Government of India
Ministry of Railways

TECHNICAL SPECIFICATION FOR DIGITAL ULTRASONIC DOUBLE RAIL TESTER HAVING CONTACT (SLIDING) PROBES WITH MULTI-BASE TRACE LINES, COLOURED SIGNALS AND A-SCAN LOGGING ALONGWITH DATA SETUP


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TECHNICAL SPECIFICATION FOR DIGITAL ULTRASONIC DOUBLE RAIL TESTER WITH COLOURED SIGNALS AND A-SCAN LOGGING ALONG-WITH DATA SETUP.

1. Scope:
This standard stipulates the technical and functional requirements for multi-channel with multi-base line (minimum two base line) real time display portable digital ultrasonic double rail tester with digital screen to display A-scan for different sliding probes fitted in double rail testing trolley. The equipment shall be capable to scan both left & right rail in a single run of testing. The equipment shall be capable to work on A-scan pulse echo technique. The equipment shall be capable for displaying different colour signals for different set of probes and facility for logging A-Scan pattern with data setup. The equipment shall be capable to scan rail head for detection of transverse defect in rail head including gauge face corner and non gauge face corner defects in both rails in a single run of testing and there shall be no need for identify the any flaw by operating the control of individual probe i.e signals appearing on the screen shall indicate that by which probe it is coming without operating the use of any control switch and only for classifying the defect the operator may use respective control switch. The equipment shall be tropicalized to suit Indian climatic condition.

2. General requirements:
2.1 The ultrasonic flaw detector shall be A-Scan pulse echo type with solid state printed circuit giving reduced inter connection noise, stray noise and radiation. The equipment shall have aesthetic look, robust, light in weight and suitable to work with battery displaying multi base line (minimum two) in digital screen for better visibility in the ambient light. There shall be provision for separate display of signals from left and right rail on monitor screen. The equipment shall be suitable to work up to ambient temperature of 55°C with multiple transducers. The equipment system shall have a system of logging 10 calibration sets (each calibration set shall display data set up of all probes) and minimum 200 data set-ups along with A-scan display in the memory. The equipment shall be capable to work properly under electrified track.

2.2 The ultrasonic flaw detector shall be equipped with real time display on the screen. The saved pattern shall consist signal appearing on the screen along with data setup and time of saving. The arrangement for real time circuitry shall be completely sealed and shall not be accessible to users. Provision shall be done that saved data when recall cannot be manipulated.

2.2 The equipment shall be capable of withstanding bumps and vibration as per stipulation of this specification.

2.3 The equipment shall be capable to suit Indian climatic condition for damp heat cyclic test as per IS 9000(Part V / Section 2):

2.4 The equipment shall be packed in a proper container of appropriate material to prevent corrosion, dust ingress and impact during transit.

2.5 The equipment shall meet the requirements of specification IS: 12666-1998 or latest version in respect of all those characteristics, which have been mentioned in this specification.

2.6 The battery shall be capable for working minimum 8 hours continuously without any drop in performance capability of the equipment.
2.7 The battery shall be easily detachable from the equipment and it should be able to charge without need of main equipment.

2.8 The equipment shall be tropicalized to suit Indian climatic conditions.

3 Technical Requirement:

Functional parameters.

The technical requirements of the equipment shall be as under-

3.1 Test mode:

The equipment shall be capable of working in single crystal mode (T+R mode), double crystal mode (T/R mode) and multi-channel mode.

3.2 Frequency range:

The equipment shall have one broadband amplifier capable of working in the frequency range from 1MHz to 6 MHz.

3.3 Test range:

The equipment shall have time scale calibration range 50 mm. or less to 600-mm minimum in the higher range.

3.4 Trace delay:

The equipment shall have trace delay facility of minimum 100 mm length in steel.

3.5 Gain/Amplification:

The equipment shall have minimum 120dB total gain (including internal gain of the equipment). Among this, minimum 80 dB shall be operatable from outside gain control key. The amplifier of the equipment shall have a very good signal to noise ratio and excellent linearity. It shall be provided with suitable gain control with fine and coarse steps. The fine gain control key shall be minimum in steps of 0.5 dB and the coarse control key shall be capable of increasing minimum amplification in step of 1dB, 2dB, 6dB, 10dB. All gain control shall be linear.

3.6 Suppression/Reject:

The equipment shall have reject facility or suppression of vertical signals from 0 to 80% of the full screen height. Reject facility shall be in step of 1%.

3.7 Monitor gate:

The equipment shall be provided with minimum two monitor gate expandable to cover entire horizontal screen display from 1% to 99% and the level (vertical height) of the gate shall be adjustable to 1% to 99%.

3.8 Data Display:

The equipment shall have provision of digital display of different data set-up values of test parameters on digital screen itself. Date and time of start shall be real and it shall need not to be feed by the operator. It shall be automatically appear in the data setup and shall also be displayed on digital screen along with equipment serial number and it should also be appear on printout.

3.9 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 trace pattern in the memory and recalling of it from the memory as and when required by the operators. There shall be arrangement for transfer of A-scan data along with other details to PC. It should be provide through USB port on removable data storage device. The A-scan and its details should be in a format which can be opened in MS Word.
3.10A-Scan and Data logging:

The equipment shall have facility to enter and logging the following data through alpha numeric keys along-with A-Scan obtained during rail testing.

i) Date & Time of start of testing (In screen itself)
ii) Operator Name / Code
iii) Division
iv) Km. Post
v) Section
vi) Rail-LH/ RH
vii) Road -Up/ Dn
viii) Location of defect (14 digit character)
ix) Rolling Mark
x) Probe Type
xi) Flaw Code
xii) Peak details, horizontal movement & vertical height
xiii) Classification of defect OBS/IMR/REM
xiv) Previous Classification

The above data shall be available along with A-scan trace pattern.

4.0 Important characteristics:

The equipment shall possess the following values in regard to the important characteristics when tested in accordance with IS 12666-1998 or latest version using 2.0/2.5 MHz single crystal probe of 20/25mm dia. crystal.

a. Linearity of time base
   The variation shall be within ±1.25% at all ranges viz 100mm, 250mm, 500mm.

b. Linearity of Amplification
   The Linearity shall be within ±3 % in all ranges viz 100mm, 250mm, 500mm.

c. 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 IIW block. It has to checked for T + R mode (single crystal mode).

d. Dead Zone
   The dead zone shall be 7 mm. or less with single crystal probe (2/2.5MHz) i.e for channels in T+R and 3 mm. or less for double/twin crystal at 4 MHz i.e for channels in T/R mode.

e. Resolution
   The resolution shall be 6mm in steel or better.

f. Sweep drift
   Sweep drift shall not be more than ±1%. Sweep drift shall be checked at room temperature and also at ambient temperature of 55°C for 2 hrs.

g. Vertical drift
   Vertical drift shall be within ±3 dB @ 1 dB/ 10°C between room temperature and 55°C ambient temperatures.

h. Alarm
   The equipment shall be provided with alarm through LED and audible sound for signals exceeding pre-set threshold value.
i. **Signal to noise ratio:**
   Signal to noise ratio shall not be more than 1/10\(^{th}\) of full screen height at 500 mm range on 23mm perspex with 2.0/2.5 MHz/20 mm dia single crystal probe, with 5 full echoes & 6\(^{th}\) appearing.

j. **Trace Pattern.**
   The trace on the screen shall be free from bow, kinks and under shoots. Its base line shall be truly horizontal and free from tilts etc. The trace pattern shall be clearly visible under shadow in bright day light from a distance of 1 metre.

k. **Bump Test.**
   The equipment shall withstand 40 g, 4000 ± 10 bumps as per IS 9000 (part VII – sec. 2).

l. **Resistance to vibration.**
   The equipment shall give normal performance after being subjected to 1g, 10 to 100 Hz vibrations for 30 minutes.

m. **Tropicalisation and Humidity Test.**
   The equipment shall be tropicalized 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 & 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.

5. **Standard parameters:**

5.1 **Display area:**
   The equipment shall have minimum 120 mm x 90 mm monitor display area. The monitor display shall have minimum two base lines. Each base line shall have minimum 50 mm length and 50 mm space for displaying vertical signal height.

5.2 **Print out facility for saved pattern and data setup:**
   The equipment shall have suitable arrangement to print out the saved data along with A-Scan trace pattern either directly from the equipment or by transferring the saved data to USB Pen drive which shall be suitable to insert into PC for taking print out. Suitable software for this operation, if required shall be supplied by the manufacturer along with the equipment.

5.3 **Battery level indicator:**
   The equipment shall have facility of battery level indicator to show its charging condition.
6. **Power Supply:**
   
i) The equipment shall be able to operate through Ni-Cd / Li-ion or any other rechargeable battery of 15 V max.

   ii) The battery shall be capable for working minimum 8 hours continuously per full charge.

   iii) The battery shall be easily detachable and can be put for charging without need of main equipment.

   iv) Automatic cut-off facility shall be provided to protect against deep discharge of battery below the workable voltage.

   v) Facility of automatic cut-off for battery and battery charger shall be available to protect the battery from over charge.

   vi) Protection against over loading of the equipment shall be provided by an automatic switch function.

   vii) Facility for full charge condition of the battery shall be displayed in digital screen of the equipment.

7. **Probes:**
   
The rail tester shall have either contact (sliding) probe. The description of each is as follows-

   **Contact (Sliding) Probe’s Description:**
   
The rail tester shall be capable of working with minimum fourteen probes simultaneously i.e seven probes for left rail and seven probes for right rail. The probe shall be of transmitter receiver type having Lead Zirconate -Titanate Piezo-electric crystals. The details of probes for each rail shall be as under-

   **Normal Probe:** There shall be one normal probe for each rail. The normal probe shall be 18-20 mm dia. (crystal) with split crystal of 4 MHz (± 10 %) frequency in stainless steel casing and perspex insert having a path length equal to 50mm in steel. The probe shall meet test requirements as stipulated in clause 4.0.

   **Angle Probes:**
   
   There shall be a provision of 6 angle probes for each rail i.e six nos. of 70° (±1°) for left rail and six nos. of 70° (±1°) for right rail. The frequency of 70° probe shall be 2 MHz (± 10 %). The angle probes shall have 18-20 mm dia. or rectangular crystal. The details of probe are as under-

   a) 70° Forward(central)

   b) 70° Backward(central)

   c) 70° Gauge Corner forward (shifted 8 - 15 mm towards gauge face side)

   d) 70° Gauge Corner backward (shifted 8 - 15 mm towards gauge face side)

   e) 70° Non-Gauge Face Side forward (shifted 8 - 15 mm towards non-gauge face side)

   f) 70° Non-Gauge Face Side Backward (shifted 8 - 15 mm towards non-gauge face side)
Each pair of 70º (±1º) shall work in forward and reverse direction. One pair shall be capable for scanning transverse defects in central portion of the rail head and another pairs shifted to 10-15 mm towards gauge face side and non gauge face side shall work to detect gauge face corner and non gauge face side corner defects respectively in forward and backward direction.

8. **Co-axial Cable:**

   Co-axial cable used for the probes shall be flexible, oil proof, durable good quality and strength to withstand service condition. The junction of the cable and the probe shall be suitably protected to avoid snipping of the cable in operation at the junction. The co-axial cable shall be ISI marked.

9. **Odometer:**

   There shall be arrangement for distance measuring device (Odometer) for determining the location of defect. The display shall be digital and in 14 digit character. First four digits are for Km post encountered first and next four digits are for Km post encountered next. Last six digits for chainage in meters. The accuracy of measurement of tachometer shall not vary by +/- 500 mm per Km when measured by calibrated scale.

10. **Carrying Case:**

    The equipment shall be provided with a Carrying Case to protect the equipment from ingress of dust, grease, oil etc. and to accommodate the unit.

11. **Carrying Bag:**

    The carrying bag shall be of molded luggage type and shall accommodate the equipment, battery, co-axial cable, probes etc. The bag shall be provided with locking facility.

12. **Trolley**

    i) The trolley shall be fabricated using fiber glass or light weight alloy material. The base frame of the trolley shall be welded. The trolley shall be ergonomically designed so as to be moved on track freely without causing undue fatigue to the operator of normal stature. There shall be minimum number of small nuts and bolts and shall be provided with spring washers and locking nuts where as it required.
ii) The trolley shall run on double rail and suitable arrangement for mounting and fixing the digital ultrasonic flaw detector in a convenient position and angle to facilitate easy and strain free visibility of the screen to the operator. The movement of trolley on rail track should be smooth and free of jerks. The trolley should not infringe with the leg of operator during testing.

iii) The space for mounting of probes should be enough so that all probes are easily mounted and there is no overlapping making it easy to move the probes laterally.

iv) Ample space is to be provided in the trolley for tool box & carrying items like paints, brushes etc. Collapsible viewing hood for better visibility is to be provided with each unit.

v) There shall be clearance of 65 mm between under frame of trolley & rail top so that there should no infringement at level crossing and point & crossing and with S&T gear.

vi) The two water containers should be of anti-rust metallic or molded plastic body, sturdy and capable to hold minimum 15 litres of water with supply nozzle placed adjacent to each probe and provided with independent regulators and main cock.

vii) The trolley shall be provided with a pair of wear resistant insulated replaceable wheel to suit 60 kg, 52 kg, 90R etc. rail sections profiles with a possibility of accommodating a variation of 10 mm in the width of rail head. The flanges of wheels shall be so mounted through a device so that there shall be minimum lateral play during the run.

viii) The dimensions of the trolley shall be such as to accommodate all sets of probes and there is no overlapping making it easy to move the probes laterally. In case of wheel probes assembly shall be mounted within the wheel base. The centre-to-centre distance of wheels shall be kept minimum required for proper positioning and operation of the probes and easy maneuverability of the trolley. In case of wheel probes, it shall be placed within the wheel base.

ix) The probe holders and carrier brackets shall be of alloy material or stainless steel or chrome plated steel. Each assembly shall be capable of self-alignment so as to ensure efficient contact of probe on the rail table. Suitable device shall be provided for raising and lowering of the probe assemblies with conveniently placed control levers preferably near the trolley handle.

x) There shall be suitable arrangement to keep the alignment of the sliding probe assembly at their desired location in order to ensure scanning of rail at Centre and Gauge Face & Non-Gauge Face corner of the rail.

13. **Over all weight of rail tester:**
The total weight of rail tester (trolley with probes & its assemblies, digital ultrasonic flaw detector, battery and empty water container) shall not exceed 70 Kg.
14. **ACCESSORIES:**
The Supply shall include the following standard accessories-

**A: Standard Accessories**

- **i)** Normal probe (4 MHz, 18-20 mm dia. Double Crystal) 2
- **ii)** 70° angle probe assembly (as per clause 7 of angle probe) 12
  
  (03 Forward & 03 Backward for each rail)
- **iii)** Polythene bottles (1 litre capacity) 2
- **iv)** Battery (Rechargeable) 2
- **v)** Battery Charger 2
- **vi)** Tool Kit as required for trolley 1
- **vii)** Cover for electronic unit 1
- **viii)** Suitable box of Aluminum or molded plastic
  
  Suitcase to keep ultrasonic flaw detector 1
  
  with proper lining.
- **ix)** Water container 15 litre minimum capacity 2
- **x)** Viewing Hood 1
- **xi)** Umbrella of standard size 1
- **xii)** Normal Probe, Single crystal/2 MHz, 20 mm dia. Crystal 1

**B: Optional Accessories**

- **i)** Desktop/ Laptop for transferring recorded data 1
- **ii)** Standard rail test piece with simulated defects 2
- **iii)** IIW/V1 or V2 Block 1
- **viii)** Printer 1
- **ix)** Step Gauge 1

( Note: For Laptop & Printer, consignee shall provide the specification )

15. **PERFORMANCE OF THE RAIL TESTER:**

The overall performance of the rail tester shall meet the requirements given below:

**15.1** The ultrasonic rail tester shall be capable of –

a) Smooth running on the rails & detecting flaws in the rails.

b) The performance of rail tester shall be checked on test rails having simulated flaws.

The standard rail test piece shall be as mentioned in Fig-1. For Double rail tester trolley, two such test pieces shall be laid on either side and fixed maintaining proper gauge as done while framing track.
15.2 Normal Probe:
The normal probes of the equipment shall be able to show 100% full screen height from the rail bottom at a gain of 45 dB max.

15.3 70° Central Angle probe (forward and backward):
The equipment shall be able to detect 12 mm dia. hole in the rail head as shown in Fig. 1, at gain 50dB max for both forward and backward scan of left & right side of probes. The height of the flaw echo shall be 60% full screen height.

15.4 70° Angle probes for Gauge Side (forward and backward):
The equipment shall be capable for detecting simulated 5 mm flat bottom hole as shown in Fig. 1 in the standard rail test piece. Reflection from the simulated defects for forward & backward probe shall be adjusted to 60% of full screen height and the gain used shall not be more than 50 dB for individual probe.

15.5 70° Angle probes for Non Gauge Face Side (forward and backward):
The equipment shall be capable for detecting simulated 5 mm flat bottom hole as shown in Fig. 1 in the standard rail test piece. Reflection from the simulated defects for forward & backward probe shall be adjusted to 60% of full screen height and the gain used shall not be more than 50 dB for individual probe.

16. Technical Literature:
One set of operating and Guidelines/Instruction Manuals in details shall be supplied with each rail tester.

17. Commissioning & Training:
The supplier shall commission the equipment at consignee place. During commission supplier shall show each control switch in working condition and capability of the equipment to detect the simulated defects in standard rail test piece as shown in Fig 1. The supplier shall also train free of cost two operators per equipment in operation and minor trouble shooting of the equipment at the time of testing in the field.

18. Guarantee:
The manufacturer shall guarantee for satisfactory operation of the equipment for a period of one year from the date of commissioning of the equipment.

19. 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 shall render service support for AMC 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 reserves the right to modify this specification time to time based on the requirements and experience gained.
1.2m long aluminium / wooden housing for test piece having top table width equal to rail head width.

SENSITIVITY SETTING BLOCK FOR 70° 2MHz (CENTRE AND GAUGE FACE) PROBES

All dimensions are in mm. Drawing is not to scale.
M&C Directorate
NDT Section

M&C/NDT Spec. Date: 05.9.12


In view of introduction of non gauge face probes in the USFD testing of rails, the specification under subject has been revised. Red paragraphs / word have been included while yellow paragraph / word have to be deleted. All concerns are requested to impart their comments on the specification. While commenting the features of approved model shall be keep in mind.

The comments shall be submitted latest by 10.9.12 .

( B.K.Saxena)
ARO/NDT

Copy to : 1. NDT Section
3. NDT Training Centre
4. ADE/Track Design Dte
1. **Scope:** Deleted - as per the selection of the operator & The equipment shall be capable of operating in mains cum- battery. When operating with mains, the voltage shall be 220± 10%.

2. Para 2.1 General requirement: Deleted – multicoloured. Deleted /EL

3. Para 2.5 General requirement: Included or latest version and deleted - not been spelt out

4. Para 3.5 is re-modified as- **Gain/ Amplification:** The equipment shall have minimum 120 dB total gain (including internal gain). Among this minimum 80 dB shall be operatable from outside gain control switch. The amplifier of the equipment shall have a very good signal to noise ratio and excellent linearity. It shall be provided with suitable gain control with fine and coarse switches. The fine gain control switch shall be minimum in steps of 0.5 dB and the coarse control switch shall be capable of increasing amplification either in 6 dB, 10 dB or higher dB steps. All gain control shall be linear

5. Para 3.8: Zoom /Expansion is deleted.

6. Para 3.9: Included words: sets, trace pattern, of it from

7. Para 3.10 Last sentence is modified as ‘The above data shall be available along with A Scan trace Pattern.

8. Para 4.0: included word – or latest version

9. Para 4.0 - d: replaced 3 mm as 3 mm or less


11. Para 5.2 modified as ‘The equipment shall have suitable arrangement to print out the saved data along with A-Scan trace pattern either directly from the equipment or by transferring the saved data to USB Pen drive to PC for printing it or by connecting the equipment to PC through USB port. Suitable software for this operation, if required shall be supplied by the manufacturer’.


13. Para 6, i) , Word ‘through’ included

14. Para 6 iii) Word ‘switch’ deleted, word ‘facility’ – included

15. Para 6, vi) – sentence- ‘The charger shall be provided with an indicator to show the full charge condition of the battery.’- deleted.

16. Para 7 A. Word ‘ten’ deleted and ‘fourteen’ included. Also word ‘five’ deleted and ‘seven’ included. Sentence- The equipment as well as its trolley shall also have provision for attachment of 70°/ 2 MHz forward & backward field side probes to detect transverse defects in field sides.- deleted. ( +/- 10%) – included.

17. Para 7. Angle Probes- Word minimum- deleted and ‘6 ‘ included instead of four angle probe. Sentence- The frequency of 70° probe shall be 2 MHz (± 10%) - included. Last sentence is re modified as ‘Each pair of 70° (±1°) shall work in forward and reverse direction. One pair shall be capable for scanning transverse defects in central portion of the rail head and another pairs shifted to 10-15 mm towards gauge face side and non gauge face side shall work to detect gauge face corner and field side corner defects respectively in forward and backward direction’

18. Para 7 B) wheel probe – Sentence included- ( including non gauge face side ).
Para 8. Co-axial cable: Sentence included- Manufacturer shall submit certificate of warrantee to inspecting official that cables supplied with the equipment will not internally break during the warrantee period of the equipment.


20. Jjh

Para 15.5: Included as 70°Angle probes for Non Gauge Face Side (forward and backward):
The equipment shall be capable for detecting simulated 5 mm flat bottom hole as shown in Fig. 1 in the standard rail test piece. Reflection from the simulated defects for forward & backward probe shall be adjusted to 60% of full screen height and the gain used shall not be more than 50 dB for individual probe. This shall be checked at the time of inspection.

For sensitivity setting during the normal rail testing of left & right side probe (both for forward & backward probes), reflection of 60% full screen height from the 5 mm dia. flat bottom hole in the rail head (as shown in Fig.1) shall be taken as reference.

16. Para 16. Printer- Reworded as: A suitable printer shall be provided as optional accessories if required by the consignee to print A-scan data along-with calibration, test and operator data as mentioned in para 3.10. This printer shall be used at local head quarter by operator to print out test data for record and analysis.


22. Para 18. Deleted- installation of the equipment. Included – testing in the field