R.D.S.O

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भारत सरकार, रेल मन्त्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

डीज़ल एवं विद्युत रेल इंजनों के ठोस रोल्ड मल्टिपल - घिसाव वाले पहियों के लिए भारतीय रेल मानक विशिष्ट

(सभी गेजों के लिए लागू)

INDIAN RAILWAY STANDARD SPECIFICATION FOR SOLID ROLLED MULTIPLE WEAR WHEELS OF DIESEL AND ELECTRIC LOCOMOTIVES

(Applicable to all Gauges)

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FOREWORD

This IRS specification was first adopted in 1969. It has been improved and revised in 1981, 1996, 1999 & 2003 to meet the enhanced performance requirements of locomotives. The current revision of 2009 incorporates revisions arising out of further advancements in technology of wheel manufacture, particularly those adopted by established OEMs.

This specification is issued under the fixed serial no. R-34 and the final number indicates the year of original adoption as standard or in case of revision, the year of latest revision.

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INDIAN RAILWAY STANDARD SPECIFICATION FOR SOLID ROLLED MULTIPLE WEAR WHEELS OF DIESEL AND ELECTRIC LOCOMOTIVES

(Applicable to all Gauges)

1. SCOPE

1.1 This standard covers the requirements of heat treated solid rolled multiple-wear wheels for Diesel and Electric locomotives of all gauges.

1.2 Any special requirements given in the relevant drawings will override this specification.

2. MANUFACTURE

2.1 Process of steel manufacture

The wheels shall be manufactured from steel made by Electric, Basic Oxygen or any other process recognised as equivalent by the purchaser. The steel shall be of killed quality.

.1 Hydrogen Content

The steel shall be vacuum degassed and hydrogen content in liquid steel shall not be more than 2.5 PPM. Hydrogen analysis shall be done as given in Para 2.1.2 & 2.1.3.

.2 Sampling for Hydrogen Analysis

The sample of liquid steel should be taken from ladle by plunging the sampler 300 mm below the molten metal-slag interface. The sample should be held 2-3 seconds and then quenched in cold water so that the sample temperature falls below 150°C within 5 seconds.

The sample should be removed from cold water and immediately packed in dry ice or liquid Nitrogen. The sample should be analysed within 48 hours and till the time of analysis, the sample should continuously be fully covered by dry ice / liquid Nitrogen.

Sampling should be done by 6 mm diameter tube of Pyrex glass or ceramic which does not react with steel. General wall thickness of the tube should be 1.5 mm and at the fill end 0.5 mm approx. The tube should be under vacuum of 10^{-3} bar (0.76 mm of Hg).

Any other method of sampling should have a prior approval of the purchaser.

.3 Hydrogen Analysis

The analysis of sample should be done by Inert Gas Fusion technique in which sample is fused at around 1900°C in induction heating crucible. A Nitrogen carrier gas transports the released Hydrogen to a thermal conductivity cell. The amplified and integrated output of the cell is to be calibrated for Hydrogen in PPM.

A Leco-RH-3 Hydrogen analyzer, Hydris system or similar precision equipment may be used for Hydrogen determination.

Any other method for Hydrogen Analysis should have a prior approval of the purchaser.

2.2 Chemical composition

.1 Ladle Analysis

The ladle analysis of steel, when carried out by the method specified in relevant parts of IS: 228[1] (latest versions) or any other established instrumental / chemical method, shall be as follows:

Elements	Permissible Percent	
Carbon	0.57 to 0.67	
Manganese	0.60 to 0.85	
Silicon (Min.)	0.15	
Phosphorus (Max.)	0.03	
Sulphur (Max.)	0.03	
Chromium (Max.)	0.25	} Combined 0.50% (Maximum)
Nickel (Max.)	0.25	
Copper (Max.)	0.28	
Molybdenum (Max.)	0.06	
Vanadium (Max.)	0.10	
Aluminum (Max.)	0.02 * (preferable)	* Aluminum upto 0.03% (max.) is permitted provided that the manufacturer ensures Al inclusions (non-metallic) to not worse than 1.5 for both thick and thin series.

In case of dispute, the procedure given in IS: 228[1] and its relevant parts shall be the reference method. However, where the method is not given in IS: 228 and its relevant parts, the reference method shall be as agreed between the purchaser and the manufacturer.

.2 Product Analysis:

The product analysis is to be carried out as laid down in Clause 11. The permissible variation from the limits specified in Clause 2.2.1 shall be as follows:

Elements	Variation Percent	
Carbon	+ 0.03 / - 0.02	
Manganese	± 0.03	
Silicon	- 0.03	
Phosphorus	+ 0.005	
Sulphur	+ 0.005	
Chromium, Nickel & Copper	+ 0.05	
Molybdenum & Vanadium	+ 0.02	
Aluminum	+ 0.002 **	** Aluminium content in product analysis upto 0.03% (max.) is permissible including this variation

1 *Method for chemical analysis of steel*

2.3 Discard

Sufficient discard shall be made from both ends of each ingot to ensure freedom from piping and undesirable segregations.

2.4 Manufacturing practice

.1 The wheels shall be manufactured by forging and rolling process from cropped ingots or from blooms produced by continuous casting process, in such a manner that the central axis of the ingot or the bloom coincides with the axis of the wheel. Each ingot or bloom shall be of suitable section and length to produce two or more wheel blanks after top & bottom discards have been made to eliminate the defective portion completely.

.2 The steel shall be refined in the ladle furnace and vacuum de-gassed. Suitable shrouding arrangements from the ladle to tundish and from tundish to mould shall be made.

.3 The minimum cross section of the cropped ingot or continuously cast bloom shall be such that a minimum reduction ratio of 4:1 is obtained with the maximum wheel section at rim portion. That is, the original height of cropped ingot piece should be at least 4 times the height of rough wheel at rim.

2.5 Cooling

.1 During manufacture, necessary care in regulation of temperature shall be exercised to obtain the best physical properties expected from the chemical composition & mechanical work and to achieve the desired microstructure.

.2 After the last hot forming operation i.e. dishing and coning, all wheels shall be slowly cooled, protected from draft of air or handled in such a manner so as to prevent injury by rapid cooling below the critical range.

.3 Optimised cooling regime should form part of a documented Quality Assurance Plan (QAP).

2.6 Heat treatment

The heat treatment shall consist treatment of only rim by way of rim quenching and subsequent wheel tempering. While employing water spraying during rim quenching, care should be taken to prevent access of cooling medium to the web.

.1 **Rim Quenching treatment**: This treatment entails heating the wheel for a sufficient time to bring it uniformly to a temperature of at least 825°C and then hardening the rim with jets of water under pressure followed by wheel tempering to a temperature of 480°C to 520°C. The wheel is then left to cool in still air preferably in a covered cooling pit or under cover. However, this heat treatment schedule is indicative only meant for guidance. The firm shall determine their heat treatment schedule on the basis of chemical composition of the metal and their laid down heat treatment process approval plan. The firm shall clearly bring out their heat treatment schedule in the QAP.

3. QUALITY OF MATERIAL

The wheel shall be free from cracks, surface flaws, laminations, inclusions, laps, hydrogen flakes and all other harmful defects.

4. DIMENSIONS AND TOLERANCES

4.1 The wheels shall be accurately machined to the dimensions and tolerances shown in the relevant drawings. When maximum weight of the finished wheel is shown in the drawing, the tolerances indicated should be worked to close limits so as not to exceed the specified weight. Any wheel not cleaning up perfectly true in the lathe shall be rejected.

4.2 The radii at junction of the web with rim and web with hub on both sides shall be machined without leaving black spots so as to blend smoothly with the web, as shown in the relevant drawings. Any hole indicated in the drawing shall also be machined and flame cutting shall not be resorted to.

4.3 Permissible variation in the dimensions where tolerances are not given in the individual drawing(s) shall be as follows:

.1 **Thickness of rim**: The radial thickness of the rim shall not vary more than 3mm around the wheel circumference.

.2 **Plane of back / inside face**: When wheels are gauged with a straight edge applied to back face of the rim, no point on back face of rim shall be more than 1mm from the straight edge.

.3 **Hub wall thickness**: The thickness of the hub wall measured at any two points, equidistant from the face of the hub, shall not vary by more than 2 mm.

.4 **Rotundity**: Tread when gauged with a ring gauge, must not have opening over 0.5mm between the tread and the gauge at any point.

.5 **Diameter of bore**: The diameter of rough finished bore shall not vary by more than 2mm from the dimension shown in the relevant drawing.

.6 **Eccentricity**: Eccentricity between the rough bore and tread, measured in the plane of taping line shall not exceed 3 mm.

.7 The difference between the minimum and maximum thickness of web at any given radius shall not be more than 1.5 mm.

5. BRANDING

Each wheel shall be legibly stamped on the outside face of hub as indicated in DDO-208 (latest alteration).

6. SAMPLING AND ORDER OF TESTS FOR ACCEPTANCE

100% wheels shall be checked for appearance, dimensions, branding particulars, hardness at outside face of the rim, ultrasonic testing and magnetic particle test. For other tests i.e. destructive tests, following provisions shall be applicable.

6.1 Lot Size

Lot size will be 150 or less. The wheels of a lot shall be from the same cast and heat treatment batch.

6.2 Sample for destructive tests

Random sampling shall be followed with the sample size as given below:

.1 Sample size will be 2. Selected wheels shall pass the outside hardness test as specified in Clause 7.1. Wheels selected for destructive testing may be in unmachined or

machined condition at discretion of the manufacturer. If the selected wheels are in unmachined condition, the surface should be prepared by grinding for hardness measurement.

.2 One wheel out of the sample drawn at Clause 6.2.1 above will be used for the test stipulated in Clause 8 after those wheels have passed the test stipulated in Clause 7.1. The wheel so selected shall pass the test specified in Clause 8.

.3 Another wheel from the sample of wheels at Clause 6.2.1 shall be used for falling weight test stipulated as per Clause 9 after it has passed the test stipulated in Clause 7.1. The wheel so selected should pass the test specified in Clause 9. Thereafter, the sample for tests stated in Clauses 7.2, 10, 11, 12 and 13 shall be prepared from the same wheel subjected to falling weight test.

6.3 Order of the tests

Wheels of the above sample shall be subjected to the tests stipulated in Clauses 7.1, 8, 9, 7.2, 10, 11, 12 and 13 in that order. Preferably, the destructive tests should be conducted in un-machined condition of the lot, after duly preparing the surface of the sample wheels for hardness test as per Clause 7.1. This is to avoid any likely damage to the surface if reheat treatment is required.

7. BRINELL HARDNESS TEST

Brinell Hardness test will be conducted with 10 mm diameter ball & 29.42 kN force (3000 kg load) combination as per IS:1500[2] (latest version). Any other method will require purchaser's or his inspecting officer's prior approval.

7.1 Hardness on outside face of the rim: This test will be conducted on all wheels after machining to the size as per the drawing. The hardness of the rim shall be measured at the following locations:

i. **At a depth of 30 mm from the tread on the outside face of the rim**: The hardness at this location shall not be less than 300 BHN.

ii. **On the outside face of the wheel with edge of impression not less than 12 mm from the chamfer joining the face and tread:** The hardness at this location shall be higher than 300 BHN but less than or equal to 341 BHN such that the hardness value specified under Para 7.1 (i) can be ensured.

7.2 Hardness Test on Cut Section: Hardness survey shall indicate a smooth transition from the radius face to the tread face. Any decarburised metal shall be removed from the outside face of the rim at a point chosen for measurement of hardness number. A cut section of wheel as shown in Fig.1 shall be prepared for the purpose of conducting hardness survey. The surface shall be properly prepared to permit accurate determination of hardness.

Note: The test piece should preferably be saw cut. Should flame cutting be employed, sufficient discard should be made during shaping so as to eliminate the heat-affected zone.

.1 The hardening effect will be as shown in Fig.1 with Brinell Hardness Number showing a minimum of 300BHN at 30 mm from tread surface (end of shaded area). The hardness

2 *Method for Brinell Hardness Test for metallic materials*

survey shall indicate a smooth transition from interior of the wheel to the tread surface (341 BHN maximum) in vertical direction.

8. VERIFICATION OF RESIDUAL STRESS

8.1 The residual stresses occurring in rim quenched wheels shall be compressive in nature.

8.2 Two datum points 100 mm apart shall be marked in the centre of thickness of rim on the flat surface on the side opposite to the flange. A radial saw cut from the top of the flange to the bore shall then be made half way between the two datum marks. Flame cut can be permitted provided the manufacturer establishes that this is practice followed by them for all locomotive wheels successfully. If the flame cut is not an established process for the manufacturer yet, the process may be approved by evaluating and comparing the residual stresses with flame cut and saw cut techniques side by side. The distance between the datum marks shall then be measured.

The reduction in distance between the datum marks should be greater than or equal to 1 mm.

9. FALLING WEIGHT TEST

9.1 The falling weight test shall be carried out in presence of the inspecting officer at the works of the manufacturer.

9.2 The wheel shall be placed flat upon a circular ring of metal, bearing only upon the rim portion of the wheel which in turn shall be resting upon a block of metal of weight not less than 5 tons supported on a rigid concrete or other solid foundation and shall withstand, without fracture, three blows from a falling weight of one ton. The weight shall be allowed to fall freely on the boss from a height of 3 m in case of wheels of 840 mm tread diameter & above, and from a height of 1.5 m in a case of wheels less than 840 mm tread diameter.

10. TENSILE TEST

10.1 The test pieces shall comply with the specified test requirements. The tensile test shall be carried out in accordance with IS: 1608[3] (latest version) using standard proportional test piece having a gauge length equal to $5.65\sqrt{A}$, where A is the cross sectional area of the test piece. Two test pieces shall be taken from the test wheel from position 1 & 2 shown in Fig. 2.

10.2 **Tensile strength at rim**: It shall not be less than 980 MPa with an elongation of 8% minimum.

10.3 **Tensile strength at web**: It shall not be less than 775 MPa with an elongation of 13% minimum and shall not exceed 900 MPa with a minimum elongation of 11%. For all UTS values within the range, the elongation value shall be proportional.

10.4 Minimum yield strength or 0.2% proof stress at rim will be 620 MPa.

11. CHEMICAL ANALYSIS OF PRODUCT

11.1 The sample shall be taken for analysis by the purchaser or his inspecting officer. These samples will be drilled or cut from a location adjacent to the location from where tensile sample for rim is required to be taken.

3 *Mechanical testing of metals– Tensile testing*

11.2 The sample shall be subjected to complete chemical analysis in accordance with IS: 228 or any other established method. In case of dispute, the procedure given in the relevant part of IS: 228 shall be the reference method. In case, the method is not stipulated in IS: 228, the reference method shall be as agreed to between the purchaser and the manufacturer. The permissible variation of percentage of elements shall be within the specified values mentioned in Clause 2.2.2.

12. IMPACT TEST (U-NOTCH)

The impact test shall be carried out in accordance with the requirements of IS: 1499[4] (latest version). Three test pieces a, b and c shall be taken from the sample at the position specified in Fig.2. The average impact value of 3 samples when done with 5 mm deep U notch at + 20°C shall be 11 Joules with no individual value below 9 Joules.

13. NON-METALLIC INCLUSIONS AND MICRO-STRUCTURE

The specimen will be from a portion of the tensile test piece at Fig.2 and taken from the position indicated in that figure.

13.1 Non-metallic inclusions: When checked as per IS: 4163[5] (latest version), inclusions shall not be worse than 1.5 thick or 2 thin for all types of inclusions (A, B, C & D types).

13.2 Microstructure: The structure at the location of tensile testing will consist of fine pearlite. ASTM grain size will be 6 or finer. Bainitic structure in the microstructure is not acceptable. However, since formation of ferrite is always associated with pearlitic structure in normal course depending on the carbon content, the microstructure at the location of tensile strength testing can consist of predominantly fine pearlite with finely dispersed ferrite.

14. RE-TEST

14.1 Should any wheel of the sample drawn for the purpose of destructive tests as indicated in Clause 6.2, fail in Brinell Hardness tests mentioned in Clause 7.1, the purchaser or the inspecting officer shall again randomly select wheel sample of the size as mentioned in Clause 6.2 from the same lot with or without re-heat treatment. Any re-heat treatment will require purchaser or inspecting officer's prior permission. The sample wheels shall be accepted if the results of these further tests are satisfactory. Should any of the retested wheels fail to fulfill the conditions of Brinell Hardness test, the sample will be rejected. In such eventuality, the manufacturer may segregate good wheels after 100% hardness check and offer the good wheels for drawing samples for other subsequent tests.

14.2 Should the sample of the lot which has passed Brinell Hardness tests of Clause 7.1, fail in residual stress test, the manufacturer may, with the concurrence of the purchaser or inspecting officer, reheat treat the lot and present it again for Brinell Hardness tests of Clause 7.1 and residual tests with double the sample size as mentioned in Clause 6.2. Should the sample fail in any of the tests, the lot shall be rejected. Should the results of these repeat tests prove satisfactory, the lot from which the wheels were selected shall be accepted.

14.3 Should the sample of the lot which has passed Brinell Hardness tests of Clause 7.1 and residual stress test, fail in falling weight test, the manufacturer may, with the concurrence of the purchaser or the inspecting officer, reheat treat the lot and present them again for Brinell

4 *Method for charpy impact test (U-notch) for metals*
5 *Method for determination of inclusion content in steel by Macroscopic method*

Hardness tests of Clause 7.1, residual stress test and falling weight test with double the sample size as mentioned in Clause 6.2. Should the sample fail in either of the tests, the lot shall be rejected. Should the results of these repeat tests prove satisfactory, the lot from which the wheels were selected shall be held to have passed the falling weight test.

14.4 Should the sample of the lot which has passed Brinell Hardness tests of Clause 7.1, residual stress test and falling weight test, fail in cut-section Brinell Hardness tests mentioned in Clause 7.2, two more sets of cut-section hardness tests be made from two wheels of the same lot for repeat tests. The wheels shall be accepted if the results of these further tests are satisfactory. Should the repeat cut-section hardness tests not prove satisfactory, the manufacturer may, with the concurrence of the purchaser or inspecting officer, reheat treat the lot and present it again for Brinell Hardness test of Clauses 7.1, residual stress test, falling weight test and cut section Brinell Hardness tests with double the sample size as mentioned in Clause 6.2. Should the sample fail in any of these tests, the lot shall be rejected. Should the results of these repeat tests prove satisfactory, the lot from which the wheels were selected shall be accepted.

14.5 Should the sample of the lot which has passed Brinell Hardness tests of Clause 7.1, residual stress test, falling weight test and cut section Brinell Hardness test, fail in tensile tests, two more sets of tensile test pieces shall be taken from two wheels of the same lot for repeat test. The wheels shall be accepted if the results of these further tests are satisfactory. Should the repeat tensile tests not prove satisfactory, the manufacturer may, with concurrence of the purchaser or the inspecting officer, reheat treat the lot and present it again for Brinell Hardness test of Clause 7.1, residual stress test, falling weight test, cut section Brinell Hardness test and tensile tests with double the sample size as mentioned in Clause 6.2. Should the sample fail in any of the tests, the lot shall be rejected. Should the results of these repeat tests prove satisfactory, the lot from which the wheels were selected shall be accepted.

14.6 Should the sample of the lot which has passed Brinell Hardness tests of Clause 7.1, residual stress test, falling weight test, cut section Brinell Hardness test and tensile test, fail in impact test, two more sets of impact test pieces shall be taken from two wheels of the same lot which has given the defective impact test results for repeat tests. The lot shall be accepted if the results of these repeat tests are satisfactory on both the wheels. Should the repeat impact tests not prove satisfactory, the manufacturer may, with the concurrence of the purchaser or the inspecting officer, reheat treat the lot and present it again for Brinell Hardness tests of Clause 7.1, residual stress test, falling weight test, cut section Brinell Hardness test, tensile test and impact test with double the sample size as mentioned in Clause 6.2. Should the sample fail in any of these tests, the lot shall be rejected. If the results of these repeat tests prove satisfactory, the lot from which the wheels were selected shall be accepted.

14.7 In Para 14.1 to 14.6, reheat treatment has been allowed as a correction measure for getting correct values of any particular property in which wheels may have failed. However, any particular lot shall not be reheat treated more than twice to meet the full requirement of this specification.

14.8 **Surface condition after reheat treatment subsequent to final machining:** It is preferable to conduct the destructive tests before machining of the lot so as to avoid damage to the machined surface if reheat treatment is done. Reheat treatment on machined wheel, if permitted, should be carried in such a manner that there is no loose scale formation. Only adherent oxide film should form. With such adherent film formation, no machining or other mechanical operation is required, discolouration of machined surface notwithstanding.

15. NORMAL AND TIGHTENED INSPECTION

Tests on the wheels shall be carried out either in normal or in tightened manner.

15.1 **Normal inspection:** In normal inspection, the sample size will be as per Clause 6.2 and retests as per Clause 14 may be permitted.

15.2 **Tightened inspection:** In tightened inspection, the sample size shall be double the size mentioned in Clause 6.2 and no retest shall be permitted.

15.3 The following criteria shall be applied for changing from normal to tightened inspection and vice versa.

a. If, while on normal inspection, 2 out of 5 (or less) consecutive lots have been rejected or have been accepted after one or more retests as per Clause 14, change over to tightened inspection.

b. If, while on tightened inspection, 5 consecutive lots have been accepted, change over to normal inspection.

16. ULTRASONIC TESTS

All the wheels conforming to the stipulation of the above-mentioned clauses shall be subjected to ultrasonic testing and only those passing the test shall be accepted. Ultrasonic testing will be done after final heat treatment and machining operations. The method of testing and acceptance standard shall be as given in Appendix "A".

17. MAGNETIC PARTICLE TESTS

All the wheels will be tested by magnetic particle method to ensure soundness of the wheels at web region. Magnetic particle testing will be done after final heat treatment and machining operations. Both sides of the wheel web (plate) shall be inspected through this method. The method of testing and acceptance standard shall be as given in Appendix "B".

18. ADDITIONAL TESTS

18.1 The purchaser or inspecting authority may, in case of reasonable doubt, also resort to other forms of testing as mutually agreed to between the purchaser or inspecting authority and the manufacturer is to satisfy that the wheels are free from defects of any kind.

18.2 **Fracture toughness at rim:** The test shall be carried out in accordance with ASTM standard E: 399. Five test samples shall be taken from points evenly distributed over the whole rim and as shown in Fig. 3. The fracture toughness value at 25 ± 5°C under consideration shall be the value K_Q. The average value calculated from the 5 measurements of K_Q shall be minimum 60 MPa$\sqrt{m}$ with no individual value below 50 MPa$\sqrt{m}$.

.1 The above test at Clause 18.2 shall be carried out when specifically mentioned in the contract by the purchaser and generally will be applicable to the bulk suppliers each supplying more than 2,500 wheel discs in a contract. The fracture toughness test will be conducted for every 10,000 wheel discs. If the manufacturer does not have the requisite facility to carry out this test, the services of any reputed agency as agreed by the purchaser / inspecting authority can be availed of.

19. INSPECTION

19.1 The inspecting officer or the purchaser shall have free access to the works of the manufacturer at all reasonable times; he shall be at liberty to inspect during any stage of manufacture and to reject any material not conforming to the terms of this specification. The

inspecting officer or the purchaser shall have the authority to mark all the rejected wheels in an easily distinguishable manner so that such wheels cannot be recycled / re-offered for inspection in subsequent lots.

19.2 The purchaser or the inspecting officer reserves the right to be present at, and take part as he deems fit, in all analysis and other chemical and physical examinations / tests which the manufacturer may carry out, either for his own purpose or under the terms of this specification, on the wheels as well as on their materials, during all stages of manufacture.

20. TESTING FACILITIES

The manufacturer shall supply, free of charge, the material required for testing, and shall, at his own cost, furnish & prepare necessary test pieces and supply labour & appliances for such testing as may be carried out at his premises in accordance with this specification. In case the manufacturer fails to provide facilities for conducting the prescribed tests at his works, he shall bear the cost of carrying out the tests elsewhere.

21. PROTECTION

After inspection and approval, the wheels shall be carefully cleaned of all rust and protected with one coat of mineral oil to IS: 1154[6] (latest version) or red oxide primer or any other protective coating as agreed to between the purchaser and the supplier.

6 - Temporary corrosion preventive, fluid, soft film, solvent deposited, water displacing

APPENDIX 'A'

METHOD OF ULTRASONIC TESTING & ACCEPTANCE STANDARD FOR LOCOMOTIVE WHEELS

(Clause 16)

For detecting internal discontinuities in the rim and hub of the wheel, ultrasonic inspection shall be carried out by following the procedure shown below and by using equipment which complies with the following requirements. Reference standard used for sensitivity setting shall be from wheels conforming to this standard. The surface finish of probing face shall be in accordance with the relevant wheel drawing. The ultrasonic inspection shall be performed after final thermal and machining operations.

A-1 ULTRASONIC TESTING ON WHEEL RIM

The rims of the wheels will be checked through ultrasonic inspection to detect the defects at two orientations:

i. Defect parallel to the rim face (axial testing)

ii. Defect parallel to the running tread (radial testing)

A-1.1 AXIAL TESTING

All wheels will be subjected to ultrasonic testing of rim through probing axially along the rim face to detect any flaw having orientation parallel to the rim face.

.1 Equipment

.1 Automatic ultrasonic testing equipment shall be used. The instrument shall have a pulse echo transmitter & receiver and shall have an operating frequency range of 2 to 5 MHz. The manufacturer shall have on-line test facility to inspect 100% wheels. For determination of final rejection, manual ultrasonic equipments approved by the purchaser may be employed.

.2 The transducers shall be of normal (0 degree) type comprising of high sensitivity Piezo electric ceramic crystal operating at 2 to 2.5 MHz frequency and of 18-20 mm diameter.

.3 An automatic flaw alarm system shall be used in conjunction with the ultrasonic instrumentation to facilitate flaw indication beyond acceptable level.

.4 An immersion or contact type testing technique shall be used in automatic on-line testing. For manual testing of suspect wheels, a suitable couplant shall be used between the test surface and the transducer. In case of dispute in respect of couplant, the decision of the inspecting officer shall be final and binding.

.5 **Calibration block**: 50mm x 50mm x 50mm block of steel to grade 45C8 of IS:1875 [7] shall be used. Alternatively, this calibration block can be made of portion of the heat-treated wheel of steel grade confirming to the specification IRS R-34.

.6 **Standard reference piece**: Standard reference piece shall be from a portion of the wheel having a 3mm diameter flat bottom hole drilled perpendicular to the rim face and to a depth of 25 ± 2mm at the mid thickness of the rim (Fig 4.1).

.7 **Alternate reference piece**: Alternate reference piece shall be from a portion of the wheel having a small diameter hole of diameter 3mm drilled at a distance from the testing surface equal to the depth of the hole indicated in A-1.1.1.6 (Fig. 4.2). The instrument shall be adjusted to give an equal test value to that of a 3mm diameter flat bottom hole.

7 Carbon Steel billets, blooms, slabs and bars for forgings

.2 Calibration

.1 **Time base**: Set the time base of ultrasonic flaw detector using 0 degree longitudinal wave with the help of calibration block as mentioned in Para A-1.1.1.5. Three multiple echoes will be observed.

.2 **Sensitivity setting**: Sensitivity setting shall be done with the help of standard wheel piece (Fig. 4.1). Gain level should be adjusted to produce 60% height from the reference standard as mentioned in Para A-1.1.1.6.

.3 Alternatively, sensitivity setting shall be done with the help of an alternate reference piece as mentioned in Para A-1.1.1.7 (Fig. 4.2) and shall be used only with the specific approval of the purchaser.

.4 Reference standard for the inspection of heat-treated wheels shall be fabricated from heat-treated wheels.

.3 Scanning

.1 Wheels shall be inspected axially from either the outside or inside rim face by automatic scanning (Fig. 4.1 and 4.2). For determining acceptance or otherwise, probing from both sides may be carried out.

.2 The speed of scanning shall permit efficient detection of the reference standard discontinuities.

.4 Rejection criteria

.1 Any wheel with a flaw indication equal to or larger than 60% of the full-scale height shall be rejected. If more than 3 defects of amplitude 20% or above are observed, the wheel shall be rejected. If two defects of amplitude 20% or above are observed, and if these defects are closer than 50 mm, the wheel shall be rejected.

.2 Ultrasonic indications that result from wheel geometry or spurious signal shall not be valid cause for rejection. The judgement of the inspecting officer shall be final and binding in this respect.

.3 The final disposal of rejection of wheels may be determined by manual testing of disputed areas. The surface finish of rim of reference standard will be almost same as that of wheels tested manually by contact probing.

A-1.2 RADIAL TESTING

All wheels will be subjected to ultrasonic testing of rim through probing circumferentially along the tread surface to detect any flaw having orientation parallel to the tread surface.

.1 Equipment

.1 Equipment shall be same as described in Clause A-1.1.1.

.2 **Calibration Block**: 50x50x50mm block of steel to grade 45C8 of IS: 1875 shall be used. Alternatively, this calibration block can be made of portion of the heat-treated wheel of steel grade confirming to the specification IRS R-34.

.3 **Standard reference piece**: Reference piece will be from a portion of new wheel having 3mm diameter flat bottom hole drilled from opposite to tread surface (Fig. 5) to depth of 20mm.

.2 Calibration

.1 **Time Base**: Set the time base of ultrasonic flaw detector using 0 degree longitudinal wave with the help of calibration block as mentioned in Para A-1.2.1.2. Three multiple echoes will be observed.

.2 **Sensitivity setting**: Sensitivity setting shall be done with the help of standard wheel piece as mentioned in Para A-1.2.1.3 (Fig.5). Probing shall be done from the tread opposite to flat bottom hole and the gain level shall be adjusted to produce an echo of 60% height of vertical scale of CRT. This gain level shall be reference gain for acceptance or otherwise for the wheel.

.3 **Scanning**

Increase the gain level by 6dB over and above the gain level described at Para A-1.2.2.2. Apply couplant on the tread surface, place the probe on this face and scan entire circumference on the wheel in case of contact type automatic scanning equipment. For immersion type of equipment, the wave propagation shall be through the liquid used for immersing the wheel. No back echo will appear. Care shall be taken during probing to cover full width of the tread. In case a flaw signal is observed, reduce the gain by 6dB.

.4 **Rejection criteria:**

Any wheel with a flaw indication equal to or larger than 60% of the full-scale height shall be rejected. If more than 3 defects of amplitude 20% or above are observed, the wheel shall be rejected. If two defects of amplitude 20% or above are observed and if these defects are closer than 50 mm, tne wheel shall be rejected.

.5 The final disposal of rejection of wheels may be determined by manual testing of disputed areas. The surface finish of tread of reference standard will be almost same as that of wheels tested manually by contact probing.

A-2 ULTRASONIC TESTING ON WHEEL HUB

Only such wheels, which pass ultrasonic test for the rim, shall be subjected to ultrasonic testing of hub.

A-2.1 EQUIPMENT

Equipment shall be the same as used for ultrasonic testing of the rim portion of the wheels, suitably calibrated for hub thickness. However, manual testing of hub will be permitted.

For hub testing, the back wall echo shall be adjusted to full screen height using a wheel hub free from internal discontinuities.

Surface finish of reference piece shall be similar to wheels tested if manual testing is resorted to.

A-2.2 REJECTION CRITERIA

.1 Any wheel with a flaw indication equal to or larger than 60% of the full-scale height shall be rejected. If more than 3 defects of amplitude less than 60% are observed, the wheel shall be rejected. If two defects of amplitude less than 60% are observed, and if these defects are closer than 50 mm, the wheel shall be rejected.

.2 Where there is a partial suppression of the back echo and flaw echo is also absent, the back echo shall not be less than 30% of the full screen height without change of testing parameters.

A-3 MARKING

Wheel conforming to the above ultrasonic stipulations shall be stenciled "UT" on the back plate with red colour paint using characters at least 25 mm in height or at such locations as may be shown on the drawing or specified by the purchaser.

APPENDIX 'B'

METHOD OF MAGNETIC PARTICLE TESTING & ACCEPTANCE STANDARD FOR LOCOMOTIVE WHEELS

(Clause 17)

B. MAGNETIC PARTICLE TESTING

B.1 PURPOSE

To supplement visual inspection of the surface of new wheels by detecting discontinuities which may be harmful to wheel in service.

B.2 SCOPE

This test method covers the wet fluorescent magnetic particle inspection of plates of the wheels ordered to this specification.

B.3 EQUIPMENTS

.1 Magnetizing Apparatus

The magnetizing apparatus will be on line and will be capable of inducing suitable magnetic fields within the entire plate area of the wheel to facilitate the disclosure of both circumferentially and radially oriented discontinuities. The magnetizing currents used shall be large enough to induce magnetic fields of sufficient intensity to disclose surface discontinuities 0.3 mm in depth. Any non-metallic entrapment on surface should also get detected.

.2 Lighting Apparatus

The inspection shall be performed in a darkened booth with the area of the wheel to be inspected illuminated with properly filtered black light. The black light shall have a predominant wavelength of 4,000 to 3,400 angstrom units and the intensity of the black light, measured at the surface to be inspected, shall be a minimum of 75 foot-candles at point of inspection.

.3 Inspection Medium

.1 The bath or solution should be prepared using a suitable carrier fluid & fluorescent magnetic particles and renewed monthly or more often if contamination is noted in weekly tests. Each time the bath is renewed, the bath container should be cleaned out and the agitation & circulation system should be flushed with 5 to 8 litres of clean carrier. Filtering screens should be removed and cleaned by blowing with air. In preparing the new bath, only recommended materials should be used. The amount of powder should be carefully weighed out in accordance with the material manufacturer's recommendation and the powder should be directly added to the bath containing the correct amount of carrier. It is recommended that powder be added directly over the sump so that it will be drawn quickly into the pump and circulated. The amount of carrier & powder used and the date of preparation should be recorded on a regular form set up for this purpose, as outlined in paragraph B.3.3.6.

.2 Concentration and contamination of the bath solution should be tested weekly as follows:

The pump and agitation system should be operated for 20 minutes and then solution should be run through hose and nozzle for 30 seconds. Using a regular 100 ml centrifuge tube, fill the centrifuge tube with 100 ml of the solution. Allow bath solution to settle for the time recommended by the manufacturer of the type of powder used

making sure that the tube is not subjected to excessive vibration during the settling period. Each horizontal division represents 0.1 ml and correct reading in volume of particles must be as stipulated by the powder manufacturer. Check should also note contamination due to dirt, chips or other foreign matter settling with the powder. Contamination is also indicated when the carrier appears to acquire more than usual fluorescence or when the magnetic particles appear to have lost fluorescent qualities. This condition can be readily observed when the settling tube is exposed to ultraviolet light. The readings obtained are to be shown on the regular report form as outlined in paragraph B.3.3.6.

.3 The ultraviolet light should be tested weekly using a light meter, such as a type having foot candle scale with 10X multiplying disc or equivalent or a meter that responds specifically to the ultraviolet range of 3,650 angstrom units (365 nanometers). The latter type meters are calibrated in microwatts per square centimetre. The meter should be held at a fixed distance of 380 mm from the light source (from black light filter surface to meter sensing element) and should have a minimum meter reading of 525 microwatts per square centimetre.

.4 The conversion factor from foot candles (for light meters) to microwatts per square centimetre is 5.7 times the foot candle reading (at 380 mm distance).

.5 The maximum allowable foot candles will be left to the discretion of the user depending on the degree of brilliance desired to obtain satisfactory inspection conditions. Before taking reading, it should be known that the glass black light filters are clean. Reports of this test are to be shown on regular form as outlined in paragraph B.3.3.6.

.6 A regular form should be prepared embodying the information to be shown on monthly and weekly tests as outlined above and this form should be on hand at the wheel shop and available to inspectors.

.4 Preparation for Inspection

The surface shall be scale free before magnetic particle inspection. The wheels will be in machined condition.

.5 Detection of Discontinuities

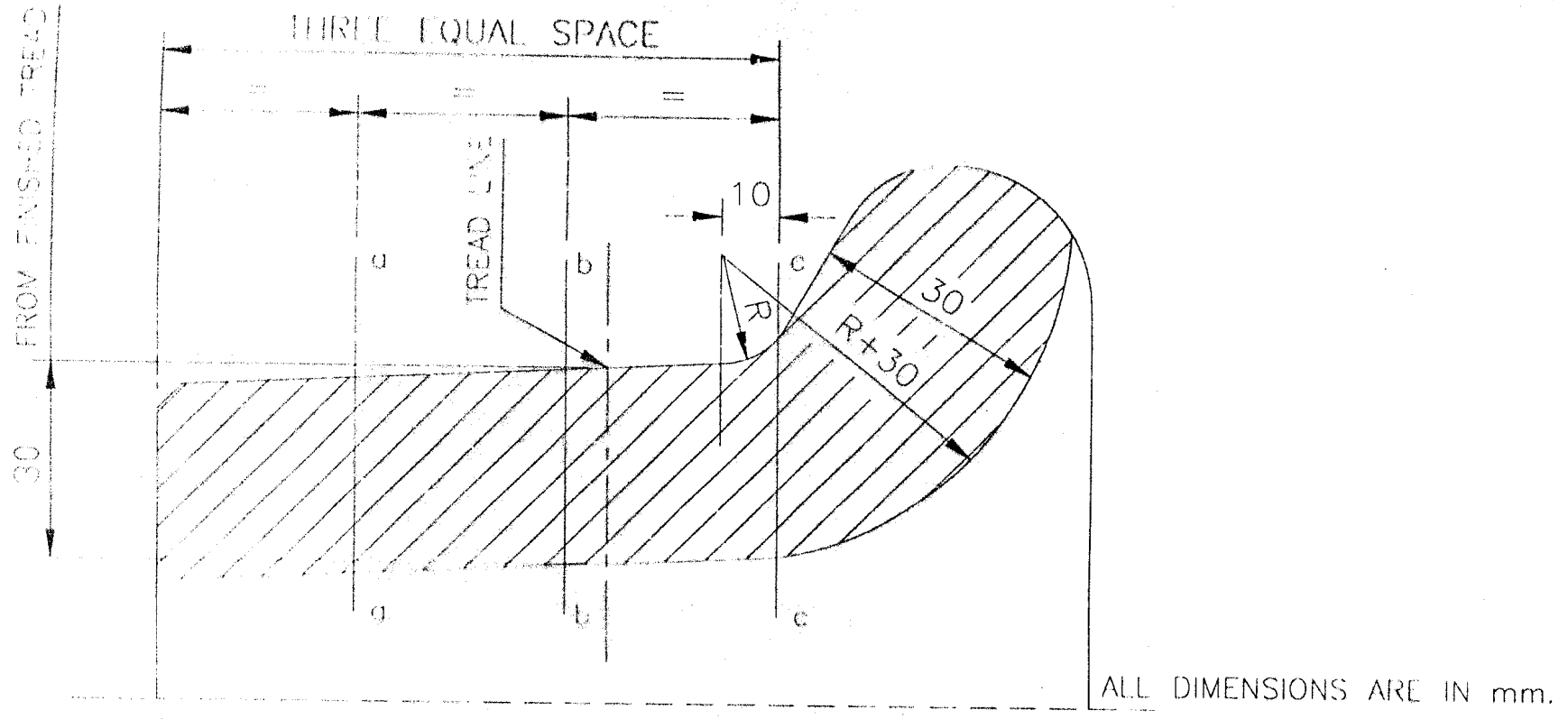
This inspection shall be performed to detect discontinuities whose axes may be in any direction. Continuous or residual magnetization shall be used with adequate coverage by the inspection medium.

.6 Time of Inspection

The magnetic particle inspection shall be performed following final machining. A wheel / wheels with standard defects will be run at start of the shift to see that detection system is functional.

.7 Rejection

Discontinuities may be removed by machining or grinding where sufficient stock remains. Such wheels shall be retested by magnetic particle inspection. Wheels where spot grinding has to be resorted to, shall be so ground that the area ground is at least 10 times the depth to avoid deep pit formation. The edges of the ground area should be smooth and rounded. Maximum depth of grinding is 3mm. However, it should be ensured that after grinding, the minimum dimensions at any spot are within the stipulated dimension in the wheel drawing. The wheel which has crack(s) which could not be removed even after grinding upto a depth of 3mm will be rejected. If entrapment material is seen even after grinding to a depth of 3mm, wheel will be rejected. If a crack is seen on bore, the wheel may be allowed to be bored upto allowable maximum bore and again put up for magnetic particle inspection.



i. The Brinell Hardness Number measured at a depth of 30 mm from tread surface (end of shaded area) shall not be less than 300 BHN.

ii. On lines a-a, b-b & c-c, the hardness should smoothly and proportionately increase in vertical direction upto 341 BHN from 300 BHN (minimum) measured at the depth of 30 mm from tread surface in the shaded zone.

Fig. 1

SKETCH SHOWING THE HARDENED ZONE FOR MONO-BLOCK WHEELS TO IRS R-34

(Refer Clause 7.2)

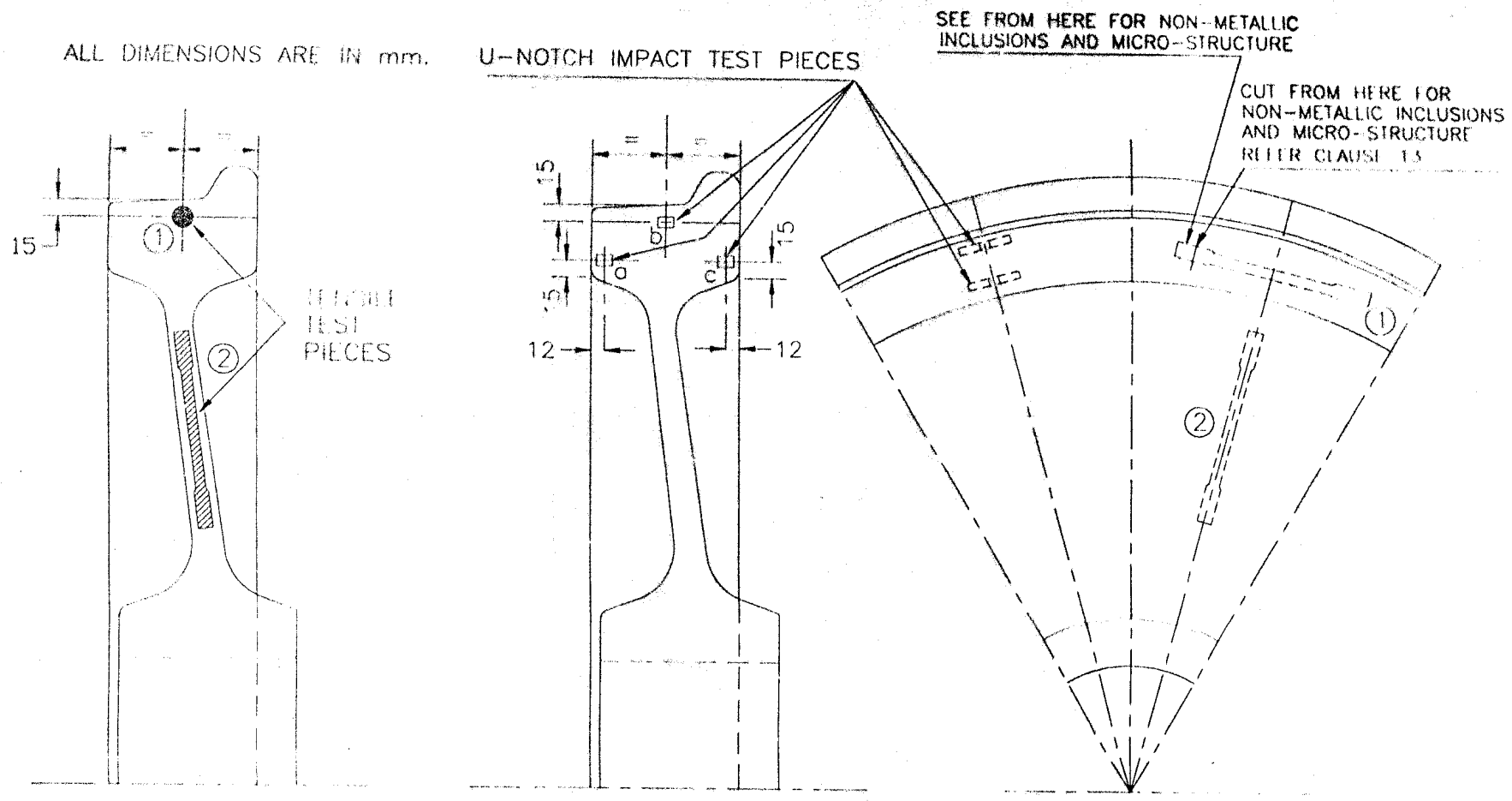


Fig. 2

POSITION OF TENSILE, IMPACT AND INCLUSION TEST PIECES

(Refer Clauses 10.1, 12 & 13)

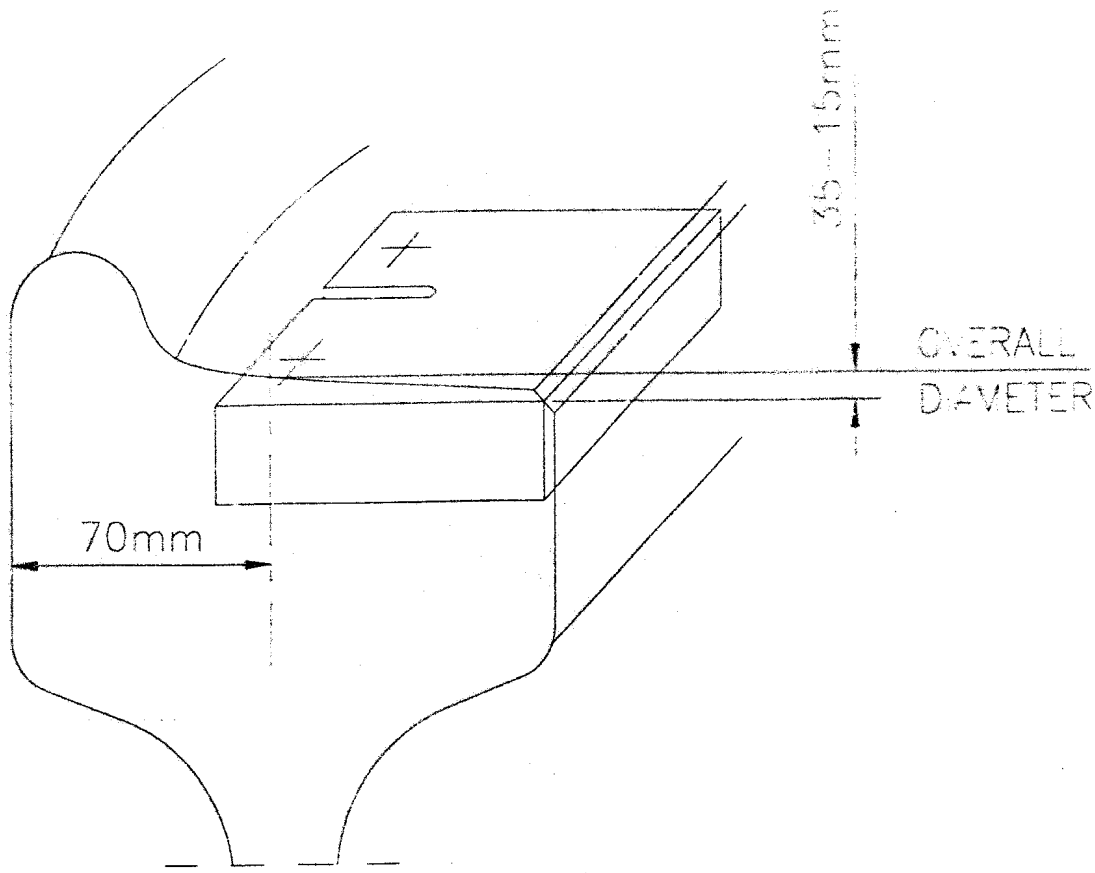


Fig. 3

LOCATION OF SAMPLE FOR FRACTURE TOUGHNESS TEST

(Refer Clauses 18.2)

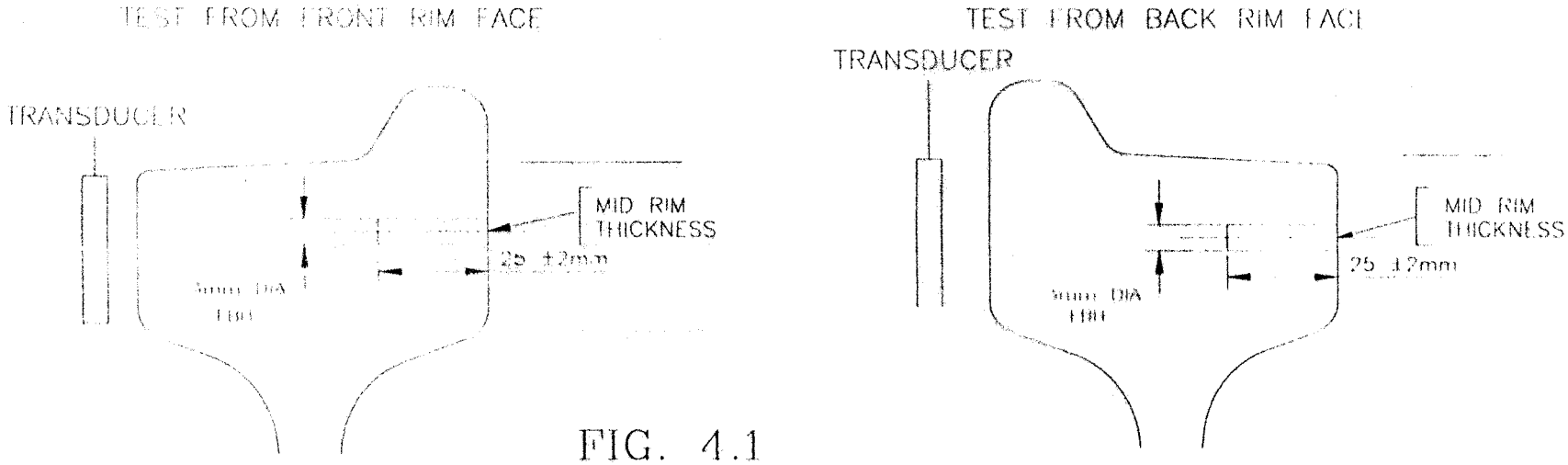


FIG. 4.1

REFERENCE STANDARD (REFER CLAUSE A–1.1.1.6)

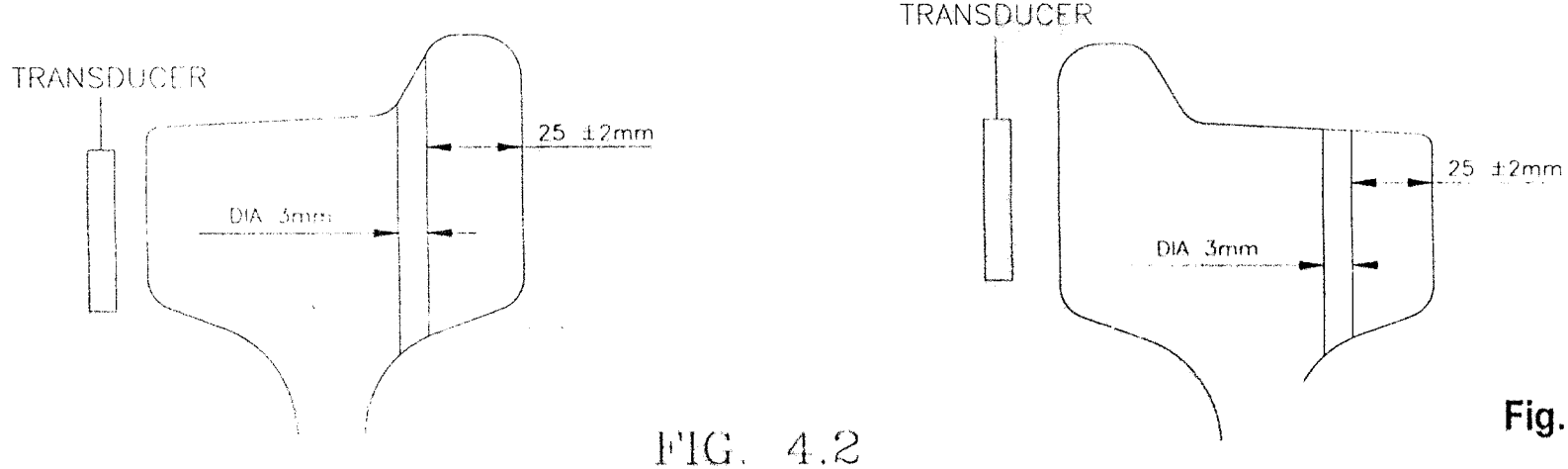


FIG. 4.2

Fig. 4

ALTERNATE REFERENCE STANDARD

(Refer Clauses A-1.1.1.7)

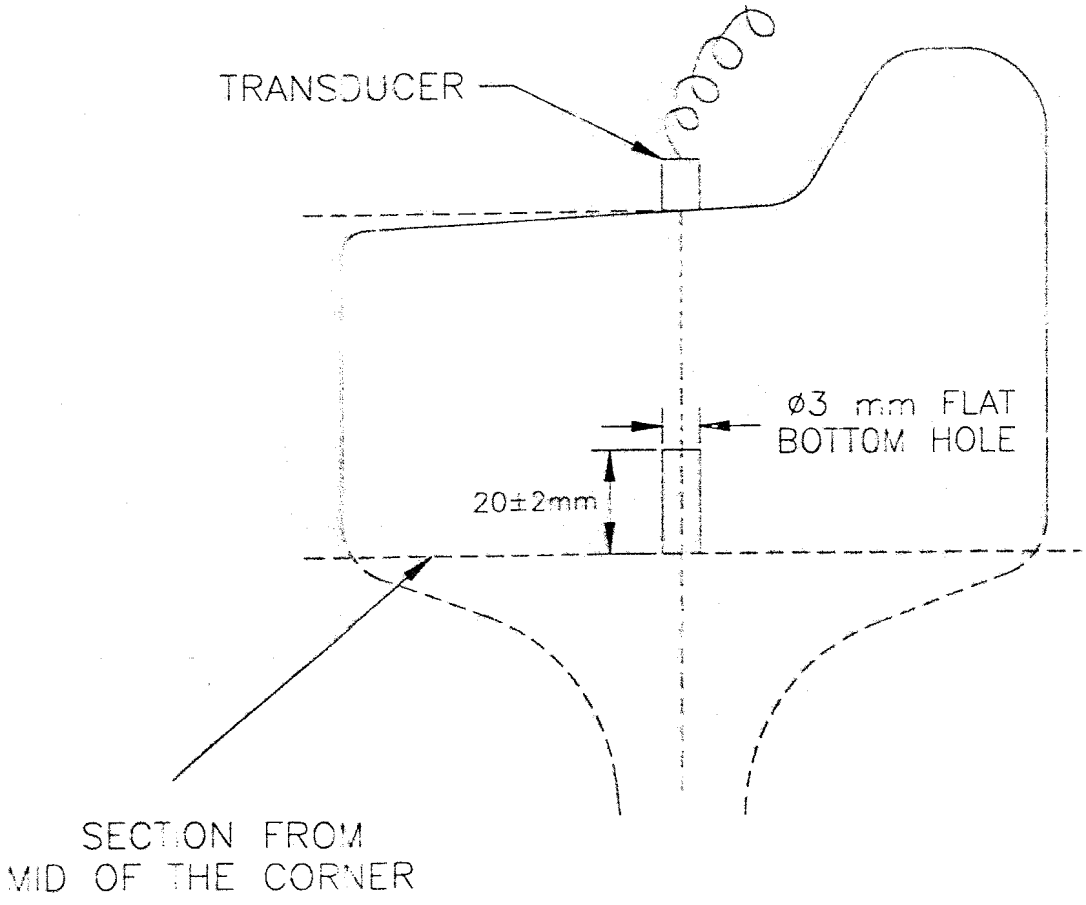
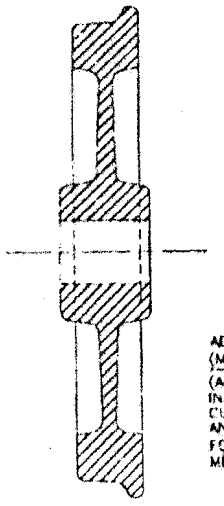


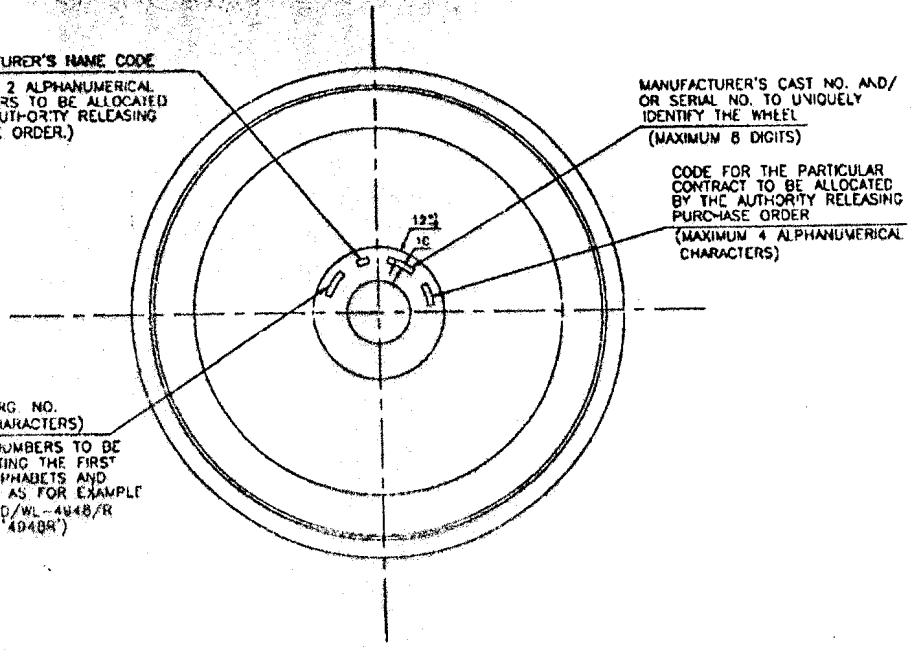
Fig. 5

REFERENCE STANDARD FOR RADIAL PROBING

(Refer Clauses A-1.2.1.3)

DDO-208





NOTE:-

1) STAMP ON OUT SIDE HUB FACE OF WHEEL.
2) NOMINAL HEIGHT OF THE LETTERS TO BE 10mm.
3) DEPTH OF IMPRESSION SHOULD BE 2.0 mm(MAX.) WHEN HOT STAMPING IS DONE AND 1.0 mm (MAX) WHEN COLD STAMPING AFTER MACHINING IS DONE. BRANDING PARTICULARS SHALL BE CLEAR AND LEGIBLE.
4) ITALICISED CHARACTERS (SLOPING UPWARD TO RIGHT) SHALL BE USED.
5) STAMPING TO BE SPACED A MINIMUM OF 3.2mm BETWEEN CHARACTERS AND 35 mm BETWEEN GROUPS. STAMPING SHALL BE AT A DISTANCE OF 12$^{+1}_{-3}$ mm FROM THE OUTER EDGE OF HUB.
6) STAMP WITH ROUNDED EDGE LETTERS SHALL ONLY BE USED.
7) STAMPING MAY BE EITHER HOT STAMPING BEFORE HEAT-TREATMENT OR COLD STAMPING AFTER MACHINING. STAMPING BY LOCALISED HEATING IS PROHIBITED.
8) ANY OTHER INFORMATION AS DEEMED NECESSARY BY THE MANUFACTURER OR PURCHASER/INSPECTOR SHALL BE STENCILLED ON THE BACK PLATE WITH RED PAINT USING CHARACTERS AT LEAST 25 mm IN HEIGHT.

GRADE NO.	N1	N2	N3	N4	N5	N6
Roum	0.25	0.5	0.1	0.2	0.4	0.8
SYMBOL		VVVV			VVV	
GRADE NO.	N7	N8	N9	N10	N11	N12
Roum	1.6	3.2	6.3	12.5	25	50
SYMBOL		VV			V	

TOLERANCES ON UNTOLERANCED DIMENSIONS - IS 2102 (COARSE)
SURFACE ROUGHNESS VALUE TO IS 3073

ALT. NO.	REF. LETT.	DESCRIPTION	DATE	AUTH.
1	L2-999	ORG. REVISED AND REDRAWN	04.05.06	RDSO

DR
CH
APPD
DT SEPTEMBER, 08

WHEEL MARKINGS

REFERENCE : SK.DL - 46

INDIAN RLYS RDSO (MP) | DRG. NO. DDO-208