

**NDE2015, Hyderabad
November 26-28, 2015**

25th National Seminar &
International Exhibition on
NON-DESTRUCTIVE EVALUATION
Automated Ultrasonic Testing of Plates in Line
For Longitudinal Submerged Arc Welded Pipes
By,

Mr. Rajul R. Parikh
Tel.: +91 9820192953,
E-mail:rajulparikh@eecindia.com

Mr. Ashok J. Trivedi
Tel.: +91 9821280878,
E-mail: ashoktrivedi1948@gmail.com

Abstract

A Multichannel, (176 Nos.) Ultrasonic Plate Testing System indigenously designed, developed & installed In-line for evaluation of the internal quality of plates, used to fabricate the L-SAW Pipes is described in the Paper.

This Paper covers the Ultrasonic Test Electronics, UT Probes, Test Procedure, Calibration Standard, Test Technique, Automation Documentation/Test reports & typical applicable Inspection Codes under which the plates are inspected.

Key Words: Indigenous Multichannel Ultrasonic Plate Testing System

Job (Plate) Description:

Plate thickness: 6-40mm
Width: 600 to 5000 mm
Material: Carbon Steel
Length: Up to 13 M
Test Speed: 12 meters/minute

Test Task:

Planar Defect Detection.
Grid Scanning or 100% scanning (with 10% overlap)
Calibration defect, 3 mm FBH & larger
Thickness monitoring
Defect location marking, test reports, test data archiving

Main Features:

176 Nos, Multi channel Digital Ultrasonic Test Electronics
Multi Test Booms with suspended Floating Probe Holder
Longitudinal Plate Edge Scanning mechanism
T/R array probes each of wide effective beam width of 100 mm
Coupling Water System
De-Watering System
Automation with PLC, HMI (Human Machine Interface), SCADA based software
PC based Data logging & Customized Test reporting
Paint Marking for location of Defects, Decoupling and Thickness out of tolerance
Strip Chart/ Proportional to echo amplitude graph for all the test Channels

Technique:

The system is suitable for detecting planar (lamination) defects which are oriented parallel to the major surface of the Plate. It meets the requirements of ASTM - A 435, EN 10160, BS5996, ISO 12094, API 5L, EIL and similar National & International testing codes/specification.

The principle of testing is based on Pulse-Echo technique with monitoring of flaw echo and back wall echo amplitude. The test electronics Gated monitors are placed to cover the plate cross section such that in presence of defect, the flaw echo triggers the alarm function. Additionally the alarms are triggered from the resultant drop in back wall echo from defect area, this concept is as well a coupling check to monitor the testing assurance for normal working of the entire set of test Probes. Plate thickness monitoring Gates are placed on the Back wall echo; resultant decrease in thickness below a set value triggers the alarms. The alarm events are recorded in the data base for subsequent test reporting.

Sensitivity setting is done by means of artificial defects i.e. flat bottom holes or flat bottom horizontal slots of the required dimensions are used during the Calibration process, prior to testing the production Plates. Various codes would specify a certain

dimension & orientation of the Calibration defect. The supplied test system is required to detect a (smallest size) 3.0 mm Flat bottom hole placed at various depths. All calibration echoes will be adjusted to a minimum of 80% full screen height.

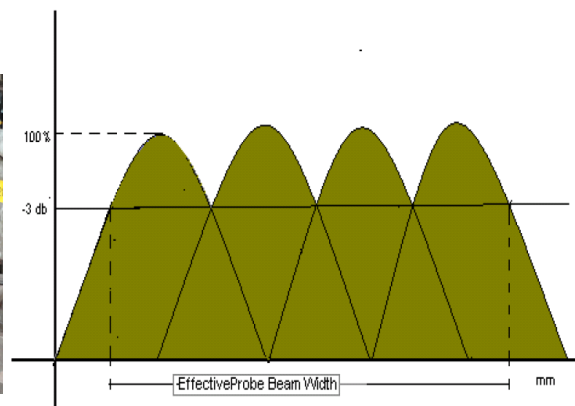
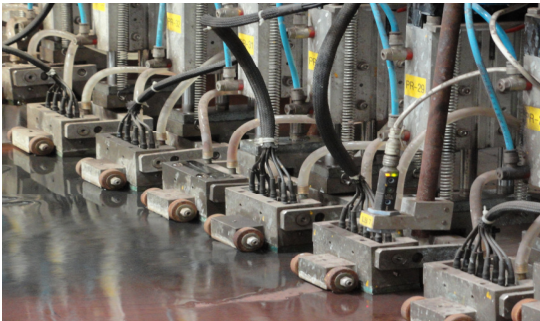
Probe Description:

The probes were customized & designed as per the test task. The testing codes allow a certain frequency, crystal size & specify the S:N ratio to be achieved. Various tests in laboratory with trial probes are necessary to arrive at final values of probes crystal frequency, size, focal distance & its housing.

The supplied system has TR Array Probes i.e. Dual crystal 0 Deg.

The probes are of 5 MHz frequency, crystal dimension of 25mm width, focal distance of 10mm, housed in a Stainless Steel housing which has water coupling feed nozzles & a probe cable of 5M length was potted in the probe assembly. Each of the Probes has an array of 4 modules, in an (external) housing to give an effective beam width of 100 mm at 3 dB. The probe housing is adapted to be housed in the probe holder mechanism.

The probes response from a calibrated defect will be within +/- 2 dB, to ensure uniformity of the large no of probes installed in the test system.



SPECIALY DESIGNED T/R PROBE

Test Mechanism:

There are two identical probe boom structures; each consists of arrangement to hold the probe holders at freely selectable position, along the plate width. Two rows of probe holders will be used so as to test the plate without gaps between the probes and achieve up-to 100% coverage with 10% overlap.

Both the longitudinal plate edges have an independent mechanism for “Edge” testing which is freely placed (adaptable) as per the width of the plate under test. The Edge testing mechanism is so designed that the probe holders placed for Edge testing float with reference to the plate edge, this takes care of un-tested regions due to variation in plate width dimension. This arrangement is mounted between the two plate body testing boom structures.

A total of 43 numbers of probe holders are provided. Each probe holder houses one probe. Probe holders are positioned across the Plate width. They have swivel movement to negotiate uncertainties in plate profile & bendiness. The probe holders have hard metal wheels which make a firm contact with the plate surface with minimum friction. Additionally the probe holders have wear plate for protection of probes from physical damage. The mechanism is designed to ensure long service life of the probes & to ensure ease of maintenance. The probe holders have a pneumatic actuated stroke of 50 mm to lower the probes on the plate surface for testing & retrieve to safe position when not being used.



Calibration Standard:

Reference standard is prepared from a plate having same grade material, having similar heat treatment condition and having same thickness as the plate to be inspected. The reference calibration standard shall have an artificially created discontinuity in the form of FBH or milled slots along the width of the plate. The location and number of defects machined in the calibration standard plate is such that each test electronic channel & its probe encounters at least one known defect. The calibration FBH are placed in a row as well as staggered along the length of the Plate. Special care is taken to cover the critical longitudinal edges of the plate.

The test code will specify the size of the Calibration defect to be used, its machined depth & location. Typically the smallest specified size in the Pipe industry is a 3mm FBH, placed anywhere on the plate body at T/4, T/2, 3T/4 depth. (as shown in the sketch)



Test Electronics:

The system consists of Model DUT 41-176 compact, modern, modular Digital Ultrasonic Test Electronics. It has two main frame located in the operator cabin. External (Remote) Pulsers and Pre-amplifiers are located on the test boom in close proximity to the Probes.

176 Channels are provided connecting each pair of crystal to an independent test channel via 22 Main Ultrasonic Boards. The system uses six Industrial PC's. Five PC's are used for UT functions, each have up to 40 channels functions. Display is via. 17" LCD monitor for the A-Scan and parameter display. A sixth PC is used for process monitoring & reports viewing via its LCD Monitor.

Presence of defects, audio/visual alarm is triggered & is noted by the computer. Defect location is marked by color spray marker.

Test Reports can be stored in the memory and recalled at a later date to copy them on a CD.



The above photograph shows Electrical Panel having PLC unit, Electronic Panel containing industrial PC, HMI Control & Mechanical Control Panel. All these are installed in the Operator Cabin.

Automation :

A PLC with required sensors and encoders is used for automatic operation of the test mechanics.

All probe holders with pneumatic cylinders have sensors to give feed back to PLC on their Up or Down position. The PLC programme has interlocks for safe operation condition.

Water circuit is provided via Solenoid which is activated during test ON condition.

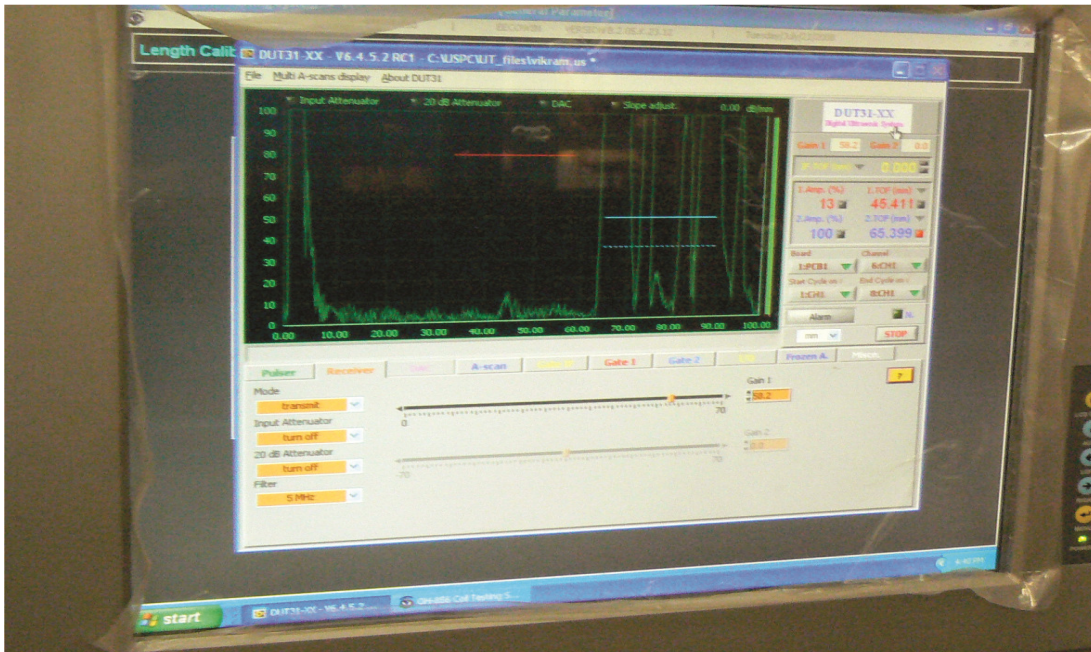
Number of probes used is selectable via Control on the HMI display unit. Since the plate reference is the center line of the mill, the numbers of probes used are selected with reference from the center line.

An encoder is used for length feedback. The same is mounted on the mill motor shaft.

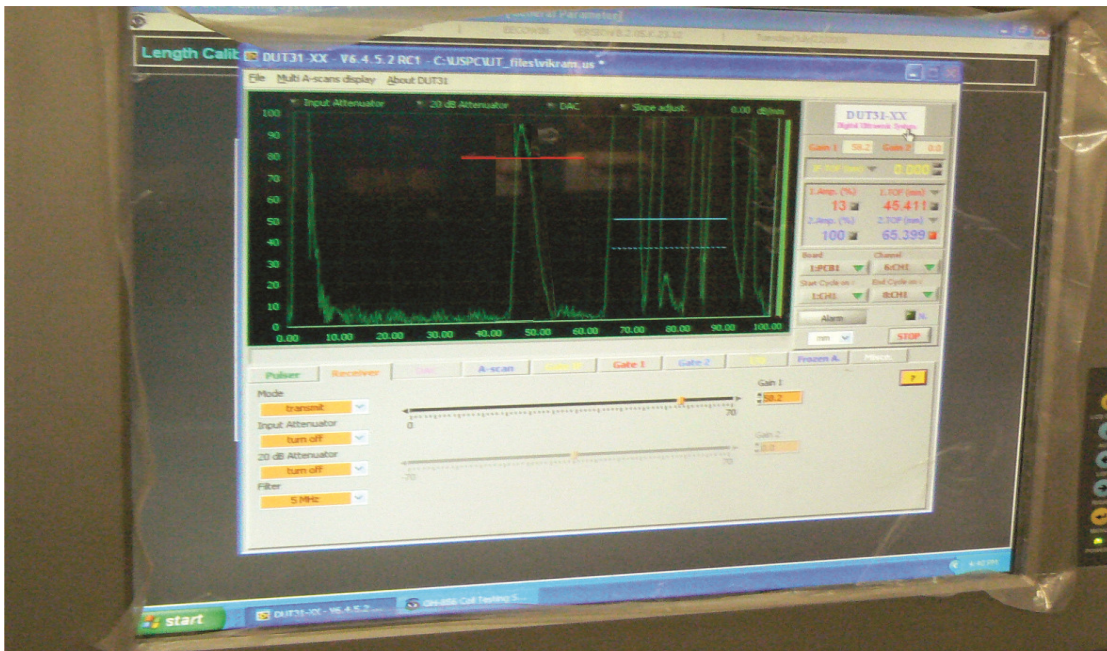


PLC & HMI control system

Signal to Noise Ratio:



A Scan presentation showing Initial Pulse, Back Surface Reflection & Noise Level during actual scanning.



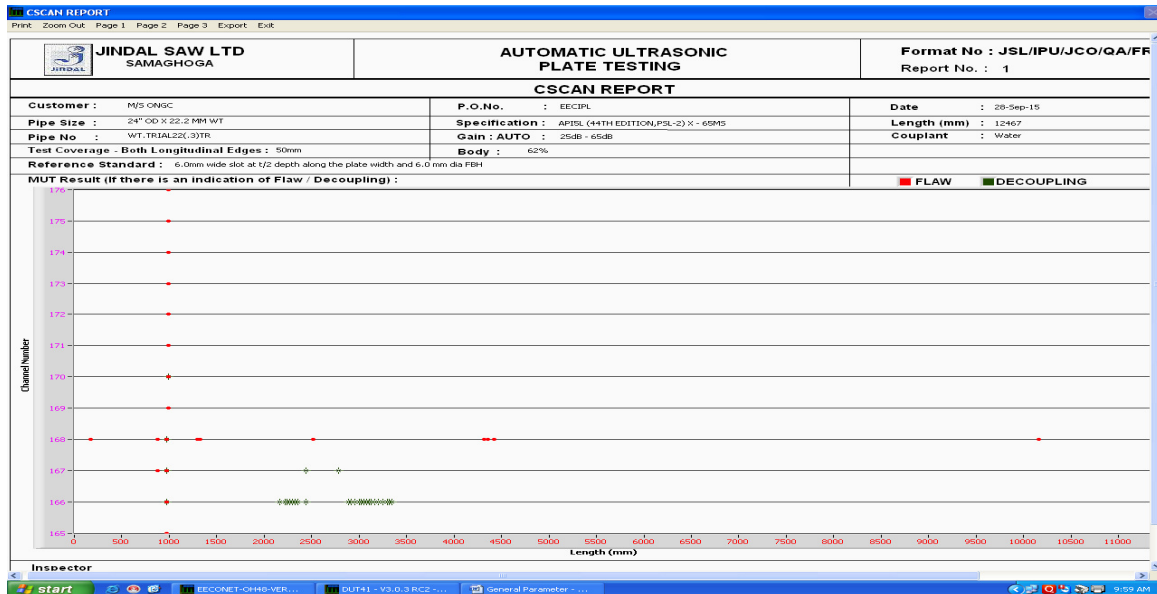
A Scan presentation showing Initial Pulse, Flaw Signal from a 3mm FBH & Back Surface Reflection during examination of Plate

Test Presentation:

On line Screen gives real time information of the test progress & assurance of test process. The On Line screen has all the relevant information like, Defect Location, Defect Channel number, Tested length, alarm condition, sensor status, Flaw and De-Coupling indications

Test Report:

Test reports are generated after each plate is inspected. It is possible to have a Test Report of individual plate or group of plates, statistical analysis or a detailed C Scan report having Information of channel wise defect with it's location along the length of the Plate are possible. The report format can be customized based on the requirement.



Acknowledgement:

The Authors thank the Management of M/s. Jindal Saw Ltd. for sharing valuable information on their process and experience with the supplied UT System.