

ABC PULP & PAPER COMPANY
ANY TOWN, ANYWHERE

REPORT of NON-DESTRUCTIVE INSPECTION
W. I. P. INSPECTION OF GENERATING BANK TUBES
POWER BOILER

MAY 2002

Submitted by,

Stasuk Testing & Inspection Ltd.

7642 Winston Street
Burnaby, B. C., CANADA
V5A 2H4
(604) 420-4433



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Any Town, Anywhere

Power Boiler

May 2002

ABC Pulp & Paper Company
123 Main Street
Any Town, Anywhere
A2B 2C3

May 28, 2002
Our file: abc-0102a.doc

Attn: Mr. John DOE - Project Manager

Re : Final Report on W. I. P. Ultrasonic Inspection of Power Boiler Generating Bank (full-length Mud Drum to Steam Drum) Tubes - May 2002.

Dear Sir,

Please find enclosed 2 copies of our final report for the WIP ultrasonic inspection of the Power Boiler generating bank (full length Mud Drum to Steam Drum - 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 / Gen Bank cross-section.

- Shows the numbering system used in the data tables. Please note that scans start at the mud drum and readings are obtained when pulled towards the steam drum. Scan "A" (of 10ft length each) starts near the mud drum and Scan "C" finishes close to the steam drum as shown.

(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 – for both "Hot" and "Cold" sides.

(4) Sample Images

- This section displays full color printouts of selected tubes that were inspected using our automated WIP ultrasonic system. 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.

WIP - Window Inspection Probe, for inspecting full-length tubes (beyond the near tube-sheet/drum area).

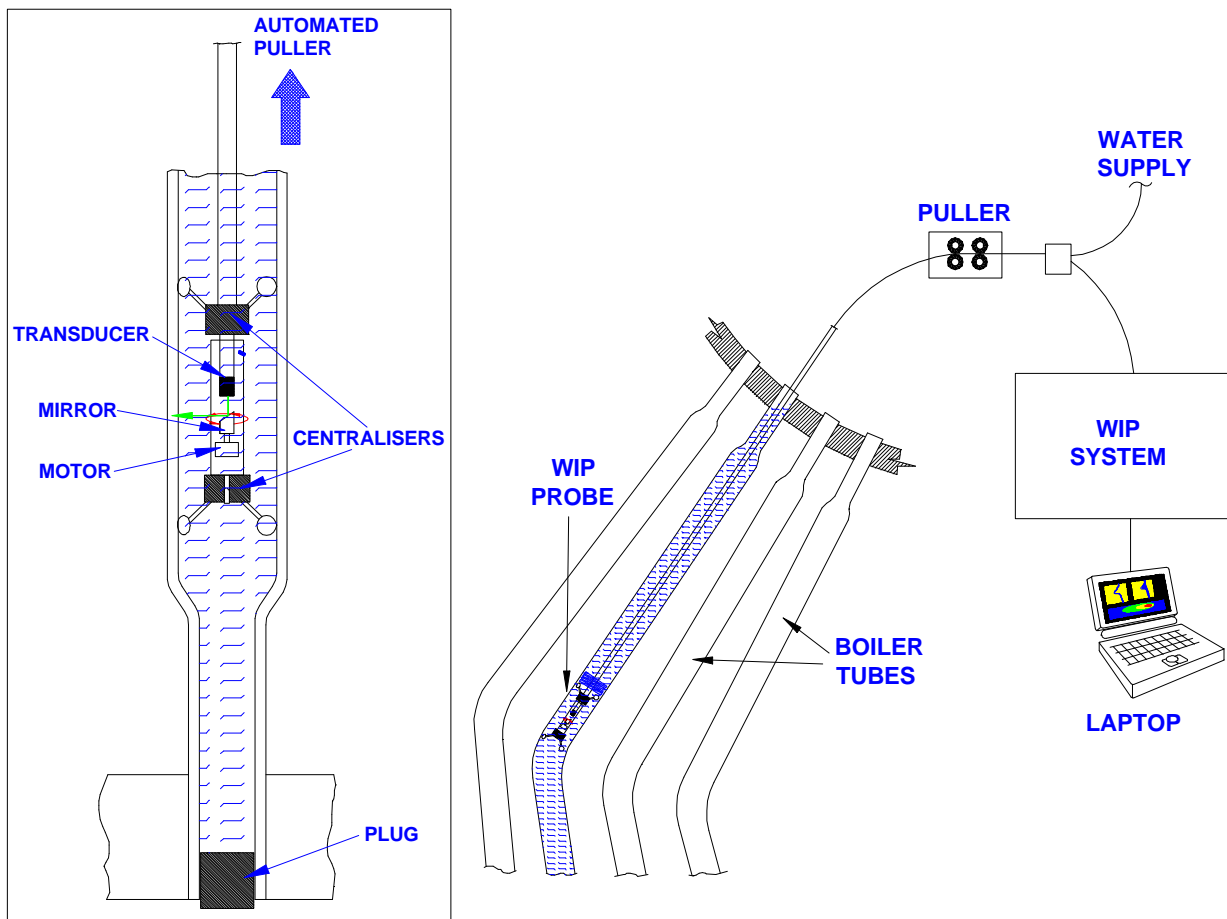
NIP - Near tube-sheet/drum Inspection Probe, for inspecting the area of the tube near the tube-sheet or drum.

DESCRIPTION OF THE WIP SYSTEM

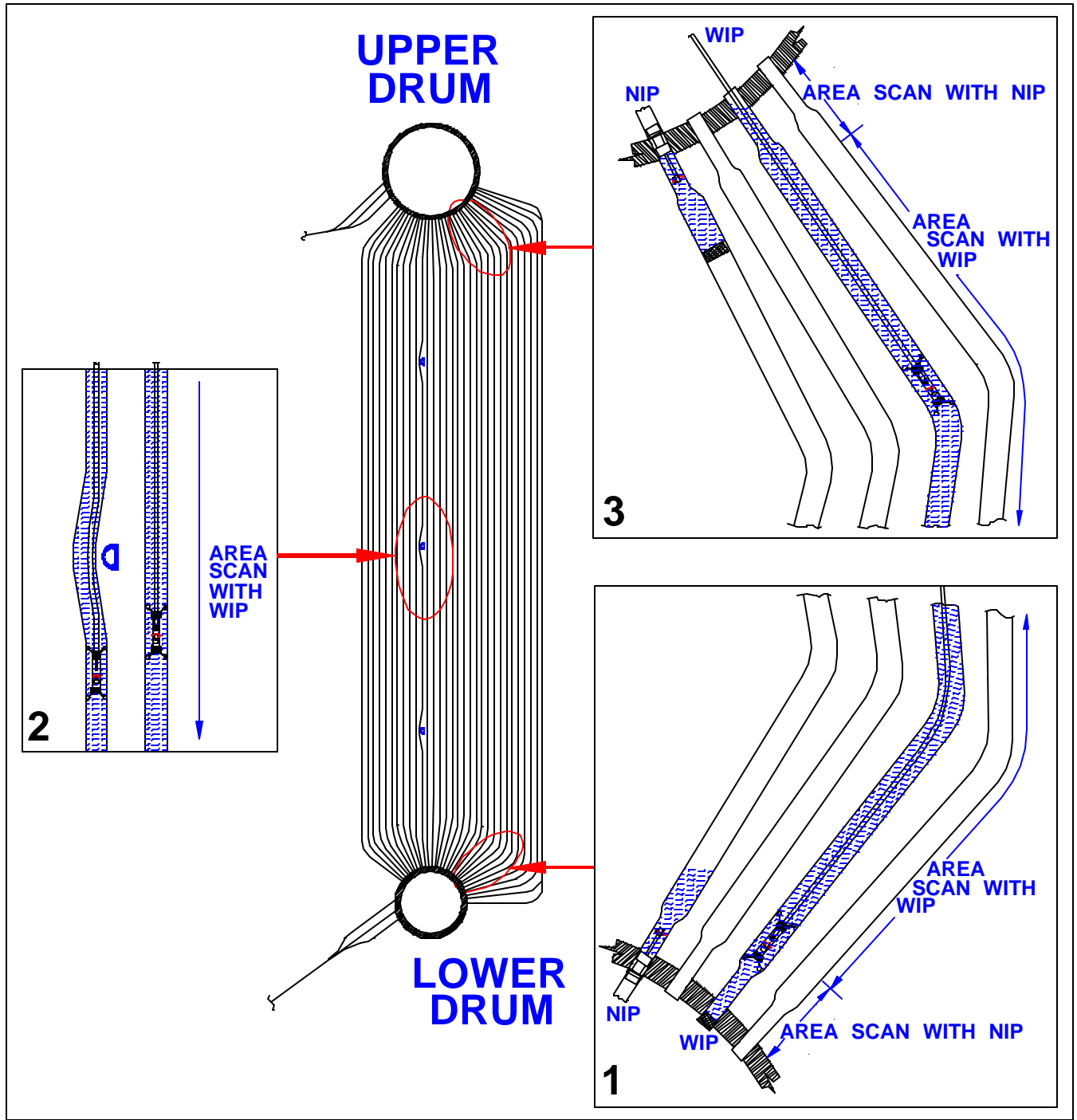
The sketch below shows a component view of the WIP system and detail view of the WIP probe. The 45° mirror is powered by a miniature motor as shown below and takes 200 readings circumferentially. Typically, we set our linear resolution to 10 spi (circ scans per linear inch) - ie. 60 inches or 5 feet for 600 circ scans. This can be programmed to be higher or lower – depending on the client's requirements. For this boiler, the tubes were scanned at 5 spi. Please note that water is used as a couplant and NOT to drive the motor. The mirror is driven by high precision electrical stepping motor to ensure high accuracy and repeatability of readings obtained. This arrangement is critical for ensuring the readings are reliable and repeatable for accurate wear trend analysis in future inspections. A "floating seal" may be used in some cases in place of the tube wooden plugs.

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 (WIP Probe Details on the left)



INSPECTION OF GEN BANK TUBE USING WIP & NIP
(Shows how the NIP and WIP system is used in the inspection of gen bank tubes)



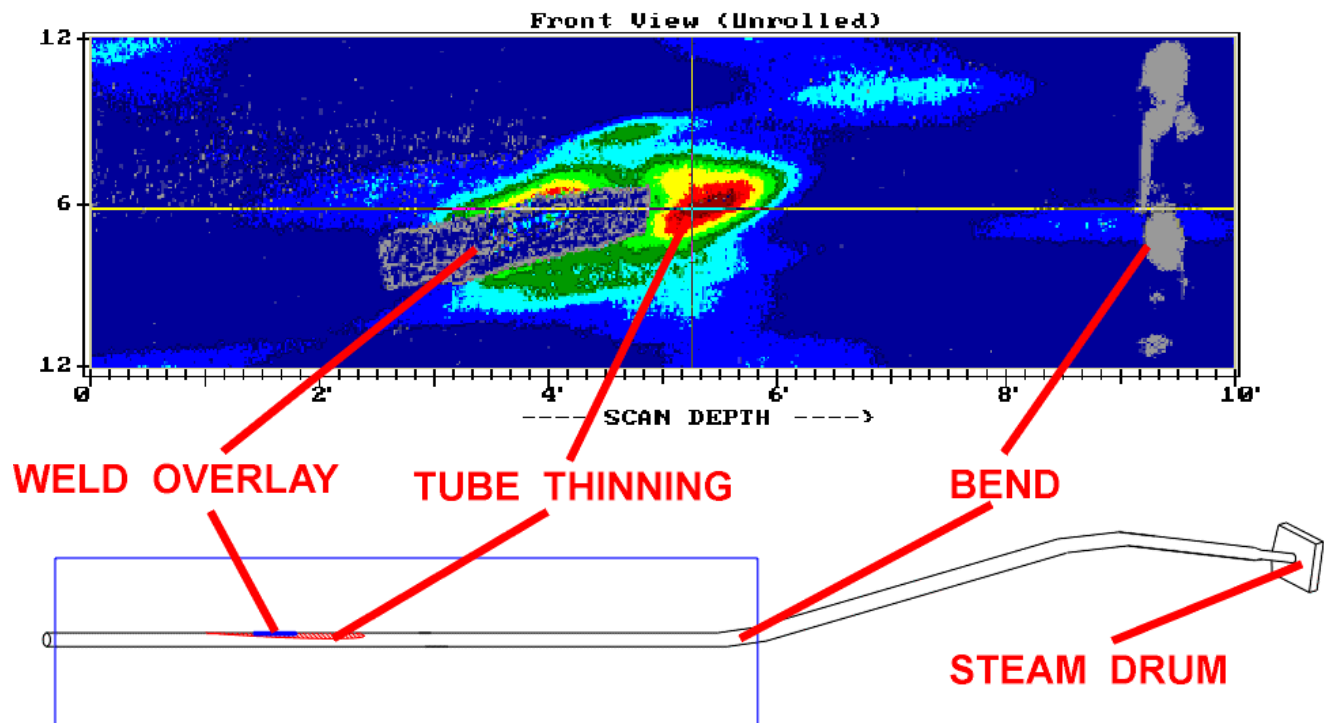
CALIBRATION OF THE WIP SYSTEM

Calibration check was performed using a stepped calibration tube. We calibrate on typically nominal tube thickness from 125 mils to 250 mils. If readings are found to be less than 100 mils, the system is re-calibrated to a lower range to suit. Calibration is performed at the beginning of every shift, every 4hrs thereafter, when there is a break (including interruptions due to electrical outage).

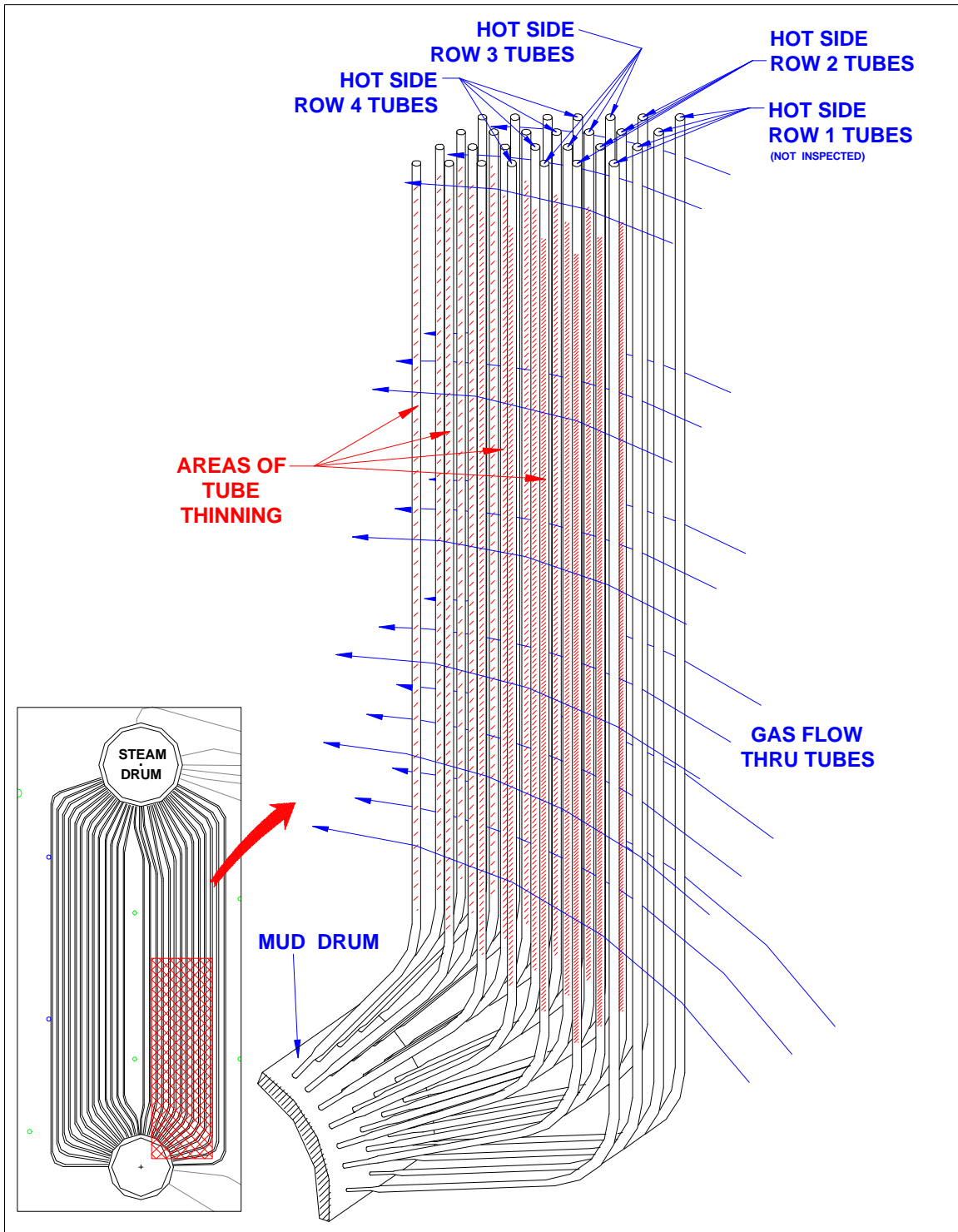
CONCLUSIONS

- (1) From the WIP inspection of the sample of generating bank tube inspected, we can conclude that the tube thinning is occurring in the following locations in the generating bank:-
 - a) In the central sootblower lanes on both the "Hot" and "Cold" sides in areas near and/or around the previous weld overlay areas – as typified by the C-scan image below. See also the "visualisation" sketches attached for both the "Lower" and "Upper" sootblower locations. The mechanism for the tube thinning is probably the action of the sootblower eroding the tubes at these sootblower (IK lane) locations. The attached sample WIP images, in the "Sample Images" section, T05R01 "B" on the "Cold" side; T06R014 "B", T67R14 "B" and T68R14 "B" on the "Hot" side, show the tube thinning at these locations.

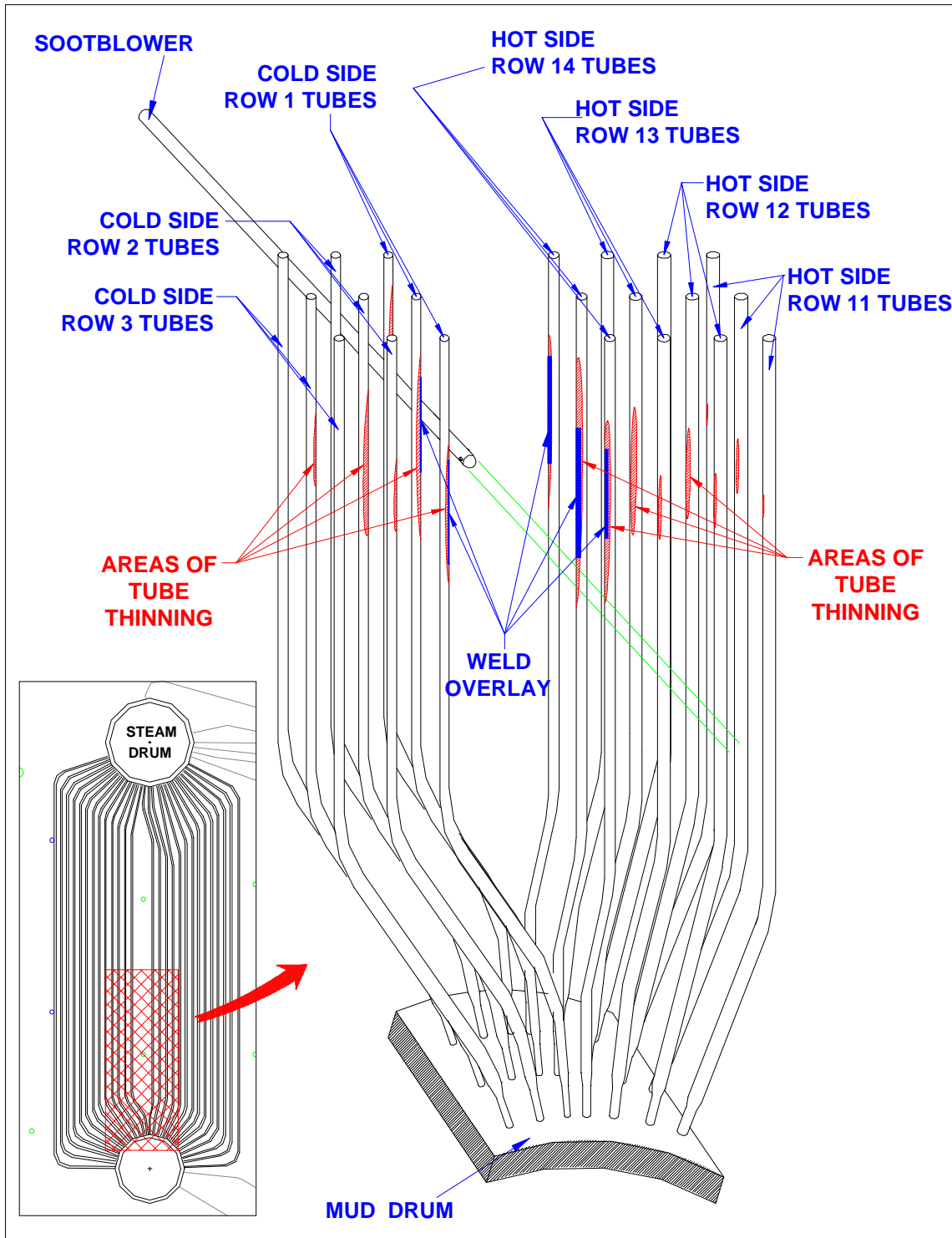
C-Scan Image of T05R01 "B" Cold Side showing typical tube thinning near a weld overlay



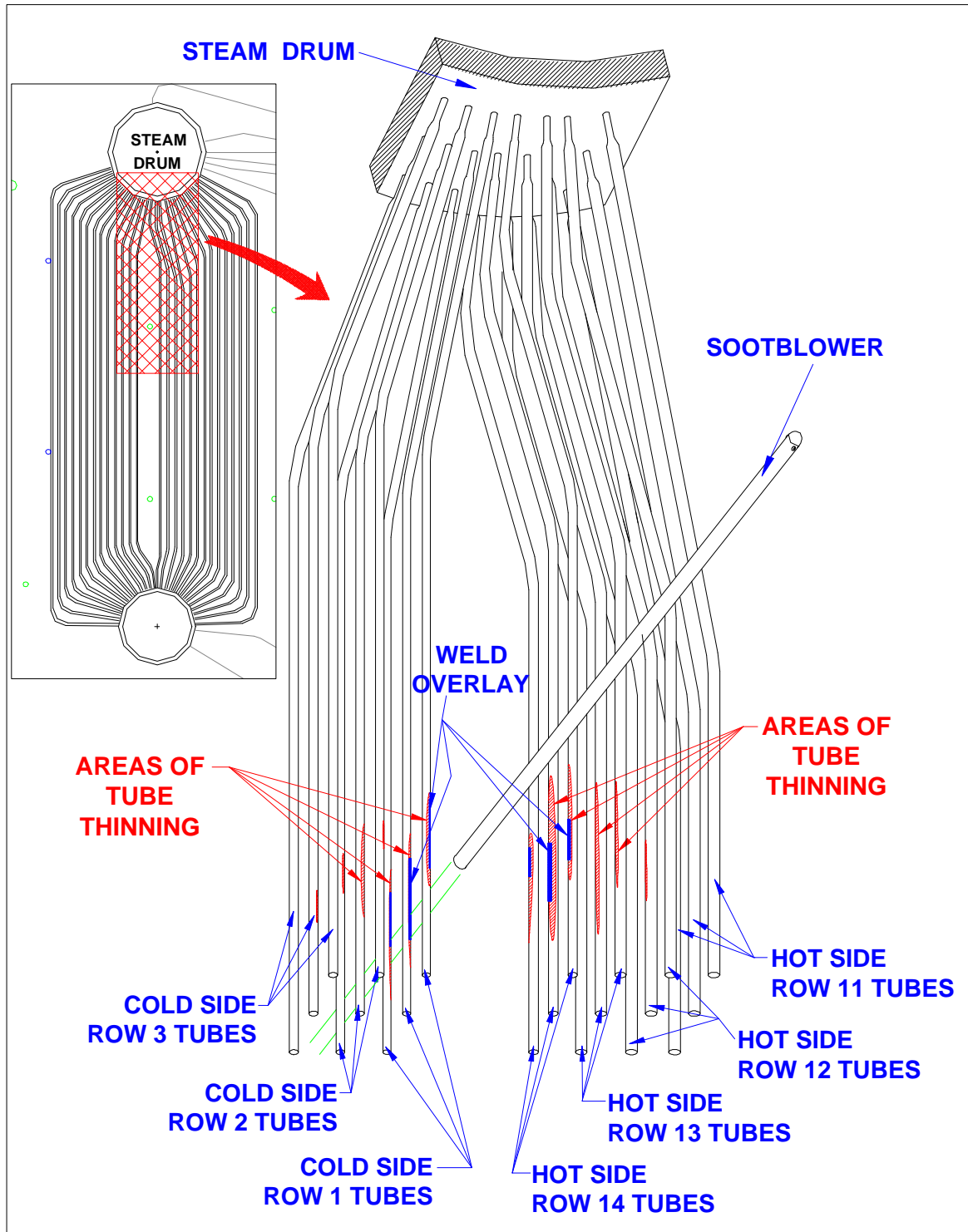
VISUALISATION OF TUBE THINNING - FRONT TUBES



VISUALISATION OF TUBE THINNING - LOWER CENTRAL SBL



VISUALISATION OF TUBE THINNING - UPPER CENTRAL SBL



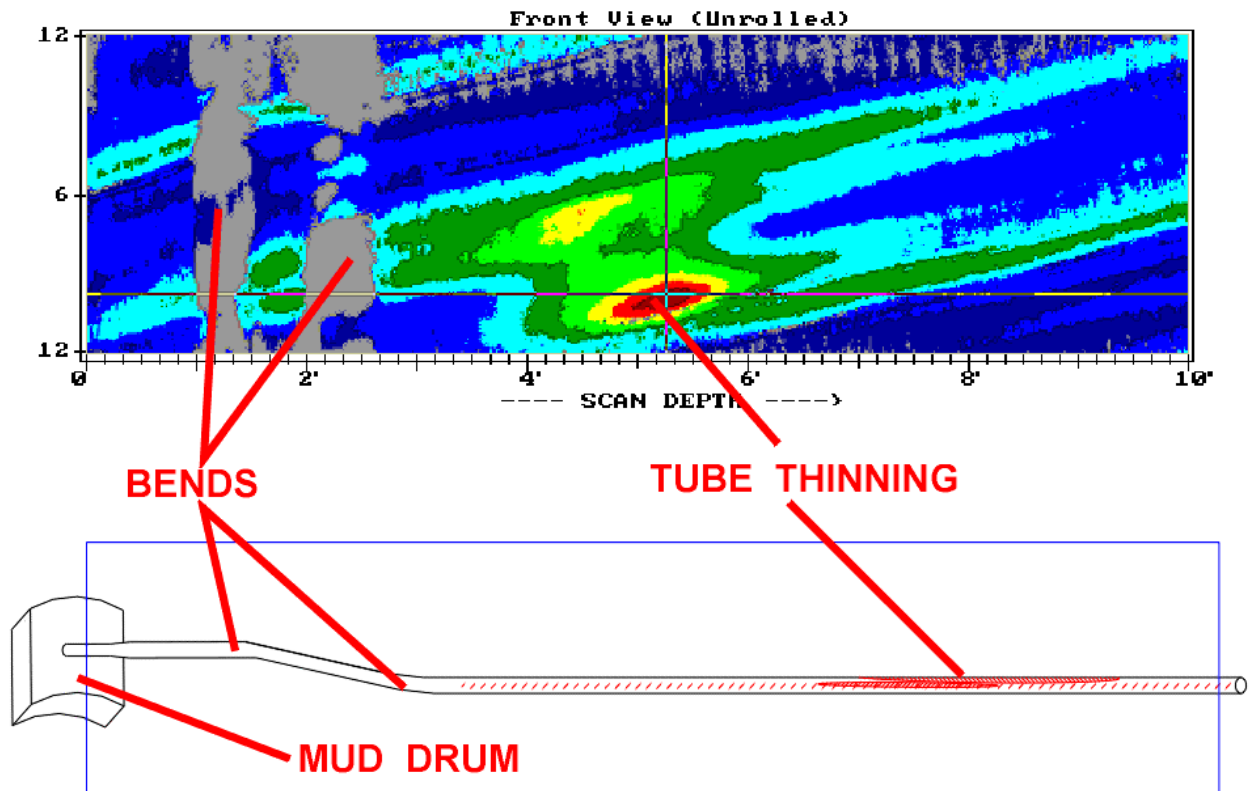
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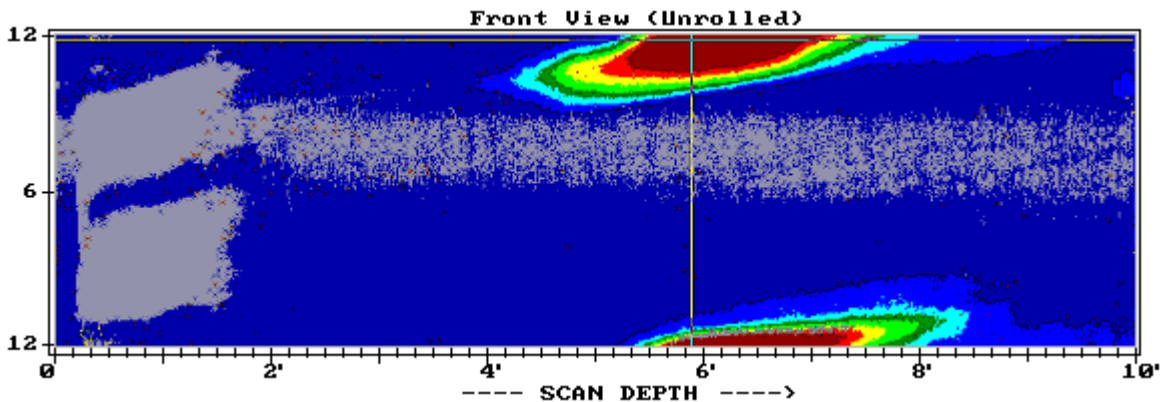
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- b) On the tubes in Rows next to the central sootblower (ie. Rows 13, 12 and 11 on the “Hot” side; and Rows 02 and 03 on the “Cold” side). The two C-scans below illustrate this, highlighting the erosive action of the central sootblower on the “inner” tubes. This type of thinning is typified by the attached WIP images T05R13 “A” and T05R02 “A”.

C-Scan Image of T05R13 “A” Hot Side showing area of typical tube thinning



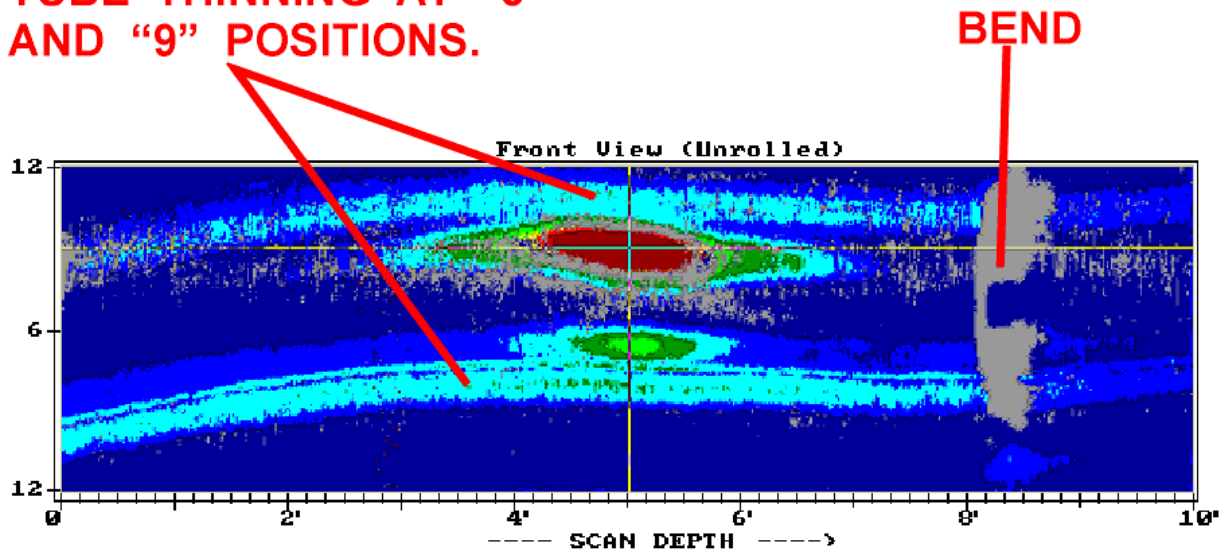
C-Scan Image of T05R02 “A” Cold Side showing area of typical tube thinning



- c) On almost all the tubes inspected in the “Hot” side had tube thinning on the sides of the tubes at the “3” and “9” o'clock position. The C-scan image below shows the tube thinning at “3” and “9” o'clock positions in addition to the thinning due to the central sootblower. This is shown in the “visualisation” sketch for the front tubes, where the flue gas passes in between the tube causing tube thinning on the sides of the tubes at “3” and “9” o'clock. The attached WIP images, in the “sample Images” section, T04R12 “A”, T06R12 “B”, T06R13 “A”, T05R13 “A”, T06R14 “B”, T67R14 “B”, T68R14 “B” “Hot” side exhibit this type of tube thinning.

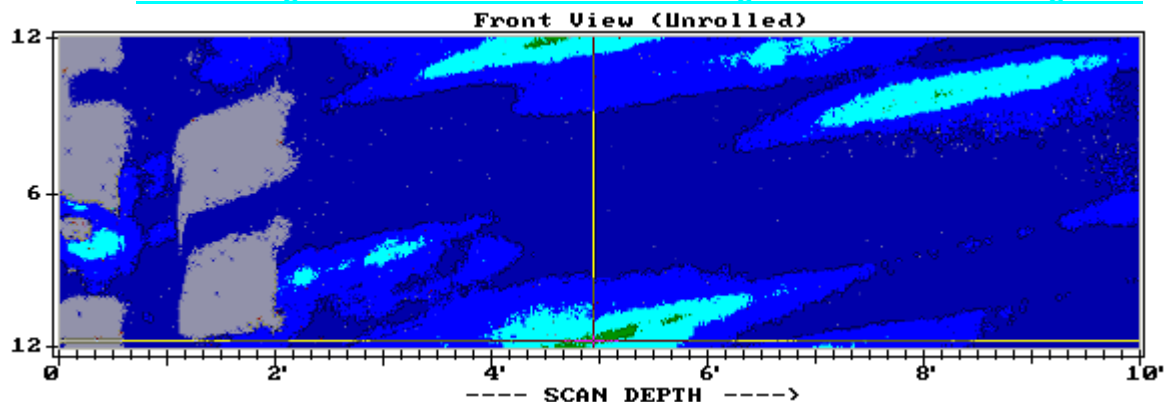
[C-Scan Image of T06R12 “B” Hot Side showing tube thinning at “3” and “9” o'clock positions](#)

TUBE THINNING AT “3” AND “9” POSITIONS.



- d) On first few rows on the “Cold” side next to the central sootblower lane, the tube exhibits “random” thinning as shown in the C-scan image below. This could be attributed to the turbulence caused by both the sootblower and the flue gas from the “Hot” side.

[C-Scan Image of T24R04 “A” Cold Side showing “random” tube thinning areas](#)



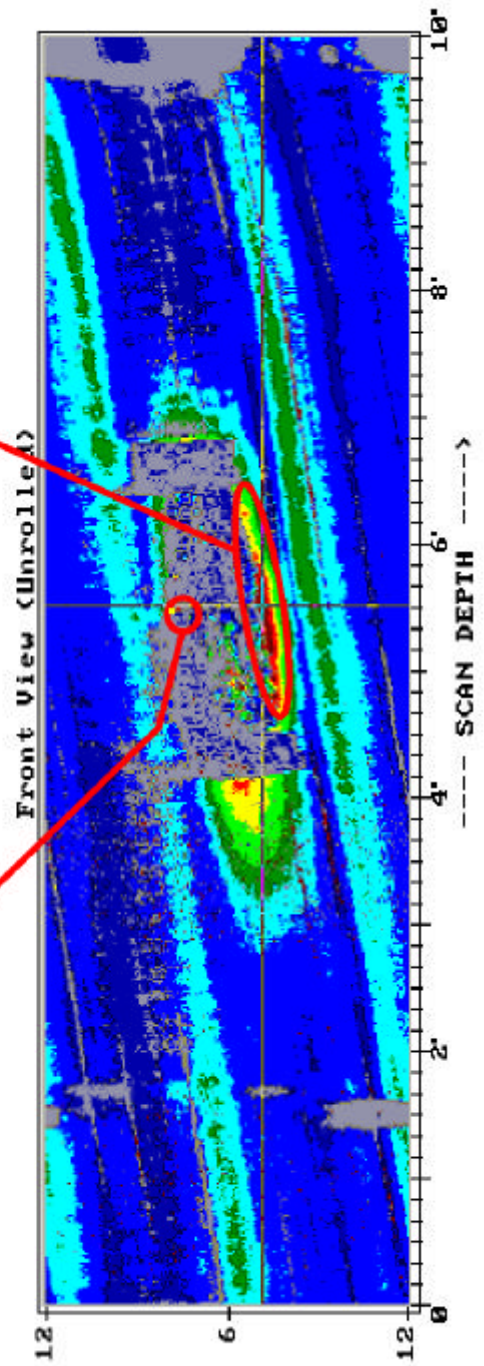
Pictures and C-Scan Image showing overlay areas in T06R14 "Hot" Side upper sootblower



Low Area "missed" by Overlay



Close-up of Large "Pit" in Overlay



"Rotated" C-Scan Image

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RECOMMENDATIONS

A total of 400 tubes were inspected of which five tubes were found to be below the "allowable" code minimum set at 0.100" on the "Hot" side and 0.115" on the "Cold" side . T05R13, T06R11, T06R12, T06R13 on the "Hot" side and T05R02 on the "Cold" side are to be plugged. T05R14, T06R14, T07R14, T67R14 and T68R14 on the "Hot" side are accessible and hence will be overlay before putting the boiler back in service again.

It would be highly recommended that you perform a full inspection on the gen bank during the next outage given the results of this inspection. This would enable us to give you a full "visualisation" of the condition of the gen bank tubes.

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 mill in Any Town again.

Yours truly,

Joe, Technician
NDT Level II

Distribution of Printed Report:

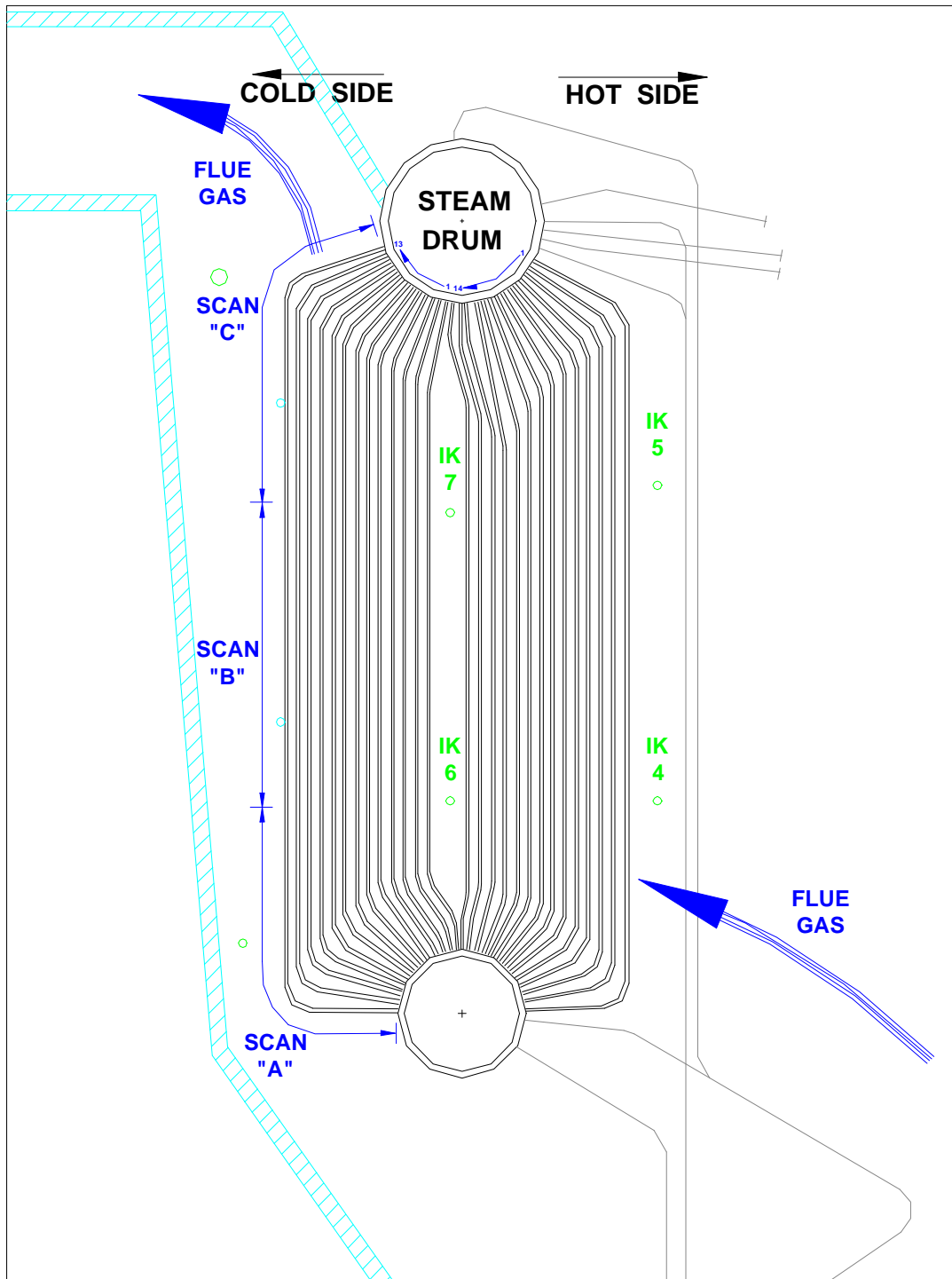
ABC, Any Town - 2 copies

Stasuk Testing, Burnaby - Original

TUBE-SHEET LAYOUT SKETCH

GENERATING BANK CROSS-SECTION

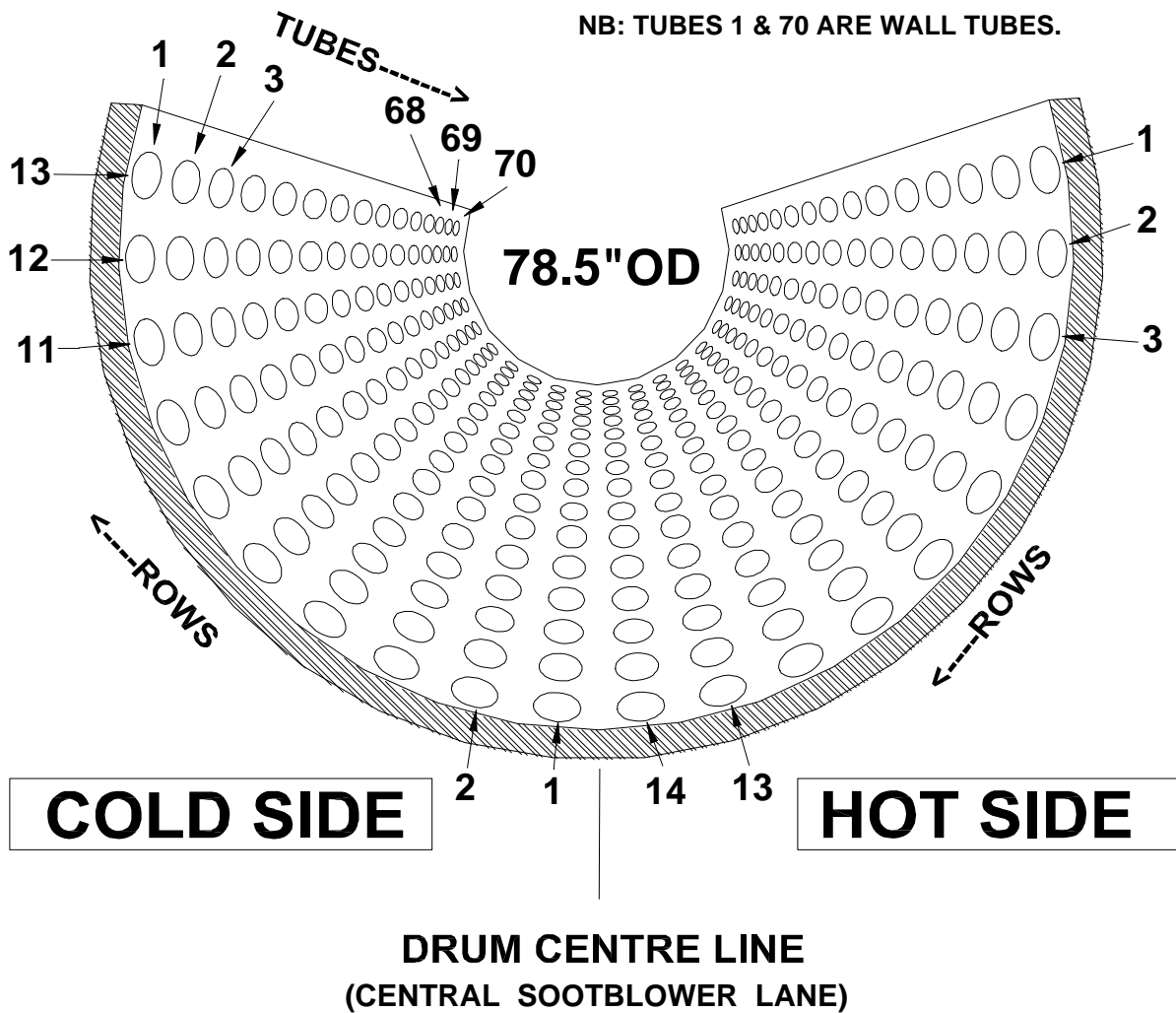
(Showing the Scan Numbers for the tubes)
Scan Numbers may vary depending on length of tube.



STEAM DRUM LAYOUT

(Tube Numbering System Used)

STEAM DRUM - LOOKING WEST



DATA TABLES

Based on Remaining Wall thickness

SAMPLE IMAGES

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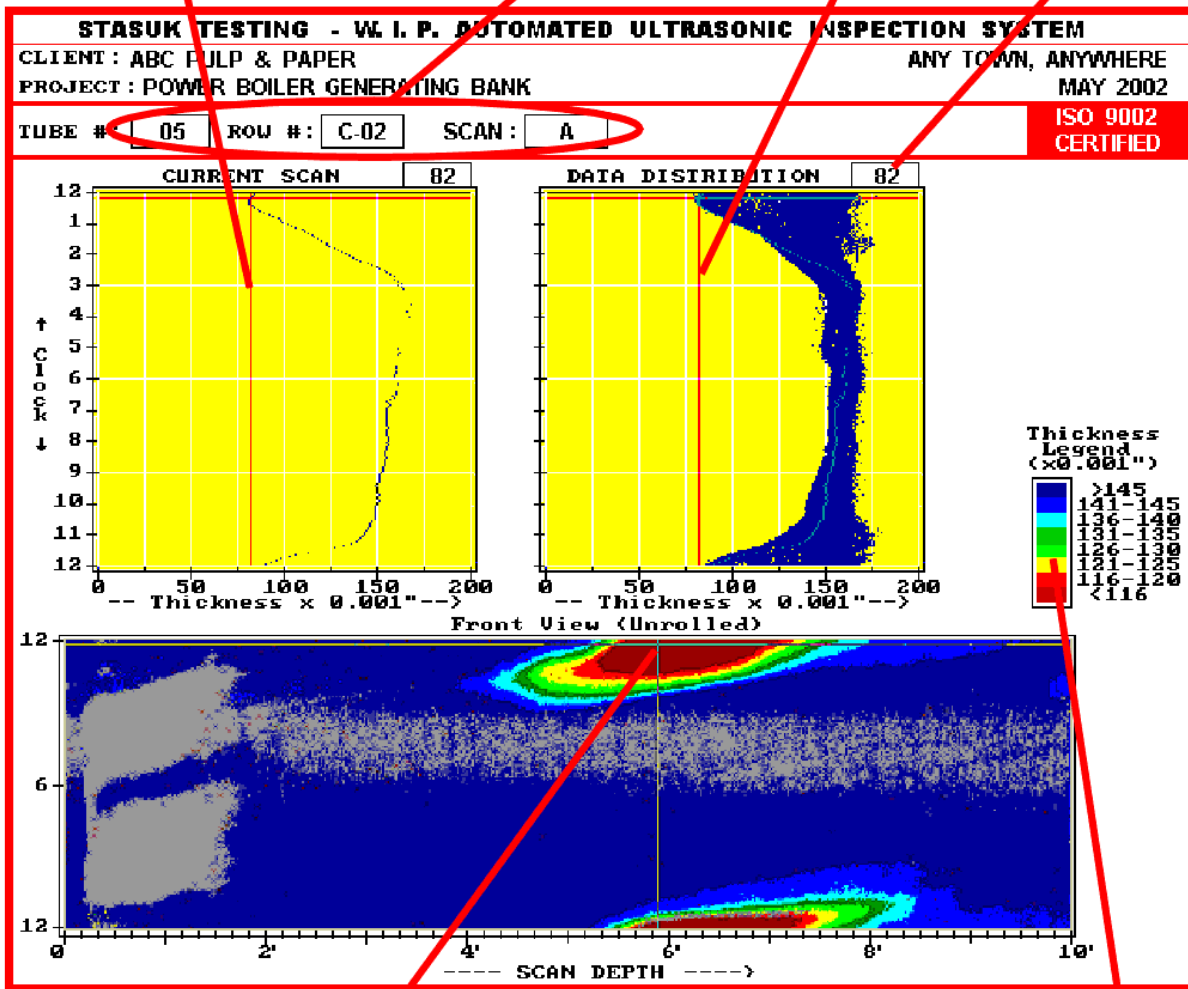
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B-scan (End View) showing the single scan where the lowest readings was found.

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

Tube identification and scan number. Eg. Row C-02 is Cold Side Row 2 & Scan "A" is the first scan from mud drum.

Lowest valid reading found.



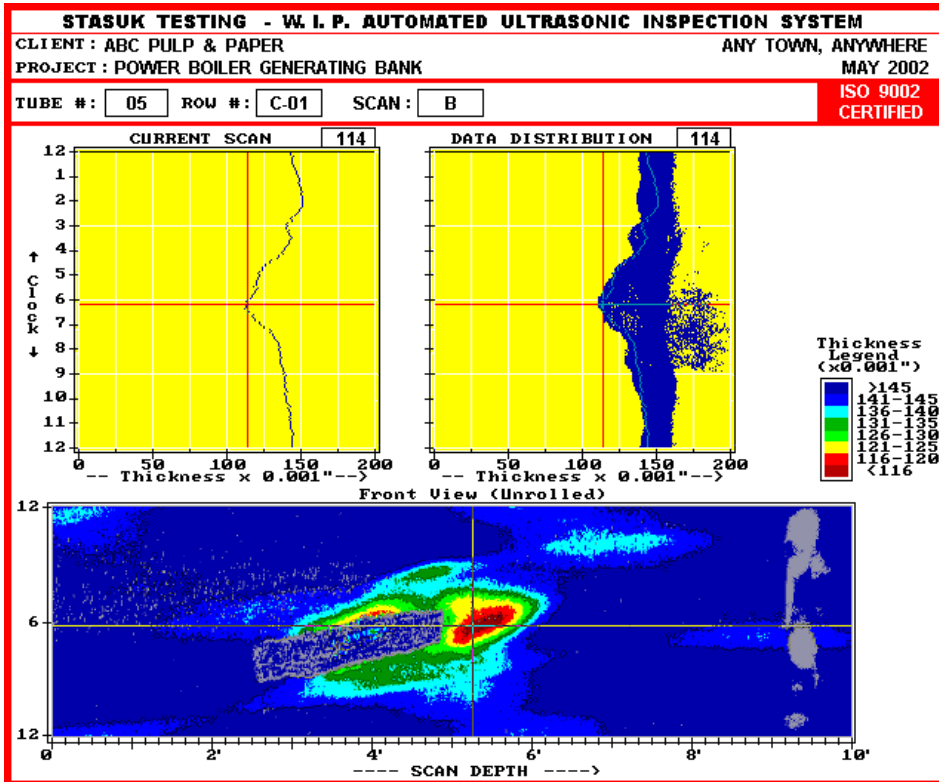
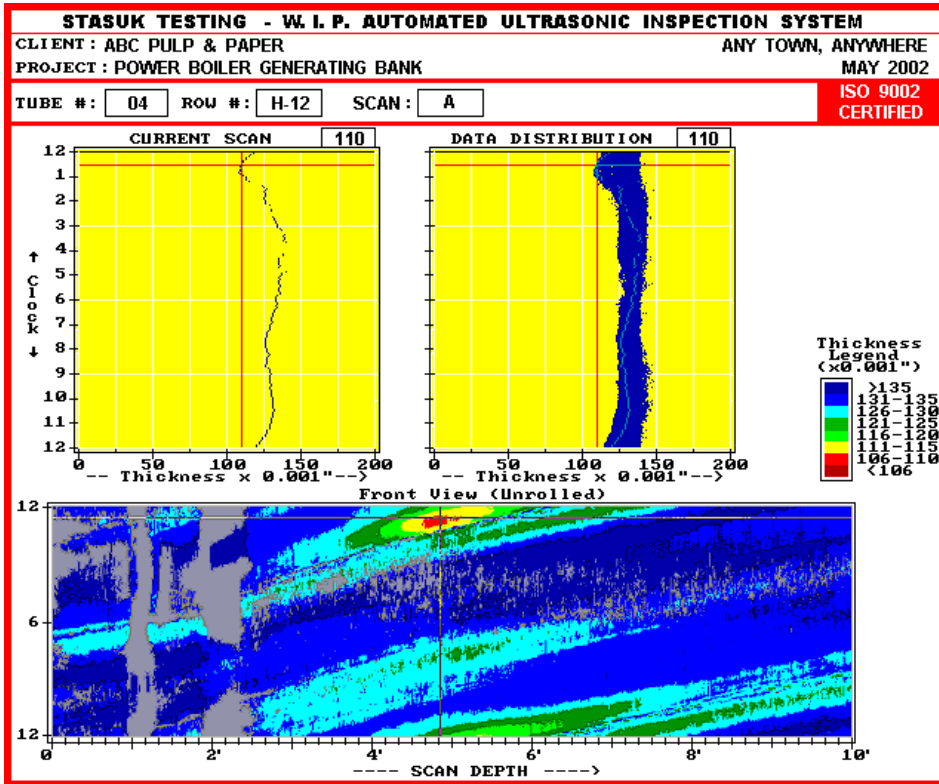
C-scan (3-D) display showing the tube thickness profile in color, assuming the tube is rolled and flattened out. The vertical axis represent the circumferential axis and the horizontal represents the axial length of the tube. The cross hair or cursor indicates the lowest valid reading. There is a total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

Thickness legend.

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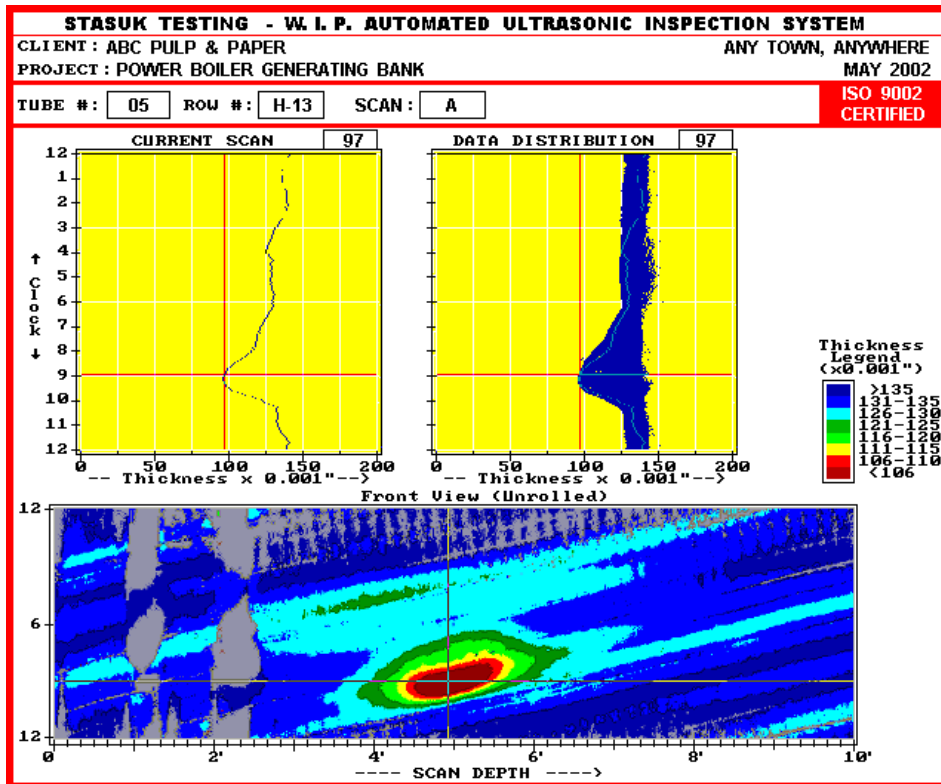
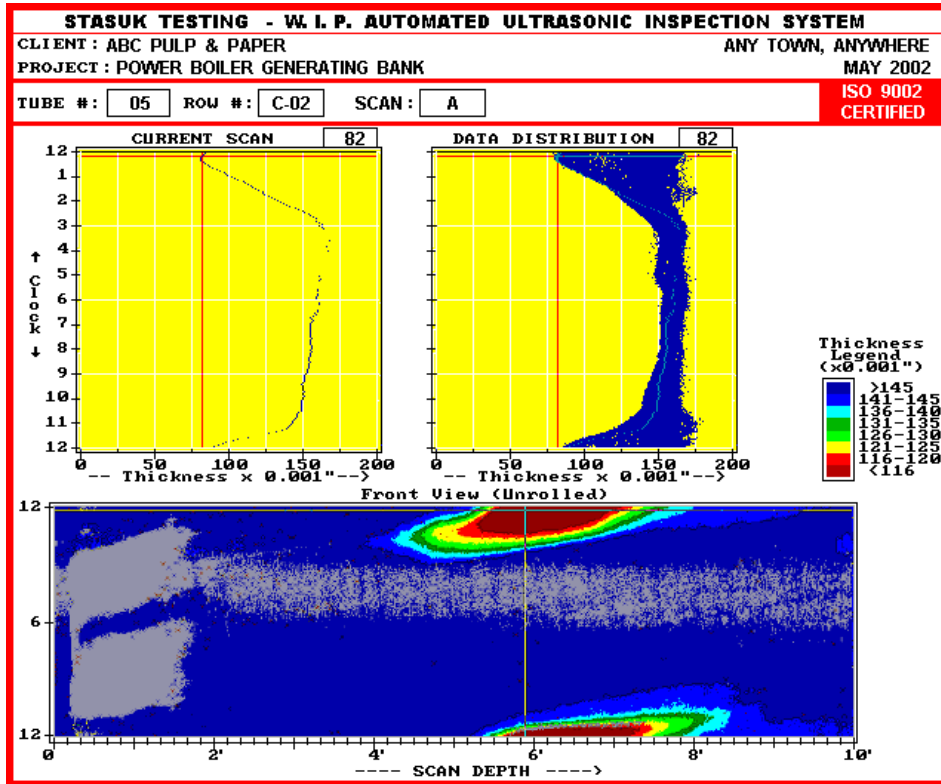
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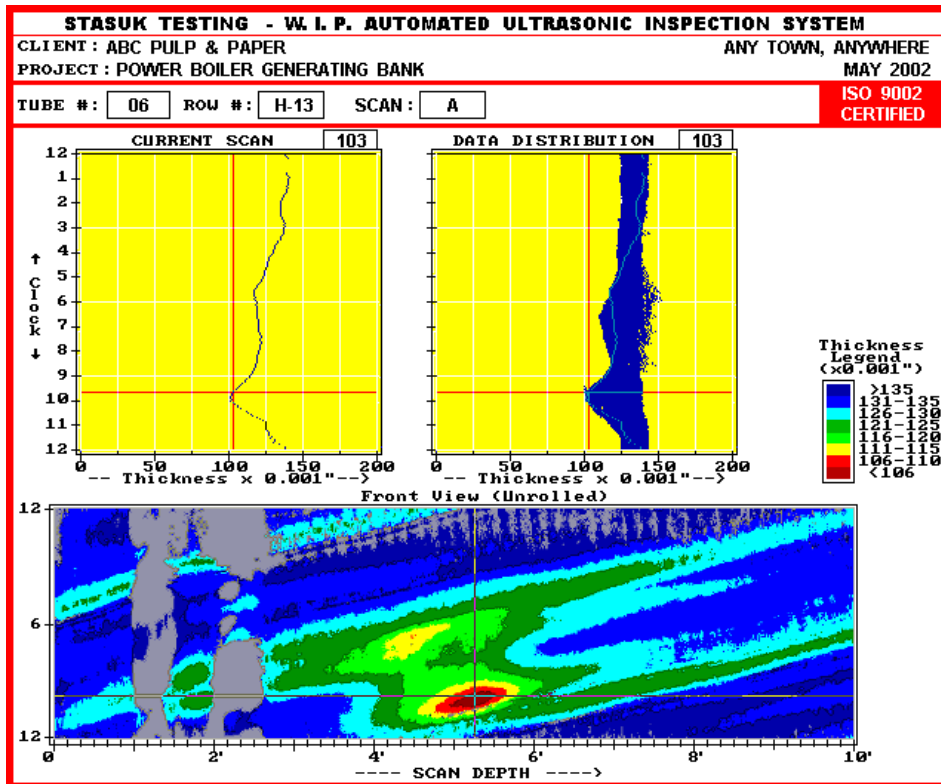
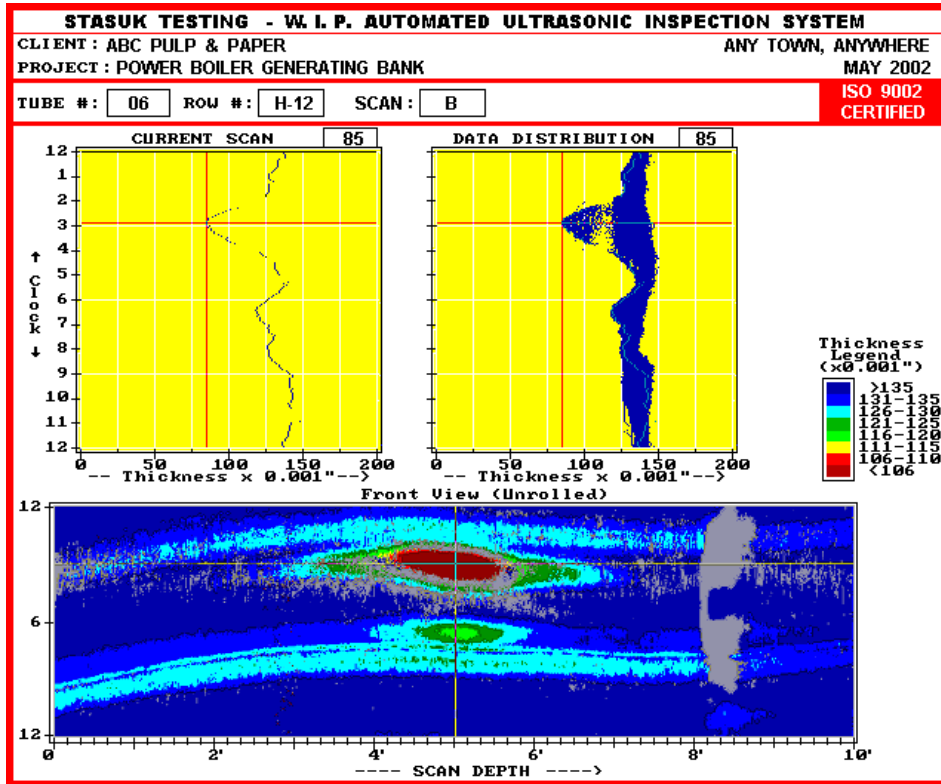
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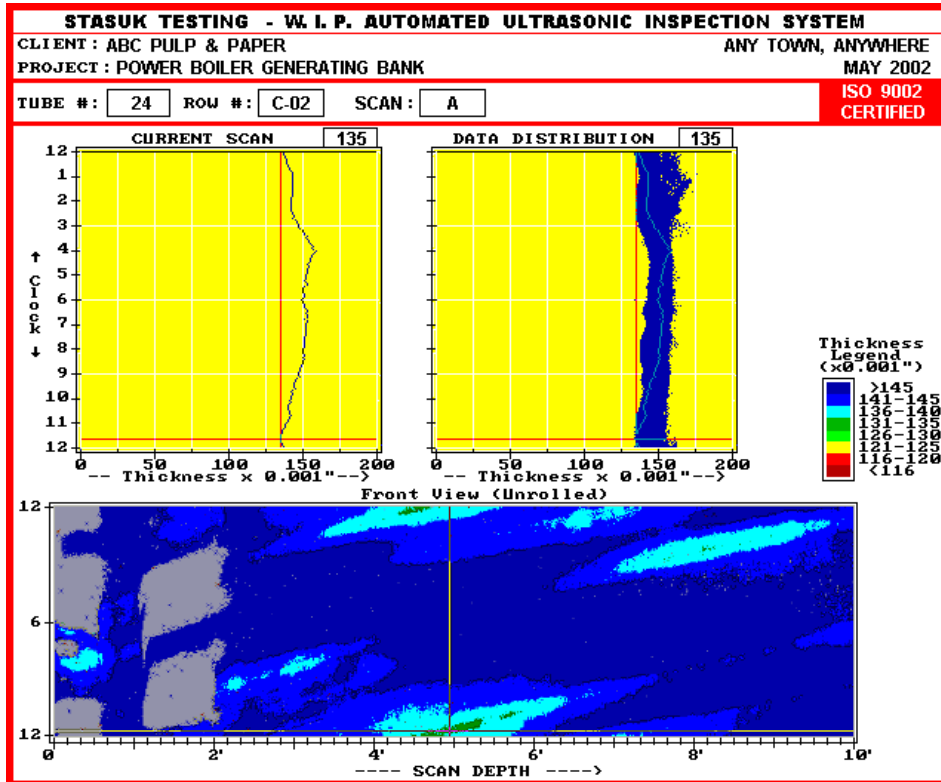
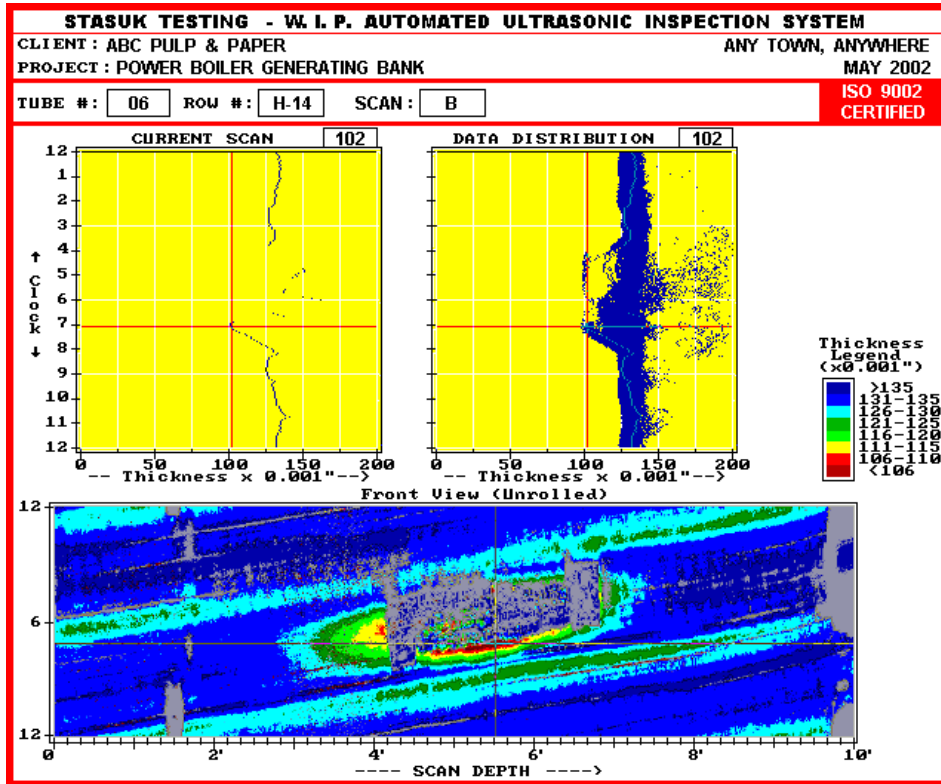
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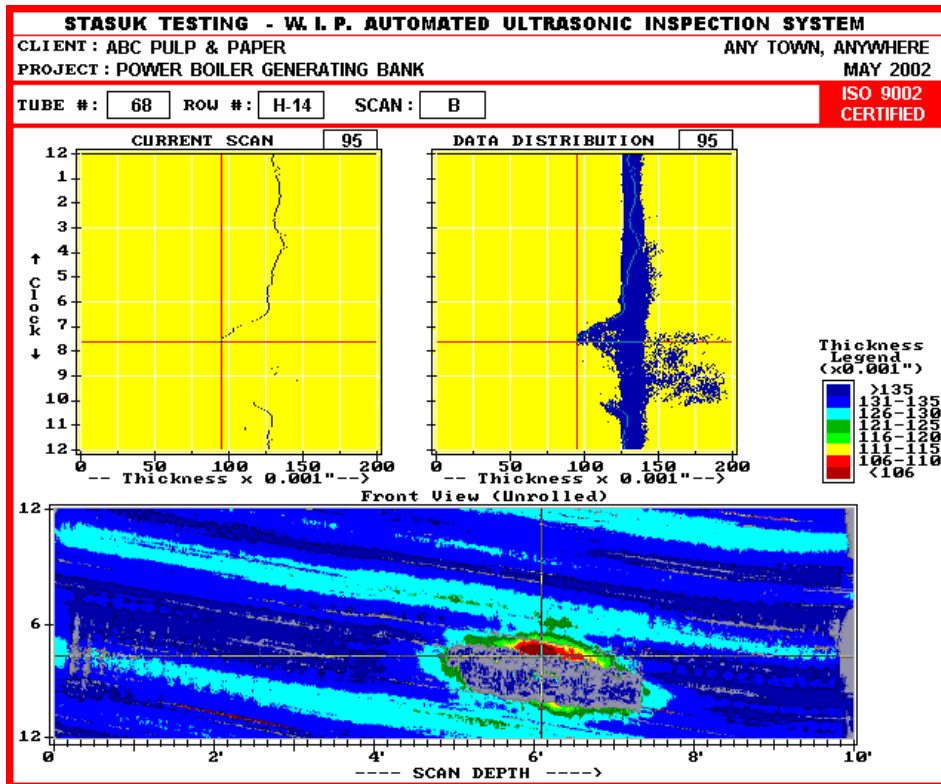
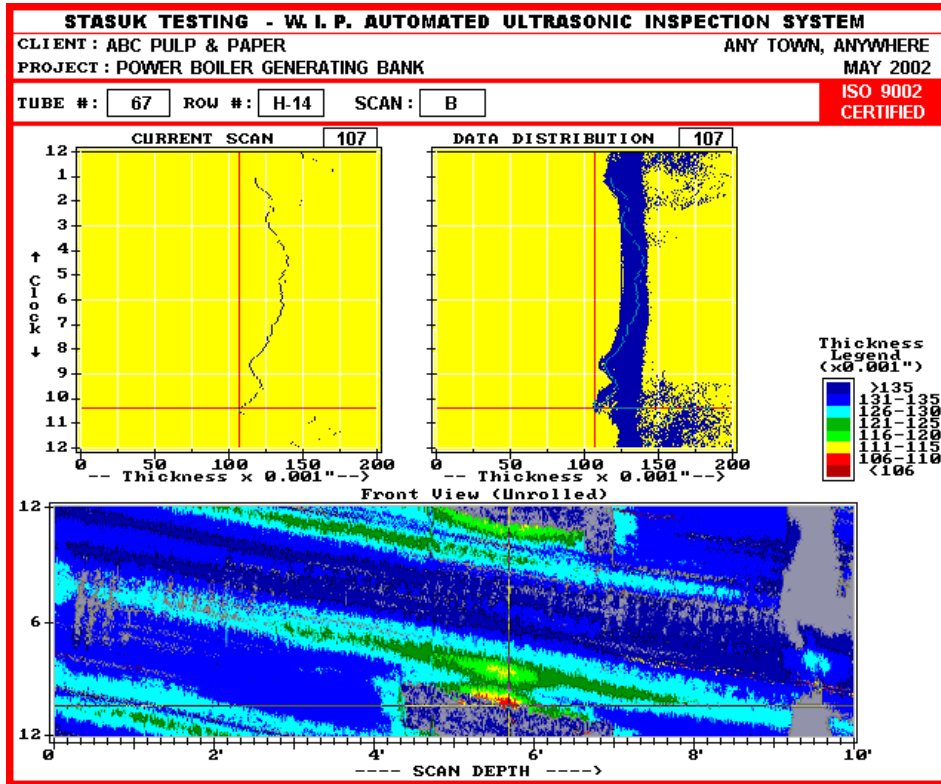
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END OF REPORT