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| ISO 9001:2008 | Document No. M&C/NDT/129/2005, Rev-II, Aug 2014 | Version No. 3.0 | Effective Date: 01.07.2015 |
| Document Title: Technical specification of Digital Ultrasonic Testing equipment for welded rail joints with coloured LCD TFT screen, trigonometrical function and A-scan storage alongwith data setup. | | | |



RESEARCH DESIGNS & STANDARDS ORGANIZATION
Manak Nagar, Lucknow-226011

M&C/NDT/129/2005, Rev-II, Aug 2014

**TECHNICAL SPECIFICATION OF DIGITAL ULTRASONIC TESTING
EQUIPMENT FOR WELDED RAIL JOINTS WITH COLOURED LCD TFT
SCREEN, TRIGONOMETRICAL FUNCTION AND A-SCAN STORAGE**

Amendment history:

| S. No. | Amendment date | Version | Reasons for Amendment |
|--------|----------------|---------|--|
| 1. | NA | 1.0 | First issue specification No. M&C/NDT/129/2005, Oct 2005. |
| 2. | June, 2011 | 2.0 | Change in clause no. 4.5, 5(m), and 8 of specification No. M&C/NDT/129/2005, Oct 2005. |
| 3. | 02.12.2014 | 3.0 | Change in clause no. 6.1, typographical error in clause No. 6.2, 8, 9, 10, 11 and some ambiguities in the interpretation of some para's. Approval accorded by ED/M&C at np-15 of file No. M&C/NDT/129/2005, Rev-II. Date of enforcement accorded by Directorate head at np-15 as per clause No. 4.7 of document No. QO-D-7.1-2 on file No. M&C/NDT/129/2005, Rev-II. |

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1. Scope:

This specification stipulates the technical and functional requirements of dedicated Digital Ultrasonic testing equipment and its essential accessories for detection of flaws in welded rail joints i.e. Alumino - Thermic (AT), Flash – Butt (FB) and Gas pressure welded rail joints. The equipment shall be capable of detecting flaws, finding their location and storing the A-scan signals obtained in joints of rail sections during Ultrasonic testing of welded rail joints used on Indian Railways.

2. General requirements:

The equipment shall be capable of carrying out flaw detection by A-Scan pulse-echo technique with coloured LCD-TFT screen display. It should be able to be continuously used for 8 hours through battery without any drop in performance. The display of A-Scan shall have visibility in the indirect light. The equipment shall be supplied with all accessories mentioned in the accessories list.

3. Functional Requirements:

The equipment shall be able to perform the following functions:

- 3.1 Shall be capable of detecting lack of fusion in rail head, web and foot, half-moon defect in rail foot, shrinkage, transverse defects in rail head, welding defects in web, flanges and other harmful defects employing A -Scan Pulse echo technique. Soft grease /oil shall be used as couplant.
- 3.2 Shall be capable of operating both in Single crystal and Double crystal mode.
- 3.3 Shall be capable of scanning the weld using 0°, 70°, 45°(Half-moon and Tandem technique) and 70° side looking probes, pitch-catch method etc. for detection of defects mentioned at Sl. No. 3.1.
- 3.4 The equipment with LCD TFT screen for A-scan display shall be capable of calculating beam path, horizontal distance and depth of discontinuity in the weld with respect to the probe index point.
- 3.5 The equipment shall have suitable cover to protect it from dust, grease etc. and the entire test equipment and accessories shall be accommodated in a suitable carrying case fitted with handles to facilitate carrying.
- 3.6 The equipment shall withstand 40 g, 4000 ± 10 bumps as per IS 9000 (Part VII- sec. II).
- 3.7 The equipment shall give normal performance after being subjected to 1g, 10 to 100 Hz vibrations for 30 minutes.
- 3.8 The equipment shall be tropicalized to suit Indian climate for damp heat cyclic test as per IS: 9000(Part-V/Sec 2).

4. Functional parameters:

- 4.1 **Test Mode:** The equipment shall be capable of working in T+R / T/R mode i.e. single crystal & double crystal mode individually.
- 4.2 **Frequency range:** The equipment shall have one band amplifier capable of working in the frequency range covering 1MHz to 6 MHz.

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- 4.3 **Test range:** The equipment shall cover test range from 50 mm to 1000mm.
- 4.4 **Trace delay:** The equipment shall have trace delay facility of minimum 100mm length in steel.
- 4.5 **Gain/ Amplification:** The equipment shall have minimum 120dB total gain (including internal gain). The operatable gain shall be 80dB. It shall be provided with suitable gain control switches/touch keys. The gain steps shall cover 0.5 dB, 1dB, 2 dB and 6dB in the equipment.
- 4.6 **Suppression/ Reject:** The equipment shall have reject facility or suppression of vertical signals from 0 to 80% minimum of full screen height without affecting the desired signals.
- 4.7 **Monitor gate:** The equipment shall be provided with minimum one monitor gate expandable to cover horizontal screen display from 5% to 99% and the level (vertical height) of the gate shall be adjustable to 5% to 99%.
- 4.8 **Expansion/ Zoom:** The equipment shall have expansion arrangement of gated signal within full screen length. (Graticule width).
- 4.9 **Data Display:** The equipment shall have provision of display of different data set-up values of test parameters on screen itself.
- 4.10 **Memory provision:** The equipment shall have arrangement for logging minimum 10 calibration sets and at least 200 data set-ups along with coloured A-scan in the memory and recalling the memory as and when required by the operators.
- 4.11 **A-scan and Data logging:** The equipment shall have facility to enter and log the following data through alpha numeric keys along with A-scan obtained during weld testing.
- i) Date of testing
 - ii) Operator Name/code
 - iii) Division /Km. Post
 - iv) Rail-LH/ RH
 - v) Road -Up/ Dn
 - vi) Location of defect/head, web, flange
 - vii) Classification of defect DFWO/DFWR/N D

The above data shall be available in the A-scan frame.

5. Important characteristics:

The equipment shall possess the following values in regard to the important characteristics when tested in accordance with IS:12666-1988 or latest using 2.0/2.5 MHz single crystal probe of 20mm crystal diameter.

- 5.1 **Linearity of time base:** The variation shall be within $\pm 1.25\%$ at ranges 100mm, 250mm & 500mm.
- 5.2 **Linearity of Amplification:** The Linearity shall be within $\pm 3\%$ at ranges 100mm, 250mm and 500mm.
- 5.3 **Penetration Power:** The equipment shall give at least 5 full echoes and 6th appearing with single crystal probe (2/2.5MHz) in 23mm perspex of Block V1 (IIW V1) as per IS: 4904.

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- 5.4 **Dead Zone:** The dead zone shall not be more than 6 mm with single crystal probe (2/2.5MHz) and not more than 3mm for double/twin crystal 0°/ 4 MHz.
- 5.5 **Resolution:** The resolution shall be 6mm or better in steel.
- 5.6 **Sweep drift:** Sweep drift shall not be more than $\pm 1\%$ between room temperature and at 55°C temperature. To check Sweep drift, the equipment shall be kept for 2 hrs. at 55°C.
- 5.7 **Vertical drift:** Vertical drift shall not be more than ± 3 dB between room temperature and at 55°C temperature. To check Vertical drift, the equipment shall be kept for 2 hrs. at 55°C.
- 5.8 **Alarm:** The equipment shall be provided with alarm and LED glow for signals exceeding pre-set threshold value.
- 5.9 **Signal to noise ratio:** Signal to noise ratio shall not be more than 10% of full screen height at 500mm range on 23mm perspex with 2.0/2.5 MHz/20 mm diameter single crystal probe, with 5 full echoes & 6th appearing.
- 5.10 **Trace Pattern:** The trace on the screen shall be free from bow, kinks and under shoots. It shall be horizontal and free from tilts etc.
- 5.11 **Bump Test:** The equipment shall withstand 40 g, 4000 \pm 10 bumps as per IS: 9000 (Part VII-sec. II).
- 5.12 **Resistance to vibration:** The equipment shall give normal performance after being subjected to 1g, 10 to 100Hz vibrations for 30 minutes.
- 5.13 **Tropicalisation and Humidity Test:** The equipment shall be tropicalised to suit Indian climate for damp heat cyclic test as per IS: 9000(Part-V/Sec 2).

Note: “One unit within a period of 06 months shall be subjected to bump, resistance to vibration and tropicalisation test. From the date of completion of these tests, another unit selected from the lot offered for the inspection after a period of six month shall be kept for above mentioned tests. Also various type of Ultrasonic apparatus viz SRT, DRT, Axle Tester, Weld Tester etc. having similar type of ultrasonic flaw detector shall be treated as one lot. However, any new developmental unit shall be subjected for above tests at the time of its approval.”

6. Standard parameters:

- 6.1 **Size of the equipment:** The size of the equipment shall not exceed 270mmx 220mm x120mm.
- 6.2 **Weight:** The weight of the electronic unit shall not exceed 3 Kg. with battery.
- 6.3 **Display area:** The display area shall be minimum 90mm x 70mm.
- 6.4 **Data transfer:** The equipment shall have facility inbuilt for saving the data and to transfer the saved data directly on to the removable USB device or alternatively the equipment shall have facility through a converter device for transferring the saved data from the machine to the removable USB device.
- 6.5 **Battery level indicator:** The equipment shall have facility of low battery indication.

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7. Power Supply:

- 7.1 The equipment shall be operatable by re-chargeable Ni-Cd/Li-ion or any other re-chargeable battery.
- 7.2 The battery shall be capable for working minimum 8 hours continuously per full charge.
- 7.3 Automatic cut-off switch shall be provided to protect against deep discharge of battery below the workable voltage.
- 7.4 Automatic cut-off for battery and battery charger shall be provided to protect the battery from over charge.
- 7.5 Automatic cut-off circuit to be provided built-in to protect against over loading of equipment.

Note: Firm has to provide the declaration regarding various features of the power supply like type of battery, its optimum voltage in full charge condition, provision of cut-off switches/circuit for clause 7.1 to 7.5.

8. Accessories:

The equipment shall be supplied along with the following accessories:

A). Standard accessories:

| Sl. No. | Item Quantity | Quantity |
|---------|---|----------------|
| 1. | Double crystal normal probe , crystal diameter 18mm, 2 MHz | 1No. |
| 2. | 45° Single crystal probe/ 2 MHz with 20mm. diameter crystal or 20mmx20mm square crystal. | 2 No. |
| 3. | 70° Single crystal probe/ 2 MHz with 20mm. diameter crystal or 20 mm x 20mm square crystal. | 1No. |
| 4. | 70° Single crystal side looking probes (SL)/ with 15 mm diameter or 15 mm x 15 mm square crystal. | 1 Set of 2 nos |
| 5. | Test Rig for Tandem technique | 1No. |
| 6. | Re-chargeable Battery for 8 hours continuous working | 1No. |
| 7. | Battery charger with auto-cut-off | 1No. |
| 8. | Cover for UFD equipment | 1 No. |
| 9. | Carrying case for UFD and accessories | 1 No. |
| 10. | Scientific calculator | 1 No. |
| 11. | Folding umbrella | 1 No. |
| 12. | Calibration block (100x50x50 mm) | 1 No. |
| 13. | Steel measuring tape (5 mts min.) | 1 No. |
| 14. | Plastic bottle for oil (Half litre capacity) | 1 No. |
| 15. | Paint bottle (Half Liter capacity) with brush | 1 No. |
| 16. | 0°/2/2.5 MHz Single Crystal probe of 20 mm diameter or 20x20 mm square crystal | 1 No. |

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B). Optional accessories:

| Sl. No. | Item Quantity | Quantity |
|---------|--|----------|
| 1. | Standard AT weld test piece for sensitivity setting | 1 No. |
| 2. | Block V1 (IIW V1) as per IS:4904 | 1 No. |
| 3. | Step Gauge of 25 mm width in steps of 1mm (covering 2mm to 10 mm) | 1 No. |
| 4. | Spare re-chargeable Battery (mentioned at Sl. No. 6 in standard accessories) | 1 No. |

NOTE:

1. For standard AT weld test piece, consignee has to provide welded rail joint executed on unused rail pieces (minimum 600mm length) as per dimension stipulated in the 'USFD manual for ultrasonic testing of rails and welds, Revised-2012 or latest'.
2. The crystal used in the various probes shall be PZT (Lead Zirconate-Titanate). The manufacturer shall give declaration for type of crystal used in the probes along with dimension of crystal of various probes.

9. Technical Literature:

One set of operating instruction with minor troubleshooting tips, DOs, DONTs and FAQs etc.

10. Training:

The manufacturer shall train two operators per equipment in operation and minor trouble shooting of the equipment at the time of installation of the equipment.

11. Guarantee:

The manufacturer shall guarantee for satisfactory operation of the equipment except consumables like battery, probes, cables and charger for a period of one year from the date of commissioning of the equipment.

12. Service facility:

The supplier shall provide and ensure servicing facilities throughout the guarantee period of the equipment. After the guarantee period is over, the supplier should give service support for AMC throughout the codal life of equipment which is estimated 08 years for which payment shall be claimed separately.

NOTE:

1. This specification is property of RDSO. Its reproduction, copying wholly or partially or assigning new number, for any purpose by Railways or any other agency is not permitted.
2. RDSO reserve the right to modify this specification time to time based on the requirements.
3. If any features and technical requirements mentioned in the above specification are changed/modified by the manufacturer against approved model, the same shall be brought into the notice of M&C Directorate/RDSO Lucknow. Approval of the same shall be taken by the manufacturer.

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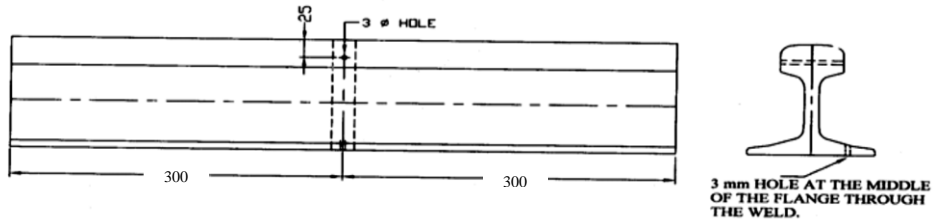


Fig: Standard A.T. welded rail piece with artificial flaws for sensitivity setting of ultrasonic equipment to examine A.T. welds

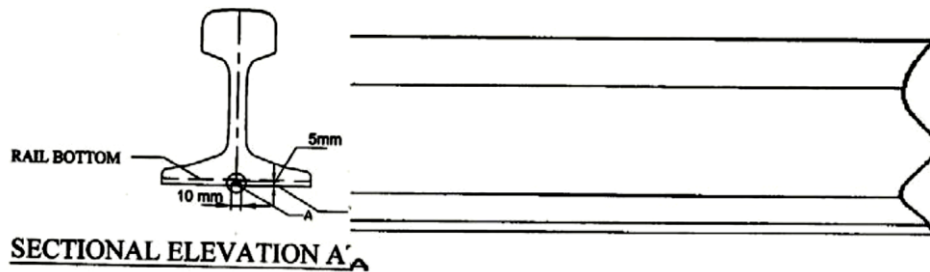


Fig: Standard A.T. welded rail test piece (Half-moon crack)
(All dimensions are in mm and drawing is not to scale)

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