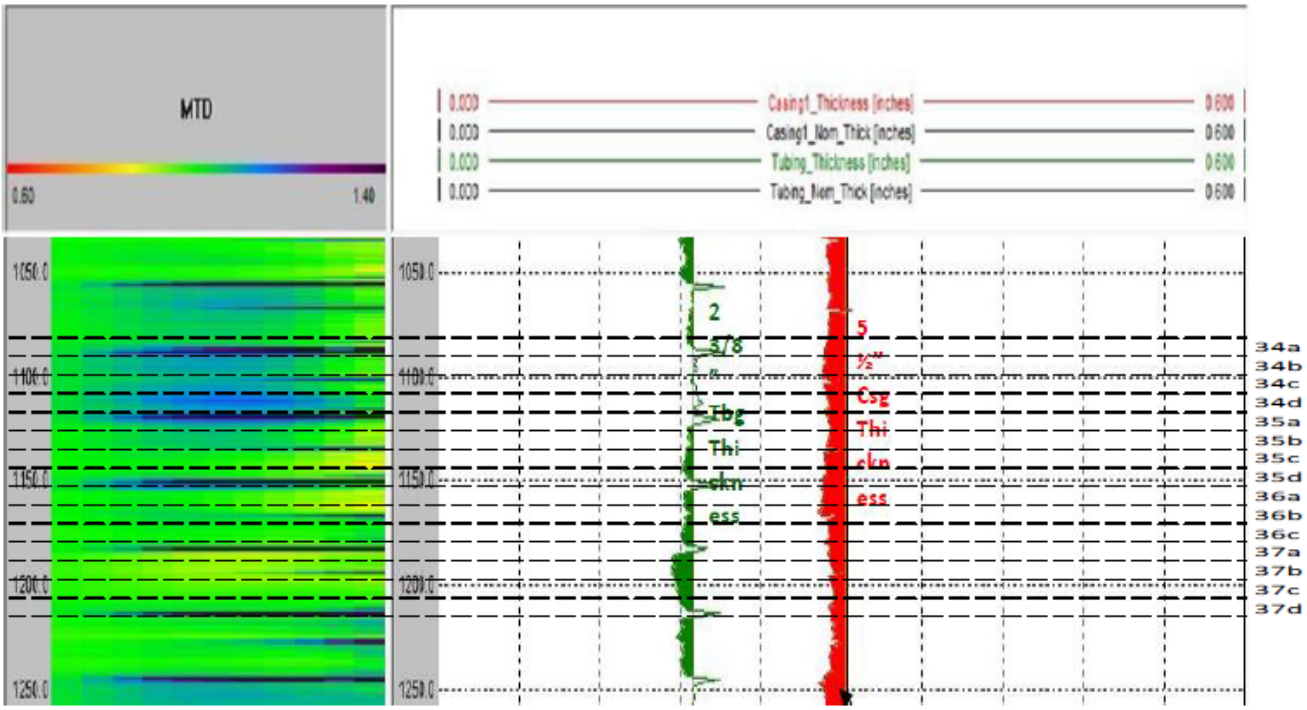


Figure 56: Joints 34-37 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
90 - 91	890.0 – 910.0 (2920 – 2986)	Scaling to wall loss

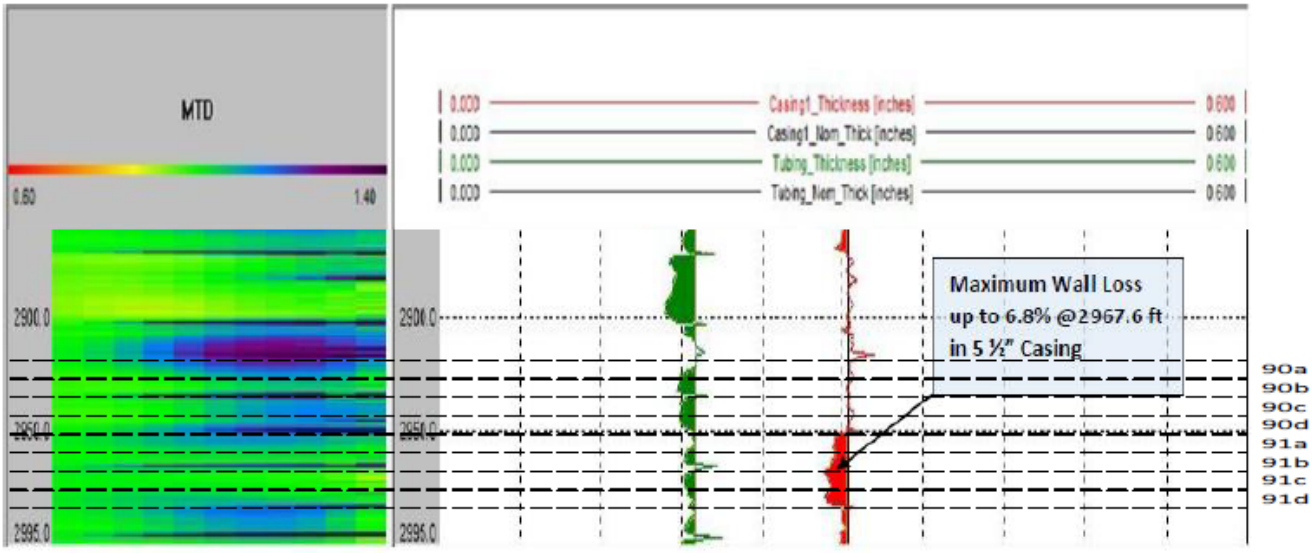


Figure 57: Joints 90-91 MTD log

Joint Range	Est. Depth Range (m (ft))	Reason for Interest
96 – 98	950.0 – 976.0 (3117 – 3202)	Last joints cut & pulled

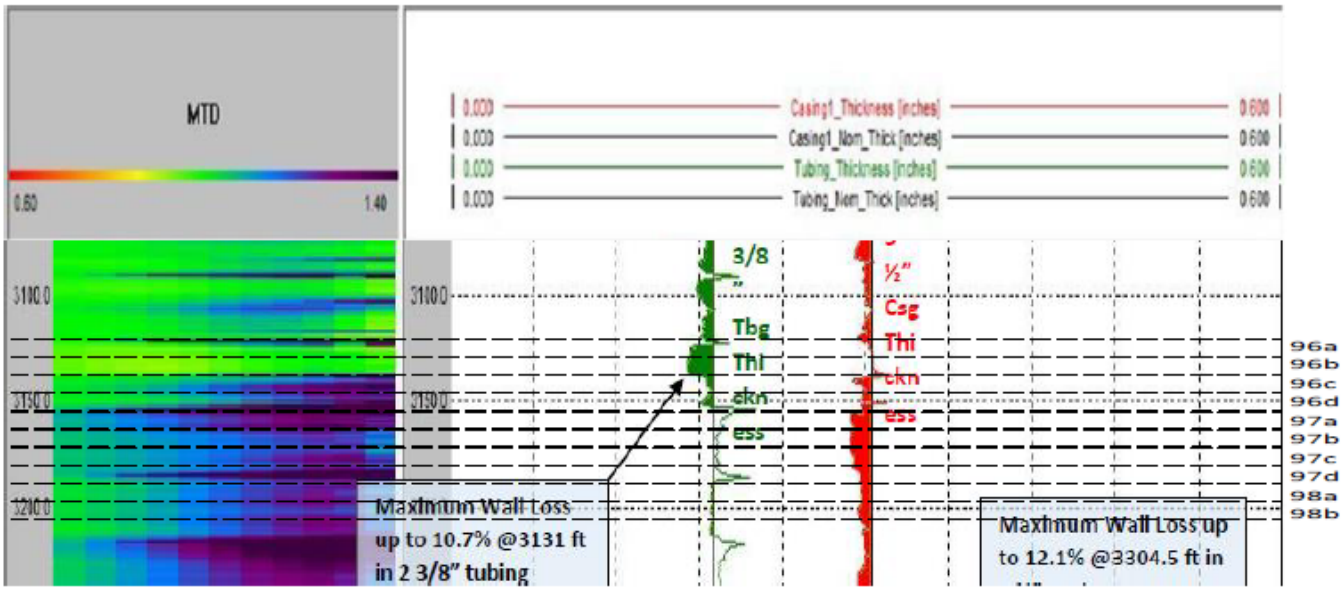


Figure 58: Joints 96-98 MTD log