

Report on Inspection on KANGRIM Aux. Boilers And Economizers

Subject LNG SOYO	Page 1/22
Customer TEEKAY SHIPPING LIMITED	Issued by Kaswadi Hussein
Place of Inspection ANCHORAGE, SINGAPORE	Date of Inspection 01/12/2013

Introduction

IMC FZC Hamriyah – Sharjah, was requested to attend the vessel “LNG SOYO” which was in, Western Anchorage, Singapore with a view to carry out inspection of the vessel’s Kangrim Aux boiler of 2 Nos. and Kangrim Exhaust Gas Economizers of 4 Nos. The inspection was needed to determine the condition of the existing boiler and exhaust gas system.

Inspection equipment used:

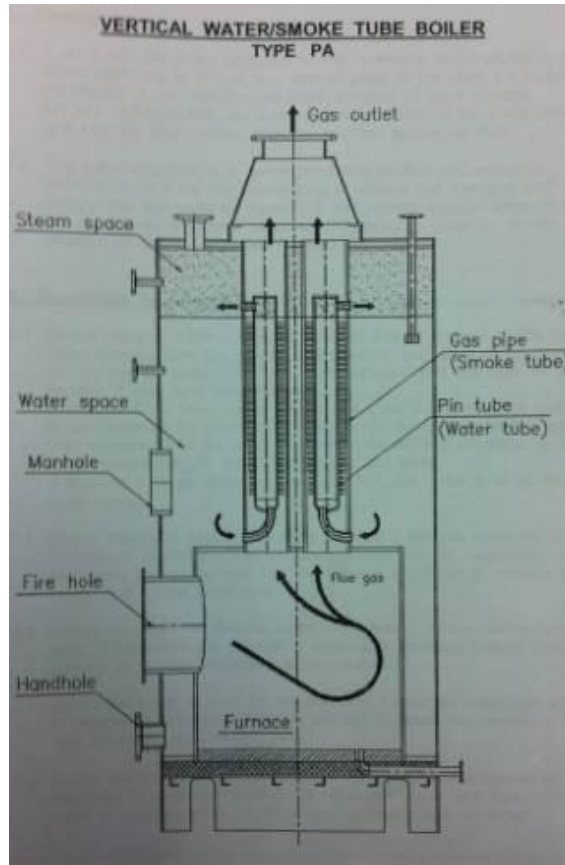
- U .T. Gauging Set
- Portable Fibro scope 15 metre long
- Fluke Laser Distance calculator
- Pitting level gauge

Fibro scope inspection was carried out on the representative section of the following tubes in the Economizer. The tubes were inspected for the full length of 20% the total number of tubes found on the tube plate

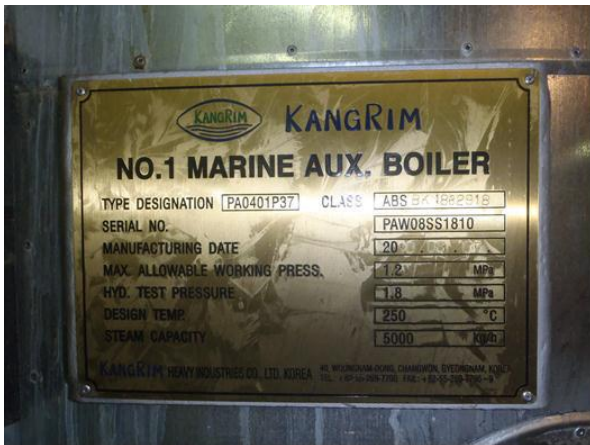
Boiler design data

Type of boiler	:	Kangrim 5T
Number of boiler(s)	:	02
Number of Economizer(s)	:	04
Boiler no.	:	PAW08SS1810 (Port & STBD)
Building year	:	07/08/2007
Class approval	:	ABS
Max. working pressure MPa	:	1.2
Steam evaporation kg/h	:	5,000
Steam temperature	:	2500C

General Structure of the Kangrim Type PA Auxiliary Boiler.



Dwg 1.001



Access into auxiliary boiler

Four (4) areas of which entrance into the boiler are currently available to accumulate the various data required for an inspection. These include:-

1. Furnace Chamber
2. Gas uptake side
3. Water Side Manhole

Gas side inspection

a) Inside the furnace

Upon entering into the furnace side, it was observed that refractory in the floor was in good condition with no visible cracking and broken areas. It was noticed to be clean with small amounts of soot in the end floor regions.

b) Pin tubes

The pin tubes assembly is a new version; there was no indication of leaking from the lower elbow. No visible cracks as well from the lower tube plate welding connection. The pin element is clear of soot build up thereby the combustion gas is free flow.

c) Furnace shell plate

The furnace shell was also found in good condition, with minor soot coating at acceptable level. There was no visible deformation, without any sign of overheating and flame impingement.

d) Uptake space

Looking from uptake space, the pin tubes were found generally in good condition, with clean pin element and no obstruction for combustion gas flow. However, there is thick layer of light/loose soot on few areas which are not easily accessible for manual cleaning. The underlying tubes are in same condition as the rest of the generating bank.

The upper tube plate is also found in good condition.

The casing plate in the uptake side was observed to be in good condition with no signs of damage.

Thickness gauging of random generating tubes from uptake side was carried out and the readings are attached in the appendix.

External of the boiler

The insulations/cladding around the boilers was found satisfactory and still fully intact, no visible hot spot or evidence of gas leaked found.

Wind Box

Air registers inside the wind box and external mountings are in good condition with no signs of visible damages.

Photos taken from Aux. Boiler 1



Pic no. 1 & 2: Burner opened for entrance. Area around the burner and full system appear to be in good clean condition.



Pic no. 3 & 4: Valves in pillows, hand hole cladding, Water level gauge glasses and mountings still in acceptable condition.



Pic 5 & 6 : Gauge glass found to be good condition with water visible and no signs of crack, mounting on top of boiler found to be in good condition.



Pic 7: Safety valves



Pic 8: Entrance into the gas uptake and water side



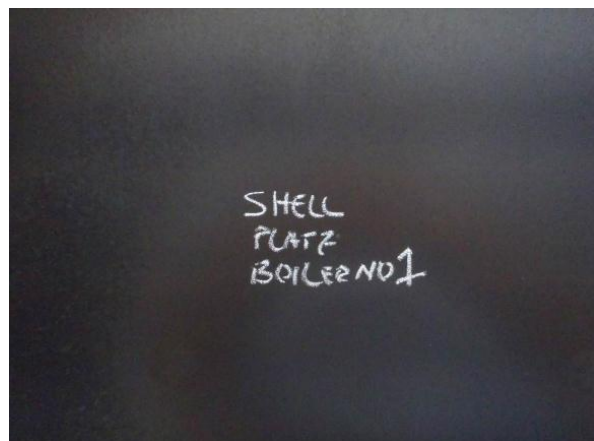
Pic 9: Tubes in gas uptake side in good condition



Pic 10: Gas side tubes plate and ends



Pic 11: Furnace floor refractory still intact with drain plug



Pic 12: Shell plate was found with no distortion/buckle



Pic 13 & 14: Bottom tube plate found without distortion and lower elbow of the pin element-weld connection has no visible crack



Pic 15: Burner assembly-diffuser plate, vanes, nozzle found in sound condition, the refractory as well is good.

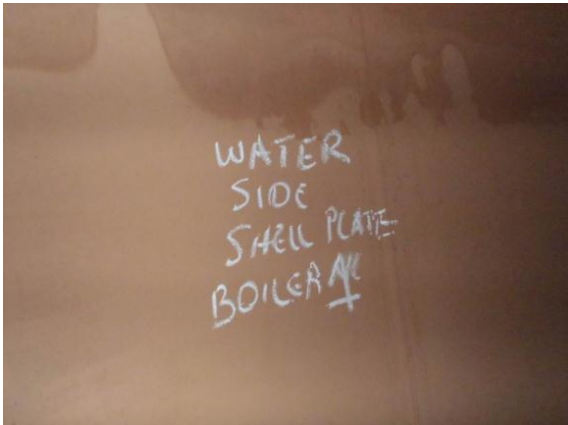
Photos taken from the boilers water space



Pic no 16 & 17: Hand-hole No.01 & 3 seating in acceptable condition with small amounts of soot deposits noticed



Pic no 18 & 19: Showing the bottom ring plate & furnace shell water side seen from hand hole No.1 & 3 respectively. No internal corrosion and negligible loose debris at the bottom



Pic no 20 & 21: Water side shell, top tube plate (Steam space) penetration piping were observed with no visible defects.



Pic no 22 & 23: All boiler internals are in good condition



Pic no 24 & 25: Viewing the boiler steam space, pin tubes were found in very good condition. No internal corrosion and deposits found. **End of auxiliary boiler no.1**

Photos taken from Aux Boiler 2



Pic no 1 & 2 Access to the furnace room and uptake space + manhole on top going to water space are open for entry.



Pic no 3 & 4: Safety valves are in good condition outside and hand hole No.2 was found with minor sign of smoke (gas leak)



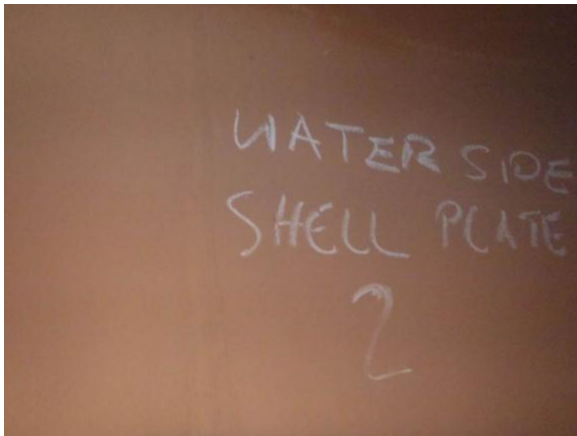
Pic no 5: Furnace entrance and furnace floor refractory



Pic no 6 & 7: Furnace shell plate with no sign deformation or buckle and pin element found to be in good condition, no visible crack or sign of leaked. Soot deposits in acceptable level.



Pic no 8: Looking the pin tubes from the uptake space, all are in good condition including the top tube plate.



Pic no 9 & 10: Boiler shell plate was found in very good condition and the steam space the top tube plate, pin tubes were also found in good condition.



Pic no 11 & 12: Minors scales but not alarming found around the outlet hole some pin tubes



Pic no 13: Showing the bottom ring plate & furnace shell water side. No internal corrosion and negligible loose debris at the bottom

Economizers Inspection

UT-Ultrasonic thickness gauging

In the field of industrial ultrasonic testing, ultrasonic thickness measurement (UTM) is a method of performing non-destructive measurement (gauging) of the local thickness of a solid element (typically made of metal, if using ultrasound testing for industrial purposes) basing on the time taken by the ultrasound wave to return to the surface. This type of measurement is typically performed with an ultrasonic thickness gauge.

We performed UT gauging on a representative of tubes and the data is attached in the appendix in a tabulated form.

The UT gauging readings do not show insignificant thinning at the points that were checked.

Tubes: **Economizer No.1**

Location: Port

Tube Size	Thickness
Tube Number	Measured Thickness
1	4.85/4.83/4.82
4	4.82/4.86/4.85
6	4.70/4.67/4.65
7	4.71/4.75/4.75
8	4.35/4.27/4.26

Tubes: **Economizer No.1**

Location : Starboard

Tube Size	Thickness
Tube Number	Measured Thickness
2	4.81/4.79/4.79
5	4.84/4.85/4.90
6	4.77/4.62/4.69
9	4.34/4.39/4.44
11	4.29/4.37/4.32

Tubes: **Economizer No.2**

Location: Port

Tube Size	Thickness
Tube Number	Measured Thickness
1	4.76/4.83/4.86
3	4.81/4.88/4.78
6	4.98/4.95/4.92
7	4.98/4.93/4.94
8	4.85/4.94/4.86

Tubes: **Economizer No.2**

Location : Starboard

Tube Size	Thickness
Tube Number	Measured Thickness
1	3.67/3.65/3.89
3	3.99/3.96/3.96
6	3.90/3.96/3.59
7	3.65/3.81/3.33
8	3.27/3.72/3.83

Tubes: Economizer No.3

Location: Port

Tube Size	Thickness
Tube Number	Measured Thickness
3	4.94/4.92/4.91
7	4.97/4.98/4.98
8	4.21/4.89/4.94
11	4.85/4.86/4.92
13	4.89/4.92/4.91

Tubes: Economizer No.3

Location : Starboard

Tube Size	Thickness
Tube Number	Measured Thickness
1	4.93/4.93/4.95
6	4.96/4.99/4.95
7	4.56/4.76/4.66
11	4.77/4.74/4.69
12	4.89/4.88/4.76

Tubes: Economizer No.4

Location: Port

Tube Size	Thickness
Tube Number	Measured Thickness
2	4.98/5.00/5.01
3	6.86/6.83/6.90
7	5.17/5.13/5.16
8	6.79/6.78/6.91
10	6.78/6.60/6.67

Tubes: Economizer No.4

Location : Starboard

Tube Size	Thickness
Tube Number	Measured Thickness
1	6.61/6.55/6.43
2	6.78/6.62/6.33
5	5.93/6.23/6.21
8	5.99/6.43/6.33
12	6.22/6.34/6.56

UT Gauging Images



Pic no 1 & 2: UT reading of 6.86 @ the smoke tubes in Economizer No1. And 4.35 @ the smoke tubes in Economizer No 2.



Pic 3 & 4: UT reading of 4.86 @ the smoke tubes in Economizer No 2. And 6.79 @ the smoke tubes in Economizer No 4.

Economizer tubes (External)



Pic 5 & 6: Top tube plate for economizer 1 with slight amounts of soot.



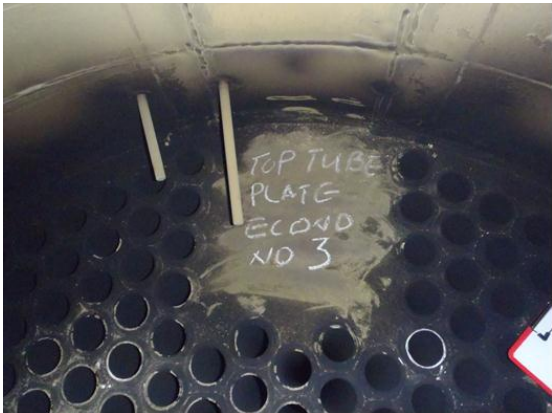
Pic 7 & 8: Top tube plate for economizer 2 with thick amounts of soot.



Pic 8 & 9: Top tube plate for economizer 2 with thick amounts of soot.



Pic 10 & 11: Top tube plate for economizer 2 with thick amounts of soot.



Pic 12 & 13: Top tube plate for economizer 3 with thick amounts of soot.



Pic 14 & 15: Top tube plate for economizer 3 with thick amounts of soot.



Pic 16 & 17: Top tube plate for economizer 4 with thick amounts of soot.



Pic 18 & 19: Top tube plate for economizer 4 with thick amounts of soot

Fibroscope Image (Economizer 1,Port side)



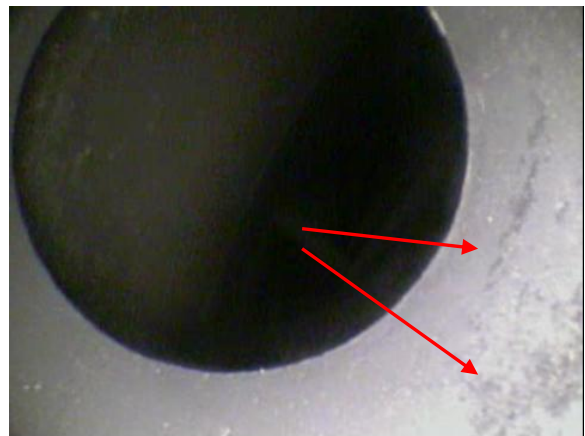
Pic 1: Tube Plate



Pic 2: Tube 004- show minor scaling



Pic 3: Tube 008- observed minor scaling



Pic 4: Tube025- small oil deposit
cause unknown



Pic 5: Tube 044- Showing carbon deposits

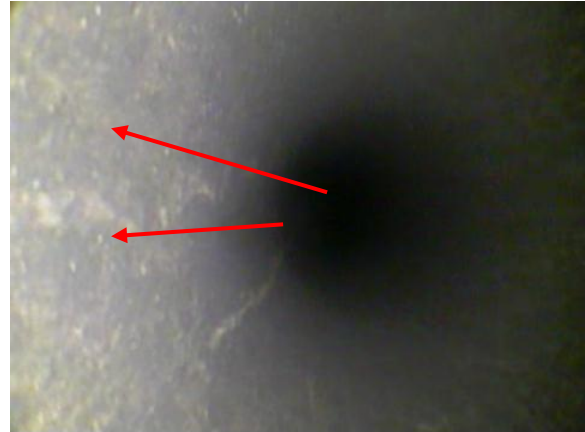


Pic 6: Tube 061-build-up of carbon and
scabs

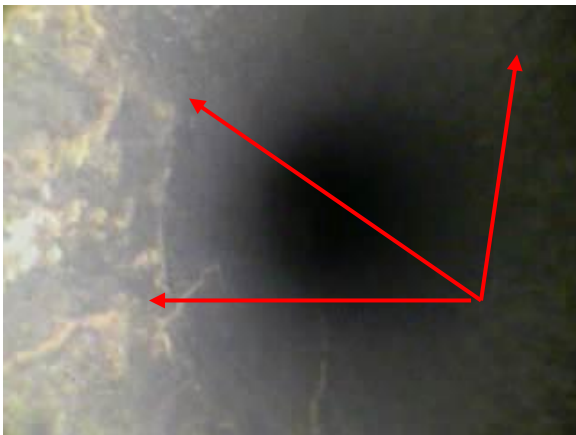
Fibroscope Image (Economizer 2, Port side)



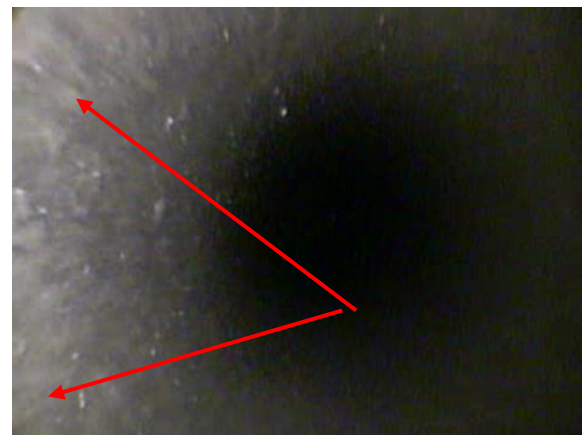
Pic 7: Tube 004- tube plate in acceptable condition



Pic 8: Tube 014- Soot deposits observed.



Pic 9: Tube 025- Scale and soot build up



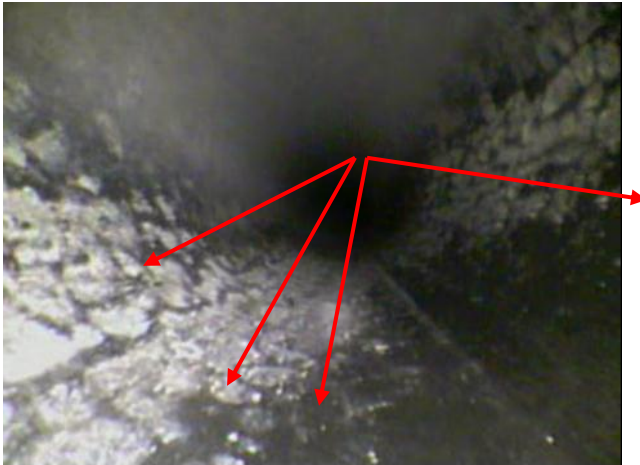
Pic 10: Tube 041- Soot build up observed



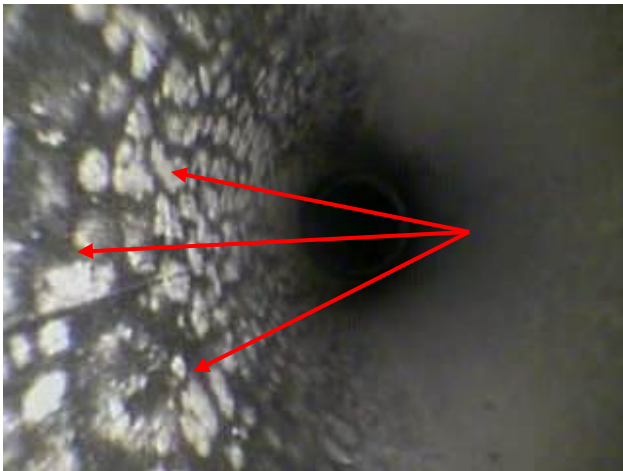
Pic 11: Tube 038- Soot build up con't



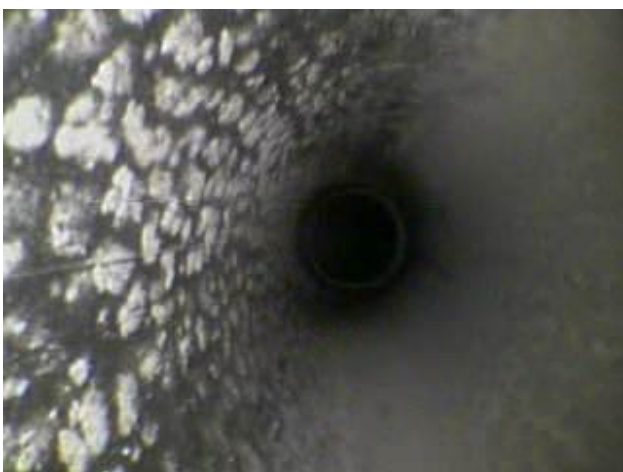
Pic 12: Tube 052- Soot and carbon build up con't



Pic 13: Tube 066- Without any proper chemical analysis, could not determine the origins of the stains and could only conclude that it could be due to bad combustion from the exhaust side



Pic 14: Tube 069- Continuation from the statement as above.



Pic 15: Tube 072- Continuation from the statement as above.

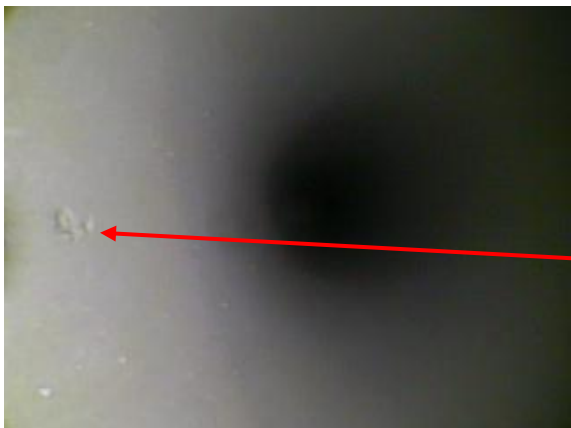
Fibroscope Image (Economizer 3, Starboard side)



Pic 16: Tube 007- Slight scaling seen



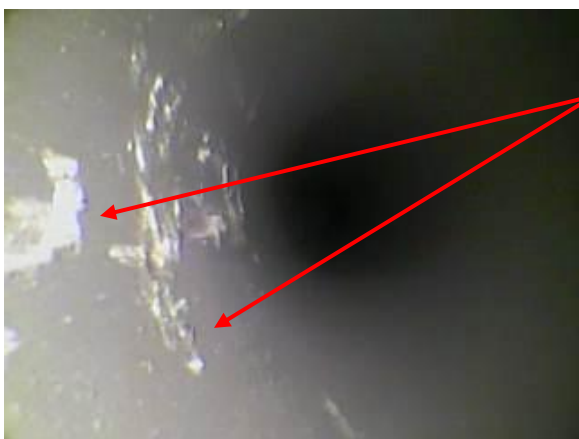
Pic 17: Tube 019- Slight scaling seen



Pic 18: Tube037- small areas noticed with pits



Pic 19: Tube044- Small amounts of scaling



Pic 20: Tube 054- Slight scales noticed



Pic 21: Tube062- Scales & soot observed

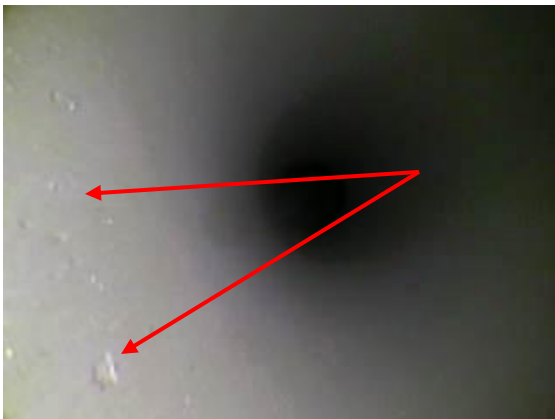


Pic 22: Tube 070- Scaling observed

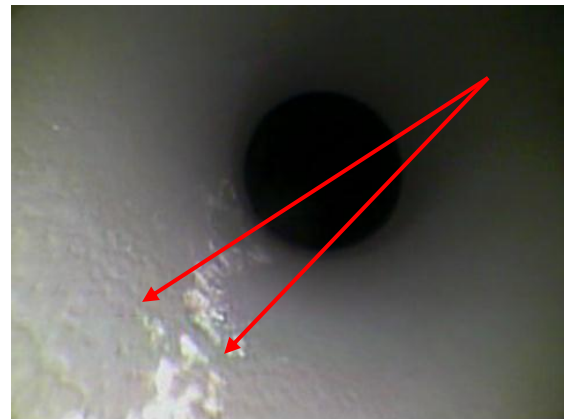


Pic 23: Tube 072- Scaling con't

Fibroscope Image (Economizer 4, Starboard Side)



Pic 24: Tubes 007- Slight pitting is observed



Pic 25: Tubes 015- Bad combusted chemical of unknown origin seen



Pic 26: Tube 022- Continued from pic above



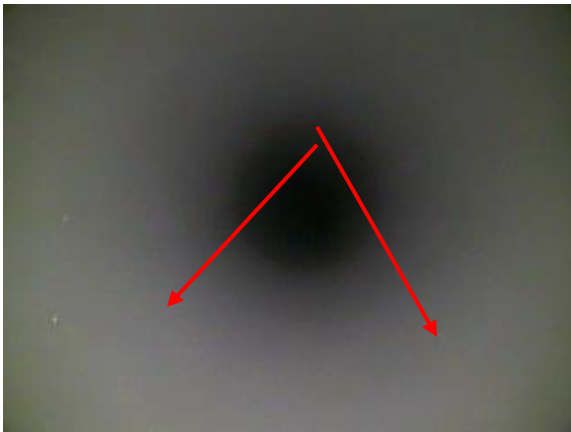
Pic 27: Tube 035- Heavy build-up of soot



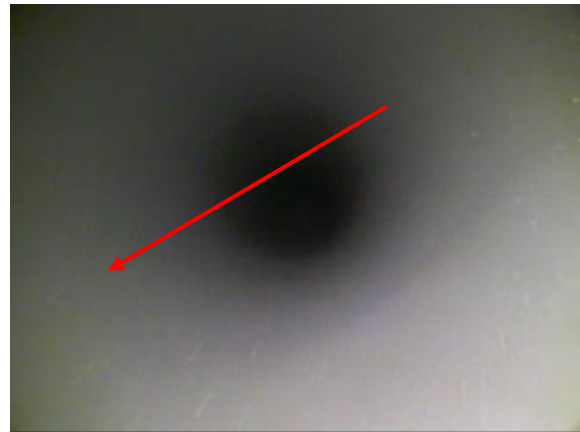
Pic 28: Tube 044- Soot and carbon build up



Pic 29: Tube 056- Soot & Carbon build up con't



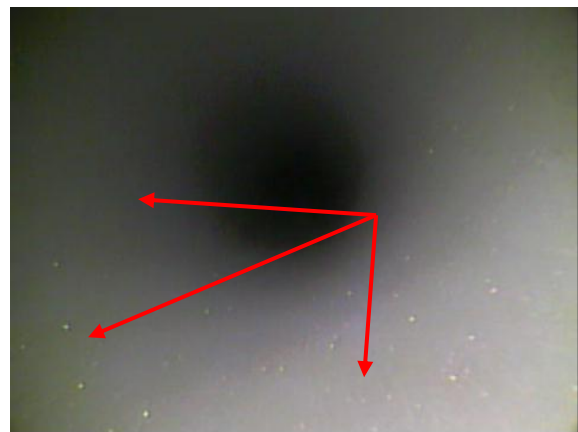
Pic 30: Tube 060- Soot & carbon build up con't



Pic 31: Most tubes have thick soot and carbon



Pic 31: Tube 026- Carbon Build up



Conclusion and recommendations

Base of the results of inspection, the auxiliary boilers and economizers can be concluded in fair and good reliable working condition.

The boilers structural parts inside water/steam space are in excellent condition which is an indication of good feed water/water treatment.

Soot build up from the economizers gas side can be easily clean by high pressure water washing, however to loosen the soot, it is also advisable to spray (soot/carbon remover) soak for around 1 hour followed by water washing.

In the meantime, just to continue the existing water treatment methods and follow the operational parameters in accordance with instruction manual.

It is also advisable to carry out a thorough inspection of boilers in a 1 year intervals and or prior to dry docking.

Maintain cleanliness of the exhaust side by water washing when required.