



Metal & Steel Factory, Ishapore
A Government of India Enterprise
Ministry of Defence
A unit of Yantra India Limited

धातु एवं इस्पात निर्माणी, ईशापुर
भारत सरकार का उद्यम
रक्षा मंत्रालय
यंत्र इंडिया लिमिटेड की एक इकाई

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ITEM CODE	ITEM SPECIFICATION
4415059245	STEEL BLOOMS SIZE 300MM X 300 MM (RCS) AS PER DETAILS SCOPE OF SUPPLY AND RAILWAY SPECIFICATION NO. IRS-R-16/95 WITH CORRIGENDUM 1 TO 3.

SCOPE OF SUPPLY OF STEEL BLOOM TO MSF, ISHAPORE AS PER INDIAN RAILWAY SPECIFICATION NO R-16/95 FOR MANUFACTURING OF SEMIFINISHED LHB AXLE TO DRAWING NO-AAA02045 Alt. -b (MSF item Code 4415059245) THROUGH SDOTE.

1. SCOPE

1.1 This specification covers the technical & dimensional, product inspection/quality audit requirements of Steel Blooms for forging of SEMIFINISHED LHB AXLE TO DRAWING NO-AAA02045 Alt. -b as per specification R-16/95 (Copy attached) of Railway Board.

with corrigendum no 1 to 3.

1.2 **Bloom dimensions & weight:** Bloom to standard size 300 (+5/-0) mm RCS / Square x 1985 (+10/-0) mm length or its multiple. However blooms to lower size, i.e. 300 (+5/-0) mm RCS/Square x 1050 (+10/-0) mm length shall be accepted only **up to 10%** of total quantity. Tentative weight in kg is 1385 (+10/-0). Firm may calculate the length to be parted considering the prime requirement of bloom weight i.e., 1385 (+10/-0) kg/bloom (two multiple).

1.3 **Delivery Schedule:** Firm should supply 200 MT within 45 days rest @ 400 MT/ month after 45 days.

1.4 MSF may carry out capacity verification (if required) of the firm to ascertain the supply capacity claimed by the firms.

1.5 **Transportation:** FOR MSF, Ishapore basis. Necessary labour and arrangement for unloading has to be provided by the firm. However, MSF will provide crane free of cost to facilitate unloading.

2. MANUFACTURING PROCESS

2.1 Process of manufacturing steel blooms.

2.2 The steel blooms shall be manufactured from steel made by basic Electric Arc Furnace or any other process recommended as equivalent. The steel must be degassed under vacuum. It must be killed and bottom pouring cast.

2.3 Strand cast bloom can also be manufactured and process shall be designed to ensure freedom from centre porosity and undue segregation.

2.4 Hydrogen content in the liquid steel determined by standard analysis method on LECO HYDROGEN analyser or similar precision equipment shall not exceed 3 ppm.

2.5 Nitrogen content of the steel determined by the standard analysis method on LECO nitrogen analyser or any other established instrumental method shall not exceed 0.007% (70 ppm).

3. QUALITY ASSURANCE PLAN

The manufacturer shall submit along with the technical bid the QAP that will be followed in the manufacturing of Steel Blooms to achieve the performance requirement described in clause 2. The QAP shall consider the following requirement.

- a) Details on the grade, source, specification and acceptance criteria of all raw materials used in the production. Additives if any used shall be mentioned.
- b) In-process parameter norms & frequency of testing.
- c) Finished product testing & the lot size.

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Other details like Technical Manpower, Details of Testing facilities (In-process & Product inspection), ISO 9001 or any other certification of Quality Management System may also be submitted with technical bid.

4. **TESTING FACILITY**

The firm shall have testing facility for testing as per clauses 5, 6, 11 & 13.

5. **CHEMICAL COMPOSITION.**

As per IRS R-16/95 with corrigendum no 1 to 3. *J110*

6. **PRODUCT ANALYSIS**

As per IRS R-16/95 with corrigendum no 1 to 3. *J110*

7. **DISCARD**

Sufficient discard shall be made from either end of each ingot to ensure freedom from piping and harmful segregation.

8. **MANUFACTURING PRACTICE**

8.1 Reduction ratio:

Size of Bloom in mm	Min reduction ratio (rolled/forged) from min. size of ingot to max. size of bloom	Min reduction ratio from min. size of strand cast bloom to max size of bloom
300 ²	2.5:1*	1.5:1

*Reduction Ratio of 2:1 from min. size of ingot to max size of bloom is permissible in case the ingot has tapering ratio of min. of 1:1.3 in sides (1:1.69 in area) from bottom to top.

8.2 The manufacturer will clearly indicate size of ingot used by them for manufacture of blooms and reduction ratio so achieved.

9. **COOLING**

9.1 When hot blooms are to be cooled, the same shall be allowed to cool uniformly and shall not be permitted to come in contact with water or draft of air.

9.2 Blooms must be pile/pit cooled.

10. **QUALITY OF MATERIAL**

The blooms shall be sound throughout and without cracks, inclusion, burrs, lack of metal, laps or any other defect detrimental to their end use and shall be supplied to the prescribed dimensions and tolerances.

11. **MECHANICAL PROPERTIES, MICRO & MARO STRUCTURE**

As per IRS R-16/95 with corrigendum no 1 to 3. *J110*

12. **DIMENSIONS, WEIGHTS AND TOLERANCES**

100% of the bloom shall be supplied to the prescribed dimensions, weights and tolerances.

13. **INCLUSION CONTENT**

As per IRS R-16/95 with corrigendum no 1 to 3.

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14. **SAMPLING NORM**

Heat/cast wise

15. ULTRASONIC REQUIREMENTS

- 15.1 Bloom shall be tested ultrasonically as per Annexure -A (Standard for UT Testing of blooms).
- 15.2 During internal inspection 100% UT of blooms by scanning through two perpendicular faces, employing oil/synthetic water-based gel as couplant shall be done to meet the ultrasonic requirement of finished axles as mentioned above. The blooms rejected during 100% UT test shall be segregated, colour coded with white paint band along the length of the bloom and kept separately. Only the accepted bloom shall be dispatched.
- 15.3 Blooms shall be tested for UT by representative of MSF at MSF premises out of 100% blooms inspected and passed by manufacturer/ authorized inspection agency of Indian Railway at firm premises and if found defective shall be rejected and to be taken back by the firm at their own cost. The manufacturer shall produce relevant documents, pertaining to material passed at their premises.

16. GEOMETRY, DIMENSIONS AND TOLERANCES OF BLOOM

The blooms shall be round cornered square or corner chamfered square as follows.

Size of bloom in mm	Type of Axle	RCS Bloom corner Radius in mm	Chamfered Bloom Diagonal size in mm	Supply Length of bloom in mm	Tentative weight in Kg	Extra length required for sample coupon in mm
300 (+5/-0)	LHB	50 ± 5	385 ± 5	1985 (+10/-0)	1385 (+10/-0)	60

Note: The length mentioned above is indicative only and may vary in actual. Firm may calculate the length to be parted considering the prime requirement of bloom weight i.e., 1385 (+10/-0) kg/bloom (two multiple).

17. LENGTH OF BLOOM

- 17.1 One bloom from each cast shall have extra length as specified in clause 16 above to accommodate sample coupon and this shall be identified by colour coding at both ends with yellow base and black zebra lines. Blooms should be marked for each unit length with white lines.
- 17.2 The blooms shall be straight throughout its length and deviation of 5 mm in one metre length of bloom may be permissible. The blooms shall be free from tapers, twists and bend ends. Both ends of the bloom shall be saw cut and straight.

18. CONDITIONING OF BLOOM

The conditioning of the bloom if any shall be done by grinding only and shall be free from cracks, laps, scabs and ruptures. The depth of conditioning allowed is 8 mm on surface of bloom. The width of conditioning shall be at least 10 times of its greatest depth to avoid laps while forging.

19. MINIMUM QUANTITY PER HEAT

- 19.1 The minimum desirable yield of blooms per heat/cast is 30 MT.
- 19.2 In case the higher heat size, one heat product in consequent supplies may be permitted.

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20. MARKING

- 20.1 All the blooms shall be marked with heat/cast number, manufacturer's serial number, length of the bloom, weight and steel designation on the big end face of the ingot. On the other face, cold stamping to be done for heat/cast No., Bloom No., and length 'R-16' shall be marked in yellow paint on both the faces of each bloom.
- 20.2 Cold stamping on side face shall also be permitted with prior approval from MSF.

21. TEST CERTIFICATE

The manufacturer must supply a certificate of testing that manufacturing stipulations of this specification have been met. In addition, the final test certificate must include the results of the following tests.

- a) Ladle analysis,
- b) Product analysis,
- c) Hydrogen content,
- d) Nitrogen content,
- e) Ingot size & reduction ratio (from ingot to bloom),
- f) Mechanical properties like UTS, YS, Elongation %, Impact charpy, (U notch) and heat treatment followed on test pieces.
- g) Microstructure,
- h) Macrostructure,
- i) Ultrasonic Test
- j) Inclusion content

22. PRODUCT INSPECTION AND TEST REPORT/PERIODICAL QUALITY AUDIT AND MANUFACTURERS TEST CERTIFICATE

- 22.1 Inspection shall be carried out either at firm's premises or at MSF by authorized representative of Indian Railways/ GM, MSF which will be final and binding to both the parties.
- 22.2 MSF reserves the right to conduct Quality audit as per QAP at the manufacturer's premises periodically. Full assistance shall be provided by the manufacturer for inspection of the bloom/quality audit at the manufacturer's works.
- 22.3 The manufacturer must inform MSF of the procedure used by them during submission of tender.
- 22.4 The representative of the MSF must be able to verify that the various manufacturing operations meet the stipulations of this technical specification to the order. To this end, he must have access to correctly calibrated radiation pyrometers and to the graphs produced by recording pyrometers.
- 22.5 The supplier shall provide test pieces and facilities for macro and micro examinations to the inspecting authorities for product audit.
- 22.6 For product Inspection at MSF one bloom shall be selected randomly from each heat for obtaining the sample for Macro structure, Microstructure and polished specimen for inclusion content determination. If the bloom so randomly selected is found unsuitable, the whole heat shall be rejected.

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22.7 No blooms will be received without the receipt of TC (Test Certificate)/MTC (Manufacturer's Test Certificate) along with supply.

23 PRODUCT GUARANTEE

If any Axle rejected after forging / machining due to inherent material defect, the same shall be replaced by firm free of cost. However, firm may ask for joint inspection at MSF for the rejected axle before final decision.

ANNEXURE-A

**ULTRASONIC TESTING STANDARD FOR BLOOMS
(ROLLED AND FORGED)**

1. **Scope:** This specification covers the procedure for detecting the gross discontinuities in round or chamfered corner square blooms for manufacturing axles.
2. **Purpose:** To ensure uniform structure and freedom from any internal discontinuities in the bloom to meet the requirement of specification - R-16/95 with corrigendum no 1 to 3.
3. **Equipment:** Krautkammer or any other equivalent make.
4. **Test Method:** Pulse echo direct contact method.
5. **Frequency:** 2 MHz to 2.25 MHz direct beam probe having crystal dia. of 3/4" to 1".
6. **Couplant:** Oil/Water.
7. **Calibration:** Calibration of equipment is to be done using IIW standard block as per IS 12666.
8. **Scanning:** Scanning should be done through out the length covering the whole surface area, giving sufficient overlapping on the two adjacent faces of bloom.
9. **Acceptance Standard:**
 - a. Flakes, piping and porosity are rejected.
 - b. Isolated flaw echo max. 25% when back echo adjusted to 100% of the full screen height acceptable and more than 25 % is unacceptable for rolled blooms. In case of forged blooms 20% when back echo adjusted to 100 % of the full screen height is acceptable and more than 20% is unacceptable.
 - c. Minimum distance between such isolated defects should be 6".
 - d. There shall not be more than three such isolated defects per meter of the bloom.
 - e. Continuous defects more than 3" shall be cause for rejection.
 - f. Testing shall not be carried out if the material is hot (> 500 C).

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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

INDIAN RAILWAY
STANDARD SPECIFICATION
FOR
STEEL AXLES FOR
CARRIAGES AND WAGONS
(APPLICABLE TO ALL GAUGES)

Serial No. R 16-95 with 2 Amendment

ISSUED BY:

RESEARCH DESIGNS & STANDARDS ORGANISATION

LUCKNOW - 226 011

SPECIFICATIONS REFERRED

This specification refers to the following specifications with their latest amendments -

1. IS:228 - Method for chemical analysis of steels.
2. IS:341 - Black Japan, type A, B & C.
3. IS:1499 - Method for Charpy Impact Test (U-notch) for metals.
4. IS:1608 - Method for tensile testing of steel products.
5. IS:2074 - Ready mixed paint, air drying, red oxide zinc chrome, priming.
6. IS:2853 - Method of determining austenitic grain size of steel.
7. IS:3073 - Assessment of surface roughness.
8. IS:7328 - High density polyethylene material for moulding and extrusion.
9. IS:9862 - Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting.

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INDIAN RAILWAY STANDARD SPECIFICATION FOR
STEEL AXLES FOR CARRIAGES AND WAGONS

(APPLICABLE TO ALL GAUGES)

IRS:R-16/95

1. SCOPE

This standard covers the technical requirements of steel axles for Carriages and Wagons including EMU trailer coaches of all gauges.

2. MANUFACTURE

2.1 Process of Manufacturing Steel

- (i) The axles shall be manufactured from steel made by Electric, Basic Oxygen or by any other process as agreed to by the Purchaser. The steel shall be of killed quality.
- (ii) The hydrogen content in the liquid shall not exceed 3 ppm. If it exceeds, then proper antifracking treatment shall be carried out after which the hydrogen content shall be measured and the same shall not exceed 3 ppm.

2.2 Chemical Composition

2.2.1 Ladle Analysis

The ladle analysis of steel, when carried out by the method specified in the relevant para of IS:228 or any other established instrumented/chemical method, shall be as per Table 1. In case of any dispute, the procedure given in the relevant para of IS:228 shall be the referee method. However, if the method is not given in any para of IS:228, the referee method shall be as agreed to between the Purchaser and the Manufacturer.

Table-1 Chemical Composition

Ladle Analysis (Percentage)

C	0.37 max.	Ni	0.30 max.
Mn	1.12 max.	Mo	0.05 max.
Si	0.15 to 0.46	Cu	0.30 max.
P	0.04 max.	V	0.05 max.
S	0.04 max.	P+S	= 0.07 max
Cr	0.30 max.		

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2.2.2 Product Analysis

The product analysis shall be carried out on the finished product. Permissible variation in case of such product analysis from the ladle analysis as obtained shall be as follows:-

<u>Element</u>	<u>Variation Percent</u>
Carbon	+0.03 -0.00
Manganese	+0.06 -0.00
Silicon	+0.04 -0.00
Sulphur & Phosphorus	+0.005 -0.000
Chromium & Nickel	+0.05 -0.00
Copper & Vanadium	+0.02 -0.00

2.3 Discard

Sufficient discard shall be made from either end of each ingot to ensure freedom from piping and harmful segregation.

2.4 Manufacturing Practice

2.4.1 The forged axles shall be manufactured from steel ingots rolled or forged down to bloom size but shall be finally shaped to profiles by forging only under a hammer or a press. The profile shall generally follow the contour of rough machined axles as given, in relevant drawings with adequate machining allowance.

2.4.2 The minimum cross section of the ingots shall not be less than twice the maximum cross section of bloom and the minimum cross section of bloom shall not be less than twice the maximum cross section of the forged axle.

2.4.3 Axles can be manufactured with a lower reduction ratio of forging provided the minimum cross section of the bloom is at least 1.5 times the maximum cross section of the axles and the minimum cross section of the ingot is at least five times the maximum cross section of the axles.

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2.4.4 In case the axles are manufactured direct from ingots by forging under a hammer or a press, the minimum cross section of the ingot shall not be less than three times the maximum cross section of the axles.

2.5 Cooling

When hot blooms are to be cooled, the same shall be allowed to cool uniformly and shall not be permitted to come in contact with water or draft of air. Forged axles shall normally be allowed to cool in a furnace.

2.6 Heat Treatment

All axles shall be normalised or heat treated by any other method as agreed to between the Purchaser and Manufacturer.

3. QUALITY OF MATERIAL

3.1 The axles shall be sound throughout and without cracks, inclusion, burrs, lack of metal, laps or any other defect detrimental to their end use and shall be supplied to the prescribed dimensions and tolerances.

4. BRANDING

Branding shall be as shown on the drawing No. Sk.92114 and such other marks as may be specified by the Purchaser, shall be stamped hot on both ends (not on body) of the axles. All the following details shall be restamped cold in 4 to 6 mm letters of scroll type on the ends after the same are machine faced -

- .1 Manufacturer's code name (in 3 digits with Purchaser's prior approval).
- .2 Year of manufacture (in 2 digits i.e. the year 1995 shall be indicated as 95).
- .3 Cast No. (in 5 digits, first digit being an alphabet).
- .4 Individual serial number (in 5 digits).
- .5 Drawing Number.
- .6 Inspector's approval stamp.
- .7 'UT' for Ultrasonic testing.

Note:- Cast Number, individual serial number and drawing number shall be separated by a '/'.

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5. SELECTION FOR TESTS

- 5.1 Axles shall be submitted in identifiable batches of maximum 100 nos. and each batch should contain axles from only one cast. The selection of axles for testing as specified in clause 6 shall be at the rate of one axle per batch or part thereof.
- 5.2 If fewer than 15 axles are made from one cast, the Manufacturer could leave on each axle a piece of the same diameter as the forged end of the axle to enable the Purchaser or his Inspecting Authority to select one such piece from which test pieces may be cut for the tests specified in clause 6.
- 5.3 The Purchaser or his Inspecting Authority shall select and test such of the axles as he may think proper to the extent of the number specified above. To ensure the proper axles being tested, distinguishing number shall be stamped or cast on every ingot made from each cast, and every billet and axle must be marked with the number of the ingot from which it was taken. The axles tested shall be held to represent the average quality of the axles of the lot presented from the cast from which they were selected. Each selected test axle or axle end piece shall comply with the following tests without further reheating or any other manipulation whatsoever, either of the axle/axle end piece selected for testing or the portion thereof selected for making the test pieces.
- 5.4 Extra axles for testing in the manner described in clause 6 shall be provided by the Manufacturer at his own expense.

6. TESTING

6.1 Tensile Test

- 6.1.1 Tensile test shall be carried out in accordance with IS:1608. Method for tensile testing of steel products other than sheet, strip, wire and tube using the standard proportional round tensile test piece having a gauge length equal to $5.65\sqrt{A}$ where A is the cross sectional area of the test piece, cold machined longitudinally from the wheel seat of the axle selected in accordance with clause 5. The axis of the test piece shall be half way along the radius of the wheel seat.

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- 6.1.2 When the axle end test piece is selected in accordance with clause 5.2 the test piece shall be machined longitudinally from the piece left on the axle selected.
- 6.1.3 The tensile strength, yield strength and percentage of elongation obtained from the test piece shall be as follows -

	<u>Normalised</u>	<u>Quenched & Tempered</u>
Ultimate tensile strength (N/mm ² min.)	550-650	550-700
Yield strength (N/mm ² min.)	320	350
Elongation percent(min.) (GL=5.65√A)	22	24
Impact U-notch at 20 deg.C (J min. lengthwise)	25	40

6.2 Impact Test (U-notch)

- 6.2.1 The impact test shall be carried out in accordance with the requirements of IS:1499. The axis of the test piece shall be half way along the radius of the wheel seat. The minimum impact strength obtained shall be 25 J at 20 deg. C for normalised steel and 40 J at 20 deg. C for quenched and tempered steel.

6.3 Metallographic analysis

6.3.1 Micro Examination:

The micro examination shall be taken from the tensile test specimen, which is drawn from the standard location of the wheel seat of the axle. The structure of normalised or quenched and tempered axle shall be uniform and typical of the heat treatment given. The sampling frequency shall be one test per cast per heat treatment batch.

6.3.2 Grain size

The samples shall be drawn from the same location of the tensile test specimen. The grain size, determined as per requirements of IS: 2853, may not be coarser than 5. The sampling frequency shall be one test per cast per heat treatment batch.

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6.4 Macro Examination

The macro examination shall be taken on the radial surface of the wheel seat area. After polishing, the surface on examination with a magnification factor 5 or less must not reveal any discontinuities. The sampling frequency shall be one test per cast per heat treatment batch.

6.5 Chemical Analysis

The Manufacturer shall supply a complete chemical analysis of each cast of the steel when required to do so by the Purchaser or the Inspecting Authority. The Purchaser or the Inspecting Authority shall also take the samples from one axle from every batch for analysis.

7. OTHER TESTS

The Purchaser or the Inspecting Authority shall, in case of reasonable doubts, resort to other forms of testing such as magnetic particle test, micro examination test etc., as mutually agreed to between the Purchaser or Inspecting Authority and the Manufacturer to satisfy that the axles are free from defects of any kind.

8. RETESTS

8.1 Should a test piece fail to meet the requirements of any test and should the Purchaser or the Inspecting Authority consider that the test piece does not fairly represent the quality of the batch, two further test pieces shall be taken for repeating the test under which failure had occurred. Before taking these test pieces the batch of axles, together with the test samples, may with the agreement of the Purchaser or Inspecting Authority, be reheat treated.

8.2 Should either retest piece fail to meet the requirements, the batch of axles, together with the test samples, may with the agreement of the Purchaser or Inspecting Authority, be reheat treated again and two further test pieces taken for repeating the test under which failure had occurred. Should either of the test pieces fail to fulfil the conditions of the test, the batch of the axle represented shall be rejected.

8.3 In case of axles reheat treated to meet the requirements of ultrasonic test (longitudinal penetration) as stipulated in Appendix 'A' clause A-6-1-3, they shall be resubmitted for testing in accordance with clause 6, except chemical analysis.

8.4 The axles shall not be reheat treated more than twice over and above the original heat treatment.

9. ULTRASONIC TEST

9.1 All axles conforming to all the aforesaid tests shall be subjected to ultrasonic test and only those passing this test shall be accepted. The method of test and acceptance standard shall be as given in Appendix A.

10. MACHINING OF AXLES

10.1 Axles shall be delivered rough turned or machined to drawings as required by the Purchaser. The rough turned/machined portion shall be concentric with the lathe centres of the axles. The axles shall be free from injurious tool marks. The surface finish on the rough turned or machined axles shall be as shown on the drawing.

10.2 Permanent lathe centres shall be smooth, accurately machined and truly in line with the centres of the axle.

10.3 Unless otherwise specified, the wheel seats shall be rough turned with an allowance of 5 mm over the finished diameter.

11. SAMPLE AXLE

11.1 A sample axle of each kind, finished complete as per contract drawing shall be approved by the Purchaser or the Inspecting Authority before the general execution of the order is proceeded with. The quality of workmanship on all other axles should be similar to the approved sample.

12. INSPECTION

12.1 The Inspecting Authority or the Purchaser shall have free access to the works of the Manufacturer at all reasonable times. He shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this specification. The Inspecting Authority or the Purchaser shall have the power to mark or deface in some easily distinguishable manner all rejected axles, but shall not be marked or defaced in such a manner so as to render them unsaleable to other parties.

12.2 Power shall be reserved with the Purchaser or the Inspecting Authority to be present at, and take such part, as he thinks fit, in all analysis and physical/chemical/metallurgical examinations which the

Manufacturer may undertake for his own purposes or under the terms of this specification, both of the axles and/or their materials, in all stages of manufacture.

13. TESTING FACILITIES

The Manufacturer shall supply free of charge the material required for testing and shall at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his own premises in accordance with this specification. Failing facilities at his own works for carrying out the prescribed tests, the Manufacturer shall bear the cost of carrying the tests elsewhere.

14. PROTECTION & PACKING

14.1 Journals

After inspection and acceptance the journals shall be carefully protected with three coats of Ready Mixed Paint, brushing bituminous black to IS:9862 or with any other equivalent anti-rust compound approved by the Purchaser, allowing sufficient drying time between each coat. The journals shall then be further protected with minimum 5 mm thick well fitted High Density Polyethylene to IS:7328 designated as HDPE-44-MB covers in two end face and surrounding the axle end collar, journal and shoulder in case of plain bearing type axles and with a minimum 5 mm thick well fitted, and one piece High Density Polyethylene cover surrounding the journal and shoulder and secured with three PVC screws to suit the axle end as given in the relevant axle drawing in case of roller bearing type axles as shown in FIG.2 & 3.

14.2 Axle Body and Wheel Seats

The axle body and wheel seats shall be painted with one coat of zinc chromate primer to IS:2074 followed by a second coat of Black Japan to IS: 341, allowing sufficient time for drying between each coat. All parts must be clean and free from rust and moisture at the time the coats are applied. The axle body and wheel seat shall then be further protected with minimum 5 mm thick well fitted High Density Polyethylene to IS:7328 designated as HDPE-44-MB covering, secured with steel straps as shown in Fig.4.

APPENDIX-A
(Ref.: Clause 9)

ULTRASONIC INSPECTION OF NEW AXLES FOR RAILWAY ROLLING STOCK
(TRACTION & TRAILING) - METHOD OF TESTING AND ACCEPTANCE
STANDARDS

A-1 SCOPE

The method of testing and the acceptance standard set out hereunder shall be used to evaluate all types of new axles of railway rolling stock (Carriage, Wagon and EMT trailer coaches) as stipulated in this specification.

A-2 PURPOSE

The axle shall be evaluated for

A-2-1 End-face to end-face penetrability.

A-2-2 For detecting discontinuities which may be harmful to the axle service.

A-3 EQUIPMENT

A-3-1 The instrument used must be of pulse echo type.

A-3-2 The instrument shall be operated at 2.0 to 2.5 MHz frequency for both penetrability test and discontinuity detection.

A-3-3 The instrument may be used with various types of transducers namely, Bariumtitanate, PZT, Lead metaniobiate etc. of 20 to 26 mm dia. or equivalent area probe. Other types and sizes of transducers of similar response capability as those described may be used with the approval of the Inspecting Authority.

A-4 STAGE OF INSPECTION

A-4-1 The axles shall be ultrasonically inspected after the stipulated heat treatment and machining of the end faces to a finish of N8 to IS:3073.

A-5 INSTRUMENT SENSITIVITY

A-5-1 The instrument sensitivity shall be adjusted with the help of a reference block manufactured from an axle forging in the normalised condition, and conforming to this specification. The block shall be 406 mm long. The two end faces shall be machined parallel to a finish of N8 to IS:3073. The reference standard shall

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be a flat-bottom 3.2 mm dia. hole drilled perpendicular to one of the end faces at mid-radius to a depth of about 25 mm such that the flat bottom of the hole shall be located at a distance of 381 mm from the other end face.

A-5-2 Using the reference block the sensitivity of the equipment shall be adjusted to give an echo amplitude of about 12.5 mm from the reference hole when probed from the opposite end face. In case of "Longitudinal Discontinuity Detection," the sensitivity shall be set on a sample piece of axle material with perspex fitted on the probes.

A-6 SCANNING

A-6-1 LONGITUDINAL PENETRATION (END-FACE TO END-FACE)

A-6-1-1 With the sensitivity setting, as described in clause A-5 above, axles when scanned manually or by automated inspection techniques from one end face shall produce a minimum of 25 mm back reflection from the opposite end face.

A-6-1-2 The scanning shall be done from both the end faces of axles.

A-6-1-3 Axles which do not meet the above requirements shall be rejected. However, the Manufacturer may, by mutual agreement with the Purchaser or Inspecting Authority, reheat treat the axles and resubmit for his test. Reheat treated axles shall conform to the stipulations of "Retests" clause 8.

A-6-2 DISCONTINUITY DETECTION

A-6-2-1 With the sensitivity setting as described in clause A-5, the instrument shall be capable of detecting in reference axle pieces, flat bottom holes of sizes and at distances indicated in the following table:

<u>Distance in mm</u>	<u>380</u>	<u>750</u>	<u>Over 750</u>
Dia. of flat-bottom hole	3.2	6	9.5

A-6-2-2 The depth range of the instrument shall be set to more than half the length of axle under test. The axles shall be scanned alternatively from both the end face covering the maximum end face area possible whether by manual or automated inspection techniques.

- A-6-2-3 The axles shall not show any discontinuity indication exceeding the levels obtained from reference flat-bottom holes of size for the various zones as indicated below -

Permissible Size of Discontinuity (Max.)

Zone	I	II	III
F.B.Hole (dia)	3.2 mm	6.4 mm	9.5 mm

Note: Please see Fig.1 (a) for identification of the zones.

- A-6-2-4 The amplitude of all discontinuity indication shall be evaluated with respect to distance from the test surface by utilising either an in-built Distance Amplitude Correction device if provided in the instrument or by establishing Distance Amplitude Curves (DAC) for the specific instrument and transducer as described in clause A-7 below.

The gain/attenuator control setting shall be the same as used for the respective zone for establishing DAC.

- A-6-2-5 Axles under test shall be rejected if the amplitude of any discontinuity indication exceeds the levels indicated in clause A-6-2-3, read with the corresponding DAC for the respective zone.

A-6-3 LONGITUDINAL DISCONTINUITY DETECTION

- A-6-3-1 With the sensitivity setting as described in Clause A-5 above, axles when scanned manually or by automated inspection technique by placing the normal probe, fitted with perspex piece having diameter of curvature to match the diameter of axle on the body of the axles, shall not produce any intermediate signal in between initial and back signal obtained from the other end of the diameter of the axle, suggestive of longitudinal discontinuity. The axle shall be tested throughout the length and calibration shall be made at 200 mm depth range

- A-6-3-2 Axle which do not meet the above requirement, shall be rejected.

A-7 DISTANCE AMPLITUDE CORRECTION (DAC)

- A-7-1 The amplitude of ultrasonic indication for a given discontinuity size varies with the distance from the test surface. It is, therefore, necessary to have

IRS:R-16/95

either an in-built distance amplitude correction device or establish DAC curve for the particular type of axle. Because the distance amplitude relationship is influenced primarily by the ultrasonic equipment and transducer, it is necessary to establish the DAC for specific equipment and transducer combination used.

A-7-1-1 For establishing DAC for the three zones, indicated in Fig.1 (a), four or more reference axle cut pieces for each zone with progressively varying lengths and with the relevant size of flat-bottom hole drilled perpendicular to one of the end faces on each piece may be used and the distance amplitude curves drawn for each zone for the particular type of axle to be tested. However, where more than one type of axle is to be tested, a common DAC could be established for axles having close geometry.

A-7-1-2 An alternate method would be to start with an axle piece equal to half the length of the axle under test with the three sizes of flat bottom holes, viz, 3.2, 6.4 and 9.5 mm dia, respectively, drilled perpendicular to one of the end-faces and mid-radius suitably dispersed around the centre. Scanning shall be continued after progressively slicing the axle from the testing end. From the amplitude indications and the distance the DAC could be drawn for each zone, and for the relevant holes.

A-7-1-3 An example of establishing a typical DAC as per above two methods is given in Fig.1 (b), 1 (c) & 1(d).

A-8 REJECTION

A-8-1 For end-face to end-face penetrability test, see clause A-6-1-1 and clause A-6-1-3.

A-8-2 For discontinuity test, see clause A-6-2-5.

A-8-3 For longitudinal discontinuity, see clause A-6-3-2.

A-8-4 Spurious echoes attributable to the geometry of the axle or ground noise of the instrument shall not be a cause for rejection.

A-9 MARKING

A-9-1 Axles that conform to the above ultrasonic stipulations shall be stamped "UT" on the end face as indicated in clause-4.

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APPENDIX-A

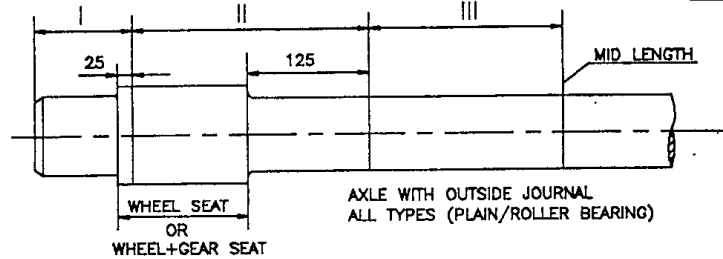


FIG. 1 (a) - ZONE DEMARCATION FOR ULTRASONIC TESTING OF ROUGH TURNED AXLES (TO BE READ ALONG WITH THE RELEVANT AXLE DRAWING)

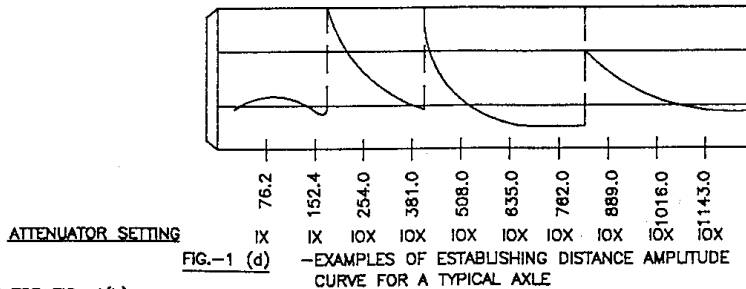
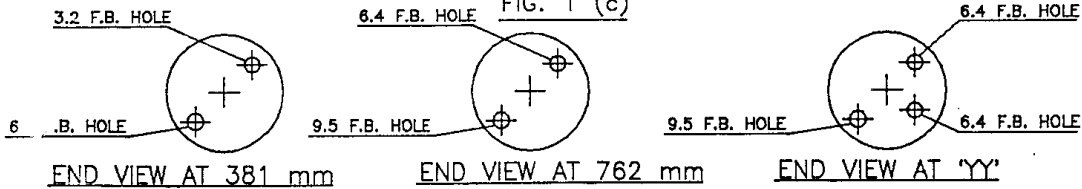
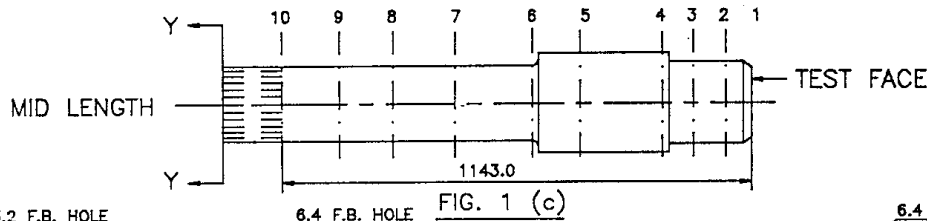
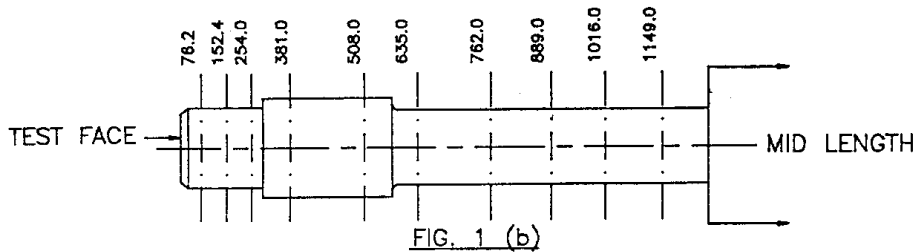


TABLE FOR FIG.-1(b)

FLAT BOTTOM HOLE (mm)	DISTANCE OF FLAT BOTTOM OF THE HOLES FROM THE TESTING FACE (mm)
3.2 φ	76.2, 152.4, 254.0
3.2 φ & 6.4 φ	381.0
6.4 φ	508.0, 635.0
6.4 φ & 9.5 φ	762.0
9.5 φ	889.0, 1016.0, 1143.0

NOTE:

FIG. 1 (c) INDICATES THE LOCATIONS 1 TO 10 WHERE THE REFERENCE AXLE WILL BE PROGRESSIVELY SLICED AND TESTED.

METHOD OF ULTRASONIC TESTING OF AXLES

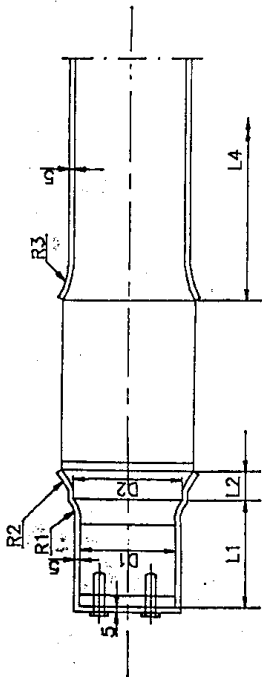


FIGURE-2

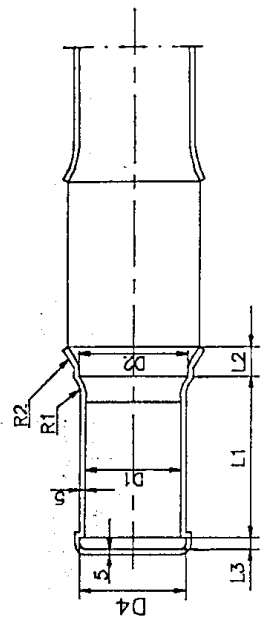


FIGURE-3

NOTE:-

1. TOLERANCE ON COVER:

DIMENSIONS	TOLERANCE
D1, D2, D3, & D4	+2 -0
L1 & L2	+0 -5
L3	+2 -0
L4	+0 -10
R1, R2 & R3	+10 -0

FOR DIAMETER, LENGTH AND RADIUS REFER TO CORRESPONDING DIMENSIONS OF THE FINISHED AXLE.

2. MATERIAL FOR THE COVER SHALL BE HIGH DENSITY POLYETHYLENE TO IS:7328-74 DESIGNATED AS HDPE-44-MB.

3. PROTECTIVE COVERS SHALL BE CLAMPED WITH MIN. 20 mm WIDE STEEL STRAPS AT SUITABLE LOCATIONS WITH MINIMUM TWO STEEL STRAPS ON EACH JOURNAL & THREE ON AXLE BODY.

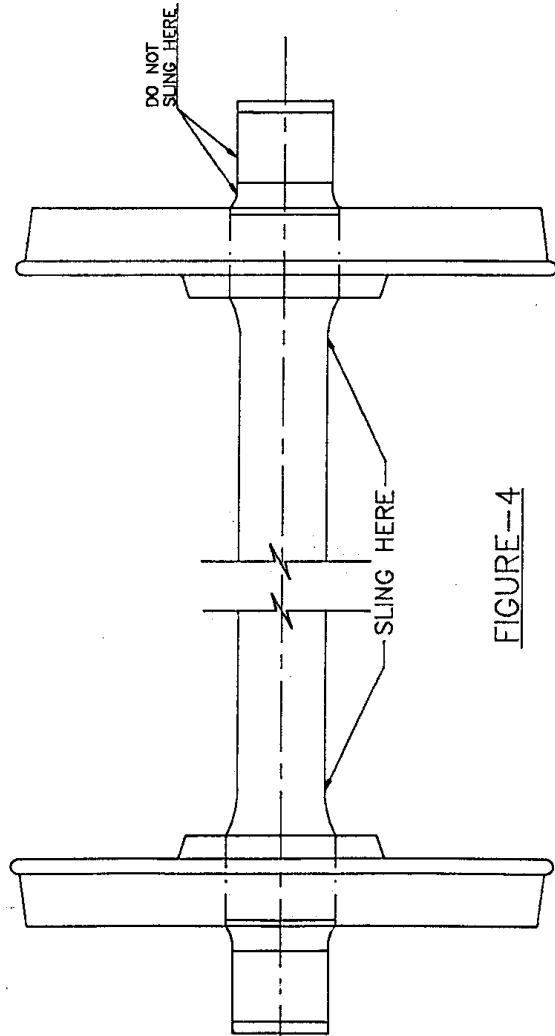


FIGURE-4

PROTECTION AND PACKING

-15-

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

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CORRIGENDUM No. 1 OF MAY, 1997

to

INDIAN RAILWAY

STANDARD SPECIFICATION

for

STEEL AXLES FOR CARRIAGES AND WAGONS

(Applicable to all gauges)

Serial No. R 16-95

1. Substitute the following against clause 2.1 (i):
"The axles shall be manufactured from steel made by Electric or Basic oxygen process. The steel shall be of killed quality."
2. Add the following in second line of clause 2.1 (ii) after 3 ppm:
"As per standard procedure."
3. Add the following clause as clause 2.1 (iii):
"Nitrogen content in the steel shall not exceed 0.007 per cent."
4. Substitute the following against existing clause 2.6:
"Heat Treatment:
All axles shall be either normalised or oil hardened and tempered to achieve the mechanical properties laid down in clause 6.1.3, to guarantee the structural homogeneity in the same axle or axles in the same batch as laid down in clause 6.3.1 and free from distortion."

5. Delete the existing clause 7 and substitute the following as clause 7:

"Magnetic Particle Test:

All axles (in rough machined condition or fully machined and heat treated condition) shall be tested by the magnetic particle method both in longitudinal and circular magnetisation and shall not reveal any harmful surface defects. The axles revealing harmful surface defects shall be rejected. All axles shall be demagnetised after the magnetic particle test."

6. Add the following ~~as~~ clause as clause 15;

15. Guarantee

15.1 The axle shall be guaranteed by the Supplier for five years against any defect attributable to the manufacture and not revealed during acceptance inspection.

15.2 This period shall be calculated from the end of the month stamped on the axle.

15.3 In case of axles for new vehicles, the delivery date of the vehicles to which they are fitted shall be regarded as the date of delivery of axles.

15.4 Axles, which during guarantee period show defects making them either unfit for service or reducing their period of service, will be rejected.

15.5 When two axles from the the same cast have failed in service, or when more than 5 % of the axles from the same cast revealed defects within the above conditions, the Purchaser shall have the right to reject the whole ^{of the} cast.

15.6 Rejected axles shall be made available to the Supplier with a view to their replacement or reimbursement.



GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

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CORRIGENDUM NO.2 OF SEPTEMBER, 1999,

TO

INDIAN RAILWAY
STANDARD SPECIFICATION

FOR

STEEL AXLES FOR CARRIAGES AND WAGONS

(Application to all gauges)

Serial NO. R 16-95

Add the following as clause 2.4.5.

The axles can also be manufactured using concast blooms.
When manufacturing axles from concast blooms a minimum reduction
ratio of 3:1 is to be maintained.

Add the following as clause 7.1, 7.2, 7.3 & 7.4

The acceptance limit of surface/sub-surface defects is given
below:

7.1 Imperfections not acceptable.

- 7.1.1 Transverse/circumferential seams cracks or laps of any
depth (indeterminate) on axle surface.
- 7.1.2 Longitudinal discontinuity (hairline, stringer, fine
seam) in machined fillets.

7.2 Imprefections considered acceptable.

7.2.1 Journals:

7.2.2 Fine longitudinal discontinuity (hairline, stringer, fine seam) on surface if:

- (i) Not extended on fillets.
- (ii) Less than 19mm individually.
- (iii) Total length of discontinuity (6.5mm & more) less than 51mm.

7.3 Wheel seats:

7.3.1 Longitudinal seams if:

- (i) Not extended on fillets
- (ii) Individually not more than 51mm long.
- (iii) Total length of imperfection (6.5mm to 51mm) not to exceed 105 mm.

7.4 Body

7.4.1 Longitudinal discontinuities (hairline, stringer, fine seams) if :

- (i) Not extended to fillets of wheels/gear seat.
- (ii) Individually not more than 38mm.
- (iii) Total length of discontinuity not to exceed 38.1mm in any 305mm.

Delete Clause A-6-3 of Annexure-A and substitute the following as A-6-3.

A-6-3 Longitudinal discontinuity detection:

A-6-3-1. Depth range calibration - The ultrasonic flaw detector is to be calibrated for 250mm depth range (longitudinal wave) with the help of a portion of approx. 200mm diameter of thickness and length 150mm. A 3.2mm dia flat bottom hole shall be drilled perpendicularly from thickness to a depth of 25-2mm. One zero degree probe fitted with perspex block having concave curvature corresponding to axle diameter shall be used. Adjust the depth and delay control knob so that on-set of the back reflection from opposite surface shall appear at 8 horizontal main scale division. Each main scale division thus will represent 25mm for longitudinal wave.

A-6-3-2 Sensitivity setting - Place the zero degree probe fitted with perspex to the diametrically opposite side of the flat bottom hole. A echo at 7.5 horizontal scale division will appear on the screen. Adjust the gain level to achieve the echo height to 60% of the vertical scale division. This gain level should not be changed during testing of axle.

A-6-3-3 Acceptance criteria - Any flaw echo having amplitude 60% or more and of characteristics indicated below shall be a cause for rejection.

a) Any longitudinal defect of length 75mm or more located in the body of the axle or 50mm or more under wheel seat and journal region.

b) Minimum distance between two successive isolated defect 200mm or less.

c) More than 3 isolated defects exist throughout the axle.

d) Flaw of any length located between surface and mid radius of the axle.

* * * * *

Government of India

Ministry of Railways

(Railway Board)

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Corrigendum No. 3 of April, 2012

To

Indian Railway

Standard Specification

For

STEEL AXLES

For

Carriages and Wagons

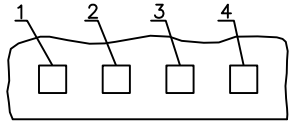
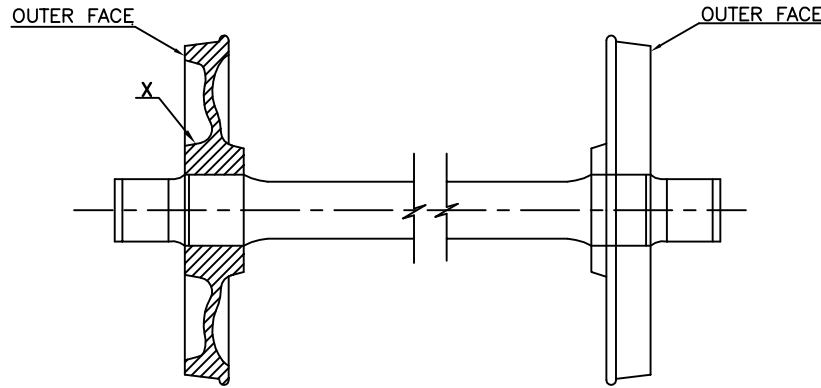
(Applicable to All Gauges)

Serial No. R 16/95

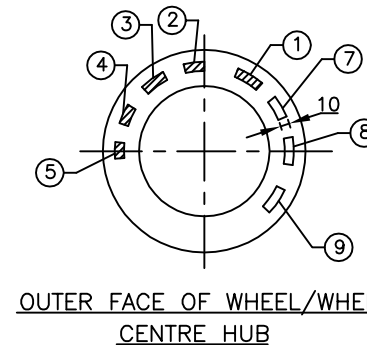
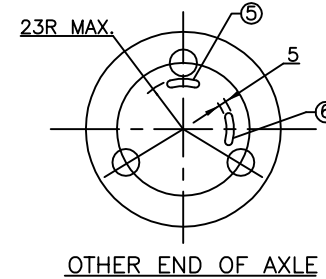
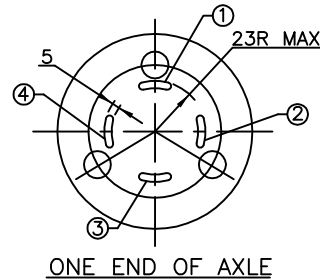
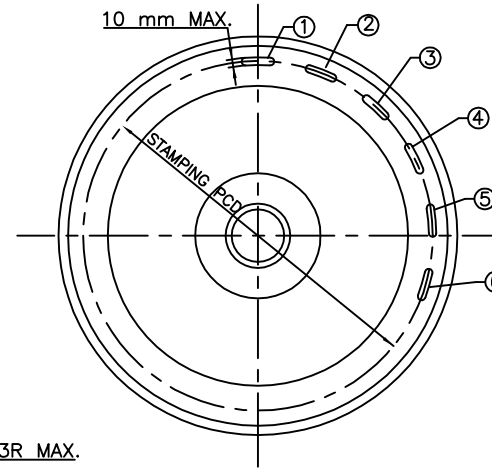
Clause 5.1

Replace 100 nos. by 140 nos. at first line.

“यह (आरेख) अनुसंधान अभिकरण एवं मालक संघटन रेल मंत्रालय) लखनऊ-226011 भारत के संपत्ति है और पर लिखित अनुमति के बिना इसका आंशिक या पूर्ण रूप से प्रयोग विजित है.”



DETAILS OF 'X' FOR MARKING ON LHB COACH WHEELS



STAMPING PARTICULARS

WHEEL/WHEEL CENTRE AND AXLE DETAILS	1	MANUFACTURER'S CODE
	2	YEAR OF MANUFACTURE
	3	CONSECUTIVE No.
	4	BATCH No.
	5	INSPECTOR'S APPROVAL STAMP
	6	'UT' FOR ULTRASONIC TESTING
ASSEMBLY DETAILS	7	MANUFACTURER'S/WORKSHOP'S CODE
	8	MONTH AND YEAR OF ASSEMBLY
	9	PRESSING ON PRESSURE IN TONNES

PCD OF STAMPING OF DIFFERENT WHEELS

TYPE OF WHEEL	PCD OF STAMPING ON RIM
COACHING	
WTAC3-0-2-301	788 mm
T-0-2-622	788 mm
W/WL-1660	788 mm
MG/T-0-1-004	610 mm
WAGON	
W/WL-4764	870 mm
W/WL-4771	780 mm
WD-89025/S-5	830 mm
WD-89025/S-9	960 mm
CONTAINER FLAT	
CONTR.-9404-S/13	755 mm
SOLID WHEEL FOR EMU	
Sk-K4004	842 mm (FOR MC) 832 mm (FOR TC)

NOTE:

- WHEEL DETAILS**
 - TO BE HOT/COLD STAMPED OR MARKED BY ELECTRIC ETCHING IN 10 mm LETTERS ON OUTER FACE OF THE RIM OF ROUGH TURNED OR FINISH TURNED WHEELS.
 - FOR LHB COACH WHEELS, STAMPING SHOULD BE DONE ON OUTER FACE OF THE HUB. PARTICULARS OF S.No. 1 TO 4 SHALL ALSO BE STAMPED ON OUTER HUB FILLET AT LOCATION MARKED AS 'X', FOR EASY IDENTIFICATION IN ASSEMBLED CONDITION.
- WHEEL CENTRE DETAILS**

TO BE COLD STAMPED OR MARKED BY ELECTRIC ETCHING IN 10 mm LETTERS AT THE HATCHED LOCATIONS ON OUTER FACE OF THE HUB.
- AXLE DETAILS**
 - TO BE STAMPED COLD OR MARKED BY ELECTRIC ETCHING ON BOTH ENDS IN 5 mm LETTERS IN CASE OF ROUGH TURNED OR FINISHED AXLES.
 - TO BE STAMPED IN 10 mm LETTERS IN CASE AXLES ARE SUPPLIED IN AS FORGED CONDITION.
- ASSEMBLY DETAILS**

TO BE STAMPED COLD OR MARKED BY ELECTRIC ETCHING IN 10 mm LETTERS ON THE OUTER FACE OF THE WHEEL/WHEEL CENTRE HUB.
- IT IS MANDATORY TO STAMP THE RESPECTIVE MARKINGS AT THE LOCATIONS INDICATED ABOVE.

⑦	--	SS/21/09	DETAILS OF 'X' FOR ADDITIONAL MARKING ON LHB COACH WHEELS ADDED AND NOTE 1.2 MODIFIED.	12/09
⑥	--	SS/19/09	RADIUS AT END VIEWS OF THE AXLE CHANGED FROM 18R TO 23R. <td>10/09</td>	10/09
⑤	--	SS/01/06	DRAWING REVISED	1/06
④	--	SS/13/03	DRAWING REVISED	3/03
③	--	SS/3/02	DRAWING REVISED	2/02
②	--	CD/17/99	DRAWING REVISED	8/99
①	--	CD/6/97	DRAWING REVISED	9/97
ALT.	ITEM	AUTHY.	DESCRIPTION	DATE

SUPERSEDED BY:	
SUPERSEDES:	
SCALE	P
Z	C G.V.RAMAN
	D PANT & SANJAY
	T --
	J.S. --
B.G.	R.D.S.O. [c]

BRANDING DETAILS ON WHEEL & AXLE

SKETCH-92114