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भारत सरकार
रेल मंत्रालय

**Government Of India
Ministry of Railways**

**Schedule & Particular Specification For
4500 hp BG Diesel-Electric EMD
WDP4E Locomotive**

(Applicable for manufacture at DLW, Varanasi)

**Particular Specification
NO. MP-0.08.00-73 (Rev-00)
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Schedule

4500 hp broad gauge diesel-electric locomotive having nominal axle load of 20.2t, complete in all respects, shall be assembled with:

1. One DLW/EMD 16 cylinder 710G3B fuel-efficient two stroke diesel engine capable of producing 4500 HP under standard conditions.
2. On Traction Alternator(Includes Rectifier) Model TA17 with Companion Alternator CA6B and independent driven blower for forced ventilation to cool Six Siemens make Traction Motors ITB-2622-0TB02 shall be used on proposed Locomotive.
3. One complete set of microprocessor control equipment i.e EM2000 suitably modified for increased power and axle load.
4. Provision of IGBT based TCC Module (with Hotel load facility optional).
5. Dynamic braking grids suitable for full self-load testing shall be provided.
6. Existing CCB equipments with minor change shall be used for brake system.
7. One air compressor model WLNA9BB or equivalent indigenously developed compressor shall be used .
8. Two sets of AAR approved E/F coupler & draft gear (MS 488-6A) shall be adapted.
9. HTSC Co-Co bogies with optimised weight is proposed to be used.

Quantity

-As per Railway Board's instruction.

Chapter 1

1.1 Scope

This specification covers manufacture and supply of a 4500 HP uprated diesel-electric locomotive fitted with two HTSC Co-Co bogies, DLW/EMD 16 cylinder 710G3B, Two Stroke fuel efficient diesel engine with AC/AC transmission suitable for operation on broad gauge track 1676 mm, to be delivered fully assembled, painted & complete in all respects for operation.

1.2 Design

1.2.1 Existing design of WDP4 locomotive with RDSO drawings and specifications suitably modified to meet the Axle load, horse power requirement shall be followed .DLW shall ensure that drawings bearing latest alteration is used.

1.2.2 Modifications, which may be necessary due to limitations of either availability of material indigenously, or manufacturing facilities at DLW shall be incorporated in consultation with RDSO.

1.3 Material

The materials to be used in the construction of the locomotive especially the vehicular portion shall, to the extent possible, be selected from IRS or IS specifications as under:

Steels :	IS : 2062 grade 'C' fully killed for bogie frame SAILMA-450 HI for underframe IS:1079,IS:8500 for superstructure IS:1079,IS:8500
Wheels	:IRS : R-34 (latest amendment)
Axles	:IRS : R-43 (latest amendment)

1.4 Definitions

1.4.1 'RDSO' means Research Designs and Standards Organization, Ministry of Railways, Manak Nagar, Lucknow-226 011.

1.4.2 'DLW' means Diesel Locomotive Works, Varanasi-221 004.

1.4.3 'BG' means 1676 mm gauge, referred to as Broad Gauge.

1.4.4 'BHEL' means Bharat Heavy Electricals Ltd, Bhopal or any of their works in India.

1.4.5 'IEC' means International Electro-technical Commission.

1.4.6 'IS' means Indian Standard.

1.4.7 'AAR' means Association of American Rail-roads.

1.4.8 'UIC' means Union International Des Chemins defer (International Union of Railways)

1.4.9 'IRS' means Indian Railway Standard.

1.4.10 Throughout this specification the words:

- .1 Horse Power (HP) shall be taken as metric horse Power, i.e. 75 kg metre/sec.
- .2 Tonnes (T) shall be taken as metric tonne i.e. 1000 kg.

Chapter 2

2.1 Operating requirements and Overall dimensions

The locomotive shall be designed to conform to the principal dimensions and operating requirements specified here under:

1	Gauge	1676mm
2	Service	Mixed traffic
3	Overall moving dimensions	The locomotive in empty condition with new wheels and also in fully loaded condition with fully worn wheels shall be within the profile shown in Annexure I.
4	Principal Dimensions Length (over buffer beam) Length (over CBC) Width over hand rail: Width over Under frame: Width over Cab: With over brake cylinder: Height, over Cooling Hood: Height over Horn :	19938 mm 21220 mm 2920 mm 3225mm up to 2800mm in length 3200mm 3074 mm 4185mm 4265 mm
5	Sharpest curve to be negotiated	174m radius. The locomotive shall also be checked for passage over standard 1 in 8½ turnouts in either direction.
6	Locomotive weight Gross Adhesive Weight Nominal Axle Load	121.2 t Maximum permissible variation in the locomotive gross weight as built shall not exceed ± 2% of the specified weight. 20.2 t The sum of axle loads of one bogie shall not differ from the sum of axle loads of the other bogie by more than 1t.
7	Axle arrangement	Co-Co (Three Axle).

8	Wheel diameter (mm)	1092 mm (new) 1016 mm (condemning)
9	Gear ratio	17:77
10	Maximum operating Speed Minimum continuous speed	120 km/hr 22.5 km/hr
11	Tractive Effort Starting	39.2 Kg.
12	Installed power under standard conditions	4500 HP
13	Installed power under site conditions	HP
14	Power input to traction under site conditions	4200HP
15	Tractive effort Vs Speed characteristics	RDSO graph no.Tentative

2.2 Climatic conditions

The locomotive shall be in continuous operation under the following atmospheric and climatic conditions: -

1	Ambient temperature	45 ⁰ C (occasional peak value of 52 ⁰ C)
2	Altitude	Sea level to 600 m
3	Humidity	Up to 100%
4	Maximum temperature	55 ⁰ C

Chapter 3

Mechanical Design

3.1 General arrangement and Equipment layout

The general arrangement and equipment layout of the locomotive shall be to RDSO drawing no. SKDL-4684 Alt-nil.

3.2 Underframe

Existing design of GMPAC loco underframe shall be optimised to achieve the weight reduction and suitable modification have been carried out as per the equipment layout shown in GA. DLW shall manufacture the underframe design as per RDSO Drawings.

3.2 Bogie

The locomotive shall be fitted with optimised design of HTSC bogie frame with three-axle uni directional arrangement of traction motors, two-stage suspension carrying conventional brake rigging with high friction brake shoe .The bogie shall be bolsterless type with helical coil springs in primary, rubber spring in secondary suspension and floating type centre pivot arrangement. The general arrangement of the bogie shall be as per RDSO drawing.

3.4 Driver's cab

3.4.1 The locomotive shall be provided with one full width wider cab developed by RDSO to improve visibility in long hood leading operation.

3.4.2 The cab shall be provided with two drivers' control desks for driving in both the directions.

3.4.3 Rainwater gutter over cab windows shall be suitably provided.

3.4.4 Left hand drive shall be used.

3.4.5 Robust design of Driver's Chair to DLW Drawing No. TPL- 3473

3.5 Superstructure

Semi monocoque bonnet type superstructure will be used, removable roof and hatches will be provided for effortless maintenance of top deck equipments.

3.6 Fuel tank

3.6.1 A detachable type Fuel Tank of 5000 litre capacity shall be provided.

3.7 Coupler, Draft gear & Side buffers

3.7.1 The locomotive shall be fitted with AAR approved high tensile transition centre buffer coupler and draft gear assembly to EMD drawing no. 10661374 and coupler parts should conform to AAR specification no M201, 901E,901G .

3.7.2 The locomotive shall be fitted with high capacity side buffers to RDSO drawing no. SKDL- 4561.

3.8 Cattle guard

No change in existing cattle guard assembly .

3.9 Brakes

- 3.9.1 Locomotive will be equipped with CCB (computer controlled braking) 1.5 system. This will be located in short nose at front of locomotive on right side. Dynamic brakes fully blended w/Automatic brakes.

1	Model	KNORR/NYAB CCB
2	Type	Electropneumatic

- 3.9.2 Existing air drier assembly used on WDP4 shall be used.

- 3.9.3 The hand brake operated by a lever from driving cab shall be provided for use on stabled locomotive and for holding a light locomotive on grade in emergency.

3.10 Compressor

Existing design of air compressor or equivalent design indigenously developed shall be adapted

1	Model	WLNA9BB
2	Type	Two stage,3 Cylinder
3	Coolant	Engine coolant
4	Displacement at 900 RPM	7.19 Cubic meter/Minute
5	Lube oil capacity	9.98 Litres

3.11 Piping

- 3.11.1 Existing piping arrangement with suitable modification shall be adapted. Heavy-duty seamless pipes to IS: 1239 shall be used for pneumatic brake system. Alternatively, stainless steel piping may be used. All pipe joints will be as per DLW standard practice.

- 3.11.2 **Schematic piping to suit the engine shall be to the relevant DLW drawings.**

3.12 Sanding

- 3.12.1 Automatic sanding during wheel slip shall be provided. Eight No's side sill mounted sand boxes shall be provided with adequate sand capacity.

3.13 Horns

Locomotive will be provided with air horns on cab end and longhood end. Dual tone horns in accordance with RDSO Specification No. MP.0.99.00.04 for each direction of motion of the locomotive shall be provided. Provision for operating horns for either of the directions from both control stands shall be made.

3.14 Journal Bearings

Locomotive shall be equipped with cartridge type grease lubricated journal bearings. These bearing are self contained, pre assembled, pre adjusted, pre lubricated, and completely sealed ,the bearings can be fitted and removed without exposing the bearing elements ,seats or lubricant to contamination or damage.

3.16 Fire Extinguisher

Two Dry Chemical Powder type fire extinguishers (Gas Cartridge type) of 5 kg capacity approx. of well-known make shall be provided one in each cab. The fire

extinguisher shall conform to IS: 2171 – 1985 and gas cartridge shall conform to IS: 4947-1985.

3.17 Use of light weight material for weight reduction.

It is proposed to use the aluminum air reservoir, air intake grills in radiator assembly and some other areas where FRP can be used to reduce the weight

Chapter 4

Power Equipment

4.1 Diesel Engine

The locomotive shall be powered by DLW/EMD 16 cylinder 710G3B fuel-efficient two stroke turbocharged smoke less, quieter 4000 HP diesel engine at 904 rpm under standard conditions. The engine shall be adjusted to deliver 4250 HP input to traction in the present application. The engine configuration and support system for the locomotive shall be as under:

4.1.1 16:1 compression ratio

4.2 Engine support system and supplies

1	Lube oil system capacity	950 Litres (TBD)
2	Cooling System Capacity	1045 Litres (TBD)
3	Sand Boxes (8) Capacity	0,04 Cubic meter
4	Fuel oil capacity	5000 Litres

4.2.1 Mechanically bonded, louvered fin enhanced capacity radiator for 3000 kw heat load to be used.

4.2.2 Stream lined lube oil and water piping network.

4.2.3 Insulated exhaust gas manifold.

4.3 Limits on critical parameters:

Following prescribed limits over critical parameters are to be observed for 4500 hp up gradation:

4.3.1 Mechanical Load: Average peak firing pressure xxxxx psi.

4.3.2 Thermal Load: Exhaust gas temperature at turbine inlet <xxxx C.

4.3.3 Specific Fuel Consumption: SFC at rated power <xxx gm/bhp-hr.

4.3.4 Surge Margin: >xx%.

4.3.5 Boost pressure <2.2 bar.

4.4 Transmission

4.4.1 Transmission shall be by means of a directly coupled pressure cooled main generator TA17-CA6B and traction alternator TA17 (includes rectifier), driving 6 axle hung nose suspended siemens make ITB-2622-0TB02 traction motors.

4.4.2 Traction alternator shall be provided with companion alternator All the traction motors & rectifier shall be cooled by air distributed through duct and path provided for

cooling by one independent driven blower assembly.

4.5 Controls

- 4.5.1 The locomotive shall be provided with EM2000 microprocessor based control system which will be suitably modified to meet the provision of six traction motors and modified TE versus Speed performance. This modification should be done by EMD for both Semens and EMD make IGBT inverters.

4.6 Cables

- 4.6.1 Electron-beam irradiation cross-linked type Power and Control cables of standard metric sizes shall be provided as per specification no. EDPS – 304 and EDPS – 179.

Chapter 5

Electrical Equipment

5.1 General

All electrical machines and control equipment shall generally conform to relevant IEC publications and EMD and shall be tested as per RDSO approved test programme. The temperature rise limits of the IEC Publication shall be reduced by 20⁰ C for traction motor and by 30⁰ C for other machines to account for higher ambient temperatures in India.

5.2 Traction Alternator - Rectifier

5.2.1 Alternator Data:

Make and Type	TA 17-CA6B
No. per loco	One
Continuous Rating	2600 VDC 1250 Amp
Temperature rise limit	IEC – 30
Insulation	Class H
Ventilation	Forced / Self-ventilated Excitation
Excitation control	Microprocessor control

5.3 Traction Motors

5.3.1 Traction motor data:

Make & Type	Simens make ITB-2622-0TB02
Number per loco	Six
Nominal rating (IEC-30°C)	500 KW,2027 VAC
Max. permissible speed	3220 RPM
Insulation:	
Armature	Class H
Field	Class H
Ventilation	2900 cfm

5.4 Auxiliary Generator

Make & Type	Model 5A-8147
Rectified output ratings	74 Volts DC(Rectified)
Nominal AC Voltage	50 VAC
Maximum Power	18KW
Insulation:	
Armature	Class H
Field	Class H

5.5 Loco performance and Electrical characteristics:

1	Gear ratio	17/77
2	Wheel diameter	1092 mm (new) 1055 mm (half worn)
3	Motor Grouping	3 in parallel per bogie
5	Maximum operating speed	130 kmph
6	Performance	RDSO graph no. Tentative

5.6 At present only M/s SIMENS has IGBT TCC software for PAC traction motor to ITB-2622-0TBO2 .The IGBT should be procured from M/S SIMENS only,However may be procured from EMD as they developed TCC software for traction motors.

6 Storage Battery

Ni -Cd battery shall be used with following details.

1	Model	Shaft- Nife SRX
2	Arrangement	2series-connected 16 cell, Ni-Cd
3	Total quantity of cells	32
4	Total potential of Batteries	64 Volts
5	Specific Gravity of Electrolyte	1.250
6	8 hour Capacity	500 Amp Hr.

5.7 Dynamic braking grids

5.7.1 Extended capacity Dynamic braking grids suitable for full self-load testing shall be provided. AC Traction motor powered two parallel 4 grid, 5 ohm (approximately) circuits.

Chapter 6

Miscellaneous

6.1 Painting and Marking

- 6.1.1 The locomotive shall be delivered finish painted. PU painting of the locomotive shall be generally on the lines of RDSO specification no M&C Spec No. M&C/PCN/100/2006.
- 6.1.2 The locomotive shall be designated as WDP4E. The individual number of the locomotives shall be advised by Railway Board.

6.2 Maker's test certificate

- 6.2.1 Copies of test certificate guaranteeing the performance of the locomotives and its equipment shall be supplied in duplicate with the delivery of each locomotive.
- 6.2.2 DLW shall supply one copy each of Maintenance Instructions, Equipment data, Schematics wherever necessary and Spare Parts Lists indicating catalogue numbers of the equipment fitted on the locomotives to RDSO. One copy of each shall be supplied to the consignee Railway of the locomotive.

6.3 Inspection

Inspection at various stages of locomotive manufacture including final inspection shall be done by DLW. The following inspection data shall be furnished to locomotive user and RDSO:

- 6.3.1 Certificate of fitness
- 6.3.2 Equipment maker's & serial Nos.- Electrical.
- 6.3.3 Equipment maker's & serial Nos.- Mechanical
- 6.3.4 Axle, wheel and gear record (Maker, Sl. Nos. etc.)
- 6.3.5 Engine test performance
- 6.3.6 Locomotive test performance- Mechanical/Electrical (As per existing test carried out on WDP4 locomotive)
- 6.3.7 Air brake test results
- 6.3.8 Wheel pressing force etc.
- 6.3.9 Axle box, bogie and undergear clearances.
- 6.3.10 Buffer height and Underframe camber.
- 6.3.11 Bogie weight, Suspension Springs test results.
- 6.3.12 Weighment particulars of locomotives including individual axle load.
- 6.3.13 Engine block stage inspection dimensions.

6.4 Other details

- 6.4.1 A list of assemblies and sub-assemblies and their respective weights shall be furnished to RDSO with each drawing set.
- 6.4.2 The manufacturing drawings shall exhibit clearly the material specification, welding symbols, manufacturing tolerances and other details that are necessary for manufacture of the components. The set of drawings shall be sent for RDSO approval before undertaking manufacture of the prototype Locomotive.
- 6.4.3 DLW shall furnish four copies each of photographs of the prototype locomotive including full broadside view, three quarter front view and a full front view.

