INDIAN RAILWAYS

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Document content	Technical Specification-	Yes
	Schedule of Technical Requirement	No
Description of item	**STEEL AXLES FOR CARRIAGES, WAGONS AND EMU-US/MEMU-US INCLUDING TRAIN-18 & VANDE BHARAT STOCK** (APPLICABLE TO ALL GAUGES)	
Remarks	----------	

S. No.	Month/Year of issue	Revision / Amendment	Page No.	Reason for Amendment/Revision
1.	1995	Nil	-	First Issue
2.	May 1997	Corrigendum No.1	-	Modified Clause No. 2.1, 2.6 & 7 Added New Clause No. 14
3.	Sep. 1999	Corrigendum No.2	-	Added New Clauses – 2.4.5, 7.1, 7.2, 7.3 & 7.4
4.	April 2012	Corrigendum No.3	-	Modified Clause No. 5.1
5.	June 2020	Corrigendum No.4	-	Modified Clause No. 15.1
6.	June 2024	Revision 1	-	To include the requirements for Powered and Non-Powered Axles of EMU-US, MEMU-US, Train-18 & Vande Bharat Stock

Issued by:

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SPECIFICATIONS REFERRED:

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

S. No.	Referred Standards	Description
1.	IS:228	Method of chemical analysis of steels.
2.	IS:341	Black Japan, type A,B & C
3.	IS:1499	Method of 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 heat resisting.
10	EN 13261	Railway Applications - Wheelsets and Bogies – Axles – Product Requirements

INDIAN RAILWAY STANDARD SPECIFICATION FOR STEEL AXLES FOR CARRIAGES, WAGONS AND EMU-US/MEMU-US INCLUDING TRAIN-18 & VANDE BHARAT STOCK

(APPLICABLE TO ALL GAUGES)

1. Scope

This standard covers the technical requirements for following:

1.1 Steel Axles for Carriages and Wagons including EMU Trailer Coaches of All Gauges.

1.2 Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock of Broad Gauges.

2 Manufacture

2.1 Process of manufacturing steel

(i) The axles shall be manufactured from steel made by Electric orBasic oxygen process. The steel shall be of killed quality.

(ii) The hydrogen content in the liquid shall not exceed 3ppm. If it exceeds, then proper antiflaking treatment shall be carried out after which the hydrogen content shall be measured and the same shall not exceed 3 ppm as per standard procedure. In case of Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock the hydrogen content shall not exceed 2.5 ppm.

(iii) “Nitrogen content in the steel shall not exceed 0.007 percent.”

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

For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock: EA1N Cat.2 as per table-1 of EN 13261:2020 or latest.

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:-

Element	Variation Percent
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 the 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.

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.

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

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 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."

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 no. (in 5 digits).
5. Drawing Number.
6. Inspector's approval stamp.
7. 'UT' for Ultrasonic testing.
8. Steel Grade (for Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock only)

Note- Cast Number, individual serial number, ~~and~~ drawing No. and Steel Grade shall beseparated by a '/'.

5. SELECTION FOR TESTS

5.1 Axles shall be submitted in identifiable batches of max. 140 nos. and each batch should contain axles from only 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 lower than 15 axles are made from once 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 √ 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.

For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock – Testing/Verification as per clause 4.2 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.

6.1.2 When the axle and 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-

	Normalised	Quenched & tempered	For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock
Ultimate tensile strength (N/mm^2 min.)	550-650	550-700	550-650
Yield strength (N/mm^2 min.)	320	350	320
Elongation percent (min) (GL=5.65 √A)	22	24	22
Impact U-notch at 20 deg. C (J min. lengthwise)	25	40	Avg. Longitudinal ≥ 30 Min. Longitudinal ≥ 21
			Avg. Transverse > 20 Min. Transverse > 14

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 axle 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.

For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock – Testing/Verification as per clause 4.2 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.

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.

For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock – Testing/Verification as per clause 4.3 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.

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.

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.

6.6 Fatigue test: only for Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock as per Para No. 4.2 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.

6.7 **Material Cleanliness : only for Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock as per Para No. 4.4 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.**

6.8 **Residual Stress: only for Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock as per Para No. 4.4 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.**

7 Magnetic Particle Test:

All axles (in rough machined condition or fully machined and heat-treated condition) shall be treated 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 shalbe demagnetised after the magnetic particle test. The acceptance limit of surface/sub-surface defects is given below:

7.1 Imperfections not acceptable.

7.1.1 Transverse / circumferential same cracks laps of any depth (indeterminate) on axle surface.

7.1.2 Longitudinal discontinuity (hairline, stringer, fine seam) in machinedfillets.

7.2 Imperfections 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 (6.5 mm & more) less than 51 mm.

7.3 Wheel Seats:

7.3.1 Longitudinal seams if:
(i) Not extended on fillets
(ii) Individually not more than 51 mm long.
(iii) Total length of imperfection (6.5 mm to 51 mm) 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 38 mm.
(iii) Total length of discontinuity not to exceed 38.1 mm in any 305 mm.

7.5 For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock MPI as per Para No. 4.7.2 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.

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 re-heat 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 re-heat 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.

9.2 For Powered and Non-Powered Axles of EMU-US/MEMU-US including TRAIN-18 & Vande Bharat Stock ultrasonic Testing as per Para No. 4.4.2 & 4.5 of EN 13261:2020 or latest for Steel Grade EA1N Cat.2.

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 of 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 5mm 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.

12.3 Inspection of all type of axles shall be as per table L.1 in Annexe-L of EN 13261:2020 or latest.

13 TESTING FACILITIES

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

14 PROTECTION AND 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 5mm thick well fitted High density Polyethylene to IS:7328 designated as HDPE-44-MB covers in two end face and surrounding the axle and collar, journal and shoulder in case of plain bearing type axles and with a minimum 5mm 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 Figure 2 & 3.

14.2 Axle Body, ~~and~~ Wheel Seats, Brake Disc Seat and Gear Seat etc.

The axle body ~~and,~~ Wheel Seats, Brake Disc Seat and Gear Seat etc. 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 Seats, Brake Disc Seat and Gear Seat etc. shall then be further protected with minimum 5mm thick well fitted High Density Polyethylene to IS:7328 designated as HDPE-44-MB covering, secured with steel straps as shown in fig.4.

15 Guarantee

15.1 The axle shall be guaranteed by the Supplier for six 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 fitted 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 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 of reimbursement.

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Signature			
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APPENDIX-A
(Ref.: Clause 9)

ULTRASONIC INSPECTION OF NEW AXLES FOR RAILWAY ROLLING STOCK (TRACTION AND 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 EMU 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 26mm dia or equivalent area probe. Other types and sizes of transducers to 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 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 distanceof 381 mm from the other end face.

A-5-2 Using the reference block the sensitivity of the equipment shall be adjusted to given 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 inspected techniques from one end face shall produce a minimum of 25mm 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 "Re- tests" 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-

Distance in mm	380	750	Over 750
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.)	3.2mm	6.4 mm	9.5mm

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 **Depth Range Calibration** – The ultrasonic flaw detector is to be calibrated for 250 mm depth range (longitudinal wave) with the help of a portion of approx.. 200 mm diameter of thickness and length 150 mm. A 3.2 mm dia flat bottom hole shall be drilled perpendicularly from thickness to a depth of 25 $\pm$2 mm. 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 rescale division. Each main scale division thus will represent 25 mm 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 horrizontal 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 cause for rejection.

(a) Any longitudinal defect of length 75 mm or more located in the body of the axle or 50 mm or more under wheel seat and journal region.
(b) Minimum distance between two successive isolated defect 200 mm 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.

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 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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Signature			
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APPENDIX - A

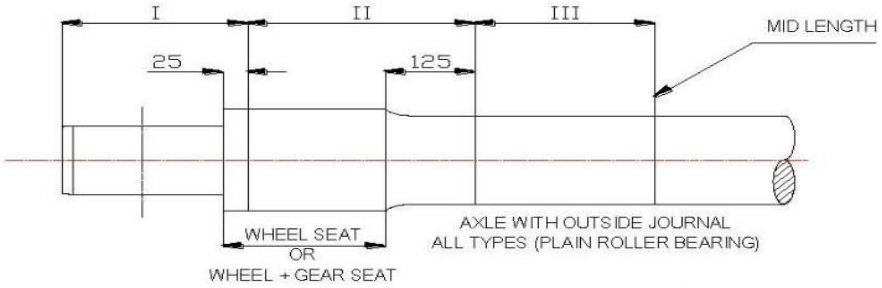


FIG. 1 (a) - ZONE DEMARCATION FOR ULTRASONIC TESTING OF ROUGH TURNED AXLES
(TO BE READ ALONGWITH THE RELEVANT AXLE DRAWING)

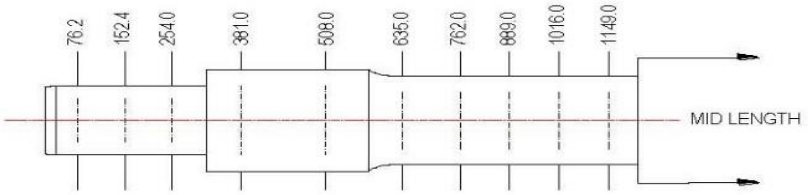


FIG. 1 (b)

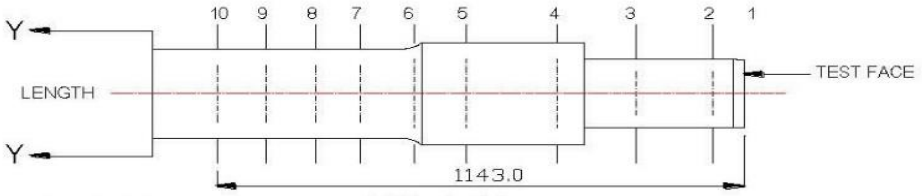
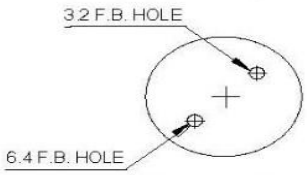
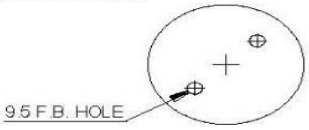


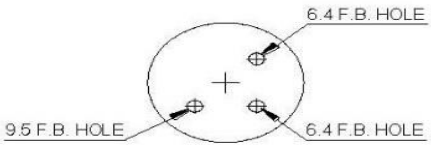
FIG. 1 (c)



END VIEW AT 381 mm



END VIEW AT 762 mm



END VIEW AT `Y Y'

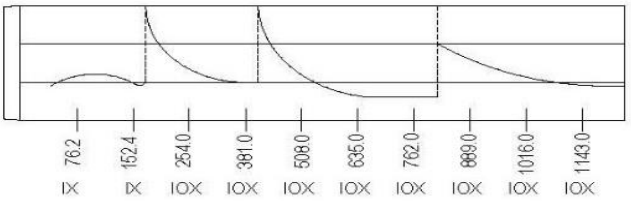


FIG. 1 (d) - EXAMPLES OF ESTABLISHING DISTANCE AMPUTUDE CURVE FOR A TYPICAL AXLE.

TABLE FOR FIG. 1 (b)

FLAT BOTTOM HOLE (mm)	DISTANCE OF FLAT BOTTOM OF THE HOLES FROM THE TESTING FACE (mm).
3.2 Ø	76.2, 152.4, 254.0
3.2 Ø & 6.4 Ø	381.0
6.4 Ø	508.0, 635.0
6.4 Ø & 9.5 Ø	762.0
9.5 Ø	889.0, 1016.0, 1043.0

NOTE:-
FIG. 1 (c) INDICATES THE LOCATION 1 TO 10 WHERE THE REFERENCE AXLE WILL BE PROGRESSEVELY SLICED AND TESTED.

METHOD OF ULTRASONIC TESTING OF AXLES

*

Signature			
Name & Designation	Vinay Kumar Yadav JE/Design/Carriage	U. P. Srivastava SSE/Design/Carriage	Prabhat R. Shukla Director/Stds./Carriage
	Prepared by	**Checked by**	**Approved by**

PROTECTION AND PACKING

NOTE :-

1. TOLERANCE ON COVER :-

DIEMSIONS	-	TOLERANCE
D1, D2, D3, & D4	-	$^{-2}_{+0}$
L1 & L2	-	$^{+0}_{-3}$
L3	-	$^{+2}_{-0}$
L4	-	$^{+0}_{-10}$
R1, R2, & D3	-	$^{+10}_{-0}$

FOR DIAMETER LENGHT AND RADIUS REFER TO CORRESPONDING DIOMENTIONS OF THE FINISHED AXLE.

2. MATERIAL FOR THE COVER SHALL BE HIGH DENSITY POLYTHYLINE TO IS:7328-74 DESIGNATED AS HDPE - 44 - MB.
3. PROTECTIVE COVERS SHALL BE CLAMPED WITH MIN.20mm WIDE STEEL STRAPS AT SUITABLE LOCATIONS WITH MINIMUM TWO STEEL STRAPS ON EACH JOURNAL & THREE ON AXLE BODY.

FIGURE - 4

FIGURE - 3

FIGURE - 2

Signature			
Name & Designation	Vinay Kumar Yadav JE/Design/Carriage	U. P. Srivastava SSE/Design/Carriage	Prabhat R. Shukla Director/Stds./Carriage
	Prepared by	**Checked by**	**Approved by**