IRIS BOILER TUBE INSPECTION
CLIENT
LOCATION

Client	**CLIENT**
Facility	**REFINERY**
Item Inspected	**BOILER No1 MAIN BANK TUBES**
Inspection Method	**IRIS**
Date Commenced	**02 FEBRUARY 2009**
Date Completed	**08 FEBRUARY 2009**
Type of Report	**FINAL**
Report Number	**J0001-09ME**

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Appendices

1. Tabulation of all minimum wall thickness.
2. Cross section overview by Row number
3. Cross section overview by Column number (Tube)

1.0 Test Object

Item	:	Boiler No 1 Main Bank Tubes
Material	:	Carbon Steel
Diameter	:	63.5mm swaged to 50.8mm
Wall Thickness	:	4.06mm & 5.0mm
Tube Length	:	13m – 16m
Quantity	:	714

2.0 Inspection Task

As per instruction an IRIS (Internal Rotary Inspection System) inspection was carried out on the 714 Main Bank tubes as listed in **1.0** above.

The inspection was performed with a computerised TC5800 single Channel ultrasonic system. All results were recorded to disk with manual analysis conducted on screen. Calibration was done on the tubing to be inspected. The IRIS testing team consisted of four qualified IRIS engineers supplied by Innospection Limited.

Purpose of the inspection was to survey for evidence of internal and external erosion and to determine the integrity of the tubing and to monitor the general condition of the main bank

3.0 Inspection Personnel

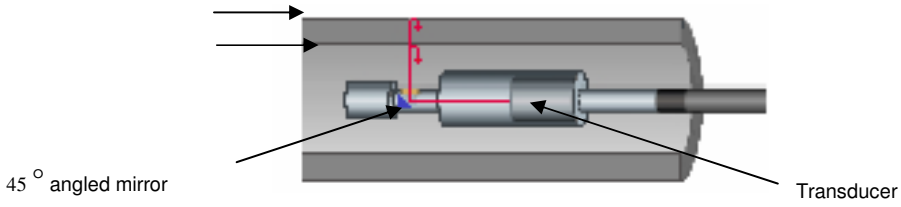
Innospection Technician:	Frederik Bothma	IRIS Level 2.
Innospection Technician:	Arno Pretorius	IRIS Level 2.

4.0 Test Equipment

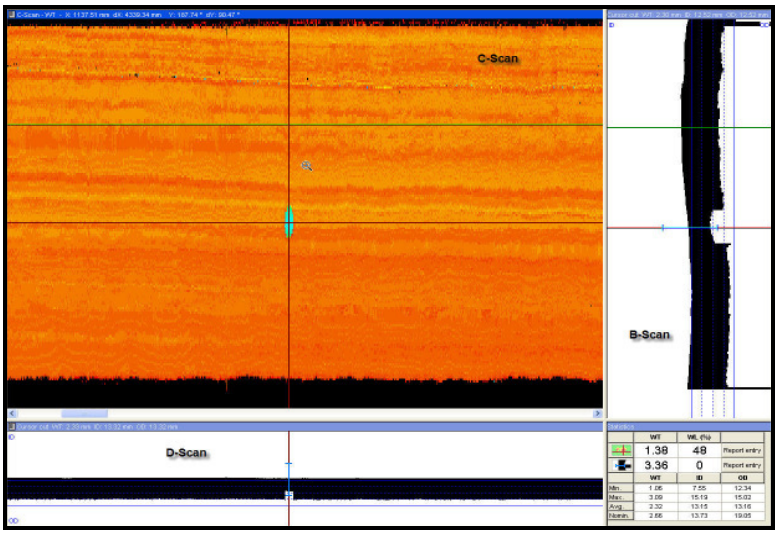
IRIS Unit	:	RD Tech Multiscan MS5800U.
Software	:	Multiview 6.0R4
Data Storage	:	Laptop Hard Drive

4.1 Concept of IRIS

Back wall
Front wall



Unlike eddy current, remote field and magnetic flux leakage, that operate on magnetic or electromagnetic principles the IRIS, technique is based on Ultrasonic's. As shown in the above illustration a beam from an ultrasonic transducer is reflected from a mirror set at 45 degrees so that the reflected ultrasonic beam impinges on the tube I.D. at right angles. Part of this beam is then reflected from the tube I.D., while the remainder is transmitted through the wall thickness and is reflected from the tube O.D. The time difference between the two reflected signals is then used to measure the tube wall thickness. The mirror is mounted on a water driven turbine that rotates at a speed of about 2 000 rpm. Measurements are then made around the full tube circumference and as the probe head is pulled through the tube the ultrasonic beam maps out a spiral along the tube length. If the probe pulling speed is sufficiently slow, taking into account the inspection parameters, 100 % coverage of the tube surface is achieved. With advanced software results can be displayed in a number of views as illustrated below



The C-scan presentation provides a plan view of the tube when it has been rolled flat. Colour-coding is used to display the wall thickness as illustrated by the rainbow of Colours displayed in the icon in the right hand bottom corner of Fig. 2. The B-scan display provides a 2 dimensional display of a transverse cut through the tube at any desired position along the tube length, while the D-scan display provides a 2 dimensional display of a longitudinal cut through the tube at any desired circumferential position on the tube

4.2 Advantages of IRIS

a) Very accurate technique. Wall thickness measurements can be made to accuracy within 0.1mm, with the use of a 15MHz-focused transducer.

b) Fairly sensitive technique. The sensitivity achieved will depend on tube dimensions and tube cleanliness. In general it can be stated that it should be possible to detect a 1.5mm defect in up to 1 inch tubing that has been properly cleaned.

c) A three dimensional picture of the defect is obtained. Thus the defect profile in addition to its depth is obtained.

d) Interpretation of results is easier than in the other techniques assuming that acceptable tube cleanliness has been achieved.

e) Ferromagnetic and non-ferromagnetic tubes can be inspected.

4.3 Disadvantages of IRIS

a) It is a slow technique. The actual testing speed will depend on a number of factors, but will generally be of the order of 0.04m/sec. to achieve 100% coverage. However it must be noted that the tube has to be filled with water (couplant) every time prior to the actual inspection. This will reduce the typical production rates to be in the order of +/- 100 tubes per 12-hour shift. Although this will depend on the tube length and number of units being inspected as well as the cleanliness of the tubes and the water pressure supplied at the point of inspection.

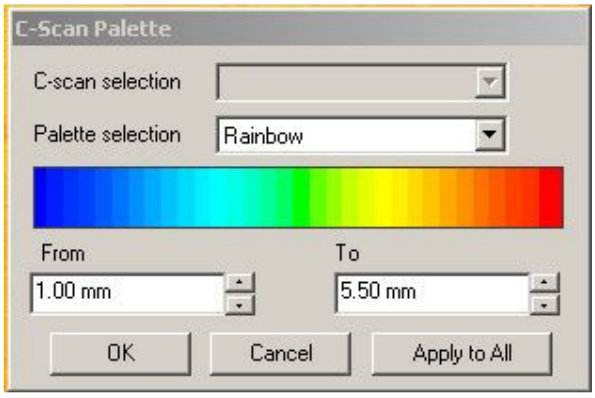
b) Tubes must be very clean. While all the other techniques can tolerate some degree of scaling, tubes must be cleaned virtually down to bare metal for a successful IRIS inspection.

c) Water must be introduced into the tube to act as a couplant. At times this can be a problem due to no suitable water outlet being available at the point of inspection. In other cases the source of water may not be clean enough or may not be at the ambient temperature required for a successful inspection. In some cases the introduction of water into the tubes may give rise to corrosion problems.

d) Only volumetric defects will be detected. It is not, therefore, sensitive to cracking.

5.0 Sensitivity Setting

The general overview of the inspected areas with its results is presented in the attached colour scan reports, with wall loss represented in colour classes as below:



6.0 Calibration Control

The general setting and calibration was performed at the beginning of the inspection and at the beginning of every shift.

A check of the calibration was done after any larger breaks and or changes in any equipment. All calibration data is stored digitally.

Calibration samples are used for initial set-up and also for the random check of operator settings.

7.0 Tube Identification

In order to be able to identify and locate each tube, and thereby create full traceability the grid coordinates of row & tube were used. The identification of Row 1 is closest to the furnace and Tubes are numbered from left to right with Tube1 being on your left hand side when seated in the stream drum facing the furnace.

8.0 Inspection Results

Tubes were found to be in a clean condition. The mud drum was sealed off and the boiler was flooded to the height of the last row of tubes in the steam drum.

Defective tubes were classified in accordance with CTBR specifications

Orange: Remaining wall thickness between 3.8mm and 4.5mm

Green: Remaining wall thickness between 3.5mm and 3.8mm

Blue Remaining wall thickness between 3.24mm and 3.5mm

Pink Remaining wall thickness between 2.4mm and 3.24mm

Red Remaining wall thickness less than 2.4mm

For analysis the tube were analysed and categorised into meter sections starting from the Steam Drum with the consensus that the 2 meter mark will be at the top bend position. A total overview in the form of a tube sheet drawing is shown in Appendix 1. Recorded minimum wall thickness is given in a tabulated format in

Appendix 2 while cross section overviews of Rows & Columns are given in Appendices 3 & 4 respectively. Below is a short summary of each row inspected.

Row 1
No wastage noted in this row. The first 9 meters of tubing from the Steam drum have been replaced with 5 mm tubing.

Row 2
Some wastage was detected in the first 6 – 7 meter from the mud drum of this row. The first 8 meters of tubing from the Steam drum have been replaced with 5 mm tubing.

Row 3
In tube 40, 3 meter from the steam drum wastage was detected. 41 tubes in this row have been replaced with 5 mm tubing from the top bend to the 8 meter mark. Tube 32 could not be inspected past the 8m mark due to the weld bead height restricting the IRIS centraliser.

Row 4
No wastage detected in this row. Tubes 5 & 6 have been replaced with 5mm tubing from the 5m mark to the Mud drum. Tubes 32 and 40 have been replaced between the 3 & 8m marks

Row 5
Wastage was found 4 meter from the steam drum in tube 42 and no other wastage was detected.

Row 6
Seven tubes exhibited slight wastage below the top bend and all tubes had sections replaced with 5mm tubing.

Row 7
Thirteen tubes exhibited wastage below the top bend another three a both the top bend. All this wastage was recorded in recently replaced 5mm tubing sections.

Row 8
8 tubes exhibited wastage Tubes 47 showed wastage just below the bottom bend. All tubes have been replaced with 5mm tubing from the 9m mark to the bottom bend.

Row 9
8 tubes showed an indication of wastage. Five was directly below the 5mm tubing that that has been inserted in all tubes between the 9 to 11m marks the other three a both.

Row 10
Only seven tubes had indications of wastage. Two tubes have the wastage indication a both the top bend at the steam drum the rest was spread between the two bends

.

Row 11
Six tubes had indications of wastage between the 3m from the mud drum up to the steam drum. The IRIS Centraliser could not be passed through the bottom bend of the tubes due to the angle of the bends

Row 12
Seven tubes had indications of wastage. Tubes 2 and 13 was plugged, al the wastage was found between the two bends

Row 13
Two tubes had indications of wastage in this row. With is situated between the two bends. The IRIS Centraliser could not be passed through the bottom bend of the tubes due to the angle of the bends.

Row14
Fourteen tubes had indication of wastage. This was mainly between the two bends. Tube 21 had a minor indication of wastage just a both the bottom bend at the steam drum. The IRIS Centraliser could not be passed through the bottom bend of the tubes due to the angle of the bends. There was one tube which could not been inspected and another one only partially.

11 .0 Documentation

This inspection data and report is stored on disk in the Innospection Limited documentation system.

12.0 Signatures

Frederik J. Bothma
Inspection Engineer
Innospection Limited

Mike Churchill
Senior Engineer
Innospection Limited

CLIENT:	**CLIENT**	**DATE**	**02-08 FEB 2009**
LOCATION:	**REFINERY**	**REPORT No**	**J0001-09ME**
UNIT:	**BOILER No1**		**#**

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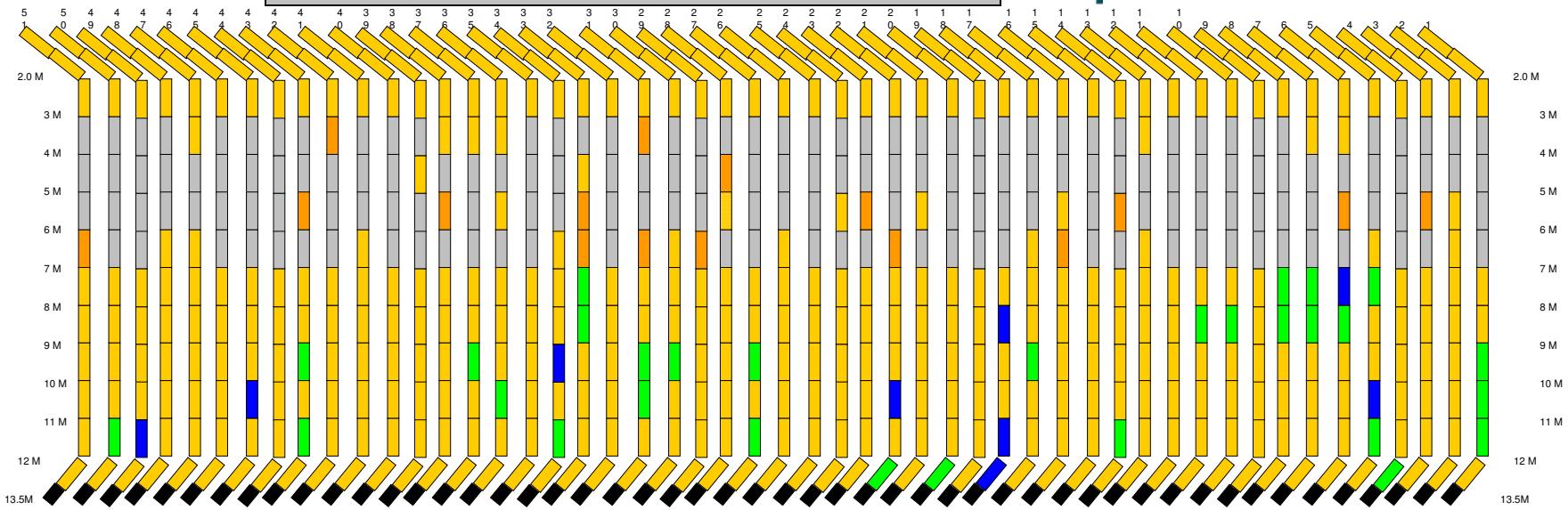

NOMINAL WALL
- 4.50 - 5.60 mm
- 3.80 - 4.50mm

EROSION DAMAGE
- 3.8 - 4.5 mm
- 3.5 - 3.8 mm
- 3.24 - 3.5 mm
- 2.4 to 3.24mm
- 0.1 - 2.4 mm
- No Result

CROSS SECTION VIEW BY ROW
ROW 02

CLIENT:	CLIENT	DATE	02-08 FEB 2009
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UNIT:	BOILER No1		#

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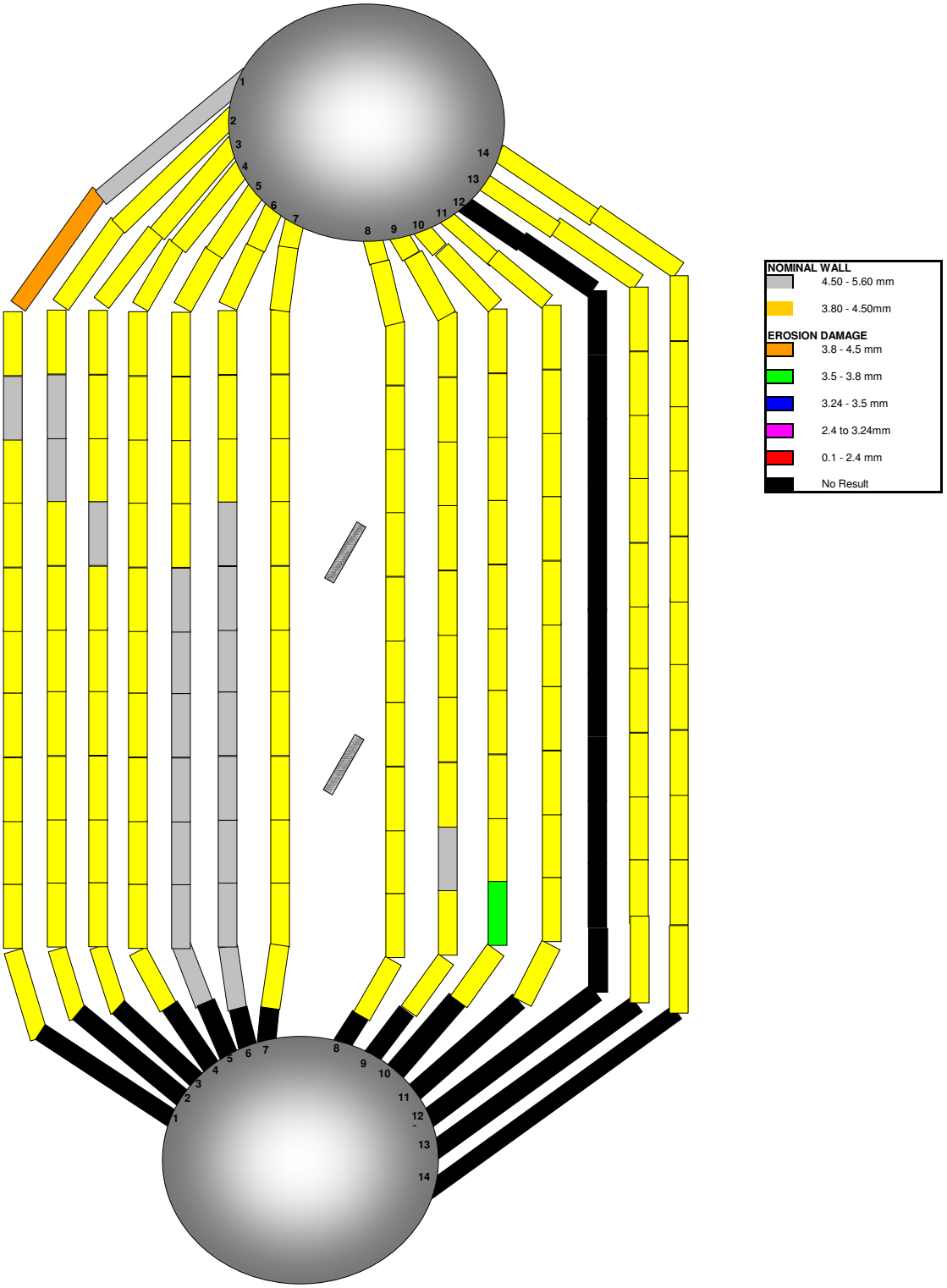
CROSS SECTION VIEW BY COLUMNS
COLUMN 02



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UNIT:	**BOILER No1**		

WALL THICKNESS MEASUREMENT
ROW 02

ROW	COL	DEFECT	Remaining wall Thickness	COMMENTS
2	1	ERO	3.68	
2	2	ERO	4.03	
2	3	ERO	3.89	
2	4	ERO	3.92	
2	5	ERO	3.45	
2	6	ERO	3.3	
2	7	ERO	3.56	
2	8	ERO	3.68	
2	9	ERO	4.06	
2	10	ERO	3.68	
2	11	ERO	3.56	
2	12	ERO	4.01	
2	13	ERO	3.98	
2	14	ERO	3.59	
2	15	ERO	4.12	
2	16	ERO	3.92	
2	17	ERO	3.71	
2	18	ERO	3.24	
2	19	ERO	4.01	
2	20	ERO	3.74	
2	21	ERO	3.89	
2	22	ERO	3.39	
2	23	ERO	3.98	
2	24	ERO	3.95	
2	25	ERO	3.83	
2	26	ERO	4.01	
2	27	ERO	3.53	
2	28	ERO	3.86	
2	29	ERO	3.98	
2	30	ERO	3.68	
2	31	ERO	3.62	
2	32	ERO	3.83	
2	33	ERO	3.71	
2	34	ERO	3.39	
2	35	ERO	3.89	
2	36	ERO	3.77	
2	37	ERO	3.74	
2	38	ERO	3.95	
2	39	ERO	3.95	
2	40	ERO	3.86	
2	41	ERO	3.8	
2	42	ERO	3.83	
2	43	ERO	3.5	
2	44	ERO	3.95	
2	45	ERO	3.45	
2	46	ERO	3.95	
2	47	ERO	3.92	
2	48	ERO	4.01	
2	49	ERO	3.45	
2	50	ERO	3.71	
2	51	ERO	3.98	