INSPECTION OF CONDENSATE STABILIZER REBOILER

LOCATION	Indonesia
SERVICE PROVIDER	PT. Grahamas Cipta Mulia

INDUSTRY	Oil and gas

Inspection and tube specifications

DATE OF INSPECTION	23 October 2021
DATE OF REPORT ISSUED	24 October 2021
TOTAL NO. OF TUBES	154
TOTAL NO. OF TUBES INSPECTED	134

CONFIGURATION OF TUBES	U-tubes
TUBE OUTER DIAMETER	19.05 mm
TUBE THICKNESS	2.11 mm
TUBE LENGTH	10.23m (longest), 9.62m (shortest)

THE CHALLENGE

The owner and operator of a liquefied natural gas (LNG) facility has an old reboiler which is prone to corrosion and rust formation due to the environment that they operate in.

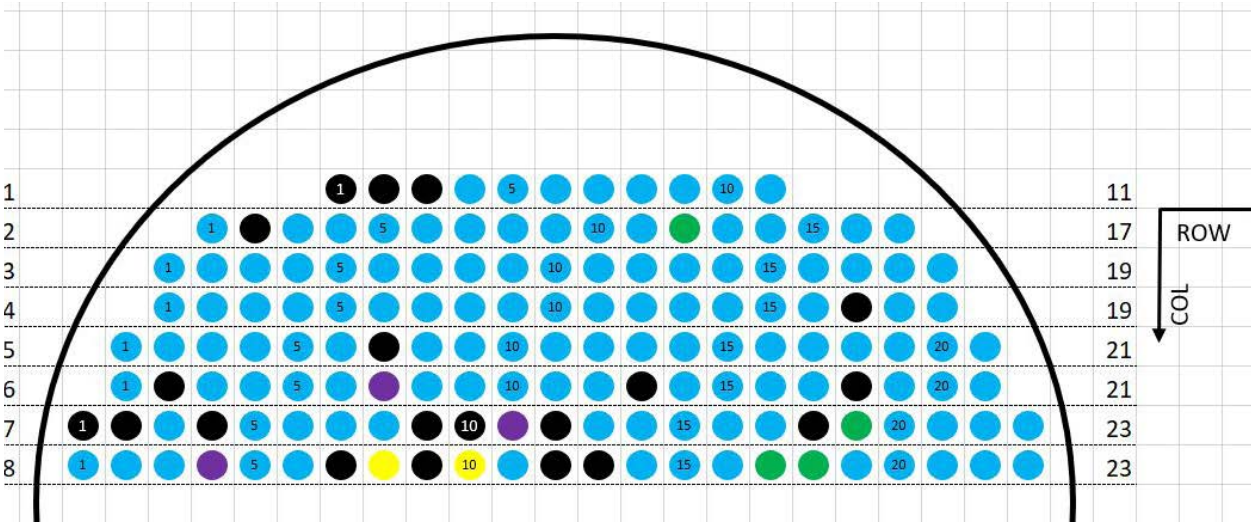
Their intention is to know the extent of corrosion and to ascertain the type of corrosion (erosion or pits). Though IRIS was deployed to inspect 100% tubes, the report didn't indicate any pits from the tube's inner surface which was a surprise to the end user. They had a history of leaks due to pin holes caused by pitting. As told by the end user, this information is vital to assess the root cause of failure and to determine the remaining lifetime of the reboiler.

THE SOLUTION

Acoustic Pulse Reflectometry Technology Inspection System (APRIS) can identify **holes, blockages, and wall loss** in a tube of regardless of tube configuration and material. It is quick as it takes only **10 seconds per tube** for measurement and indicate the **location and size of the defects.**

APRIS
ACOUSTIC PULSE REFLECTOMETRY INSPECTION SYSTEM

IRIS REPORTING EXCERPT



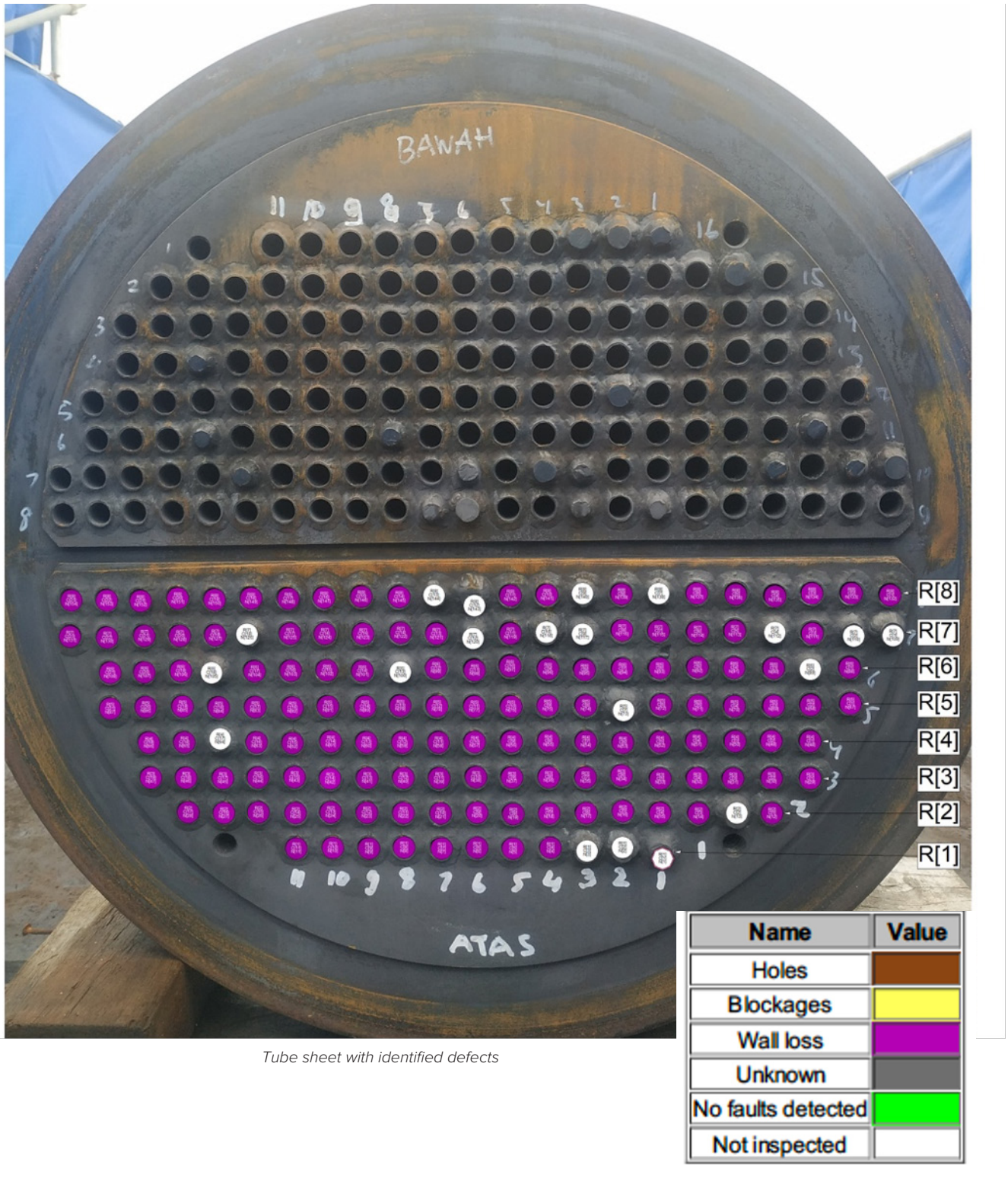
NDD		219		71%
11%	- 20%	8		3%
21%	- 40%	27		9%
41%	- 60%	14		5%
61%	- 100%	-		

No	Row	Column	Depth Wall loss (%)	Range of Defect	Remaining Wall Tickness (mm)	Side	Eval.	Location (from U-Tube), estimate in mm
1	2	6	10%	-	1.90		OD_CORR	1000mm
2	2	8	9%	-	1.92		OD_CORR	670mm
3	2	10	10%	-	1.90		OD_CORR	150mm
4	2	12	13%	-	1.84		OD_CORR	1022mm
5	6	7	33%	-	1.41		OD_PIT	3360mm
6	7	11	38%	-	1.31		OD_PIT	3825mm
7	7	19	20%	-	1.69		OD_CORR	1650mm
8	7	20	9%	-	1.92		OD_CORR	530mm
9	8	4	27%	-	1.54		OD_PIT	3920mm
10	8	8	45%	-	1.16		OD_PIT	4650mm
11	8	10	44%	-	1.18		OD_PIT	4175mm
12	8	17	17%	-	1.75		OD_PIT	273mm
13	8	18	15%	-	1.79		OD_CORR	2100mm
14	9	5	44%	-	1.18		OD_CORR	4300mm
15	9	6	39%	-	1.29		OD_CORR	4300mm
16	9	8	48%	-	1.10		OD_CORR	4350mm
17	9	10	50%	-	1.06		OD_PIT	3490mm
18	9	11	49%	-	1.08		OD_PIT	4300mm
19	10	5	40%	-	1.27		OD_CORR	3720mm
20	10	7	34%	-	1.39		OD_CORR	4100mm
21	10	8	45%	-	1.16		OD_CORR	4140mm
22	10	11	38%	-	1.31		OD_CORR	4220mm
23	10	13	23%	-	1.62		OD_PIT	4260mm
24	10	14	30%	-	1.48		OD_PIT	4320mm
25	10	16	26%	-	1.56		OD_CORR	4350mm
26	11	4	37%	-	1.33		OD_CORR	4330mm
27	11	5	30%	-	1.48		OD_PIT	4300mm
28	11	6	31%	-	1.46		OD_PIT	4300mm

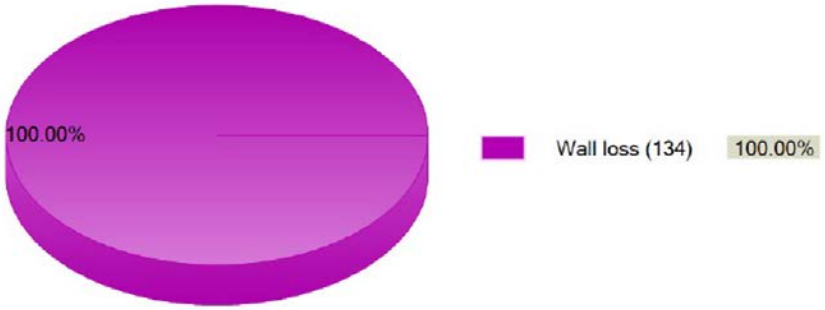
THE RESULT

After inspection using APRIS, all 134 tubes were found to have wall loss of 15-30% and its exact location was reported. 17 of these localized wall losses occurred in the bend area of the tube.

Verification of APRIS inspection was then carried out using boroscope.



Tube sheet with identified defects

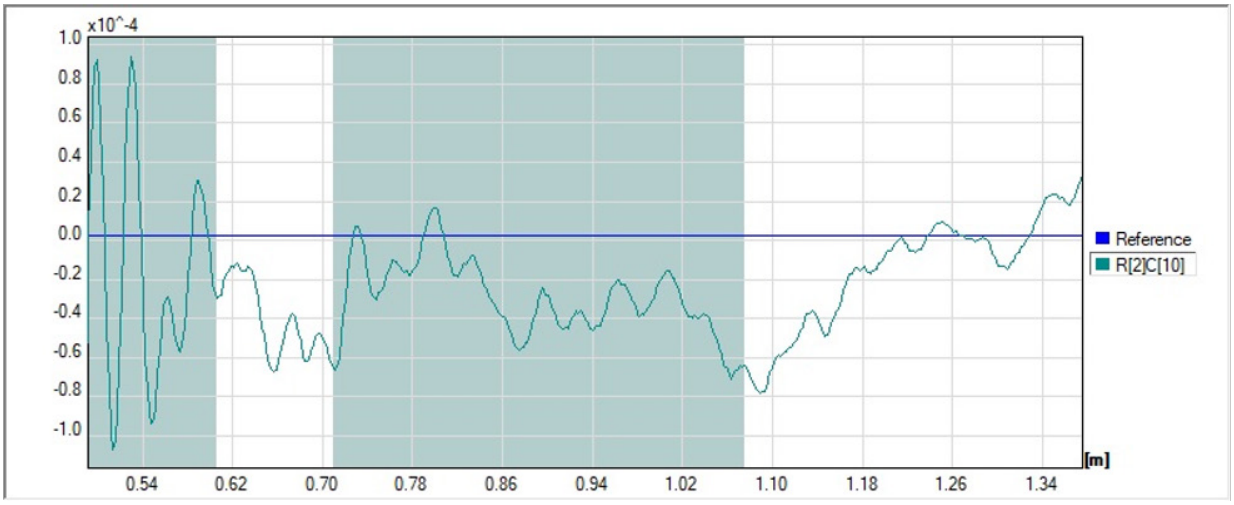


Fault distribution chart

Fault ID	Tube ID	Pos[m]	Type	Size	Comments	Graph
249	R[1]C[4]	5.46	Wall loss	30 %		Link
251	R[1]C[5]	4.03	Wall loss	25 %		Link
253	R[1]C[6]	8.12	Wall loss	30 %		Link
255	R[1]C[7]	2.47	Wall loss	25 %		Link
257	R[1]C[8]	5.75	Wall loss	25 %		Link
259	R[1]C[9]	2.78	Wall loss	30 %		Link
261	R[1]C[10]	3.43	Wall loss	20 %		Link
263	R[1]C[11]	7.07	Wall loss	30 %		Link
265	R[2]C[1]	5.38	Wall loss	30 %		Link
267	R[2]C[3]	0.88	Wall loss	35 %		Link
269	R[2]C[4]	7.98	Wall loss	20 %		Link
271	R[2]C[5]	3.51	Wall loss	20 %		Link
273	R[2]C[6]	2.51	Wall loss	25 %		Link
275	R[2]C[7]	5.43	Wall loss	25 %		Link
297	R[2]C[8]	4.1	Wall loss	30 %		Link
299	R[2]C[9]	4.55	Wall loss	25 %	Wall loss in bend portion	Link
301	R[2]C[10]	0.93	Wall loss	20 %		Link
303	R[2]C[10]	2.79	Wall loss	30 %		Link
305	R[2]C[11]	5.47	Wall loss	25 %	Wall loss in bend portion	Link

33	R[4]C[5]	5.25	Wall loss	30 %	Wall loss in the bend portion	Link
35	R[4]C[6]	2.31	Wall loss	30 %		Link
41	R[4]C[7]	5.24	Wall loss	30 %	Wall loss in bend portion	Link
37	R[4]C[7]	7.07	Wall loss	15 %		Link
39	R[4]C[7]	8.75	Wall loss	15 %		Link
43	R[4]C[8]	5.84	Wall loss	25 %		Link
45	R[4]C[9]	8.77	Wall loss	25 %		Link
48	R[4]C[10]	8.59	Wall loss	25 %		Link
52	R[4]C[11]	4.03	Wall loss	25 %		Link
50	R[4]C[11]	8.33	Wall loss	30 %		Link
54	R[4]C[12]	5.2	Wall loss	25 %	Wall loss in bend portion	Link
56	R[4]C[13]	5.34	Wall loss	20 %	Wall loss in bend portion	Link
58	R[4]C[14]	2.3	Wall loss	25 %		Link
60	R[4]C[15]	5.26	Wall loss	30 %	Wall loss in bend portion	Link

A portion of defect table (wall loss)



Wall loss signature

VERIFICATION WITH BOROSCOPE

Visual inspection using boroscope was conducted to confirm the tubes internal condition with maximum wall loss of 35%, as IRIS reported defect free on inner surface of all reboiler tubes.

LEARNING

Each tube testing technique has pros and cons. It all depends on the application and nature of defects from the process and operation. An adage from NDT industry, “one NDT technology shall not fulfill all the requirements of end user”. Hence screening followed by inspection not only meets the requirements but also provides confidence to the end user when equipment returns to the operation upon inspection.

Fig 37. Borescope image U-tube Row 7 Column 17 position 2.45m

Fig 38. Borescope image U-tube Row 7 Column 17 position 2.45m

Fig 39. Borescope image U-tube Row 7 Column 17 position 2.45m

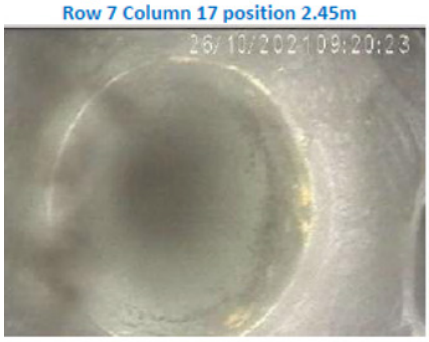


Fig 40. Borescope image U-tube Row 7 Column 20 position 3.17m

Fig 41. Borescope image U-tube Row 7 Column 20 position 3.17m

Fig 42. Borescope image U-tube Row 7 Column 20 position 3.17m

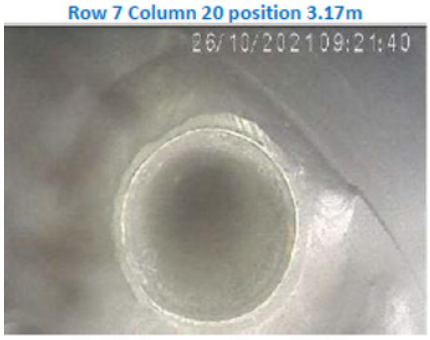


Fig 43. Borescope image U-tube Row 7 Column 23 position 2.48m

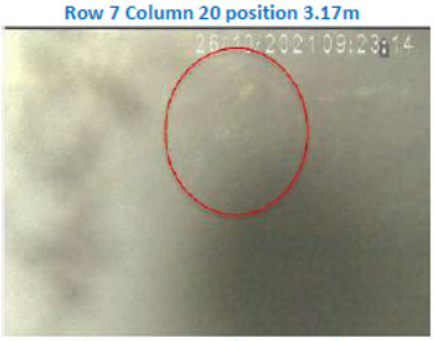


Fig 44. Borescope image U-tube Row 7 Column 23 position 2.48m

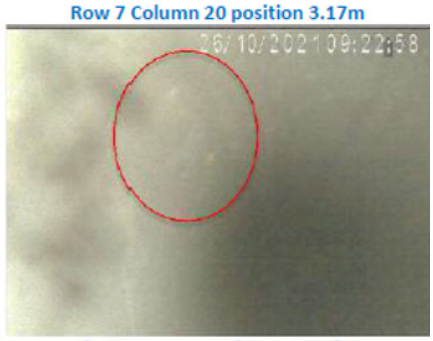


Fig 45. Borescope image U-tube Row 7 Column 23 position 2.48m

Some photographs taken by boroscope

CONCLUSION

The advantages of APRIS were demonstrated by the following:

1. **Speed of measurement** : APRIS was able to quickly assess the condition of the tubes in a fraction of the time as compared to other technologies.
2. **U-bend defect detection** : APRIS was able to detect holes, blockages and wall loss.
3. **Sizing and location indicated** : APRIS indicated the size and location of the defects.

APRIS is recommended as the **initial non-destructive testing method** for applications such as condensers, reboilers and heat exchangers, which have defects originating from the inner diameter of the tubes.

APRIS was proven to be useful in quickly detecting inner diameter surface defects.

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