

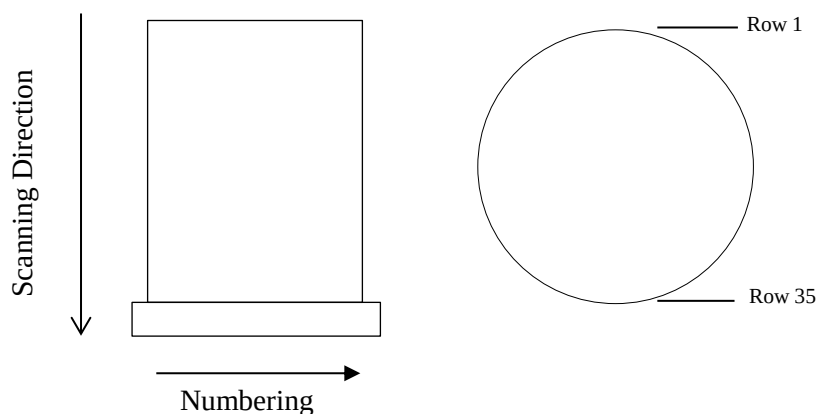


1.0 UNIT / INSPECTION DETAILS

Report Reference	ETI/SJI/SCSL/E111/PR/21
Client	Shell Chemicals Seraya Pte. Ltd.
Plant	SMPO - 1
Location	Jurong Island, Singapore
Component Type	Heat Exchanger
Component S/N	E111 – Recycle Water Cooler
Orientation	Horizontal
Tube Material	Titanium
Tube Details	19.05mm O.D., 2.00mm W.Thk, 7333mm Length
Tubes in the bundle	1061 Tubes
Total tubes inspected	1061 Tubes (ECT) & 9 Tubes (IRIS)
Reference standard	ASME SEC V ARTICLE 8 (2019) & Escon's Internal Procedure for IRIS
Procedure	WI-ESCON-01 - ECT Procedure Rev 2 & WI-ESCON-02 - IRIS Procedure Rev 2
Calibration Standard S/N	19.05 / 2.03 -TITANIUM- 01E - SG (For ECT) & 1 st Backwall echo is used as reference for IRIS
Inspection period	2 & 4 August 2021
Equipment used	Eddyfi Reddy (S/N: 1934307) & Eddyfi Ectane Series (S/N: 1615801)
Data storage	Hard disk of Reddy & Panasonic Toughbook (S/N: 5HTMA13926)
Probe details	14.0mm OD., Absolute & Differential Bobbin Coil (S/N: 2026703) & Panametrics IRIS Transducers (S/N: 715386)
Probe frequency	40 kHz (Prime, operating frequency) for ECT & 15MHz for IRIS inspection
Turbine details	12mm (S/N: 1724015), Not applicable for ECT
Inspection mode	Immersion - Pulse-Echo, Not applicable for ECT
Probe cable length	20 m
Sampling rate	4000 Hz (Max) for ECT & 17.6KHz for IRIS



Scanning mode	Manual (Data was recorded during the probe pulling sequence)
Scanning speed	≈ 700 - 900 mm/s for ECT & ≈ 70 - 80 mm/s for IRIS
Turbine rotation speed	≈ 70 - 80 Rotation Per Second
Row numbering	Top to bottom (Row 1 to Row 35)
Tube numbering	Left to right
Inspection side	Stationary tube sheet side





2.0 INSPECTION RESULTS

All the 1061 tubes were inspected with ECT, followed by 9 tubes with Ultrasonic IRIS in the unit # E111.

1. *External corrosion was observed in all the tubes inspected, resulting in a maximum of $\leq 20\%$ wall loss. The corrosion was predominantly seen between the stationary tubesheet side and 2nd baffle as counted from the stationary tube sheet side and in some cases it was observed to be scattered along the entire tube length. IRIS cross verification on some randomly selected tubes confirmed the presence of external corrosion with a maximum of 13% wall loss.*
2. *Some scattering of ultrasonic signals were seen mostly due to the corrosion profile/geometry and hence all the values provided herewith are strictly based on the regions from where the ultrasonic reflections were observed.*
3. *IRIS is not a leak detecting system and hence a through hole cannot be picked by IRIS due to lack of reflecting surface.*
4. *Standard differential bobbin coil ECT probe that was used for this inspection is strictly optimized to detect and size localized erosion/pitting corrosion and damage mechanism like circumferential cracks, very fine axial cracks and defects at the tube to tube sheet zone are beyond the detectable limits of such probes.*
5. *The summary of findings of the tubes inspected with IRIS is presented in Table 1, followed by a pictorial representation of the tube sheet diagram.*



Table 1: Summary of findings of IRIS inspection on E111

Row	Tube	AWT(mm)	MWT(mm)	%WL
3	2	2.14	1.88	6
3	3	2.23	1.91	4
9	29	2.20	1.91	4
10	28	2.19	1.95	3
13	5	2.13	1.85	7
15	36	2.12	1.79	10
23	31	2.08	1.73	13
23	33	2.12	1.79	10
25	23	2.10	1.79	10

Legend:

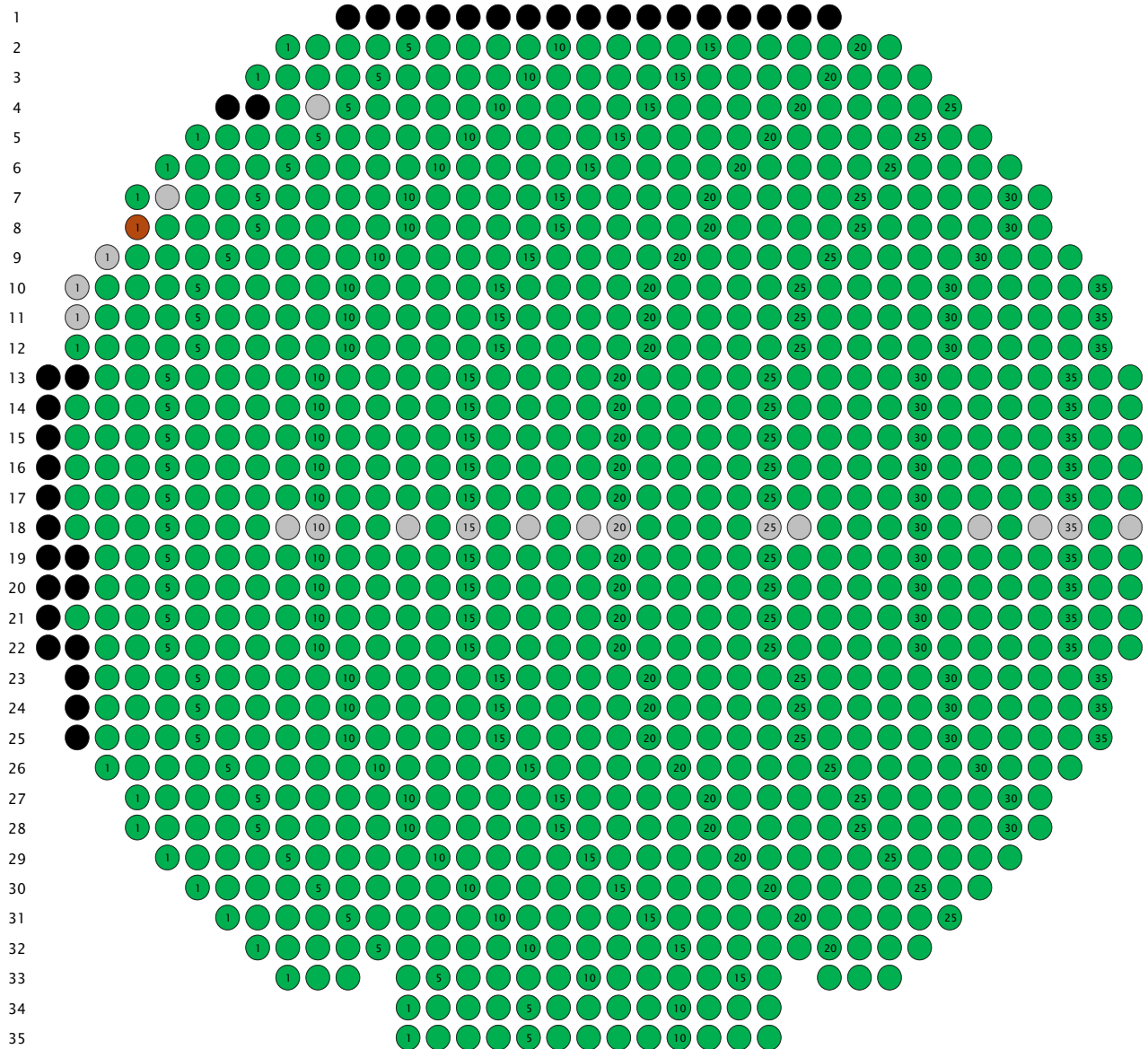
AWT (mm) – Average wall thickness

MWT (mm) – Minimum wall thickness

WL – Wall loss based on the nominal wall thickness of 2.00mm



ECT & IRIS inspection on E111



WL ≤20% OD	
WL ≤20% OD & PB	
Blocked	
Plugged	

Uninspected	0	0.0%
WL ≤20% OD	1006	94.8%
WL ≤20% OD & PB	18	1.7%
Blocked	1	0.1%
Plugged	36	3.4%
Total Tubes	1061	100%

Note: PB – Partially blocked
OD – Outer diameter