

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

**SCHEDULE & PARTICULAR SPECIFICATION
FOR
Co-Co TYPE, WDM2C CLASS, 1676 mm GAUGE,
3100 HP DIESEL-ELECTRIC LOCOMOTIVE
(Applicable for manufacture at DLW/Varanasi)**

Particular Specification No. MP.0.0800.20

Issued by:

**MOTIVE POWER DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW - 226 011**

SCHEDULE

3100 HP mixed traffic, Broad Gauge, Co-Co type, WDM2C class diesel-electric locomotive with maximum axle load of 18.8t and fitted with DLW 16 cylinder fuel efficient diesel engine and AC/DC transmission, complete in all respects, shall be assembled with:-

1. One DLW 16 cylinder 251 B fuel efficient diesel engine capable of producing 3100 HP under standard conditions.
2. One BHEL make traction alternator model TA 10102 CW with panel mounted BHEL make rectifier to their drawing No. 2 667 05 0 0064.
3. Six BHEL make 4906 AZ model traction motors.
4. One BHEL make AG 3101 AY auxiliary generator.
5. One BHEL make AG 3101 AY exciter.
6. One set of BHEL make dynamic brake equipment.
7. One complete set of "E" type excitation control equipment.

QUANTITY

-As required-

Note:- The equipment shall conform to particular Specification No. MP.0.0800.20.

PART - 1

1.1 SCOPE

This specification covers manufacture and supply of mixed traffic diesel- electric locomotive WDM2C class, Co-Co type, fitted with DLW 16 cylinder 251 B fuel efficient diesel engine and AC/DC transmission suitable for operation on 1676 mm gauge track to be delivered fully erected, painted & complete in all respects and ready for operation.

1.2 DESIGN DEVELOPMENT

1.2.1 Wherever RDSO drawings are quoted, DLW shall ensure that drawings bearing latest alteration are followed.

1.2.2 Modifications which may be necessary due to limitations of either availability of material indigenously or of 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.

PART - 2

2.1 OPERATING REQUIREMENTS AND OVERALL DIMENSIONS

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

.1	Gauge	1676 mm
.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 maximum and minimum moving dimensions shown in RDSO Drg. No. CSL - 3039.
.4	Schedule of moving dimensions	Indian Railway Schedule of maximum, minimum and recommended dimensions, Broad Gauge 1939, reprinted in 1973.
.5	Sharpest curve to be negotiated	174 m radius. The locomotive shall also be checked for passage over standard 1 in 8½ turnouts in either direction.
.6	Maximum axle load	18.8t. Maximum permissible load variation in the locomotive weight as built shall not exceed $\pm 2\%$ of the specified weight. 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
.8	Wheel diameter (mm)	1092 (new) 1055 (half worn)
.9	Gear ratio	18:65
.10	Motor rev./min	18.16x km/h (with half worn wheel)
.11	Maximum operating speed	120 km/h
.12	Continuous speed	22.8 km/h
.13	Maximum tractive effort at start ($\mu = 0.27$)	30456 kg
.14	Continuous rating (temp. limit IEC - 30°C)	28050 kg tractive effort at 22.8 km/h speed (with new wheels)
.15	Installed power under standard conditions	3100 HP

- .16 Installed power under site conditions. 2900 HP
- .17 Power input to traction under site conditions 2750 HP
- .18 Speed Vs Tractive Effort characteristics RDSO Graph No. G.DP-1034
- .19 Dynamic Brake characteristics RDSO Graph No. G.DP-1043

2.2 CLIMATIC CONDITIONS

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

- .1 Ambient temperature 45°C (occasional peak value of 52°C)
- .2 Altitude Sea level to 600 m
- .3 Humidity 40% - 100%
- .4 Maximum temperature 55°C

2.3 MULTIPLE OPERATION

The locomotives shall be suitable for multiple operation upto a maximum of three units. Multiple operation shall also be possible with both ALCO and DLW built WDM2 locomotives.

PART - 3

MECHANICAL DESIGN

3.1 UNDERFRAME

- 3.1.1 The underframe shall be constructed from rolled steel sections and plates designed to withstand a maximum static compression load of 300t without signs of permanent distortion and shall be manufactured to RDSO drawing Nos.39.02.01, 39.02.02, 39.02.03 and 39.02.04.
- 3.1.2 The underframe ballast arrangement shall be as per RDSO drawing No.39.02.06.
- 3.1.3 The ends of the underframe shall be designed to accommodate high tensile transition centre buffer couplers.

3.2 BOGIE

The locomotive shall be fitted with three axle trimount type bogies to RDSO drg. No. SK.DL-3869 designed to accommodate resilient thrust units on end axle boxes and floating bearings on middle axle boxes.

3.3 CAB & SUPERSTRUCTURE

- 3.3.1 The locomotive shall be provided with a full width driving cab between the long and short hoods to RDSO Drg.Nos. 39.10.01 to 39.10.07.
- 3.3.2 Hood over engine shall be as per RDSO Drg. Nos.39.10.13 and 39.10.14.
- 3.3.3 Short hood arrangement shall be as per RDSO drawing No.39.10.22.
- 3.3.4 Rain water gutter over engine hood door to DLW drg. No.2213V500460 shall be provided.
- 3.3.5 Rectifier mounting arrangement and details shall be to RDSO Drg.No.39.10.26.
- 3.3.6 Air duct arrangement for cyclonic filter to turbo supercharger shall be to RDSO Drg No. 39.35.01.
- 3.3.7 Battery box arrangement shall be to RDSO Drg. No. 39.53.01.
- 3.3.8 Radiator compartment arrangement shall be to RDSO Drg. No.39.31.01. ECC, gearbox and radiator fan mounting arrangement shall be to RDSO Drg.No. 39.31.02.

3.4 FUEL TANK

- 3.4.1 A detachable type fuel tank of 5000 litre capacity shall be provided. Fuel tank arrangement and details shall be to RDSO Drg. Nos. 39.11.01 and 39.11.02.
- 3.4.2 Fuel tank and air reservoirs mounting shall be in accordance with RDSO Drg No. 39.02.05.
- 3.4.3 Sight glass type fuel measuring gauge to indicate fuel capacity shall be to RDSO Drg. No.39.11.03.

3.5 DRAW AND BUFFING GEAR

The locomotive shall be fitted with high tensile transition centre buffer couplers to RDSO Specn.No.56-BD-92.

3.6 CATTLE GUARD

Short hood side cattle guard arrangement and details shall be to RDSO Drg. Nos. SKDL - 4131 & 4132. Radiator end cattle guard shall be to RDSO. Drg. Nos. DDO-198 & 199.

3.7 BRAKES

- 3.7.1 The locomotive shall be equipped with IRAB-1 brake system in accordance with RDSO Drg.No.SK DP- 3100.
- 3.7.2 Panel mounted brakes applicable to pure air brake system to RDSO Specification No.MP- 0.0102.02 and RDSO Drg. No. SK.DP -3100 shall be provided.
- 3.7.3 All cutout cocks and self locking angle cocks shall be ball type and open line parallel (OLP) except drain cocks which shall be close line parallel (CLP) type.
- 3.7.4 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.

3.8 COMPRESSOR/EXHAUSTER (Expressor)

KPC make compressor-exhauster model KE-6 or its equivalent shall be provided (Pure compressor shall, however, be used). Expressor mounting arrangement and details shall be to RDSO Drg.No.39.14.02.

3.9 PIPING

- 3.9.1 Heavy duty seamless pipes to IS specification 1239 shall be used for pneumatic brake system. All pipe joints will be as per DLW standard practice.
- 3.9.2 Schematic piping to suit the engine shall be to the relevant DLW drawings.

3.9.3 Flexible pipes shall be provided at the following locations :-

- .1 Vent pipe connecting turbo supercharger intermediate casing to expansion tank.
- .2 Vent pipe connecting turbine casing to expansion tank.
- .3 Vent pipe connecting the turbo super-charger outlet header to expansion tank.
- .4 Vent pipe connecting bubble collector to expansion tank.
- .5 Lube oil pump to lube oil cooler.
- .6 Lube oil secondary filters inlet and outlet.

3.10 SANDING

3.10.1 Automatic sanding during wheel slip shall be provided.

3.10.2 Bogie mounted sand boxes to RDSO drg. No. SK.DL- 4217 shall be provided.

3.11 HORNS

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.

3.12 LUBRICATION

3.12.1 Grease nipples shall conform to IS specification No. 4009.

3.12.2 Grease nipples and adaptors where used shall be tack welded to prevent them from unscrewing and falling off in service.

3.13 ROLLER BEARINGS

Roller bearings used on the locomotive at various locations shall be such which can be inspected easily. Pre-packed bearings are not preferred for auxiliary equipment.

3.14 FIRE EXTINGUISHER

Two CTC type fire extinguishers of about 2.5 litre capacity of well known make shall be provided; one in the engine compartment and the other in the cab.

PART - 4

POWER EQUIPMENT

4.1 DIESEL ENGINE

- 4.1.1 The locomotive shall be powered by DLW 16 cylinder 251 B fuel efficient diesel engine capable of producing 3100 HP at 1050 rpm under standard conditions. The engine shall, be adjusted to deliver 2900 HP (site) during the present application. The engine shall deliver 2750 HP to the alternator under most adverse site conditions indicated in Clause 2.2.
- 4.1.2 Steel cap pistons shall be used.
- 4.1.3 Napier NA-295 IR model turbo supercharger shall be used.
- 4.1.4 Modified cam shafts with 140° overlap shall be used.
- 4.1.5 Engine speed/load governor of proven Make shall be used.
- 4.1.6 17 mm fuel injection pumps and modified supports shall be used.
- 4.1.7 Modified water connections to the aftercooler for better cooling of engine inlet air shall be provided.
- 4.1.8 To cater for increased air flow and better effectiveness, a larger aftercooler shall be provided.
- 4.1.9 Cyclone type inertial air filters shall be provided for combustion intake air. Pre-cleaner assembly shall be to RDSO Drg.No.SK.DP-3024 and pleated paper secondary engine air filter assembly to RDSO Specification No. MP-0-2600-10 and Drg.No.SK.DP-3022.
- 4.1.10 Radiator assembly and core shall be to RDSO Drg. Nos. SK.DP-3087 and SK.DP-3088 respectively.

4.2 TRANSMISSION

Transmission shall be by means of a directly coupled self ventilated BHEL make TA 10102 CW model traction alternator with BHEL make panel mounted rectifier to their drawing number 2 667 05 0 0064 driving 6 axle hung nose suspended BHEL model 4906 AZ traction motors.

4.4 CONTROLS

- 4.4.1 Adequate control equipment including gauges, instruments and safety devices in the cab shall be provided for safe and satisfactory operation of the locomotive. The controls shall be so arranged in the cab that it will be within easy reach of the driver from all driving positions.

4.4.2 The following gauges shall be provided in the cab :-

- .1 Diesel engine lube oil pressure gauge.
- .2 Cooling water temperature gauge (Electronic).
- .3 Fuel oil pressure gauge.
- .4 Boost pressure gauge.
- .5 Traction motor load Ammeter.
- .6 Compressed air reservoir pressure gauges.
- .7 Air brake gauges
- .8 Battery charge and discharge ammeter.
- .9 Water level indicator (Electronic).

4.4.3 The following audio-visual signals or reference panel lights shall be provided in the cab for single and multiple operation of the locomotives :

- .1 Low lubricating oil pressure.
- .2 Radiator water temperature too high.
- .3 Engine shut-down by safety relay.
- .4 Wheel slip indication.
- .5 Battery discharge indication.
- .6 Aux. Gen. failure indication.
- .7 Low idle rpm indication.
- .8 Power ground.
- .9 GFOLR trip indication.
- .10 Cranking contactor welding indication.

4.4.4 The following safety devices shall be provided :

- .1 Water temperature too high (95°C)- Transmission cut-off and engine returned to idle.
- .2 Low water in radiator - Power to transmission cut-off and engine shut down.

- .3 Low lube oil pressure - Power to transmission cut-off and engine shut down.
- .4 Engine speed too high - (Over speed trip)-Power to transmission cut-off and engine shut down.
- .5 Adequate protection of an approved design shall be provided against electrical overloads and grounding.

4.4.5 The following minimum operating controls for multiple unit operation of locomotives from any one locomotive shall be provided :-

- .1 Notch control
- .2 Brakes
- .3 Forward and reverse movement control
- .4 Sanding
- .5 Dynamic brake

Safety interlock shall be provided to prevent locomotives in multiple unit operation from being moved when all the locomotives are not set for propulsion in the same direction.

- 4.4.6 All gauges shall be of proven and reliable design. Graduations of all gauges shall be in metric units.
- 4.4.7 Boost Pressure Gauge shall be of at least 100 mm diameter with a range of 0-3kg/sq.cm.
- 4.4.8 The locomotive shall be provided with Hasler Tachograph Model RT9 and Tachometer A-16 with electric drive as per RDSO Drg. No.SKDP-2534 or their equivalent.

PART - 5

ELECTRICAL EQUIPMENT

5.1 GENERAL

All electrical machines and control equipment shall generally conform to relevant IEC Publications and shall be tested as per RDSO approved test programme. The temperature rise limits of the IEC Publication shall be reduced by 20°C for traction motor and by 30°C for other machines to account for higher ambient temperatures in India.

5.2 TRACTION ALTERNATOR

5.2.1 Alternator Data:

Make and Type : BHEL model TA 10102 CW

No. per loco : One

Low voltage : 3700 A, 525 V

High voltage : 1760 A, 1100 V

Temperature rise limit : TI_a -90°C for armature
 TI_f -70°C for field

where TI_a and TI_f are the established temperature indices for armature, field insulation respectively as determined as per IEC 505, read with Draft Supplement and IEEE 304.

Insulation : Class H

Ventilation : Self-ventilated

Excitation control : Type E suitable for BHEL alternator model TA 10102 CW

5.2.2 Alternator

Characteristics : BHEL curve No. TME/401061

5.3 TRACTION MOTOR

5.3.1 Traction motor data

Make and Type : BHEL make 4906AZ

No. per loco : Six

Continuous rating : 325 V, 1000 A
(IEC-30°C)

Max. permissible : 2275 RPM
speed

Insulation

(i) Armature : Class H

(ii) Field : Class H

Ventilation : 65 m³/min (forced)

5.3.2 Traction Motor characteristics

: BHEL curve No. TME/400890 A

5.4 AUXILIARY GENERATOR/EXCITER

Make & Type : BHEL make AG 3101 AY or equivalent.

Number per loco : One Pair

Continuous rating : 80 V, 250A, 20kW
(IEC-30°C)

Operating rpm : 760 to 2380 rpm corresponding to low idle and
8th notch engine speed.

Insulation

(i) Armature : Class F

(ii) Field : Class H

Ventilation : Self-ventilated

Voltage regulator

Type	:	CGE 17FH 20-B or Equivalent
No. per loco	:	One
Regulation	:	72 ± 1 V DC

5.5 LOCO PERFORMANCE AND ELECTRICAL CHARACTERISTICS

.1	Gear ratio	:	18/65
.2	Wheel diameter	:	1092 mm (new) / 1055 mm (half worn)
.3	Motor Grouping	:	2S-3P
.4	Continuous speed (IEC -30°C)	:	22.8 km/h at 28050 kg TE
.5	Maximum operating speed	:	120 km/h
.6	Performance	:	RDSO Graph No.GDP-1034

5.7 STORAGE BATTERY

The battery shall provide 64 V DC supply and consist of 32 lead acid cells of 450 AH capacity at 10 hour rating conforming to IS:7624/1990.

5.8 ELECTRICAL FITTINGS

- 5.8.1 The locomotive shall be equipped at both ends with standard headlights to DLW drawing DEL-1/15. Aspect lights, cab lights/ conduits etc. shall be of type available indigenously.
- 5.8.2 The locomotive shall be provided with flasher lights to RDSO Specn. No. SPEC/E-14/6/02-A of Aug '88 with amendment dt. 4-4-90.
- 5.8.3 The cable running below the Alternator shall be protected by wooden cover/conduits or by suitable means to prevent contamination with oil, water or dirt.

PART - 6

MISCELLANEOUS

6.1 PAINTING AND MARKING

- 6.1.1 The locomotive shall be delivered finish painted. The scheme for marking and painting of the locomotive shall be on the lines of RDSO drg. No. SK-DL 4001.
- 6.1.2 The locomotive shall be designated as WDM2C class. The individual number of the locomotives will be advised by the 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 For each locomotive, DLW shall supply three copies each of Maintenance Instructions, Equipment data, Schematics wherever necessary and Spare Parts Lists indicating catalogue numbers of the equipment fitted on the locomotives. One copy of each shall be supplied to the consignee Railway of the locomotive.

6.3 INSPECTION

The following inspection data shall be furnished to the locomotive user and RDSO:-

- 6.3.1 Certificate of fitness
- 6.3.2 Equipment serial Nos.- Electrical.
- 6.3.3 Equipment 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
- 6.3.7 Air and vacuum brake tests
- 6.3.8 Wheel pressing force etc.
- 6.3.9 Axle box, bogie and undergear clearances.
- 6.3.10 Underframe and bogie dimensions.
- 6.3.11 Lubrication chart.
- 6.3.12 Weighment, moving dimensions etc.

6.3.13 Part Sl. Nos. (Pistons, connecting rods etc.)

6.3.14 Engine block stage inspection dimensions.

6.4 AS MADE DRAWING SETS

6.4.1 Three complete sets of "As made" drawings on transparent tracing cloth or reproducible plastic films shall be supplied to RDSO at the time of delivery of the first locomotive.

6.4.2 A list of assemblies and sub-assemblies and their respective weights shall be furnished with each drawing set.

6.4.3 The drawings shall exhibit clearly the material specification, manufacturing tolerances and other details that are necessary for manufacture of the components.

6.4.4 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.