REVISION OF SPECIFICATION / STR

Item Name: INDIAN RAILWAY STANDARD SPECIFICATION FOR AXLE FOR DIESEL AND ELECTRIC LOCOMOTIVES, EMU MOTOR COACHES AND POWERED AXLES OF RAIL CARS (Applicable to all Gauges)

Specification No. : IRS: R-43-24, November 2024

1. RDSO is reviewing the specification/STR to cater to the latest technological developments in the field, modify clauses not relevant in the present context and making them more enabling with focus on functional requirements.

2. It is requested that your comments / suggestions with regard to improvements / modifications in specification/ STR of the above mentioned item may be submitted in the following format along with the justification for the changes required.

Part A: Basic Information

SN	Particulars	Information
1.	Name	
2.	Designation	
3.	Professional Qualification	
4.	Organization / Firm's Name	
5.	Address for correspondence	
6.	Email ID	
7.	Whether firm is registered with RDSO for the subject item. If yes, details like date of registration, current status etc. If no, firm's experience in manufacturing of subject item or similar item.	
8.	Whether any technical document/ Report/ Study to support suggested changes in available/ enclosed for better appreciation.	

Part B: Comments / suggestions on the specification

SN	Clause No. of RDSO STR/ Spec	Clause, as it exists in RDSO STR/ Spec	Clause, as it should read after incorporation of comments/ suggestions in RDSO Spec / STR	Justification for changes

Comments may be sent to following address within 15 days from the date of publication on rdso.indianrailways.gov.in

Director/ MP-VDG
Research Designs and Standards Organization
Manak Nagar, Lucknow – 226011

Email: edmprdso@gmail.com, neelesh.singh811@gov.in , bmandalrdso@gmail.com

R.D.S.O

IRS R-43

भारत सरकार रेल मन्त्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

डीजल और इलेक्ट्रिक लोकोमोटिव, ईएमयू मोटर कोच एक्सल और रेल कारों के पावर्ड एक्सल के लिए भारतीय रेलवे मानक विशिष्ट

(सभी गेजों पर लागू)

INDIAN RAILWAY STANDARD SPECIFICATION FOR AXLE FOR DIESEL AND ELECTRIC LOCOMOTIVES, EMU MOTOR COACHES AND POWERED AXLES OF RAIL CARS

(Applicable to all Gauges)

Serial No. R-43-24

November 2024

अनुसंधान अभिकल्प और मानक संगठन
लखनऊ–226 011
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW - 226 011

Cost (Rs).....

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Prepared By	Checked By	Approved By

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लखनऊ–226 011
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW - 226 011

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FOREWORD

This Indian Railway Standard specification was originally issued to cover the requirements of motor driven axles of Diesel and Electric Locomotives, EMU motor coaches and powered Axles of Rail Cars. It has been revised to cover the requirement of Cardan shaft driven axles of Diesel Hydraulic Locomotives and Rail Cars also. The requirement of axles for Steam Locomotives and tenders are covered by IRS Specification No. R-18.

This Indian Railway Standard specification was first adopted in 1969. It has been improved and revised in 1992 to meet the enhanced performance requirements of locomotives. Corrigendum No. 1 was issued in January 2000 to incorporate the acceptance limit of surface and sub-surface defects in locomotive axles as Appendix-B. Further, Corrigendum No. 2 was issued in October 2013 to revise the existing acceptance criteria of ultrasonic testing. Current revision incorporates the above corrigendum of this specification and further revision of existing acceptance criteria of ultrasonic testing.

This specification is issued under the fixed Serial No. R-43; the final number indicates the year of original adaptation as standard or, in the case of revision, the year of last revision.

ADOPTED 1969, REVISED 1992 & 2024

CONTENTS

APPENDIX

REFERENCE DOCUMENTS

S. No.	Document No.	Title
1.	DIN 17200	Quenched and Tempered steels – (Technical delivery condition)
2.	IS:228	Method of analysis of steel
3.	IS:1608	Method of Tensile Testing of Steel product
4.	IS:1499	Method for Charpy Impact Test (U-Notch) for metals
5.	IS:152	Ready mixed paint, brushing, storing, lead free, for general purpose, colour, as required.
6.	IS:2074	Ready mixed paint, red oxide-zinc chrome, Priming.
7.	IS:311	Black Japan:- Type A, B & C.

INDIAN RAILWAY STANDARD SPECIFICATION FOR

AXLE FOR DIESEL AND ELECTRIC LOCOMOTIVES, EMU MOTOR COACHES AND POWERED AXLES OF RAIL CARS

(Applicable to all Gauges)

1 SCOPE

This standard covers the requirement of the following two categories of straight steel axles.

Category – A: Motor driven axles of Diesel and Electric Locomotives, EMU Motor Coaches and Rail Cars.

Category – B: Cardan Shaft driven axles of Diesel Hydraulic Locomotives and Rail Cars.

2 STEEL MAKING PROCESS

2.1 Axles of Category-A shall be manufactured from steel made by Open Hearth, Electric Basic Oxygen or a combination of these processes. The steel shall be of killed quality. In case basic oxygen process is used:

2.1.1 Nitrogen content of steel determined by analysis of finished product shall not exceed 0.007%.

2.1.2 Hydrogen content of the steel determined by analysis of finished product shall not exceed 2 PPM.

2.1.3 The manufacturer shall furnish full details of the steel making process, including subsequent refining and prior approval taken from the purchaser for use of Basic oxygen or LD steel for manufacturing of the axles.

2.2 Axles of category-B shall be manufactured from steel conforming to Grade 25CrMo4 to DIN 17200 –Nov., 1984.

2.3 Chemical Composition:

2.3.1 Ladle Analysis:

The chemical composition of steel shall be as under when analysed in accordance with IS: 228 or any other established instrumental /chemical method. In case of dispute, the procedure given in the relevant part of IS: 228 shall be the reference method. However, where the method is not given in IS: 228 and its relevant part, the reference method shall be as agreed to between the purchaser and the manufacturer.

Contents	**Category – A**	**Category – B**
Carbon	0.40 – 0.55 %	0.22 – 0.29 %
Manganese	0.60 – 0.90 %	0.60 – 0.90 %
Sulphur	0.05 % max.	0.03 % max.
Phosphorus	0.045 % max.	0.035 % max.
Silicon	0.15 % min.	0.15 – 0.40 % max.
Chromium	--	0.90 -1.20 %
Molybdenum	--	0.15 – 0.30 %

2.3.2 Check Analysis:

Permissible variation in case of check analysis over the limits specified in clause 2.3.1 shall be as under:

Contents	**Category – A**	**Category – B**
Carbon	± 0.03 %	± 0.02 %
Manganese	± 0.03 %	± 0.04 %
Sulphur	+ 0.005 %	+ 0.005 %
Phosphorus	+ 0.005 %	+ 0.005 %
Silicon	- 0.02 %	+ 0.03 %
Chromium	--	- 0.105 %
Molybdenum	--	± 0.03 %

NOTE: The variations may occur either below or above the individual elements ranges but shall not be applied both above and below the specified range for any one element in anyone cast of steel.

2.4 Discard:

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

3 MANUFCTURING PRACTICES:

3.1 The forged axles shall be manufactured from ingots rolled down to bloom size but shall be finally shaped to profile by forging only under a hammer or press. The forging profile shall generally follow the contour of the rough machined axles (as given in relevant drawings) with adequate machining allowances. The minimum cross section of ingot shall not be less than twice the maximum cross section of bloom and minimum cross section of bloom shall not be less than twice the maximum cross section of axle.

3.2 In case the axles are manufactured direct from ingots by forging under a hammer or press only, the minimum cross section of the ingot shall be not less than three times the maximum cross section of the axles. The forging profile shall be as described in Clause 3.1 above.

3.2.1 Axle can also be manufactured with a lower reduction ratio of forging provided the minimum section of the bloom is at least 1.5 times the maximum section of the axles and the minimum section of the ingot is at least five times the maximum section of the rolled/forged axles.

3.3 Cooling:

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

3.3.2 The cooling of axles after forging operation shall be controlled by a suitable method as mutually agreed to between the Purchaser and supplier.

3.4 Heat Treatment:

While Category-A axles shall be either normalized or oil hardened and tempered, Category-B axles shall be oil hardened and tempered to achieve the desired mechanical properties.

4 QUALITY OF MATERIAL

4.1 The axles shall be sound throughout and without cracks, inclusions, flows, burrs, lack of metal, laps or any harmful defect detrimental to their functions and shall be supplied to the prescribed dimensions and tolerances.

5 BRANDING

5.1 Each axle shall be legibly stamped after forging at a suitable location for identification. The axles after machining, shall be stamped with an identifying cast number, manufacture's code, month, year of manufacture and such other marks as may be shown on the drawings or otherwise specified by the Purchaser. The branding shall be with the letters of at-least 6 mm in height.

6 SELECTION FOR TESTS

6.1 The axles shall be submitted in identifiable batches of a maximum of 60, each batch containing axles from only one cast and heat treated in a similar manner. The selection for testing as specified in clause 7 shall be at the rate of one axle per batch or part thereof.

6.2 If less than 15 axles are made from one cast of the same heat treatment batch, the test requirements shall be either:

6.2.1 One axle tested in accordance with clause 7.

Or

6.2.2 The manufacturer shall leave an extra length of the same diameter as that of forged end of the axle on 50% of the axles (subject to a minimum of 5 nos.) so as to enable the Purchaser or his Inspecting officer to select and cut one such coupon tor tensile test, cold bend test, Charpy Impact test and macro-examination as specified in clauses 7.2, 7.3, 7.4 and 9.4 respectively.

6.3 The Purchaser or the Inspecting officer shall select and test such of the axles as he may think proper to the extent of the number specified above. Proper cast identification shall be maintained at the Ingot and bloom stages. The axles tested shall be correlated and considered to represent the average quality of the axles of the lot produced from the same cast from which they were selected. After selection of the axles tor testing, each test axle shall comply with the following tests without further re-heating or any other manipulation whatsoever, either of the axle selected for testing or any portion selected therefrom to prepare the test pieces.

7 MECHANICAL TESTING

7.1 From the test piece selected in accordance with clause 6, following test pieces shall be cold machined in the longitudinal direction. The test pieces shall be taken from the wheel seat location of the axle or the test prolongation as the case may be as shown in Figure-1.

7.1.1 Tensile test piece shall be round and of standard proportion in accordance with IS:1608, having a gauge length equal to $5.65\sqrt{A}$, where A is cross sectional area of the test piece.

7.1.2 The cold bend test piece 250 mm x 52 mm sq. with corners rounded off with 1.6 mm radius shall be machined from positions adjacent to tensile test piece.

7.1.3 Charpy Impact test piece shall be of square section, 10 mm x 10 mm, in accordance with IS:1499. The depth of 'U' notch shall be 5 mm. (See Figure-1)

7.2 Tensile Test :

Tensile test shall be carried out in accordance with IS: 1608. Tensile strength, yield stress and percentage of elongation obtained from the test piece shall be the follows:

		Category – A	**Category – B**
7.2.1	Tensile strength	570 N/mm2 (Minimum) 685 N/mm^2 (Maximum)	650 N/mm2 (Minimum) 800 N/mm^2 (Maximum)
	Yield Stress	Not less than 50% of Tensile Strength	400 N/mm^2 (Minimum)
	Elongation	Minimum of 21% and 17% corresponding to 570 and 685 N/mm^2 Tensile strength respectively	18% Minimum
	Reduction in Area After fracture % min.	--	60%

7.2.2 Intermediate elongation shall correspond to tensile strength occurring within the permissible range.

7.3 Cold Bend Test:

Cold bend test piece (7.1.2) shall be bend cold by direct pressure from a tool 50 mm wide and having 50 mm diameter at the thrust end, until the sides of the test piece are parallel. The test piece shall not show any sign of fracture.

7.4 Charpy Impact Test:

Charpy Impact (U-Notch) test can be carried out in lieu of cold bend test in accordance with IS: 1499. The minimum impact strength obtained shall be:

Condition	**Category – A**	**Category – B**
Normalised	KU 20J	--
Hardened and tempered	KU 35J	KU 40J

8 TEST BY CHEMICAL ANALYSIS:

8.1 The sample shall be taken for analysis by the Purchaser or the Inspecting Officer from one axle from every heat, or from one axle in every 60 in case there are more than that number in the cast or as specified in clause 6.2.2 if less than 15 axles are made from one cast. The chemical analysis shall be carried out in accordance with IS: 228.

9 OTHER TESTS :

9.1 Magnetic Particle Test:

All axles (in proof machined or fully machined and heat treated condition) shall be tested by the Magnetic Particle Method both in longitudinal and circular magnetization shall not reveal any harmful surface defects. The axles revealing harmful surface defects shall be rejected. The acceptance standards shall be as given in Appendix B.

9.2 Ultrasonic Test:

All axles conforming to the stipulation of clauses mentioned above shall be subjected to Ultrasonic test and those passing the test shall be accepted. The method of testing and acceptance standards shall be as given in Appendix – A.

9.3 Microscopic Examination:

9.3.1 The transverse section of the gripping portion of tensile test piece shall be examined under microscope. The test piece of Category-A axle in normalized condition shall generally show well defined uniform fine grained structure comparable with ASTM grain size No. 8 and shall not be coarser than grain size No. 6.

The test piece of Category-A axles in hardened and tempered condition and Category-B axle shall show well defined fine tempered martensite structure and shall not show undesirable ferrite patches.

9.3.2 Longitudinal section of the gripping portion of tensile test piece on microscopic examination shall not show any banding.

9.3.3 A specimen, representing each size classification per cast and per heat treatment batch shall be selected for microscopic examination from the tensile test specimen. The specimen for microscopic test shall be cut from the large undistorted portion of the tensile test specimen in such a way as will give a face transverse to the axis of the axle.

9.4 Macro Examination:

9.4.1 Macro-examination shall be conducted on the transverse cross section of the representative sample cut from the test prolongation (extra length) of the axle selected as per clause 6, by deep etching in 50, hydrochloric acid. The section of the sample if taken from the axle shall be from the thickest portion.

9.4.2 Sample shall not show presence of harmful defects such as remnant of piping, harmful segregation and non-metallic inclusion etc.

9.4.3 The sampling plan for macro examination shall be one test per cast per heat treatment batch.

10 ADDITIONAL TESTS :

10.1 If so desired by the Purchaser/Inspecting Officer, sulphur prints of the transverse sections cut from the test prolongation (extra length) or the axle selected as per clause 6 shall be carried out to ensure freedom from sulphur segregation and other defects. The sample shall be free from harmful segregation, inclusions etc.

11 RE-TESTS :

11.1 Should a tensile, cold bend test or impact test piece fail to meet the requirements of clause 7 or micro-structure be found unsatisfactory and the purchaser or the Inspecting Officer considers that the fractured test piece or its micro-structure does not fairly represent the quality of the batch, two further test pieces shall be taken for repeating the test in respect of the same batch in which failure occurred. As an alternative to double retesting or should either retest fail to meet the requirements, the batch of axles together with the test samples, may, with the agreement of the Purchaser or Inspecting Officer, be re-heat-treated and re-submitted for testing in accordance with clause 6.

11.2 In case of axles re-heat-treated to meet the requirement 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.

11.3 The axle shall not be re-heat-treated more than twice over and above the original heat-treatment.

12 MACHINING OF AXLES :

12.1 Axles shall be delivered rough turned or machined to drawing as required by the Purchaser. The rough turned/machined portion shall be concentric with the un-machined portion of the axle. The axles shall be free from injurious tool marks.

12.2 Axles shall be roller burnished at portions, if so specified on the relevant drawings, by following process:

12.2.1 Turned with fine feed and subsequently burnished by revolving hardened rollers.

12.2.2 Turned, ground and then burnished by revolving hardened rollers.

12.2.3 Turned with a skin cut using a broad-faced spring tool with a suitable lubricant and then burnished by revolving hardened rollers.

12.3 Lathe Centres:

Permanent lathe centers shall be smooth and accurately machined and truly in line with the centre of the axle, shall be provided in the ends of the axle. The centres shall be of the form shown in Figure-2. The included angle shall be 60^0 unless otherwise specified.

13 SAMPLE AXLE:

13.1 A sample axle of each kind, finished complete, shall be approved by the Purchaser or the Inspecting Officer before the general execution of the order is proceeded with and the whole supply must be in accordance with the approved sample (s).

14 INSPECTION:

14.1 The Purchaser or the Inspecting Officer 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 Purchaser or the Inspecting Officer shall have the power to mark or deface in some easily distinguishable manner all rejected axles, but they shall not be marked or defaced in such a manner as to render them unsaleable to other parties.

14.2 Power shall be reserved to the Purchaser or the Inspecting Officer to be present at, and take such part as he thinks fit, in all tests such as macroscopic examination, sulphur print test and microscopic examination etc. which the manufacturer may carry out for his own purpose or under the terms of this specification, both of the axles and of their materials, in all stages of manufacture.

15 TESTING FACILITIES:

15.1 The manufacturer shall supply the material required for testing free of charge, 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 in his own premises in accordance with this specification. Failing facilities at his own works for making the prescribed tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

16 GUARANTEE:

16.1 The axle shall be guaranteed by the supplier for four years against any defect imputable to the manufacture and not revealed during acceptance at the works.

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

16.3 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.

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

16.5 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.

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

17 PROTECTION AND PACKING:

17.1 After inspection and approval, the axles shall be carefully protected with three coats of bituminous paint to IS:152 or with any other approved anti-rust compound, easily removable with kerosine or white spirit, allowing sufficient drying time between each coat. After the coat has dried, the journals, wheel and gear seats, wherever relevant, shall be covered with water proof paper and gunny cover tied with jute string. The Journals, wheel and gear seats shall, then be further protected with well fitted and tightly bound wood lagging or by any other approved material. The wood used shall be dry and shall be held in place either by hoop iron bands or by steel wire not less than 1.6 mm in grooves cut in the periphery of the protecting, wood pieces.

17.1.1 For roller bearing axles; the ends shall be protected by mild steel plate about 5 mm thick and 25 mm larger than journal diameter screwed or secured in position by a method approved by the Purchaser or the Inspecting Officer.

17.2 Axle middle except for gear seat locations of finished axles shall be painted with one cost of zinc chromate primer to IS: 2074 followed by a second coat of black Japan to IS: 311, proper time for drying shall be allowed between the coats. All parts must be cleaned and free from rust and moisture at the time the coating is applied.

APPENDIX-A
(Ref: Clause 9.2)

Ultrasonic Inspection of New axles in Rough Turned / Finished or both for Railway Rolling Stock (Traction & Trailing) – Method of Testing and Acceptance Standard.

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 (locomotive, EMU, Carriage & Wagon) as stipulated in the relevant IRS Specification, for axle.

A-2 PURPOSE:

The axles shall be evaluated for

A-2.1 End-face to end-face penetrability.

A-2.2 Detecting discontinuities which may be harmful to the axle service.

A-2.3 Longitudinal discontinuity detection.

A-3 EQUIPMENT:

A-3.1 The instrument used must be of the pulse echo type.

A-3.2 The instrument shall be operated at 2 to 2.5 MHz for penetrability test, transverse discontinuity detection and longitudinal discontinuities.

A-3.3 The instrument may be used with various types of transducers namely, Bariumtitanate, PZT, Lead netaniobate etc. of 20 to 26 mm dia. or equivalent area probe, at the option of the axle manufacturer. 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

The axles shall be ultrasonically inspected after the stipulated heat treatment and machining of the end faces to a finish better than 6.35 µm.

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 the relevant IRS specification for axle. The block shall be approximately 406 mm long. The two end faces shall be machined parallel to a finish better than 6.35µm. The reference standard shall be at 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 20% from the reference hole When probed from the opposite end face.

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 40% 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/ Inspecting Officer, re-heat-treat the axles and re-submit for this test. Re-heat-treated axles shall conform to the stipulations of "Re-test" clause in the relevant IRS specification for axles.

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 tables-

Distance in mm	380	750	Over 750
Dia. of flat bottom hole (mm)	3.2	6.4	9.5

A-6.2.2 The depth range of the instrument shall be set to cover half the length of axle under test. The axles shall be scanned alternatively from both the end faces covering the maximum end face area possible either 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 sizes 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 Figure-3 for identification of the zones.

A-6.2.4 The amplitude of all discontinuity indications shall be evaluated with respect to distance from the test surface by utilising either an in-built Distance Amplitude Correction electronic device if provided in the instrument or by establishing Distance Amplitude correction (DAC) Curve 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 400 mm depth range (longitudinal wave) with the help of a piece of wheel seat of one of the axles of type to be tested or piece of any other axle of approximately 260 mm diameter, conforming to IRS-R-43. The approximate thickness of axle piece will be 150 mm. A 3.2 mm diameter flat bottom hole of length 25±2 mm shall be drilled such that axis of the hole passes through the centre of the axle. The sketch of standard block thus to be made is given in Figure-4. One normal (0^0) probe fitted with perspex block having concave curvature of diameter approximately corresponding to the axle diameter shall be used. Place the probe on the periphery of the axle piece at a location away from the flat bottom hole. Adjust the depth & delay control knob of the flaw detector so that on-set of the back-wall echo from opposite surface shall appear at approximately 6.5 horizontal main scale division such that each division corresponds to 40 mm for longitudinal wave.

A-6.3.2 Sensitivity Setting: - Place the 0^0 probe fitted with perspex to the diametrically opposite side of the flat bottom hole. An echo at approx. 6.0 horizontal scale division will appear on the screen. Adjust the gain level to achieve the echo height to 60% of the vertical scale. This gain level should not be changed during actual testing of axle.

A-6.3.3 Acceptance criteria: No flaw echo with an amplitude of 60% or more in conjunction with the following shall be permitted.

a) Flaw of any length located between surface and 1/3 radius from centre of the axle as shown in Figure-5.

b) A longitudinal defect of 50 mm and above located between centre and 1/3 radius of axle covering the journal length.

A-7 Distance Amplitude Correction (DAC) Curve

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 electronic distance amplitude correction device or establish DAC 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 the specific equipment and transducer combination used.

A-7.1.1 For establishing DAC for the three zones, indicated in Figure-3, 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 curve 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, vis. 3.2, 6.4 and 9.5 mm dia., respectively, drilled perpendicular to one of the end-faces and at mid-radius suitably dispersed around the centre. Scanning should be done from the other end face and the amplitude of the indications noted down. 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 reference holes.

A-7.1.3 An example of establishing a typical DAC as per above two methods is given in Figure-6a & 6b.

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.

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:

Axles that conform to the above ultrasonic stipulation shall be stamped ‘UT’ on the end face which contains the axle identification marks, adjacent to heat number or Sl. No.

APPENDIX – B
(Ref: Clause 9.1)

Acceptance Limit of Surface and Sub-Surface Defects in Locomotive Axles

Nature of defects:- seams, hairlines, stringers, shadow, ghost lines etc.

Stage/Condition for examination:- Proof machined or fully machined.

B-1 Imperfections not acceptable:

a) On any part of axle:

Transverse/ circumferential seams, cracks or laps of any depth (indeterminate) on axle surface.

b) On machined fillets:

Besides above, longitudinal discontinuity (hairlines, stringer, fine seam) in machined fillets are not acceptable.

B- 2 Acceptable limits of other discontinuities:

a) Journals:

Fine longitudinal discontinuities on surface (hairlines, stringer, fine seams) if,

i) Not extended on fillets.

ii) Less than 12 mm individually.

iii) Total length of imperfection of 6-12 mm size not exceeding 40 mm.

iv) Not more than 2 defects of 6-12 mm within 75 mm.

b) Wheel & Gear seats:

Longitudinal discontinuity (hairlines, stringers. fine seams, tight seams) if,

i) Not present within 40 mm of wheel/gear seat ends.

ii) Individually not more than 12 mm.

iii) Total length of discontinuities (6-12 mm) not more than 75 mm

c) Body:

Longitudinal discontinuities (hairlines, stringer, fine seams) if,

i) Not extended to filets of wheel / gear seat.

ii) Individually not more than 12 mm.

iii) Total length of discontinuity not to exceed 40 mm in any 300 mm.

iv) Discontinuity more than as indicated in (ii) & (iii) above to be reconditioned.

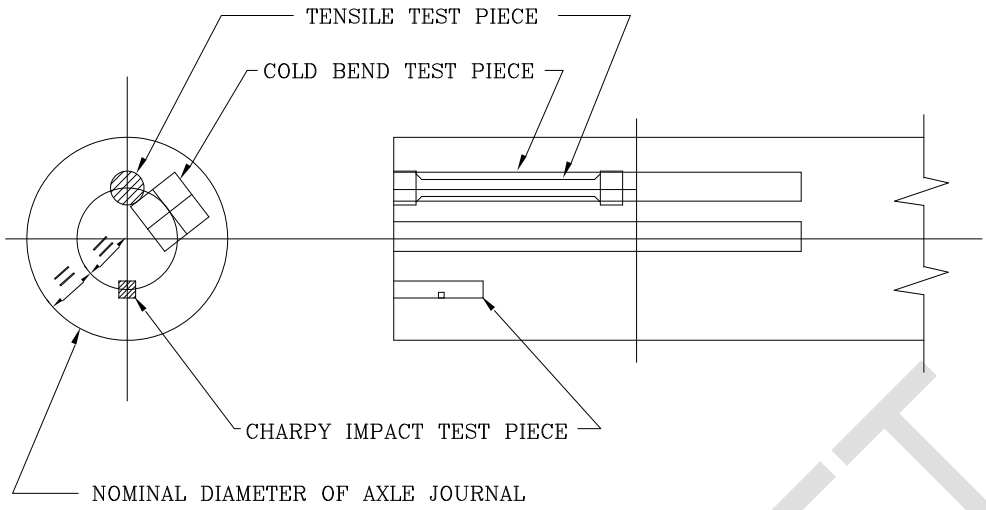


FIGURE-1

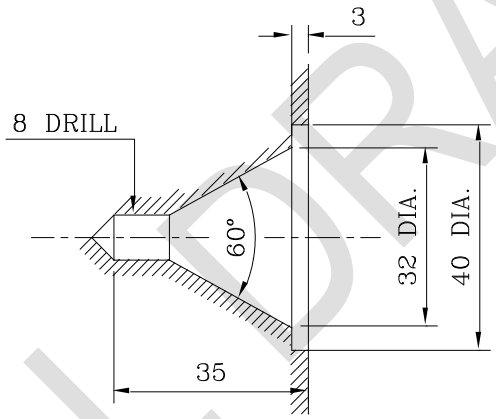
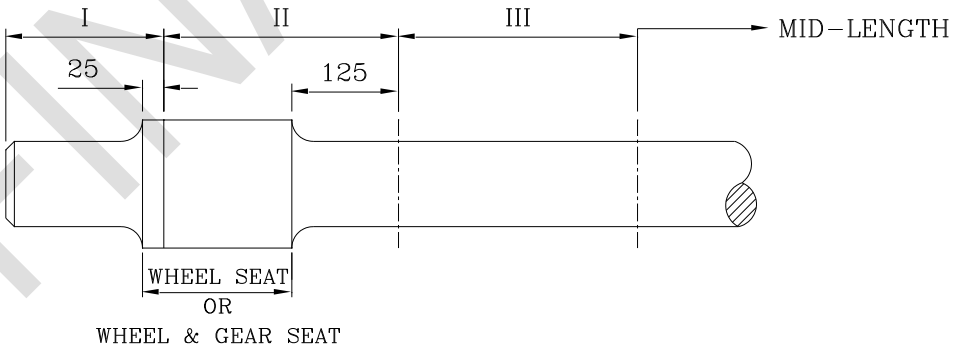


FIGURE-2



AXLE WITH OUTSIDE JOURNAL ALL TYPES (PLAIN/ROLLER BEARING)

ZONE DEMARCATION FOR ULTRASONIC TESTING OF PROCURED AXLES
(TO BE READ ALONG WITH THE RELEVANT AXLE DRAWING)

FIGURE-3 (APPENDIX-A)

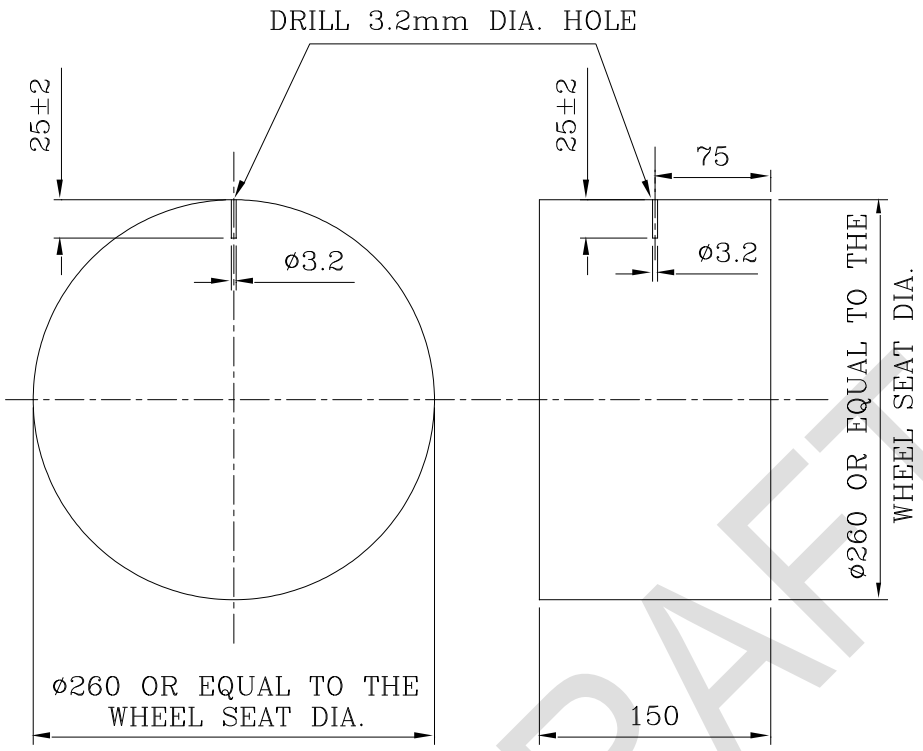
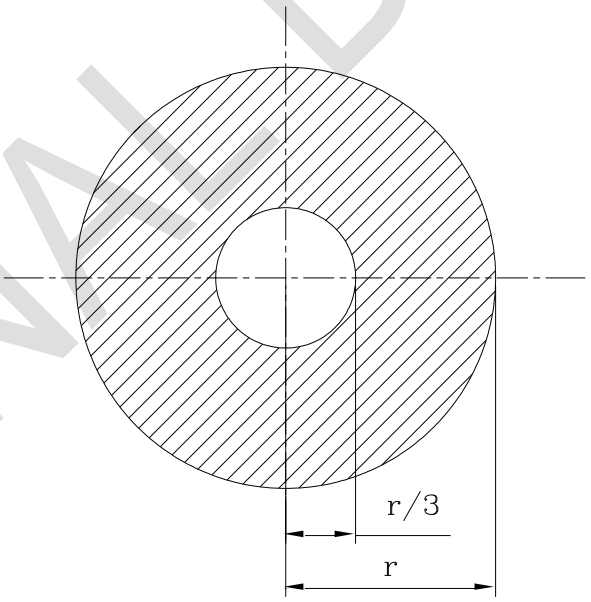


FIGURE-4 (CLAUSE A-6.3.1)



DEFECT WITH AMPLITUDE OF 60% OR MORE FOR ANY LENGTH IN SHEDED ZONE IS CAUSE FOR REJECTION

FIGURE-5 {CLAUSE A-6.3.3 (a)}

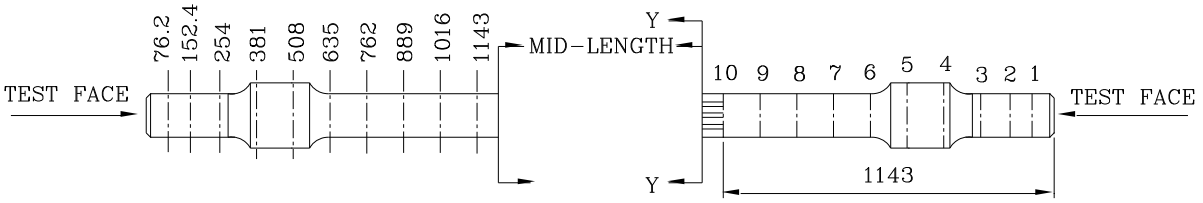


FIGURE-6a **FIGURE-6b**

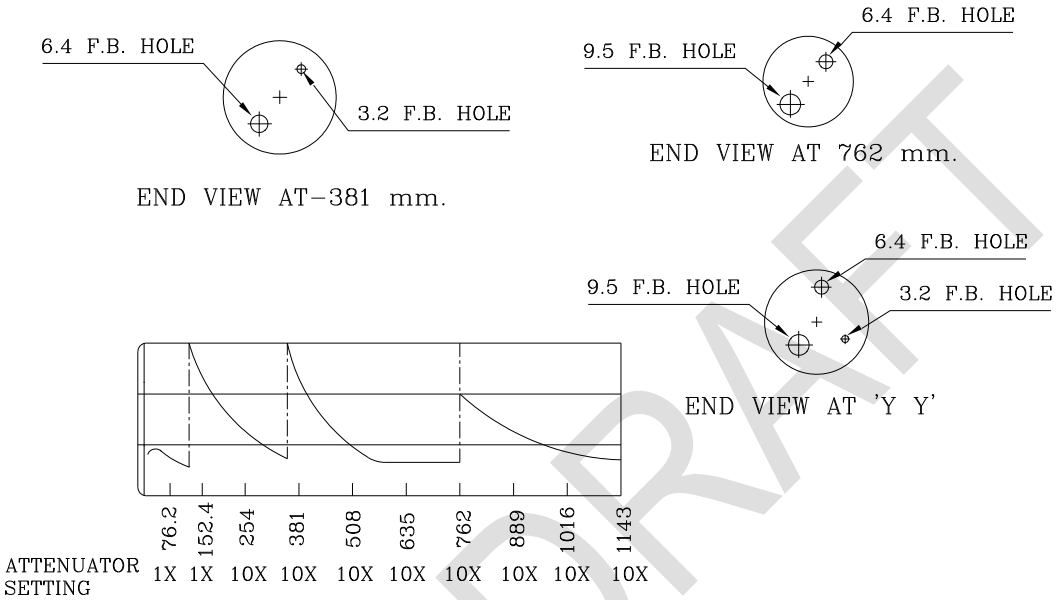


FIGURE-6c

FIGURE-6a, 6b,6c EXAMPLE OF ESTABLISHING DISTANCE-AMPLITUDE CURVE FOR A TYPICAL AXLE

TABLE FOR FIGURE-6a

FLAT BOTTOM HOLE (mm)	DISTANCE OF THE FLAT BOTTOM OF THE HOLES FROM THE TESTING FACE (mm)
Ø 3.2	76.2, 152.4, 254
Ø 3.2 & 6.4	381
Ø 6.4	508, 635
Ø 6.4 & 9.5	762
Ø 9.5	889, 1016, 1143 – This applies to axles having half axle length up to 1143mm. If half axle length is more than 1143mm, then additional piece equal to half length of axle shall be prepared. e.g. if axle length is 2560mm i.e. half-length 1260mm (which is greater than 1143mm), then additional piece of 1280mm with 9.5 mm dia FBH shall be prepared.

NOTE:- FIGURE-6b INDICATES THE LOCATIONS 1 TO 10 WHERE THE REFERENCE AXLE WILL BE PROGRASSIVELY SLICED AND TESTED.

FIGURE-6 (APPENDIX-A)