The issues raised by Wheel Manufacturers against IRS specification No. R 19/93 Part-II (Rev.5) and Draft Rev.6 were discussed in detail during VC on 08.02.2024 and the same is mentioned below:

1	2	3	4	5	6	7	8	9	10	11
SN	**Clause No.**	**Description**	**Comments of DSP/SAIL**	**Comments of RINL**	**Comments of M/s TZ**	**Comments of M/s Nippon Steel**	**Comments of M/s Stork**	**Comments of M/s Lucchini**	**Comments of ICF**	**RDSO Remarks**
1	1.0 1.1	SCOPE 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. 'a' or latest for Trailer Coaches (TC) & ICF drawing No. 89002003 alt. 'a' 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.	1.1B Drawing no. mentioned in SAIL P.O is: AAA02173 for solid forged wheels rough machined for Trainset Trailer coaches. AAA02161 for solid forged wheels rough machined for Trainset Motor coaches. We shall be making wheels as given in P.O.	-	-	Comments dated 07.11.2023 1.1 NSC does not have drawings specified. Therefore, we would like RDSO provide those drawings for further comments or suggestion.	-	-	1.1B "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. Train-18 , MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. "Solid forged wheel (finish machined)for Train-18, MEMU/US & EMU/US Coaches".the wheel conforms to Drg No.AAA02141 alt 'c' or latest for both MC & TC and	- ICF comments to be included. - NSC may approach to ICF for drawings of wheels of VB coaches.

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									shall be suitable for carrying wheelset of 21t axle load provided with wheel mounted disc brakes for maximum speed of 200 kmph.	
2	2.0	**MANUFACTURE**		.						
3	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 & 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	-	-	-	-	clause 2.1 (sub clause 4 for LHB wheels) should be amended as follows: "The oxygen content in liquid steel should not exceed 20 ppm".	-	Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY:-	- ICF comments to be included. Clause 2.1.4: During steel processing, the presence of oxygen in the steel matrix is recognized as one of the main problems. Oxygen can be present in steel in the form of non-metallic inclusions or as micro-porosity which effects the impact strength, fatigue failure & fracture toughness. Therefore, oxygen should be kept as low as possible to minimize non-metallic inclusions, micro-porosity. All Manufacturer except Stork has agreed with proposed clause hence proposal of M/s Stork is not acceptable. Hence, no change is envisaged.

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<table>
<tr>
<td></td>
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<td>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.</td>
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<td>4</td>
<td>2.2</td>
<td>2.2 <u>CHEMICAL COMPOSITION</u>

2.2.1 <u>LADLE ANALYSIS</u>
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.
<u>CHEMICAL COMPOSITION</u>
Ladle analysis (Percentage)
<table><tr><th>Element</th><th>Percentage Composition</th></tr><tr><td>C</td><td>0.52 max</td></tr><tr><td>Cr</td><td>0.25 max.</td></tr><tr><td>Combined Cr + Ni + Mo</td><td>0.50 max.</td></tr><tr><td>Mn</td><td>0.60 to 0.80</td></tr></table></td>
<td>-</td>
<td>-</td>
<td>Comments dated 27.10.2023
1. The different chemical composition means that the material of the wheels has changed. Previously, the C content of the wheels was ≤ 0.52%, similar to ER7 in EN 13262. The new standard has changed the C content to ≤ 0.54%, mainly to improve hardness, but C content is already close to ER8 in EN 13262.
2. The content of V has increased from ≤ 0.15% to 0.03 – 0.10%, mainly to increase hardness. The increase in V content greatly</td>
<td>-</td>
<td>2.2.1.1 in the table "Chemical composition" only for LHB wheels in the percentage column, the maximum carbon content "C" is taken equal to 0.56%;

<u>2.2.2.1</u>
In the table of the Product Analysis section,
Exclude the deviation in carbon content "-0.02" from the carbon content in the ladle sample,
since the carbon content in the ladle sample is not indicated in the "minimum-maximum" range, but only maximum.</td>
<td>Method of chemical analysis according to ASTM E415-2014 and E1019-2011. Modifications according to Rev.6 of Oct. 2023: Table of Sub-clause 2.2.1.1: OK</td>
<td>-</td>
<td>On Stork & TZ Comments: 0.56% carbon is not acceptable as wheel steel with 0.56%C may reduce the fracture toughness of wheel steel and majority of manufacturer agreed to manufacture the wheel steel with 0.54%C max.

M/s Lucchini comments are in line with this clause and acceptable.

2.2.2.1
On Stork Comments- Variation of "-0.02%" in Carbon from ladle analysis is allowed in finished produced and it is different from the ladle analysis.

On TZ Comments- V is used for increasing the tensile strength, Hardness, fracture strength and increase in wear resistance.
During VC, TZ has also agreed for V</td>
</tr>
</table>

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		<table><tr><td>Ni</td><td>0.25 max.</td></tr><tr><td>Si</td><td>0.15 to 0.40</td></tr><tr><td>Mo</td><td>0.06 max.</td></tr><tr><td>P</td><td>0.03 max.</td></tr><tr><td>Cu</td><td>0.20 max.</td></tr><tr><td>S</td><td>0.03 max.</td></tr><tr><td>V</td><td>0.10 max.</td></tr></table> **FOR LHB WHEELS ONLY: -** <table><tr><td>**Element**</td><td>**Percentage Composition**</td></tr><tr><td>**C**</td><td>**0.54 max**</td></tr><tr><td>Cr</td><td>0.25 max.</td></tr><tr><td>Combined Cr+Ni+Mo</td><td>0.50 max.</td></tr><tr><td>Mn</td><td>0.60 to 1.00</td></tr><tr><td>Ni</td><td>0.25 max.</td></tr><tr><td>Si</td><td>0.15 to 0.40</td></tr><tr><td>Mo</td><td>0.08 max.</td></tr><tr><td>P</td><td>0.020 max.</td></tr><tr><td>Cu</td><td>0.20 max.</td></tr><tr><td>S</td><td>0.020 max.</td></tr><tr><td>**V**</td><td>**0.03 to 0.10**</td></tr></table> **FOR 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: - <table><tr><td>Element</td><td>Variation Percent</td></tr><tr><td>Carbon</td><td>+0.03 /-0.02</td></tr></table>	2.2.2 Weather permissible variation in product analysis is applicable to Vande Bharat wheels.	-	increases the cost of steel.	-	-	-	-	*content as specified in the specification.* Hence, no change is envisaged. **SAIL:** Permissible variation in product analysis is also applicable to Vande Bharat wheels.

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		<table><tr><td>Manganese & Silicon</td><td>+0.03 / -0.03</td></tr><tr><td>Phosphorous & Sulphur</td><td>+0.005 / -0.000</td></tr><tr><td>Chromium & Nickel</td><td>+0.05 / -0.00</td></tr><tr><td>Copper, Molybdenum & Vanadium</td><td>+0.02 / -0.00</td></tr></table>								
5	2.3	<u>PROCESS OF MANUFACTURING WHEEL</u> 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	-	-	-	Comments dated 24.08.2023 2.3.3 Electromagnetic Stirring should not be applied to wheel material - This modification helps to improve quality of wheel material. Inclusions gather to center area of continuous casted billet without electromagnetic stirring. And center area is punched off through forging process. Therefore, it should be better for getting clean steel wheel, not to apply electromagnetic stirring. Actually, our casting machines have electromagnetic facility, but that is not applied to wheel material casting intentionally. And that helps our steel to be clean. If IR concerns steel cleanliness, it would be better to specify cleanliness stricter. (for example, same	-	-	2.3.3 Train-18 , MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. <u>FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:-	2.3.3 NSC Not agreed. EMS facility helps not to segregate NMIs in localized area in molten metal during CC. Since, wheels are also manufactured from Ingots by upsetting having RR 4:1, forging and piercing and rough shape by a hammer or press, therefore there is a possibility that some area of centre containing high values of NMIs may remain in forging after centre punching. In that case NMIs may be segregate across the hub area of the wheel. Also for uniform distribution of all alloying elements in mould / tundish, EMS facility is recommended. Hence, no change is envisaged. **<u>2.3.4 NSC</u>** Not agreed. RR of 4:1 have superior mechanical properties as compared to RR 3:1. Hence, being a critical

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		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 & 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.				level as EN13262 category 1). 2.3.4 Reduction ratio is not necessary to be specified - This modification helps IR to reduce procurement cost. Generally, improvement of mechanical properties as a result of grain refinement, bonding of void, reduction of segregation and so on, is expected by forging. Practically speaking, reduction ratio of 2:1 is enough for carbon steel like IRS R19 to improve mechanical properties (ref. attached document). And also, the effect of forging will be confirmed by specification of mechanical properties. In case reduction ratio is not unsatisfactory even if mechanical properties are satisfactory, excessive weight would be added. That would cause extra cost to IR. Therefore, it is not necessary to specify reduction ratio. As per other major international wheel standards (AAR M-107/208, EN13262), reduction ratio is not specified.				safety item, mechanical properties having less reduction ratio is not recommended even the minimum mechanical properties are achieved by RR 3: I. Hence, no change is envisaged.
6	2.4	HEAT TREATMENT 2.4.1 All wheels must be Rim quenched and tempered.				Comment dated 24.08.2023 2.4.2			2.4.2 Train-18, MEMU/US &	**NSC -** Any other equivalent process for rim quenching &

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		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 & 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)	-	-	-	NSC believes Minimum tempering temperature is not necessary to be specified IRS specifies that the tempering temperature shall be over 500℃. NSC would like to change this specification as follows: 'Manufacturer shall control the conditions of heat treatment such as wheel temperature, water (for quenching) volume, water temperature and so on in order to satisfy the required mechanical properties.' * NSC believes that this specification about minimum temperature of tempering is referred UIC812-3. But EN13262, which is issued with reference to UIC812-3, has no longer specified the heat treatment temperature.	-	-	EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY:-	tempering and also cooling method adopted for the wheel is permitted for LHB & VB wheels. However, the firm is required to submit the details/data of heat treatment process to this office for further examination.

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7	4.2	<u>WEB THICKNESS</u> 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.	-	-	-	Comment dated 24.08.2023 4.2.1 NSC would like to just confirm- NSC understands that this specification means that the tolerance of web thickness shall be 'nominal value +5/0', is it correct?	-	-	-	Tolerance on web thickness shall not vary more than +5/-0. Further, thickness variation on rim around the circumference shall not be more than 1.5 mm at given radius on periphery. Hence, no change is envisaged.
8	4.3	<u>MACHINING AND ELIMINATION OF IMBALANCE</u> 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 be made by machining and not by flame cutting. **4.3.2. FATIGUE TEST (FOR LHB & 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	-	-	Comments dated 20.07.2023 Fatigue Test was not required before, the cost is 50000 USD for this test, with the period fort 12 months, we cannot do this test in China. This is for prototype and new vendor not for us. TZCO do not take the Fatigue Test. Comments dated 27.10.2023 Require Fatigue testing with an additional cost of	-	-	LRS is able to perform the qualification tests, but based on the timing and the costs this point will be discussed separately and a dedicate offer will be issued.	Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. <u>FOR LHB,VB ,TRAIN-18, MEMU/US</u>	ICF comments to be included. On TZ Comments - Agreed as M/s TZ has supplied more than 300 wheel discs of LHB wheels to IR as per RDSO specification having speed potential of 160 kmph or more for more than 2 years. Comments of M/s TZ is in line with this clause. Hence, no change is envisaged. On Lucchini Comments – No comments.

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		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.			approximately 300000 RMB and a testing time is one year.				&EMU/US WHEELS ONLY:-	
9	4.4	**SHOT PEENING (FOR LHB & 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.	-	4.4 RDSO is requested to review the requirement of Shot peening for LHB wheels. As per the FEA report, safety factor has come better in LHB wheel with 18.5 mm web thickness. Hence the shot peening may be taken out from the IRS specification. Further the shot peening would add to cost a considerable amount and may affect the productivity. It may not be possible to insert shot peening facility in the compact line of FWP at present. Our experts from Germany are suggesting not to add shot peening in the automatic processing line which may damage other testing equipment due	Comments dated 20.07.2023 As regards Shot Peening, we do not recommend it because it has no impact on product performance and increase only the cost of manufacturing. Comments dated 27.10.2023 OK	-	-	Please confirm that the signs of shot peening on rim and hub surfaces will be accepted.	Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. <u>FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:-	ON TZ & NSC Comments: 1. Shot peening improves the fatigue strength and fatigue life of the wheels. Therefore, it is recommended to carryout shot peeing in order to increase surface finish which enhances fatigue life. 2. Moreover, shot peening induces compressive stresses which is beneficial to retard the crack propagation rate, improves the fatigue strength & fatigue life. 3. M/s Lucchini comments are in line with this clause and acceptable. However, procedure for shot peening shall be as per clause 7.0 of AAR M-107/M-208. *All wheel manufacturers were agreed to. However, as raised by the firms the enforcement of the same will take some time.* Hence, no change is envisaged.

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				to dust generation & spreading and create havoc. Hence the shot peening may be taken out of the IRS Specification.						
10	5.0 5.1	**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). iv) Heat/Batch Number (in 6 digits in numeric or alpha numeric). v) Inspector's approval stamp. vi) 'UT' for ultrasonic testing.	-	-	Comments dated 09.02.2024 LHB wheel cannot perform 5.1 and Sketch - 92114 alt. '10'. simultaneously. Because 5.1 has mentioned that the stamping position is the outer rim surface, but the Sketch-92114 alt. '10' has mentioned position of LHB wheel is the outer rim surface, and the stamping position of other type of wheel (expect LHB) is the outer rim surface, the two requirements are contradictory. Therefore, it should be confirmed clear that LHB stamping should use Sketch-92114 alt.10 instead of 5.1. We use OTZ for supplier code: for the batch no. We use 00XXXX	-	-	Modifications according to Rev.6 of Oct., 2023: LRS batch number has 8 digits, but consecutive number can be of 3 digits to redeem. In case of order LRS will share with customer marking data sheet for check and approval.	-	On TZ Comments: Please refer Para No. 5.2 of this specification for Branding of LHB Wheel. On Lucchini Commets: As the total no. of digits for Batch number & Consecutive number is 11 in M/s Lucchini branding procedure & also in this clause. Hence, M/s Lucchini may shift 2 digits of batch number to consecutive number for uniformity in marking details across the manufacturers. Hence, no change is envisaged.
10	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.	-	-	-	Comments dated 07.11.2023 NSC does not have drawings specified. Therefore, we would like RDSO provide	-	-	-	NSC may be approach to RCF for drawing of LHB wheel. RDSO drawing No. Sketch-92114 alt. '10' will be provided.

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						those drawings for further comments or suggestion.				
11	5.3	For VB wheels, ICF drawing No. 89102004 alt. 'a' or latest for Trailer Coaches (TC) and ICF drawing No. 89002003 alt. 'a' or latest for Motor Coaches (MC), and location of stamping shall be as per RDSO drawing No. Sketch-92114 alt. '10' or latest.	-	-	-	Comments dated 07.11.2023 NSC does not have drawings specified. Therefore, we would like RDSO provide those drawings for further comments or suggestion.	-	-	Latest alt revised by ICF. Sketch- 92114 may be revised as per clause 4.10 of EN13262:2020 for VB Wheels. 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 Drg No.AAA02141 alt 'c' or latest and location of stamping shall be as per RDSO drawing No. Sketch-92114 alt. '10' or latest.	ICF comments to be included. NSC may be approach to ICF for drawings of wheels of VB coaches. RDSO drawing No. Sketch-92114 alt. '10' will be provided.
	5.6	For LHB & 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 ≤ 50 gm-m. • E2 for a residual imbalance of ≤ 75 gm-m. • E3 for a residual imbalance of ≤ 125 gm-m	-	-	Comments dated 09.02.2024 1) If the static balance mark on the outer hub surface is mixed with other wheel markings, making it difficult to recognize and mark. It is recommended the static imbalance mark on the surface of the inner wheel hub at the end of the static imbalance paint strip, which is easy to identify and mark, and	-	-	-	-	Marking for residual imbalance (E1, E2 & E3) is required only 2 digits, whereas other branding details required more than 2 digits. Threfore, there should no confusion in marking for residual imbalance. Hence, no change is envisaged.

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					consistent with the current YD918 wheel. 2) Because the maximum operating speed of LHB wheels is 200kmlh, according to Table 1, LHB belong to Class 2 wheels. We should confirm that the imbalance requirements of LHB wheels according to Class 2 wheels, that is: the maximum imbalance value of the wheels should be; 75g-m, and the imbalance mark should be E2.					
12	6.0 6.1	**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.	-	-	Comments dated 27.10.2023 All IS Standards involved can be replaced by ISO standards.	-	-	-	-	**Comments of M/s TZ is acceptable, relevant ISO standards can be used in place of IS standards.** i. ISO 6506-1: 2014 & IS 1500 (Part 1): 2019 are equivalent. ii. ISO 6892-1: 2019 & IS 1608 (Part 1): 2022 are equivalent. iii. ISO 148-1: 2016 & IS 1757 (Part 1): 2020 are equivalent.
13	6.2	<u>PRODUCT ANALYSIS</u> 6.2.1 Unless otherwise specified in the order or its appended documents one of the following samples shall be				Comment dated 24.08.2023 6.2.1 NSC would like to take a test piece separately from a tensile test piece.				Agreed but the sample position must be the same.

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		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.	-	-	-	NSC would like to suggest 'In the case of spectrographic analysis, one sample taken from the tensile test piece shown in position 1 of Fig. 1 or one sample taken from the same position as the tensile test piece shown in position 1 of Fig. 1' to shorten the testing period.	-	-	-	
14	6.5 6.5.1 6.5.2	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.	-	-	-	Comment dated 24.08.2023 6.5.1 NSC would like to perform the impact test in accordance with ISO 148-1. NSC would like to perform impact tests as per ISO 148-1 (specified in EN13262) even though IRS specifies that the impact test shall be performed as per IS 1499 and IS 1757.	-	Sub clause 6.5.1: test according to ISO 148-1.	-	Agreed as ISO 148-1: 2016 & IS 1757 (Part 1): 2020 are equivalent.
15	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 & VB WHEELS ONLY**: - Thickness of radial slice shall be **13 ± 2 mm.**	-	-	-	Comment dated 24.08.2023 6.6.1 NSC would like to confirm why the thickness is specified - NSC thinks that the thickness of test piece has no impact on the result because the observed area (specified in 9.1.2.1) has only impact on the result.	-	-	Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY:-	ICF comments to be included. Clause 9.1.2.1 belongs to micrographic examination whereas 6.6.1 specified about the dimensions for macroscopy examination. Hence, no change is envisaged.
16	6.7	HARDNESS	6.7.1.1 (For non LHB wheel & Non VB wheel)							

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	6.7.1	6.7.1 <u>UNIFORMITY OF HARDNESS OF BATCH</u> 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.	In DSP, uniformity of hardness is measured online on all machined wheels of a batch as the logistics do not allow testing on black wheels. Non-uniform removal of surface layers during machining operation causes variation of hardness in the batch. Heat treatment of wheels from the same batch takes place in two rotary hearth furnaces as there is no single tunnel furnace in which all the wheels of a batch can be heat treated; this also causes variation. As the uniformity of hardness requires that all wheels in a batch shall not exceed 30 BHN, approx. 10-15% of good quality BG/EMU wheels are rejected during online hardness testing even though they are within specified hardness range of 241 to 320 BHN. It is proposed that for batch homogeneity, the hardness variation within a batch may be increased to 50 BHN with the minimum hardness greater than 260 BHN. Each and every wheel will be in the range of 261 to 310 BHN which is	-	-	-	-	-	-	Not agreed: May not be allowed for maintaining the uniformity of hardness within the batch and also minimize the differential wearing between the wheels during service. Hence, no change is envisaged.

RESPONED DOCUMENT

			well within specified hardness range.							
17	6.7.2	6.7.2 <u>HARDNESS SURVEY OF RIM</u> 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 ~~less~~ 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. **<u>FOR LHB & VB WHEELS ONLY</u>**: - The hardness value measured at point 'A' shall not exceed **260 BHN.**	-	-	Comments dated 09.02.2024 The IRS R-19 93 Part II Rev.6 standard increases the C content in the chemical composition of LHB wheels to O.54max, similar to the ER8 material in EN 13262, but requires a hardness of 265-320HB at the wear limit. It is much higher than the minimum hardness of 245HB at 35mm in the EN13262 standard. And the hardness test position was changed from 35mm under the tread to the wear limit (approximately 46.5mm). Difficult to achieve and unreasonable. We suggest hardness at the wheel wear limit is 250-320HB. -	Comments dated 24.08.2023 6.7.2.1 Hardness of point 'A' shall be lower than at 35mm depth from tread surface by more than HB I0. This modification helps IR to improve safety and consistency to international standards (EN13262). To satisfy ≦229 at point 'A', hardness at web should be lower. That would cause lower strength of web. On the other hand, IR has a plan to improve fatigue strength of web. That may cause contradiction. The purpose of the specification would be considered as to prohibit quenching the web (that would cause worse residual stress distribution). To prohibit web quenching and keep higher strength of web at the same time, it is better to specify as written in the left. That way to specify is also improve consistency to EN 13262. In addition, NSC would like to perform Impact Test as per ISO 6506-1 (specified in EN 13262) even though IRS specifies that the Impact Test shall be performed as per IS 1500.	-	Su clause 6.7.2.1: Test according to ISO 6506-1. Modifications according to Rev.6 of Oct., 2023: Sub clause 6.7.2.1: Not OK because minimum hardness value of Table 2 cannot be granted if wear limit is higher than 35mm from the tread.	In table-3 of EN13262 the specification mentions the min hardness required. RDSO may suggest range for hardness. <u>FOR LHB WHEELS ONLY</u>: - The hardness value measured at point 'A' shall not exceed 260 BHN. <u>FOR VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:- The hardness value measured at point 'A' shall be at least 245 BHN	ICF comments to be included. **<u>On NSC Comments</u>** Doubt clarified. **<u>On TZ Comments</u>**: Doubt clarified and also communicated that limit of wear for LHB wheel is 35mm (915mm-845mm). Not agreed as other manufacturers are agreed to meet hardness values at different points. Hence, no change is envisaged. Comments of M/s Lucchini to use relevant ISO standards in place of IS standard is acceptable. ISO 6506-1: 2014 & IS 1500 (Part 1): 2019 are equivalent. Comments of M/s Lucchini for change in wear limit of more than 35mm is not acceptable in view of Para No. 4.2.2.1 of EN 13262:2020. However, wear limit for various design of solid forged wheels are different and specified in respective wheel/wheelset drawings. Hence, no change is envisaged.

REASONED DOCUMENT

18	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 & 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. 'a' or latest for Trailer Coaches (TC) & ICF drawing No. 89002003 alt. 'a' or latest for Motor Coaches (MC). 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.	-	-	-	Comments dated 07.11.2023 NSC does not have drawings specified. Therefore, we would like RDSO provide those drawings for further comments or suggestion.	-	Sub clause 6.8.1: OK	Latest alt revised by ICF. 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 Drg No. AAA02141 alt 'c' or latest for all coaches. Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. FOR LHB, VB, TRAIN-18, MEMU/US &EMU/US WHEELS ONLY: -	ICF comments to be included. NSC may approach to ICF for drawings of wheels of VB coaches.
19	7.0 7.1	**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 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	-	-	Comments dated 27.10.2023 **All IS Standards involved can be replaced by ISO standards.**	Comment dated 24.08.2023 7.1.1 NSC would like to perform the tensile test in accordance with ISO 6892-1. NSC would like to perform impact tests as per ISO 6892-1 (same as EN13262) even though IRS specifies that the impact test shall be	-	The test will be carried out according to ISO 6892-1, method B. The gauge length will be 5 times the diameter of test piece.	Tensile test to be conducted for VB wheels also ref:4.2.1 of EN13262:2020 FOR LHB & VB, TRAIN-18, MEMU/US &EMU/US WHEELS ONLY	ICF comments to be included. Comments on TZ, NSC & Lucchini: Refer comments at Para No. 6.1 above.

REASONED DOCUMENT

<table>
<tr>
<td></td>
<td></td>
<td>be agreed between manufacturer and purchaser.</td>
<td></td>
<td></td>
<td></td>
<td>performed as per IS 1608.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>7.3

7.3.1</td>
<td><u>RESIDUAL IMBALANCE</u>

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.

<u>TABLE-1</u>
<u>LIMITS FOR OUT OF BALANCE MOMENT</u>
<table>
<tr><th>Sl. No.</th><th>Application</th><th>Maximum residual imbalance in gm-m</th><th>Symbol</th></tr>
<tr><td>1.</td><td>Wheels for stock running at a speed > 200 Kmph.</td><td>50</td><td>E1</td></tr>
<tr><td>2.</td><td>Wheels for stock running at a speed >120 and <u>≤</u> 200 Kmph</td><td>75</td><td>E2</td></tr>
<tr><td>3.</td><td>Wheels for stock running at a speed <u>≤</u> 120 Kmph.</td><td>125</td><td>E3</td></tr>
</table>
</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Maximum residual imbalance : 75 gm (E2) according to Table 1</td>
<td>-</td>
<td>Comments of M/s Lucchini is in-line with the clause of specification. Hence, no change is envisaged.</td>
</tr>
</table>

REASONED DOCUMENT

<table>
<tr>
<td>20</td>
<td>7.4</td>
<td><u>IMPACT TEST (U-NOTCH & V-NOTCH)</u>
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.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Comment dated 24.08.2023
6.5.1
NSC would like to perform the impact test in accordance with ISO 148-1.
NSC would like to perform impact tests as per ISO 148-1 (specified in EN13262) even though IRS specifies that the impact test shall be performed as per IS 1499 and IS 1757.</td>
<td>-</td>
<td>Test will be carried out according to ISO 148-1</td>
<td>-</td>
<td>Comments on NSC & Lucchini:
Refer comments at Para No. 6.1 above.</td>
</tr>
<tr>
<td>21</td>
<td>7.6</td>
<td><u>BRINELL HARDNESS</u>
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.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.6.1
NSC would like to perform the hardness test in accordance with ISO 6506-1.</td>
<td>-</td>
<td>Test method according to ISO 6560-1</td>
<td>-</td>
<td>Comments on NSC & Lucchini:
Refer comments at Para No. 6.1 above.</td>
</tr>
<tr>
<td>22</td>
<td>8.0</td>
<td>8.0 MECHANICAL PROPERTIES
8.1 The mechanical properties of the wheel shall be in accordance with the requirements of table 2.
<u>A. Mechanical properties of rim:</u>
<u>TABLE – 2</u>
<table>
<tr><th>Tensile strength N/mm²</th><th>Yield Strength N/mm²</th><th>Minimum Elongation Percentage Gauge Length : 5.65 √So</th><th>Hardness range BHN</th><th>Minimum Impact strength in Joules at +20°C.</th></tr>
<tr><td colspan="3">See position 1 of figure 1</td><td></td><td></td></tr>
<tr><td>820 – 940</td><td>>520</td><td>>14</td><td>241 to 320</td><td>Average value : 17</td></tr>
</table></td>
<td><u>8.1A</u>
<u>(For Non LHB wheel &Non VB Wheel)</u>
BG and EMU wheels are exposed to less severe service stresses than LHB & VB wheels. The elongation values for BG and EMU wheels may be made 13% min, as in the case of LHB & VB wheels. Operating on the higher band of given composition for BG, EMU wheels results in marginally lower</td>
<td>-</td>
<td>Comment dated 20.07.2023
Any performance index of material is correlated with each other. TZ CO can accept this requirement on the condition that the impact and hardness are unchanged.
Hardness has strong correlation with Tensile properties and Impact Strength. Changing in Hardness properties will lead major change in microstructure, Tensile & Impact Strength. In current</td>
<td>Comment dated 24.08.2023
8.1A
NSC would like to discuss the lower limit for LHB wheels.</td>
<td><u>8.1</u>
8.1 subsection B (only for LHB wheels) exclude the requirements for the disk strength range of 750-850 N/mm2. By analogy with EN 13626-2020, formulate sub paragraph B (only for LHB wheels) in the wording "The reduction in the tensile strength of the wheel disc compared to the tensile strength of the rim of the same wheel must be greater than or equal to 120 N/mm2</td>
<td>Table – 2 Elongation carried out with gauge length 5 times the diameter of test piece.

Clause 8.0 B: 760 N/mm2 could not allow enough reduction of tensile strength in the web due to the value of Rm in the rim in the range 820-860 N/mm2. We suggest to prescribe a reduction of tensile strength in the web of min 110N/mm2 like EN13262, instead of "Maximum 760 N/mm2".</td>
<td>Train-18, MEMU/US &</td>
<td>ICF comments to be included.

On comments of M/s DSP: Not agreed.

On comments of M/s TZ: Both properties also depend upon alloying element and heat treatment. Required hardness 265-330 BHN can be achieved in consonance with modified increased TS of 870-980 MPa. Impact test at -20 degree C in Indian climate is essential.

On comments of M/s NSC:
Not agreed because</td>
</tr>
</table>

PERSONAL DOCUMENT

											EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. FOR VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY:-	design & safety factor is calculated on YS value. Not agreed to other manufacturers comments as already covered in reply above. Hence, no change is envisaged in this clause.

				Individual value: 12	elongation values than 14%.

FOR LHB WHEELS ONLY:-

Tensile strength N/mm^2	Yield Strength N/mm^2	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 -20^{0}C
See position 1 of figure 1					
870 – 980	> 540	>13	265 to 330	Average value : 17 ndividual value: 12	Average value : 10 ndividual value : 5

FOR 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/mm^2
Reduction of tensile strength in web in comparison to tensile strength of rim on same wheel

steel materials as specified in Rev.5 is a combination of ER7 & ER8 grade which is totally not in line with material science & technology. The hardness requirements s of EN standard ER7 is ≥ 235 HB, but ER7 require 241-320 HB in Indian Standard, which can only reach the lower limit of this range. It is completely impossible to achieve more than 265 HB. TZCO cannot meet this requirement and can only achieve 241 HB. "We request to re-define specific steel grade ER7 or ER8 as per EN 13262:2020 € or latest revision. This will help to avoid all confusion related to mechanical properties."
This does not seem to possible to meet any request for low temperature impact.

Comments dated 27.10.2023
Tensile strength, Yield Strength, Hardness Range BHN, Minimum Impact Strength (KV) in joules at -20degree Celsius cannot comply requirements for LHB wheels.

8.1B

NSC would like to discuss the criteria of tensile strength of web for LH8 wheels.

NSC would like to propose to specify not tensile strength but yield point same as EN13262, a minimum value of 355 N/mm2. In the point of assuming the web strength, NSC thinks that the yield point is better. If it is necessary to specify the upper limit, NSC would like to propose 455MPa same range as current range as tensile test (750-850 N/mm2).

REASON FOR DOCUMENT

<table>
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<td></td>
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<td>should be more than or equal to 120 N/mm².

• <u>FOR VB WHEELS ONLY</u>:-

Refer Para No. 4.2 (Table 2 - for Steel Grade to ER8) of EN 13262:2020 or latest.</td>
<td></td>
<td></td>
<td>Comments dated 09.02.2024
High wheel hardness, toughness will inevitably be reduced. The wheel hardness required by LHB is very high, it is difficult to reach the impact strength (KV) at -20 °C. which require average value is 10 and Individual value is 5. India's climate is warm, the wheel is not in cold weather operation, there is no need to require the low temperature impact toughness of the wheel.</td>
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</tr>
<tr>
<td>23</td>
<td>9.0

9.1.1</td>
<td><u>MICROGRAPHIC CLEANLINESS</u>

<u>LEVEL TO BE ACHIEVED</u>

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.

<u>TABLE 3</u>

<table>
<tr><th>Type of inclusions</th><th>Thick series (Maximum)</th><th>Thin series (Maximum)</th></tr>
<tr><td>A (Sulphide)</td><td>1.5</td><td>2</td></tr>
<tr><td>B (Aluminate)</td><td>1.5</td><td>2</td></tr>
<tr><td>C (Silicate)</td><td>1.5</td><td>2</td></tr>
<tr><td>D (Globular Oxide)</td><td>1.5</td><td>2</td></tr>
<tr><td>B+C+D</td><td>3</td><td>4</td></tr>
</table>
<u>FOR LHB & VB WHEELS</u>:-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.1.1.1
The degree of cleanliness during micrographic examination is assumed to be equal to the degree of cleanliness on wheels of category 2 according to EN 13262:2020.</td>
<td>Modifications according to Rev.6 of Oct 2023: Sub clause 9.1.1.1: OK</td>
<td>Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262.

<u>FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:-</td>
<td>ICF comments to be included.

On Stork Comments - Both are already same. Hence, no change is envisaged.</td>
</tr>
</table>

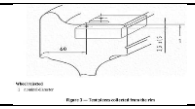
REASONED DOCUMENT

		<table><tr><td>Type of inclusions</td><td>Thick series (Maximum)</td><td>Thin series (Maximum)</td></tr><tr><td>A (Sulphide)</td><td>1.5</td><td>1.5</td></tr><tr><td>B (Aluminate)</td><td>1.0</td><td>1.5</td></tr><tr><td>C (Silicate)</td><td>1.0</td><td>1.5</td></tr><tr><td>D (Globular Oxide)</td><td>1.0</td><td>1.5</td></tr><tr><td>B+C+D</td><td>2.0</td><td>3.0</td></tr><tr><td>DS</td><td colspan="2">1.5</td></tr></table> 9.1.1.2 In one single frame, either thick or thin & not both simultaneously should be reported.								
24	9.1.3	<u>TEST METHOD</u> 9.1.3.1 Determination of the level of cleanliness shall be made in accordance with the requirements of IS: 4163, method “A”.	-	-	-	Comment dated 24.08.2023 Perform the evaluation of micrographic cleanliness in accordance with ISO 4967 method A. NSC would like to perform the evaluation of micrographic cleanliness in accordance with ISO 4967 method A (specified in EN 13262) even though IRS specifies that the Impact Test shall be performed as per IS 4163.	-	Sub clause 9.1.3: test method according to ISO 4967:1998, method "A". About microstructure, LRS proposes:- to perform the test in the position indicated in picture 4 of the specification IRS R-19/93 Part II (Rev. 6) like EN13262- the bainite content shall be not more than 1% for the average value of three measurements at the position 15mm under the rolling circle based on wheel tread at new build condition.	-	Already mentioned in 6.0 and 6.1 above
25	9.2	**MICROSTRUCTURE EXAMINATION (FOR LHB & 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	-	-	-	Comment dated 24.08.2023 NSC would like to interpret the specification as described - The microstructure of wheel shall be mainly fine pearlite structure….	-	Par. 9.2.1: Bainiti zero is very difficult to grant, especially on the tread. We suggest values for info only at 0mm and ≤1 % for the average value of three measurements at 5mm depth from the tread.	-	**<u>Comments on M/s NSC:</u>** Doubt clarified in previous meeting. It should be fine pearlite and free from bainite with ASTM grain size 6 or finer as per clause 9.2.1 of IRS.

REASONED DOCUMENT

		structure in the microstructure is not acceptable.								**Comments on M/s Lucchini:** Not agreed, fine pearlite is always recommended. Hence, no change is envisaged.
	10.2	<u>VALUES TO BE ACHIEVED</u> 10.2.1 The average value obtained from six test pieces shall be greater than or equal to 80 N/mm²√m, and any single value shall not be below a minimum of 70 N/mm²√m.	-	-	Comments dated 09.02.2024 The wheel requires fracture toughness mainly to prevent damage caused by brake on the wheel tread, The LHB wheel is disc brakes and does not require fracture toughness testing according to the requirements of EN 13262-2020 standard. Non-tread brake wheels do not need to be tested for fracture toughness. It is recommended to cancel the fracture toughness test of LHB wheels.	-	-	Modifications according to Rev.6 of Oct 2023: Sub clause 10.2: for LHB and VB values for information only	-	**Comments on M/s TZ & M/s Lucchini:** Not accepted as this requirement is same as in Rev.4 & Rev.5 of this Specification. Hence, no change is envisaged.
26	10.3	<u>LOCATION OF TEST PIECES</u> 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.	-	-	-	Comment dated 24.08.2023 Change the sampling position. To take a test piece at 70mm depth from back rim face is impossible with considering the rim width and test piece size. NSC would like to take a test piece from the position shown in below quoted from EN13262 Figure 3.	-	-	-	Agreed with comments of M/s NSC.

REASONED DOCUMENT

										
	11.0	**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						Sub clause 11.4: General requirement of magnetic Inspection according to ISO 6933. Modifications according to Rev.6 of Oct 2023: Ok.		Comments of M/s Lucchini are in line with Para No. 11.5 of this specification. Hence, no change is envisaged.

REASONED DOCUMENT

		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.								
27	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	13.1 The existing opening sentence in the clause may be changed to "Should a wheel fail in any tests as given in Table-4, the purchaser or inspecting officer shall select two more wheels from the same lot and repeat the tests as in the case of LHB & VB wheels.	-	-	-	-	-	Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. <u>FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:-	Comments on SAIL: Not acceptable. ICF comments to be included.

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		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. **<u>FOR LHB & VB WHEELS ONLY</u>: -** 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. **<u>FOR LHB & VB WHEELS ONLY</u>: -** 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.								
28	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	-	-	-		-	-	-	

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		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 WHEELS** The method of Ultrasonic testing of LHB 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.				Comment dated 24.08.2023 14.3 NSC would like to confirm the details of requirement - NSC would like to confirm the requirement of UT for web and hub. ➢ Frequency of probe ➢ Array type (phased array or single) ➢ Level to be achieved (acceptable defect size)		Appendix C: OK		**<u>Comments on M/s NSC:</u>** Desired details are already mentioned under Appendix 'C'. Hence, no change is envisaged.
	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						A dedicated Manufacturing and Inspection Plan will be issued for the customer to express his will to attend any stage of the manufacturing process.		Inspection Plan shall be as per Table 4 of this specification.

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		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.								
30	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	-	-	-	-	18.2 The first sentence of the paragraph should be amended as follows: Manufacturer may use any other suitable alternative painting system (surface protection) subject to the approval of the buyer.	Wheels will be painted after wheelset assembling. Please, see CbC document for IRS R 19-93 part. 1, chapter 12. "Chrome" products are illegal. In case of order LRS will submit the proposal of a painting cycle fro your approval. With reference to VB wheels, we need to check if Fluoropolymer can be applied in Lucchini.	-	**Comments on M/s Stork:** Alternative painting system is already mentioned in clause 18.2 as "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." Hence, no change is envisaged.

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		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 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.				Comments dated 07.11.2023 18.4 NSC does not have RDSO specification No. M&C/PCN/111/2018 . We would like RDSO to provide this specification to study feasibility.			18.4 Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. <u>FOR VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:-	RDSO specification No. M&C/PCN/111/2018 will be provided. ICF comments to be included.
	20.0 20.1	**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.	-	-	-	-	-	LRS is able to perform the qualification tests, but based on the timing and the costs this point will be discuss separately and a dedicate offer will be emitted.	-	No comments

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		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	-	-	-	-	-	-	-	

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		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.								
31	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	-	-	-	-	-		20.2.1.2.2	

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		20.2.1.2.1 The supplier shall operate a quality assurance system conforming to ISO 9001-2000. 20.2.1.2.2 **For LHB & VB 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.							Train-18, MEMU/US & EMU/US shall be included in the specification as they are similar to the VB wheels and generally confirms to EN 13262. <u>FOR LHB,VB ,TRAIN-18, MEMU/US &EMU/US WHEELS ONLY</u>:-	ICF comments to be included.
	APPENDIX-C (Clause 14)	METHOD OF ULTRASONIC TESTING AND ACCEPTANCE STANDARD			Comments dated 09.02.2024 The standard requires that the LHB wheel rim					On comments of M/s TZ: Clause No. 3.3, & 4.4.2.2.1 of EN 13262 is self-explanatory.

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		FOR LHB & VANDE BHARAT 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 & 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 & 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	-	-	ultrasonic inspection acceptance standard shall be carried out in accordance with the requirements of EN13262 for Class 2 wheels that is there should be no internal defects with a diameter greater than or equal to 2mm. This item needs to be confirmed with the customer.					Hence, no change is envisaged.

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		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								

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		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: $e = \frac{m+n}{2}$ $= \frac{17 + 29}{2}$ $= 23$ The location of the artificial defects is given as below. They shall be at least 100 mm apart in a circumferential orientation.								

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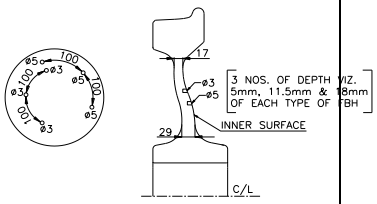
		- Three 3 mm diameter flat bottom holes located at 5 mm, e/2 mm i.e. 11.5 mm and (e – 5) mm i.e. 18 mm below the inner surface of the web. - Three 5 mm diameter flat bottom holes located at 5 mm, e/2 mm i.e. 11.5 mm and (e – 5) mm i.e. 18 mm below the inner surface of the web. - DAC (Distance amplification 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)								

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		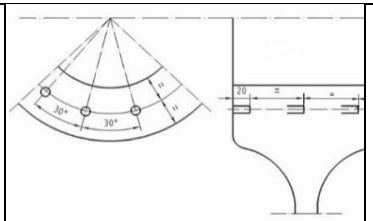 **Figure B — Standard Hub for Ultrasonic Examination** DAC (Distance Amplification Curve) / DGS (Distance Grain Size) NOTE: Calibration references are: - Three 3 mm diameter holes located at different depths - Three 5 mm diameter holes located at different depths spaced as shown in the figure B. C-6 **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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