Government of India

भारत सरकार
रेल मंत्रालय

Wheel Profile Measurement System for Rolling Stock

Specification No.: IS/RDSO-RES/---------

अनुसंधान निदेशालय
अनुसन्धान अभिकल्प एवं मानक संगठन
मानक नगर, लखनऊ - 226011

Research Directorate
Research Designs & Standards Organization
Manak Nagar, Lucknow – 226011

CONTENTS

NORMATIVE REFERENCES		
SN	**Subject**	**Reference Document**
1.	Wheel Profile Parameters for Coaches (LHB & ICF/ Vande Bharat/ MEMU)	Drawing no SK – 91146 Alt.3
2.	Wheel Profile Parameters for Diesel/ Electric loco	Drawing no SK.DL-2561 Alt.8, CSL-3040 Alt.2
3.	Wheel Profile Parameters for Wagon	Drawing no. WAP/SK/M/153 (BOXN/BCN) , CONTR 9404/S13 (BLC)
4.	Indian Railway Wheel Identification of Rolling Stock	Guideline issued by CRIS: 2019/ CRIS/NDLS-ITPI /RFID /POLICY/0151/PT-1,dated:22.08.2019
5.	Wheel Profile Detector	AAR Manuals Standard S-6103
6.	Indian Railways Permanent Way Manual	IRPWM Latest issued in June 2020
7.	Study of measurement accuracy and resolution	An Implementation Guide for Wayside Detector Systems issued by Federal Railroad Administration's (FRA) issued in May 2019.
8.	Maintenance Practice of rolling stock	IRCA Part III and Part IV (Latest)

ABBREVIATIONS			
AC	Alternating Current	**ANOVA**	Analysis of Variance
API	Application programming interface	**BG**	Broad Gauge
B2B	Back face to Back face of Wheel	**BV**	Brake Van
CAMC	Comprehensive Annual Maintenance Contract	**CMM**	Coaching Maintenance Management
CRIS	Centre for Railway Information System	**EMC**	Electromagnetic compatibility
EMI	Electromagnetic interference	**FAT**	Factory acceptance test
FMM	Freight Maintenance Management	**ICF**	Integral Coach Factory
ICD	Interface control document	**IR**	Indian Railway
IRSOD	Indian Railway Schedule Of Dimensions	**IRPWM**	Indian Railways Permanent Way Manual
JSON	JavaScript Object Notation	**LHB**	Linke Hofmann Busch coach
NABL	National Accreditation Board for Testing and Calibration Laboratories	**OHE**	Over Head Equipment
RDSO	Research Designs & Standards Organization	**RFI**	Radio-frequency interference
RFID	Radio Frequency Identification	**SLAM**	Software for Loco Asset Management
TCP/IP	Transmission Control Protocol /Internet Protocol	**UPS**	Uninterruptible Power Supply
VB	Vande Bharat Coaches	**WPMS**	Wheel Profile Measurement System

1. Introduction

Accurate and real-time monitoring of wheel profiles enables early detection of wear, incipient abnormalities and defects. This allows for proactive maintenance contributing to cost-saving measures by optimizing maintenance schedules. It aligns with the global trend in rail transportation to adopt smart technologies that enhance the performance and reliability of railway networks.

This specification covers requirements for design, development and supply of all-weather Wheel Profile Measurement System hereinafter referred as WPMS installed besides or between tracks for inspection of wheel Profile as well as measurement of wheel diameter and wheel gauge for IR wheels while in motion under their respective Broad Gauge (BG) Rolling Stock. The system output expected include the following

1.1 The graphical presentation of Wheel Profile.
1.2 Wheel parameters as identified in para no.18
1.3 Defect Detection based on Parameters indicated in Part B

The specification is generic in nature and describes the technical and functional requirements while remaining technology agnostic. Vendors are free to select available state of art technologies as per industry practices to meet the requirements stipulated in this specification.

2. Scope of supply

2.1 The WPMS systems shall be supplied and installed with adequate redundancy on turnkey basis by OEM and/or their trained and authorized personnel. The scope of supply shall include:

2.1.1 Material, as required for civil engineering work
2.1.2 WPMS site Equipment including necessary software database and GUIs for parameters and profile measurement along with an integrated RFID reader
2.1.3 Sensors for Train Detection Systems
2.1.4 Purging and/or cooling system as may be required.
2.1.5 Concomitant accessories for alarms, computer, servers, Power and Data Cables, provision for internet connection etc.
2.1.6 Tool kit with periodic calibration accessories: For every WPMS one calibration and validation tool kit should be supplied by the supplier.
2.1.7 Spares and consumable for normal maintenance during warranty period.
2.1.8 Site safety apparatus and tools required for functioning, calibration and maintenance.
2.1.9 Any other accessory/component/system(s) essentially required for proper functionality of the equipment.
2.1.10 Training as per Para no.12
2.1.11 System Literature: Operating, Maintenance Trouble Shooting instruction and all calibration/ sensor certificates in original.

Part-A: General Requirement for Equipment

3. Installation and Site Selection Criteria

Installation of the system should be done by supplier on turnkey basis. Following General requirements/ guidelines for the site may be agreed to unless otherwise agreed to between consignee and Supplier

3.1 The system is intended to be used at different Rolling Stock Depot and the location of the system should be selected in consultation with consignee (IR). The site requirement would be consider as under:

3.1.1 Minimum 15 meters Straight and level track on either side of equipment

3.1.2 Away from switches and transition zones

3.1.3 Track structure should be stable and well maintained with proper drainage system.

3.1.4 Site should be preferably within 200 meters from the main power distribution box. In case the distance of power distribution box is more than 200 meter from the installation site, the power cable shall be arranged by consignee.

3.1.5 Supplier shall visit the location and finalise the location with the consent of consignee. As per site conditions, a GA drawing shall be prepared by the supplier and to be got approved by the consignee.

3.2 Civil engineering and other allied works (if required) such as foundation for suitable enclosure/hut to accommodate UPS, batteries, electronic and electrical equipment, power system etc.; grouting supports for steel enclosures/equipment, control box, battery box etc., necessary work e.g. trench etc. for power and data cables shall be carried out by the system supplier. Adequate space and permissions where necessary may be provided by consignee.

3.3 The system shall not infringe IRSOD and shall be installed in consultation with authorized Railway Engineer.

3.4 The track in the instrumented area shall be maintained manually by Indian Railways. The firm shall provide proper demarcation of instrumented area under the guidance of engineering supervisor and consignee.

3.5 The system shall be suitable for operation on three phase 400 volt+/-10% or single phase 230 Volt +/- 10%, 50 Hz+/- 3% confirming to IS 12360:1988 Amendment no 3 Feb 2009 or latest. This power shall be made available at main power distribution box by consignee. From this point the tenderer shall bring power supply to the site of installation by laying suitable power cable. The maximum load on the power supply system should not exceed 15 KVA.

3.6 UPS or alternate power back-up like DG Set for at least 4 hours or 10 rake pass byes whichever is lesser with auto switch-over functionality shall be provided by the system supplier.

3.7 The internet and data connectivity should be provided for transfer of data, display of reports and audio-visual alarms from site of installation to centralized location as finalized by consignee.

3.8 For providing internet and data connection, there shall be provision of wired network. A standby provision of wireless connection through mobile network (4G/5G SIM enabled) should also be provided in case of failure of main internet connectivity. Suitable buffer storage for minimum 03 days or of minimum 50 rakes of data is required.

3.9 The recurring expenditure on internet connectivity during warranty from the date of commissioning shall be borne by the supplier. Subsequent expenditure shall be borne as a part of CAMC by Indian Railways and paid as per actuals.

3.10 Necessary mounting arrangement that can be easily disassembled within 05 hrs and reassembled within 07 hrs (Including time for calibration and validation). For this purpose, a notice shall be sent to the concerned agency by the consignee at least 48 hours in advance. Drawings of mounting arrangement of sensors should be submitted along with the proposal to consignee. Additional time of upto 6 hours may be permitted by the consignee considering nature of Track repair involved and the rolling stock maintenance requirement in depot.

4. Operational Requirements: The system should conform to following operational requirements

4.1 **Operating speed:** 05 to 30 KMPH

4.2 **Train length:** Upto 300 Axles

4.3 **Train headway**: 15 minutes between trains having upto 300 axles each.

4.4 **Degree of protection for electronics (embedded microprocessor system):** IP 55 (For electronics housed in console/hut)

4.5 **Degree of protection for trackside/rail mounted sensors housed in enclosure**: IP 67

4.6 **Degree of protection for Measurement Optics**: IP 67

4.7 **Ambient temperature range:** (-)10^0 to (+)55^0 Celsius

4.8 **Relative humidity:** Up to 100%

4.9 **Track Structure**: Rail Section and profile as per Para 203 of IRPWM, June 2020

4.10 **Wheel Profile Measurement locations**: Data(for parameters to be measured as mentioned in Para 18) should be collected from 6 or more different locations around the circumference of the wheel covering at least 0.5 meter of circumference length.

4.11 **Technology:** Latest available state of art technology like laser based and/or high speed camera or any other proven technology.

4.12 **System Thresholds:** Limits for alert (Multiple Alerts levels- Attention Alert & Withdrawal Alert) shall be set centrally by RDSO or admin ID holders based on written requests duly approved by competent authority.

4.13 **System Activation:** The system should be capable of automatic detection of approaching train along-with automatic switching-on/off of relevant systems.

4.14 **Vehicle Identification:** The system should be capable of automatic identification of rolling stock (Locomotives, Wagons, ICF or LHB Coach, BV, etc.) based on the integrated RFID reader and be capable of wheel identification within the rolling stock as per guideline No.: 2019/ CRIS/NDLS-ITPI/RFID/POLICY/0151/PT-1,Dated:22.08.2019 or latest issued by CRIS along with Annexure-4. The type of rolling stock identification can also be done by inter axle distance measurement and vehicle identification can also be achieved by manual input of data when a RFID tag is not read due to reasons like damage or missing or equipment failure etc.

4.15 **Calibration:** The system should be calibrated as recommended by the OEM but no later than every one year or earlier if requested by consignee. Details of calibration methodology shall be submitted along-with the offer. The supplier should arrange all equipment/accessories required for calibration of the system. All calibration activities should get logged in the data base indicated in dash board and calibration report also generated.

4.16 **Integration:** Full TCP/IP (Transmission Control Protocol/Internet Protocol) support should be inbuilt into the system to facilitate smooth integration into all existing

railway data networks. The system should be integrated with CMM, FMM and SLAM (CMM, FMM and SLAM are the modules developed by CRIS for monitoring of coaching, freight and locomotives respectively)–and should also be able to integrate with above multiple applications at the same time. For this purpose, successful bidder shall be required to send processed data in JSON format using restful API with token based authentication. The details of the API shall be provided by CRIS and JSON format will be decided based on the data generated by systems. System shall be capable of communicating over https protocol with external application and necessary communication protocols and details required for integration of the system should be provided by the OEM to Indian Railways. System shall support multiple data formats such as JSON, XML, CSV, flat file etc. for information exchange. System shall be capable of handling security requirements of the communication. The transmitted data to CMM, FMM, and SLAM shall be the mean of minimum 06 values of the parameters as given in Annexure-1 & 2 for each wheel as recorded in the pass by, the graphical plot of profile generated for each wheel and shall highlight alarms raised if any along with date, parameter of concern and time stamps. These may be advised as per IR wheel numbering scheme (Annexure - 4).

4.17 **Interface Control Documents (ICD):** The firm shall submit ICD to Indian Railways. This ICD will be used to integrate with other railway systems.

5. Functional Requirements: The system should be run 24x7 (available round the clock) without any human intervention. Following information is required to be captured and displayed in reports for all type of broad-gauge (BG) rolling stock by wheel profile measurement system:

5.1 Date and Time of Passing Rake
5.2 Site/ Depot Name
5.3 Direction of passing Rake (IN/OUT)
5.4 Rake Speed at entry exit from the system
5.5 Total number of axles passed and total number of vehicles in the rake
5.6 Identification of rolling stock and wheel
5.7 Parameters (Annexure-1 to 2) of each Wheel (Left & Right)
5.8 User defined Alarms based on measured parameters as per Annexure-1 & 2.
5.9 Type of rolling stock: Locomotives, Coaches (LHB, ICF), Wagons, Train set/ Vande Bharat, DEMU, MEMU, Brake Vans etc. as deduced from the RFID tag.

6. Software Requirements:

6.1 The supplier shall have to provide documents explaining the methodology and logic used to develop the algorithm for the system to get the required output. Any information/ explanation deemed proprietary may be indicated in the technical bid for comparison with their offers. Unless indicated, it shall be presumed that the tenderer has no limitation in sharing any information on logic/ methodology used.

6.2 The supplier shall be responsible for providing required software for collecting data, storage, graphical and tabular presentation of reports sent by the system. The Database Management and archiving shall also be carried out by the supplier at regular intervals.

6.3 The system should be able to record and measure all the parameters of each passing wheel as mentioned in Annexure-1 &2

6.4 The System server must have the capability to store a history of all type of data for at least the last 24 months for each vehicle wheel.

6.5 The system should be capable to integrate with CMM, FMM and SLAM for all reports generated from the system. Also user feedback from CMM, FMM and SLAM should be reflected in system software.

6.6 The system should be equipped with robust, networked, alert-management software with full suite of graphical analysis and diagnostic tools.

6.7 The system server must have software for trending of the data history of the Wheels and be capable of presenting graphically the progression of observed parameters & profile based on data, duration and interval/step selected for any wheel.

7. Web-server Requirements

The supplier shall launch and maintain an internet web-server at any location (in India) with following features:

7.1 Multiple User password protected log-in

7.2 Differential access and usage rights to multiple levels of users e.g. write-only, read-only, query design and administrator rights.

7.3 Facility to export data in latest version of MS-Excel, CSV (Comma Separated Value) and PDF format. All the data transfer must be over secured network with token based authentication and shall be properly logged for audit and tracking.

7.4 Firms shall also provide ICD (Interface control document) for system database for transferring data from provided web-server to server of FMM, CMM and SLAM.

8. Safety Requirements

8.1 The system shall comply with EN 50121-4 and EN 50122 for protection against external EMI/EMC/RFI interferences and electrified OHE (Over Head Equipment.

8.2 The system shall be so designed that it shall not hamper signaling, track, communication, electrical systems, etc. in service in IR.

8.3 The functioning of the system shall not get affected by the usual environmental and site conditions like vibrations from passing trains, track maintenance vehicles/ equipment not involved in pre-advised and scheduled maintenance activity at the site, heavy rain and water and heat/ sunlight.

8.4 The system shall be designed on fail-safe principles and adequate safety margins must be incorporated in the design for systematic and random failures.

8.5 The system should be adequately protected from waste discharge from the rolling stocks and other ambient conditions including moisture and dirt.

8.6 System shall be designed and installed in such a way that it should be well protected during accident free train operation and routine maintenance and should have reasonable anti pilferage mechanism as per good industry practices.

8.7 System should be able to protect train drivers, passengers and train side personnel from dazzling lights. To ensure human eye and skin safety, the system shall not exceed the Maximum Permissible Exposure (MPE) from a Nominal Ocular Hazard distance (NOHD) of 1 m from the track as per EN 60825 1:2014 +A 11:2021. Necessary certificate may be provided from OEM in original. Adequate view cutters or absorbent/diffusers may also be planned in the vicinity to ensure safety of maintenance and train side personnel.

8.8 The system should be protected from lighting and surge. Suitable lighting arrestors/ earthing of the system may be planned for suppression of power line surges, spikes, transients to protect electronic circuits and equipment.

9. Output Requirements

9.1 Data Communication

9.1.1 All the data being generated by the system equipment, website, servers etc. with respect to Indian Railway operations shall be the exclusive property of Indian Railway and firm shall not use it for any other purpose.

9.1.2 The data shall be made available in a format as finally decided by Indian Railways in consultation with the supplier in suitable database. At the end of the contract, or as and when required by Indian Railways, firm shall hand over the complete data set to IR and must destroy any left-over data. Indian Railway shall be free to put data for any alternative use during the contract as well as after the contract period. Any alternate use of such data by the firm shall only be done with the expressed written permission of IR.

9.1.3 The report of the data captured by the system shall be relayed by the device via suitable communications media to a secure web server on the internet within 15 minutes after the passage of the last axle.

9.1.4 The equipment shall have the capability to record and locally store raw captured data and processed reports for upto at least the last 10 days.

9.1.5 The backend server systems shall be maintained and operated by the supplier. These servers shall be capable of storing data and shall be able to display average readings of every parameter of each wheel in reports for every pass-by and its graphical representation for up to last 24 months. The individual (Min 6 locations around the circumference of the wheel) readings of each parameter constituting the average may also be retained and be available to holders of admin logins.

9.1.6 The access to the report shall be provided by a standard web browser that works on various devices such as desktops/laptops/notebooks. Users of the systems shall be provided logins / passwords for accessing the data.

9.1.7 The data shall not be divulged by the supplier to anyone other than consignee and to those authorized by consignee.

9.2 **Diagnostic reports:** The system shall be capable of running self-diagnostic programs and report the result through the website and by SMS at least once every day. It should log all system errors such as system reboot, main power failure, network failure, poor network speed etc.

9.3 **Feedback:** System database should have provision of recording and analyzing the feedback of action taken by the depot staff on alerts generated by the system, including provision of entry of false negatives cases. For this purpose, standard feedback messages may be provided in a dropdown menu besides a category for 'Other' defects feedback allowing detailed write-up of upto 50 Characters. Feedbacks received through CMM, FMM, and SLAM should also get recorded.

9.4 **Highlight Thresholds Limits**: In the reports & graph, the system shall be able to highlight the wheel parameters that exceed different thresholds limits (as specified in Annexure-1 & 2) in up to three (3) different colours.

9.5 **Identification & Position**: The system should be able to identify and count no of engines, coaches, wagons or brake vans based on the RFID read and wheels passed.

9.6 **Alarms through SMS:** Reports for alarms based on parameters exceeding the prescribed limits shall be sent to up to four users for every site through SMS. Alarms report should be communicated through SMS within 15 minutes after passage of the rake. If the SMS is not received within 15 minutes of the last passing wheel of the rake,

it will be considered delayed. The Alarms messages shall convey the following minimum information:

9.6.1 Vehicle identification as per clause no. 4.14

9.6.2 Location of identified wheel as per IR numbering scheme for wheels within the rolling stock

9.6.3 Rolling Stock type Passenger (ICF,LHB,VB), Freight or Locomotive

9.6.4 Date and time

9.6.5 Direction of movement (IN or OUT)

9.6.6 Vehicle position from the first locomotive

9.6.7 Axle number where the parameters are found out of range.

9.6.8 System Error Message: In case of error in recording or any system failure, Messages shall be generated and transmitted similarly to nominated users through SMS

9.7 **Basis of alarms:** In addition to withdrawal limits, it should be possible to raise at least one additional user settable (Attention) graded maintenance alarm for each parameter, when the measurement exceeds the user prescribed limit of the parameters. The wheel parameters and their attention/withdrawal values are prescribed in Annexure -1 & 2. These limits may be modified as per Para 4.12 based on experiences.

9.8 **Data Querying**: The generated data shall be downloadable by user in MS Excel sheet/PDF for any time duration from date of commissioning of equipment, using a user-settable data filter in the dash board. User should be able to apply any or all of the following filters on database simultaneously or otherwise as per requirement of rolling stock for further analysis in the database:

9.8.1 From …date to …date

9.8.2 Specific rolling stock(s) or type of stock(s)

9.8.3 Direction wise (In/Out)-user selectable

9.8.4 Summary of alerts –month wise, year wise-user selectable

9.8.5 System Site wise alert analysis with one or more user selectable sites

9.8.6 Parameter wise-user selectable range of one or more of the parameters in para no.18

9.9 **Report Generation:** The supplier shall launch, operate and maintain an internet-based website during warranty and comprehensive maintenance period for making available the reports to users authorized by consignee. The website shall have the following features: -

9.9.1 Password based access so that only personnel authorized by consignee can enter/ view/download data and reports.

9.9.2 Differential privileges to different levels of users to access the resources of the website. Minimum 03 accesses/ privilege levels will be designed as follows:

Type of user	**Privilege Levels**		
	Access	***Edit***	***Query***
Admin	Yes	Yes (Excluding system measured value)	Yes
User	Yes	Limited to RS ID and feedback entry	Yes
External	Yes	No	No

9.9.3 The supplier shall supply one laptop per system supplied at a place nominated by consignee of the configuration as specified by tenderer along with relevant software. The configuration may be specified by the tendering authority and

incorporated in the tender document. At the discretion of the consignee, software installation in up to three additional existing machines at the depot or control offices may be requested for access to exception reports.

9.9.4 The system output shall consist of data reports. Data acquired by the system shall be sent to a web server and the reports shall be available to the users on demand.

9.9.5 **Raw Data Report**: This report will provide all parameters of each wheel with each location of measurement as per format in Annexure-3. This shall be available to Admin login only.

9.9.6 **Detailed Report**: This report shall provide a table giving values of all parameters in Part C as acquired around the wheel circumference and averaged by the system. These may be used to develop the profile plot for each wheel. The profile plot of each wheel may be plotted graphically and presented against suitable grid background.

9.9.7 **Exception repor**t: This report shall be an abridged version of the detailed report showing only the list of wheels where the parameters have exceeded the prescribed attention (if specified) and withdrawal limits. It should be possible to directly obtain up to 5 prior measurements reported for the same wheel/axle/rolling stock by digging down (hyperlinked) information through the electronic report of exceptional wheels.

9.9.8 System should be able to generate customized report as per requirement of Indian Railways/RDSO based on flexible queries.

10. Standards and norms applicable:

System should be follow latest applicable National/International standards to meet technical and functional requirements and shall submit data sheet indicating compliance of each sub system equipment at the bidding stage. Some of indicative relevant standards as applicable for the reference of bidder are as under:

SN	Standards/Norms	
1.	EN 15313:2016	Railway applications - In-service wheelset operation requirements - In-service and off-vehicle wheelset maintenance
2.	EMVA 1288	Standard for Characterization of Image Sensors and Cameras
3.	EN 60825-1:2014 +A 11:2021	Safety of laser products - Part 1: Equipment classification and requirements
4.	EN 50125-3	Railway applications - Environmental conditions for equipment Part 3: Equipment for signaling and telecommunications
5.	EN 50121- 4:2015	Railway applications - Electromagnetic compatibility - Part 4: Emission and immunity of the signaling and telecommunications apparatus.
6.	IEC 61000-6-4:2019	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards - Emission standard for industrial environments
7.	2014/35/EU	Low Voltage Directive - Electrical equipment designed for use within certain voltage limits
8.	ISO 14837-1	General guidance on mechanical vibration for ground-borne noise and vibration arising from rail system
9.	IS 12360	AC Power Supply (the voltage and frequency values) to be followed in India
10.	Indian Railway Schedule of Dimensions	Railway Board letter no 2021/CEDO/SD/IRSOD 2021 dated 27/07/2022

11. Warranty:

The supplier shall confirm warranty of complete system for a period of 24 months from date of successful commissioning and also 03 years comprehensive maintenance after completion of warranty period. At the end of the Warranty period, the supplier shall transfer all Hardware and Software in working condition along with software in an executable file with all upgrades and patches upto the end of warranty period.

12. Training Requirements:

The supplier shall provide training for minimum 20 man days per system installation at factory premises and training for minimum 50 man days per system installation at depot premises of consignee or mutually agreed location/ facility in following areas:

12.1 Operation of the System
12.2 Calibration of the System
12.3 Trouble shooting and Maintenance of the System
12.4 Management of Data, Software maintenance and Caches
12.5 Reading and interpretation of reports, alarms and SMS's etc.

13. Documents to be submitted:

13.1 **Test certificates:** Test records, test certificates, evidence for conformance to this specification & IP ratings of enclosures, original sensor's data sheet, performance curves from OEM (if applicable) and it's warranty etc. Results of all inspections and tests, whether witnessed or not by IR personnel, shall be supplied at the time of Factory Acceptance Test. One set of above mentioned documents shall be supplied properly bound in books. The softcopies of the said documents should also be provided by the firm.

13.2 **System Literature:** The supplier shall provide following literature in two copies to consignee along with the delivery of the Measurement System.

13.2.1 Complete drawings and system architecture.
13.2.2 Operating manual
13.2.3 Maintenance manual
13.2.4 Trouble Shooting manual
13.2.5 Calibration and validation manual
13.2.6 Spare part catalogue
13.2.7 The tenderers shall provide a list of literature to be supplied with the system in his offer.

Part-B: Technical Requirement for Equipment

14. System Capability: The WPMS shall be capable for non-contact measurement of the railway wheel profile's parameter listed in para 18. The condition of the wheel set is monitored over repeated pass-byes and preventive measures can be planned for necessary repairs. The system shall be 'easy to use' and not require any contact with the wheel.

15. Main Sub system of WPMS:

15.1 Scanning/ Imaging System including trigger sensor for switching on/off.
15.2 Cooling and/or purging systems as required
15.3 Equipment protection as given in para 8 of Part -A
15.4 RFID Identification device for Rolling stock
15.5 Control Device
15.6 Communication system
15.7 Power Supply system
15.8 Vibration Isolation System
15.9 Suitable enclosure/hut/cabinet for housing of electronics and other components
15.10 Software & Hardware for evaluation of parameters including ICD for transferring data to CMM, FMM and SLAM.
15.11 Any other components required for the satisfactory working of the system and for calibration & Validation of the WPMS system.

16. Technical Requirements:

16.1 The system should be designed for non-contact automatic measurement of parameters of wheel sets as per para 18.
16.2 System should record wheel wise parameters as per clause 4.10 and their average value for each wheel in the tabular format as per Annexure-3
16.3 The average values of each parameter of the wheel shall be reported and plotted to generate the wheel profile.
16.4 Alerts should be based on one or more measured parameter and alert levels should be user configurable as per IR requirement and shall be different for various categories of rolling stock as given in Annexure-1&2

17. Measuring Range:

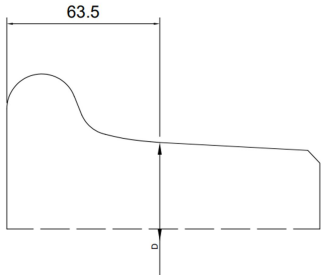
The system should be capable to measure different parameters of following range:

Wheel width (Rim width)	:	100 mm to 150 mm
Wheel diameters	:	770 mm to 1250 mm
Wheel gauge	:	1590 mm to 1610 mm
Train Speed	:	5 to 30 kmph
Resolution	:	0.1 mm

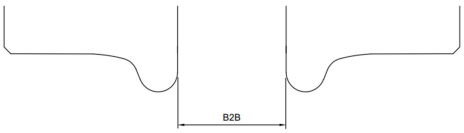
18. Parameters to be Measured:

A typical wheel profile of Indian Railways rolling stock follows the sketch as per Annexure-5. This profile is extremely important because the rail wheel interaction occurs through this profile. The WPMS will measure all wheel profile parameters as well as wheel diameter, width and wheel gauge.

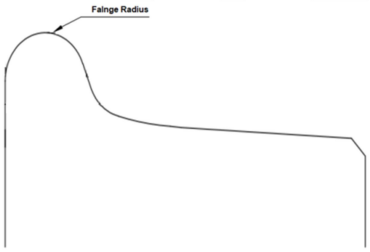
18.1 **Wheel diameter (D):** It is measured at a distance of 63.5mm from back of the flange face. No profile defect is associated with this measurement.



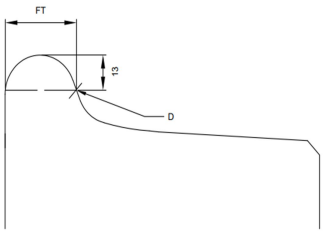
18.2 **Wheel gauge**: Wheel gauge is the back-to-back distance between the inner surfaces of the wheels in a wheelset. No profile defect is associated with this measurement.



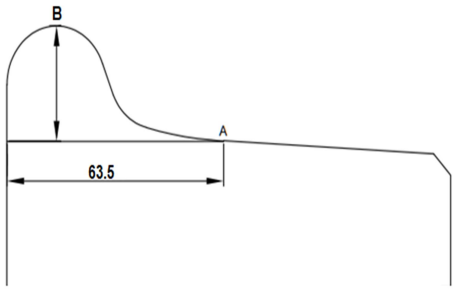
18.3 **Flange Radius:** Radius at the apex of the flange is called flange radius. If this radius reduces to 5mm the defect is called sharp flange.



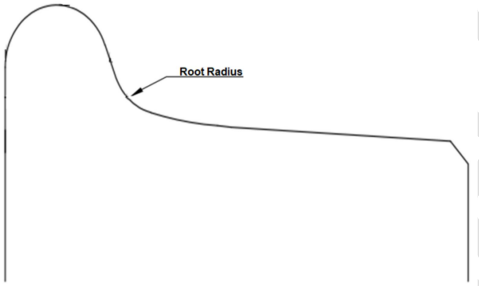
18.4 **Flange Thickness (FT):** The thickness of flange horizontally measured below 13 mm from flange apex is known as flange thickness. When same is reduce to less than prescribed limit the defect is called a thin flange.



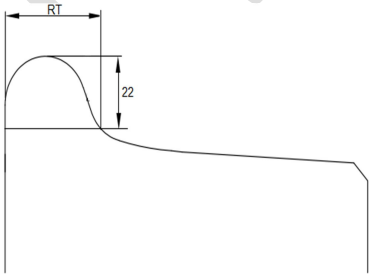
18.5 **Flange Height (FH):** The vertical distance between point A on the tread 63.5 mm from the back face of flange and point B (the apex of the flange) is called the flange height. If height of flange becomes greater than prescribed limit the defect is called deep flange.



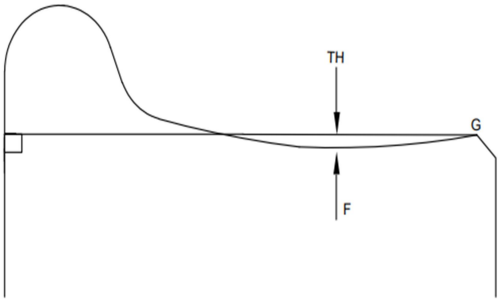
18.6 **Root Radius:** The radius of the root curve reduces to less than 13 mm, the condition is called worn root. It is the radius of root of flange of a wheel. If the radius of the root curve reduces to less than 13 mm, the condition is called worn root. (Note: For the co-ordinates of center for corresponding arc radius DRG No. SK.DL.-2561, SKETCH-91146 & CONT-9404/ S-13 of this specification may be referred for respective wheel)



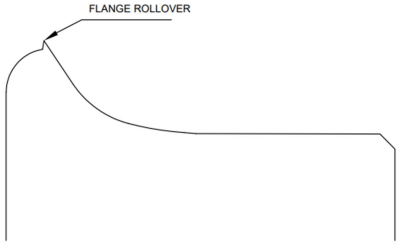
18.7 **Root Thickness (RT):** The thickness of flange horizontally measured below 22 mm from flange apex is known as root thickness. When the same is reduced to less than prescribed limit the defect is called a root wear.



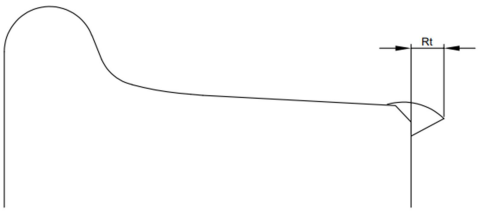
18.8 **Tread Hollow (TH):** When the center of the wheel tread is worn below the level of the end of the tread the defect is called hollow tread. It is the vertical distance between end of tread and center of tread.



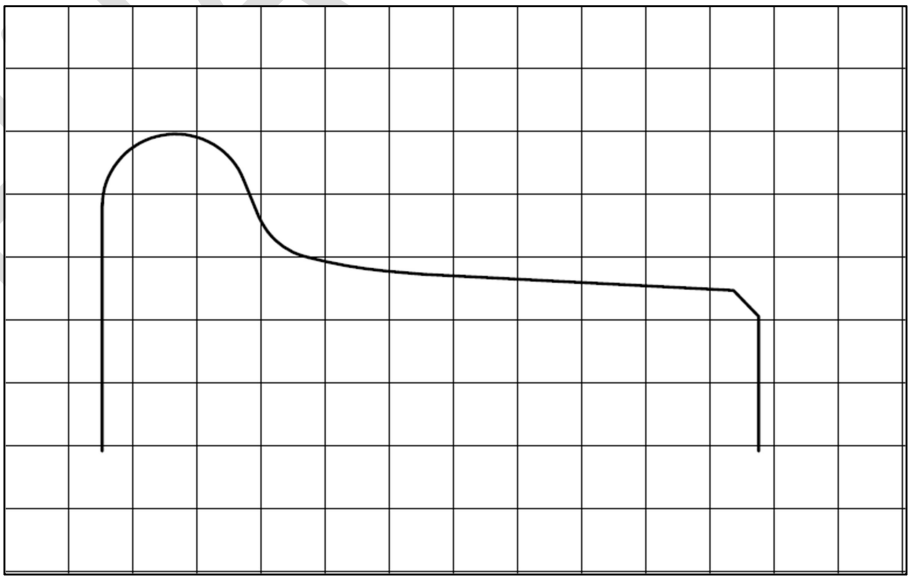
18.9 **Flange rollover:** The flange rollover is a protrusion resulting from the deformation of the surface layers of the flange metal toward its apex.



18.10 **Tread rollover:** The displacement of the metal from the rolling surface to the chamfer and then to the outer edge of the rim. The distance from the outer edge of the rim to the most protruding part.



18.11 **Full wheel profile:** System should plot wheel profile of the individual wheel based on average measurement of minimum six points around the tread of the wheel. The parameter values used for plotting may be measured in the legend section of Profile drawn.



Part-C: Inspection and Testing of Equipment

19. **Objective:** Inspection and testing of the equipment shall include all inspections, tests, checks, procedures etc., whether mechanical, electrical or software related as required to ensure that the supplied system meets the technical & functional requirements stipulated in the specification. The tenderer shall submit details of test plan for proposed system for each level of testing towards compliance of this specification. However any addition/deletion/modification in the test plan can be considered on mutually agreeable basis. The successful bidder shall depute team of engineers to perform all level of testing and ensure availability of testing facilities and spare parts in adequate quantity for these tests. All the instruments, apparatus, devices, sensors etc. used during all levels of inspection and testing should have valid calibration certificate issued by an independent authority/component supplier/ institute approved by NABL/IR or accredited lab. The Validation of the system shall be carried out by RDSO. The validation scheme shall be finalized with concerned RDSO, supplier and consignee.

20. **Factory Acceptance Test:** All technical and design features shall be inspected and witnessed by RDSO at the firm's premises. During the factory acceptance test, firm shall demonstrate the capability of the system to measure all parameters mentioned in specification. Factory Acceptance test scheme shall be finalized by inspecting/ tendering agency jointly with the firm. Necessary facilities, equipment, tools and gauges, duly calibrated shall be provided by firm at its premises.

21. **Calibration Test:** The system should be calibrated before offering for proving-out test at site. The tests shall be initiated upon the submission of a certificate by the firm confirming site readiness and calibration. Details of calibration methodology shall be submitted along-with the offer. All calibration activities should get logged on the data base or user dashboard. For this test wheels shall be provided by the consignee and the supplier shall provide and use a duly calibrated static profile measuring system. All further calibration shall be carried out as per Para 4.15. Calibration kit to be provided by the supplier to the consignee as per para 2.1.6 along with the required training as per Para 12.

22. **Proving-out Tests:** First two system or 5% of the supplied quantity whichever is more shall be proven out by RDSO team. The Supplier, in consultation with the consignee, shall perform the following proving out tests after installation and calibration of the system:

    22.1 **Formation of Test Train:** The test train shall comprise of 10 rolling stocks (8 wheels each) with one locomotive (12 wheels) for which 25-40% of the wheels shall carry pre-existing defects jointly agreed by the consignee and the system provider. The system provider shall satisfy themselves regarding adequacy of stock/wheels offered before commencement of Test train run. The test train shall be passed over the system for six movements at different speeds between 05 and 30 kmph. Typical speeds can be 05, 10, 15, 20, 25, and 30 kmph. These may vary due to site constraints.

    22.2 **Consistency Test:**

        22.2.1 All test train pass byes should be correctly recorded with regard to direction of motion (in/out), date and time of passing, speed, no. of axles, no of locomotives.

        22.2.2 For the above test train with 92 (8x10 Rolling stocks + 12 Locomotive) wheels each parameter given in Part B shall be measured at a minimum of 6 locations per pass bye. Total number of data therefore shall be.

        92 (Wheels) X 10(Parameters) X 6 (Readings) X 6 (Pass byes)

        This may be presented by the system as a Raw Data report in Tabular form.

22.2.3 A minimum of 500 data points should be included to form the profile output.

22.2.4 The complete data report including all parameters of wheels and speed of rake passed (without missing any wheel) shall be generated. The reports of all passing rake should be generated 100% successfully during the proving out tests.

22.3 **Reliability Test:**

22.3.1 The reliability of the system shall be observed for the following seeded defects in wheels as a part of the test train/ rake. These defective wheels shall be jointly verified for flaws or absence of flaws before pass bye over the WPMS system.

22.3.1.1 Sharp Flange - As measured through reduced flange radius
22.3.1.2 Thin Flange – As measured through reduced flange thickness
22.3.1.3 Deep Flange – As measured through increased height of the flange
22.3.1.4 Worn Root – As measured through root radius (As applicable in Rolling stock)
22.3.1.5 Root Wear – As measured through root thickness (As applicable in Rolling Stock)
22.3.1.6 Tread Hollow – As measured through Tread hollow

22.3.2 For this test the data shall be taken from the six pass Byes of the test rake (comprising good wheels and wheels with seeded defects) as used in the Consistency test. The fault seeded wheels should be logged under alerts conditions by the system.

22.3.3 The following levels of false positive and false negative shall be acceptable for each of the six pass byes individually.

False Positive alerts reported	10%
False negative alerts reported	5%

22.4 **Repeatability**: Repeatability of parameters of the system should statistically satisfy ANOVA Test with 95% confidence level for the entire test rake with data as described below. The data should not indicate statistically significant variation across passes for at least 90 percent of the 92 (see para no. 22.2.2) wheels in the test train.

SN	Mean Value of Parameter Recorded	Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	Pass 6
1	Wheel Diameter						
2	Wheel Gauge (B-2-B)						
3	Flange Radius						
4	Flange Thickness						
5	Flange height						
6	Root radius						
7	Root Thickness						
8	Tread Hollow (mm)						

23. **RFID Reader Test:** RFID readers should be capable for reading RFID Tags tagged on IRs rolling stocks. The extent of vehicle identification/ tag reading should be in line with the guidelines issued by CRIS.

NOTE: The final validation scheme should be followed for validation of the remaining supplied systems.

Annexure-1

Wheel diameter and Wheel gauge Parameters for Rolling stocks with Alerts

Wheel Diameter

Rolling stocks	Withdrawal Limit	Attention Alerts* (User settable)
Diesel/ Electric Loco (SK. DL-2561 Alt-8 , CSL-3040,Alt-2) including WAG9 /WAP7	1016	1026
WAP5 & WAG 12B	1164	1174
LHB (DRG No.SK-91146 Alt.-3)	845	864
ICF	825	833
MEMU	877(MC) 857(TC)	885 (MC) 865(TC)
BOXN, BCN & other wagons with Drawing No. WAP/SK/M/153	906	916
BLC	780	790
Vande Bharat	877	885

Wheel Gauge (B-2-B)

Rolling stocks	Withdrawal Limit	Attention Alerts* (User settable)
Locomotive (Diesel and Electric)	1596 +3/-0.5	>1598.5 or <1595.5
Wagons and Coaches	>1602 or <1599	>1601.5 or <1599.5
Vande Bharat	>1600.8 or 1599.2	>1600.5 or <1599.5

Note:

All dimensions are in mm

***** Limits to be set as per Para 4.12 based on approval of competent authority Attention alerts are user settable. These user settable limits are defined specifically from the point of view of inventory planning and may vary from one depot to another

Annexure-2

Wheel Profile Parameters for Rolling stocks with Alerts

Parameters Flange thickness		Diesel/ Electric Loco (SK. DL-2561 Alt-8 /CSL-3040,Alt-2)	LHB, ICF, VB	MEMU (DRG No.SK-91146 Alt.-3)	Wagon (BOXN, BCN, BLC)
Flange Radius	Withdrawal Limit	<5			
	Attention Alerts	6			
Flange Thickness	Withdrawal Limit	29	22	16	16
	Attention Alerts	30	23	18	18
Flange Height	Withdrawal Limit	35			
	Attention Alerts	34			
Root Radius	Withdrawal Limit	NA	R13		
	Attention Alerts	NA	>13.5		
Root Thickness	Withdrawal Limit	31.5	NA		
	Attention Alerts	32.5	NA		

Wheel defects with Alerts

Parameters		Diesel / Electric Loco	LHB, ICF, MEMU	Wagons	Vande Bharat
Tread hollow	Withdrawal Limit	NA	<5		<2
	Attention Alerts	4			<1
Tread Rollover	Attention Alerts	3			
Flange Rollover	Attention Alerts	1			

Note:

All dimensions are in mm

***** Limits to be set as per Para 4.12 based on approval of competent authority Attention alerts are user settable. These user settable limits are defined specifically from the point of view of inventory planning and may vary from one depot to another

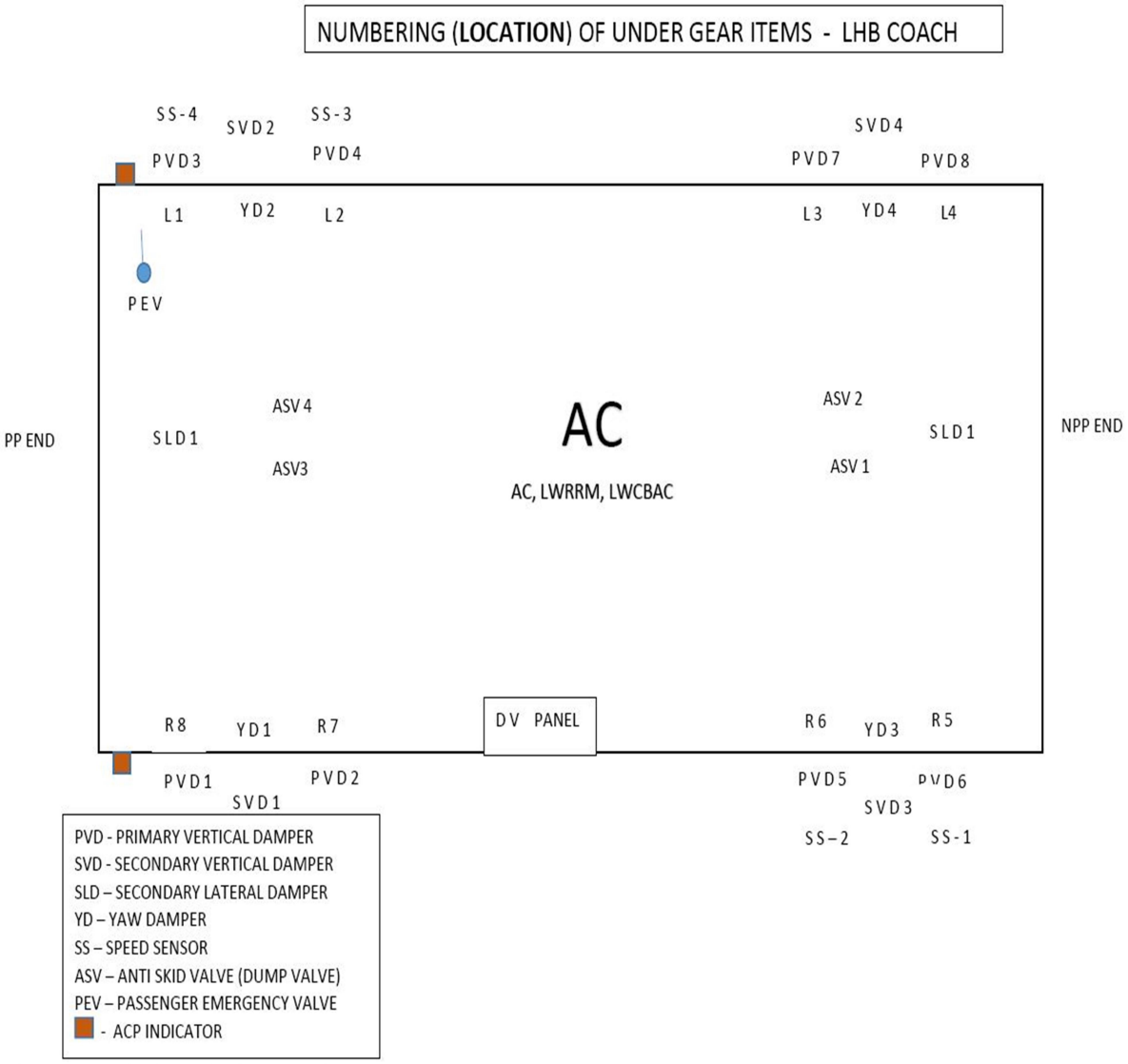
Annexure-3

No. of Measuring point for Parameters accessible to RDSO/ Admin login holders

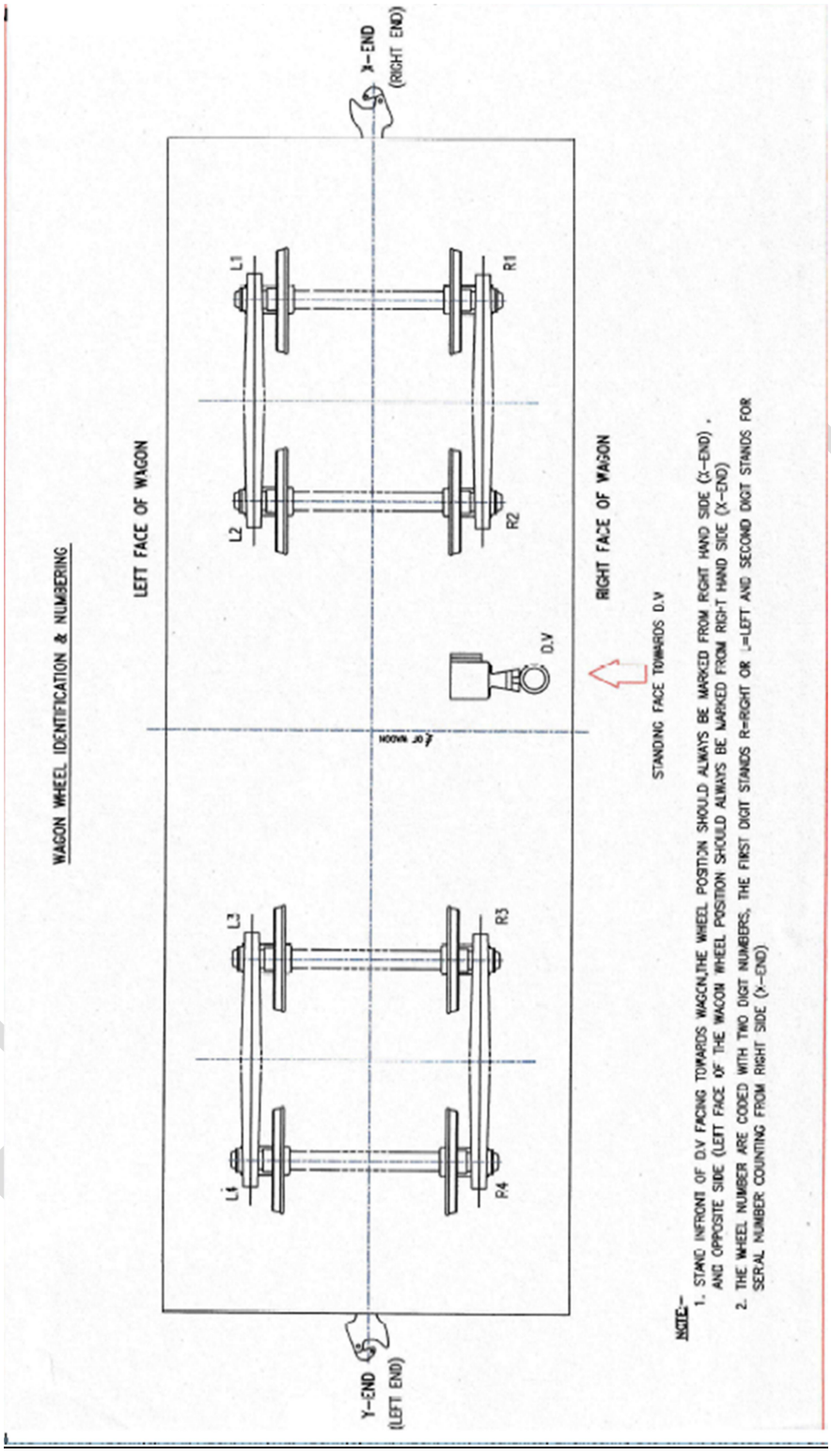
Axle No	No. of Measuring point	Name of Depot.		Type of rake		Date		tim e	Direction		Total No. of Axle	
		Left and Right Wheel										
		1	2	3	4	5	6	7	8	9	10	11
		Wheel Dia.	Wheel Gauge	Flange Radius	Flange Thickness	Flange Height	Root radius	Root Thickness	Tread Hollow	Flange Rollover	Tread Rollover	Wheel Profile
1	1.											
	2.											
	3.											
	4.											
	5.											
	6.											
	& more if any											
	Avg.											
2	1.											
	2.											
	3.											
	4.											
	5.											
	6.											
	& more if any											
	Avg.											

Annexure-4

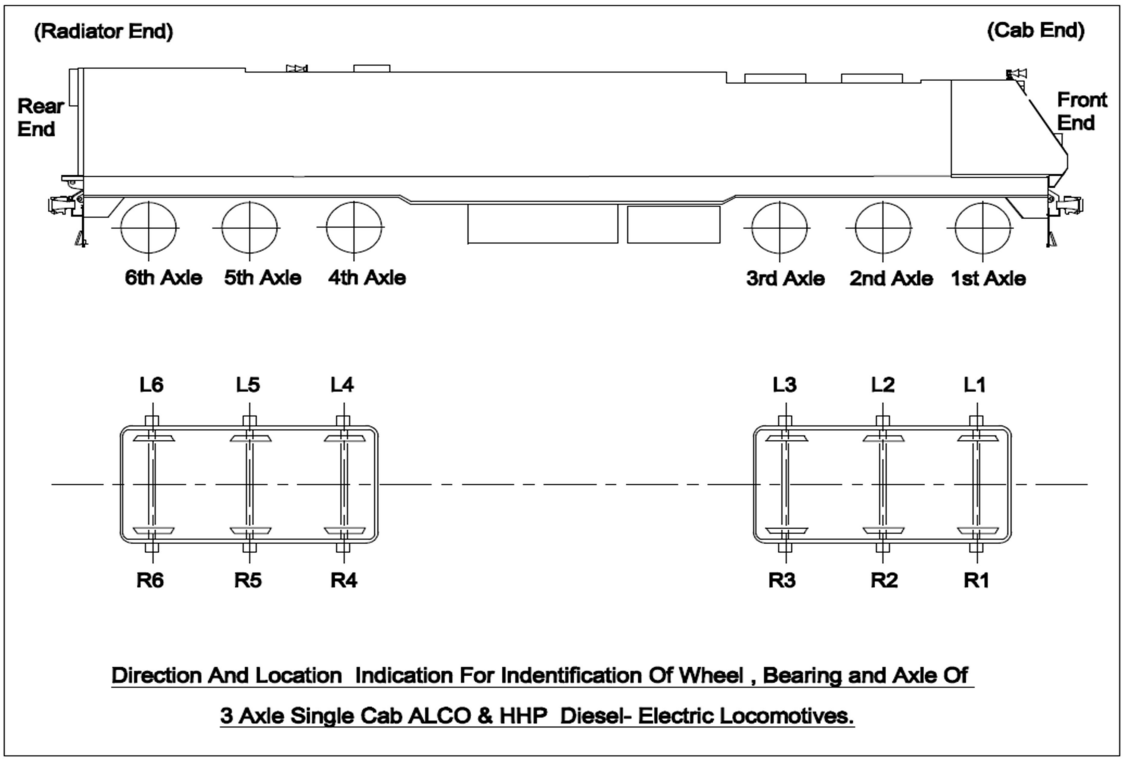
1. Wheel Numbering of LHB Coaches



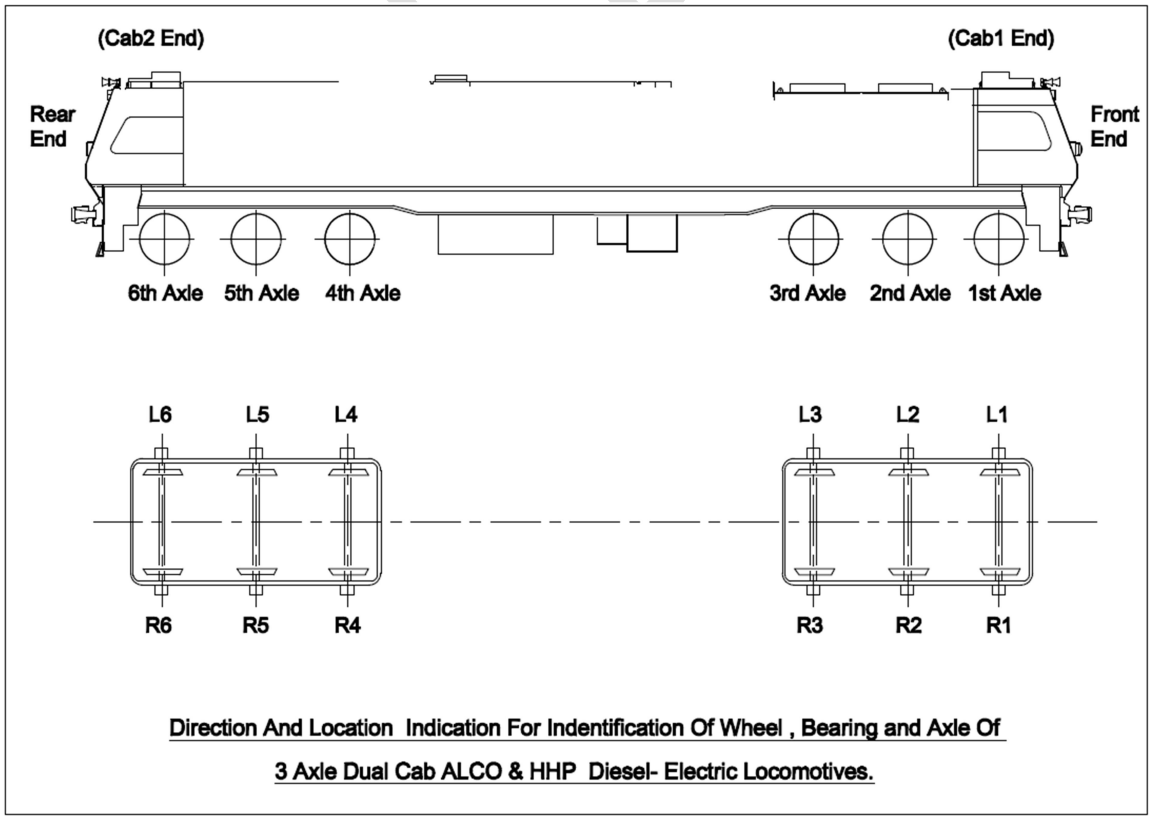
2. Wheel Numbering of Wagons



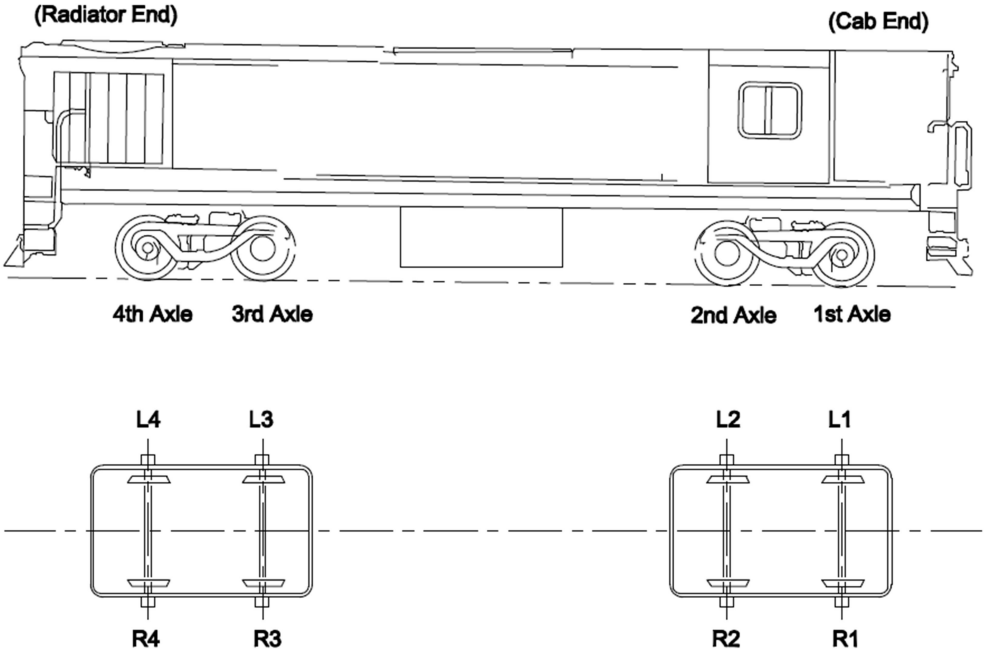
3. Wheel Numbering of Locomotives



Direction And Location Indication For Indentification Of Wheel , Bearing and Axle Of 3 Axle Single Cab ALCO & HHP Diesel- Electric Locomotives.



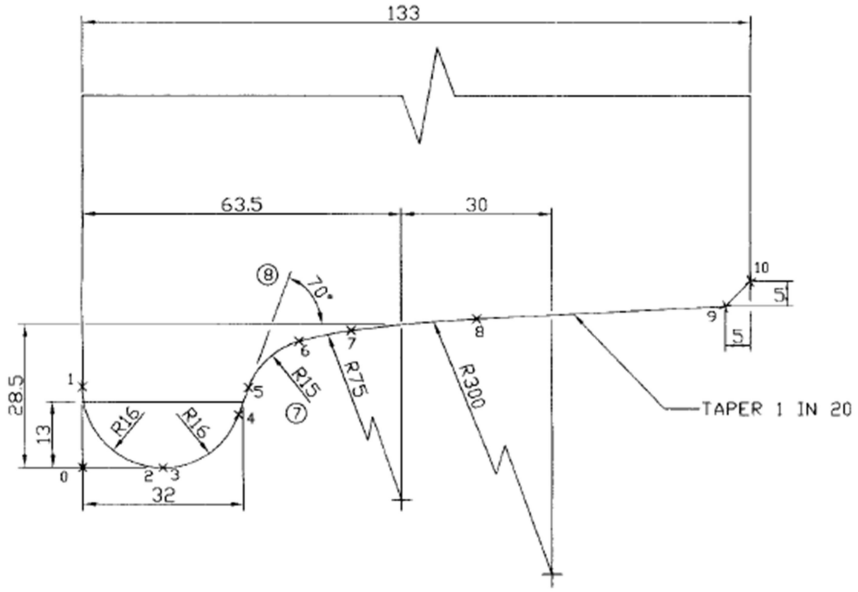
Direction And Location Indication For Indentification Of Wheel , Bearing and Axle Of 3 Axle Dual Cab ALCO & HHP Diesel- Electric Locomotives.



Direction And Location Indication For Indentification Of Wheel , Bearing and Axle Of 2 Axle WDP1 Diesel- Electric Locomotives.

Annexure-5

INDIAN RLYS. RDSO(MP)	APPLICABLE FOR B.G LOCOS.	WEAR ADAPTED WHEEL PROFILE FOR DIESEL & ELECTRIC LOCOMOTIVES



⑥ CO-ORDINATES ARE GIVEN BELOW:-

Pt.	X	Y
0	0.0000	0.0000
1	0.0000	16.0000
2	16.0000	0.0000
3	16.0651	0.0000
4	31.1001	10.5277
5	33.0371	15.8495
6	43.0407	25.1503
7	53.5000	27.3251
8	78.5187	29.6295
9	128.0000	32.1035
10	133.0000	37.1035

⑦

⑥ NOTE: GIVEN POINTS CO-ORDINATES ARE ROUNDED OFF UPTO FOUR DECIMAL PLACE.

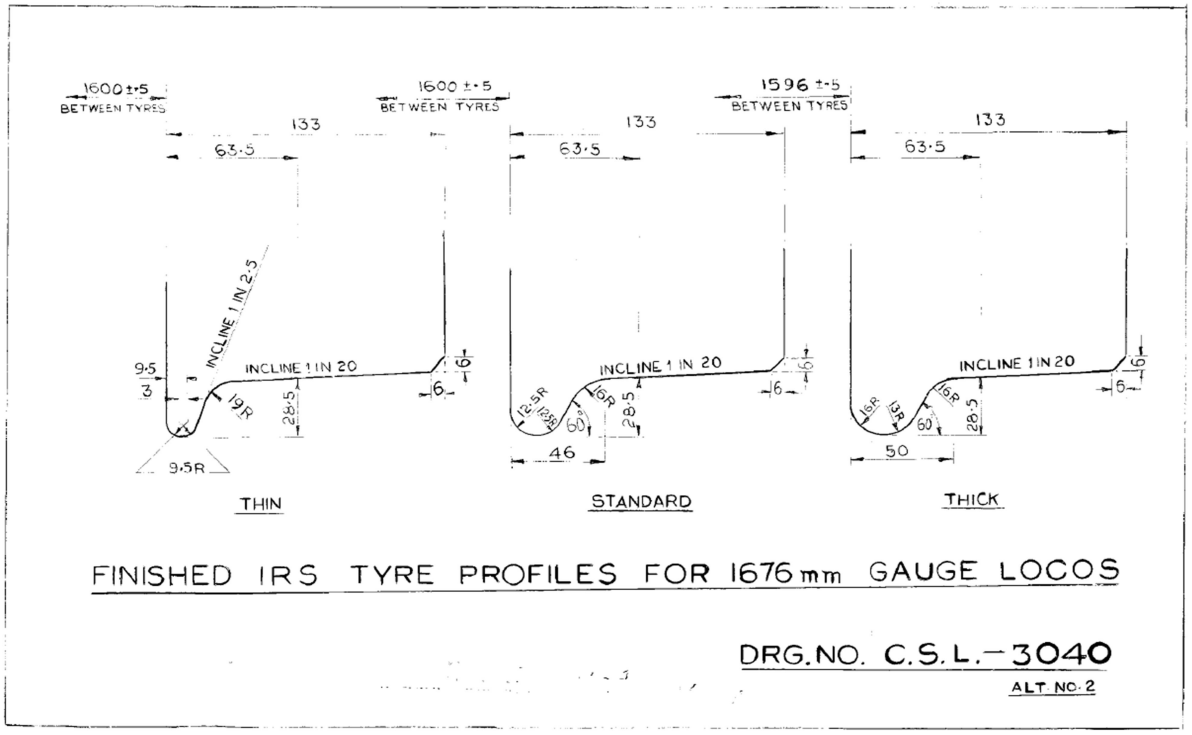
ALL DIMENSION ARE IN mm.

ALT.NO.	REF.NO.	DESCRIPTION	ALT.NOTE NO.	SIGN	DATE
⑧	-	FLANGE ANGLE 70° INDICATED.	L2-980		17.10.06
⑦	-	ROOT RADIUS CHANGED FROM R17 TO R15. CO-ORDINATES OF THE POINTS 5&6 REVISED ACCORDINGLY.	L2-977	Sd/-	07.9.06
⑥	-	DRG. REVISED & NOTE ADDED.	DV/L2/924	Sd/-	23.8.05
⑤	-	DRG. REVISED	DV/L2/XXX	Sd/-	-12.93
④	-	DRG. REDRAWN	DV/L2/452	Sd/-	5.7.89

SCALE 1:1 | REF: SK.DL-2561 ALT.3

DRG NO. SK.DL-2561

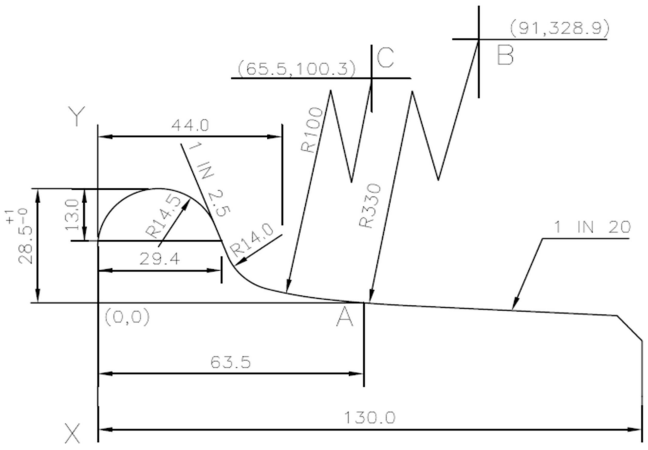
FIRST ISSUED JAN,76 | SUPERSEDES ALT. 6 | SUPERSEDED BY



FINISHED IRS TYRE PROFILES FOR 1676 mm GAUGE LOCOS

DRG.NO. C.S.L.–3040

ALT NO. 2



PROCEDURE OF DRAWING:–

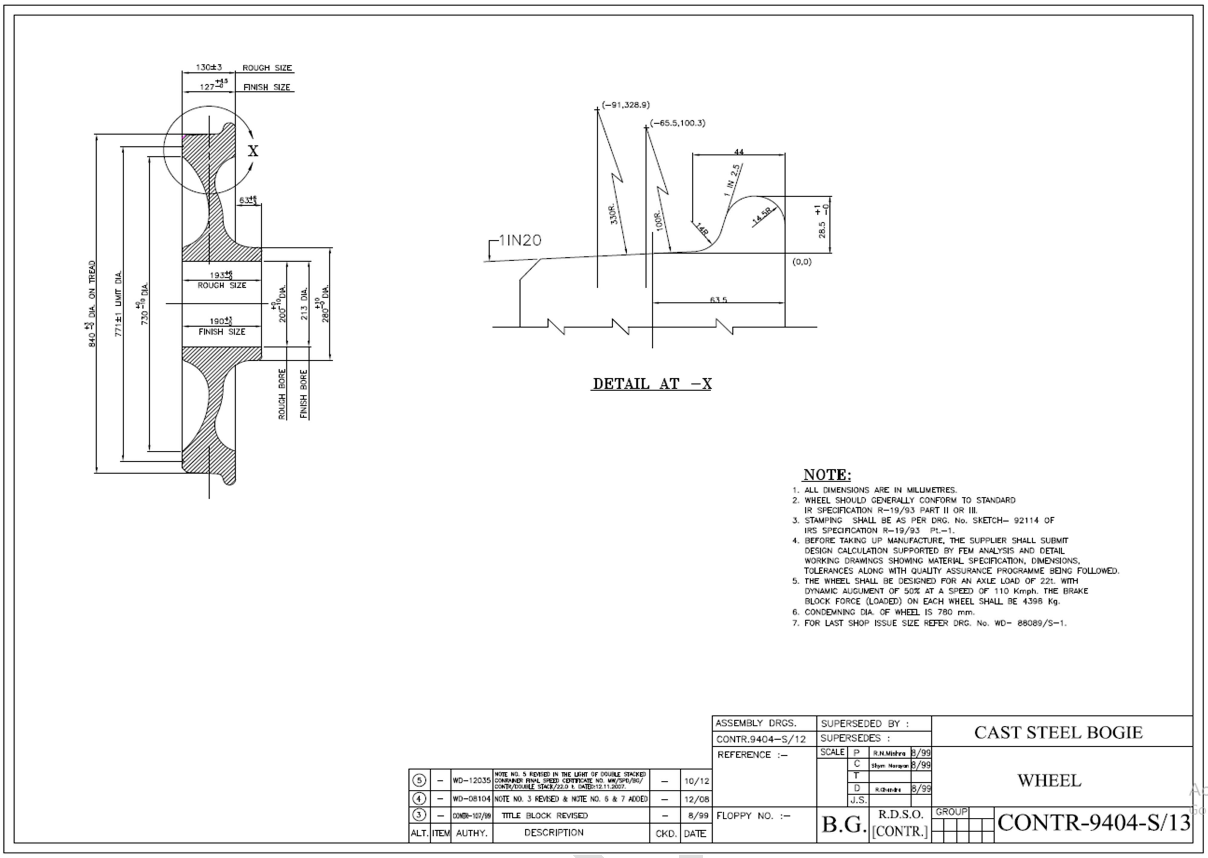
1. DRAW A VERTICAL LINE X–Y.
2. DRAW SEMI–CIRCLE OF 14.5R TANGENTIAL TO LINE X–Y.
3. DRAW LINE 1:2.5 TANGENTIALLY TO 14.5R SEMI–CIRCLE.
4. DRAW A HORIZONTAL LINE AT 28.5mm FROM THE TOP OF THE FLANGE. AND LOCATE Pt. 'A' AT 63.5mm FROM THE LINE X–Y.
5. FROM Pt. A LOCATE CENTRE 'B' OF ARC OF 330R ON A VERTICAL LINE AT 91mm FROM X–Y.
6. DRAW ARC OF 330R FROM CENTRE 'B'
7. LOCATE CENTRE 'C' ON VERTICAL LINE AT A HORIZONTAL DISTANCE OF 65.5mm FROM THE LINE X–Y SUCH THAT BC = (330–100) ie 230mm.
8. DRAW ARC OF 100R WITH CENTRE AS 'C'.
9. DRAW ARC OF RADIUS 14mm TANGENTIALLY TO 100R ARC AND LINE 1:2.5.
10. DRAW LINE 1:20 TANGENTIALLY TO 330R ARC.
11. DRAW A VERTICAL LINE AT A DISTANCE OF 130mm FROM THE FLANGE END.

NOTE:

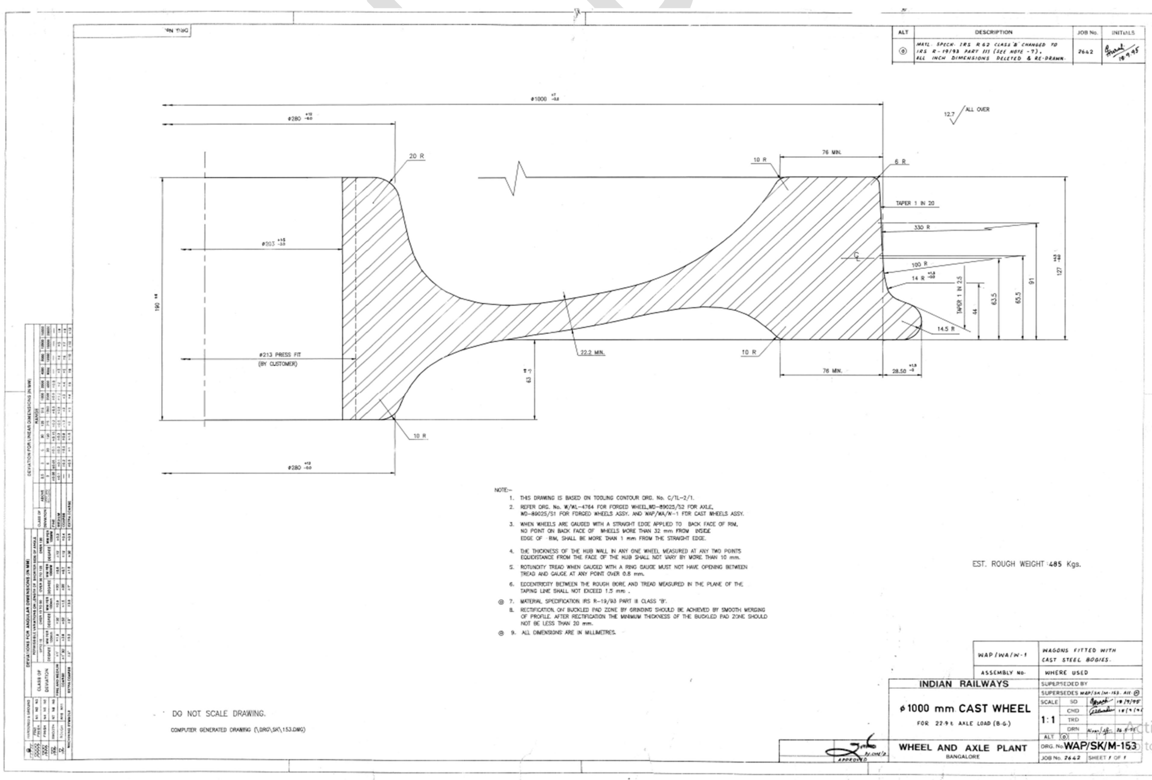
CO–ORDINATES OF POINTS B & C ARE BASED ON NOMINAL DIMENSION OF 28.5mm.

ALT.	AUTH.	DESCRIPTION	DATE
③	SS/24/04	DIMENSION 73.7 DELETED	9/04
②	CD/3/94 JS	REVISED & REDRAWN	3/94
①	CD/ JS /92	CO–ORDINATES OF ARCS SHOWN	3/92

SUPERSEDED BY:			
SUPERSEDES:			
SCALE 1:1	P		WORN WHEEL PROFILE
	C		
	D	G.V.RAMAN	
	T		
	J.S.		
B.G.	R.D.S.O. (C)	GROUP ③	SKETCH–91146



DETAIL AT –X
NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. WHEEL SHOULD GENERALLY CONFORM TO STANDARD IR SPECIFICATION R–19/93 PART II OR III.
3. STAMPING SHALL BE AS PER DRG. No. SKETCH– 92114 OF IRS SPECIFICATION R–19/93 Pt.–1.
4. BEFORE TAKING UP MANUFACTURE, THE SUPPLIER SHALL SUBMIT DESIGN CALCULATION SUPPORTED BY FEM ANALYSIS AND DETAIL WORKING DRAWINGS SHOWING MATERIAL SPECIFICATION, DIMENSIONS, TOLERANCES ALONG WITH QUALITY ASSURANCE PROGRAMME BEING FOLLOWED.
5. THE WHEEL SHALL BE DESIGNED FOR AN AXLE LOAD OF 22t. WITH DYNAMIC AUGUMENT OF 50% AT A SPEED OF 110 Kmph. THE BRAKE BLOCK FORCE (LOADED) ON EACH WHEEL SHALL BE 4398 Kg.
6. CONDEMNING DIA. OF WHEEL IS 780 mm.
7. FOR LAST SHOP ISSUE SIZE REFER DRG. No. WD– 88089/S–1.
CAST STEEL BOGIE
WHEEL
CONTR-9404-S/13
R.D.S.O.



DO NOT SCALE DRAWING.
EST. ROUGH WEIGHT 485 Kgs.
INDIAN RAILWAYS
ϕ1000 mm CAST WHEEL
WHEEL AND AXLE PLANT
BANGALORE
WAP/SK/M-153