



PRODUCT STANDARD
TME DIVISION, BHOPAL

TM20587

Rev 03

PAGE 01 OF 14

TME/2023

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED
It must not be used directly or indirectly in any way detrimental to the interest of the company

TECHNICAL SPECIFICATION OF GEAR DRIVE ASSEMBLY FOR TRAIN SET APPLICATION

(Against ICF PO no. 08220144D01401 dated
09/05/2023 for 4 rakes)

Revision : 03

Date: 12/05/2023

Distribution

Qty.

Approved :

(M.Verma)

Prepared by:

Checked by:

Date :

TME
TXM-Plg.

1
1

(M.Parothia)

(A.Sharma)

12/05/2023



**PRODUCT STANDARD
TME DIVISION, BHOPAL**

TME/2023

TM20587

Rev 03

PAGE 02 OF 14

CONTENTS

Sl. No.	Description	Page no.
1	General	3
2	Scope of supply	3
3	Information to be provided by supplier (within 3 weeks after date of PO placement)	4-5
4	Operating environmental and climatic conditions	5-6
5	Technical requirements	6-8
6	Documents submission and supplier's responsibility	9-12
7	Type Test	12-13
8	Enclosures	14

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of **BHARAT HEAVY ELECTRICALS LIMITED**
It must not be used directly or indirectly in any way detrimental to the interest of the company



**PRODUCT STANDARD
TME DIVISION, BHOPAL**

TM20587

Rev 03

PAGE 03 OF 14

TME/2023

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of **BHARAT HEAVY ELECTRICALS LIMITED**
It must not be used directly or indirectly in any way detrimental to the interest of the company

1. GENERAL

This specification governs the requirement for design, manufacturing and supply of gear drive assembly for use with BHEL traction motor for train set application in Indian Railways. The gear drive assembly should be reliable for operational speed of 160 kmph and should also be able to serve at a design speed of 180 kmph. Supplier shall clearly specify compliance of each clause of this specification in their offer. In case of any deviation w.r.t any clause of this specification, supplier should also specify the same in their offer.

2. SCOPE OF SUPPLY

Scope of supply for gear drive assembly shall be as given below:

Sl. No.	Component	Qty. per gear drive assy.	Remarks
1	Gear drive assembly consisting of:		
1.1	Main driving gear along with pinions	1 set	
1.2	Input Shaft for pinion & half coupling mounting	1 no.	
1.3	Gear drive housing	1 no.	
1.4	Other gear drive assembly components viz. Labyrinths, Seals, Fasteners, Reaction rod mounting bush (elastomer), 'O' rings, Bearings etc. required for complete gear drive assembly	1 set	
1.5	Reaction rod along with items required for mounting of reaction rod on gear drive housing.	1 set	
1.6	Gear drive half coupling	1 no.	
1.7	Traction motor half coupling	1 no.	

NOTE: Necessary support shall be provided by supplier for the following:

- 1) Submission of design documents (to BHEL) as mentioned in clause 6.2 of this specification.
- 2) Clarification to RDSO queries, discussion with RDSO for finalization and approval of design documents of gear drive assembly.



**PRODUCT STANDARD
TME DIVISION, BHOPAL**

TM20587

Rev 03

PAGE 04 OF 14

TME/2023

3. INFORMATION TO BE PROVIDED BY SUPPLIER (WITHIN 3 WEEKS AFTER DATE OF PO PLACEMENT)

- a. Supervision & training required for assembly/disassembly, testing & commissioning of gear drive assembly:

Sl. No.	Details
1	Drive system testing: a. Details of training at BHEL Bhopal for alignment of coupling halves of motor & gear drive for drive system testing with actual motor, converter, inverter at variable speed & torque. b. Details of training at BHEL Bhopal for assembly & dismantling of gear drive assembly before & after drive system testing.
2	Details of training at ICF bogie manufacturer's facility for installation/integration of gear drive assembly on axle & bogie for initial 4 bogies (consisting of 8 gear drive assy. sets).
3	Details of training at ICF/RCF/MCF for assembly of reaction rod and alignment of coupling halves of gear drive assembly & motor for initial 4 bogies (consisting of 8 gear drive assy. sets).
4	Any other training required for maintenance & overhauling.

- b. Tools required for assembly, disassembly & testing:

Sl. No.	Details	Qty.	Remarks
1	Special tools, fixtures, gauges, templates, special equipment etc. required for assembly / installation, disassembly, inspection & testing of gearbox and its components with axle.	1 set	List of tools tools, fixtures, gauges, templates, special equipment shall be provided.
2	Castor wheels/Suitable support for gearbox in wheel set stage (before fitment of reaction rod on bogie).	10 sets	
3	Special tools, fixtures and gauges required for adjustment / levelling of gearbox w.r.t motor / alignment of coupling halves and assembly of reaction rod on bogie.	1 set	
4	Shims required for adjustment / levelling of gear drive w.r.t motor / alignment of coupling halves.	1 set per gear drive assembly	



PRODUCT STANDARD
TME DIVISION, BHOPAL

TM20587

Rev 03

PAGE 05 OF 14

TME/2023

COPYRIGHT AND CONFIDENTIAL
The information on this document is the property of **BHARAT HEAVY ELECTRICALS LIMITED**
It must not be used directly or indirectly in any way detrimental to the interest of the company

c. Consumables required for assembly & testing:


Sl. No.	Consumables	Remarks
1	Consumables viz. grease, thread locker, oil etc. required for assembly of Gear drive assembly on axle.	Supplier to provide the make, type and quantity of consumables required for assembly of each gear drive assembly on axle.
2	Consumables viz. grease, oil, thread locker etc. required for assembly of gear drive assembly on bogie.	
3	Shims required for adjustment / levelling of gear drive w.r.t motor / alignment of coupling halves.	Supplier to provide the details and tentative quantity of shims required for adjustment/ levelling of 1 set of gear drive w.r.t motor.


d. List of spares, must change items during scheduled maintenance and consumables required for satisfactory maintenance and operation of gear drive assembly for a period of 10 years.


4. OPERATING CLIMATIC AND ENVIRONMENTAL CONDITIONS


The gear drive assembly shall be designed suitably to ensure its normal working under following adverse climatic and environmental conditions:


- Relative Humidity:** up to 100% saturation during monsoon season.
- Ambient temperature** max. : 50° C
min. : -10° C
- Altitude (Max):** 1600 meter
- Rainfall:** Very heavy and continuous at any rate between 0 and 100 mm / hour (up to 2500mm during rainy season).
- Flooding:** The gear drive assembly shall be designed for train to run up to 8 km/h through water up to 203 mm above rail level, excluding the increase in the height of the water level due to wave effect. Even in case of flood levels more than the mentioned above, the gear drive assembly shall not get damaged and it should be possible to rejuvenate the gear drive assembly with minor attention without any adverse effect on its performance.
- Atmosphere during hot weather:** Extremely dusty, humid and salty. The trainset shall be working in coastal area also and thus shall be continuously exposed to highly corrosive, salty atmosphere along with industrial pollutants.


	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 06 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>vii. The gear drive assembly shall function in accordance with this Specification when subjected continuously to an atmosphere containing dust in concentrations up to 1.6 mg / m³.</p> <p>viii. The gear drive assembly shall function in accordance with this Specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value of 8.5, sulphate content of 7 mg per litre, maximum concentration of chlorine 6 mg per litres and maximum conductivity of 130 micro Siemens / cm.</p> <p>ix. The gear drive assembly shall function in accordance with this Specification when subjected to high wind speed in certain areas, with wind pressure reaching 216 kg/m².</p> <p>x. Gear drive assembly shall function in accordance with this Specification when exposed to solar radiation in the range from 0 kW/m² to 1 kW/m².</p> <p>xi. Special care shall be taken to ensure no damage to gear drive assembly due to deposition of atmospheric salts and industrial pollutants. Supplier shall enclose the details of specific measures adopted to ensure the satisfactory working of gear drive assembly against the deposition of salts & industrial pollution.</p> <p>5. <u>TECHNICAL REQUIREMENTS</u></p> <p>5.1 Gear Drive Assembly</p> <p>i. The gear drive assembly shall be of proven design for same or higher traction/braking transmission.</p> <p>ii. The gear drive assembly shall be totally enclosed and free from lubricant leakage.</p> <p>iii. The tractive/braking effort shall be directly transferred from the input pinion to wheel gear. The torque transmission arrangement of gear drive assembly shall be simple and suitable for both traction and braking forces.</p> <p>iv. The gear drive assembly design shall be suitable for climatic and environmental conditions as specified in clause no. 4 of this specification. Special care shall be taken in design with respect to high track vibrations as mentioned in clause 5.2.</p> <p>v. The gear drive assembly design documents as per clause 6.2 shall be furnished and finalized during design approval by RDSO Lucknow. The suitability of gear drive assembly should be proved in a type test.</p> <p>vi. The gear drive shall be compatible with the flexible coupling. Gear drive assembly movements shall be restrained by a torque reaction link between the gear drive and bogie frame. A safety device shall be incorporated to restrain gear drive rotation shall the link fail in service.</p> <p>vii. Gear drive assembly shall have toothed wheel for sensing speed and suitable provision for mounting of speed sensor on gear drive assembly.</p>	


	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 07 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>5.2 Vibrations</p> <p>Gear drive assembly complete along with flexible coupling shall be so designed that its performance is not adversely affected due to vibration and shock as per EN13749:2021 with sufficient factor of safety. Factor of safety kept by supplier in other proven gear drive assembly designed & supplied earlier shall be provided.</p> <p>5.3 Coupling</p> <ol style="list-style-type: none"> The coupling shall compensates radial, axial and angular misalignments between motor and gear drive assembly. The coupling design and the motor to gear drive assembly mounting arrangement shall minimize coupling dynamic angular displacement. The coupling should be suitable for operation at speed of 6000 rpm. The coupling should be able to withstand the maximum level of shocks of magnitude as per EN13749:2021. The sealing system should be adequate to prevent dirt/dust and water into couplings. The coupling shall be grease lubricated. Slipping bush shall be installed at the gear box side to protect the gearbox of too high shock torques that can be generated in the motor in case of a converter short circuit. The coupling shall be insulated to ensure that the gearbox bearings are not affected by discharging currents of the rotor. <p>5.4 Gears and Pinion</p> <ol style="list-style-type: none"> Gear & pinion should be produced from case hardened alloy steel and complying with national/international standards of gears & pinion being used in traction application. The MTBF for the pinion should at least be 1 million Km and for the gear wheel at least 2 million km. Gear ratio of 5.158 is to be used for gear drive assembly in trainset application. Supplier shall submit proof of stability for gear tooth forming and total design (i.e. design documents mentioned in clause 6.2), description of the gear tooth forming, used materials, manufacturing and hardening procedures with corresponding specifications, Oil types, lubrication process and lubrication intervals. Gear & Pinion used in gear drive assembly shall be guaranteed against any failure for a period of 6 years from the date of supply. 	


	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 08 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>5.5 Gear drive housing</p> <ul style="list-style-type: none"> i. Gear drive housing shall be made of proven material and shall have sufficient mechanical strength so as not to get damaged due to hitting by ballast or any other foreign objects at high speed during run. Supplier may use alloys, which have been used for traction application and has been validated and time tested. Aluminium should not be used anywhere in the gear drive housing. The use of heli-inserts in the threaded holes for fastening of bolts shall not be permissible. The gear drive housing shall be totally enclosed and free from lubricant leakage during operation. ii. The gear drive housing shall be totally enclosed and free from lubricant leakage during operation. iii. The quantity of oil in the housing and its replenishment/replacement period shall be provided in the maintenance manual. It shall not be necessary to change the oil earlier than 300,000 km or once a year whatever comes first. The lubrication points of gear drive housing shall be easily accessible. The oil recommended for use in gear drive housing shall be of Indian make available readily in India. iv. Gear drive housing and its sealing arrangement shall be designed in such a way that there should not be any ingress of water inside gear drive assembly upto a height of 203 mm from rail level. v. Gear drive assembly shall be suitably painted (light grey colour) to prevent any deterioration of surface due to operation in extremely dusty, humid & salty conditions for most part of the year. <p>5.6 Bearings</p> <ul style="list-style-type: none"> i. Details of the fits kept in the bearings of gear drive assembly should be furnished during design documents approval by RDSO. ii. L10 life calculation report for complete duty cycle shall be submitted. <p>5.7 Mounting and suspension arrangement</p> <ul style="list-style-type: none"> i. Suitable reaction rod mounting bush (elastomer) shall be provided for suspension of gear drive housing. ii. The mounting bolts/nuts shall be accessible for easy mounting and dismounting during maintenance. <p>5.8 Packing</p> <p>Gear drive assembly shall be suitably packed to avoid any damage during transit.</p>	


	 <p style="text-align: center;">PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p style="text-align: center;">TM20587</p> <p style="text-align: center;">Rev 03</p> <p style="text-align: center;">PAGE 09 OF 14</p>
	TME/2023	
<p style="text-align: center;">COPYRIGHT AND CONFIDENTIAL</p> <p style="text-align: center;">The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>6. <u>DOCUMENTS SUBMISSION AND SUPPLIERS RESPONSIBILITY</u></p> <p>6.1 The supplier shall submit the following documents <u>along with their techno-commercial offer</u>:</p> <ul style="list-style-type: none"> i. Reference of projects executed for similar applications during the last 10 years wherein supplier has designed, manufactured and supplied at least 240 no. of gear drive assembly for Railway stock speed of 130 KPH or more. Firm should submit necessary supporting credentials i.e. PO, outline drawing, document indicating maximum service & design speed and invoice of supply of supplied gear drive assembly for the purpose of verification. ii. Scope of supply as per clause 2 of this specification shall be furnished along with offer. iii. Separate offer for tentative price (budgetary quotation) of training & tools required as per clause no. 3.a & 3.b of this specification. <p>6.2 Supplier shall submit the design documents of gear drive assembly along with required technical data and calculations to BHEL Bhopal (for further submission to RDSO for approval) <u>within 4 weeks</u> after date of PO placement. Design documents shall comprises of following:</p> <ul style="list-style-type: none"> i. Detailed outline drawing indicating weight and centre of gravity. <p style="margin-left: 40px;">Note: Outline drawing shall be submitted to ICF by BHEL for fitment clearance of gear drive assembly on bogie. Based on ICF feedback, modification in fitment dimensions may be required to be done. Supplier to carry out the modifications.</p> <ul style="list-style-type: none"> ii. General assembly/long section drawing with exploded view and complete bill of material. iii. 3D model of complete gear drive assembly. iv. Type of gear and pinion, grade of steel used and particulars of heat treatment. v. Values of gear & pinion from maintenance point of view for deciding the usability/condemning limit like chord over teeth ('k' value) etc. vi. Particulars of gear and pinion as per requirement of RDSO. vii. Material and type of construction of gear drive housing. viii. Strength calculation for gear and pinion. ix. Calculation report (bearing, gearing, safety nose, reaction rod, connection gear drive-reaction rod, shrink fit of gear axle). 	

	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 10 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>x. Details of fits used in assembly of different components of gear drive assembly including gear, pinion, bearings etc.</p> <p>xi. The supplier shall submit finite element analysis (FEA) report in all 3-axis which includes stress analysis, fatigue analysis, modal analysis and harmonic analysis of complete gear drive assembly including sub-components considering boundary conditions for vibration & shocks as per EN13749:2021. Factor of safety kept by vendor in other proven gear drive assembly (details provided by supplier against clause 6.1) designed & supplied earlier shall be considered for FE analysis. Note: Any other additional boundary conditions for FEA desired by RDSO shall be suitably incorporated in the FE analysis.</p> <p>xii. Make & type of bearings, L-10 life calculation of bearings for complete duty cycle and life span of bearing while considering the axle deflection.</p> <p>xiii. Make & type of lubrication compound of gear drive assembly and bearing grease along with their technical datasheet. Quantity for initial fill of lubricant and refill along with periodicity of refilling shall also be indicated. Note: The lubricant recommended for use in gear drive assembly shall be made in India.</p> <p>xiv. Quality Assurance Plan of complete gear drive assembly including gear & pinion.</p> <p>xv. Reliability prediction calculations complying the requirements of clause 5.4 (ii) of this specification.</p> <p>xvi. Source for flexible coupling. Note: The flexible coupling selected shall be such that vibration coming on motor from gear drive shall not adversely affect the performance of the complete system (motor & gear drive).</p> <p>xvii. For motor shaft, supplier shall suggest length, taper, diameter, fit/advancement for coupling and other relevant dimensions to be kept for mounting of motor half-flexible coupling.</p> <p>xviii. Test schedule & format for type and routine test (with acceptance limit of each parameter).</p> <p>xix. Documents detailing assembly procedure of gear drive assembly complete on axle with suitable photographs/views.</p> <p>xx. Documents detailing assembly procedure of reaction rod on gear drive housing & bogie with suitable photographs/views.</p> <p>xxi. Documents detailing assembly procedure of half coupling on traction motor & gear drive with suitable photographs/views.</p> <p>xxii. Documents detailing procedure for alignment of coupling halves with suitable photographs/views.</p> <p>xxiii. Maintenance manual of gear drive assembly.</p>	

	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 11 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>Note:</p> <ol style="list-style-type: none"> The approval/clearance of design documents of gear drive assembly shall be given by customer RDSO, Lucknow. All the documents submitted by the supplier shall be in English language. Any other documents besides above, if desired by RDSO during design documents approval, shall also be submitted. Supplier shall be required to depute his technical experts to RDSO for discussions, finalization and approval of design documents of gear drive assembly. <p>6.3 Installation and Commissioning:</p> <p>A. At bogie manufacturer works (Mounting of gear drive assy. on axle):</p> <ol style="list-style-type: none"> Gear drive assembly components in kit form shall be supplied to BHEL Bhopal. Installation of gear drive assembly complete on axle & bogie will be in the scope of bogie manufacturer of ICF Chennai. The supplier shall submit assembly procedure, inspection check sheets etc. for proper installation of gear drive assembly complete. Any special tools, fixtures, gauges, templates, special equipment etc. required for assembly / installation, inspection & testing of gear drive components with axle shall be provided by supplier. BHEL will issue separate enquiry for the same. Castor wheels/Suitable support for gear drive assembly in wheel set stage (before fitment of reaction rod on bogie) shall be provided by supplier. BHEL will issue separate enquiry for the same. For initial 4 bogies (consisting of 8 gear drive assy. sets), during installation/ integration of gear drive assembly on axle & bogie, supplier shall depute its experts to supervise, train/ guide at ICF bogie manufacturer's facility. <p>B. At BHEL Bhopal:</p> <ol style="list-style-type: none"> Supplier shall provide assembly procedure of half coupling on traction motor. <p>C. At ICF/RCF/MCF (Mounting of assembled gear drive with axle on bogie):</p> <ol style="list-style-type: none"> The supplier shall submit detailed instructions for adjustment / levelling of gear drive w.r.t motor / alignment of coupling halves, assembly of reaction rod and any checking to ensure proper alignment of coupling halves. Special tools, fixtures, gauges & shims required for adjustment / levelling of gear drive w.r.t motor / alignment of coupling halves and assembly of reaction rod on bogie shall be provided by supplier. BHEL will issue separate enquiry for the same. For initial 4 bogies (consisting of 8 gear drive assy. sets), during alignment of coupling halves, supplier shall depute its experts to supervise, train/ guide at ICF/RCF/MCF. 	

	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 12 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>6.4 Maintenance:</p> <ol style="list-style-type: none"> i. The supplier shall submit maintenance manual for the gear drive assembly containing following details: <ol style="list-style-type: none"> a. Write up on the working of gear drive assembly. b. The dimensional drawing of complete gear drive assembly (including flexible coupling) with technical data. c. The detail functioning of each item and its sub-assembly. d. Part list of components used in gear drive assembly. e. Assembly & disassembly procedure of gear drive assembly along with drawings indicating usage of special tools. f. Fitment procedure of half couplings on traction motor & half coupling. g. Testing procedure of gear drive assembly. h. Maintenance instructions for inspection, troubleshooting and recommended maintenance schedule. i. List of special tools & instruments required for assembly, disassembly & maintenance. j. List of spares, must change items during scheduled maintenance and consumables. ii. The supplier shall be responsible for carrying out improvements and modifications on the gear drive assembly supplied, in case any repetitive issues are observed during service (provided such modifications/ improvements are necessary for meeting the requirements of reliability, performance and safety etc., jointly with Indian Railways/RDSO Lucknow). <p>6.5 Warranty:</p> <p>Warranty period shall be <u>24 months</u> from date of commissioning.</p> <p>7. <u>TYPE TEST</u></p> <p>The type test of individual items of gear drive assembly and complete gear drive assembly shall be in the scope of supplier. The supplier shall have in-house testing facility for the same. During testing, designed load and working conditions shall be simulated. The product shall conform to the designed parameters with respect to its application, efficacy and effectiveness. Axle & other test equipments for type testing by supplier, shall be in the scope of supplier.</p>	

	 <p>PRODUCT STANDARD TME DIVISION, BHOPAL</p>	<p>TM20587</p> <p>Rev 03</p> <p>PAGE 13 OF 14</p>
	TME/2023	
<p>COPYRIGHT AND CONFIDENTIAL</p> <p>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED It must not be used directly or indirectly in any way detrimental to the interest of the company</p>	<p>Following tests shall be done as a part of type test of gear drive assembly:</p> <ol style="list-style-type: none"> Dimensional, material & other necessary inspection of gear drive assembly items viz. gear, pinion, housing etc. Name plate verification Weight measurement of complete gear drive assembly including coupling half and without axle, traction motor & oil in gear drive housing. Dimensional inspection of gear drive assembly including axial & radial clearances of bearings, backlash, push on length gear coupling half gear drive side and other dimensions. Oil level inspection Oil leakage verification from gear drive housing. Oil splashing verification Vibration measurement at various speeds with no load (clockwise direction). Sound level and Air pressure measurement at various speeds with no load (clockwise direction). Vibration measurement at various speeds with no load (counter clockwise direction). Sound level for counter clockwise direction at no load. Temperature rise test in no load condition (both clockwise & counter clockwise directions). Temperature rise test in load condition (at starting torque, both clockwise & counter clockwise directions). Temperature rise test in load condition (at continuous rating, both clockwise & counter clockwise directions) and vibration measurement. Temperature rise test in load condition (at one hour rating, both clockwise & counter clockwise directions) and vibration measurement. Temperature rise test in load condition (at maximum operating motor speed, both clockwise & counter clockwise directions). Water tightness test. Gear drive oil analysis. Visual inspection of gear & pinion contact pattern and condition of bearings and other components. Inspection of interference fit details of components of gear drive system. 	

		PRODUCT STANDARD TME DIVISION, BHOPAL	TM20587
			Rev 023
			PAGE 14 OF 14
TME/2023			
<div>COPYRIGHT AND CONFIDENTIAL</div> <div>The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED</div> <div>It must not be used directly or indirectly in any way detrimental to the interest of the company</div>	8. <u>ENCLOSURES</u>		
	<div>i. Annexure-1 as input datasheet required for design of gear drive assembly.</div> <div>ii. Annexure-2 as preliminary motor shaft view for coupling fitment.</div> <div>iii. Annexure-3 as BHEL drawing no.14450005052 rev.01 of gear drive assembly.</div> <div>iv. Annexure-4 as ICF drawing no. TS/MC-0-0-001 of bogie general arrangement.</div> <div>v. Annexure-5 as ICF drawing no. 8900003 of Reaction rod fixing arrangement.</div> <div>vi. Annexure-6 as drawing no. MT18Br2 001477-7 of axle.</div> <div>vii. Annexure-7 as drawing no. MT18Br2 001480-4 of axle wheelset.</div> <div>viii. Annexure-8 as revision sheet.</div>		

Annexure-1

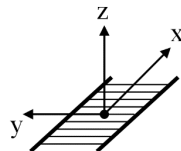
Input datasheet for design of Gear drive assembly		
General Data:		
1	End Customer	Indian Railways
2	Application	Electric Train set
3	Location	Chennai / Kapurthala / Rae Bareilly, India
Vehicle:		
1	Type of rail vehicle	Train set
2	Electrical drive type	IGBT based 3 phase drive
3	Bogie configuration (eg. Fully, partly etc.)	BO-BO
4	Axle or Wheel drive	Axle drive
5	Allowable sound power level [dB(A)]	120 dB(A)
6	Vehicle life (year)	25 years
7	Environment temperature (°C)	-10°C (Minimum)
8	Environment temperature (°C)	50°C (Maximum)
9	Service speed (worn wheels) (km/h)	160 Km/h (Maximum)
10	Design speed (new wheels) (km/h)	180 Km/h (Maximum)
11	Number of bogies	32
12	Number of motor bogies	16
13	Axle load (kg)	17000 kg (Maximum)
14	Wheel diameter new (mm)	952 mm
15	Wheel diameter worn (mm)	877 mm
16	Track gauge (mm)	1676 mm (Broad gauge)
17	Truck wheel base (mm)	2700 mm
18	Daily running (km)	2000
Drive gear assembly:		
1	Drive concept	Traction motor fully suspended in bogie frame
2	Final drive gear type	Preferably helical
3	Number of Gear drive assembly per Bogie	2
4	Number of Gear drive assembly per Motor	1
5	Overall gear ratio	5.158
6	First stage gear ratio	5.158
7	Efficiency	98%
8	Weight (kg)	420±7% kg
9	Rail clearance at fully worn wheel	91 mm (Minimum)
10	Gear drive suspension type (fully or partially)	Partially
11	Axle diameter (between wheels)	179 mm (Refer annexure-6)
12	Axle diameter for Gearwheel sitting (mm)	217.5 mm (Refer annexure-6)
13	Axle diameter for bearings sitting (mm)	216.5 mm (Refer annexure-6)
14	Range of centre distance between axle C/L & motor shaft C/L	372 - 376 mm (Refer annexure-3)
15	Pinion offset (Position of motor shaft C/L above axle C/L)	20 mm above axle C/L (Refer annexure-3)
16	Distance between C/L of gear drive & bogie (mm)	513 mm (Refer annexure-6)
17	Distance to bottom of gear drive from axle C/L (mm)	347.5 (Maximum) (Refer annexure-3)

18	Distance to top of gear drive from axle C/L (mm)	350 mm (Maximum) (Refer annexure-3)
19	Distance between end of flexible coupling (face towards motor side) and gear drive assembly pinion side (including all possible movements) (mm)	515 mm (Maximum) (Refer annexure-3)
20	Width of Gear drive assembly sitting on axle	350 mm (Maximum) (Refer annexure-3)
21	Length of Gear drive assembly upto safety catch from axle C/L (mm)	600 mm (Maximum) (Refer annexure-3)
22	Horizontal distance of bogie connection point of reaction rod (in relation to wheel axle centre) (mm)	545 mm (Refer annexure-5)

Traction motor:

1	Motor manufacturer	BHEL
2	Motor type	AC
3	Motor weight (kg)	1100±5% kg
4	Motor shaft end	Enclosed as annexure-2
5	Motor maximum power (motoring) (kW)	297
6	Motor maximum power (braking) (kW)	373
7	Motor continuous power (kW)	240
8	Motor continuous torque (Nm)	905
9	Motor continuous speed (min^{-1})	3136
10	Motor maximum speed (min^{-1})	5616
11	Maximum starting torque (Nm)	2298
12	Maximum braking torque (Nm)	2250
13	Root mean square torque (Nm)	1340
14	Motor short circuit torque [value in air gap?] (Nm)	12000

Bogie primary suspension movement

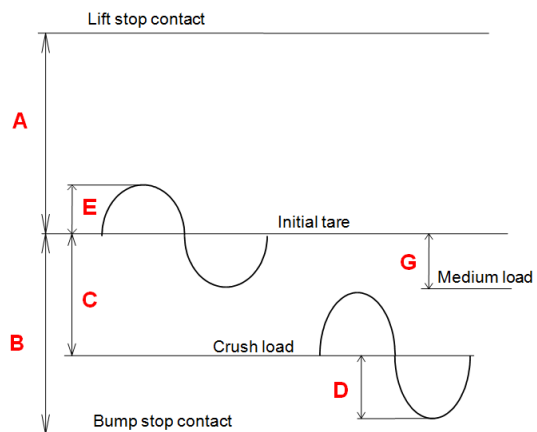


X (longitudinal) to mechanical stop + tolerances [mm]

Y (lateral) to mechanical stop + tolerances [mm]

Maximum dynamic and continuous dynamic movement values for X and Y directions.

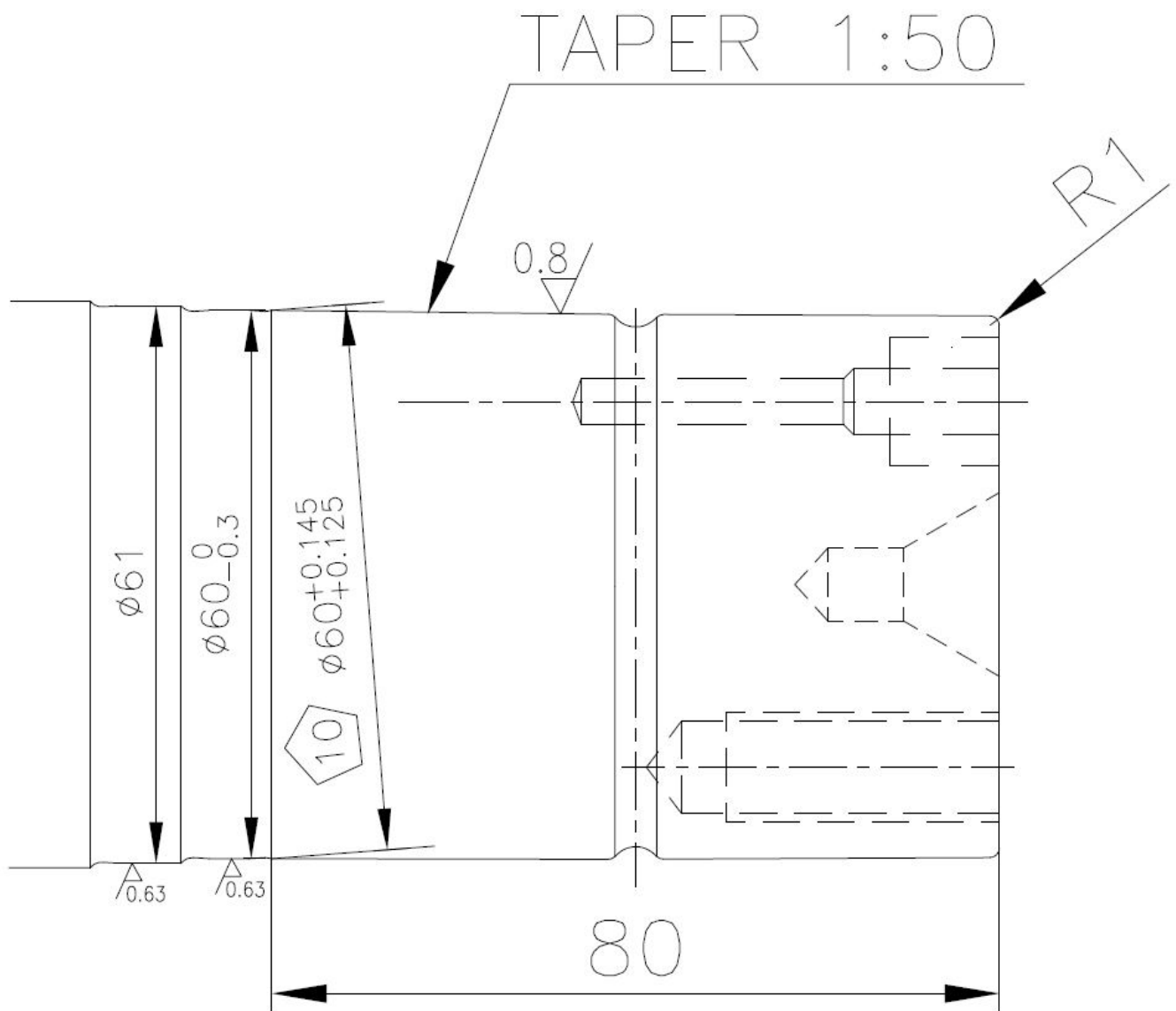
Z (vertical) [mm] – distances A, B to mechanical stops + tolerance of stop position along with E, C and D.

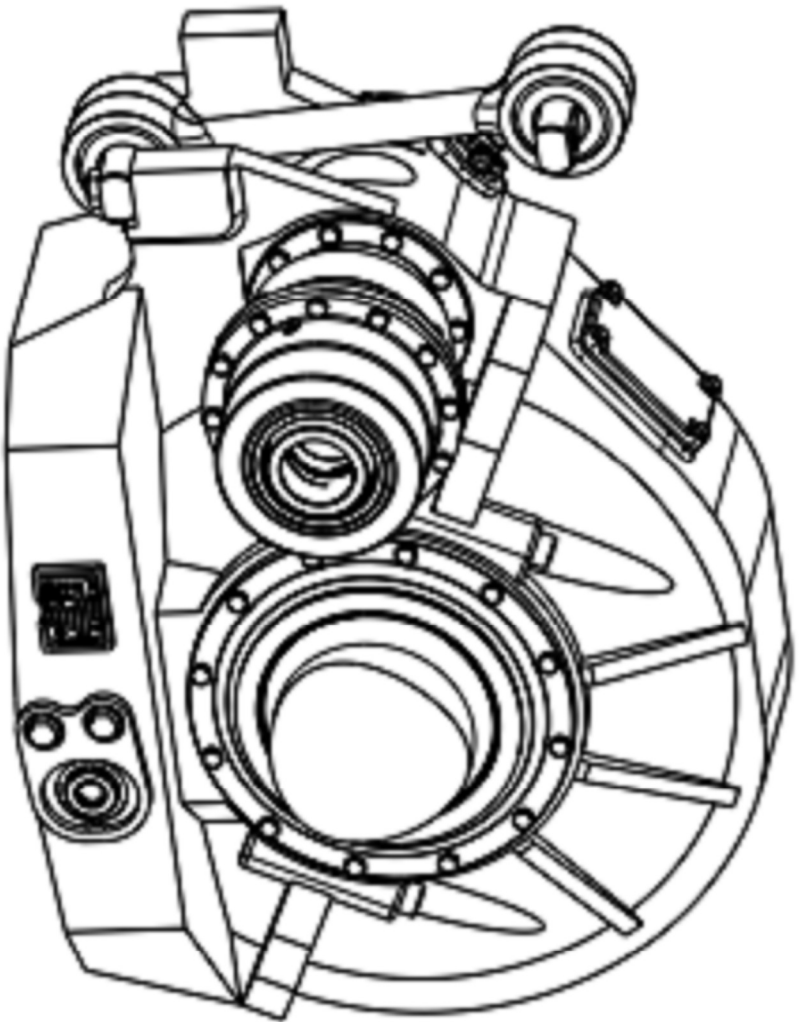
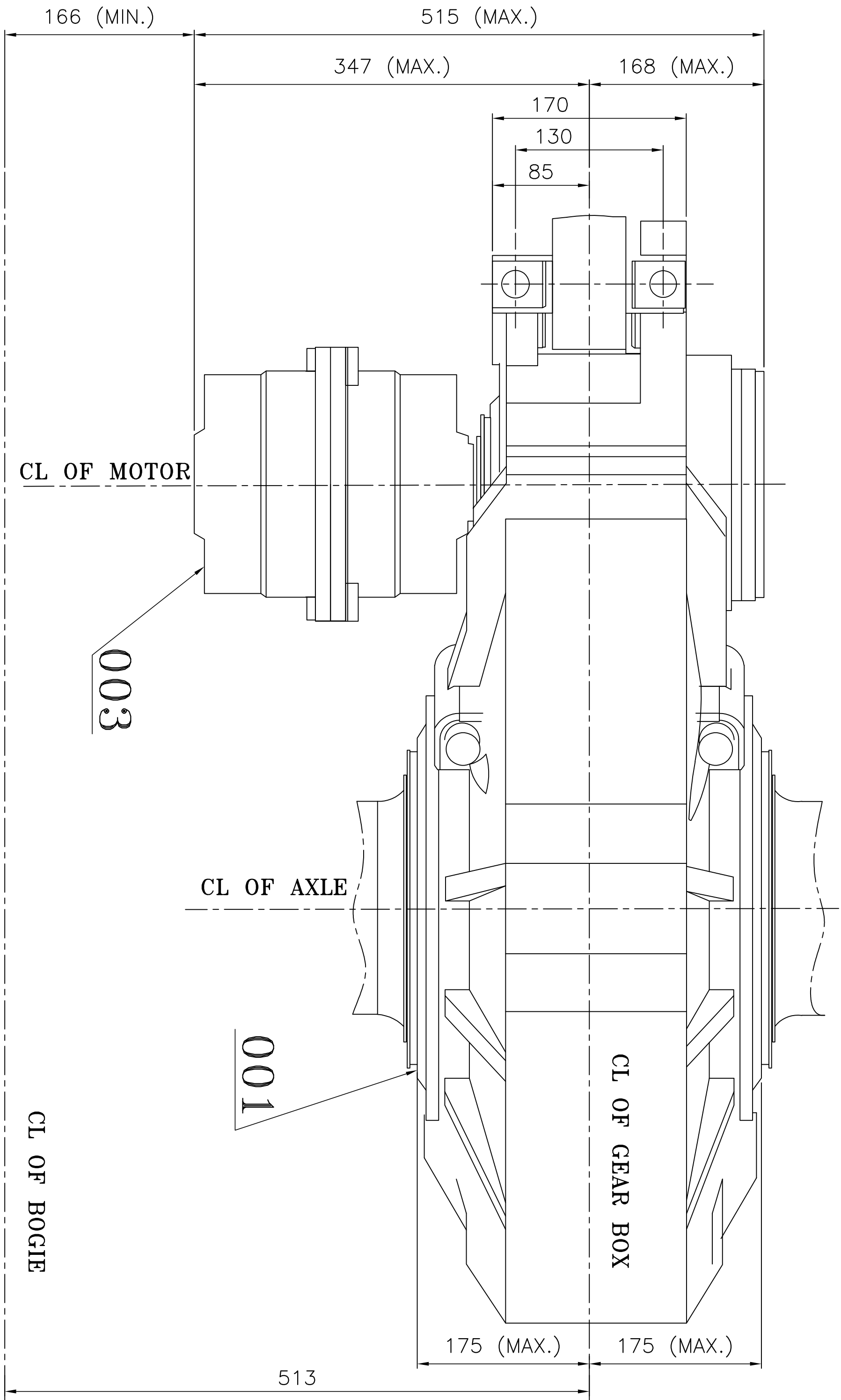
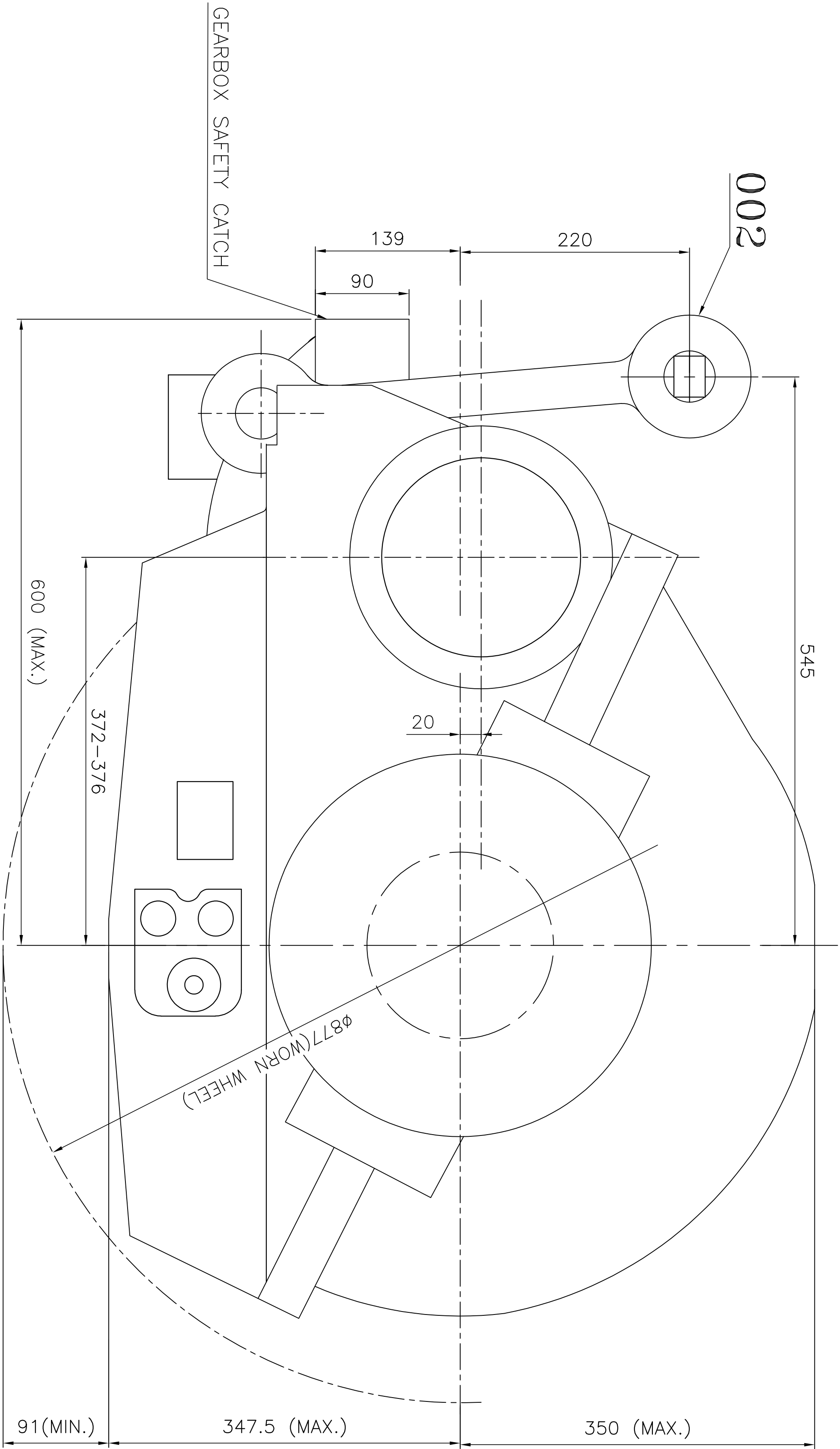


Primary suspension (bogie tolerances ± 2 mm in all directions)

Drives shown in position		Z = tare	
Prehold		4 mm at Z = 0	
X	Max.	± 10 mm	
Y	Max.	± 8 mm	
Z (bump stop)	Max.	- 45 mm	
Z (lift stop)	Max.	+ 25 mm	
Tare AWO	10%	Z = 0 mm	Dyn.: X ± 5 ; Y ± 4 ; Z ± 13
Nominal AW3	80%	Z = -12.5 mm	Dyn.: X ± 9 ; Y ± 4.5 ; Z ± 14
Full load AW4	10%	Z = - 15 mm	Dyn.: X ± 9.5 ; Y ± 5 ; Z ± 14

Annexure-2





3D VIEW FOR REF.

INVENTORY NO.

SIGN. & DATE

REF. DRG. NO.

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

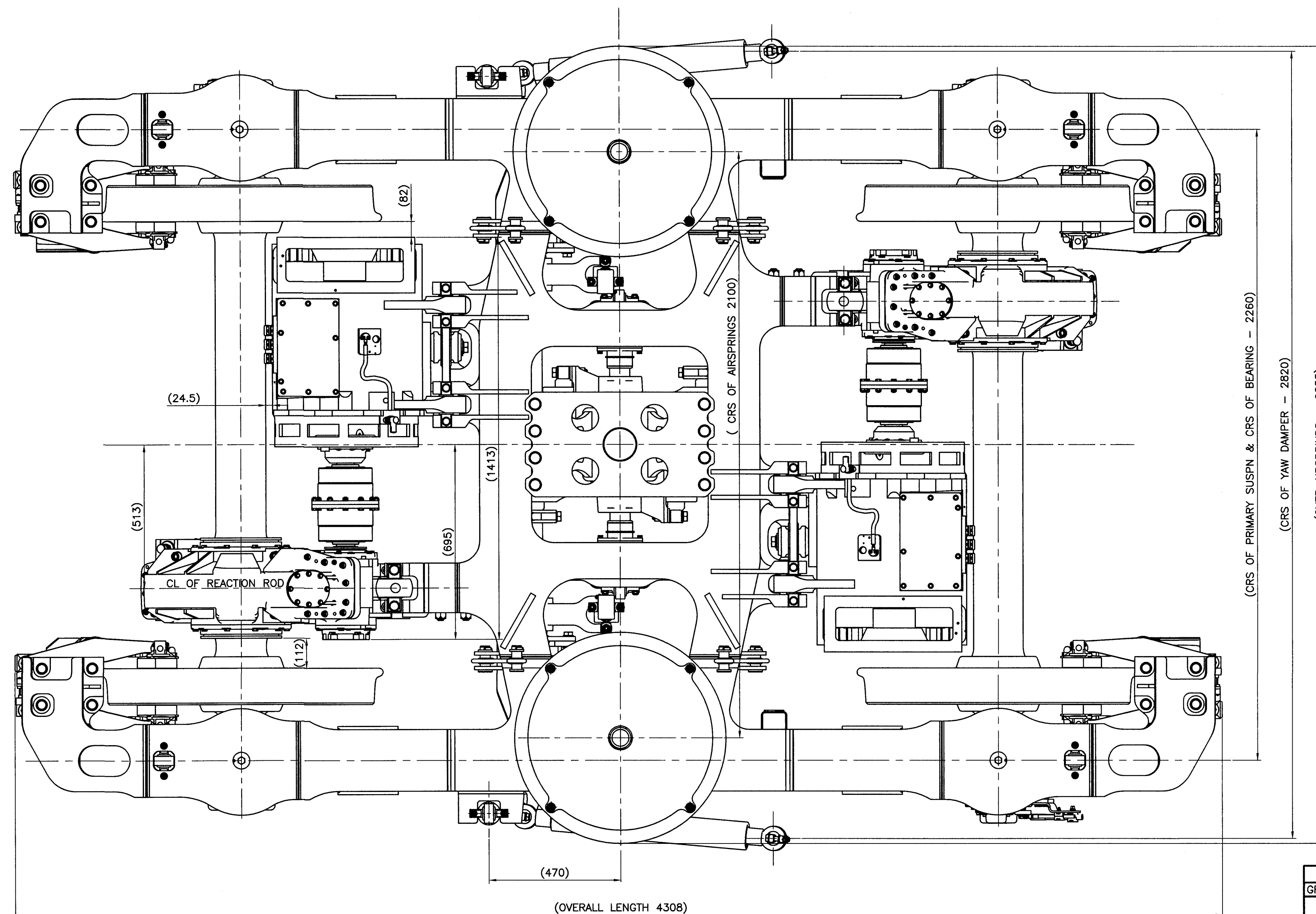
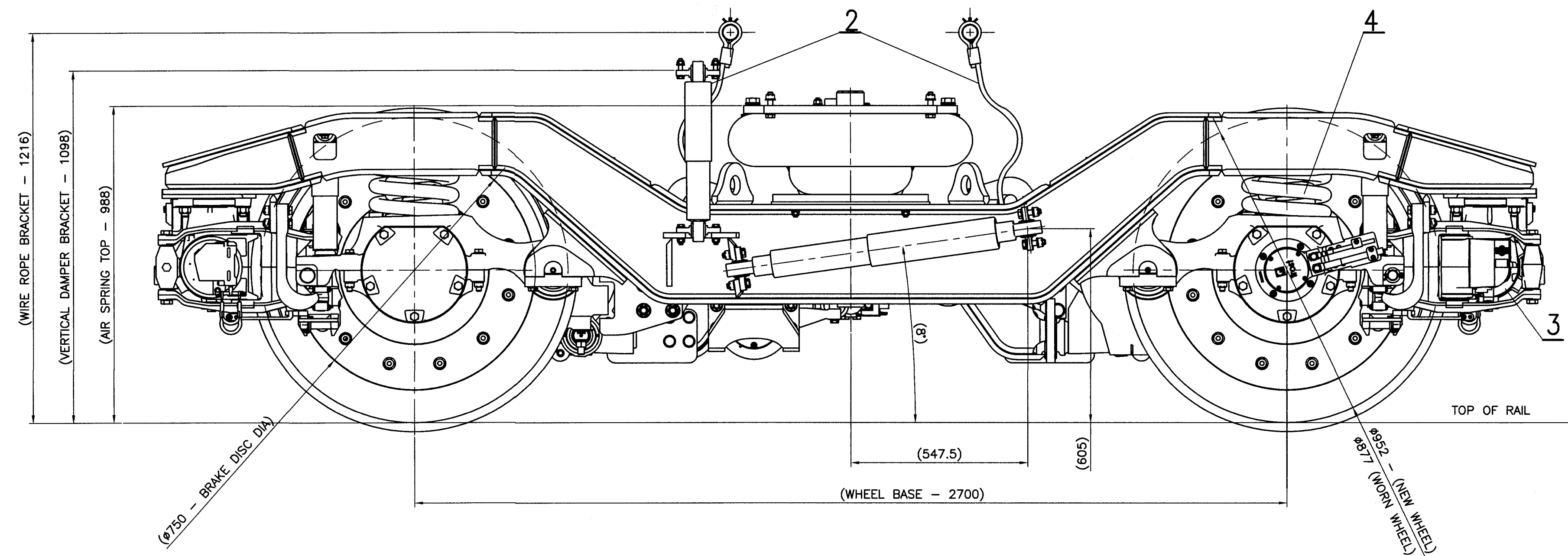
REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED

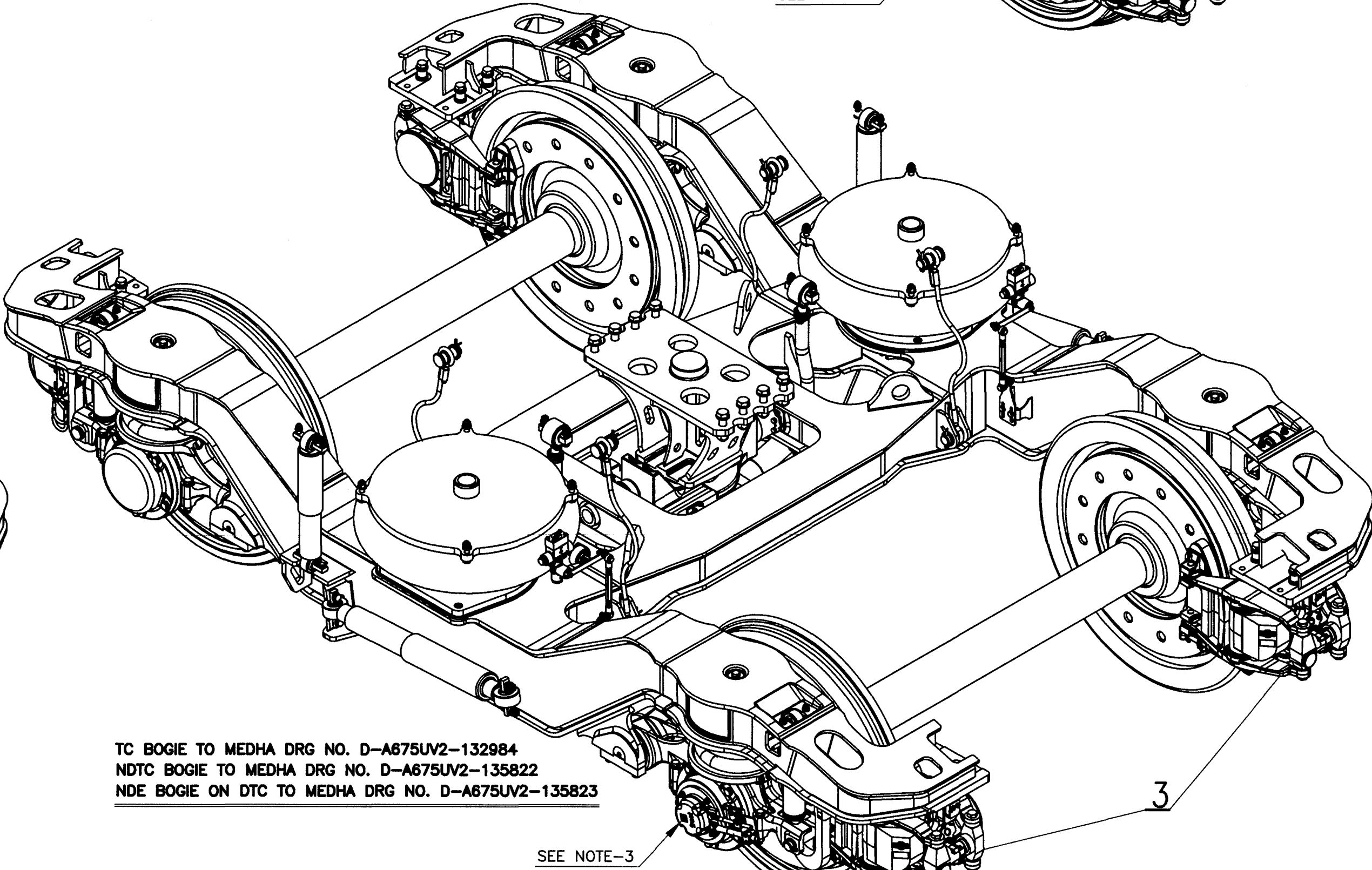
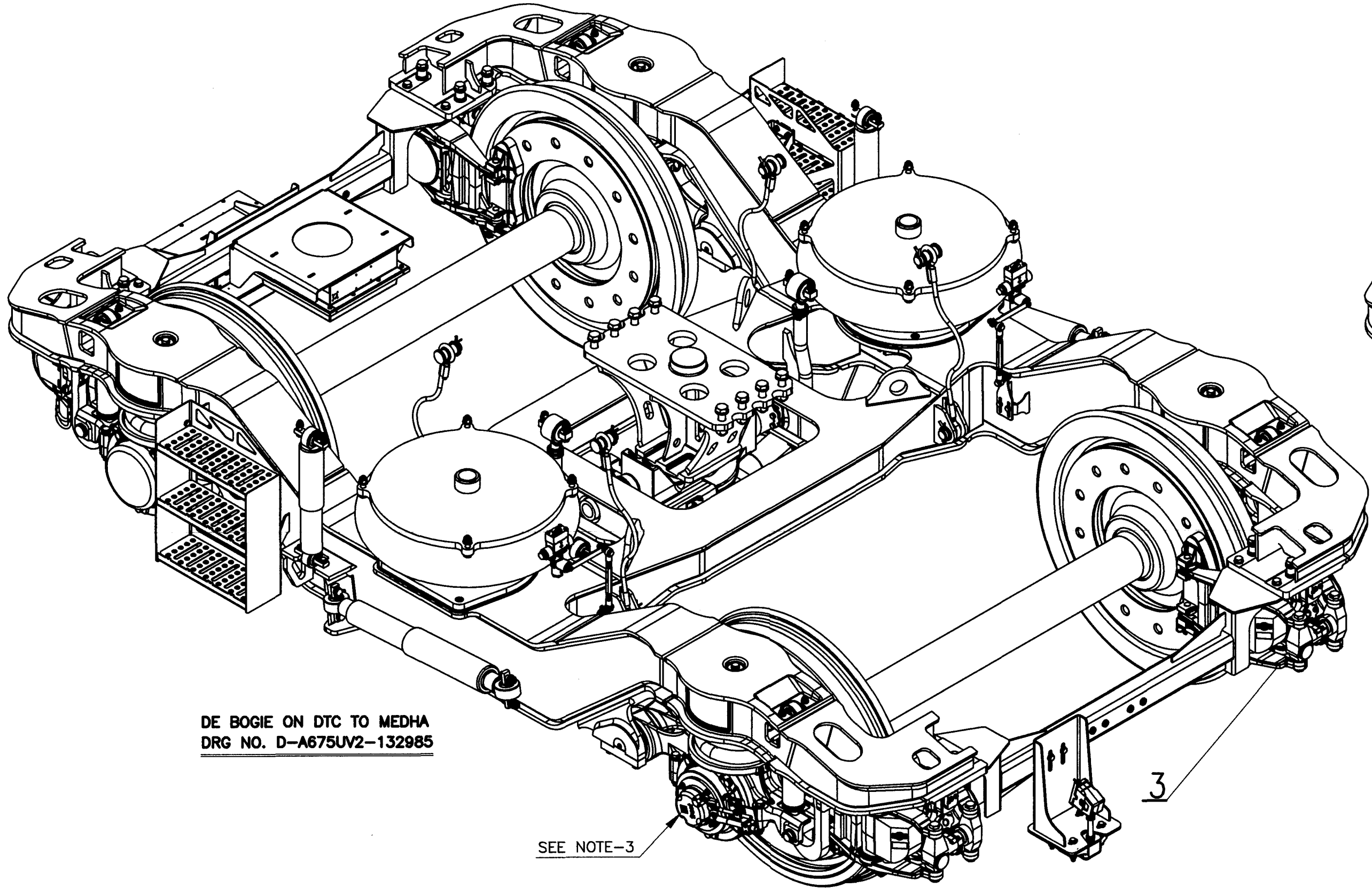
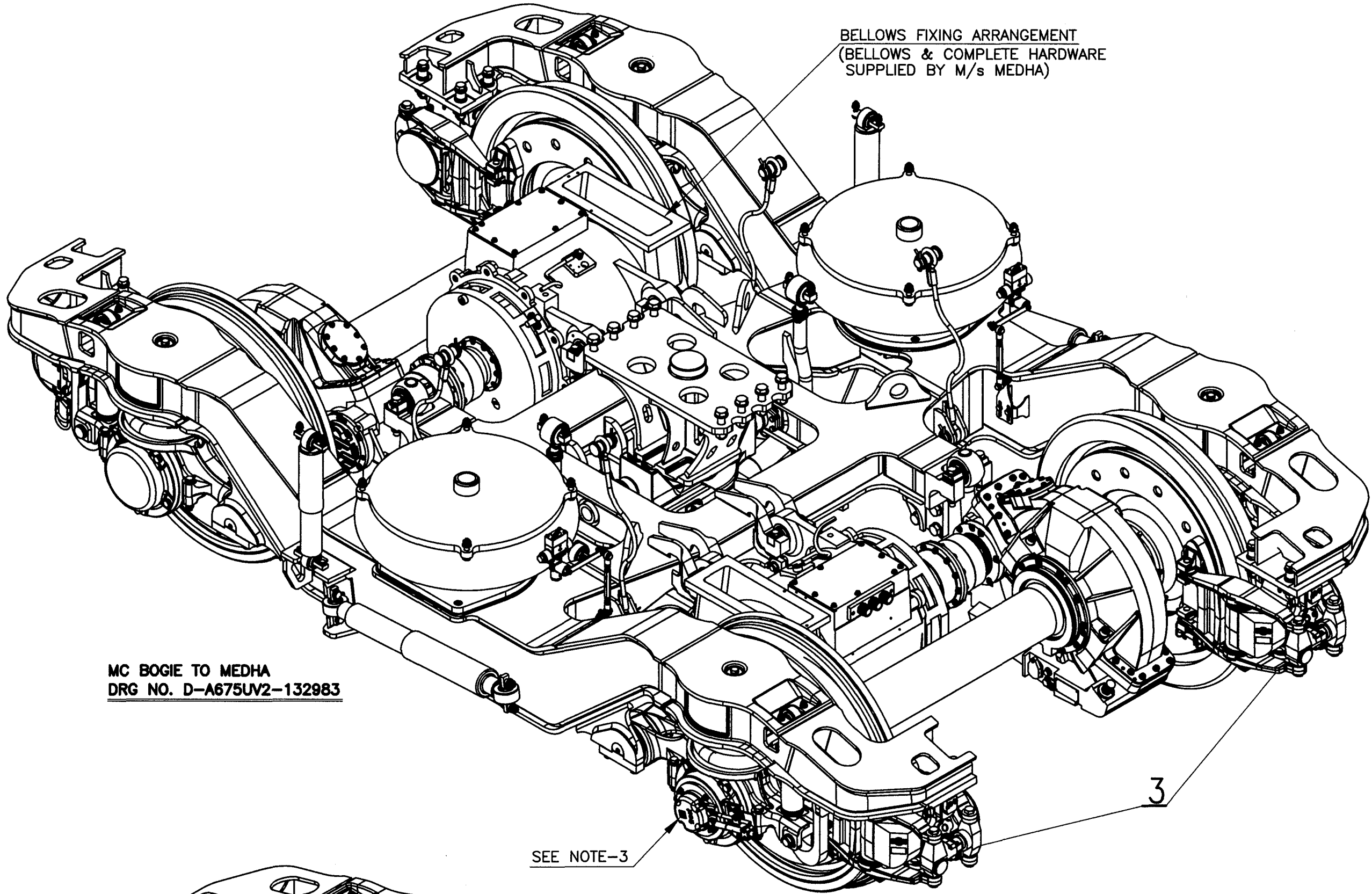
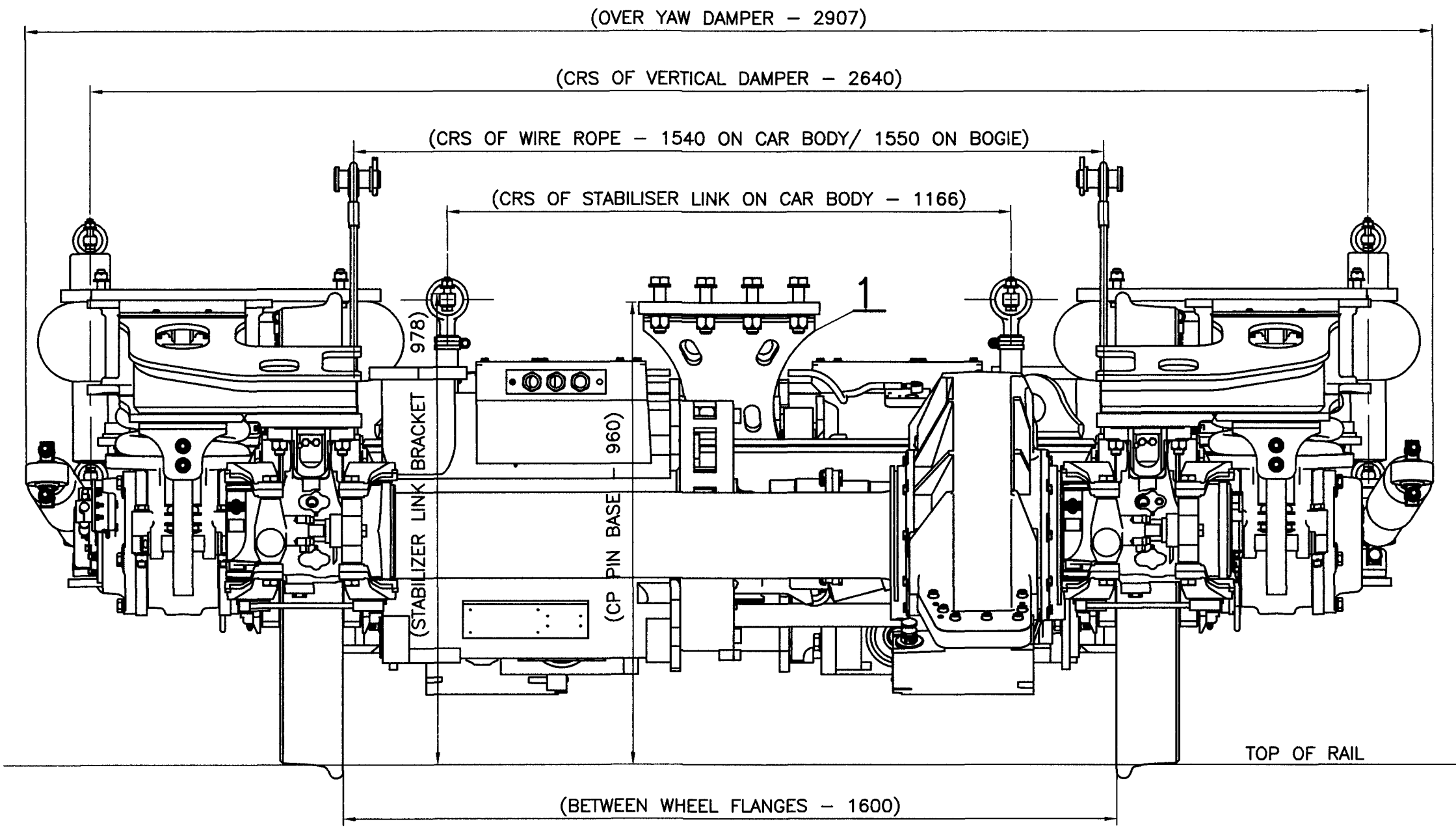
REV.	DATE	REASON	REV.	DATE	REASON
01	17.03.23	CHECKED	01	17.03.23	CHECKED
		APPROVED			APPROVED



ASSEMBLY DRAWINGS			
15-9-2021	15/9/21	AME/SME	
0 Num. Alt.	DATE OF LATEST ALT	DATE OF FIRST ISSUE	

DESCRIPTION & DIMENSION		ITEM	REF.DRGS	MAT.SPEC	WEIGHT/UNIT	REMARKS	
GROUP: 0-0					SUPERSEDED BY:		
BOGIE GENERAL ARRGT. FOR TRAINSET BOGIES					SUPERSEDES:		
					SCALE	SSE/D	SABAPATHY NATHAN M
						CHD	
						ALTD	
						DRN	S.N.Karthikeyan
					Alpha Alt:- -		
DATA CODE NO. 890	INDIAN RAILWAY STANDARDS			SHEET 1 OF 2	INTEGRAL COACH FACTORY CHENNAI-38		
					TS/MC-0-0-001		

▽ ROUGH MACHINED	① ROUGH CLEANED	ALTERATIONS
▽▽ FINISH MACHINED	② CHAMFERED	
▽▽▽ FINE FINISH MACHINED	③ BURRS REMOVED	



NOTE:

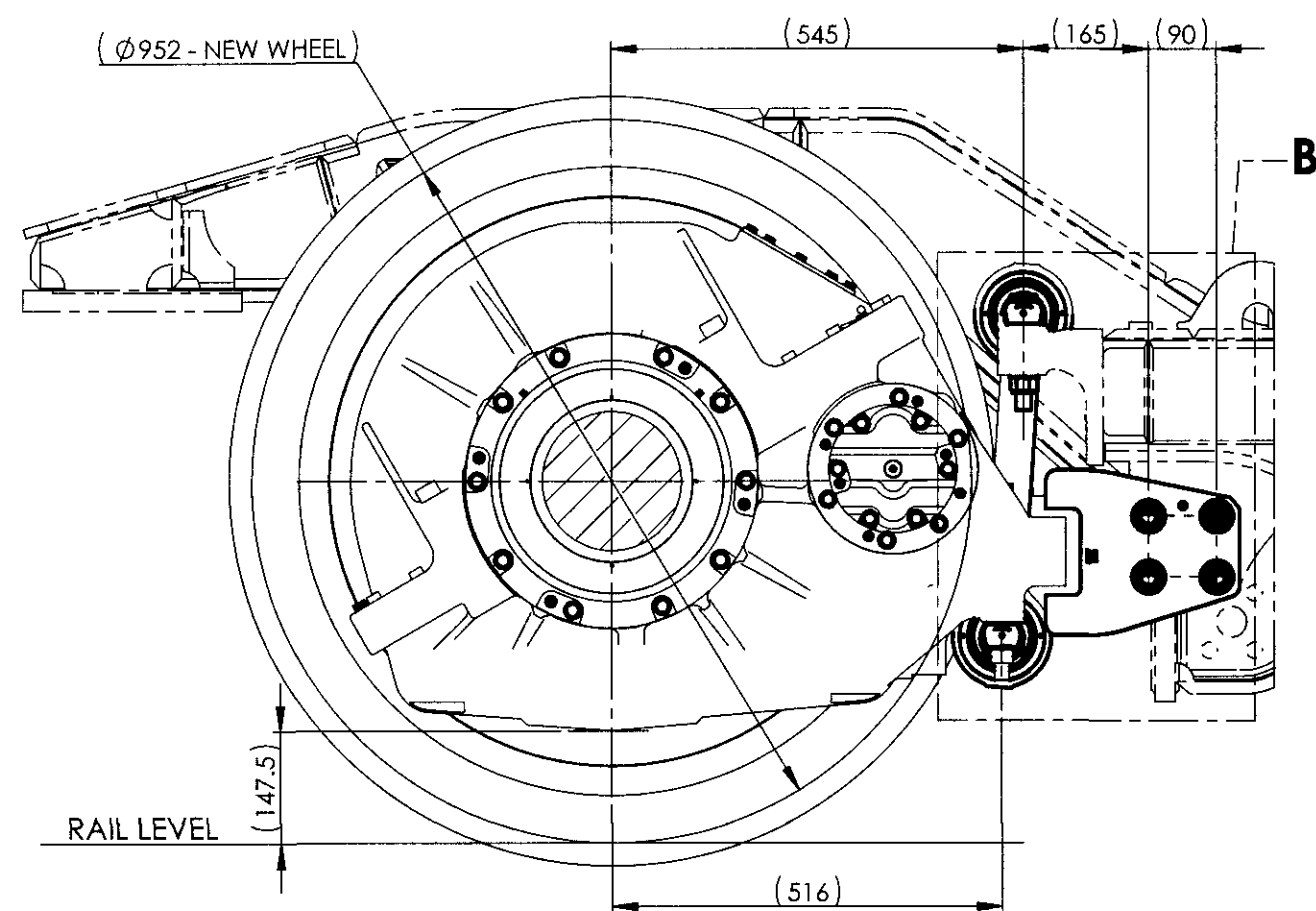
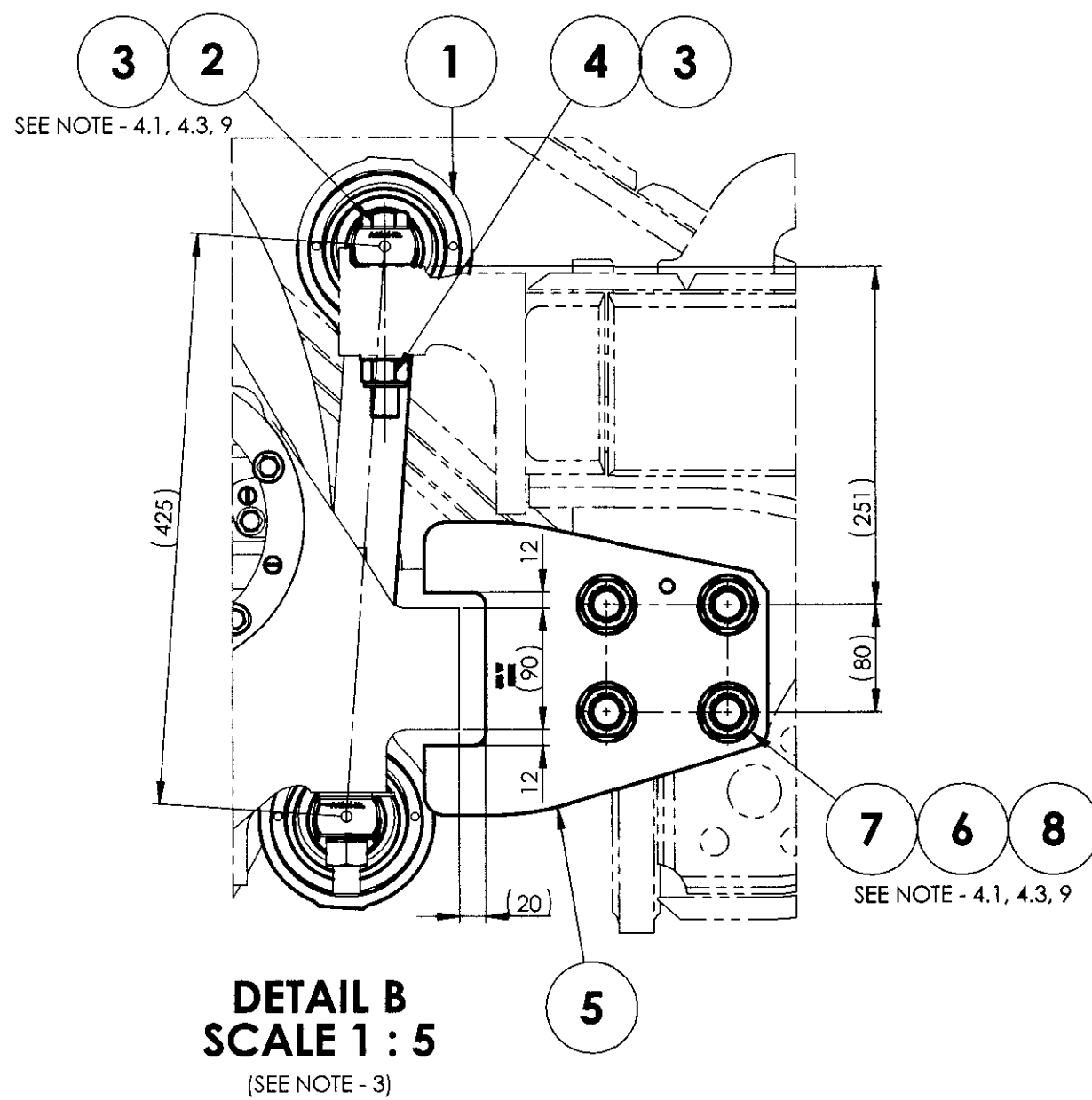
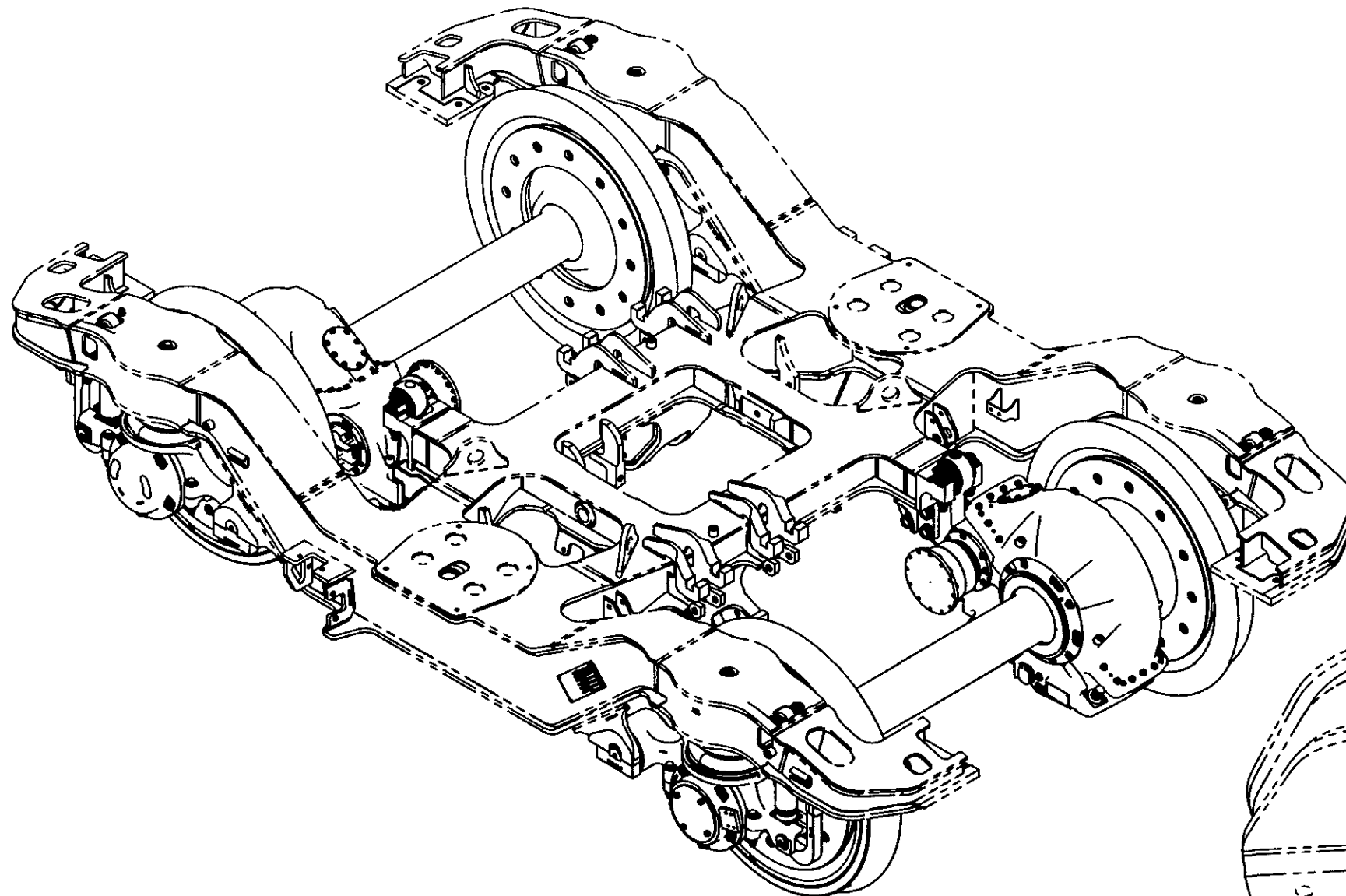
- FOR OPEN TOLERANCES REFER NO: ICF/STD-9-0-001.
- COL-1 PERTAINS TO SHELL ITEMS.
COL-2 PERTAINS TO FUR ITEMS.
- LOCATION/KEY DIAGRAM OF AXLE END EQUIPMENTS AS PER DRG NO. 89002001 SHALL BE FOLLOWED.
- BOGIE ASSEMBLY
 - BOGIE COMPLETE SUPPLIED BY M/s MEDHA.
 - THIS DRG IS APPLICABLE FOR FITMENT OF LOOSE ITEMS (OF BOGIE) ON CAR BODY AND BRAKE ITEMS ON BOGIE.

ISO VIEWS

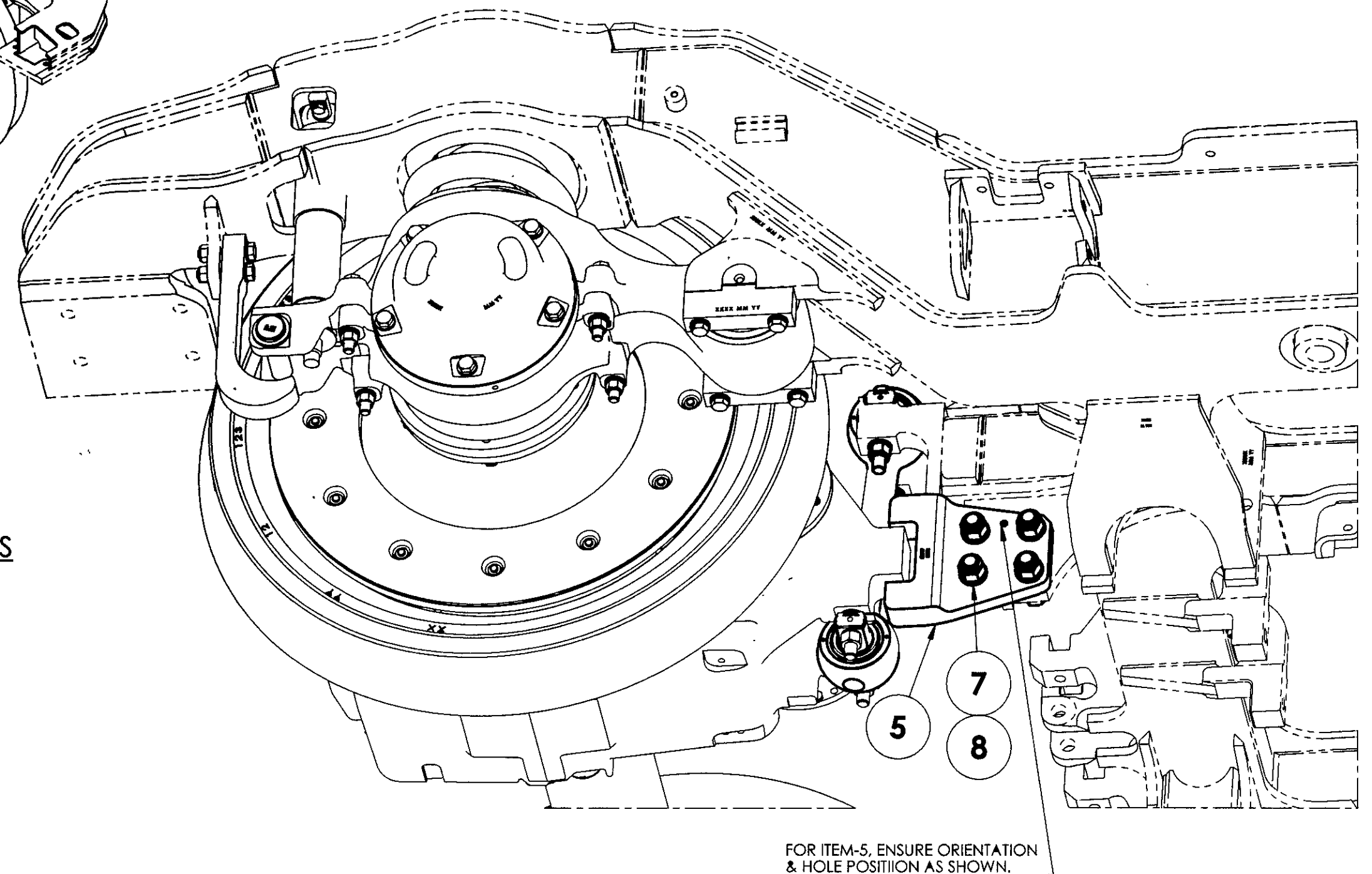
NO. OF ASSY. REQD. PER COACH			
TYPE OF COACH	COLS.	1	2
	②	TS/MC, TS/TC, TS/DTC, TS/MC2 TS/NDTC/EC, TS/NDTC/EC2	2 2

TS/NDTC/EC2-9-0-002
TS/NDTC/EC-9-0-002
TS/MC2-9-0-002
TS/TC-9-0-002
TS/MC-9-0-002
TS/DTC-9-0-002
ASSEMBLY DRAWINGS

✓	SUSPENSION DIAGRAMMATIC ARRANGEMENT	4	TS/MC 9-0-004			
1	DISC BRAKE FIXING ARRANGEMENT	3	TRAIN18/MC/MC 3-2-001			
1	SECONDARY SUSPENSION ARRANGEMENT (STAGE-2)	2	89005001			
-	1 CP PIN FIXING ARRGT.	1	89006001			
QTY	DESCRIPTION & DIMENSION	ITEM	REF.DRGS	MAT.SPEC	WEIGHT/UNIT	REMARKS
2	1 GROUP: 0-0					SUPERSEDED BY:
BOGIE GENERAL ARRGT. FOR TRAINSET BOGIES						SUPERSEDES:
						SCALE SSE/D SABAPATHY NATHAN M.
						1:10 CHD
						ALTD DRN S.N.Karthikeyan
Alpha Alt:-						
DATA CODE NO. 890				INDIAN RAILWAY STANDARDS		
15-9-2021				SHEET 2 OF 2		TS/MC-0-0-001
0 Num. Alt.				DATE OF LATEST ALT		FORM:-IR.A1-840X600
				DATE OF FIRST ISSUE		
				AME/SME		

SECTION A-A
SCALE 1 : 10DETAIL B
SCALE 1 : 5
(SEE NOTE - 3)

ISO VIEWS



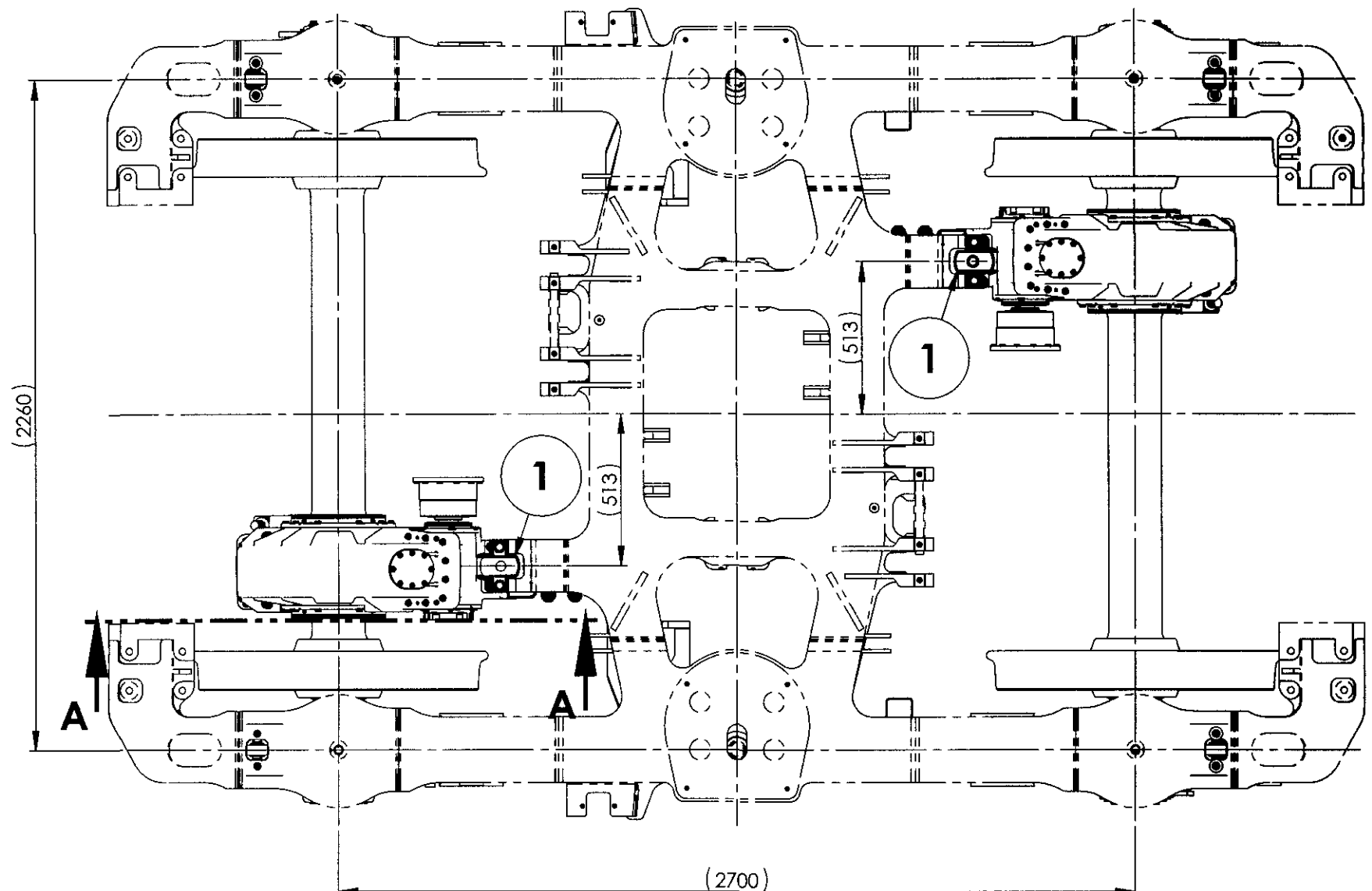
NOTE:

- REACTION ROD COMPLETE (REF. M/S TSA DRG. NO. TSA024288) SUPPLIED BY PROPULSION SYSTEM SUPPLIER ALONG WITH MOTOR / GEAR BOX AND COVERED IN ELECTRICAL SCOPE.
- FOR GEAR BOX SIDE, ALL FASTENERS - BOLT, NUT, WASHER, ADJUSTMENT SHIMS ARE SUPPLIED BY PROPULSION SYSTEM SUPPLIER ALONG WITH MOTOR / GEAR BOX AND COVERED IN ELECTRICAL SCOPE.
- ZINC ELECTROPLATED TO GRADE A3L OF ANNEX-E OF IS:1367 (PART-ELEVEN).
- DIMENSIONS SHOWN ARE WITH NEW WHEEL IN TARE LOAD.
- TIGHTENING TORQUE:
 - M20-10.9 - 530 ± 5% Nm (REACTION ROD TOP SIDE)
 - M24-10.9 - 900 ± 5% Nm (SAFETY CATCH)
 - AFTER TIGHTENING TORQUE APPLICATION, SUITABLY MARK WITH PERMANENT MARKER OR PAINT ON BOLT/SCREW, NUT FACE, WASHER AND PART. THIS IS NECESSARY FOR INSPECTION / VERIFICATION / CHECKING IN SERVICE.

EXAMPLE:



- FOR ASSEMBLY OF REACTION ROD, INSTRUCTIONS OF PROPULSION SYSTEM SUPPLIER SHALL BE FOLLOWED.
- BOLTS / SCREWS (ITEMS-2 & 6) SHALL BE OF MAKE - TVS OR UNBRAKO ONLY.
- AFTER ASSEMBLY, UNPAINTED EXPOSED MATING SURFACES ON BOGIE FRAME SHALL BE SUITABLY COATED WITH RUST PREVENTATIVE.
- FS ALL STEEL LOCK NUT:
 - DIMENSIONS OF NUT SHALL BE AS PER DIN 6925/ DIN 980M.
 - NUT SHALL BE OF MAKE M/S FLAIG + HOMMEL GmbH, GERMANY.
- DURING ASSEMBLY, THREADS & BEARING SURFACES OF BOLTS & NUTS SHALL BE SUITABLY APPLIED WITH ANTI-SEIZE COMPOUND (MOLYKOTE 1000 or ANABOND NEVESEIZ C-975 or SIMILAR).
- FASTENERS & SAFETY CATCH (ITEMS - 2 TO 8) AND SHALL BE IN BOGIE SUPPLIER'S SCOPE.



8	FS ALL STEEL LOCK NUT	M24- PROPERTY CLASS - 10	8				ZINC ELECTROPLATED SEE NOTE-3, 8, 10
16	WASHER ISO 7089 - 24 - 300 HV		7	ISO 7089			ZINC ELECTROPLATED SEE NOTE-3, 10
8	HEXAGON HEAD BOLT	ISO 4014-M24 x 90-10.9	6	IS:1364 PART-1			ZINC ELECTROPLATED SEE NOTE-3, 6, 10
2	SAFETY CATCH		5	AAA00005	10.25		SEE NOTE - 10
4	FS ALL STEEL LOCK NUT	M20- PROPERTY CLASS - 10	4				ZINC ELECTROPLATED SEE NOTE-3, 8, 10
8	WASHER ISO 7089 - 20 - 300 HV		3	ISO 7089			ZINC ELECTROPLATED SEE NOTE-3, 10
4	HEXAGON HEAD BOLT	ISO 4014-M20 x 140-10.9	2	IS:1344 PART-1			ZINC ELECTROPLATED SEE NOTE-3, 6, 10
2	REACTION ROD		1		2.43		SEE NOTE-1, 2, 5
QTY.	DESCRIPTION	DIMENSIONS	ITEM NO.	REF.DRGS.	MATL	WT/UNIT IN KGS	REMARKS

GROUP: 0-0

SURFACE AREA IN Sq.m.:

WT/ASSY IN Kgs:

REACTION ROD FIXING ARRGT.
FOR TRAIN SET MOTOR BOGIESINDIAN RAILWAY STANDARDS
INTEGRAL COACH FACTORY, CHENNAI - 600038SHEET
1 OF 1

89000003

A1

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED. FOR UNTOLERANCED DIMENSIONS AND ROUGHNESS VALUES, REFER DRAWING NO ICF/STD-9-0001. ANY MANUAL ALTERATION SHALL AUTOMATICALLY RENDER THIS DRAWING INVALID. WELDING SYMBOLS ARE AS PER IS:813-1986. WEIGHT GIVEN IN DRAWING IS FOR INDICATIVE PURPOSE ONLY.

REF.DRG.NO.-

DATE OF LATEST ALT.	06-04-2022	DATE OF FIRST ISSUE	1	AM/MSME
---------------------	------------	---------------------	---	---------

▽ ROUGH MACHINED	(1) ROUGH CLEANED	REVISONS			
▽▽ FINISH MACHINED	(11) BURRS REMOVED	ALT.	ZONE	DESCRIPTION	APPROVED & DATE
▽▽▽ FINE FINISH MACHINED	(18) CHAMFERED				



M20-6H, 3N05 OF EQUISPACED ON 84 ± 0.3 PCD
SEE NOTE-3



1. INFORMATION FOR THE MANUFACTURER (acc to annex J of EN 13261:2009+A1:2010)

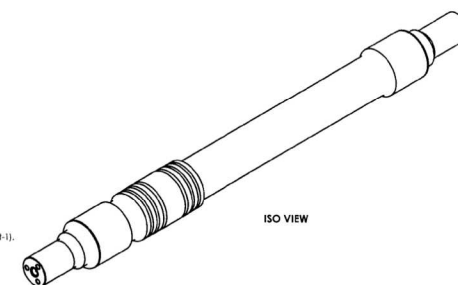
CLAUSE	DESCRIPTION	REQUIREMENT
J.2.1	GEOMETRY AND DIMENSION	AS PER DRG NO. 89002002
J.2.2	STEEL GRADE	EN 13261, CATEGORY 2, GRADE EA1N
J.2.3	CATEGORY OF AXLE	
J.2.4	DELIVERY CONDITION	READY TO ASSEMBLE
J.2.6	TEMPORARY PROTECTION	WITH CORTEC VpCI-368 ANTI-CORROSION COATING ON ALL SURFACES
J.2.7	MARKING ON THE AXLE ENDS	AS PER DRG NO. 107383-9-2-036

2. MANUFACTURE, INSPECTION AND DELIVERY ACCORDING TO EN13261, CATEGORY 2, GRADE EA1N



3. THE THREAD PROFILE ON AXLE END HOLES SHALL BE AS PER IS: 4218 (Part-1) AND TOLERANCE 6H SHALL BE AS PER IS: 14962 (Part-1).

4. ALL UNSPECIFIED DIMENSIONS AND TOLERANCE SHALL FULFIL EN 13261

5. ANY SLIGHT TAPER WITHIN THE PERMITTED TOLERANCE SHOULD BE ON THE CONDITION THAT THE LARGER DIAMETER IS AT THE INBOARD END OF THE WHEEL SEAT.

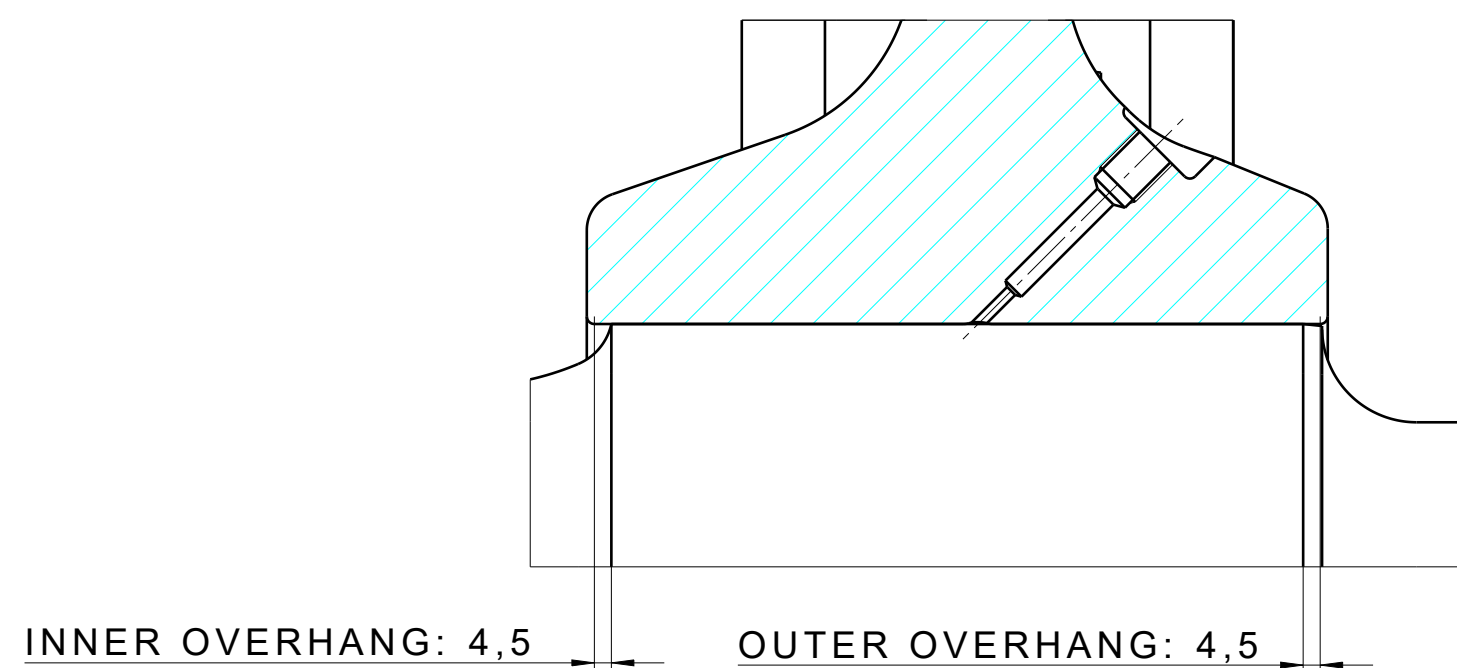
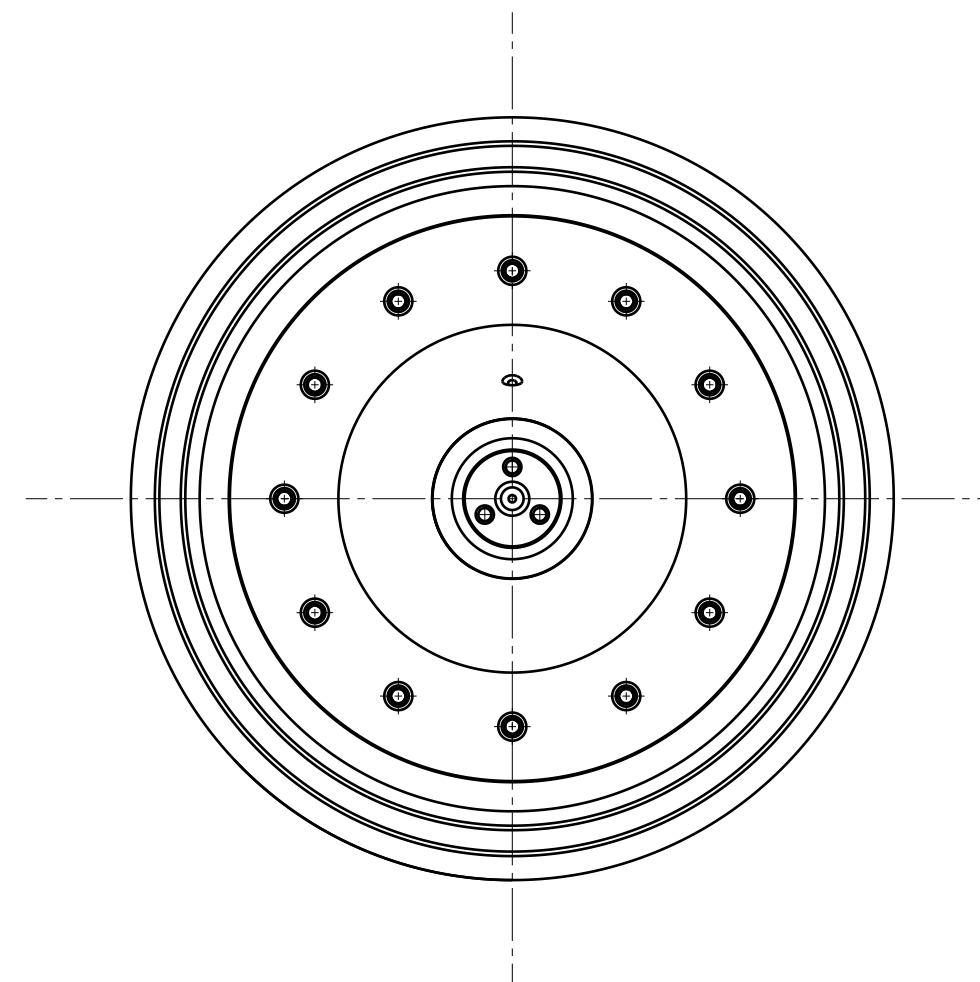
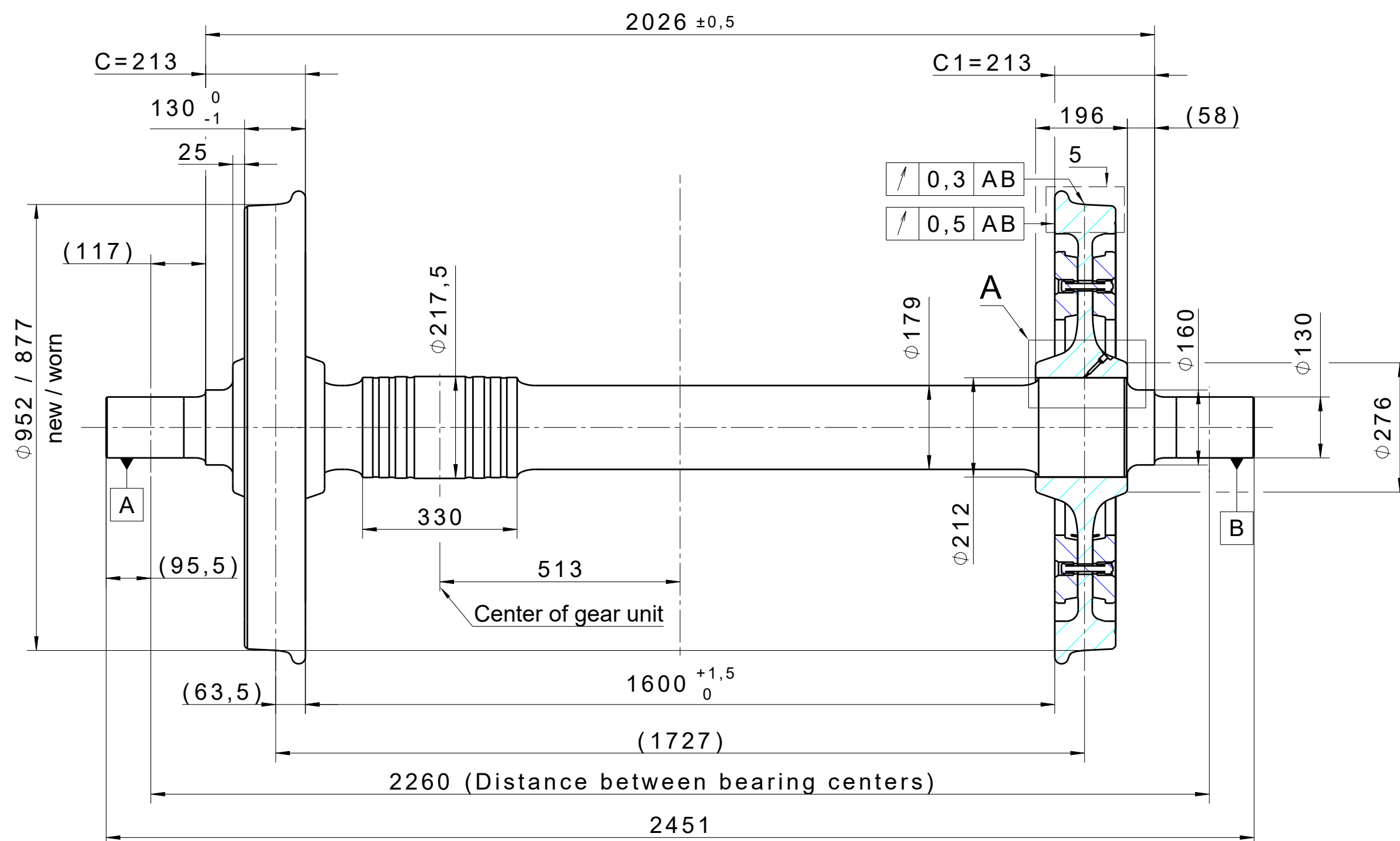


ISO VIEW

1	ROUGH TURNED AXLE			REF. NO.	AA02142		544.42	
QTY.	DURATION	DIMENSIONS	ITEM NO.	REF. DIMS.	MATL.	WT/UNIT IN KGS	REMARKS	
GROUP: D-2		SURFACE AREA IN Sq.m.			WT/UNIT IN KG		SCALE	
AXLE FINISHED FOR TRAIN SET MOTOR COACHES					ALT	CHD		
					ALT	DRN		
					S.N. Karthikeyan			
					TS/MC			
INDIAN RAILWAY STANDARDS INTEGRAL COACH FACTORY, CHENNAI - 600088						89002002		A1
SHEET					1 OF 1			


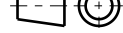
This drawing is property of EC Engineering Sp. z o.o.
and shall not be used or reproduced without the prior permission of the owner

RELEASED FOR
PROTOTYPE



A
1:2

1. DIFFERENCE BETWEEN C AND C1 DIMMENSION $\leq 1\text{mm}$
2. DIFFERENCE IN TREAD CIRCLE DIAMETER $\leq 0,3\text{mm}$
3. MAXIMUM DYNAMIC IMBALANCE ACCORDING TO EN 13260: 75 gm
4. MAXIMUM AXLE LOAD: 17 TONNES
5. WHEEL PROFILE AS PER RDSO SKETCH SK-91146
6. MAXIMUM OPERATING SPEED: 160 KM/H
7. WHEEL OVERHANG:
NOMINAL: 4,5mm (INNER AND OUTER)
MAXIMUM: 6,2mm (INNER)
MINIMUM: 2,05mm (INNER)
MAXIMUM: 7,45mm (OUTER)
MINIMUM: 3,3mm (OUTER)
8. MANUFACTURE, MARKING AND DELIVERY ACCORDING TO EN13260, CATEGORY 2b

4	RELEASE	10.2021	M. Wróblewski	Weight [kg]	-	General Tolerances: ISO 2768-mK ISO 8015	Material:
3	GEOMETRY UPDATE	10.2021	M. Wróblewski	Size	A2		
2	GEARBOX INTERFACE CHANGE	06.2021	M. Wróblewski				
1	DIMENSIONS CHANGE	04.2021	M. Wróblewski				
Rev.	Description	Date	Name				
Scale:	1:5	Prepared	03.2021	M. Wróblewski	Name: Driven Wheelset Specification		
	Checked	03.2021	R. Grzesiak				
	Approved						
		Date	Name				
		en					
Drawing number:						Revision:	Sheet number:
MT18Br2 001480-4						-	01/01

**REVISION SHEET OF BHEL TECHNICAL SPECIFICATION NO. OF TM20587
FOR GEAR DRIVE ASSEMBLY FOR TRAIN SET APPLICATION**

Sl. No.	Page No.	Details of revision in SPEC. No. TM20587 REV.02 DT 27.03.2023 with respect to REV 01 DT. 02/02/2023
1	6	Sl. no. vii added in clause no. 5.1.
2	7	Sl. no. v to vii added in clause no. 5.3.
3	-	Annexure-1: In sl. no. 11 to 21 (Drive gear assembly), reference of relevant annexures mentioned.
4	-	Annexure-1: In sl. no. 8 (Drive gear assembly), gear drive assembly weight updated from 400 kg to 420 kg (max.).
5	-	Annexure-1: In sl. no. 14 (Drive gear assembly), range of center distance (372-376) mm added in place of center distance 372 mm.
6	-	Annexure-1: In sl. no. 19 (Drive gear assembly), distance between end of flexible coupling & gear drive assy. pinion side updated from 500 to 515 mm (max.).
7	-	Annexure-1: In sl. no. 20 (Drive gear assembly), width of gear drive assembly sitting on axle updated from 320 to 350 mm (max.).
8	-	Annexure-1: In sl. no. 3 (Traction motor), motor weight updated from 1000 to 1100 kg.
9	-	Annexure-1: Details of bogie primary suspension movement updated.
10	-	Annexure-3: Revision of drawing no. 14450005052 changed from 0 to 1.

Sl. No.	Page No.	Details of revision in SPEC. No. TM20587 REV.03 DT 12.05.2023 with respect to REV 02 DT. 27/03/2023
1	4	Information submission time changed to “within 3 weeks from PO date” in place of “with techno-commercial offer”.
2	4	In sl. no. b of clause 3, quantity of tools added.
3	9	In clause no. 6.1, sl. no. ‘iii’ added.
4	9	In clause no. 6.2, document submission time after PO placement changed from 2 months to 4 weeks.
5	12	Sl. no. 6.5 added.
6	-	Annexure-1: In sl. no. 8 (Drive gear assembly), tolerance of $\pm 7\%$ added in weight.