TECHNICAL SPECIFICATION OF DIGITAL ULTRASONIC TESTING EQUIPMENT FOR WELDED RAIL JOINTS WITH LCD SCREEN, TRIGNOMETRICAL FUNCTION AND A-SCAN STORAGE ALONGWITH DATASETUP

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 reflection technique with LCD screen or coloured LCD TFT screen display. The equipment shall be lightweight, portable, suitable to be carried by the operator himself in a carrying case. The equipment shall be robust in construction, amenable for use in Indian field and ambient conditions, reliable, of good workmanship and capable of providing trouble free service for the intended application. The ultrasonic equipment shall be provided with solid state circuitry, with high component population density, reduced inter-connection noise and good quality assembly. It should be able to be continuously used for 8 hours without any drop in performance through battery. The display of A-Scan shall have good visibility in the light. The equipment shall be supplied complete with all accessories.

3: **Functional Requirements:**
   a) The equipment shall be able to be perform the following functions-
      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.
b) Shall be capable of operating both in Single crystal and Double crystal mode.
c) Shall be capable of scanning the weld using 0°, 70°, 45° (Tandem technique) using test Rig, pitch-catch method etc for detection of defects mentioned at a) above.
d) The equipment with LCD screen for A-scan display shall be capable of calculating beam path, horizontal distance and depth of discontinuity in the weld from the probe index point.
e) The equipment shall have suitable foam 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 proper straps and handles to facilitate carrying.
f) The equipment shall withstand 40 g, 4000 ± 10 bumps as per IS 9000 (Part VII – sec. II).
g) The equipment shall give normal performance after being subjected to 1g, 10 to 100 Hz vibrations for 30 minutes.
h) The equipment shall be tropicalised 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 narrow band amplifier capable of working in the frequency range from 1MHz to 6 MHz.

4.3 Test range: The equipment shall have test range 50 mm or less to Max1000-mm.

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. The amplifier of the equipment shall have a low signal to noise ratio and excellent linearity. It shall be provided with suitable gain control switches. The fine gain control switch shall be in steps of 0.5 dB or less and the coarse control switch shall be capable of increasing amplification either in 6 dB or 10 dB steps. All gain control shall be linear.
4.6 **Suppression/ Reject:** The equipment shall have reject facility or suppression of vertical signals from 0 to 80% 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 entire horizontal screen display from 1% to 99% and the level (vertical height) of the gate shall be adjustable to 1% 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 LCD/LCD coloured TFT display of different data set-up values of test parameters on monitor 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 multi-coloured A-scan in the memory and re-calling 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 rail 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 D/ N D

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

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

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 as per IS:4904.

d. **Dead Zone**
   The dead zone shall be less than 6 mm. with single crystal probe (2/2.5MHz) and 3 mm. or less for double/twin crystal 0°/4 MHz.

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

f. **Sweep drift**
   Sweep drift shall not be more than ± 1%. Sweep drift and 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 temperature.

h. **Alarm**
   The equipment shall be provided with alarm (through LED) for signals exceeding pre-set threshold value.

i. **Signal to noise ratio:**
   Signal to noise ratio shall not be more than 1/10th 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 & 6th appearing.

j. **Trace Pattern.**
   The trace on the screen shall be free from bow, kinks and under shoots. It shall be truly horizontal and free from tilts etc. The trace pattern shall be clearly visible 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. II).

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 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 & 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 250mm x 200mm x 100mm.

6.2 **Weight:**
The weight of the equipment shall not exceed 3 Kg. with battery and all accessories.

6.3 **Display area:**
The display area shall be minimum 90mm x 70mm approx.

6.4 **Printer connectivity:**
The equipment shall have suitable port arrangement to connect it to printer and a suitable small size, lightweight printer to print out all logged data as and when required by the operator.

6.5 **PC connectivity:**
The equipment shall have suitable port and transfer software to connect with PC.

6.6 **Battery level indicator:**
The equipment shall have facility of battery level indicator to show its condition.

7.0 **Power Supply:**
   i) The equipment shall be operatable by mains (230 ± 10 V) as well as by re-chargeable Ni - Cd/Li - ion or any other re-chargeable alkaline battery or combination of cells providing 15 V max.
   ii) The battery shall be capable for working minimum 8 hours continuously per full charge.
   iii) Automatic cut-off switch shall be provided to protect against deep discharge of battery below the workable voltage.
   iv) Automatic cut-off for battery and battery charger shall be provided to protect the battery from over charge.
   v) Protection against over loading of the equipment shall be provided by an automatic switch function (electronic fuse). The fuse shall be so located that the same can be easily attended to as and when necessary.
8. **Accessories:**

The equipment shall be supplied along with the following standard accessories:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Item Description</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>i)</td>
<td>Double Crystal Normal probe, crystal dia. 18mm, 2 MHz</td>
<td>1 No.</td>
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<tr>
<td>ii)</td>
<td>45° Single crystal probe/ 2 MHz with 20 mm. dia crystal or 20mm x 20mm square crystal</td>
<td>2 Nos.</td>
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<tr>
<td>iii)</td>
<td>70° Single crystal probe/ 2 MHz with 20 mm. dia crystal or 20 mm x 20 mm square crystal</td>
<td>1 No.</td>
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<tr>
<td>iv)</td>
<td>70° Single crystal side looking probes (SL)/ with 15 mm dia or 15 mm x 15 mm square crystal</td>
<td>2 No.</td>
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<td>v)</td>
<td>Test Rig for Tandem technique</td>
<td>1 No.</td>
</tr>
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<td>vi)</td>
<td>Re-chargeable Battery/Cells for 8 hours continuous working</td>
<td>1 No.</td>
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<td>vii)</td>
<td>Battery charger with auto-cut-off</td>
<td>1 No.</td>
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<td>viii)</td>
<td>Foam cover for UFD equipment</td>
<td>1 No.</td>
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<td>ix)</td>
<td>Carry case for UFD and accessories</td>
<td>1 No.</td>
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<td>x)</td>
<td>Scientific calculator</td>
<td>1 No.</td>
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<td>xi)</td>
<td>Folding umbrella</td>
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<td>xii)</td>
<td>Calibration block (100 x 50 x 50 mm)</td>
<td>1 No.</td>
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<td>xiii)</td>
<td>Standard AT weld Test Piece for sensitivity setting</td>
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<td>xiv)</td>
<td>Steel measuring tape (5 mts min.)</td>
<td>1 No.</td>
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<td>xv)</td>
<td>Plastic bottle for oil (Half Litre capacity)</td>
<td>1 No.</td>
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<tr>
<td>xvi)</td>
<td>Paint bottle (Half Litre capacity) with brush</td>
<td>1 No.</td>
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<td>xvii)</td>
<td>IIW V1 Block as per IS 4904</td>
<td>1 No.</td>
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<td>xviii</td>
<td>Step Gauge of 25 mm width in steps of 1 mm (Range 2 mm to 10 mm)</td>
<td>1 No.</td>
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<tr>
<td>xix)</td>
<td>0°/2 MHz Single Crystal probe of 20 mm Dia. or 20 x 20 mm square crystal</td>
<td>1 No.</td>
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9. Technical Literature:
One set of operating and service instruction, complete with details of circuit diagram indicating values of the components shall be supplied with the equipment.

10. Training:
The supplier shall train one operator 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 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.

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STANDARD AT WELD T'EST PIECE FOR SENSITIVITY SETTING