# Technical Specifications for Inline Ultrasonic Inspection Test System for Seamless Steel Tubes

## 1.0 Job Description:

1.1 Seamless Steel Tubes made by both hot rolling and cold drawing processes need to be tested for internal and surface defects. The inside surface is plain in major portion of the production quantum and has rifled profile for a small quantum of production. The defects normally occur are longitudinal and transverse flaws with respect to the tube axis.

1.2 The method for detecting defects shall involve Ultrasonic Test (UT) system. The system shall be capable of scanning the entire cross section and length of the tube. The system shall generally use non-contact probes and be suitable for testing tubes at a sufficient speed to match mass production rates.

1.3 Provision in the system for measurement of Tube Outside diameter, Wall thickness, eccentricity Ovality and length also shall be offered as optional.

1.4 The parameters of the product to be tested are as below:-

| | | |
|---|---|---|
| - Tube diameter (OD) | : | 19 mm to 160 mm |
| - Wall thickness (WT) | : | 2 mm to 15 mm |
| - Tube length | : | 3 meters to 22 meters |
| - Material | : | Plain carbon steel, Low alloy steel of 1¼ Cr, ½ Mo and 2¼ Cr 1 Mo Steels and equivalent materials. |
| - Surface condition | : | As rolled or as drawn with minor sticky scales. |
| - Tube Straightness | : | 1 mm/meter, 15 mm maximum full length. |
| - Required Speed of Testing | : | 30-90 meters/minimum (Nominal 60 m/Min) with overlap of 25% |

1.5 Offer for the range of tube diameter 19 – 140mm and 19 – 160 mm shall be given separately if covered by different models.

1.6 The test method can involve any combination of relative motion between tube and the test head. The method shall be of advanced technology including rotating transducers or phased array technique.

2.2 The test system to be offered is to replace an existing UT system. The current system has a tube transport system with linear movement of tube, an eddy current system, drive roller sets, centering device, UT systems, Paint marking system for defects. The layout of the existing system is shown in the drawing in Page 6. Photograph of the existing m/c is shown in page 7.

## 2.0 QUALIFYING CRITERIA FOR THE SUPPLY

**2.2** The BIDDER / VENDOR has to necessarily provide the following details, for making an assessment of the firm's capability and competency: [The BIDDER is expected to give complete details against each clause in the table given below and wherever necessary an additional sheet may be attached (giving clear reference number) to cover the required details]

| S. No. | PARTICULARS | BIDDER's OFFER [with Complete Technical Details] |
|---|---|---|
| **1.0** | Number of Years of Experience of the BIDDER/ VENDOR in the field of design, manufacture and supply of 'Inline Ultrasonic Inspection Test System for Seamless Steel Tubes' | |
| **2.0** | YEAR of LAUNCH of the Model quoted against this ENQUIRY | |
| **3.0** | Is there any other model launched after the quoted Model? Why it is not quoted. Otherwise, indicate the likely year in which the next model is likely to be launched | |
| **4.0** | Number of Inline Ultrasonic Inspection Test System for Seamless Steel Tubes supplied, installed and commissioned till date, in the QUOTED MODEL | |
| **5.0** | Number of Inline Ultrasonic Inspection Test System for Seamless Steel Tubes supplied, installed and commissioned till date for tube manufacturers (within INDIA):<br>Attach list of organisations with model and contact address. | |
| **6.0** | Number of Inline Ultrasonic Inspection Test System for Seamless Steel Tubes for tube manufacturersthe following Category (around the GLOBE) :<br>Attach list of organisations with model contact address | |
| 7.0 | Details of Design Set-Up and Technology Back-Up assured for the PRINCIPAL Equipment Maker | |
| 8.0 | Details on International Standards followed in Design of the Equipment (including detection Methodology and Calibration of Equipment) | |
| 9.0 | Details of performance testing of the equipment to be ensured prior to dispatch from supplier's end | |
| 10.0 | Details of Quality System followed (Kindly furnish the salient aspects of the QA system followed) | |
| 11.0 | Details on SERVICE-after-SALES Set-Up in India including the addresses of Agents/Service Centres in India and Asia | |
| 12.0 | Any Additional Data to supplement the manufacturing capability of the BIDDER | |

2.2 The BIDDER / VENDOR has to compulsorily meet the following requirements to get qualified for submitting an offer for the Optical Vacuum Spectrometer.

| S. No. | REQUIREMENTS | Bidder's offer [with Complete Technical Details] |
|---|---|---|
| 13.0 | The BIDDER / VENDOR shall have a minimum of FIVE Years of Continuous Experience in the Design, Manufacture & Supply of Inline Ultrasonic Inspection Test System for Seamless Steel Tubes . Indicate the actual experience. | |

| | | |
|---|---|---|
| 14.0 | The BIDDER / VENDOR shall have supplied at least 2 number of the offered model, within the last five years. The equipment shall be working satisfactorily at lease for the past 2 years. Indicate the number of equipment (of QUOTED MODEL) sold in India & Other Countries. | |
| 15.0 | Reference List of Customers and Performance Certificate from CUSTOMERS (minimum 2 Customers) with full contact details of CONTACT PERSON. | |

2.3 The BIDDER / VENDOR has to comply with the following, for accepting the Technical Offer for scrutiny by the Purchaser :

| S.No. | REQUIREMENTS | Bidder's offer [with Complete Technical Details] |
|---|---|---|
| 16.0 | The BIDDER / VENDOR shall submit the offer in TWO PARTS – "Part I - Technical and commercial bid", and "Part II - Price bid",<br>The Technical Offer – Part A, shall be in line with the BHEL Technical Specifications and the Guidelines or Annexures mentioned, wherever applicable. | |
| 17.0 | The Offer shall contain a comparative statement of Technical Specifications given by BHEL and the Offer Details submitted by the Bidder, against each clause. A just 'CONFIRMED' or 'COMPLIES' or 'YES' or 'NO-DEVIATION' or similar words in the technical comparative statement may lead to disqualification of the Technical Offer. | |
| 18.0 | The BIDDER / VENDOR shall assure a continuous support for SPARES and SERVICE for TEN Years, from the date of commissioning of the equipment at BHEL Works. | |
| 19.0 | The Technical Offer shall be supported by Product Catalogue and Data Sheets in ORIGINAL and complete technical details of 'Bought-Out-Items' with copies of Product Catalogue and Selection Criteria | |
| 20.0 | The Commercial Offer (given with the Technical Offer – Part I) shall contain the Scope of Supply and the Un-Priced Part of the Price-Bid, for confirmation of Scope of Supply. | |
| 21.0 | The reference List of Customers shall be accompanied with the details (Phone Number / E-Mail ID) of the CONTACT PERSON for cross reference by BHEL | |

3.0 **Scope of Supply:**

3.1 The scope of the new system shall include the following as necessary for the technology offered.

- UT head
- Control electronics
- Tube centering device and
- Tube transport drive
- UT test bed with height adjustment system
- Water circulation system for water coupling.
- Tube cleaning system at tube entry side if necessary (e.g. water jet cleaning system)
- Defect marking system

3.2 The following shall be offered separately as optional scope of supply:

- Tube transport system at entry to UT m/c.
- Tube transport system after UT m/c exit.
- Material handling for input and exit of tubes, inclusive of any sorting of accepted and rejected tubes.

3.3 The following shall be excluded from the scope of supply:

- Input Stack for storage of Tubes.
- Out put stack for accepted and segregated tubes.

3.4 The UT machine shall be matched with the existing feeding and output tube handling system w.r.t. position and alignment. Non Potential relay outputs for activation of acceleration signal after blanking with a distance of 2 meters, adjustable from 1 to 4 meters shall be provided.

3.5 Non Potential relay outputs for activation of 'Accept" , Reject" segregation function shall be provided by the supplier.

4.0 **Testing Requirements:**

4.1 Defects are detected in comparison with a reference standard defect (notch) intentionally made in OD and ID of the tubes. The details of these reference notches and test requirements are:

- Length of Notch : OD: 25 mm for plain tube and rifle tube
  ID : 25 mm for plain tube
  5 mm for rifle tube RIB on ID
  5 mm for rifle tube grove on ID
- Depth of notch : 5% of nominal WT of tube with min.0.2 mm.
- Width of notch : Same as above.
- Cross section of notch : Square
- Direction of notch : Longitudinal and transverse to tube axis.

- Scanning : Dual direction for both transverse and longitudinal.
- Detection,measurement: Longitudinal defects, and lamination
  OD : 19 to 108 mm Measurement of OD, WT, ID and length.
  (Eccentricity, ovality to be calculated)
- Detection,measurement: All the above characteristics and
  OD: above 108 mm Transverse defects
- For OD below 108 mm also, possibility of configuring the longitudinal detection probes for transverse detection also, shall be indicated.

4.2 Un-inspected Ends: Maximum 50 mm on either end of the tube. (min. possible untested end to be attempted and shall be indicated in the offer). The blanking location and length shall be adjustable over 0-150 mm. Range.

4.3 Scanning shall be in both clock wise and anti clock wise direction.

4.4 % Overlap of scanning: Minimum 25%.

4.5 Machine Setting and calibration time required for each size change shall be indicated.

4.6 Calibration reference tubes to be supplied to manufacturer by BHEL for the purpose of testing and proving at Suppliers works if required shall be indicated.

4.7 Rifle Tube Testing**:**

The length of notch will be only 6 mm (instead of 25 mm on plain tube) corresponding to the Rib and grove of the rifle profile. it must be possible to increase the DB level locally to enable same sensitivity of test of Rib and Grove of the rifle profile as that of OD with 25 mm notch length. A drawing of rifle tube and ref. notch are provided in page 8 and 9.

5.0 **Construction**

5.1 Test Bed**:**

5.1.1 The speed of rotation of test head/tube where applicable shall be indicated.

5.1.2 Number of Transducer Probes to be proposed by the supplier for maximum effectiveness and test speed. Additional Probe / channels to increase speed / effectiveness shall be quoted as options. No. of probes or channels for each combination of diameter and direction of test and test speed shall be tabulated in the offer. Probes for detecting transverse defect are required for tubes of OD greater than 108 mm. only.

5.1.3 The method of signal transfer between probes and control system is to be indicated.

5.1.4 Test bed shall consist of a height adjusting mechanism automated through the control system. The test bed shall accommodate tube drive unit, centering devise, UT head, and defect marking system.

5.1.5 Additionally provision for accommodating existing Eddy current (EC) test Head (Make: Foerster, Germany. Model:MK170 Type: 2.852-02-1001. of DEFECTOMAT CP2.8.4.2) on the test bed shall be offered. This EC head test system shall be integrated with the UT test system in all aspects. These shall be offered as optional feature.

5.2 Coupling water system:

5.2.1 If applicable, the coupling water circulation system with necessary filter pumps lines and other accessories shall be provided. The detailed list of items with flow diagram shall be included in the offer.

5.3 Control System:

5.3.1 The features of the Test and control electronics shall be explained in the offer. This shall include PC based multi channel electronics. This shall include the following as applicable:-

**Transmitter Parameters:**

Pulse repetition frequency 0.50 KHz- 15 kHz

Pulse rise time: = 10n Sec.

Pulse Voltage: = 250 V in 50-ohm load. (To be decided by supplier).

**Display:** Colour LCD monitors shall be provided at testing head and Control panel. Display shall show conventional UT signal and digital display. Signal recorder with suitable printer shall be provided.

**Amplifier:**

Band width selection: Single wide band amplifier from 1 MHz to 25 MHz.

Attenuation: Total: 99dB, Coarse Step: 90 in 10dB step. Fine Step: 9 in 0.5dB step

Rectification : Half Wave & Full Wave

Noise Suppression: Linear from 0-80 percentage FSH.

Separate gain control for ID signal shall be provided for the gate.

**Gate:**

Number of gates : min 4. All Gates shall be software configurable.

Main delay : Variable form 0 to 100 mm.

Position : Variable from 1mm to 100 mm.

Width : Variable from 1 to 100 mm

**Threshold for interface echo trigger**:

Variable from : 5 % to 100 %.

Threshold for alarm : 5% to 95%

Number of thresholds : 2 nos

**Trigger mode selection:** TX Pulse

Delayed with main bang.

Gate start.

Real Time RF wave form Capture, and A-Scan Display along with Gate, Alarm and Trigger Thresholds.

5.3.2 Data Acquisition & Processing:

Industrial Grade PC with connected hardware, printer, software and online UPS Shall be provided. Features of the system shall be detailed in the offer

Analog to digital converter / digitiser shall be with min. 20 million samples per second with 14 bit / 12 bit resolution.

There shall be Synchronized data acquisition for position of tube, and defect.

Real Time Display: Real Time Display of each channel. The presence of defect is marked with respect to its position in the tube.

Real Time Storage of inspection data: The status of tubes i.e. inspection result, length of tube inspected, location of defect, and length of defect is recorded.

5.3.3 Alarm & Paint Marking:

Audio alarm is to be activated for defect amplitudes more than the pre-set amplitude along with signal to trigger defective tube segregation.

A paint marking is also to be activated to mark the part of the tube with defects with one colour for ID defects and one colour for OD defects. The accuracy of paint marking system to be indicated in the offer. Paint marking system shall be efficient self cleaning type.

A tube identification marking system shall also be offered to correlate captured data to the actual tube in case of defective tubes.

Option of any other marking system like laser shall also be proposed.

Optional selection of Rejection commands for Low wall thickness, High wall thickness, Low OD, High OD, Eccentricity and Ovality to be proposed

5.3.4 Report: Test result report generation in a format as given by SSTP. Data transfer through Ethernet connection shall be provided.

5.3.5 The control cabinet shall be fully enclosed, moisture and dust proof with self-contained Voltage stabilizer and cooling system to work in a dusty industrial atmosphere.

5.3.5 The entire system shall have self-diagnostic capability with error reporting and audio/visual display. Items covered by self diagnosis shall be indicated in the offer. Essential shall be probe failure, coupling water system failure, test control failure and drive control failure. Auto shut off systems shall be provided wherever essential (including for safety requirements).

## 6.0 Installation, Performance & Acceptance of the system:

6.1 The system shall be installed and commissioned by the manufacturer of the system.

6.2 The system shall be shipped after inspection and testing at Suppliers works by BHEL.

6.3 The system performance shall be checked on a set of reference tubes, which will be supplied by SSTP.

6.4 Three reference tubes (preferably in minimum, middle and maximum Dia/Wt combination) shall be given by BHEL for acceptance test at Supplier's works. The same will be used for acceptance test at BHEL after installation.

6.5 The above tubes will be calibrated by the system for artificial defect detection, and passed through the system at specified linear speed in accordance of the diameter of the tube. The artificial defects of the standard tubes shall be detected and marked by the system in all passes of the calibration tube.

6.6 The repeatability of the results shall be demonstrated by repeating the test for the same tube a suitable no. of times. No. of tests for this purpose shall be indicated in the offer. Production tubes shall be tested for 24 Hrs continuously. The rated output for a

reference size commensurate to the speed of testing for that size shall be demonstrated for 8 hours shift.

6.7 Service shall be provided by the supplier during guarantee period and also later through AMC. The supplier shall confirm the period for which Spares and services will be provided. The method of circumventing the un-availability of service and spares At the end of the indicated period shall be explained in the offer.

6.8 Remote troubleshooting from Suppliers works is to be provided through ISDN-modem / Ethernet connectivity.

6.9 Certification of the UT probe modules shall be done by the supplier once a year. This is to ensure certification for QMS (ISO-9000) purpose on periodic basis.

6.10 Guarantee for the trouble free performance of the system shall be provided for min. 1 year for 3 shift operation.

7.0 **Training and Documentation:**

7.1 Supplier shall provide operational and first level system maintenance training for 4 persons at suppliers works. Further training as required shall be provided at BHEL for operation and maintenance.

**7.2** Operating instruction manual shall be provided - min. 3 Nos. along with the equipment. Drawings for all the mechanical parts with material and strength requirements has to be supplied along with the equipment. Stage wise and total Electrical and electronics circuit drawings for the complete system to be supplied with the equipment.

8.0 **General Requirements:**

8.1 Break up cost for Mechanical, Test head, Electronics, Dimension measurement facility, Paint marking, Tube cleaning system shall be furnished. Optional Systems / items shall be indicated separately.

8.2 Guide bushes and such other items if required for each size of tube to be tested shall be offered. Supplier shall provide the necessary drawings for guide bush and such other items which can be procured by BHEL locally.

8.3 One set of Additional probes for dimensional measurement and Longitudinal flaw to be included in the main offer as spare.

8.4 List of spares with part identification no. (Tools, Mechanical, Electrical & Electronics) to be maintained for ensuring continuous operation with least delay time shall be provided in the offer with price.

8.5 The Total system shall be in compliance to permitted emission level (CE).

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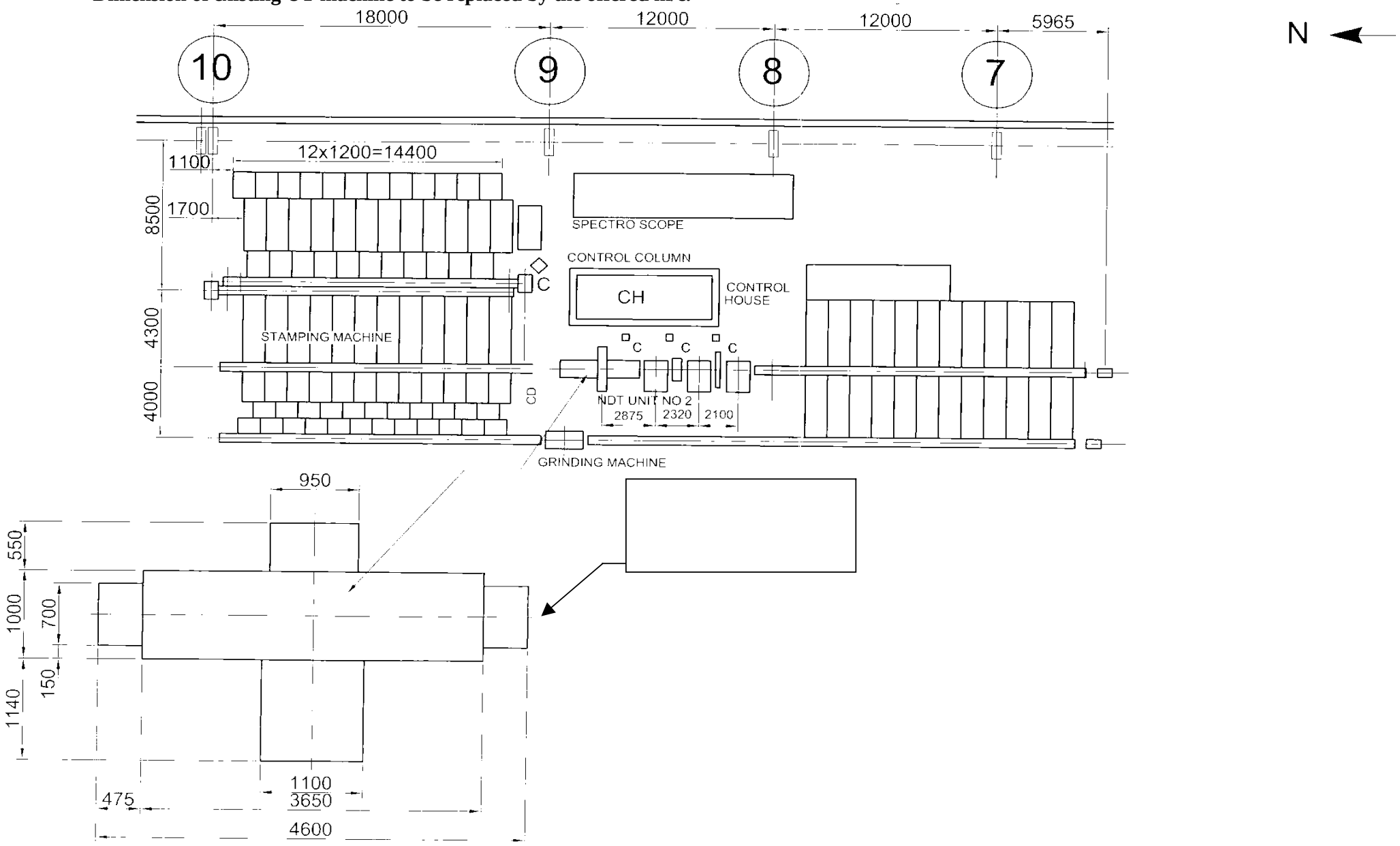
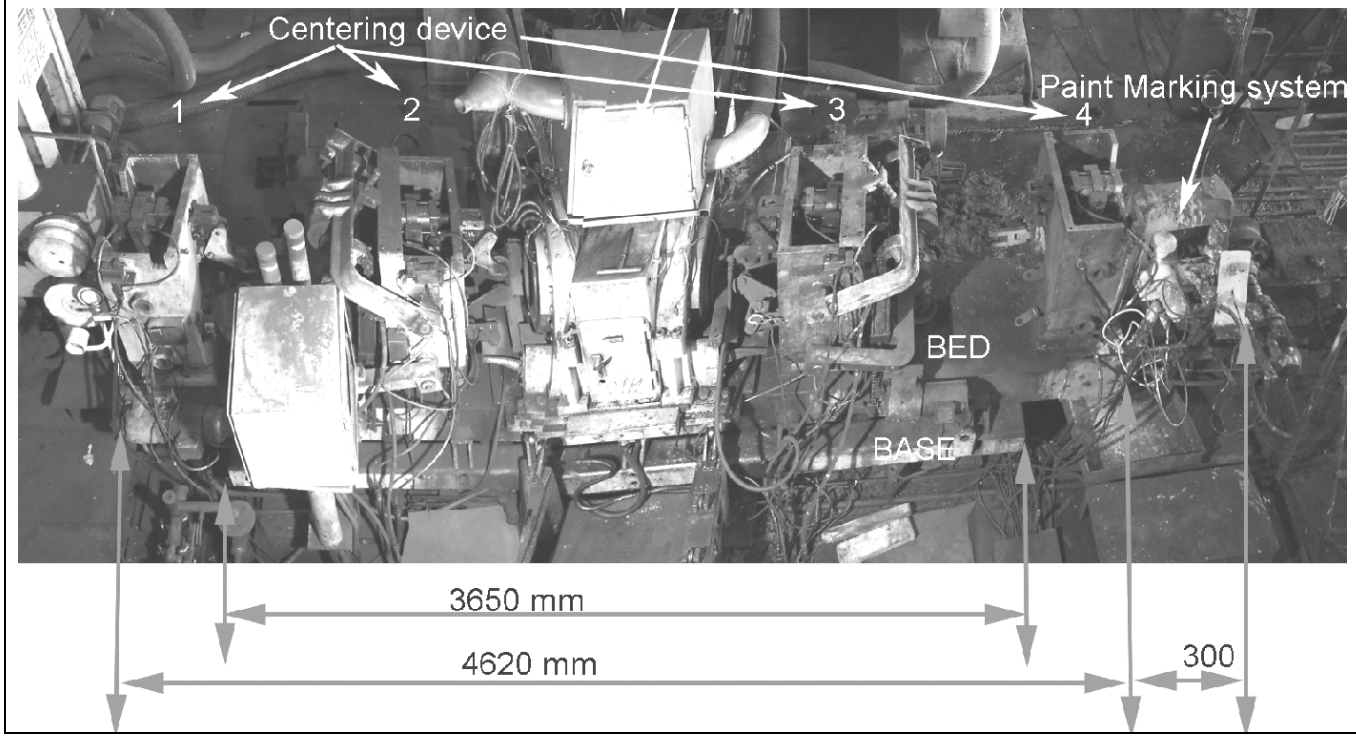
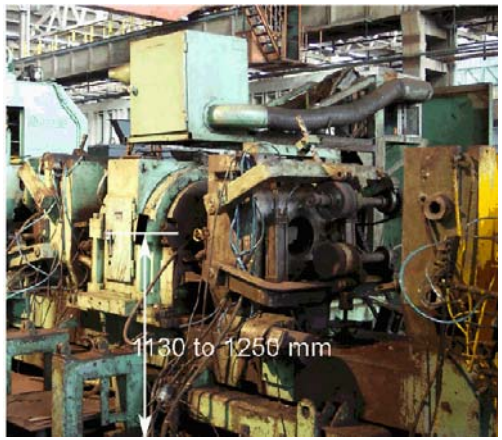
**Dimension of existing UT machine to be replaced by the offered m/c.**




UT Head
Centering device
1
2
3
4
Paint Marking system
BED
BASE
3650 mm
4620 mm
300


1130 to 1250 mm

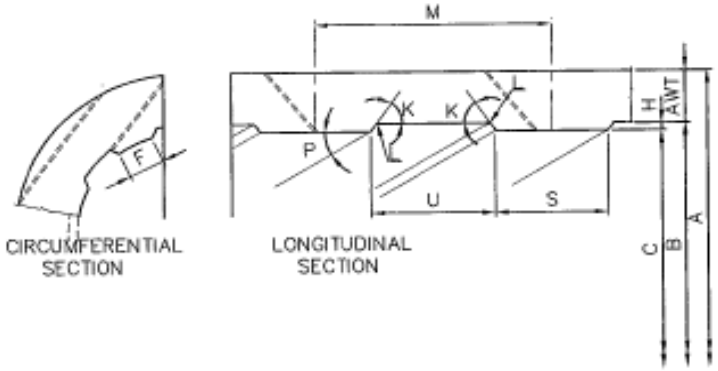
3-06-651-03853

# DIMENSIONAL SPECIFICATION FOR MULTI-RIFLED TUBING

FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD.NO TP 023 0299

MATERIAL SPECIFICATION : SA 210 GrC

| ↓PARAMETERS / TUBE SIZE→ | | TUBE ø51x5.6 | TUBE ø51x6.0 | TUBE ø51x7.1 | TUBE ø63.5x7.1 | TUBE ø63.5x11 | TUBE ø63.5x12 |
|---|---|---|---|---|---|---|---|
| A | TUBE OUTSIDE DIAMETER | 51.00 ±0.25 | 51.00 ±0.25 | 51.00 ±0.25 | 63.50 ±0.30 | 63.50 ±0.30 | 63.50 ±0.30 |
| B | MAJOR INSIDE DIAMETER | 38.57 ±0.25 | 37.68 ±0.25 | 35.24 ±0.25 | 47.74 ±0.30 | 39.08 ±0.30 | 36.86 ±0.30 |
| C | MINIMUM INSIDE DIAMETER | 35.57 | 34.71 | 32.30 | 44.53 | 36.03 | 33.85 |
| D | MINIMUM WALL THICKNESS | 5.6 | 6.0 | 7.1 | 7.1 | 11 | 12 |
| E | NUMBER OF RIBS | 8 | 8 | 8 | 8 | 8 | 8 |
| F | RIP WIDTH AT TOP (NOMINAL) (CIRCUMFERENTIAL) | 4.78 | 4.78 | 4.78 | 4.78 | 4.78 | 4.78 |
| H | RIB HEIGHT | 1.07 ±0.30 | 1.06 ±0.30 | 1.04 ±0.30 | 1.15 ±0.30 | 1.07 ±0.30 | 1.05 ±0.30 |
| K | RIB SIDE ANGLE | 55° ±15° | 55° ±15° | 55° ±15° | 55° ±15° | 55° ±15° | 55° ±15° |
| L | RIB RADIUS | 0.13-1.27 | 0.13-1.27 | 0.13-1.27 | 0.13-1.27 | 0.13-1.27 | 0.13-1.27 |
| M | RIB PITCH | 26.23 ±3.18 | 25.62 ±3.18 | 23.97 ±3.18 | 32.46 ±3.18 | 26.57 ±3.18 | 25.06 ±3.18 |
| N | LEAD LENGTH (360°) | 209.8 ±25.4 | 205.0 ±25.4 | 191.8 ±25.4 | 259.7 ±25.4 | 212.6 ±25.4 | 200.5 ±25.4 |
| P | LEAD ANGLE (NOMINAL) | 30° | 30° | 30° | 30° | 30° | 30° |
| S | RIB WIDTH AT TOP (LONGITUDINAL) | 8.28 ±1.27 | 8.28 ±1.27 | 8.28 ±1.27 | 8.28 ±1.27 | 8.28 ±1.27 | 8.28 ±1.27 |
| U | GROOVE WIDTH AT TOP (LONGITUDINAL) | 17.95 ±1.90 | 17.34 ±1.90 | 15.69 ±1.90 | 24.18 ±1.90 | 18.29 ±1.90 | 16.78 ±1.90 |




| VARIANT NUMBER | ITEM NUMBER | DESCRIPTION | STD | DRAWING NUMBER | ITEM NO | MATERIAL CODE | A/S/P | UNIT | UNIT WEIGHT | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | VAR NO | MATERIAL SPECN | | DI | QUANTITY | |

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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
355-055

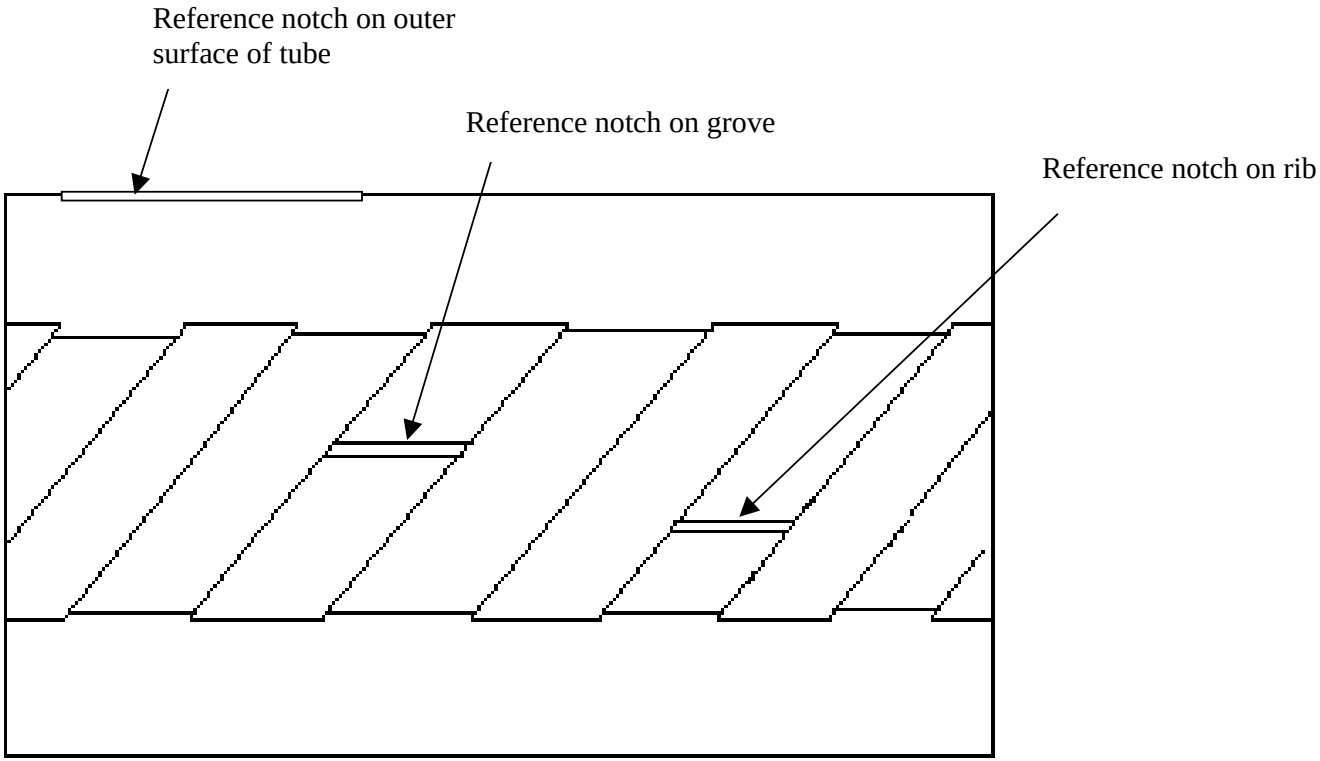
| | NAME | SIGNATURE | DATE |
|---|---|---|---|
| DRN | R.MURALI | | 9.2.99 |
| CHD | M.SOMU | | 10.2.99 |
| APPD | P.S.GURU | | 12.2.99 |

DEPT PP | CODE 121 | ALL DIMENSIONS ARE IN MM | PROJECTION | SCALE NTS | WEIGHT (Kg) — | REF TO ASSY / OLD DWG

TITLE: DIM. SPEC. FOR MULTI-RIFLED TUBING

DRAWING NO : 3-06-651-03853 | REV

| REV | DATE | ALTERED : |
|---|---|---|
| 01 | | CHD & APPD: |
| ZONE | | |




**Internal cross section of Rifled tube**