

INDIAN RAILWAYS



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1.0 FOREWORD

- 1.1 LHB type coaches of Indian Railways have been provided with Axle Mounted Disc Brake system wherein Brake Disc is that part of vehicle brake system that serves to convert kinetic energy into heat by means of friction. Axle mounted brake disc are ring-shaped castings made from cast steel or grey cast iron with crosswise cooling ribs. ~~Presently, two types of Brake Discs i.e. 9 Bolt & 12 Bolt Design are being supplied by two renowned suppliers.~~
- 1.2 This specification is intended to cover the provisions related to grey cast iron brake disc or superior material to be pressed onto the Wheel set axle.
- 1.3 Following standards as applicable may be referred to in conjunction with this specification:
- UIC 541-3
 - EN 14535-1
 - EN 14535-3
 - DIN 27205-3

1.4 General:

- 1.4.1 Following shall be applicable when this item appears in RDSO's vendor directory:

"All the provisions contained in RDSO's ISO procedures laid down in Document No. QO-D-7.1-11 dated 19.07.2016 (titled "Vendor-Change in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.

- 1.4.2 The Govt. of India policy on 'Make in India' shall apply.

2.0 SCOPE

- 2.1 This specification is intended to provide technical specification for standardized Brake Disc for LHB Coaches with interchangeability & ease in maintenance and does not include all the necessary provisions of the contracts.

3.0 PARTICULAR REQUIREMENTS

- 3.1 The firm seeking registration for Brake Disc of LHB Coaches shall register with RDSO/~~Vendor approving authority~~ as per extant procedure.
- 3.2 The firm shall have adequate infrastructures for manufacturing, testing and quality control requirements of Brake Disc. This will be verified by the RDSO/~~Vendor approving authority~~ at the time of registration of the firm.
- 3.3 The firm shall submit their design of brake disc for approval of RDSO/~~Vendor approving authority~~.

4.0 FUNCTIONAL REQUIREMENT

- 4.1 The Brake Disc of Axle Mounted Disc Brake system shall fulfil the following requirement, under Indian Railway service conditions without crack, damage over permitted under DIN27205-3, damage or degradation other than normal wear of the friction face beyond permissible limits.
- 4.1.1 Brake Disc shall permit a braking moment or torque to be generated, supported and transmitted to the rail vehicle axle.
- 4.1.2 Brake Disc shall permit, by frictional engagement of a brake pad or pads, the conversion into heat of the kinetic and potential energy involved in retarding the vehicles which is attributed to the use of the disc brake.
- 4.1.3 Brake disc shall absorb part or all of the kinetic and potential energy arising from the braking of coaches.
- 4.1.4 Brake disc shall dissipate the absorbed energy by radiation, convection and conduction.

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5.0 DESIGN REQUIREMENT

- 5.1 The axle mounted brake disc shall consist of the friction ring with cooling ribs and the hub. The friction ring of Brake Disc shall have to be cast as a single piece or two piece (split brake disc) followed by its machining on required surfaces as per EN 14535-1. The thickness of the friction ring and the size of the cooling ribs are related to prevent overheating during brake application.
- 5.2 The brake disc (including friction ring and spokes) shall have adequate mechanical and thermal capacity for service on and off the Indian Railways, under the environmental and operating conditions identified in Annexure-III.
- 5.3 Brake Disc shall be of 12 bolt design.
- 5.4 Friction ring & hub shall be assembled by using M12 bolts conforming to IS:1364-2002 Part-I and IS:1367-2002 Part-III or equivalent, with suitable mating nuts.
- 5.5 All parts of the brake disc shall be designed for fatigue strength.
- 5.6 In the design of axle mounted discs, the fatigue life of the connection between the hub and friction ring must take into account cyclic loading from thermal and shock environments that are separately considered and are encountered in normal service.
- 5.7 The fatigue life at the most highly stressed location in the connection between the hub and spoke, due to combined strains from thermal load and shock load, shall be equal to or greater than the projected service life of the friction ring or 20,00,000 km, whichever is greater.
- 5.8 Brake disc shall be designed and constructed in such a way that in case of hitting of flying stones raised from ballast track, it does not affect the functional efficiency or cause failure of disc.
- 5.9 The connections between brake discs and wheel set axle must satisfy the following requirements:
- 5.9.1 Transmission of brake power.
- 5.9.2 Largely unrestricted thermal expansion of friction faces and friction segments.
- 5.10 A minimum true specific weight shall be of great importance.
- 5.11 The friction ring shall be designed additionally with a view to minimizing their overall weight.
- 5.12 The friction ring of brake disc shall have a groove around their outside circumference to indicate the condemning limit and when they have to be exchanged.
- 5.13 The crosswise cooling ribs carry off the heat and serve simultaneously to maintain a thermal balance within the friction rings.
- 5.14 Cooling fins that are arranged radially between the friction surfaces provides for sufficient cooling at the friction ring. They convey a stream of cooling air from the hub through the interior of the friction ring to the outside, using a centrifugal force that is controlled by speed.
- 5.15 Low-noise behaviour by the brake disc under all operational conditions shall be of great importance.
- 5.16 Ventilation grids of the brake disc to be so designed to avoid entrapping of debris like paper, polythene etc. may get trapped in service which may choke them. The design of the ventilation grids of the brake disc shall be suitably modified/ redesigned to get self-cleaning properly.
- 5.17 Brake Disc should be easy to replace, single damaged piece friction ring can be dismount after cutting and it shall be possible to replace with split disc friction ring.
- 5.18 Supplier should also offer split disc design so that replacement for damaged or worn out friction rings can be achieved with ease without the necessity of dismounting of wheels from the axles and also the same can be mounted on hub of standard interface having 12 bolts design of any

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make.

- 5.19 Unless the purchaser requests otherwise, a suitable hole and groove feature shall be incorporated to facilitate pressurized liquid assisted assembly and/or disassembly of hub and axle. The threaded hole connection is to be closed with a locking bolt G1/4A DIN 908/DIN 910 and sealing ring A14 x 20 x 1.5 DIN 7603.

6.0 PERFORMANCE REQUIREMENTS

- 6.1 The brake disc is to be so designed that it provides faultless operation under the conditions of use mentioned at Annexure –III for a period of at least 6 years from the date of commission.
- 6.2 Brake disc should be designed in such a way that it has minimum wear and tear and maintenance possibility. The goal for the wear limit on friction faces and friction segments shall be 2 million kilometres.
- 6.3 Design of the brake disc shall be such that the performance is not adversely affected under extreme positions of wheel and suspension movements under maximum wear conditions.
- 6.4 Brake Disc shall be able to expand during the braking process to avoid crack formation on the disc. The expansion shall be in such a dimension that vibrations are minimised.
- 6.5 Brake Discs shall have a higher strength against external dynamic loads (shocks upto 100g).
- 6.6 The maximum thermal heating of brake disc in no case exceeds the permissible value of chosen material.
- 6.7 The brake disc offered shall be suitable to work with any UIC/RDSO approved Organic Brake Pads suitable for operational speed upto 160kmph and must qualify frictional and thermal characteristics as stipulated in UIC 541-3.

7.0 GENERAL TECHNICAL REQUIREMENTS

- 7.1 The general technical requirements for manufacture of Standardized Brake Disc are mentioned in Annexure-I.
- 7.2 The general design and drawing of the brake disc shall be got approved from RDSO/**Vendor approving authority**.
- 7.3 QAP for the manufacture and inspection of the brake discs should be prepared by the firm and submitted to RDSO/**Vendor approving authority** for approval.
- 7.4 Routine and Type tests on the brake disc shall be done as indicated in Clause 14.
- 7.5 The prototype testing of any new design brake disc (which is being used by IR for the first time) shall be witnessed by the RDSO/**Vendor approving authority** at the firm premises. In case, type testing facilities are not available in firm's premises, the test may be conducted in UIC approved friction test benches or labs meeting accreditation criteria as detailed in RDSO ISO procedure.

8.0 SUBMISSION OF TECHNICAL DOCUMENTS

- 8.1 The following technical documents/details in triplicate shall be submitted by the firm along with application:
- 8.1.1 The clause by clause comments on this specification, confirming compliance with all the clauses and elaborating, wherever necessary shall be enclosed.
- 8.1.2 Detailed drawing in A1/A2 size of Brake Disc which shall contain details regarding broad material specification, dimensions, estimated weight, testing parameters, marking particulars, reference to manufacturing / original collaborator's drawing etc.
- 8.1.3 Material data sheet for all components i.e. friction ring, hub, bolts etc. shall be made available for verification to the visiting inspection agency.
- 8.1.4 FEA report of brake disc **must be** offered to Indian Railways **in case of new supplier entrant or any critical design changes in brake disc by existing supplier which may affect any**

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physical/chemical/functional property of the brake disc. The maximum stress from the FEA at the specified load, with a factor of safety of atleast 1.50, shall be less than the allowable fatigue limit. The FEA report must include an analysis for fatigue life showing the damage factor due to loads imposed by vertical and lateral axle box acceleration and thermal loads resulting from friction between disc and brake pads. The FEA report shall include but not limited to, the following:

- a) Introduction
- b) Table of contents
- c) Summary
- d) Physical properties of each material used for the disc. This table shall include but not limited to:
 - Yield strength
 - Ultimate strength
 - Elongation
 - Tension modulus
 - Compression modulus
 - Shear modulus

Minimum values shall be used and shall be selected from material specification

- e) Views of key structural areas (spoke, hub-friction ring connections, etc.) showing member locations and geometry, and indicating the material and thickness of each. Other FEA views may be required where critical stresses are identified.
 - f) A tabulation or fatigue curve justifying the contractor's selection of allowable fatigue stresses for the disc material for each transition or joint, and the fatigue-critical stress ranges. The FEA report shall include a description of how this process is carried out.
 - g) The complete test report must be submitted including procedure, raw and induced data, and summary of results, including:
 - Structural sketches and/or layouts of the critically stressed locations showing locations and shapes depicted in scale, thickness, section properties and material.
 - Diagrams displaying externally applied loads and boundary conditions.
 - Colour plots of the stress under each loads and boundary conditions.
 - Natural frequencies of the disc.
- 8.1.5 In the FEA analysis following braking conditions must be considered with emergency braking (with maximum deceleration value as 1.3 m/sec²).
- 8.1.5.1 Simulation of one emergency braking with new disc.
 - 8.1.5.2 Simulation of two consecutive emergency braking with new disc.
 - 8.1.5.3 Simulation of three consecutive brakings (1 Emergency Braking + 1 service braking + 1 Emergency Braking) with new disc.
 - 8.1.5.4 Simulation of one emergency braking with worn out disc (7mm taken out per side).
 - 8.1.5.5 Simulation of two consecutive emergency braking with worn out disc (7mm taken out per side).
 - 8.1.5.6 Simulation of three consecutive brakings (1 Emergency Braking + 1 service braking + 1 Emergency Braking) with worn out disc (7mm taken out per side).
 - 8.1.5.7 Bolt calculation in the worst of the above configurations.
 - 8.1.5.8 Maximum/Allowable temperature for the Brake Disc and its associated components.
 - 8.1.5.9 Stress & Displacement values under dynamic condition.
 - 8.1.6 Hub & Friction ring connecting Bolt calculation report.
 - 8.1.7 The corresponding wear calculations and/or tests at the testing bench.

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8.1.8 Details of testing facilities available at manufacturers.

8.1.9 For a new entrant or in case of any design changes of the registered suppliers, the type and routine test specification and test reports shall be submitted. RDSO or authorized Railway representative have their discretion to pick up sample for conducting type and routine test.

8.1.10 Operation & maintenance manual and service instructions.

8.2 In addition to the above, further information, if required by the RDSO/Indian Railways, shall be promptly provided by the firm.

9.0 APPROVAL OF DRAWING

9.1 The design/drawing of the Brake disc shall be developed based on the technical and performance requirements given in this specification and sound engineering practice. The entire drawing shall be submitted by the firm with technical data and calculations to RDSO/**Vendor approving authority** for approval.

9.2 The drawing shall be developed in SI units.

9.3 Broad material grade/ specifications for main component shall be indicated on the relevant drawings of the firm and the firm shall supply copies of translation in English of such specifications/ drawings other than Indian Standard Specifications to purchaser/RDSO.

9.4 Approval of the design means the approval of the general design features. Notwithstanding the approval, the contractor will be wholly responsible for the performance of the Brake disc offered.

10.0 DIMENSIONS AND TOLERANCES

10.1 Brake discs are intended to be mounted on the axle to RCF Drg. No.LW02100 alt '**Nil latest**'. It shall be ensured by the firm that disc/discs offered by him are suitable to be fitted on to the axle as per this drawing.

10.2 Broad specification of the brake disc shall be as under:

a)	Dimensions	640 x 110 mm
b)	Outer Diameter of friction ring	640 ^{+0/-1} mm
c)	Inner Diameter of friction ring	350 ^{+1/-1} mm
d)	Width of friction ring	110 ^{+0/-0.3} mm
e)	Inner bore	199 mm (H6)
f)	Width of hub	150 mm
g)	Pitch Circle dia of hub/friction ring connecting bolt	276 ^{+0.5/-0.3} mm
h)	No. of connecting bolts	12 nos.
i)	Size of connecting bolts	M12

Also reference sketch for general arrangement & interface dimension of hub and friction ring provided in Annexure-IV (RDSO Sketch No.CG-15066 Alt.**0 latest**).

10.3 The imbalance of new discs shall be equal to or less than 16g.m.

11.0 MANUFACTURE

11.1 Brake Disc shall be manufactured as per drawing approved by the RDSO/**Vendor approving authority**.

11.2 Brake Disc shall be free from casting defects.

11.3 No sharp corners or edges shall be present.

11.4 The surface roughness on friction faces shall be **Rz** ≤ 16µm, except where otherwise specified by the IR or purchaser.

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- 11.5 The surface roughness on hub bore shall be between $Ra=0.8\mu\text{m}$ to $3.2\mu\text{m}$, except where otherwise specified by the IR or purchaser.
- 11.6 The distance of edges from the center of M12 holes should be minimum 20 mm from all sides in both friction ring & hub.
- 11.7 Hub connection to the friction ring shall be made properly. The connecting bolts shall be tightened with the specified torque wrench.
- 11.8 The brake disc shall be carefully protected against corrosion.
- 11.9 The friction faces, friction segments and surfaces which are exposed to high temperature shall not be provided with surface protection.
- 11.10 The remaining surfaces shall be provided with either an appropriate lacquer structure or galvanic coating or phosphating. Other suitable coating for corrosion protection can also be considered with prior approval of RDSO/~~Vendor approving authority~~.
- 11.11 Surface protection shall be evident on the drawing.

12.0 PROTOTYPE INSPECTION

- 12.1 The manufacturer shall offer at least 3 Nos. Prototype discs of a new or modified brake disc, the necessary testing according to Para 14 of this specification shall be carried out on test piece.
- 12.2 The Prototype inspection of brake disc shall be carried out by ~~Carriage Directorate of RDSO/Vendor approving authority or their nominee~~ at manufacturer's premises. The manufacturer shall provide, without extra charges material, tools and any other assistance, which may consider necessary for any test examination and dimensional checking.
- 12.3 After prototype clearance, the brake disc shall be subjected to field trial as per Para 15.0 of this specification.
- 12.4 ~~The manufacturer shall preserve three prototype Brake Disc samples for a period of 18 months from the date of start of field trial.~~

13.0 PURCHASE INSPECTION

- 13.1 The purchase inspection shall be carried out at the premises of the manufacturer who are registered with RDSO/~~Vendor approving authority~~. The following procedure shall be followed:
- 13.2 The Inspecting Authority shall make audit checks of the manufacturing procedure 'Internal Quality Assurance System' to ensure that the Brake Disc offered for inspection is manufactured strictly as per 'Internal Quality Assurance System' and the manufacturer has carried out all the tests/inspections during manufacturing stage to ensure that the Brake Disc as well as their components are manufactured strictly to the specification/drawing and quality standard of the collaborator. During audit checks the inspection Authority shall see from the records of 'Internal Quality Assurance' that the Raw material used for the manufacture of Brake Disc is as per specification laid down.
- 13.3 Manufacturer shall have to maintain the internal tests record and submit to the Inspection Authority.
- 13.4 The Inspection Authority shall conduct the following checks/tests of the Brake Disc from a lot of 250 Nos. or part thereof.
- 13.4.1 2% or minimum three number Brake Discs picked up at random shall be checked for dimensions and tolerances, general workmanship and surface finish as per RDSO/~~Vendor approving authority~~ approved drawings.
- 13.4.2 1% or minimum two disc picked up at random shall be verified for tests mentioned in clause 14.2.1 (a), (b), (c) & (d) of specification during prototype inspection. The supplier shall produce relevant test reports of the test done on the test bars/~~chills~~ samples used for the manufacture of

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particular batch/lot/heat of disc for the tests mentioned in clause 14.2.1 (a), (b), (c) & (d) during purchase inspection. Manufacturer also keep the test bar/~~chills~~ samples with appropriate marking of each heat, received from raw material supplier, which have gone for manufacturing of friction ring and to be tested. The test result must be confirming to specified value.

The manufacturer shall preserve the test bar samples for the period of 18 months from the date of supply.

- 13.4.3 Test reports for 2% or minimum three numbers Disc picked up at random shall be verified for tests mentioned in clause 14.2.1 (e) & (f) of specification.
- 13.5 In case the samples picked up fails in any of the tests/checks indicated at clause 13.4.1 to 13.4.3, the entire lot of the Brake Disc shall be rejected by the Inspecting Authority.
- 13.6 Inspecting authority shall have access to all detailed manufacturing/original collaborator's drawings for all items of equipment. The firm shall be obliged to show these drawings as and when called for.
- 13.7 The inspecting authority may deviate from the agreed procedure if and when found necessary to re-assure that the material is being furnished in accordance with this specification. In this regard the manufacturer shall not be entitled to object on any ground whatsoever on the nature and procedure of testing that may be followed by the inspecting authority.

14.0 TESTS

14.1 Type Test

- 14.1.1 The following test shall constitute type test and shall be carried out in accordance to EN 14535-3 at the time of Product approval of new entrant or at the time of design change of existing design:

- a) Performance and Endurance Test
- b) Centrifugal Test
- c) Ventilation Test
- d) Heat dissipation test

14.2 Routine Test

- 14.2.1 The following test shall constitute routine test and shall be verified against value specified in manufacturer's specification/QAP:

- a) Chemical characteristics
- b) Hardness
- c) Tensile Testing
- d) Microstructure
- e) Magnetic Particle Testing
- f) Residual imbalance

15.0 FIELD TRIAL

- 15.1 The brake disc offered by the new supplier having no prior experience in manufacturing of brake disc for Railway application shall be subjected to field trials on minimum 18 coaches (Preferably 1 rake) for a period of minimum 18 months or 3,00,000 Km whichever is earlier.
- 15.2 In case the brake disc is offered by a new supplier having technical collaboration with any collaborator having experience for at least 5 years in manufacturing of brake disc for Railways, and similar design brake disc of collaborator has satisfactory performance for more than 2 years on any international Railways (at least 18 coach set) each, the field trial shall be on minimum 18 coaches (Preferably 1 rake) for a period of minimum 09 months or 1,50,000 Km whichever is earlier. The supplier shall provide collaborator's detail design, drawings, supplies

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made to Railways and satisfactory performance certificate from end user. Supplier also submit MOU with collaborator for transfer of technology (TOT). Authenticity of MOU of Collaborator should be checked at initial level before any decision on trial etc. for item.

- 15.3 After the satisfactory performance of the field trials, the disc offered may be considered for regular service on Indian Railways and firm may be approved.

16.0 GUARANTEE

- 16.1 The firm shall, at their cost, replace the Brake Disc failing prematurely or proving unsatisfactory in service for reasons attributed to defective/faulty design, defective material or poor workmanship within a period of 72 months from the date of delivery or 66 months from the date of fitment, whichever is earlier. This warranty shall survive, notwithstanding the fact that the brake disc may have been inspected, accepted and payment thereof made **by to** the firm.

- 16.2 Brake Disc shall be subjected to detailed trials as discussed in Clause 15 of the specification. Any modifications found necessary as a result of these tests or further service trials shall be carried out by the contractor at his own cost in the coaches in a manner approved by the purchaser. All schematic layout and installation drawings incorporating the modifications shall be submitted to RDSO/**Vendor approving authority** for final approval.

17.0 AFTER SALES SERVICE

- 17.1 Firm may be required to send their technical expert during the installation and commissioning of their brake disc on coach/coaches. The charges for this service shall be quoted separately.

- 17.2 Firm shall also depute its technical expert on request by the Purchaser/RDSO to investigate and attend to specific problems that may come up during actual operation of Brake Disc.

- 17.3 Firm shall supply at least 3 copies (soft & hard copy both) of the Operation & Maintenance Manuals and Servicing Instructions to each coaching depot where LHB coach maintenance is done:

- 17.3.1 Brief details of brake disc.

- 17.3.2 Details of attention to be given during IOH/POH or any other schedule examination.

- 17.3.3 Details of tools & machinery for maintenance of brake disc.

- 17.3.4 Typical defects and their remedial measures.

- 17.3.5 Maintenance standards including clearances and tolerances at various locations and permissible limits of wear for good service performance of equipments.

- 17.3.6 Firm shall submit the frequency and detailed work content of various inspection / maintenance schedules necessary for maintenance of brake disc offered by them. Whether these requirements are time based or distance travelled based shall be indicated for each schedule.

18.0 MARKING

- 18.1 The detailed form of the marking shall be defined on the drawing. The following data shall be applied to the part in a clearly recognized way:

- a) Manufacturer's data (manufacturer's name / trade mark), month & year of manufacture and serial number.
- b) Residual imbalance in g.m (Data regarding residual brake disc imbalance shall be located directly in the place where the imbalance occurs).

The above data shall be stamped/engraved, clearly legible, in an appropriate location.

19.0 PACKING

- 19.1 Supplier shall ensure that Brake Discs in an assembled condition are adequately packed before dispatch to prevent damage in transporting, handling and storage. The safe transportation shall be the responsibility of manufacturer.

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ANNEXURE-I**INFRASTRUCTURE & TESTING FACILITIES REQUIRED FOR MANUFACTURE OF STANDARDIZED BRAKE DISC USED IN LHB COACHES OF INDIAN RAILWAYS****1.0 SCOPE**

- 1.1. This section covers the infrastructural requirements for manufacture of ~~manufacture of~~ standardized brake disc used in LHB Coaches of Indian Railways.

2.0. REQUIREMENTS

- 2.1 All vendors seeking registration with RDSO/Railways as decided by Ministry of Railways must fulfill the requirements of this schedule.
- 2.2 The firm should have adequate plant, machinery and manufacturing capacity for manufacture and supply the brake disc within the delivery schedule.
- 2.3 The firm should have a well-established quality control system and testing facility to ensure adequate quality, at all stages of manufacture.

3.0 PLANT, MACHINERY AND INFRASTRUCTURE REQUIREMENTS

- 3.1 The Manufacturer shall have adequate space and covered area with cemented floor to accommodate the following and for smooth logistics:

- a) Damp-free place for storage of raw materials.
- b) Adequate manufacturing area.
- c) Finishing, Assembly and Inspection area.
- d) Storing and dispatch of finished products.

- 3.2 The Manufacturer shall have following machines/facility:

For Friction Ring**a) Vertical Turret Lathe/Special Purpose Machine (SPM):**

Capacity:- Minimum turning diameter 700 mm

Minimum turning thickness 200 mm

For Hub

- a) Turret Lathe/Special Purpose Machine (SPM):** For machining, facing, drilling, internal boring & finishing operation etc.

Capacity:- Minimum turning diameter 400 mm

Minimum turning length 200 mm

Minimum turning internal bore size 199mm (H6)

- b) Phosphating Plant (Outsource facility with MOU may also be acceptable) for phosphating of hub or suitable method for corrosion protection.**

- c) Grinding machine of suitable capacity for grinding of inner bore size.**

For Brake Disc

- a) Hub & Friction Ring assembly stand having suitable jigs & fixtures with auto torquing tool having screw tightening sequencing program.**

- b) Auto balancing machine for Brake Disc (with material removal provision).**

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4.0 TESTING FACILITIES

The manufacturer shall have the following testing and other equipments to test the product as per the relevant requirements of the specification, installed in a workstation with controlled temperature and humidity.

- a) Magnetic particle testing facility.
- b) 3-D CMM for checking geometrical dimensions.
- c) Other required testing facilities to conduct routine tests.

5.0 QUALITY CONTROL REQUIREMENTS

- 5.1 The firm should have acquired ISO:9000 series certification for the product for which an approval is sought.
- 5.2 Quality manual of the firm for ISO:9000 should clearly indicate at any stage the control over manufacturing and testing of the railway product.
- 5.3 The firm should submit the Quality Assurance Plan (QAP) as per relevant ISO document.
- 5.4 The firm must ensure that proper analysis is being done on regular basis to study the rejections at various internal stages and it is well documented.
- 5.5 The firm should ensure that latest version all the relevant specifications, IS Standards are available with the firm.
- 5.6 Traceability of product/parts thereof should be ensured from raw material upto finished stage.
- 5.7 There should exist a quality manual of the firm indicating the extent of control for production and testing.
- 5.8 System for calibration of testing & measuring equipment.

6.0 DOCUMENTATION

Firm shall maintain the following documents/ records:

- 6.1 A well-documented Quality Plan.
- 6.2 Incoming raw material register with Test Certificates references of suppliers and internal test results.
- 6.3 Stage inspection results including finished products results.
- 6.4 Records of internal rejection and its analysis vis-à-vis action plan.
- 6.5 Records of final products inspection by external agencies (like RDSO/Railways), Non-Conformity Reports and case analysis as well as action taken thereof.
- 6.6 There should exist a system of documentation in respect of rejection at customer end, warranty replacement and in service performance.
- 6.7 Records of raw material received and supplies made to Railways against the raw material. Incoming raw material with TC reference of supplier as well as internal test/audit checking from outside agency.
- 6.8 The details regarding Stage inspection and test result.

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ANNEXURE-II**DESIGN DATA AND LOAD CASES FOR BRAKE DISC****a) THERMAL LOAD AND BRAKING SCENARIO**

S. No.	Description	Unit	Emergency Braking	Service Braking
1.	Mean Braking Radius (m)	Meter	0.247	0.247
2.	Wheel diameter (New) (m)	Meter	0.915	0.915
3.	Wheel diameter (Worn) (m)	Meter	0.845	0.845
4.	Mean Co-efficient of friction of Brake Pads	-	0.35	0.35
5.	Surface Area of Brake Pads	cm ²	400	400
6.	Braked Mass	Kg	8000	8000
7.	Starting velocity	Kmph	160	160
8.	Final velocity	Kmph	0	0
9.	Brake application time	Sec	4	4
10.	Deceleration rate	m/sec ²	1.2	0.80
11.	Clamping force per disc	kN	42	25
12.	Kinetic energy	MJ	7.9	7.9
13.	Load cycles	-	6000	62500

b) IMPACT LOAD

S.No.	Description	Vertical	Axial
1.	Standard Impact	25g	3g
2.	Extraordinary Impact	100g	100g

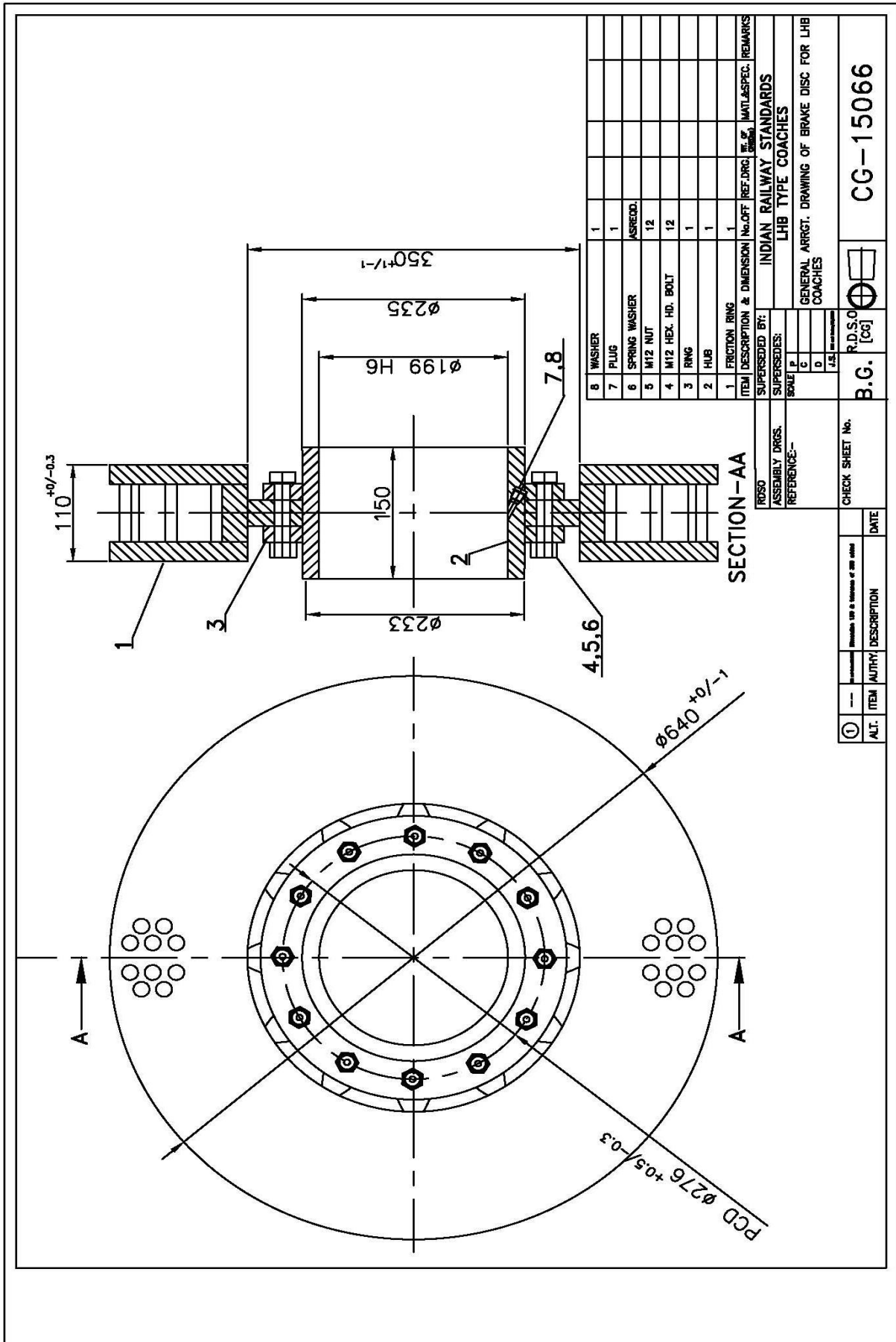
Signature			
Name & Designation	Prepared by: Mahesh JE/Carriage	Checked by: Vivek Anand SSE/Carriage	Approved by: Sudhir Singh Jt. Director/Carriage

Annexure-III**OPERATING CONDITIONS FOR BRAKE DISC**

1. Coach Type : LHB Type BG Passenger Coaches
2. Axle Load : 16.25t (max.)
3. Gross Load (Coach) : 65t (max.)
4. Gross Load (Train) : 1700t (max. without loco)
5. Operating speed (max) : 160 Kmph
6. Maximum deceleration : 1.3 m/sec²
7. Emergency Braking distance : 1200 meter
8. Wheel diameter : 915 (New)
: 845 (Worn)
9. Wheel base : 2560mm
10. Minimum clearance above rail level : 91 mm under loaded and worn condition
11. Maximum bogie rotation and swing : 3.5°, 82mm
12. Track Parameters
- a) Steepest Gradient : 1 in 37
- b) Sharpest curvature : 152.4 m or greater radius
- c) Super elevation (max) : 185 mm
13. Environmental condition
- a) Maximum temperature under sun : 70 °C
- b) Maximum temperature under shade : 45 °C
- c) Minimum temperature at Night : - 10 °C
- d) Altitude : Sea level to ~~1000~~ 1776 meters
- e) Humidity : 100% saturation during rainy season
- f) Rain falls : Fairly heavy
- g) Atmosphere during hot weather : Dusty
- Environment: Coaches shall be working in coastal area with saline and corrosive atmosphere.
14. The vibrations and shocks normally to be encountered in service.
- a) Maximum vertical acceleration = 3.0 g
- b) Maximum longitudinal acceleration = 5.0 g
- c) Maximum transverse acceleration = 2.0 g

Signature			
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Annexure-IV



Signature			
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