Specification No. RDSO/2006/EL/SPEC/0047 (Rev.'1')

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

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SPECIFICATION FOR DESIGN, MANUFACTURING, SUPPLY AND FITMENT OF MODIFIED MOTOR SUSPENSION UNIT DRIVE SYSTEM FOR WAP7/WAG9 CLASS OF LOCOMOTIVES

FEBRUARY 2007

ISSUED BY

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SPECIFICATION FOR DESIGN, MANUFACTURING, SUPPLY AND FITMENT OF MODIFIED MOTOR SUSPENSION UNIT DRIVE SYSTEM FOR WAP7/WAG9 CLASS OF LOCOMOTIVES

1.0 FOREWORD:

1.1 The motor suspension unit(MSU) drive system of WAG9 locomotives using cylindrical roller bearings was designed for maximum working speeds of 100 km/h. Subsequently, the design was adapted on WAP7 locomotives with speeds upto140 km/h. The existing design of MSU drive system on WAG9/WAP7 locos consists of cylindrical roller bearings. The driving end bearing is mounted on the gear hub itself and is lubricated by gear oil. Non Drive End bearing is grease lubricated.

1.2 The life of gear and pinion achieved on WAG9 locomotives has been a cause of concern. This is attributed to faster wear of the gears and pinions in service due to low viscosity gear oil causing inadequate film formation between gear and pinion at low working speeds. Feasibility of use of gear oil having much higher viscosity is limited due to same oil is being used for lubrication of the Drive end MSU bearing also. As a solution segregation of lubricating systems of gear and pinion from MSU bearing is required. This will facilitate use of gear oil with much higher viscosity as per requirements.

1.3 As per experience of Indian Railways with conventional types of traction motors,, taper roller bearings have been used for MSU drive applications due to their capacity to take axial thrust loads especially at higher speeds. The expected life of the system with use of taper roller bearings is generally higher. The cases of bearing seizures leading to locomotive failures on line are also comparatively less.

1.4 It is intended to develop a modified design of MSU drive system for WAP7/WAG9 class of locomotives with use of taper roller bearings having segregation of lubrication of gear and pinion from MSU bearings and higher expected life.

2.0 SCOPE:

2.1 Through this specification, it is intended to specify the requirements of the proposed modified MSU drive system, to be designed, manufactured, supplied and fitted on the Locomotives.

2.2 Following shall be the scope of work:-

2.2.1 Design and development of modified drive system consisting of suspension tubes, MSU bearings and associated components.

2.2.2 Submission of complete design to RDSO and getting design approval.

2.2.3 Manufacturing of prototype units to be inspected and approved by RDSO in association with CLW.

2.2.4 Fitment of prototype units on locomotives at CLW and monitoring the performance in service during field trial period.

2.2.5 Bulk production of the balance ordered quantity after clearance of prototype by RDSO on completion of field trials.

2.2.6 Association with RDSO, CLW and Railways for performance monitoring.
2.2.7 Investigations in case of warranty failures, suggesting and taking remedial steps if any.

2.3 After approval of the design of successful tenderer by RDSO, all the drawings and design documents submitted to RDSO by the firm shall become the property of RDSO.

3.0 GOVERNING SPECIFICATIONS

3.1 The following specifications shall be referred wherever applicable-

- IEC: 61373 – Vibration and Shocks in rolling stock.
- IEC: 77 – Requirements of equipment for use in Rail Vehicles.
- ISO:281(1990) – Rolling Bearings- Dynamic load ratings and rating life.

4.0 QUALIFICATION CRITERIA FOR TENDERERS

4.1 The tenderer must have in house design and development capability for bearings and drive systems (consisting of suspension tubes, MSU bearings and associated components) suitable for traction rolling stock applications. They should also have manufacturing and testing facilities for bearings for traction applications. This must be substantiated in tender by way of attaching necessary documents. Tenderer not having adequate competence in this field will not be considered.

5.0 TECHNICAL CONDITIONS

5.1 The offered drive system design should be a proven one in international railway traction systems of comparable duties already having run successfully for adequate amount of time. The tenderer shall furnish adequate documentary proof to this effect in their offer.

5.2 Based on satisfactory service experience with taper roller bearings on Indian Railways, it is intended to go for a drive system with such design. However, if a tenderer has adequate reasons and justification to offer a drive system based on an alternative design of bearings, same should be clearly brought out in the offer along with full details of such systems in service and their performance reports.

5.3 Integration requirements of suspension tube with traction motor type 6FRA6068 shall be kept unchanged. No modification on mounting dimensions of the traction motor, wheel set or bogie shall be permitted.

5.4 The existing design of gear case shall be used without any change.

5.5 The axle dimensions shall be maintained to the extent possible. Minor changes, however, may be considered with approval of RDSO if found unavoidable.

5.6 The design shall have adequate sealing arrangement so as to eliminate possibility of mixing of gear case lubricant with MSU bearing grease. The sealing arrangement shall be got approved from RDSO at design stage.

5.7 The tenderer shall furnish detailed bearing life calculations worked out as per ISO-281. The expected L10 life of bearing as per ISO-281 calculations shall not be less than 5 million kms.

5.8 In the current design, Optimol longtime PD-2 grease is used for ND End MSU bearing. Trials are underway for use of Servoplex SHC120 grease of M/s Indian Oil Corporation as common grease for traction motors and MSU tubes. It is, therefore, desirable that

use of Servoplex SHC120 grease is explored as far as possible on the proposed design. If, however, the tenderer recommends using different grease due to strong technical reasons, same should be clearly mentioned by them while submitting the design of the drive system along with reasons thereof. The characteristics of the greases are being supplied as part of tender document.

5.9 The lubrication system shall be so designed that grease lubrication, grease replacement and drive system overhauling schedules are synchronized to the extent possible with existing maintenance schedule of the locomotives being followed currently. The current maintenance schedules are as follows:

Maintenance schedule	WAP7	WAG9
IA	90 days	90 days
IB	180 days	180 days
IC	270 days	270 days
AOH	18 months	18 months
IOH	4.5 years or 12 lakh kms w.i.e.*	6 years or 12 lakh kms w.i.e.
POH	9 years or 24 lakh kms w.i.e.	12 years or 24 lakh kms w.i.e.

* w.i.e.: whichever is earlier.

5.10 The greasing schedule for non driving end MSU bearing is given below for information:
Interval of regreasing – After 250,000 Km
Interval of grease change – After 500,000 Km

5.11 The suspension tube along with assembly components shall be manufactured on CNC machines with requisite accuracy and the process of manufacturing shall be clearly laid down in Quality Assurance Plan (QAP).

6.0 QUALITY ASSURANCE PLAN (QAP)

6.1 The successful tenderer shall formulate and furnish a Quality Assurance Plan (QAP) covering the manufacturing and testing of all components of the drive system. The QAP shall be furnished to RDSO at design approval stage and got approved as part of design approval.

6.2 The QAP shall essentially contain the following information on all components of the drive system:

- Manufacturing process specifying the type of machines used.
- Critical dimensions on which on-line checks are carried out.
- Bill of material for all components.
- Details of NDT methods like radiography, UST etc to be carried out on the components.

7.0 TEST PLAN AND WARRANTY

7.1 **Prototype clearance**: The clearance of the prototype unit shall consist of the following stages:

iv) Prototype inspection by RDSO. The successful tenderer shall offer prototype units of drive system to RDSO for inspection as per approved QAP.

v) Assembly and Initial test run on the locomotive after commissioning at CLW.

vi) Successful field trial for a period of 6 months after commissioning of the locomotive.

7.2 **Routine Inspections**: The routine inspections shall be carried out as per test plan approved by RDSO as part of QAP.

7.3 **Warranty:** The contractor shall warrant that the equipment furnished under the contract shall be free from defects and faults in design, material, workmanship and manufacture. In case of any failures/defects of the drive system noticed within 36 months of the commissioning of the locomotives, the drive system shall be repaired/ replaced by the contractor free of cost.

8.0 CLIMATIC AND ENVIRONMENTAL CONDITIONS:

The climatic and environmental conditions of working of the Electric locomotives are given below for reference and guidance.

8.1 Max. Atmospheric Temperature:-

Under Sun - 70°C
Under shed - 50°C

8.2 Humidity:- 100% saturation during rainy season.

8.3 Reference side conditions:-

Ambient temperature - 0°C Min., 50°C Max.
Humidity – 60%
Altitude – 160 m above mean sea level

8.4 Rain fall:- Very heavy in certain areas.

8.5 Atmosphere during hot weather:- Extremely dusty and desert terrain in certain areas.

8.6 Coastal area:- Humid and salt laden atmosphere.

8.7 Vibration:- The suspension tube shall be designed to withstand vibrations and shocks encountered in service as specified in IEC: 61373 and IEC: 77 publications unless otherwise specified.

9.0 DRIVE SYSTEM DETAILS:

9.1 Nose Suspended drive assembly

Drg. No. 1B011-00267

9.2 Total mass of locomotive:-

123 ± 1 tonne.

9.3 No. of Axles:- 06

9.4 Wheel Diameter:-

New	-	1092 mm
Half worn	-	1054 mm
Fully worn	-	1016 mm

9.5 Axle load:- 20.5 ± 2% tonne

9.6 Max. Service Speed: - 130 kmph

9.7 Tractive Effort Vs Speed Curve of WAG9 & WAP7 locos – Curves enclosed.

9.8 Traction motor mounting: - Axle hung nose suspended.

9.9 Traction motor shaft output:- 850 kW

9.10 Traction motor max. speed: - 2584 rpm

9.11 Gear Ratio WAP7- 20:72 with 4^0 helix angle
WAG9- 21:107 with 5.972^0 helix angle

9.12 Total horse power of locomotive:- 6000 HP

9.13 Max. Torque at start:- 10500 Nm on each TM.

9.14 Centre distance between gear and pinion:- 464 mm

9.15 Weight of Traction Motor = 2150 kg.

9.16 Suspension tube of existing WAG9 loco:-

ABB drawing No. 1B-011-00265.

10.0 DOCUMENTS TO BE FURNISHED BY TENDERERS

10.1 The tenderer shall submit clause by clause compliance of this technical specification along with the offer document. Statements like "noted" etc shall not be treated as compliance. The tenderer should explicitly write "complied" or otherwise with comments wherever applicable.

10.2 The following documents shall be submitted along with the offer document:

vi) General Arrangement of MSU assembly
vii) Statement of changes from the existing arrangement.
viii) Details of bearings offered and bearing life calculations as per ISO281.
ix) Sealing arrangement details.
x) Lubricants and lubrication schedule.

11.0 DOCUMENTS SUPPLIED AS PART OF TENDER

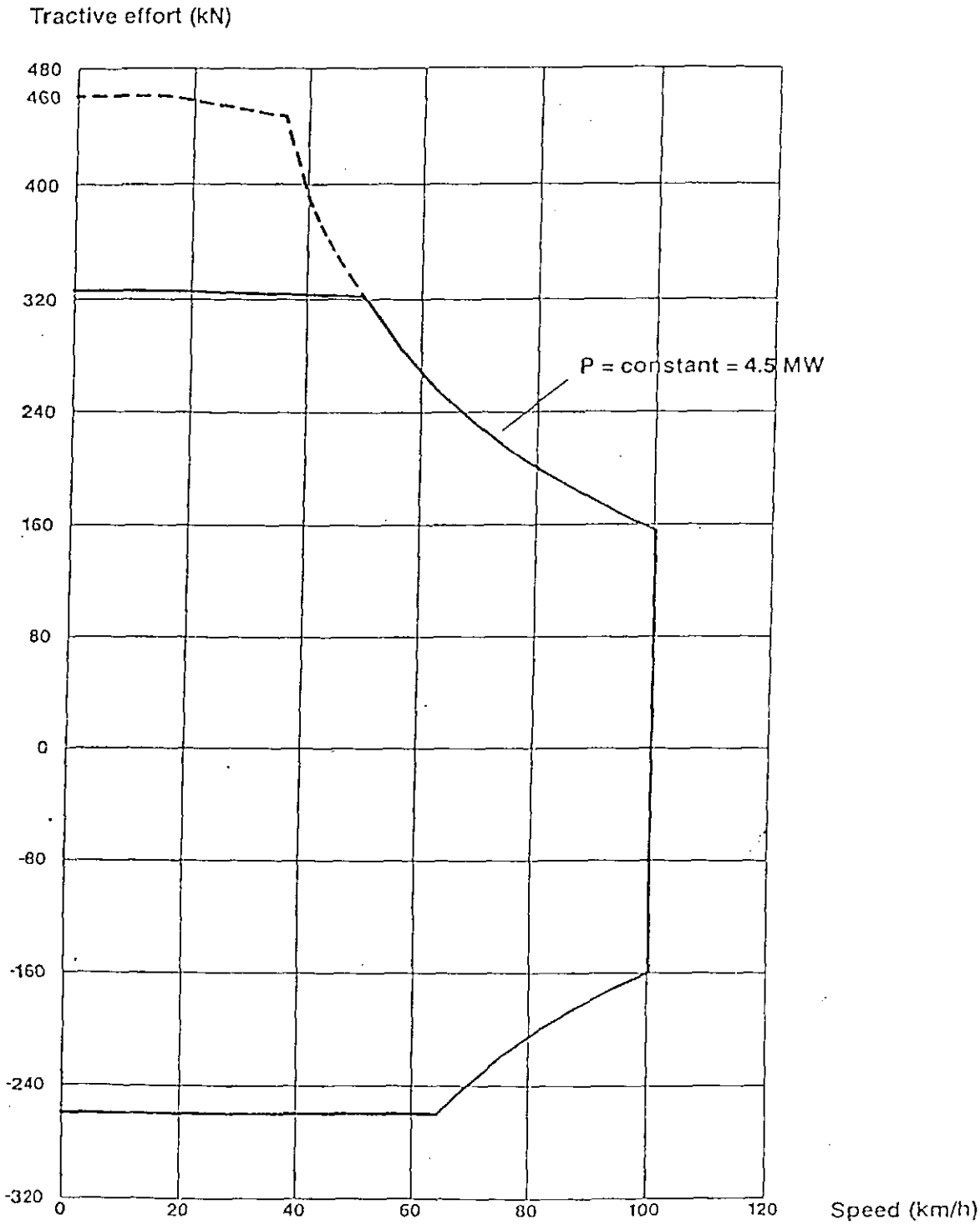
11.1 The following documents are being supplied as Annexure as part of the tender documents to help the tenderers in understanding the requirement of Railways:

i) Drg. No. 1B-011-00265
ii) Drg. No. 1B-011-00267
iii) Characteristics of Greases (optimal long time PD2 & Servoplex SHC120)
iv) TE Vs Speed characteristics of WAG9/WAP7 locos.

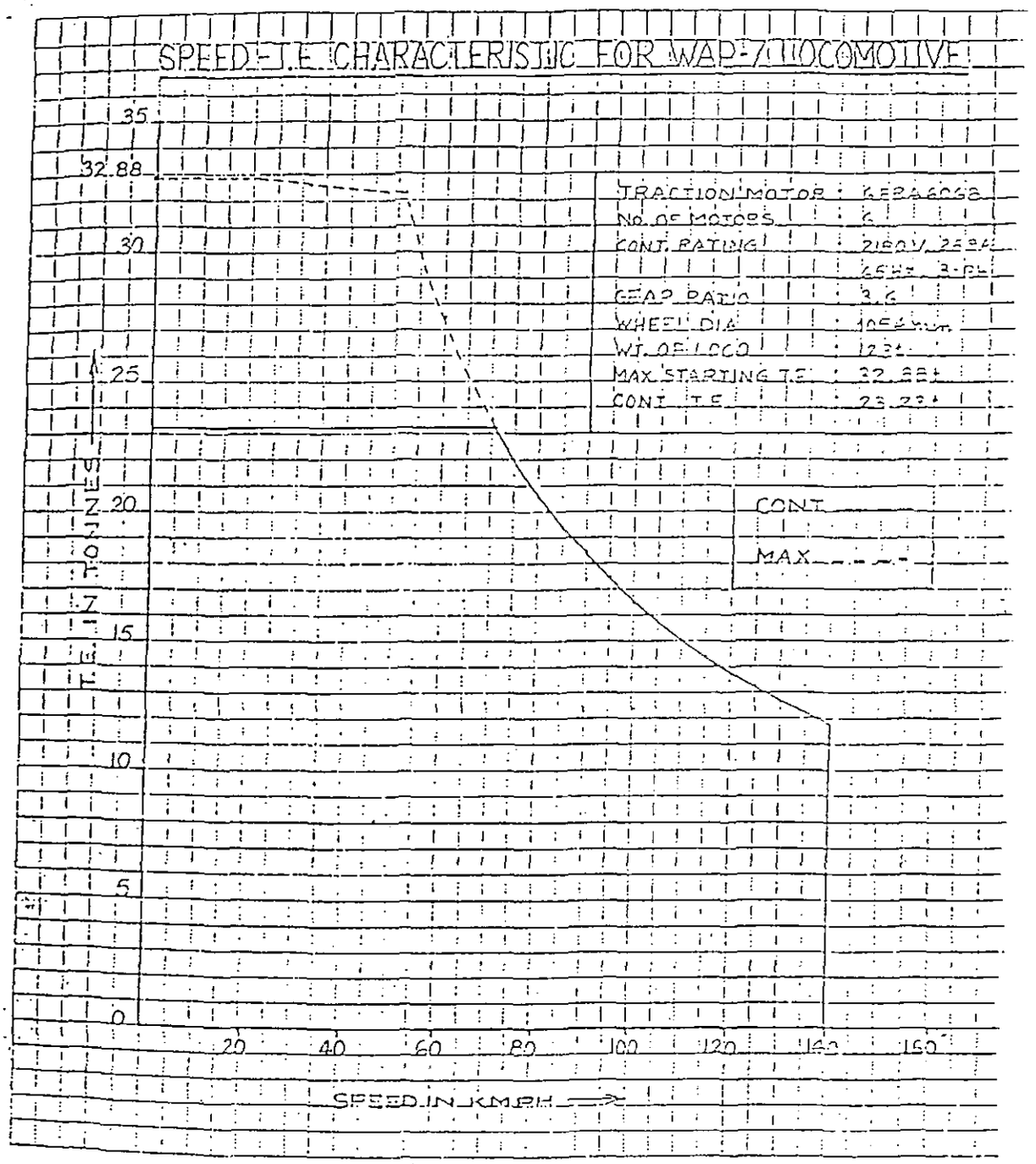
11.2 It is however clarified that the actual requirements of the working of the system may be seen at CLW or GZB/GMO/AQ sheds. Tenderers in their own interest are advised to acquaint themselves with the system before formulating the offers.

2.5 Tractive/Braking effort

2.5.1 Tractive effort/speed–diagram (at wheel rim)



ig. 2.8 Tractive effort/speed–diagram


SPEED-T.E. CHARACTERISTIC FOR WAP-7 LOCOMOTIVE
TRACTION MOTOR : HS15250A
No. OF MOTORS : 6
CONT. RATING : 2160 V, 255 A
45 HP, 3-PH
GEAR RATIO : 3.6
WHEEL DIA : 1092 mm
WT. OF LOCO : 123 t
MAX STARTING T.E : 32.88 t
CONT T.E : 23.23 t
CONT
MAX
TONNES
T.E.
35
32.88
30
25
20
15
10
5
0
20
40
60
80
100
120
140
160
SPEED IN KMPH

63111

Characteristics of greases for suspension tubes of 3 phase locomotives

SN	Characteristics	Optimol Longtime PD2	Servoplex SHC120
1.	Texture	---	Homogeneous
2.	Colour	Reddish brown	Light brown
3.	NLGI Grade	2	2
4.	Thickener Type	Lithium	Lithium Complex
5.	Penetration, worked, 60X	265-295	275
6.	Dropping point, °C	180	>285
7.	*Viscosity of base oil at 40°C, cSt*	95	115
8.	Weld load, kg	---	315
9.	Wear Scar Dia, mm	---	0.60
10.	EMCOR Test	0,0	0,0
11.	Type of oil	---	Synthetic Hydrocarbon