

ABC CHEMICALS LIMITED  
ANY TOWN, ANYWHERE

1-E CAUSTIC PRE-HEATERS

JANUARY 2002

ABC CHEMICALS LIMITED  
ANY TOWN, ANYWHERE

**REPORT of NON-DESTRUCTIVE INSPECTION**  
**W. I. P. ULTRASONIC INSPECTION OF HEAT EXCHANGER TUBES**  
**1-E CAUSTIC PRE-HEATERS**

JANUARY 2002

Submitted by,

***Stasuk Testing & Inspection Ltd.***

7642 Winston Street  
Burnaby, B. C., CANADA  
V5A 2H4  
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WIP - Window Inspection Probe, for inspecting full-length tubes (beyond the near tube-sheet/drum area).  
NIP - Near tube-sheet/drum Inspection Probe, for inspecting the area of the tube near the tube-sheet or drum.

ABC Chemicals Ltd.  
Choro-alkyl Division  
P. O. Box 1234  
Any Town, Anywhere  
A1B 2C3

January 31, 2002  
Our file: abc-1pe02a.doc

Attn: Mr. John Doe - Senior Engineer

**Re : Final Report on the W. I. P. Ultrasonic Inspection of the 1-E Caustic Pre-Heaters - January 2002.**

Dear Sir,

Please find enclosed 2 copies of our final report for the WIP ultrasonic inspection of the 1-E Caustic Pre-Heaters (full length - thinning inspection only) tubes.

This report incorporates four (4) basic sections, which show the thickness data in different ways. A brief description of each section follows:

**(1) Title page and Summary.**

- These are self-explanatory.

**(2) Sketch showing Tube Layout.**

- Shows the numbering system used in the data tables. Please note that scan numbers for the WIP inspection with Scan "A" is the further away from the west tube-sheet and Scan "D" is closest to the east tube-sheet.

**(3) Data Tables (Colored readings in spreadsheet format).**

- This section gives the actual thickness data for each tube, color-coded in the same ranges, again according to your specifications. Only the lowest reading is recorded as shown. A summary of the number of tubes in each thickness range is given at the bottom of the page.

**(4) Sample Images**

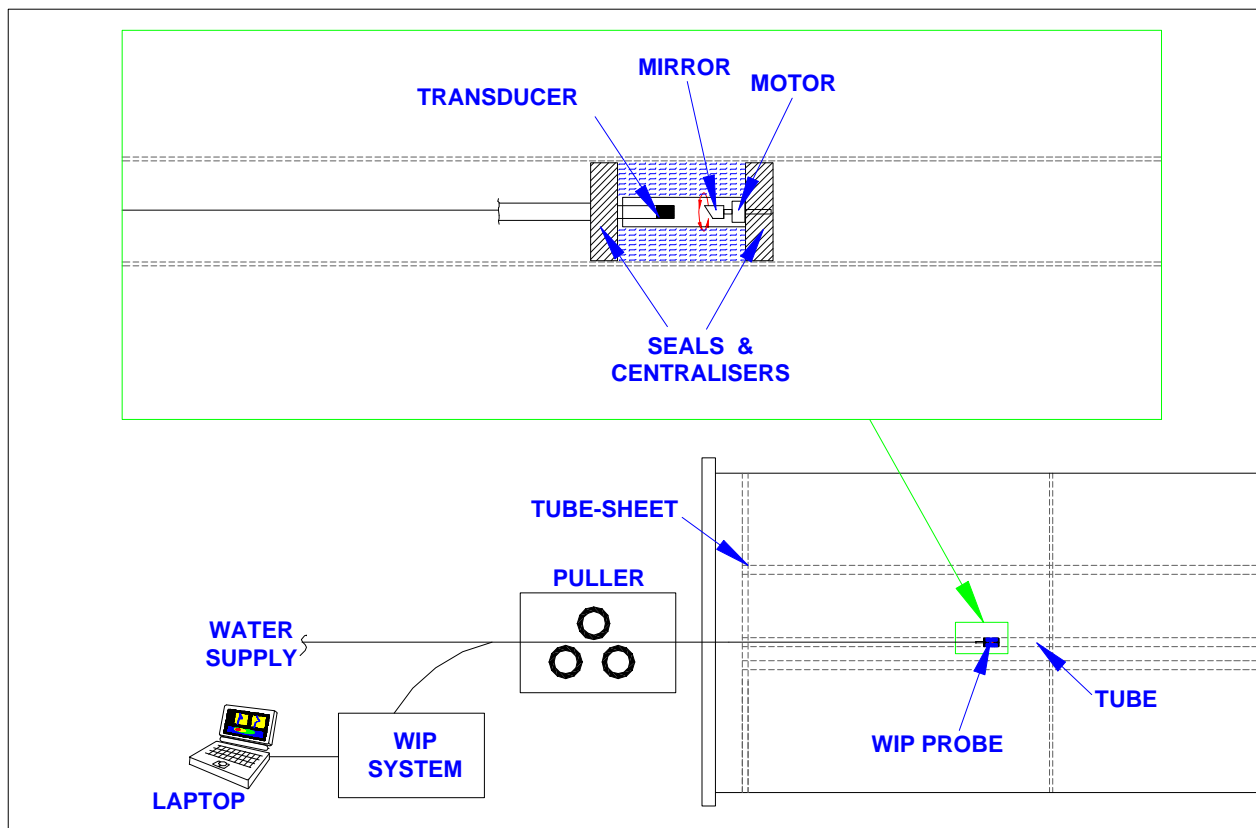
- This section displays full color printouts of selected tubes that were inspected using our automated NIP and WIP ultrasonic systems. This data is displayed on the computer screen in real time for immediate analysis, then stored on disk and can be printed out on a color printer. These printouts are very informative and we usually only give a few representative examples of tubes covering typical thinning patterns for your analysis, rather than having a report of 500 to 2,000 pages. The main features are as shown in the viewing guide attached.

## DESCRIPTION OF THE WIP SYSTEM

The sketch below shows a component view of the WIP system and detail view of the WIP probe. The 45° mirror is powered by a miniature motor as shown below and takes 200 readings circumferentially. Typically, we set our linear resolution to 10 spi (circ scans per linear inch) - ie. 60 inches or 5 feet for 600 circ scans. This can be programmed to be higher or lower – depending on the client's requirements. Please note that water is used as a couplant and NOT to drive the mirror. This configuration is critical to achieve accurate readings.

All the data is display in real-time on a laptop and saved on the hard drive and other media for storage and review. The real-time displays are in full colour B- and C-scans similar to those attached in the "Sample Images" section of this report.

### Sketch Showing the WIP System



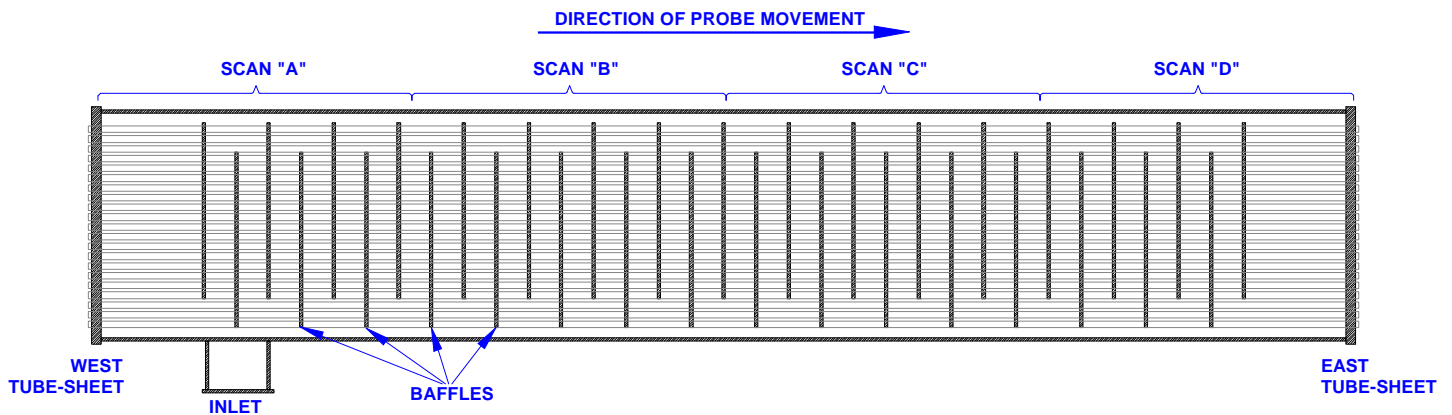
## CALIBRATION OF THE WIP SYSTEM

Calibration check was performed using a calibration tube of the same or similar material velocity and nominal tube thickness. Calibration is performed at the beginning of every shift, every 4hrs thereafter, when there is a break (including interruptions due to electrical outage).

## SCANNING OF HEAT EXCHANGER TUBE

The data for each tube inspected is saved as files, which correspond, to the scan number as shown "Sketch for scan numbers for WIP". The sketch shows how the files are labelled, with the segment closes to the West tube-sheet as Scan "A" and the one closest to the East tube-sheet as Scan "D". Each segment is approximately 60 ins. or 5ft (or a linear resolution of 10 spi). Note the location of the steam inlet and number of baffles in the heat exchanger.

### Sketch for scan number for WIP



## CONCLUSIONS

From the WIP inspection of the sample of heat exchanger tubes inspected, we can conclude that the tube thinning is occurring in the bottom pre-heater (see sketch on tube thinning visualisation).

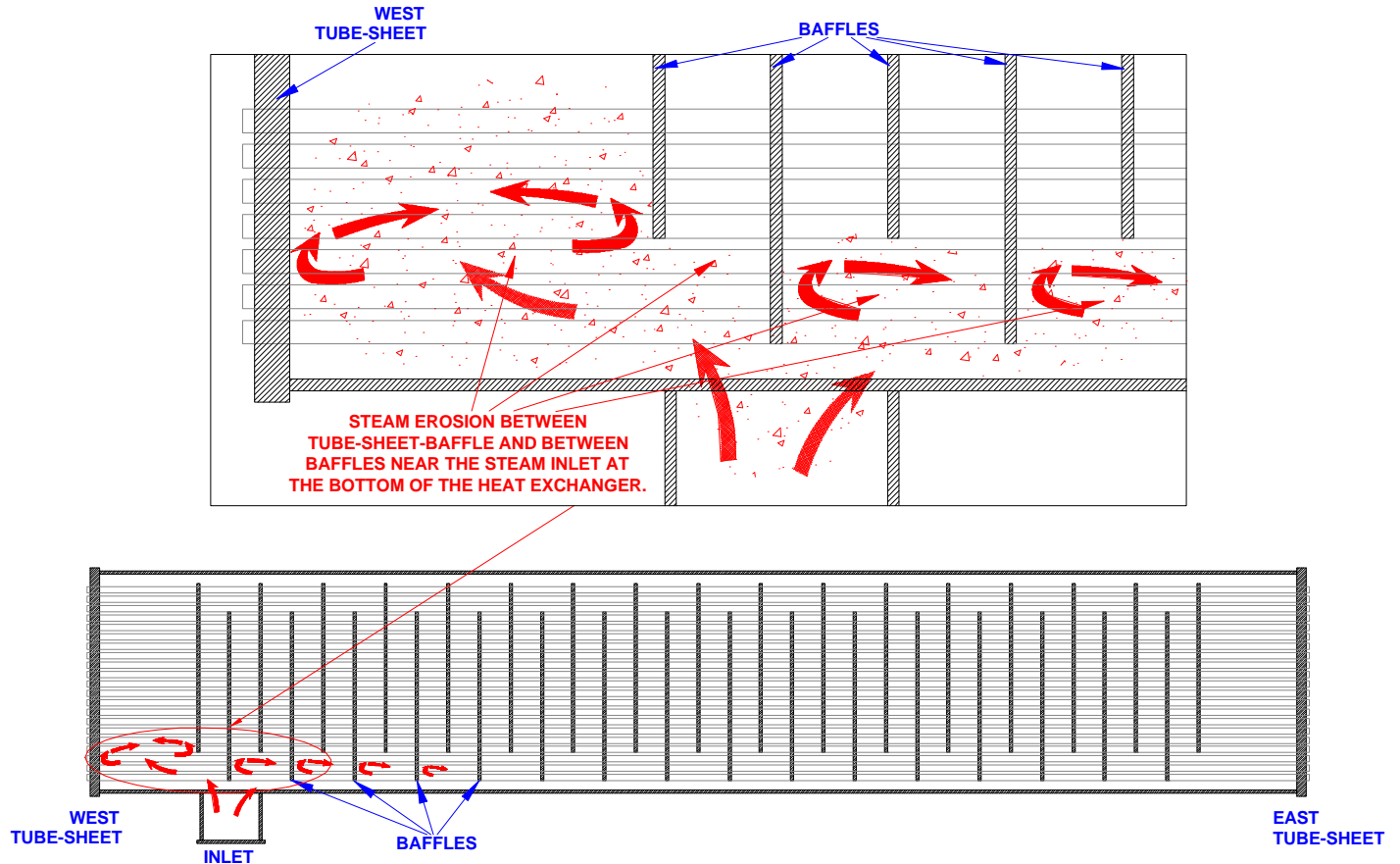
The area of concern or thinning is near the steam inlet at the bottom of the bottom/lower pre-heater. The sketch on tube thinning visualisation shows how the steam is probably "swivelling around" and eroding the tubes between the West tube-sheet and the first baffle and between the neighbouring baffles as shown in the sketch.

As indicated in the WIP sample images attached – T09RI Scan A, T10RI Scan A and T11RG Scan A – show the main thinning between the West tube-sheet and the first baffle. There is also significant tube thinning in the area(s) between the neighbouring baffles.

The tube thinning diminishes away from the steam inlet in the bottom pre-heater. Also, the top pre-heater does not seem to have any significant tube thinning – even at the inlet.

## Visualisation of Areas of Concern/Thinning

Showing the areas where significant tube thinning is occurring for the bottom heat exchanger.



## RECOMMENDATIONS

We recommend that you carry out a full inspection in the heat exchangers during the next outage given the findings of this inspection. This would enable us to give you a full visualisation of the condition of the tubes in the heat exchangers.

**ABC CHEMICALS LIMITED  
ANY TOWN, ANYWHERE**

**1-E CAUSTIC PRE-HEATERS**

**JANUARY 2002**

I trust this information will be useful to your maintenance planning operations. Thank you for the work and we look forward to working with you at the ABC plant in Any Town again.

Yours truly,

**Joe, Technician**  
NDT Level II

**Distribution of Printed Report:**

*ABC Chemicals, Any Town - 2 copies*  
*Stasuk Testing, Burnaby - Original*

## TUBE-SHEET LAYOUT SKETCH



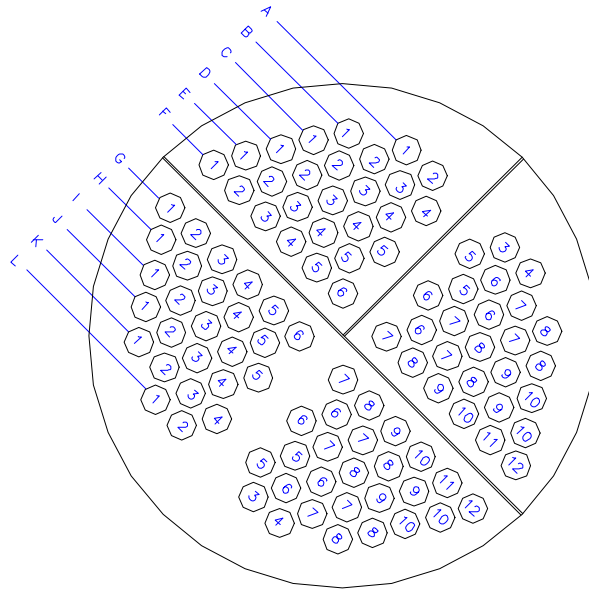
## TUBE NUMBERING

### VIEWED LOOKING WEST

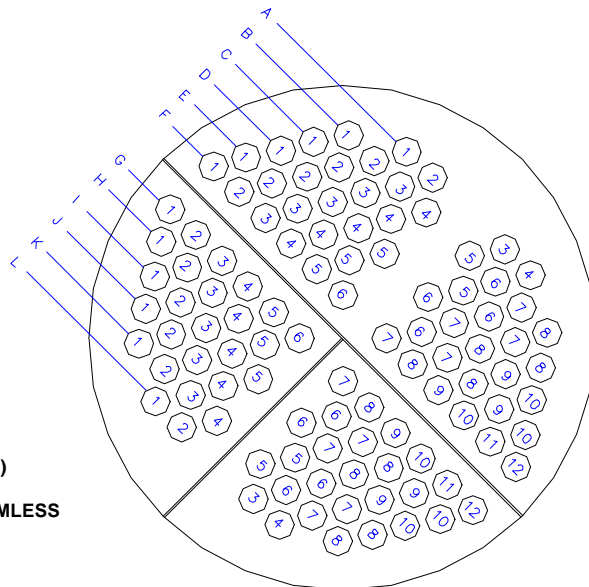
TOP



TOP  
PRE-HEATER



BOTTOM  
PRE-HEATER



EQUIP. I. D.: 1E PRE-HEATERS  
NUMBER OF TUBES = 104 EACH  
TUBE DIAMETER = 1.5" O. D.  
TUBE THICKNESS = 16 BWG (0.065")  
TUBE LENGTH = 21 FT.  
TUBE MATERIAL = SB-163-200 SEAMLESS  
TUBE-SHEET MTL. = SB-162-200  
TUBE COR. ALLOW. = NIL  
MFG. = ELLETT INDUSTRIES, POCO

## DATA TABLES

Based on Remaining Wall thickness



# ABC CHEMICALS

Any Town, Anywhere

1-E Pre-Heater

Jan 2002

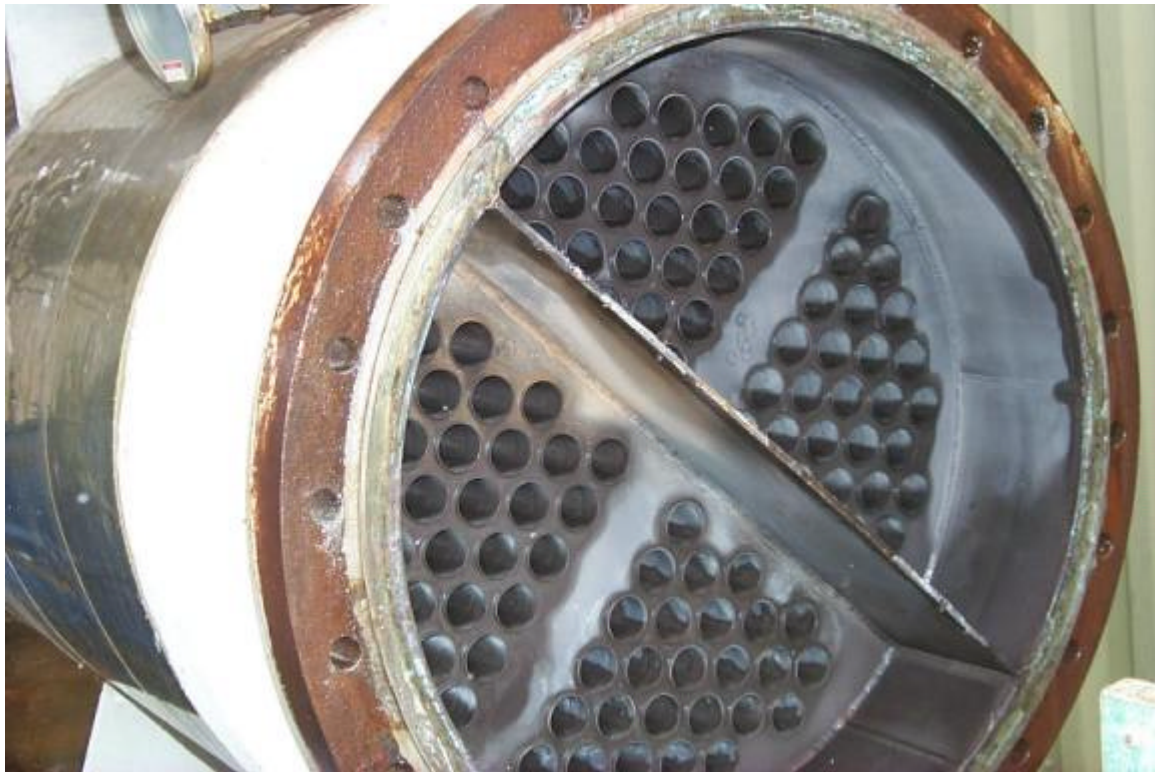
## ULTRASONIC THICKNESS - W.I.P. of FULL LENGTH TUBES

		ROW NUMBERS - TOP												ROW NUMBERS - BOTTOM											
		A	B	C	D	E	F	G	H	I	J	K	L	A	B	C	D	E	F	G	H	I	J	K	L
T	1	61						60																	1
U	2		56									60						58					56	56	2
B	3	58				60						60					48		58						3
E	4		57						57																4
	5					60		57								51		52			38				5
N	6																49		39			34			6
U	7				61				60													28	35		7
M	8	58					59				60	60				49		35	34	32	35				8
B	9					61		61									36	32	27						9
E	10																32	33	23						10
R	11																32								11
	12							60								45	39								12

Data Distribution				ALL	TOP	BOT
Range	<30	30-34	35-39	40-44	>44	
No.	3	7	7	0	38	
NO. INSPECTED				55	20	35
AVERAGE				49	59	42
MINIMUM				23	56	23

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## SAMPLE IMAGES

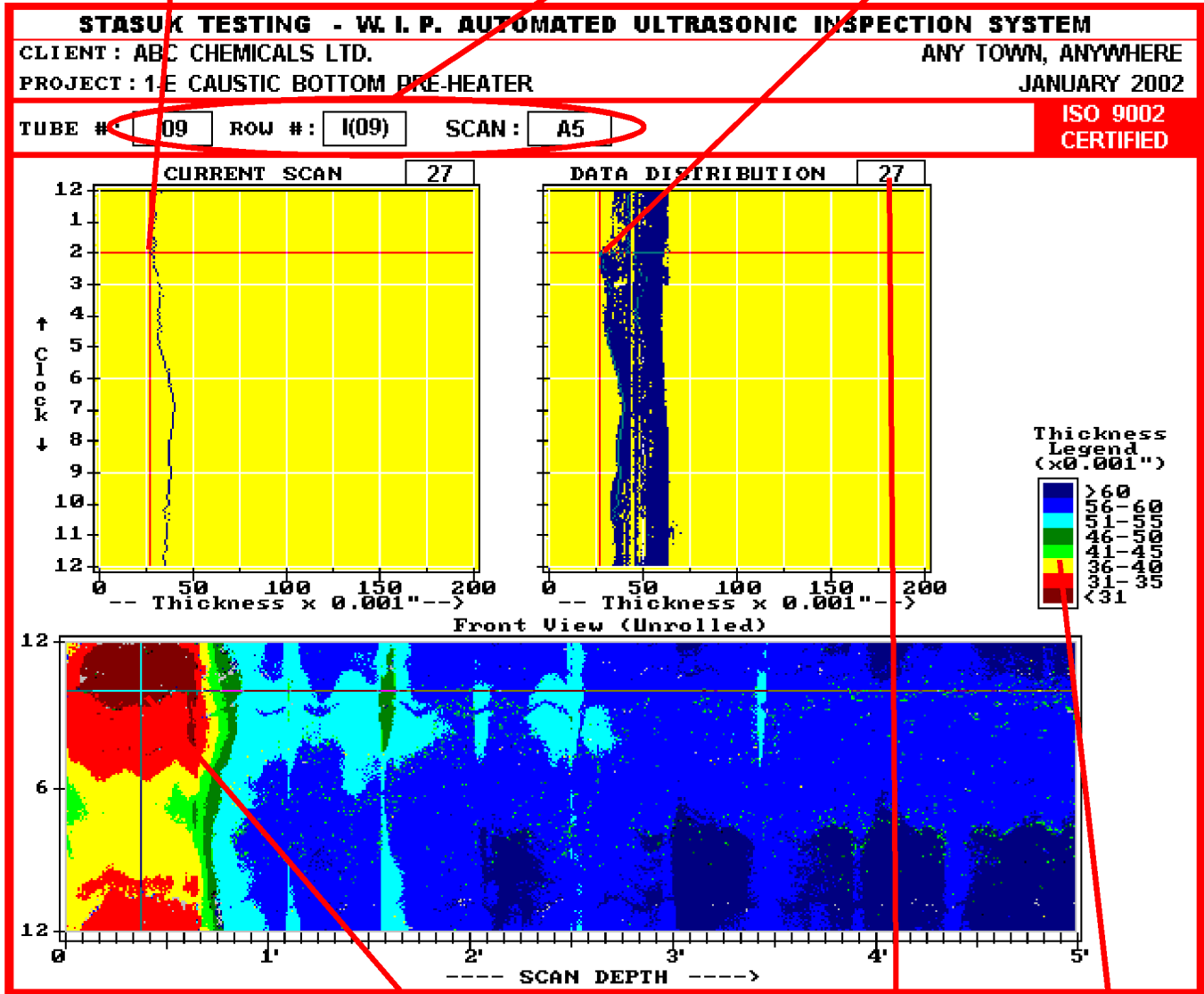


## WIP IMAGE GUIDE

**B-scan** (End View) showing the single scan where the lowest readings was found.

Accumulation of all **B-scans** in the portion of tube tested.

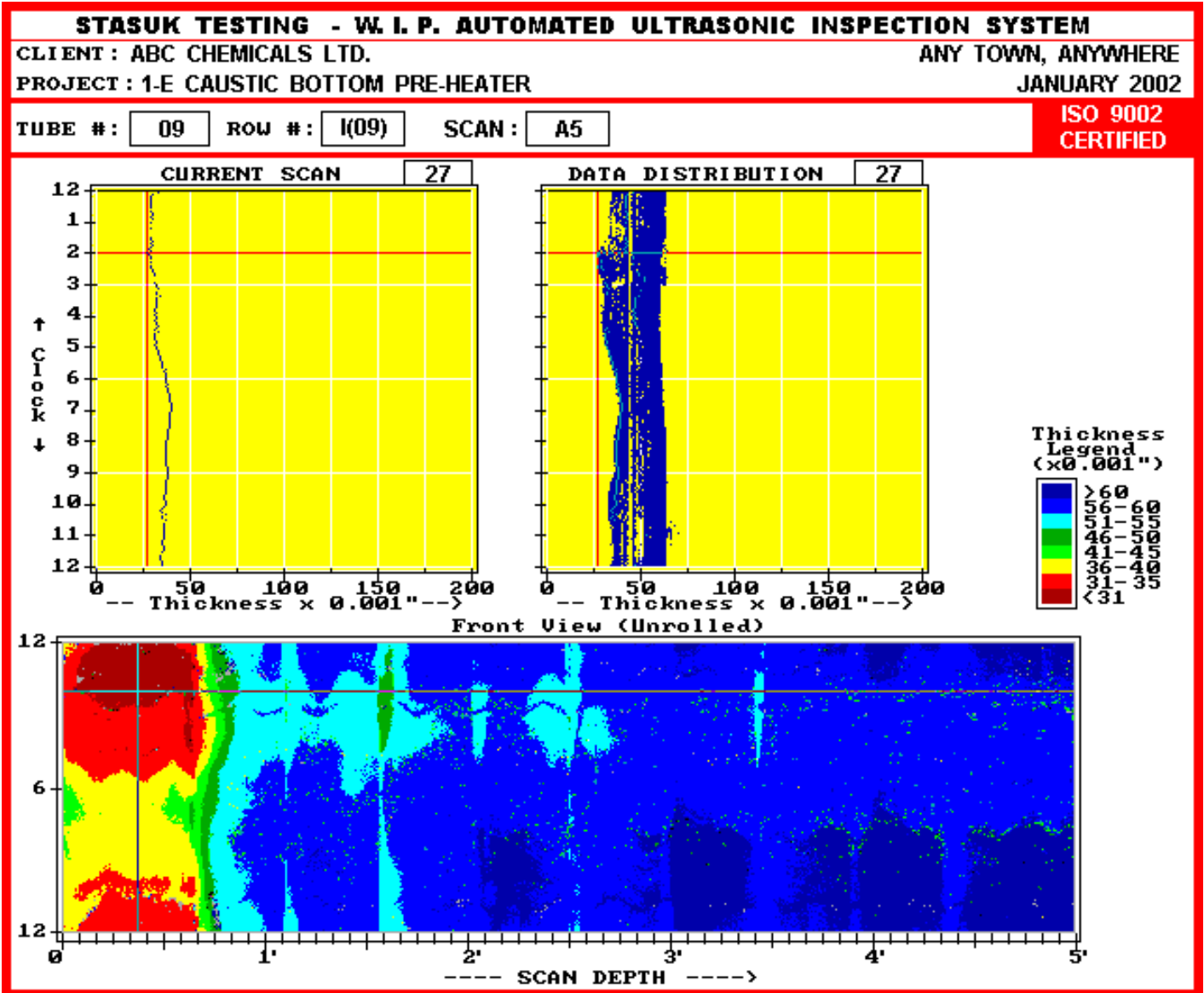
Tube identification and scan number.

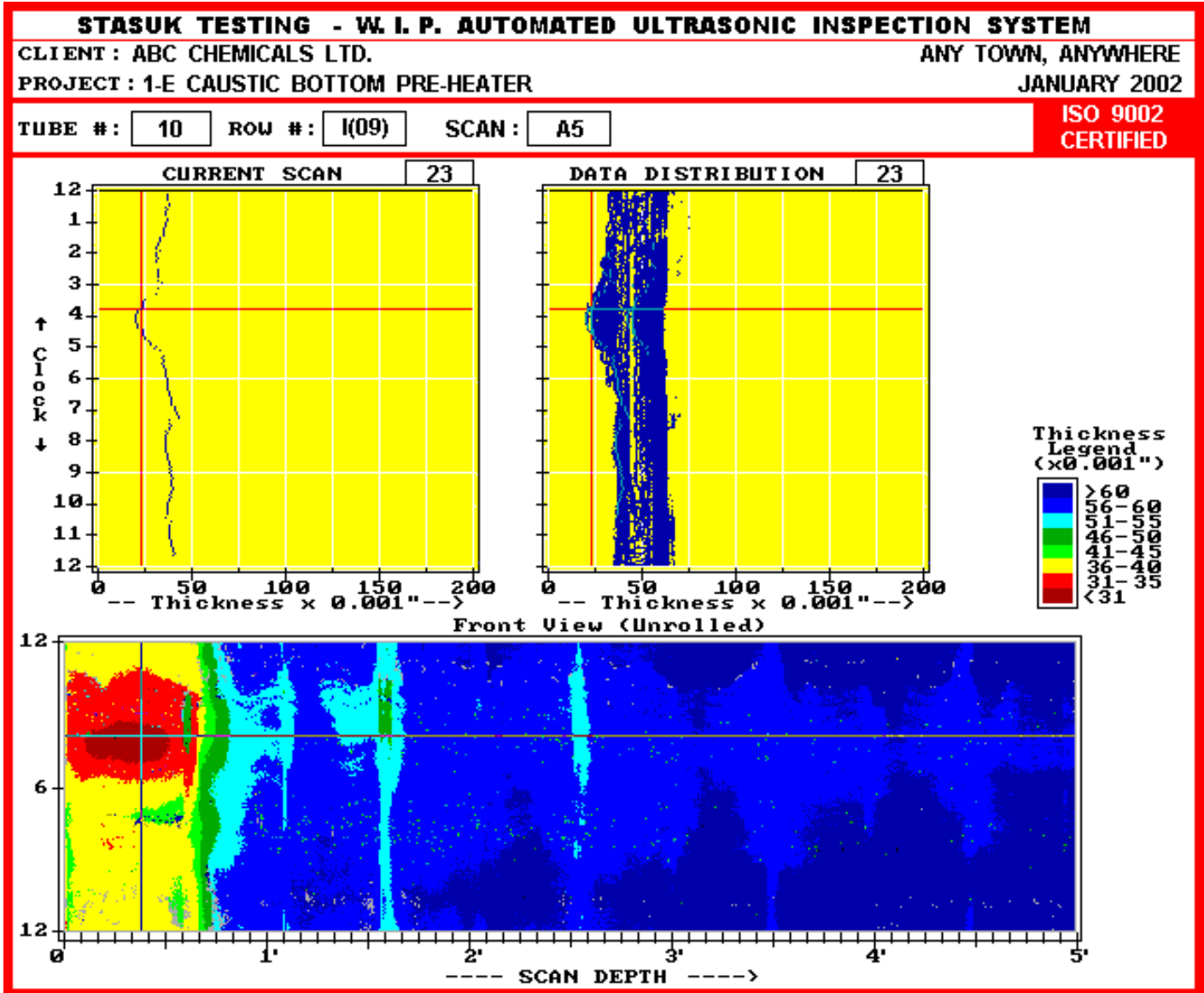


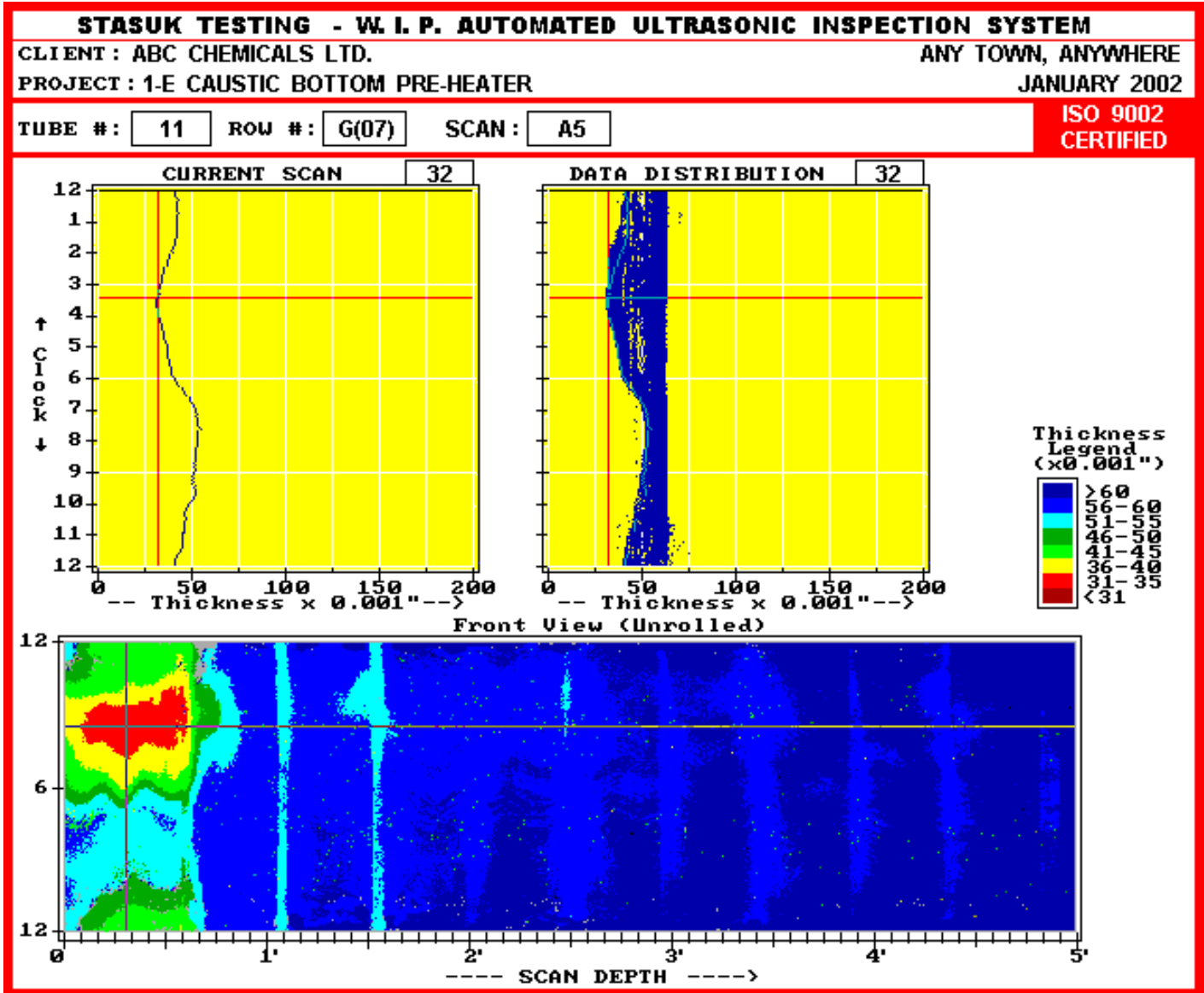
**C-scan** (3-D) display showing the tube thickness profile in color, assuming the tube is rolled and flattened out. The vertical axis represent the circumferential axis and the horizontal represents the axial length of the tube. The cross hair / cursor indicates the lowest valid reading. There is a total of 120,000 possible readings (200 circ. x 600 linear).

Lowest valid Reading.

Thickness legend.







## END OF REPORT

