INDIAN RAILWAYS

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Document content	Technical Specification-	Yes
	Schedule of Technical Requirement	No
Description of item	**SOLID FORGED STEEL WHEELS FOR CARRIAGES, WAGONS AND EMU/EMU-US/MEMU-US INCLUDING TRAIN-18 & VANDE BHARAT STOCK** (APPLICABLE TO ALL GAUGES)	
Remarks	New Clause 4.4: Shot Peening, shall be applicable after 6 months from date of issue of this revision.	

S. No.	Month/Year of issue	Revision / Amendment	Page No.	Reason for Amendment/Revision
1.	July 2012	Revision 4	-	**1.** Corrigendum 1 to 4 have been incorporated. **2.** Minutes of Meeting held at Railway Board in June 2012 **3.** Comments received from stakeholders/M&C Directorate
2.	Aug. 2015	Corrigendum No.1	-	Revised requirements for LHB Wheels incorporated
3.	April 2022	Revision 5	-	To upgrade specification for the solid forged wheel of LHB Coaches
4.	July 2023	Corrigendum No.1	-	Revised requirements for UST of LHB wheels
5.	Sept. 2023	Corrigendum No.2	-	Revised requirements for Marking
6.	Feb. 2024	Revision 6	-	To include the requirements for solid forged wheels of EMU-US, MEMU-US, Train-18 & Vande Bharat Stock and to upgrade the specification for solid forged wheel of LHB Coaches

Issued by:

CARRIAGE DIRECTORATE
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SPECIFICATIONS REFERRED

This specification refers to the latest amendments of the following specifications:

S. No.	Specification	Description
1.	IRS R-19/93 (Part I)	Wheel and axle assembly for carriage and wagon
2.	IS: 228	Method for analysis of steel
3.	IS: 1499	Method for Charpy Impact test (U-notch)
4.	IS: 1500	Method for Brinell Hardness test for steel
5.	IS: 1608	Method for Tensile testing of steel products other than sheet, strip, wire and tube
6.	IS: 4163	Method of determination of non-metallic inclusions
7.	IS: 3703	Code of practice for magnetic particle flaw detection
8.	ASTM E 399/90	Method of plane strain fracture toughness of metallic material
9.	ISO 6933	Magnetic particle testing of wheels
10.	AAR-M107/208	Ultrasonic testing of wheels
11.	IS: 2074	Coating to Red Oxide Zinc Chrome Primer
12.	JIS Z2305	Qualification for Non-destructive testing of wheels
13.	BS EN ISO 9712	Qualification for Non-destructive testing of wheels
14.	EN13262:2020	Railway applications- Wheelsets and bogies-Wheels-Product requirements
15.	IS: 9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
16.	IS: 4748/ ISO 643	Steels — micrographic determination of the apparent grain size
17.	ASTM E112	Standard test methods for determining average grain size
18.	ISO 5948	Railway rolling stock material — Ultrasonic acceptance testing
19.	IS: 1875	Carbon Steel Billets, Blooms, Slabs And Bars For Forgings - Specification
20.	IS: 1757	Charpy Impact Test (V-Notch) on metallic material
21.	M&C/PCN/111/2018	High Build Epoxy Paint
22.	JIS K 5659:2008	Long durable paints for steel structures

INDIAN RAILWAYS STANDARD SPECIFICATION FOR SOLID FORGED WHEELS FOR CARRIAGES, WAGONS AND EMU/EMU-US/MEMU-US, TRAIN-18 & VANDE BHARAT STOCK
IRS R-19/93 Part II (Rev.6)

1.0 SCOPE

1.1 This standard covers the requirements for heat-treated, solid forged and rolled wheels for carriages (including EMU/DMU/MEMU and self-propelled vehicles) and wagons of all gauges. The specification also incorporates a procedure for qualification of wheels from non-qualified suppliers, which in turn is based on similar provisions of EN 13262.
This standard also covers requirements for:

A. "LHB wheels (Solid forged wheels for FIAT IR bogie)". The LHB wheel conforms to RCF drawing No. MI006615 alt. 'b' (rough turned wheel) or latest and shall be suitable for a carrying wheelset of 18t axle load provided with axle mounted disc brakes for maximum speed of 200 kmph.

B. "Vande Bharat wheels (Solid forged wheels for VB bogie)". The Vande Bharat wheel conforms to ICF drawing No. 89102004 alt. 'b' or latest for Trailer Coaches (TC) & ICF drawing No. 89002003 alt. 'b' or latest for Motor Coaches (MC) and shall be suitable for a carrying wheelset of 17t axle load provided with wheel mounted disc brakes for maximum speed of 200 kmph.

C. "Solid forged wheel (finish machined) for Train-18, MEMU/US & EMU/US Coaches". The wheel conforms to ICF drawing No. AAA02141 alt. 'c' or latest for both Trailer Coaches (TC) & Motor Coaches (MC) and shall be suitable for a carrying wheelset of 21t axle load provided with wheel mounted disc brakes for maximum speed of 200 kmph.

2.0 MANUFACTURE

2.1 PROCESS OF MANUFACTURING STEEL

1. The wheel shall be manufactured from steel made by Electric or Basic Oxygen process. The steel should be vacuum degassed and shall be of killed quality. Manufacturer shall furnish full details of steel making process and take prior approval from the purchaser for the use of any other equivalent process for manufacture of steel.
2. The hydrogen content in liquid steel shall not exceed 3.0 ppm. The method of determination and equipment used may be as agreed to between manufacturer and purchaser.
3. The Nitrogen content in the steel shall not exceed 0.007 percent.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: -

1. The wheel shall be manufactured from steel made by Electric or Basic Oxygen process with secondary refining facility. The steel should be vacuum degassed and shall be of killed quality. Manufacturer shall furnish full details of steel making process and take

prior approval from the purchaser for the use of any other equivalent process for manufacture of steel.

2. The hydrogen content in liquid steel shall not exceed 2.0 ppm. The method of determination and equipment used may be as agreed to between manufacturer and purchaser.
3. The Nitrogen content in the steel shall not exceed 0.007 percent.
4. The Oxygen content in the liquid steel shall not exceed 15 ppm.

2.2 CHEMICAL COMPOSITION

2.2.1 LADLE ANALYSIS

2.2.1.1 The ladle analysis of steel, when carried out by the method specified in the relevant part of IS: 228 or any other established instrumental / chemical method shall be as per Table given below. In case of any dispute, the procedure given in the relevant part of IS: 228 shall be the determining method. However, if the method is not given in any part of IS: 228, the determining method shall be as agreed to between the purchaser and the manufacturer on the basis of similar national or international methods.

CHEMICAL COMPOSITION

Ladle analysis (Percentage)

Element	**Percentage Composition**
C	0.52 max
Cr	0.25 max.
Combined Cr + Ni + Mo	0.50 max.
Mn	0.60 to 0.80
Ni	0.25 max.
Si	0.15 to 0.40
Mo	0.06 max.
P	0.03 max.
Cu	0.20 max.
S	0.03 max.
V	0.10 max.

FOR LHB WHEELS ONLY: -

Element	**Percentage Composition**
C	0.54 max
Cr	0.25 max.
Combined Cr+Ni+Mo	0.50 max.

Mn	0.60 to 1.00
Ni	0.25 max.
Si	0.15 to 0.40
Mo	0.08 max.
P	0.020 max.
Cu	0.20 max.
S	0.020 max.
V	0.03 to 0.10

FOR Train-18, MEMU/US, EMU/US & VB WHEELS ONLY:

- Steel Grade to ER8 as per EN 13262:2020 or latest.

2.2.2 PRODUCT ANALYSIS

2.2.2.1 The product analysis shall be carried out on the finished product. Permissible variation in case of such product analysis from the limit specified under clause 2.2.1 for ladle analysis shall be as follows: -

Element	Variation Percent
Carbon	+0.03 -0.02
Manganese & Silicon	+0.03 -0.03
Phosphorous & Sulphur	+0.005 -0.000
Chromium & Nickel	+0.05 -0.00
Copper, Molybdenum & Vanadium	+0.02 -0.00

2.3 PROCESS OF MANUFACTURING WHEEL

2.3.1 Rolled / forged wheels shall be manufactured from ingots capable of producing two or more wheels after removal of discards. The ingots shall be bottom poured. Cropping shall be sufficient to eliminate defective sections of the ingot. Any superficial defects shall be completely removed before or during working.

2.3.2 The sections of ingots shall be forged, pierced and rough shaped by a hammer or press. They shall be finally shaped by rolling or by drop forging supplemented by sizing if

necessary. The finished rolled or forged wheels shall comply with the dimensional requirements given in clause 4 of this specification. Suitable precautions shall be taken during hot working to ensure that material is not damaged by over heating or by grain growth due to prolonged exposure at high temperature. The temperature of the product should not exceed 1260 degree C and working should terminate between 850 and 1000 degree C.

2.3.3 The wheels can also be manufactured from cheeses of steel blooms of suitable section, length and weight manufactured by the continuous casting method. The steel shall be refined in the ladle furnace and vacuum degassed before using continuous casting process. The continuous casting machine should have the facility of electromagnetic stirring.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: - The continuous casting machine should have the facility of electromagnetic stirring and Hydrogen determination facility in the tundish.

2.3.4 The manufacturer shall furnish full details of the steel making process including ladle refining and vacuum degassing and take prior approval from the purchaser for the use of the above methods. The minimum cross section of the cropped ingot or continuous cast bloom shall be such that a minimum reduction ratio of 4:1 is obtained. That is, the original height of cropped ingot piece should be at least 4 times the height of upset blank at the completion of up-setting.

2.4 HEAT TREATMENT

2.4.1 All wheels must be Rim quenched and tempered.

2.4.2 Rim quenching and tempering shall be understood to mean heating the wheel for a sufficient time to bring it uniformly to a temperature exceeding the transformation temperature of the steel within 50^0C, then hardening the rim with a jet of water under pressure, followed by tempering at Minimum temperature of 500^0C. The wheel is then left to cool in still air/draught free area preferably in a covered cooling pit or under cover. The wheel can also be cooled in "retarded-cooling chambers of conveyer type."

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: - The manufacturer shall furnish full details of the rim quenching & tempering and take prior approval from the purchaser for use of any other equivalent process for rim quenching & tempering and also cooling method adopted for the wheel.

2.4.3 The quenching operation of wheel shall be carried out in such a manner as to prevent the formation of cracks.

2.4.4 The heat treatment shall not modify the hardness values measured at point –A (Fig. 2)

3.0 QUALITY OF WHEEL

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

4.0 DIMENSIONS AND TOLERANCES

4.1 The wheels shall be accurately machined to the dimensions and tolerances shown in the drawings. Any wheel that will not clean up perfectly true in the lathe shall be rejected.

4.2 WEB THICKNESS

4.2.1 In case tolerances are not given in the drawing, the web shall be of uniform thickness and shall not vary more than 5.0 mm over the specified dimension. In any one wheel, the difference between the minimum and maximum thickness of web at any given radius shall not be more than 1.5 mm.

4.3 MACHINING AND ELIMINATION OF IMBALANCE

4.3.1 Machining operation shall be chosen so that the wheels comply with the requirements for both surface finish and tolerances specified by the purchaser. Elimination of imbalance shall be obtained by eccentric machining of the fillet between the web and the rim, on the flange side as shown in Fig.6. The thickness of the metal removed shall not exceed 4 mm and the resultant surface shall be carefully blended into adjacent material. In no case shall it be permitted to add additional mass. Drilling of holes for correction of imbalance is prohibited. The sprag holes or any other holes as indicated in the drawing will be made by machining and not by flame cutting.

4.3.2. FATIGUE TEST (FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY):

As quality assurance measure, fatigue test shall be carried out in accordance with clause 4.2.4 of EN 13262:2020 or latest version on prototype wheel produced by such manufacturer who has not successfully supplied wheels having design speed potential of 160 kmph or more for Railway application, in past. Successful supply for the purpose shall mean satisfactory performance of at least 300 such supplied wheels in service for at least 2 years.

4.4. SHOT PEENING (FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY):

Shot peening of rough machined wheels shall be carried out in accordance with the requirements of clause 7.0 of AAR M-107/M-208. Surface roughness of web achieved after Shot peening will be acceptable. On shot peened wheels, surface roughness of web in deviation of drawing shall be applicable.

5.0 BRANDING

5.1 Marking/Stamping/Branding shall be as per RDSO drawing No. Sketch-92114 alt. '10' or latest. Following particulars shall be stamped as per RDSO drawing No. Sketch-92114 alt. '10' or latest on outer face of the rim before machining.

- **i)** Manufacturer's code name (in 3 alphabets, with purchaser's prior approval)
- **ii)** Month & Year of manufacture (in 4 digits separated by "/" i.e. February 2014 should be indicated as 02/14).
- **iii)** Consecutive/Individual serial number (in 5 digits numeric only).

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

iv) Heat/Batch Number (in 6 digits in numeric or alpha numeric).
v) Inspector's approval stamp.
vi) 'UT' for ultrasonic testing.

5.2. For LHB wheels, RCF drawing No. MI006615 alt. 'b' or latest and location of stamping shall be as per RDSO drawing No. Sketch-92114 alt. '10' or latest.

5.3 For VB wheels, ICF drawing No. 89102004 alt. 'b' or latest for Trailer Coaches (TC) and ICF drawing No. 89002003 alt. 'b' or latest for Motor Coaches (MC), for all Train-18, MEMU/US & EMU/US wheel to ICF drawing No. AAA02141 alt 'c' or latest and location of stamping shall be as per RDSO drawing No. Sketch-92114 alt. '10' or latest.

5.4 For wheels, which are fully machined after heat treatment, the hot stamped particulars are likely to be removed during machining. For such wheels, the particulars hot stamped should be transferred by cold stamping. However, care should be taken that the impression does not have sharp corners/edges and the entire preparation is suitably rounded to remove the sharp corners. The depth of cold stamping should be in between 0.15 mm to 0.5 mm. Stamping by localized heating is prohibited.

5.5 Manufacturer should ensure complete traceability of their wheels throughout the life cycle of the wheel.

5.6 For LHB, Train-18, MEMU/US, EMU/US & VB wheels, position of the residual imbalance and the symbol reflecting its value shall also be stamped on outer face of hub. The values of imbalance shall be stamped according to the following code: -

- E1 for a residual imbalance of $\leq$ 50 gm-m.
- E2 for a residual imbalance of $\leq$ 75 gm-m.
- E3 for a residual imbalance of $\leq$ 125 gm-m.

5.7 Manufacturer shall maintain and preserve the record co-relating every individual wheel with the cast number, the contract number, the drawing number of the wheel and heat treatment given and produce the same on demand by the purchaser/Inspecting officer. The details regarding the contract number and drawing number of every wheel shall be furnished to the consignee.

6.0 SELECTION OF TEST PIECES

6.1 The number of wheels per batch to be subjected to the checks and tests shall be in accordance with Table-4. Test pieces shall be selected at random by the inspector and shall be stamped for identification. For this purpose, each batch shall comprise of wheels from the same cast and having undergone the same heat treatment. However, for chemical analysis and macroscopic examinations, the batch shall comprise of wheels from the same cast.

6.2 PRODUCT ANALYSIS

6.2.1 Unless otherwise specified in the order or its appended documents one of the following samples shall be taken from one of the wheels:

- At least 50 gm of millings representing the average chemical composition of a radial section of the wheel.
- In the case of spectrographic analysis, one sample taken from the tensile test piece shown in position 1 of Fig.1.

6.3 VERIFICATION OF RESIDUAL STRESS

6.3.1 One complete wheel after heat treatment and before machining.

6.4 TENSILE TEST

6.4.1 Two pieces one each from "Position 1" and "Position 2" (As shown in Fig. 1) shall be taken for tensile testing.

6.5 IMPACT TEST

6.5.1 IMPACT TEST (U-NOTCH)

Three test pieces shall be taken from the position a, b & c of the sample as shown in Fig. 1. The impact test pieces shall be marked to identify their longitudinal surfaces, which are parallel to section AA (see Fig. 1). The axis of the cylindrical bottom of the notch shall be parallel to radius AA in Fig. 1. The test will be done on standard 'U' notch test specimen with 5 mm deep 'U' notch, as per IS: 1499.

6.5.2 IMPACT TEST (V-NOTCH)

The test will be carried out on standard 'V' notch test specimen in accordance with IS:1757.

6.6 MACROSCOPY

6.6.1 The test piece shall consist of a radial slice through the whole cross section of the wheel, with one surface ground or polished sufficiently to eliminate machining marks and to obtain a clear macro graphic image.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: - Thickness of radial slice shall be **13 ± 2 mm.**

6.7 HARDNESS

6.7.1 UNIFORMITY OF HARDNESS OF BATCH

6.7.1.1 Each wheel produced shall be subjected to a Brinell hardness test on the plane face of the rim on the side opposite the flange. The position selected for indentation shall be on a circumference with a radius approximately 25 mm less than that of a running circle (see Fig 2.). The position shall, where appropriate, be prepared by grinding in order to remove any decarburised material. The difference between extreme hardness values within a batch shall not exceed 30 BHN.

6.7.2 HARDNESS SURVEY OF RIM

6.7.2.1 The test piece shall consist of a small plate comprising the complete radial section of the rim and its joint with the web, selected from the sample segment (see Fig.2). One of its face shall be prepared in accordance with IS: 1500 (Method for Brinell Hardness test for steel). The hardness indentations three each at a distance of 5 mm and 35 mm from the tread and one at point 'A' shall be situated on the three lines, shown in fig. 2. If the limit of wear is greater than 35 mm from the tread, the indentation shall be made at this limit instead of 35 mm. The hardness values at points other than 'A' contained should be within the range mentioned in Table-2. The hardness value measured at point 'A' shall not exceed 229 BHN.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: - The hardness value measured at point 'A' shall not exceed **260 BHN.**

6.8 BALANCING TEST

6.8.1 The test specimen shall consist of the finished wheel. This test shall be applicable only in case specified in the purchaser order. The balancing of each wheel shall be checked by means and methods agreed to between the purchaser and manufacturer.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: - The test specimen shall consist of LHB wheel to RCF drawing No. MI006615 (rough turned wheel) alt. 'b' or latest and finished VB wheels to ICF drawing No. 89102004 alt. 'b' or latest for Trailer Coaches (TC) & ICF drawing No. 89002003 alt. 'b' or latest for Motor Coaches (MC) & finished Train-18, EMU/US, MEMU/US wheels to ICF drawing No. AAA02141 alt. 'c' or latest for all coaches. Unless otherwise specified in the order or its appended documents, this test shall be applicable on 100% wheels as it is a pre-requisite to dynamic balancing test on assembled wheel sets. The balancing of each wheel checked by means and methods agreed to between the purchaser and manufacturer. In the event of any dispute regarding the means and methods, decision of the inspecting authority shall be final and binding.

7.0 TEST METHODS

7.1 TENSILE STRENGTH

7.1.1 The tensile test shall be carried out in accordance with the requirements of IS: 1608 with Gauge length 5.65 √ So, where So is the cross sectional area of the test piece.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: - The diameter of test piece shall be at least 10 mm in the parallel length. If the test piece cannot be taken from the web, a smaller diameter shall be agreed between manufacturer and purchaser.

7.2 VERIFICATION OF RESIDUAL STRESS

7.2.1 Two datum points 100 mm apart shall be marked, in the center of the thickness of the rim on the flat surface of the side opposite the flange. A radial saw cut from the top of the flange to the bore shall then be made half way between the top datum mark. 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 one mm. The test shall be carried out on un-machined wheel.

7.2.2 Gas cutting is also allowed as an alternative method for verification of residual stress. However, the closure should be not less than 2 mm in case of gas cutting.

7.3 RESIDUAL IMBALANCE

7.3.1 Unless otherwise specified in the order or its appended documents, the out of balance moment of the finished wheel shall not exceed the limits indicated in Table-1. For this purpose, the finished wheels shall mean where all parts of the wheel required to be machined have undergone their final machining. The exception is the case of the bore which is normally finished machined by the manufacturer responsible for the final assembly of the wheel to the axle.

TABLE-1
LIMITS FOR OUT OF BALANCE MOMENT

Sl. No.	Application	Maximum residual imbalance in gm-m	Symbol
1.	Wheels for stock running at a speed > 200 Kmph.	50	E1
2.	Wheels for stock running at a speed >120 and ≤ 200 Kmph	75	E2
3.	Wheels for stock running at a speed ≤ 120 Kmph.	125	E3

7.4 IMPACT TEST (U-NOTCH & V-NOTCH)

7.4.1 The impact test U-notch & V-notch shall be carried out in accordance with the requirements of IS: 1499 & IS:1757 respectively.

7.5 MACROSCOPIC EXAMINATION

7.5.1 The polished surface of the test piece shall be examined with a magnification 5x to 10x. HCL shall be used as etching reagent.

7.6 BRINELL HARDNESS

7.6.1 The brinell hardness test shall be carried out in accordance with the requirements of IS: 1500. The hardness survey test shall be carried out with a ball of nominal diameter of 5 mm for impressions close to the tread and 5 mm for impressions within the rim.

8.0 MECHANICAL PROPERTIES

8.1 The mechanical properties of the wheel shall be in accordance with the requirements of table 2.

A. Mechanical properties of rim:

TABLE – 2

Signature			
Name & Designation	Vinay Kumar Yadav, JE/Design/Carriage	U. P. Srivastava, SSE/Design/Carriage	Prabhat R. Shukla, Jt. Director/Stds./Carriage
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Tensile strength N/mm²	Yield Strength N/mm²	Minimum Elongation Percentage Gauge Length: 5.65 √So	Hardness range BHN	Minimum Impact strength in Joules at +20ºC.
See position 1 of figure 1				
820 – 940	≥ 520	14	241 to 320	Average value : 17 Individual value: 12

FOR LHB WHEELS ONLY:-

Tensile strength N/mm²	Yield Strength N/mm²	Minimum Elongation Percentage Gauge Length: 5.65 √So	Hardness range BHN	Minimum Impact strength (KU) in Joules at +20 ºC.	Minimum impact strength (KV) in joules at -20ºC
See position 1 of figure 1					
870 – 980	≥ 540	≥ 13	265 to 330	Average value : 17 Individual value: 12	Average value : 10 Individual value : 5

FOR Train-18, MEMU/US, EMU/US & VB WHEELS ONLY:-

Refer Para No. 4.2 (Table 2 - for Steel Grade to ER8) of EN 13262:2020 or latest.

B. Mechanical Properties of web:

- The mechanical properties of test piece removed from the rim-quenched wheels as shown in position 2 of Fig.1 shall be as under.

  Tensile strength : Maximum 760 N/mm^2
  Elongation %age : Minimum 16

- **FOR LHB WHEELS ONLY:-**

  Tensile strength : 750-850 N/mm²

  Reduction of tensile strength in web in comparison to tensile strength of rim on same wheel should be more than or equal to 120 N/mm².

- **FOR Train-18, MEMU/US, EMU/US & VB WHEELS ONLY:-**

  Refer Para No. 4.2 (Table 2 - for Steel Grade to ER8) of EN 13262:2020 or latest.

9.0 MATERIAL CLEANLINESS

9.1 MICROGRAPHIC CLEANLINESS

9.1.1 LEVEL TO BE ACHIEVED

9.1.1.1 It shall be measured by micrographic examination in accordance with clause 9.1.2. Values to be achieved are given in table 3.

TABLE 3

Type of inclusions	Thick series (Maximum)	Thin series (Maximum)
A (Sulphide)	1.5	2
B (Aluminate)	1.5	2
C (Silicate)	1.5	2
D (Globular Oxide)	1.5	2
B+C+D	3	4

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS:-

Type of inclusions	**Thick series (Maximum)**	**Thin series (Maximum)**
A (Sulphide)	1.5	1.5
B (Aluminate)	1.0	1.5
C (Silicate)	1.0	1.5
D (Globular Oxide)	1.0	1.5
B+C+D	2.0	3.0
DS	1.5	

9.1.1.2 In one single frame, either thick or thin & not both simultaneously should be reported.

9.1.2 LOCATION OF THE MICROGRAPHIC SAMPLE

9.1.2.1 The examination field is situated in the shaded area of figure 4. Its center "F" is situated 15 mm below the tread.

9.1.3 TEST METHOD

9.1.3.1 Determination of the level of cleanliness shall be made in accordance with the requirements of IS: 4163, method "A".

9.2 MICROSTRUCTURE EXAMINATION (FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY)

9.2.1 LEVEL TO BE ACHIEVED

The microstructure of wheel shall be fine pearlite structure with ASTM grain size 6 or finer. Bainitic structure in the microstructure is not acceptable.

9.2.2 LOCATION OF THE MICROSTRUCTURE SAMPLE

One sample shall be taken from the tensile test piece as shown in position 1 of figure 1.

9.2.3 TEST METHOD

It shall be examined by micrographic examination test with a magnification of 100X and 500X. Grain size shall be measured as per IS: 4748 / ISO 643 or using standard charts as per ASTM E112. Methods selected shall be agreed between manufacturer and purchaser.

10.0 TOUGHNESS CHARACTERISTIC OF RIM

10.1 GENERAL

10.1.1 This test shall be carried out on one in every 3000 wheels or part thereof for a supplier who has qualified as per clause 20.1 of the specification. For other manufacturer/supplier, who has not qualified, the test shall be carried out on one in every 500 wheels or part thereof upto first 3000 wheels.

10.2 VALUES TO BE ACHIEVED

10.2.1 The average value obtained from six test pieces shall be greater than or equal to 80 $N/mm^2\sqrt{m}$, and any single value shall not be below a minimum of 70 $N/mm^2\sqrt{m}$.

10.3 LOCATION OF TEST PIECES

10.3.1 Six test pieces shall be taken from the rim as indicated in figure 3. The test pieces shall be evenly distributed around the rim.

10.4 TEST METHOD

10.4.1 The test shall be performed according to ASTM E 399/90. The particular conditions which shall be used are as follows:

- Compact specimen CT: thickness of 30 mm (CT 30 specimen), with chevron notch with an aperture angle of 90º (figure 4 ASTM E 399/90).
- Temperature during the test to be between +15 ºC and +25 ºC.
- Measurement of the crack displacement of the specimen as indicated in figure 3 of ASTM E 399/90.
- Rate of increase of stress intensity ΔK/s should be within the range from 0.55 $N/mm^2\sqrt{m}$ /s to 1 $N/mm^2\sqrt{m}$ /s (clause 8.3 of ASTM E 399/90)

10.4.2 The value of the toughness to be considered shall be the value K_Q which is calculated from the value of the load F_Q from the load-displacement record.

11. SURFACE INTEGRITY

11.1 GENERAL

11.1.1 Surface integrity shall be determined by a magnetic particle test.

11.2 LEVEL TO BE ACHIEVED

11.2.1 The maximum indicated length of permissible surface breaking defects shall be, as follows, unless otherwise defined in the order.

- 2 mm on machined faces,
- 6 mm on black faces either forged or rolled.

11.3 TEST PIECE

11.3.1 Examination shall be made on the complete wheel after heat treatment, in the finished or part finished machined condition before corrosion protection is applied.

11.4 METHODS OF INSPECTION

11.4.1 General requirements for the magnetic particle test shall be defined according to IS: 3703-2004 (Reaffirmed 2020) or latest version, except that:

- The level of the surface magnetic induction shall be greater than 4 mT.
- The level of the lighting energy of ultra-violet light shall be greater than 15W/m^2.

11.4.2 The apparatus used shall scan the entire wheel surface and be able to detect the defects whatever their orientation.

11.5 The magnetic particle tests as per ISO 6933 / AAR 107/208 is also allowed as an alternative method. The judgment criteria shall be same as clause 11.2. The sampling plan and the number of checks and tests shall be as per table 4 of this specification.

11.6 After performing a magnetic particle examination, the wheels must be de-magnetized. Residual magnetism should be less than 4 A/cm.

12.0 NUMBER OF CHECKS AND TESTS

12.1 The sampling plan and the number of checks and tests to be carried out shall be as mentioned in table 4.

TABLE – 4

TYPES AND NUMBER OF TESTS

S. No	Type of checks and tests	Number of wheels per batch to be subjected to the checks & tests		Number of tests per wheel
		Total number of wheels in a batch		
		≤ 200	> 200	
1	Chemical Analysis	1	1	1

1a	Hydrogen Content (Train-18, MEMU/US, EMU/US & VB Wheel)	1	1	1 as per Annex F of EN 13262
2	Verification of residual stress	1	2	1
3	Rim Tensile Test	1	2	1
4	Web Tensile Test	1	2	1
5	Impact Test	1	2	3
6	a) Macroscopic Examination	1	2	1
	b) Metallographic* Examination (For LHB Wheels, Microstructure Examination)	1	2	1
7	Hardness Survey of rim	1	2	As per Cl. 6.7.2
8	Rim Hardness	100%	100%	1
9	Ultrasonic Flaw detection	100%	100%	1
10	Appearance and Dimensions	100%	100%	1
10a	Surface Condition	100%	100%	1 as per Para 4.6.1 of EN 13262
11	Balancing (where applicable)	100%	100%	1
12	Inclusion Cleanliness	1	2	1
13	Surface Integrity	100%	100%	1
14	Fracture Toughness	As per para 10.1		

* The microstructure of wheel shall be "Fine Pearlite structure with ASTM grain size 6 or finer".

13.0 RETESTS

13.1 Should a wheel fail in any of the above tests the purchaser or the inspecting officer shall select two more wheels from the same lot, and all of which may, with his permission, be reheat treated before the selection is made. Should either of the re-tested wheels fail to fulfill the conditions of any of the above tests, the manufacturer may, with the concurrence of the purchaser or the inspecting officer, reheat treat the bulk again, from which the purchaser or the inspecting officer shall select two more wheels for further tests. Should the results of these repeat tests be satisfactory, the wheels represented shall be held to have passed the test. Should either of these wheels fail to fulfill the conditions of the test, the wheels represented shall be rejected.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: -

Should a wheel fail in any of the above tests mentioned in table-4 (except S. Nos. 8, 9, 10, 11, 13 and 14), the inspecting official shall select two more wheels from the same lot and repeat the tests. If both of the pieces pass the tests, the lot will be accepted.

13.2 Only two reheat treatments shall be permitted in all.

FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS ONLY: -

If any of two test pieces fail, the lot shall not be accepted. However, the re-heat treatment of the unaccepted lot shall be carried out with the permission of purchaser/inspecting official, provided no such compromise with the dimensional aspect and other parameters as per the contractual obligation is done. Only two re-heat treatments shall be permitted at all.

14.0 ULTRASONIC FLAW DETECTION

14.1 All the wheels confirming to the stipulation of the above-mentioned clauses shall be subjected to ultrasonic testing and only those passing the test shall be accepted. Ultrasonic examination shall be done using on line testing equipment for 100% wheels. The equipment shall have facility for documentation of wheel Sr. No. vis-a-vis U.T. operator. The method of testing and acceptance standard shall be as given in Appendix 'A'.

14.2 Ultrasonic testing can also be carried out in phased array method, as per AAR-M107/208 specification, as an alternative method.

14.3. ULTRASONIC TESTING OF LHB, Train-18, MEMU/US, EMU/US & VB WHEELS

The method of Ultrasonic testing of LHB, Train-18, MEMU/US, EMU/US & VB wheels and acceptance standard shall be as per Appendix 'C' of this specification. For first 3000 wheels from supplier, rim, hub & web/plate of all wheels shall be subjected to ultrasonic testing. If no defect in web/plate is found in these 3000 wheels. Further supplies of wheels from that supplier shall be subjected to 100% UT on rim & hub and 20% UT on web/plate. If in these further supplies from that supplier, for a batch, even a wheel is rejected for UT on web/plate, UT of web/plate shall be checked for 100% wheels for the same batch.

15.0 ADDITIONAL TESTS

15.1 The Purchaser/Inspecting authority may, in case of reasonable doubt, also resort to other forms of testing such as magnetic particle examination, micro tests etc., as mutually agreed to between the Purchaser/ Inspecting authority and the manufacturer to satisfy that the wheels are free from defect of any kind.

16.0 INSPECTION

16.1 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 the manufacturer at any stage and to reject any material that does not conform to the terms of this specification. The Inspecting Officer or the Purchaser shall have the power to mark in some easily distinguishable manner all rejected wheels, but they shall not be marked in such a manner as to render them unsaleable to other parties.

16.2 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 analysis and other chemical and physical examinations which the manufacturer may make for his own purposes or under the terms of this specification, both of the wheels and / or other material in all stages of manufacture.

17.0 TESTING FACILITIES

17.1 The manufacturer shall supply the material required for testing, free of charge, and shall, at his own cost, furnish and prepare 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 carrying out the prescribed tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

18.0 PROTECTION

18.1 After inspection and approval, the wheels shall be cleaned of all rust, apply one coat of Red Oxide Zinc Chrome Primer to IS: 2074 followed by one coat of Ready Mixed Paint, Finishing, Bituminous Black, lead free, Acid, Alkali, Water and Chlorine Resistant to IS: 9862. The above method is applicable for the wheels except for the tread and bore areas (on these areas, suitable rust preventive compound shall be applied with approval of purchaser).

18.2 The manufacturer may use any other suitable alternate painting (surface protection) system consisting at least one coat of primer & at least one coat of paint, subject to approval of purchaser. Due consideration to hot & humid environment in India should be given in this regard. If alternate painting system is provided, method /details for touch up & maintenance of such painting system during operation & maintenance of these wheels shall also be provided with relevant reference standards. Wheels are to be supplied in painted condition. Safe transportation of solid forged wheels shall be the responsibility of supplier ensuring that no damage or corrosion during transit.

18.3 Effective protection of finish-machined parts of the wheels against impact damage during transit shall be ensured by the supplier before dispatch.

18.4 For Train-18, MEMU/US, EMU/US & VB Wheels : the following specifications for painting scheme shall be used:

(a) Primer: "High Build Epoxy Paint (Two Pack)" conforming to RDSO Specification No. M&C/PCN/111/2018

(b) Fluoropolymer as per Japanese Industrial standard JIS K 5659:2008 (Long durable paints for steel structures) - Class- 1 as an Intermediate Coat.

(c) Fluoropolymer as per Japanese Industrial standard JIS K 5659:2008 (Long durable paints for steel structures) - Class-1 as a Top Coat.

19.0 GUARANTEE

19.1 The wheel shall be guaranteed by the supplier for five years against any defect attributable to the manufacture and not revealed during the acceptance inspection.

19.2 This period shall be calculated from the end of the month stamped on the wheel.

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

19.4 Wheels, which during their guarantee period show defect making them either unfit for service or reducing their period of life will be rejected.

19.5 When two wheels from the same cast/heat have failed in service, or when more than 5 % of the wheels from the same cast reveal defects which are inherent to material quality including its soundness, the purchaser shall have the right to reject the entire cast.

19.6 Rejected wheels shall be made available to the supplier with a view to arrange their replacement or reimbursement.

20.0 MANUFACTURER'S QUALIFICATION / PRODUCT QUALIFICATION

20.1 GENERAL

20.1.1 Before acceptance for regular use by Indian Railways, a wheel shall be qualified.

20.1.2 This clause defines the requirements and the procedures to be applied for the product qualification.

20.1.3 Qualification of a wheel is directly linked to the supplier, and a wheel can only be considered for qualification if the supplier follows the requirements defined in clause 20.2.

20.1.4 The requirements and the procedures of this clause apply only to wheels for which the design has been approved:

- Either by a previous use on Indian Railways;
- Or by a recognized technical approval procedure

20.1.5 The requirements are to be applied in the following cases:

- Any wheel from a new supplier;
- Any non-qualified wheel from a supplier, when its geometry is appreciably different to qualified wheels from this supplier (shape and thickness of the web, diameter, etc.)
- Any change in the manufacturing process of a producer for a qualified wheel.

20.1.6 A supplier who has already supplied more than 3000 wheels of the tendered design to Indian Railways and minimum 300 numbers of such wheels have run satisfactorily for more than two years will be deemed to have qualified for the particular design and shall not require to undergo the qualification procedure as in para 20.0.

20.1.7 The manufacturers who are not qualified will not be given order for more than 3000 number of wheels. However, the limit of 3000 wheels may be exempted/relaxed for those

internationally reputed wheel manufacturers whose wheels have run satisfactorily for at least five years on passenger coaches at speeds more than 160 Kmph on any international railway system and have also supplied wheels of different design(s) to Indian Railways but conforming to this specification. Such supplier shall however, with his offer, submit evidence of conformance to Clause 20.2 of the specifications and furnish documentation in accordance with Clause 20.3.2.

20.1.8 The limit of 3000 Nos. of wheels is to be treated as a regular order with a cap in case of non - qualified manufacturers, or vendors not covered under internationally reputed manufacturers.

20.1.9 If performance of wheels supplied by a qualified manufacturer is unsatisfactory, the manufacturer may be asked to re-qualify for supply to Indian Railways.

20.2 REQUIREMENTS

20.2.1 REQUIREMENTS FOR THE SUPPLIER

20.2.1.1 GENERAL

20.2.1.1.1 When manufacture of a wheel involves more than one supplier, the following requirements shall be satisfied by all concerned.

20.2.1.2 QUALITY ORGANIZATION

20.2.1.2.1 The supplier shall operate a quality assurance system conforming to ISO 9001-2000.

20.2.1.2.2 **For <u>LHB, Train-18, MEMU/US, EMU/US & VB</u> Wheels:**
The supplier shall have quality assurance program certification for manufacture of wheels from AAR or any other reputed organization/agency for the purpose.

OR

The supplier must have supplied solid forged wheels with design potential for operation at 160 kmph or higher to any reputed Railway.

20.2.1.3 STAFF QUALIFICATION

20.2.1.3.1 Staff trained in non-destructive testing shall be qualified in accordance with BS EN ISO 9712:2012 (or latest) OR JIS Z2305 or equivalent.

20.2.1.4 EQUIPMENT

20.2.1.4.1 The equipment used by the supplier for production, control and monitoring, shall allow the requirements of this standard to be satisfied.

20.2.2 REQUIREMENTS FOR THE PRODUCT

20.2.2.1 The product shall be in accordance with the product requirements listed in this specification. Traceability of each wheel must be established after its heat treatment.

20.3 QUALIFICATION PROCEDURE

20.3.1 GENERAL

20.3.1.1 The qualification procedure for the product comprises four successive stages.

- Provision of documents by the supplier;
- Evaluation of the manufacturing equipment and production processes;

- Laboratory tests;
- Service experience of wheels.

20.3.2 DOCUMENTATION REQUIRED

20.3.2.1 At the time of tender, the manufacturer shall provide a document that comprises:

- A description of the wheel:
- A description of the company stating:
  - Company size (number of people employed, defining the proportion between manufacture, control and quality assurance),
  - Production per year of all products,
  - A list of all the means of manufacture and quality control;

- Data about the company organization with the appropriate organization charts;
- A description of manufacturing processes with descriptions of the different stages of manufacturing;
- Details of supplies to Indian Railways, if the product has been previously qualified.
- Bidders/Manufacturers shall submit the details in support of their qualification as "Internationally reputed manufacturer" in the format below.

Sl No	Purchase Order Number and Date	Name of Passenger Service (with Operation Speed > 160 kmph)	Date of Supply	Quantity Supplied	Details of Wheels Supplied to Indian Railways conforming to this specification.

20.3.3 EVALUATION OF MANUFACTURING EQUIPMENT AND THE PRODUCTION PROCESSES

20.3.3.1 This evaluation comprises:

- An inspection of the manufacturing plant and examination of the process.
- An inspection of the raw material manufacturing plant and examination of its production process.
- Auditing of the manufacturing organization against the requirements of 20.2.1
- Auditing of the information provided in the documents referred to in 20.3.2.
- Data about raw materials with the list of suppliers;

20.3.4 LABORATORY TESTS

20.3.4.1 All characteristics defined in this specification, shall be proven on wheels produced by the manufacturer's standard processes.

20.3.4.2 A report shall be drawn up at the end of this stage, describing the test pieces, the test carried out as well as test results. It shall specify whether or not the wheels are in compliance with the requirements.

20.3.5 TESTING OF WHEELS

20.3.5.1 OPERATIONAL TESTING

20.3.5.1.1 The first minimum 300 number of wheels supplied shall be specially monitored in service as per monitoring scheme given in appendix B. It shall contain:

- Type and extent of intermediate and final inspections;
- Time period for the testing.

20.3.5.2 RESULTS OF TESTING

20.3.5.2.1 The product (wheel to a particular design) shall be deemed as qualified at the earliest after two years after the first 300 wheels have entered service, provided that the performance recorded does not deviate repeatedly from the acceptance criterion given in table 4 of clause 12 of this specification.

20.4 QUALIFICATION

20.4.1 Based on the successful completion of the above, the manufacturer will be qualified for supply of wheels to Indian Railways. The qualification shall be limited in validity for:

- Wheels diameters;
- Web thickness and shapes.

20.4.2 If the customer records significant defects on the product, the relevant parts of the qualification procedure shall be repeated.

20.4.3 If the supplier has not respected important conditions of the qualification, it may be cancelled.

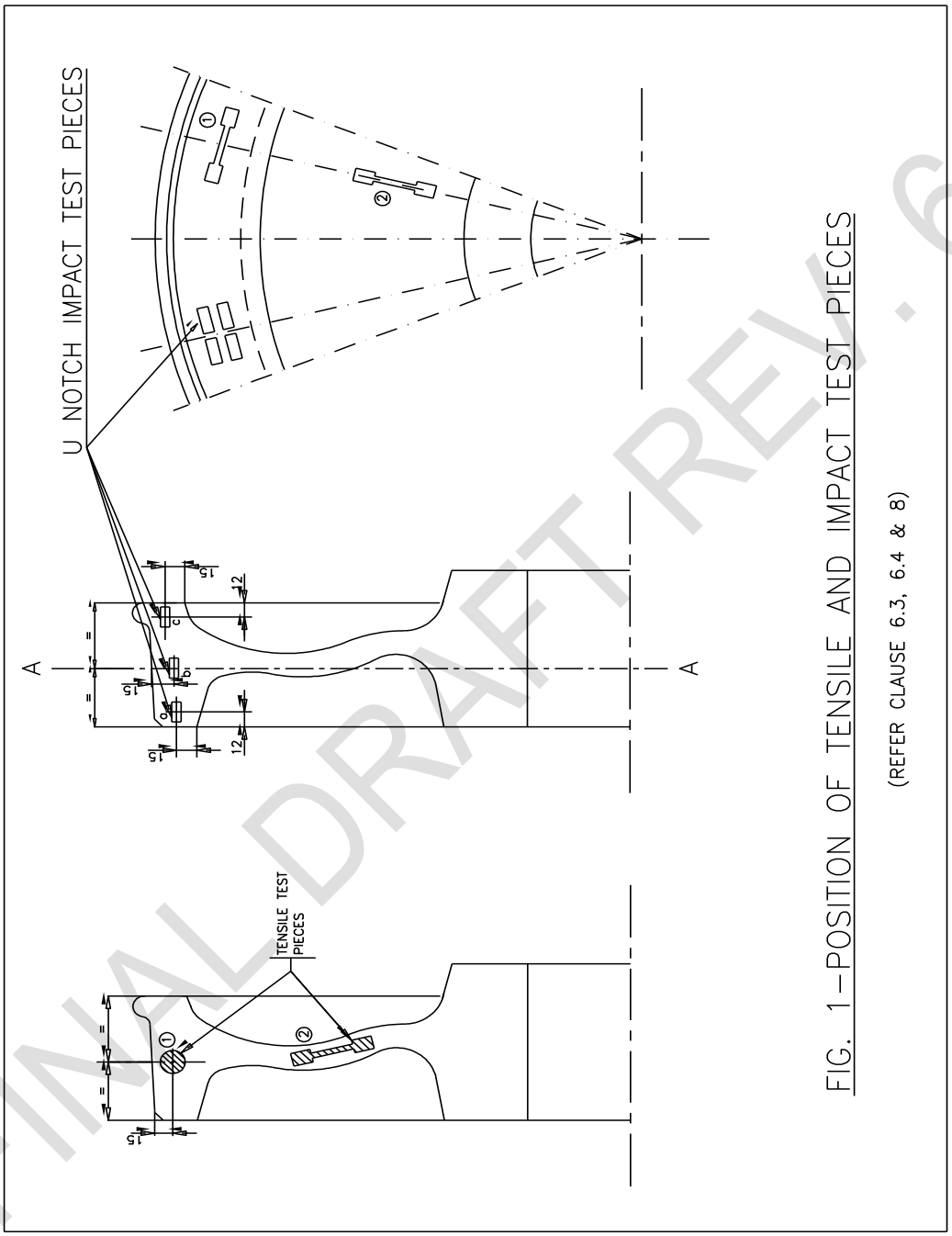

FIG. 1—POSITION OF TENSILE AND IMPACT TEST PIECES

(REFER CLAUSE 6.3, 6.4 & 8)

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	Prepared by	**Checked by**	**Approved by**

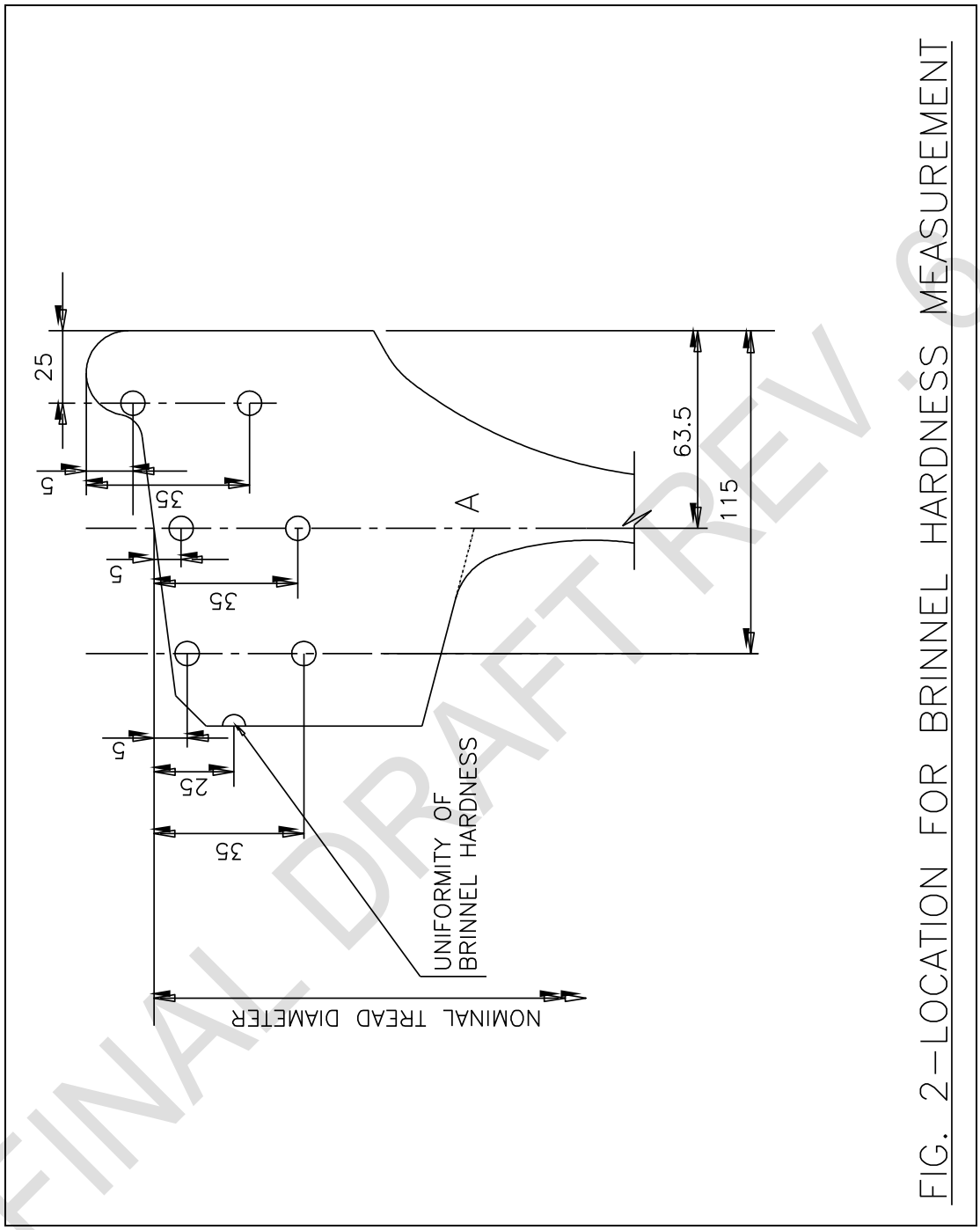

FIG. 2—LOCATION FOR BRINNEL HARDNESS MEASUREMENT

(REFER CLAUSE 6.7)

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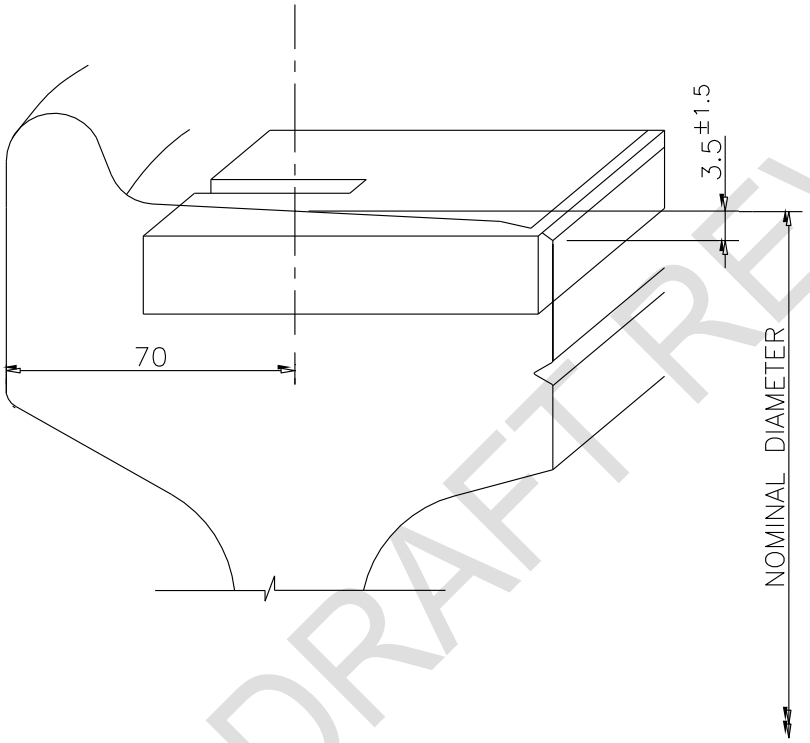

FIGURE 3

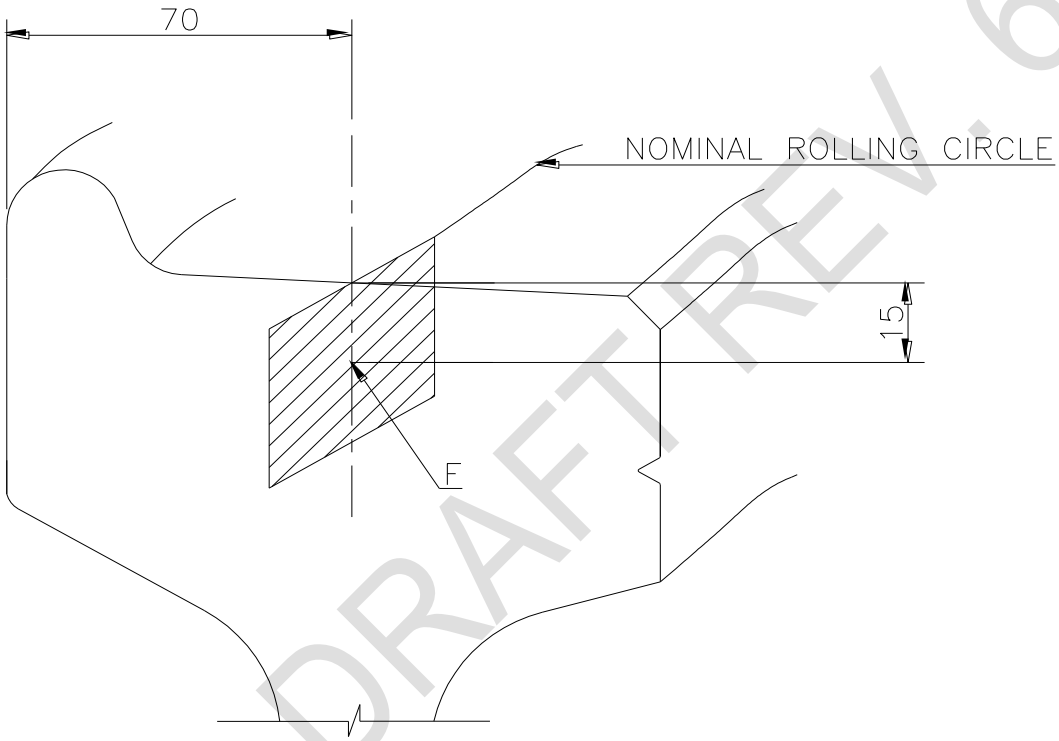

FIGURE 4

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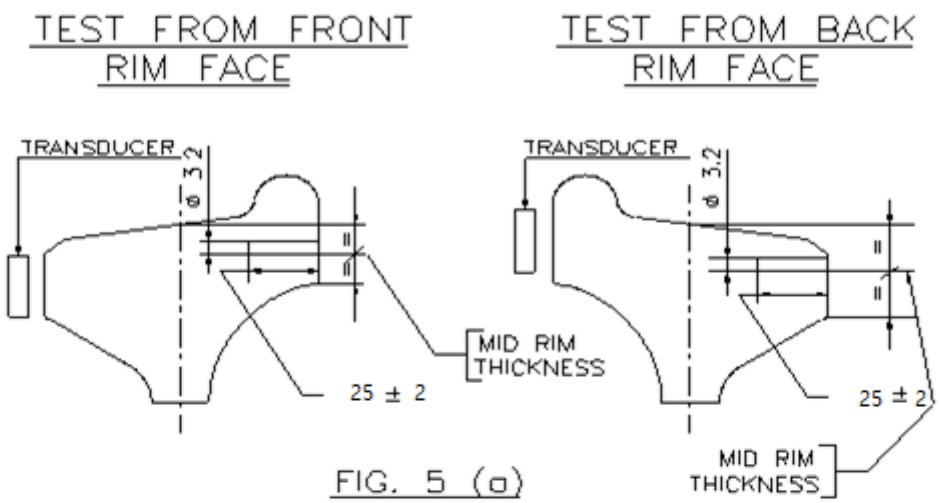

FIG. 5 (a)

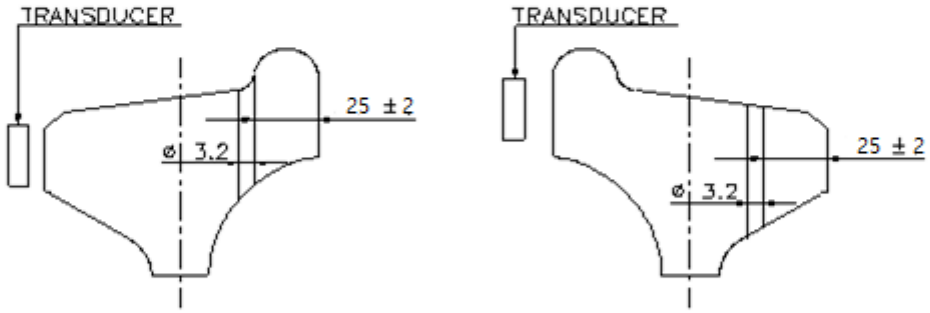

FIG. 5 (b)

FIG. 5– REFERENCE STANDARDS FOR ULTRASONIC TESTING OF THE WHEEL RIM

(REFER CLAUSE A-2-6 (a), A-4 & A-5)

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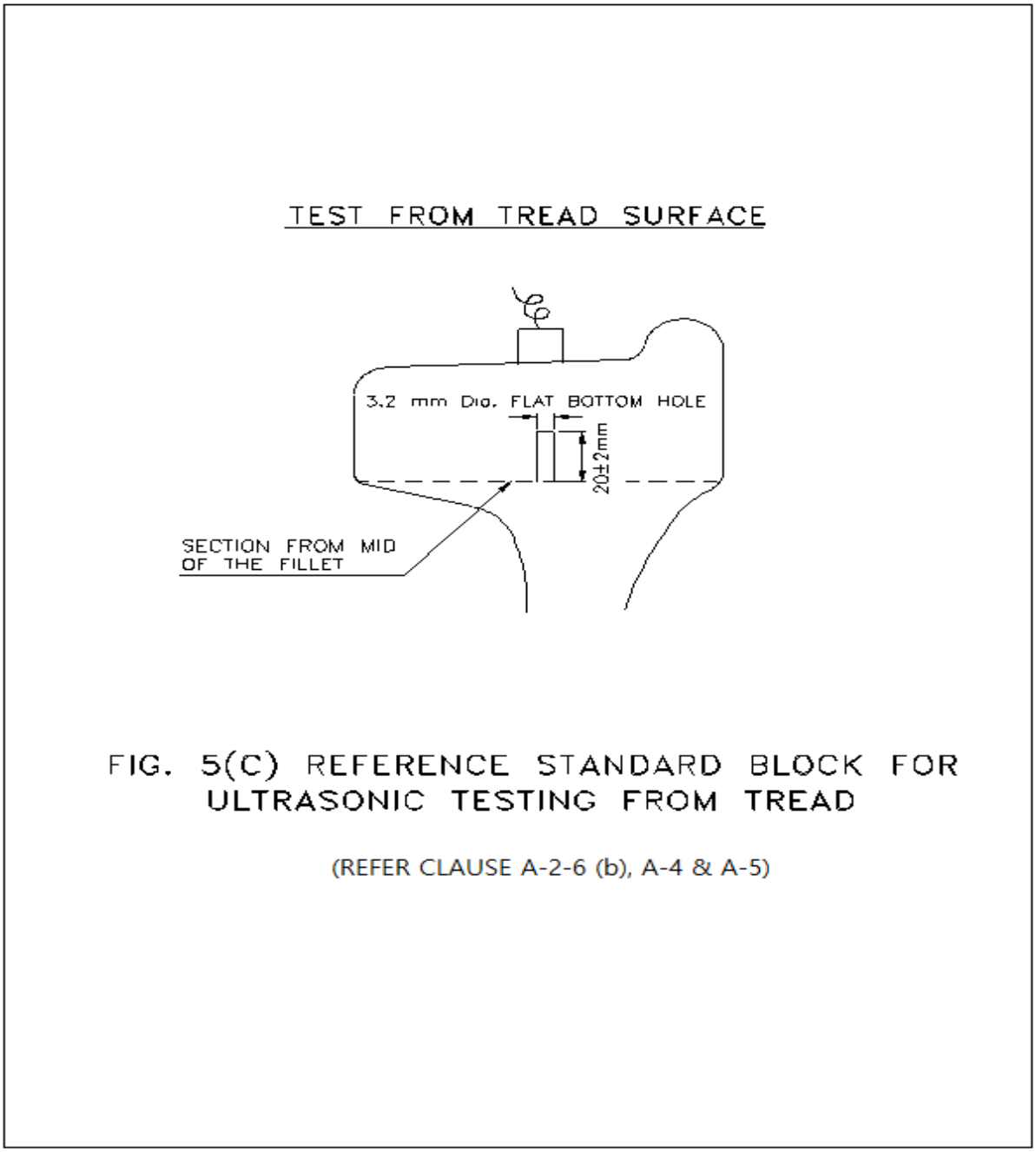

FIG. 5(C) REFERENCE STANDARD BLOCK FOR ULTRASONIC TESTING FROM TREAD

(REFER CLAUSE A-2-6 (b), A-4 & A-5)

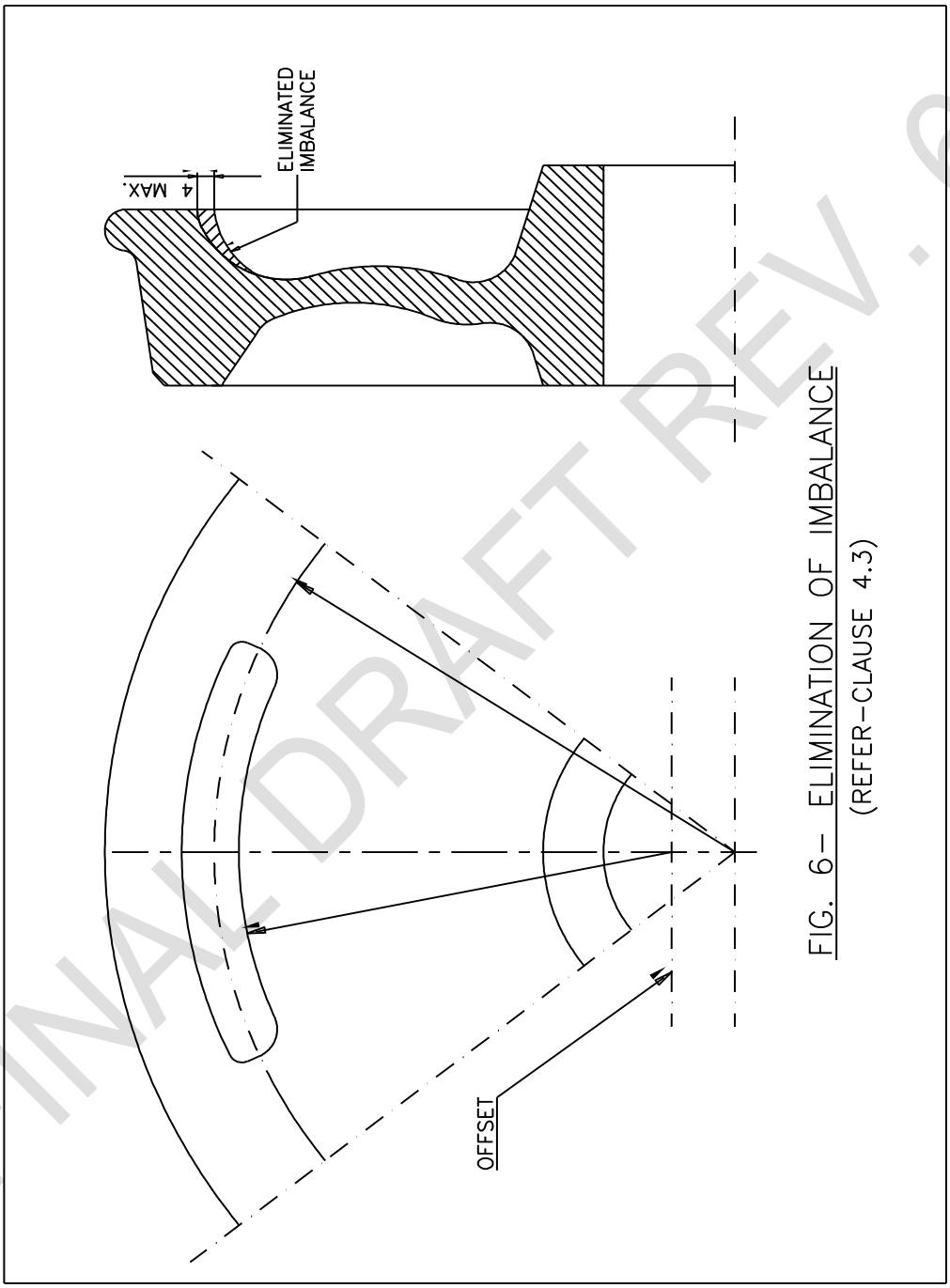

FIG. 6– ELIMINATION OF IMBALANCE
(REFER–CLAUSE 4.3)

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APPENDIX -A
(Clause-14)

Method of Ultrasonic Testing and Acceptance standard for Wrought Steel Wheels

A-1 For detecting radial defects and flaws oriented circumferentially in the rims of wrought steel wheels, ultrasonic inspection shall be made by following the procedure shown below and by using equipment which complies with the following requirements.

A-2 **Equipment**

A-2-1 The instrument shall have a pulse echo transmitter and receiver and shall have an operating frequency range of 2 to 5 MHz. for the test method employed. Ultrasonic examination shall be carried out using on line facility. For determination of final rejection, manual Ultrasonic equipments approved by the purchaser may be employed.

A-2-2 The transducers shall be of normal (0°) type composed of highly sensitive Piezo-electric ceramics crystal operating 2 to 2.5 MHz. and of 18-20 mm diameter.

A-2-3 An automatic flaw alarm system shall preferably be used in conjunction with the Ultrasonic instrumentation.

A-2-4 A suitable couplant shall be used between the test surface and the transducer. An immersion testing technique could be used to facilitate automatic in line testing.

A-2-5 **Calibration Block:** 50x50x50 mm Block of steel to grades 45C8 of IS: 1875.

A-2-6 **Standard reference blocks:** Reference blocks shall be made from wheel conforming to this standard in all respects.

(a) **For rim testing**- For rim testing the reference standard block shall be taken from the portion of rim having 3.2mm dia. flat bottom hole drilled perpendicular to the rim face and to the depth of 25 ± 2 mm at the mid thickness of the rim, see Fig.5 (a). An alternate reference block may also be used as mentioned in Fig. 5 (b).

(b) **For tread testing** – For tread testing the reference standard block shall be taken from a portion of wheel having 3.2 mm dia. flat bottom hole drilled from opposite to tread surface Fig. 5 (c) to the depth of 20 ± 2 mm. The tread surface of the reference piece shall be free from rough turning marks and surface finish shall be 6.3 microns or better.

A-3 **Time of Inspection**

Inspection shall be performed after final thermal processing.

A-4 **Procedure for range Calibration and sensitivity setting**

A-4-1 Set the time base of Ultrasonic Flaw detector using 0° longitudinal wave with help of Calibration block as mentioned in para A-2-5 for 200 mm.

A-4-2 **Sensitivity setting**

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(a) For rim testing the instrument sensitivity level shall be adjusted to produce an echo of 60% height of vertical scale of CRT using standard reference block as mentioned in para A-2-6 (a). This gain level shall be reference gain for acceptance or otherwise for the wheel.

(b) For testing from tread, the instrument Sensitivity level shall be adjusted to produce an echo of 60% height of vertical scale of CRT using standard reference block as mentioned in para A-2-6 (b). This gain level shall be reference gain for acceptance or otherwise for the wheel.

A-5 **Scanning**

A-5-1 Wheels shall be inspected axially from either the front or back rim face by manual or automatic scanning, see Fig. 5 (a) & 5 (b).

A-5-2 One or more transducers shall be designed and located to give maximum coverage of the rim section. Maximum possible area shall be scanned.

A-5-3 In case of automatic scanning, the speed of scanning shall permit detection of the reference standard discontinuities.

A-5-4 Wheels shall also be inspected by probing from the tread surface as per the procedure mentioned below:

A-5-4-1 Increase the gain level by 6 dB over and above the gain level described at para A-4-2 (b).

A-5-4-2 Apply couplant on the tread surface, place the probe on this face and scan entire circumference of the wheel, no back echo will appear on the screen.

A-5-4-3 Care shall be taken during probing to cover full width of the tread.

A-5-4-4 In case flaw signal is observed reduce the gain by 6dB.

A-6 **Rejection criteria**

A-6-1 Any wheel with an individual flaw indication equal to or larger than that obtained from the reference discontinuities shall be cause for rejection (in both case i.e. probing from rim side or from tread).

A-6-2 The number of flaw signal of amplitude ≥20% and <60% shall not be more than 5 probing locations for tread & rim combined.

A-6-3 The distance between two consecutive defects of signal amplitude ≥20% and <60% shall not be less than 20 mm, if it is less, it will be a cause for rejection.

A-6-4 Ultrasonic indications resulting from wheel geometry or spurious signals due to other reasons shall not be a valid cause for rejection. In the event of any dispute regarding the nature of signal, the decision of the Inspecting authority shall be final and binding.

A-6-5 When automated equipments are employed, the final disposal of the rejectable wheel may be determined by Manual testing of questioned area.

A-7 **Marking**

A-7-1 Wheels conforming to the above stipulation shall be marked /stamped UT as a token of acceptance. Wheels not conforming to the stipulation shall be defaced and records for the same maintained.

APPENDIX - B

(Clause-20.3.5.1)

MONITORING SCHEME FOR QUALIFICATION OF FORGED WHEELS OF NON-QUALIFIED MANUFACTURERS

1. OBJECTIVES

As specified under clause 20.1.1 of RDSO specification No. R-19/93 Part II (Rev.6), Before acceptance for regular use by Indian Railways, a wheel shall be qualified.

As per clause 20.1.6 supplier who has already supplied more than 3000 wheels of the tendered design to Indian Railways and minimum 300 numbers of such wheels have run satisfactorily for more than two years will be deemed to have qualified for the particular design and shall not require to undergo the qualification procedure as in para 20.0.

As per clause 20.3.5.1.1 of the specification R-19/93 Part II (Rev.6), the first 300 Nos. of wheels supplied shall be specially monitored in service.

2. REPORTING RAILWAYS

User Railways will nominate one officer and a supervisor to co-ordinate and monitor the service performance.

3. NUMBER AND TYPE OF ROLLING STOCK

300 Nos. of prototype forged wheels manufactured as per RDSO specification No. IRS R-19/93 Part-II (Rev.6) shall be fitted on Carriages/Wagons/EMU stock of Indian Railways by user Railway. The rolling stock numbers on which wheel sets have been fitted should be recorded in the Proforma-I.

4. PERIOD OF MONITORING

Monitoring period for field service of first 300 Nos. of non-qualified wheels will be 2 years. The frequency of monitoring of these wheels shall be half yearly (6 months). In the first inspection of monitoring, if certain defects are noticed the service period shall be increased suitably.

5. AGENCY FOR SUBMISSION OF REPORTS

GM (Mechanical/Electrical) of user Railway shall submit reports to RDSO.

6. COORDINATING OFFICER AT RDSO

Nominated Officer at RDSO, Lucknow will be the overall Co-Ordinator.

7. FITMENT OF WHEELS AT WORKSHOPS

a. Wheels shall be fitted on Carriages/Wagons/EMU stock of Indian Railways in accordance with Para 3 and details submitted to RDSO.

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b. For easy identification of the wheels, it should be ensured that the wheels are painted yellow on both sides of the web and following legend is painted with blue paint on the bogie frames of each Rolling stock on which wheels have been fitted.
"FORGED WHEELS FOR QUALIFICATION"

c. The Rolling stock numbers and bogie numbers shall be recorded in Proforma-I and passed on to DG (Carriage), RDSO, Lucknow.

8. MONITORING OF WHEELS IN WORKSHOPS AND OPEN LINE

a. Constant monitoring is to be carried out to assess the suitability and life of prototype wheels, of non-qualified manufacturer, on Carriages/Wagons/EMU stock of Indian Railways.
b. The workshop/PU should measure the initial tread diameter of wheels before putting the coaches/wagons/EMU stock into service.
c. During IOH/ROH/POH of Rolling stock, Railways should ensure that as far as possible both bogies of the nominated coaches/wagons/EMU stock are provided with these wheels only.
d. For easy identification of the wheels under qualification, Railways should ensure that during IOH/ROH/POH of coaches/wagons/EMU stock, the service wheels are re-painted yellow on both sides of the wheel web and the following legend is painted with blue paint on the bogie side frames of each Rolling stock under which the wheels have been provided.
"FORGED WHEELS FOR QUALIFICATION"
e. Wheels shall be inspected once a month in accordance with CMI-K003 and report submitted to RDSO in Proforma-II with respect to any defect under CMI-K003. In case of any rejectable defect as per CMI-K003, these wheels shall be withdrawn from service and DG (Carriage), RDSO, Lucknow and manufacturer advised to inspect wheels.
f. Whenever any of these wheels is taken up for tread re-profiling whether during IOH/ROH/ POH or out of course, particulars as per Proforma-III should be recorded and quarterly statements should be sent to DG (Carriage), RDSO, Lucknow.
g. Whenever such a wheel set has to be removed for repairs, as far as possible it must be put back under the same coaches/wagons/EMU stock. The period for which the wheel set would remain out of service, shall be recorded under Proforma-IV.
h. If the wheel set removed for repairs undergoes dismounting of any of its wheels, the wheel set shall be taken out from the qualification process.
i. In case any wheel is detected to have any major defects like thermal cracks etc., at any time during life span of these wheels, then such a wheel should be immediately removed from service and DG (Carriage), RDSO, Lucknow and manufacturer advised for further disposal.

In order to calculate the life of each wheel, it is essential to maintain the master sheet (as per specimen enclosed) with data duly filled in, against each wheel. Wheels should be identified by their individual consecutive numbers and batch numbers.

9. PRECAUTION AGAINST TEST COACHES/WAGONS/EMU STOCK / WHEEL SETS GETTING LOST

It should be ensured that all the coaches/wagons/EMU stock under which the prototype wheels have been provided shall run in nominated rakes.

10. RESULTS OF TESTING

The product (wheel to a particular design) shall be deemed as qualified at the earliest after two years after the first 300 wheels have entered service, provided that the performance recorded does not resulted in any repeated problem from the acceptance criterion given in table 4 of the specification No. IRS R-19/93 Part II (Rev.5).

11. SUBMISSION OF REPORTS

Quarterly, a report shall be sent to DG (Carriage), RDSO, Lucknow, enclosing Proforma I to IV.

Encl.: Proforma-I to IV and Master sheet

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

PROFORMA-I

Sl. No.	Wheel Number	Bogie Number	Rolling Stock No.

PROFORMA-II

MONTHLY PROFORMA TO BE FILLED BY WORKSHOPS/COACHING DEPOT

Sl. No.	Rolling Stock No.	Bogie No.	Wheel No.	Defects as per CMI-K003
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Signature			
Name & Designation	Vinay Kumar Yadav, JE/Design/Carriage	U. P. Srivastava, SSE/Design/Carriage	Prabhat R. Shukla, Jt. Director/Stds./Carriage
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PROFORMA-III

PROFORMA TO BE FILLED IN BY POH WORKSHOPS WHILE TURNING FORGED WHEELS OF NON QUALIFIED MANUFACTURERS

(Consolidated statement to be submitted Quarterly by the Railways)

A. Type of defects

1. Thermal crack
2. Flat spots
3. Sharp flange
4. Thin flange
5. Hollow tread
6. Shelling
7. Spalling
8. Any other defect (Elaborate)

Sl. No.	Wheel Consecutive No.	Diameter before turning	Diameter after turning	Reason for turning (*)	Whether turning during POH/IOH/ROH/ Out-of-course	Date of tyre turning	Code of POH/IOH/ROH depot or workshop	Earned Kilometer
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
01.								
02.								
03.								
04.								
05.								
06.								
07.								
08.								
09.								
10.								

(*) State only defect Nos. 1, 2, 3, 4 etc. whatsoever under col. (5)

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

PROFORMA-IV

STATEMENT SHOWING IDLE PERIOD OF FORGED WHEELS UNDER QUALIFICATION

(TO BE MAINTAINED BY BASE MAINTENANCE DEPOTS/EMU CAR SHEDS)

Sl. No.	Axle No.	Consecutive No. of the wheel	Removal Date of wheel set for repairs	Rolling Stock No.	Fitment Date of wheel set after repairs	Rolling Stock No.	Idle period

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

MASTER SHEET

(TO BE MAINTAINED BY NOMINATED WORKSHOPS AND RAILWAY HEADQUARTERS)

Name of reporting Railway:……
Name of nominated POH workshop:…….
Name of ROH/IOH Depot/Workshop:……..

TYPE OF DEFECTS

1. Sharp flange
2. Thin flange
3. Hollow tread
4. Flat spots
5. Thermal cracks
6. Shelling
7. Spalling
8. Any other defect

DETAILS REGARDING TYRE TURING OF FORGED WHEELS

Sl No.	Axle No.	**INITIAL DETAILS**				**TYRE TURNING DURING IOH/ROH**					**OUT OF COURSE TYRE TURNING, IF ANY**					**TYRE TURNING DURING Ist POH**					**TYRE TURNING DURING IOH AFTER Ist POH**					**OUT-OF-COURSE TYRE TURNING AFTER Ist POH**					**TYRE TURNING DURING SECOND POH**					**LIFE OF WHEEL**		
		Cast / Consecutive No.	Coach No.	Date put into service	Initial tread dia in mm.	Tread dia before turning	Tread dia after turning	Reasons for turning	Date put into service	Earned kilometer	Tread dia before turning	Tread dia after turning	Reasons for turning	Date put into service	Earned kilometer	Tread dia before turning	Tread dia after turning	Reasons for turning	Date put into service	Earned kilometer	Tread dia before turning	Tread dia after turning	Reasons for turning	Date put into service	Earned kilometer	Tread dia before turning	Tread dia after turning	Reasons for turning	Date put into service	Earned kilometer	Tread dia before turning	Tread dia after turning	Reasons for turning	Date put into service	Earned kilometer	Average rate of wear	Average rate of cutting during turning	Life of wheel

Signature			
Name & Designation	U.P.Srivastava, SSE/Stds./Carriage	Pawanjeet Singh, SSE/Stds./Carriage	Prabhat R Shukla, Jt. Director/Stds./Carriage
	Prepared by	**Checked by**	**Approved by**

APPENDIX-'C' (Clause 14)

METHOD OF ULTRASONIC TESTING AND ACCEPTANCE STANDARD FOR LHB, Train-18, MEMU/US, EMU/US & VB WHEELS

C-1 General

Internal integrity shall be defined from Ultrasonic examination. Standard defect is a flat-bottom hole with specified diameter as per EN 13262:2020 or latest. It is also clarified that as operational speed of LHB coach does not exceed 200 km/h. LHB, Train-18, MEMU/US, EMU/US & VB wheel shall fall under "Category 2 wheels" for the purposes of interpretation of EN 13262:2020 or latest for this clause. The probe frequency shall be 4 MHz or higher.

C-2 Level to be achieved

C-2-1 **Rim**

The rims shall have no internal defects which give echo magnitudes higher than or equal to those obtained for a standard defect situated at the same depth. To apply the rejection criteria a DAC (Distance Amplification Curve)/ DGS (Distance Grain Size) curve is required to be drawn. The diameter of this standard defect is as per EN 13262:2020 or latest. It is also clarified that as operational speed of LHB coach does not exceed 200 km/h. LHB, Train-18, MEMU/US, EMU/US & VB wheel shall fall under "Category 2 wheels" for the purposes of interpretation of EN 13262:2020 or latest for this clause. There shall be no attenuation of the back echo greater than or equal to 4 dB should be tolerated when examining the rims in the axial examination. The distance between two consecutive acceptable defects shall not be less than 20 mm. if it is less, it will be a cause for rejection.

Ultrasonic indications resulting from wheel geometry or spurious signals due to other reasons shall not be a valid cause for rejection. In the event of any dispute regarding the nature of signal, decision of the Inspecting Authority shall be final and binding. When automatic equipments are employed, the final disposal of the rejectable wheel may be determined by manual testing of questioned area.

C-2-2 **Web**

The web shall not have:

- more than 10 flaw echoes with magnitudes greater than or equal to those obtained for standard defects of ø 3 mm;
- echoes with magnitudes greater than or equal to those obtained for standard defects of ø 5 mm.

The distance between two acceptable defects shall be at least 50 mm.

C-2-3 **Hub**

The hub shall not have:

- more than 3 flaw echoes with magnitudes greater than or equal to those obtained for standard defects of ø 3 mm;
- echoes with magnitudes greater than or equal to those obtained for standard defects of ø 5 mm.

The distance between two acceptable defects shall be at least 50 mm.

For the same circumferential examination, no attenuation of the back echo equal to or greater than 6 dB is permitted.

C-3 Test Piece

Examination shall be made of the complete wheel, after heat treatment, either in rough machined condition or in the complete finish machined condition, before corrosion protection is applied.

C-4 Methods of examination

C-4-1 General

The general conditions for ultrasonic examination are given by ISO 5948:1994 or latest in accordance with the following special conditions:

C-4-2 Rim

The rim examination shall be made according to the D1 (Axial testing) and D2 (Radial testing) methods of Table-1 of ISO 5948:1994 or latest.

Defect estimation shall be made by comparison to artificial defects in the standard rim described by Figures 1 and 2 of ISO 5948:1994 or latest.

C-4-3 Web

The web examination shall be made from its two faces. The direction of the examination is perpendicular to the surface. Defect estimation shall be made by comparison to artificial defects in a standard web.

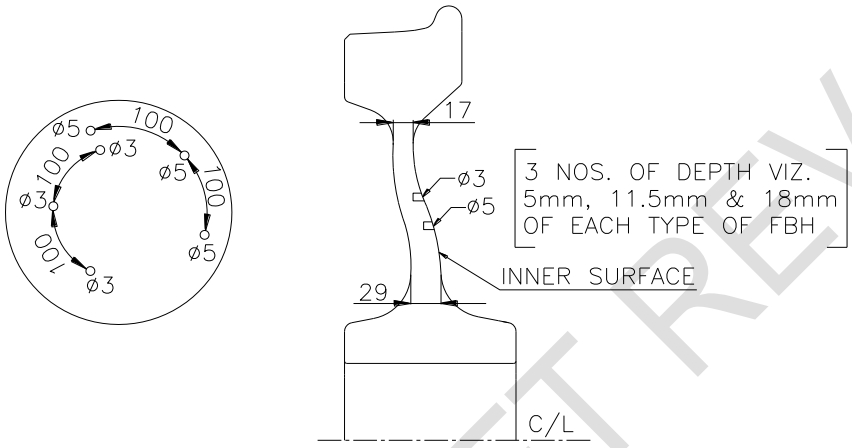
The web is defined as the part of the wheel between the two diameters where “m” (thickness of web near rim side) and “n” (thickness of web near hub side) are defined. The thickness “e” of the web is defined as:

$$e = \frac{m+n}{2}$$

$$= \frac{\mathbf{17 + 29}}{\mathbf{2}} = \mathbf{23}$$

The location of the artificial defects is given as below. They shall be at least 100 mm apart in a circumferential orientation.

- Three 3 mm diameter flat bottom holes located at 5 mm, e/2 mm i.e. 11.5 mm and (e – 5) mm i.e. 18 mm below the inner surface of the web.
- Three 5 mm diameter flat bottom holes located at 5 mm, e/2 mm i.e. 11.5 mm and (e – 5) mm i.e. 18 mm below the inner surface of the web.
- DAC (Distance amplification curve) / DGS (Distance Grain Size) has to be applied.
- Following is the sketch of reference standard block.



NOTE: - All dimensions are in mm

Figure-A Standard web for ultrasonic examination

C-5 **Hub**

The hub examination shall to be made from its two faces. The direction of the examination shall be perpendicular to the surface.

Defect estimation shall be made by comparison to artificial defects in the standard hub described by the following figure-B. The rejection to be applied after drawing DAC/DGS curves for 3 mm ø & 5 mm ø defects.

Depth of simulated defects (3 mm dia & 5 mm dia) is mentioned as per following sketch (Fig. B)

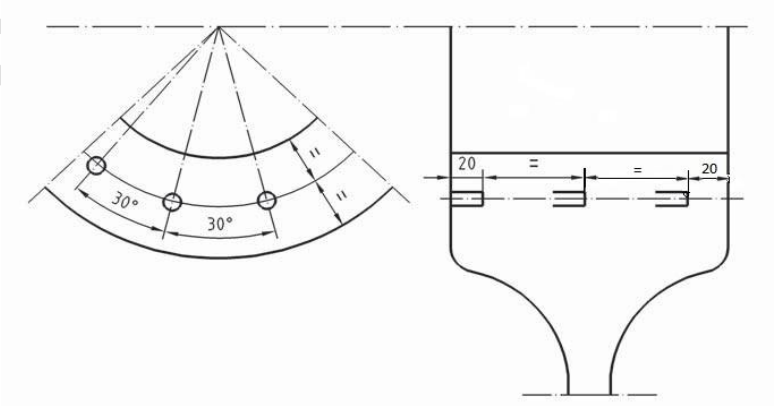


Figure B — Standard Hub for Ultrasonic Examination

Signature			
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DAC (Distance Amplification Curve) / DGS (Distance Grain Size)

NOTE: Calibration references are:

- Three 3 mm diameter holes located at different depths

- Three 5 mm diameter holes located at different depths spaced as shown in the figure B.

C-6 **Marking**

Wheels confirming to the above stipulation shall be marked/stamped UT as a token of acceptance. Wheels not confirming to the stipulations shall be defaced and record for the same shall be maintained.

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