GOVERNMENT OF INDIA

(Ministry of Railways)

SPECIFICATION FOR STEEL BLOOMS

REQUIRED FOR FORGING

CARRIAGE, WAGON AND EMU TRAILING

AXLES TO IRS R- 16/95

287mm^2 - PL NO. 90100967
&
300mm^2 - PL NO. 90100992

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Issued by
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SPECIFICATION FOR STEEL BLOOMS REQUIRED FOR FORGING CARRIAGE, WAGON AND EMU TRAILING AXLES TO IRS R- 16/95

1. SCOPE

1.1 This specification covers the technical & dimensional, product inspection/quality audit requirements of steel blooms for forging axles of carriages, high-speed coaches, wagons and EMU trailer coaches.

2. MANUFACTURING PROCESS

2.1 Process of manufacturing steel blooms

2.2 The steel blooms shall be manufactured from steel made by basic electric arc furnace or any other process recommended as equivalent and approved by the purchasing railways. The steel must be degassed under vacuum. It must be killed and bottom cast.

2.3 Strand cast bloom can also be manufactured and process shall be designed to ensure freedom from centre porosity and undue segregation.

2.4 Hydrogen content in the liquid steel determined by standard analysis method on LECO hydrogen analyser or similar precision equipment shall not exceed 3 ppm.

2.5 Nitrogen content of the steel determined by the standard analysis method on LECO nitrogen analyser or any other established instrumental method shall not exceed 0.007% (70 ppm).

3 QUALITY ASSURANCE PLAN

The manufacturer shall submit their QAP that will be followed in the manufacturing of Steel Blooms to achieve the performance requirement described in clause 2. The QAP shall consider the following requirement.

a) Details on the grade, source, specification and acceptance criteria of all raw materials used in the production. Additives if any used shall be mentioned.
b) In-process parameter norms & frequency of testing.
c) Finished product testing & the lot size.
d) After sales service

Other details like M&P, Technical Manpower, Testing facilities (In-process & Product inspection), ISO 9001 or any other certification of Quality Management System shall be as per tender document.

4 TESTING FACILITY

The firm shall have testing facility for testing as per clauses 5, 6, 11&13.

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5. CHEMICAL COMPOSITION

5.1 LADLE ANALYSIS

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

Element	Percentage
Carbon	0.30 to 0.37
Manganese	1.12 max.
Silicon	0.15 to 0.46
Phosphorus	0.04 max.
Sulphur	0.04 max
Chromium	less than 0.30
Nickel	less than 0.30
Molybdenum	less than 0.05
Copper	less than 0.30
Vanadium	less than 0.05
Phosphorus & Sulphur (Combined)	less than 0.07

6. PRODUCT ANALYSIS

6.1 Permissible variation in case of product analysis over the limits specified in clause-5.2 shall be as under:

Element	Variation percentage
Carbon	+ 0.03 - 0.00
Manganese	+ 0.06
Silicon	+ 0.04 - 0.00
Sulphur	+0.005
Phosphorus	+0.005
Copper	+0.02
Vanadium	+0.02
Sulphur & Phosphorus (Combined)	+0.005

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7. DISCARD

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

8. MANUFACTURING PRACTICE

8.1 Reduction ratio:

Size of Bloom in mm	Min. reduction ratio (rolled/forged) from min.. size of ingot to max. size of bloom	Min. reduction ratio from min.. size of strand cast bloom to max. size of bloom
287^2	**2.5:1***	1.6 : 1
300^2	**2.5:1***	1.5 : 1

* Reduction Ratio of 2:1 from min. size of ingot to max. size of bloom is permissible in case the ingot has tapering ratio of min. of 1: 1.3 in sides (1: 1.69 in area) from bottom to top.

8.2 The manufacturer will clearly indicate size of ingot used by them for manufacture of blooms and reduction ratio so achieved.

9. COOLING

9.1 Blooms must be pile/pit cooled.

10. QUALITY OF MATERIAL

10.1 The blooms shall be sound throughout and without cracks, inclusion, burrs, lack of metal, laps or any other defect detrimental to their end use and shall be supplied to the prescribed dimensions and tolerances.

11 MECHANICAL PROPERTIES, MICRO & MACRO STRUCTURE

Sl. No.	**Test Parameter**	**Specified Value**	**Test Method***
1	UTS	550 – 650 N/mm^2 (56.1 - 66.3 kg/mm^2)	IS1608/1972
2	YS	320 N/mm^2 (32.6 kg/mm^2)	IS1608/1972
3	Elongation	22% Minimum	IS1608/1972
4	Impact Charpy U-Notch at 20°C length wise (5mm U-notch depth)	Minimum KU 25 Joules	IS1499/1977

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Sl. No.	Test Parameter	Specified Value	Test Method*
5	Micro Structure	Well defined uniform fine grain structure not coarser than ASTM No.5	ASTM E-112/2004
6	Macro Structure	On transverse section - Shall be free from harmful shrinkage, porosity, laps, blow holes, cracks, inclusions or any other defects. Pipe, bleeding, butt tears, flute marks, internal bursts and flakes not acceptable to any degree. Central segregation acceptable up to C-2 Level. Any indication of pinholes shall be macro etched and tested for suitability.	ASTM E-381/1994

* As specified, else latest.

Note: 1 For items 1 to 5, bloom shall be forged down to 150 mm square/round austenitised at 850 °C (two hours soaking & air cooling). Sample shall be taken from mid radius only.

Note: 2 Test for item 6 shall be conducted on complete transverse slice section drawn from the bloom.

12 DIMENSIONS AND TOLERANCES

12.1 100% of the bloom shall be supplied to the prescribed dimensions and tolerances.

13 INCLUSION CONTENT

13.1 This clause is only applicable to new first time suppliers to RWF.

Sl. No.	Test Parameter	Specified Value		Test Method *
1	Inclusion content on polished section	Thin Series	Thick Series	IS 4163/1967
	'A' Type (Sulphide)	2	1.5	
	'B' Type (Alumina)	2	1.5	
	'C' Type (Silicate)	1	0.5	
	'D' Type (Oxide)	2.5	1.5	
		(All the values above denote maximum values)		

* As specified, else latest.

Note: Inclusion content shall be estimated preparing the sample from the test coupon used for mechanical testing as discussed in Note 1 under clause 11 or from the tensile test-piece end.

14 SAMPLING NORM : Heat/cast wise

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15. ULTRASONIC REQUIREMENTS

15.1 Bloom shall be tested ultrasonically as per Annexure-A (Standard for UT testing of blooms).

15.2 During internal inspection 100% UT of blooms by scanning through two perpendicular faces, employing oil/synthetic water-based gel as couplant shall be done to meet the ultrasonic requirement of finished axles as mentioned above. The blooms rejected during 100% UT test shall be segregated, colour coded with white paint band along the length of the bloom and kept separately. The supplier will ensure that blooms offered for inspection do not contain any reject piece.

15.3 Blooms shall be tested for UT by representative of Rail Wheel Factory out of 100% blooms inspected and passed by manufacturer in their internal inspection/testing. The manufacturer will produce relevant documents pertaining to material passed by their inspection and testing. If any one bloom is found rejected during this inspection by representative of Rail Wheel Factory, the manufacturer will be permitted once to re-test the entire lot of blooms on their own and offer RWF representative for re-inspection. If any one unit is found rejected during this re-inspection, entire quantity of the heat stands rejected. In case of periodical quality audit, if more than single unit length rejected in ultrasonic inspection in the course of the audit, whole heat shall be rejected.

15.4 Bloom of one heat shall be offered at a time for UT test.

16. GEOMETRY, DIMENSIONS AND TOLERANCES OF BLOOM

16.1 The blooms shall be round cornered square or corner-chamfered square of odd multiple lengths (upto a maximum of 5 lengths) as follows.

Size of bloom in mm	Type of Axle	RCS Bloom Min. Corner Radius Tol. ±5 mm	Chamfered Bloom Max. Diagonal size Tol. ±5 mm	Unit length in mm	Length of bloom, if supplied in multiples, in mm	Extra length required for sample coupon in mm
300^{+5}_{-0}	BOXN	50±5	385±5	$975^{+5}/_{-0}$	$975^{+5}/_{-0}$ $2965^{+5}/_{-0}$ $4955^{+5}/_{-0}$	60
300^{+5}_{-0}	LHB	50±5	385±5	$950^{+5}/_{-0}$	$950^{+5}/_{-0}$ $2890^{+5}/_{-0}$ $4830^{+5}/_{-0}$	60

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Size of bloom in mm	Type of Axle	RCS Bloom Min. Corner Radius Tol. ±5 mm	Chamfered Bloom Max. Diagonal size Tol. ±5 mm	Unit length in mm	Length of bloom, if supplied in multiples, in mm	Extra length required for sample coupon in mm
287^{+5}_{-0}	ICF	48±5	366±5	$810^{+5}/_{-0}$	$810^{+5}/_{-0}$ $2470^{+5}/_{-0}$ $4130^{+5}/_{-0}$	60

Note: The unit and multiple lengths given in the above table are liable to change from time to time. If the lengths given in the purchase order differ from that given in the table above, the lengths indicated in the purchase order shall prevail.

17. LENGTH OF BLOOM

17.1 The length of bloom shall be in multiples of the unit length as shown in clause 16.1. One bloom from each cast shall have extra length as specified in clause 16.1 above to accommodate sample coupon and this shall be identified by colour coding at both ends with yellow base and black zebra lines. Blooms should be marked for each unit length with white lines. However, if the unit length exceeds 100 numbers for the cast offered, for every hundred unit length offered one extra length as in clause 16.1 shall be given as sample coupon.

17.2 The blooms shall be straight throughout its length and a deviation of 5 mm in one metre length of bloom may be permissible. The blooms shall be free from tapers, twists and bend ends. Both ends of the bloom shall be saw cut and straight.

18. CONDITIONING OF BLOOM

18.1 The conditioning of the bloom if any shall be done by grinding only and shall be free from cracks, laps, scabs and ruptures. The depth of conditioning allowed is 8 mm on surface of bloom. The width of conditioning shall be at least 10 times of its greatest depth to avoid laps while forging.

18 MINIMUM QUANTITY PER HEAT

19.1 The minimum desirable yield of blooms per heat/cast is 30 MT. However, the minimum acceptable yield shall in no case be less than 15 MT per heat/cast. In case any bidder opts to supply yields lower than 30 MT (but not less than 15 MT) per heat/cast, then such bidders, if successful, will have to bear the following costs:

(a) The cost of material for extra sample coupons due to yield per heat/cast being lower than the minimum desired level of 30 MT. The quantity of material for additional sample

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coupons, for which the cost has to be borne by the successful bidder, will be worked out as follows:

$$\text{Qty. ordered} \times \left[\frac{1}{\text{Yield offered}} - \frac{1}{30} \right] \times \text{Wt. per sample coupon}$$

(b) Test charges for additional sample coupons required to be tested as a consequence of (a) above. These test charges are reviewed periodically and rates applicable at the time of supply of the material will be levied for the purpose of fulfilment of this clause.

19.2 In case the heat size is 75 to 150 MT, one heat product in two consequent inspections may be permitted.

20. MARKING

20.1 All the blooms shall be marked with heat/cast number, manufacturer's serial number, length of the bloom, weight and steel designation on the big end face of the ingot. On the other face, cold stamping to be done for heat/cast No., Bloom No., and length. 'R-16' shall be marked in yellow paint on both the faces of each bloom.

20.2 Cold stamping on side face shall also be permitted with prior approval from RWF.

21. TEST CERTIFICATE

21.1 The manufacturer must supply a certificate of testing that manufacturing stipulations of this specification have been met. In addition, the final test certificate must include the results of the following tests.

a) Ladle analysis,
b) Product analysis,
c) Hydrogen content,
d) Nitrogen content,
e) Ingot size & reduction ratio (from ingot to bloom),
f) Mechanical properties like UTS, YS, Elongation %, Impact charpy U notch and heat treatment followed on test pieces.
g) Micro-structure,
h) Macroscopic appearance
j) Ultrasonic Test
k) Inclusion content (only for new first time suppliers)

22 PROCESS REQUIREMENT FOR REGULAR AND HIGH SPEED APPLICATION OF LHB/FIAT BOGIE COACHES (HSA)

22.1 One third (33.3%) of supply in R-16 300mm^2 RCS for each consignment shall be for HSA or as per schedule requirement of RWF. Such bloom shall be marked as HSA at one of the end by paint by the manufacturer.

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22.2 Efficient hot top shall be used for effective feeding for all ingots. For blooms of HSA, hot top of "VESUVIUS" make shall be used so that piping in the ingot is eliminated. In case the manufacturer proposes to use an alternate for the hot top used for HSA blooms, prior approval from RWF shall be obtained.

22.3 A minimum of 12% end cropping after blooming shall be ensured for regular blooms and a minimum of 16% end cropping after blooming shall be ensured for blooms of HSA application.

22.4 Branded and efficient Bottom Pouring Compound (BPC) of proven make shall be used during teeming. The bidder shall indicate the details of BPC proposed along with usage particulars for manufacture of RWF blooms in tendering stage.

23 PRODUCT INSPECTION AND TEST REPORT/PERIODICAL QUALITY AUDIT AND MANUFACTURERS TEST CERTIFICATE

23.1 The Purchaser has the option to conduct 100% Product Inspection at the manufacturer's premises with a test plan confirming to clause No 21.1 or accept the products based on Manufacturer's Test Certificate (MTC) as per clause No 21.1 in part or full quantity to be supplied.

23.2 Irrespective of the type of product inspection, RWF reserve the right to conduct Quality audit at the manufacturers premises periodically

23.3 The inspection delegated by the purchasing railway to manufacturer shall not remove the purchasing railway's right to supervise the credentials and effectiveness of the manufacturer's inspection or to verify the effectiveness of inspection and test methods in its own laboratories.

23.4 In case of resorting to product inspection, representative of the purchasing railway is authorised to be present at all the tests carried out under the responsibility of the manufacturer and to check the results recorded.

23.5 The manufacturer must inform the purchasing railway of the procedure used to fulfil the order.

23.6 The representative of the purchasing railway must be able to verify that the various manufacturing operations meet the stipulations of this technical specification to the order. To this end, he must have access to correctly calibrated radiation pyrometers and to the graphs produced by recording pyrometers.

23.7 An authorised technical representative of the Railways will inspect the material **or** conduct quality audit including test activities. Full assistance shall be afforded by the manufacturer for inspection of the bloom/quality audit at the manufacturer's works.

23.8 The supplier shall provide test pieces and facilities for macro and micro examinations to the inspecting authorities for product Inspection.

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23.9 Any blooms/ axles shall be rejected during course of inspecting / processing / testing at the premises of the Rail Wheel Factory at Yelahanka, on the basis of ultrasonic or magnetic particle or physical and chemical test, or due to inclusions, or faulty structure etc., not withstanding any inspection carried out by the Railways or the authorised agency of the Railways at the supplier's works. The Railways' decision regarding soundness, or otherwise be final and binding.

23.10 For Product Inspection one bloom shall be selected randomly from each heat for obtaining the sample for macro-structure, microstructure and polished specimen for inclusion content determination (only for new first time suppliers). If the bloom so randomly selected is found unsuitable, the whole heat shall be rejected.

23.11 In case of a lot cleared for dispatch under MTC is taken for periodic quality audit at the manufacturer's premises by RWF, and ultrasonic rejection of more than one unit length is found on blooms that are offered (after clearance in the internal ultrasonic test by the manufacturer), then the entire heat shall be liable for rejection.

23.12 The entire quantity of the blooms of one to two heats passed after inspection shall be despatched in one lot. In case of supply by rail, if the wagon capacity is less than 60 tonnes, then the blooms from one heat should be loaded in not more than two wagons. However in such cases, both the wagons should be booked together. Under no circumstances should quantity of one heat be loaded in more than two wagons.

23.13 No blooms will be received without the receipt of T.C./MTC in advance.

24. PRODUCT GUARANTEE

24.1 For axles that are rejected as per clause 23.9, the cost of bloom will be recovered along with entire process cost of axle manufacture at RWF.

24.2 If the rejection of axles for reasons mentioned in clause 23.9 exceeds 1.0 % for a given month (for a specific product) given that the number of axles manufactured of the type is more than 500 or on basis of latest tested 500 axles whichever is higher, RWF reserve the right to stop further supply schedule of that type of bloom till a fresh quality audit is conducted and found satisfactory in the quality audit of the process at manufacturer's premises.

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ANNEXURE-A

ULTRASONIC TESTING STANDARD FOR BLOOMS (ROLLED AND FORGED)

1. **Scope:** This specification covers the procedure for detecting the gross discontinuities in round or chamfered corner square blooms for manufacturing axles.

2. **Purpose:** To ensure uniform structure and freedom from any internal discontinuities in the bloom to meet the requirement of specification- R-16/95.

3. **Equipment:** Krautkrammer or any other equivalent make.

4. **Test Method:** Pulse echo direct contact method.

5. **Frequency:** 2 MHz or 2.25 MHz direct beam probe having crystal dia. of 3/4" to 1".

6. **Couplant:** Oil/Water.

7. **Calibration:** Calibration of equipment is to be done using IIW standard block as per IS 12666.

8. **Scanning:** Scanning should be done through out the length covering the whole surface area, giving sufficient overlapping on the two adjacent faces of bloom.

9. **Acceptance Standard:**
   a. Flakes, piping and porosity are rejected.
   b. Isolated flaw echo max. **25%** when back echo adjusted to 100% of the full screen height acceptable and more than **25%** is unacceptable for rolled blooms. In case of forged blooms 20% when back echo adjusted to 100% of the full screen height is acceptable and more than 20% is unacceptable.
   c. Minimum distance between such isolated defects should be **6"**.
   d. There shall not be more than three such isolated defects per meter of the bloom.
   e. Continuous defects more than **3"** shall be cause for rejection
   f. Testing shall not be carried out if the material is hot (>50°C).

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AMENDMENT SHEET FOR RECORD

Sl. No	alt 'n'		alt 'o'		Job No	Signature
	Clause No.	Description	Clause No.	Revised Description		
1	16.1	For Type of Axle: LHB Unit Length (Column No. 5): $930^{+5}/_{-0}$ Multiple Lengths (Column No.6) $950^{+5}/_{-0}$ $2830^{+5}/_{-0}$ $4730^{+5}/_{-0}$	16.1	For Type of Axle: LHB Unit Length (Column No. 5): $950^{+5}/_{-0}$ Multiple Lengths (Column No.6) $950^{+5}/_{-0}$ $2890^{+5}/_{-0}$ $4830^{+5}/_{-0}$	7006	Chaude

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