



भारत सरकार, रेल मन्त्रालय

**GOVERNMENT OF INDIA**  
**MINISTRY OF RAILWAYS**

**SPECIFICATION FOR**  
**DUAL MODE PASSENGER LOCOMOTIVE**

Specification No. MP.0.0800-108  
(Revision - 02)

March 2016



भारत सरकार, रेल मन्त्रालय  
**GOVERNMENT OF INDIA**  
**MINISTRY OF RAILWAYS**

**SPECIFICATION FOR**  
**DUAL MODE PASSENGER LOCOMOTIVE**

Specification No. MP.0.0800.108  
(Revision - 02)

March 2016

ADE/MP	JD/MP	EDSMP
<i>Prepared By</i>	<i>Checked By</i>	<i>Approved By</i>

## CONTENTS

Para	Description	Page
1.	Introduction & Benefits of dual mode loco	1
Chapter-1	Scope & Design/details of modification	3
Chapter-2	Design requirements	4
Chapter-3	Mechanical Design	5
Chapter-4	Power Equipment	7
Chapter-5	Control system, electrical equipment & power supply system	8
Chapter-6	Dimensions, clearances & track Geometry	15
Chapter-7	Miscellaneous	17
Annexure - I	Tentative Weight Reduction / Additional in the proposed trade off on WDP4D platform to keep the axle load of dual mode locomotive within 21 T	i
Annexure - II	Tentative General Arrangement of Proposed Dual Mode Locomotive on WDP4D platform	ii
Annexure - III	Performance characteristics of Dual Mode locomotive for passenger service	iii
Annexure – III-A	Dynamic Braking Characteristics	iv
Annexure – III-B	Dynamic Brake Effort Vs Speed Curve	v
Annexure - IV	Tentative list of additional Items to be fitted on locomotive for Dual mode Operation & Major uncommon items w.r.t. WDP4D	vi
Annexure-V	Dual Mode Power Flow	vii

## SPECIFICATION FOR DUAL MODE PASSENGER LOCOMOTIVE

### 1.0 Introduction

The networks of Indian Railways have a considerable mix of electrified and non-electrified sections. Certain sections are getting electrified based on the traffic density and their financial viability. Thus mixed routes of traction are inevitable and will continue to exist. Electric locomotives can work only with overhead catenary supply, whereas diesel locomotives have the flexibility to operate anywhere in the Indian railways network. As a result some of the trains operate with diesel locomotives even in electrified sections until their end destinations to avoid delays due to changeover from diesel to electric locomotives and for logistic reasons.

This specification intends to specify the requirements for a dual-mode locomotive, which combines the advantages of electric locomotives with the flexibility of diesel locomotives. Dual-mode locomotives can work with diesel engine as the primary power source while operating in non-electrified routes and work as an electric locomotive by drawing power from OHE in electrified sections.

#### Benefits of dual mode locomotive

- Reduction in the detention time of locomotive and rakes in the traction change points to less than 15 minutes.
- Increased availability of locomotives by eliminating the need for stabling additional locomotives at traction supply changeover points thereby reducing the overall requirement of locomotives.
- Reduced man days for shunting of locomotives at traction supply changeover points.
- Improved flexibility in last mile operation in the goods yards / sidings which are generally non-electrified.
- Increased throughput of the sections.
- In the event of major accident in natural calamities like cyclone and disturbed areas where OHE gets affected, dual mode loco provides excellent operational flexibility to work on diesel mode until normalcy is established.
- Higher reliability due to redundancy of traction power supply system in electrified territories.
- Reducing operation of diesel engine while operating with overhead supply

Dual-mode locomotives are being built by reputed rolling stock suppliers worldwide.

Design of a dual mode locomotive has the challenge of housing the on-board equipment of both diesel loco and electric loco with a common control system, Converter and Motorized Truck Assembly in a single dual mode loco, keeping the axle load and the dimensions of locomotive within the acceptable limits. Additional electrical equipment such as traction transformer, heat exchanger, vacuum circuit breaker and pantograph would not only add additional weight to the locomotive but also demand meticulous planning of the general arrangement these equipment and balancing the weights on the vehicle

Complete new design of a locomotive with transfer of technology would be an expensive proposition and it will be a long route for the project to materialize. Modifying of existing diesel locomotive duly retaining the common items and integration of additional uncommon items by carrying out necessary modification in the carbody would be economically cheaper and a quicker route for design and manufacture of dual mode locomotive for IR.

As such, RDSO worked in the direction of developing a dual mode locomotive on the platform of the existing HHP locomotive (WDP4D) platform with a view to develop the dual mode passenger locomotive.

It is proposed to design new locomotive on 4500 HP WDP4D platform and motorized bogies (WDG5 bogie) using existing 710-16 cylinder diesel engine coupled with TA17 alternator. For operating under OHE, a suitable traction transformer of suitable rating containing main traction windings and filter windings for line harmonic filtering (if required) be provided. The AC output either from traction transformer traction windings (single phase) or rectified DC output from the diesel engine driven alternator is fed to the traction converter to drive traction motors. It is proposed to have regenerative braking while working under electric mode and dynamic resistive braking in diesel mode.

Various options for reducing the weight of the sub-assemblies of the WDP4D locomotive were examined to keep the overall weight of the locomotive to less than 126 tonnes and achieve a target speed of at least 135 km/h, with the following would be the key modifications –

- Reduction in the fuel tank capacity from 6000 litres to 3000 litres.
- Weight reduction of superstructure and cabs by using SS in place of structural steel.
- Weight reduction by optimized design of cattle guard and use of AI air reservoirs, AI grills and other miscellaneous fittings.
- Use of TBU with light weight WDG5 bogie
- AC-AC traction system with integrated auxiliary power supply system thereby removing AG & mechanically driven TM blower.
- Use of electrically driven compressors in order to replace engine driven mechanical compressor.
- Use of compact equipment rack

The approximate weight reduction due to the above modifications and the increase in weight due to the additional electrical equipment is tabulated in Annexure-I.

## **CHAPTER - 1**

### **1.1 Scope**

This specification covers manufacture and supply of a broad gauge dual-mode and Dual Cab 4500 HP locomotive fitted with DLW/EMD 16 cylinder 710G3B diesel engine for diesel traction and 4500 wheel HP in electric traction mode with combined AC-AC transmission for passenger service. The specification basically covers the integration kit required for development of a dual mode loco on the WDP4D platform. The integration kit mainly comprises of additional items required for electric traction and the items of WDP4D which required to be modified to have a common system for both electric traction and diesel traction like AC-AC system, electrically driven compressor, etc. The integration shall develop a design to produce a wheel horse power of 4500 HP (min) duly keeping the axle load upto 21T\*. The design details given are indicative to meet the functional requirement. The integration kit shall meet the functional requirements of the locomotive with respect to vital parameter like HP, axle load, IRSOD envelope, etc.

### **1.2 Design / Details of Modification**

Existing design of WDP4D locomotive shall be suitably modified from diesel electric locomotive to dual mode with a new General Arrangement, duly incorporating the proposed changes.

**CHAPTER - 2****2.1 Design requirements**

Sharpest curve to be negotiated Single unit without buffer Double unit with buffer	174m radius and 1 in 8½ turnout in either direction.
Locomotive weight Nominal Axle Load	126* T (Max.) 21.0 T*
Wheel diameter (mm)	1092 mm (new) 1016 mm (condemning)
Gear ratio	17:77
Maximum operating Speed	135 km/hr
Starting Tractive Effort	40.7 T
Braking Effort	19 T
<b>Diesel Traction Mode</b>	
Installed power under standard conditions	<b>4500 HP</b>
Power input to traction under site conditions	4000HP
Tractive effort Vs Speed characteristics	RDSO graph See Annexure-III
Load to be hauled	26 coach AC in 1: 37 gradient
<b>Electric Traction Mode</b>	
Power to the wheels	<b>4500 HP (Min.)**</b>

\* To maintain the required speed potential it is essential that axle load be maintained within 21.0 T. Efforts are being made to reduce the axle load by using light weight WDG5 fabricated bogie in place of Fab-II. However, in the case of any eventuality of not able to maintain the axle load within 21 T, the increase in the axle load would be permitted upto 21.5 T during the detailed design review stage.

\*\* The power to the wheels shall be min. 4500 HP and maximum power shall be limited by the weight/envelope of the transformer/heat exchanger to keep the axle load of the locomotive under Limit. Any additional power above 4500 HP is welcomed within the specified weight schedule and envelope.

## **CHAPTER - 3**

### **Mechanical Design**

#### **3.1 General arrangement and Equipment layout**

The general arrangement and equipment layout of the locomotive shall be jointly worked out by RDSO, DLW and the firm based on the envelope of the additional equipment offered.

#### **3.2 Underframe**

Design of under frame shall be suitably modified to suit the new general arrangement as per Para 3.1.

#### **3.3 Bogie**

WDG5 bogie shall be used with fabricated bogie frame with TBU.

#### **3.4 Driver's cab**

3.4.1 The locomotive shall be provided with two full width cabs.

3.4.2 Each cab shall be provided with one driver's control desk (with a single unified Master Controller for both diesel and electric traction). Design details of the unified control desk should be submitted by the vendor for necessary approvals by RDSO/DLW.

3.4.3 Left hand drive shall be used.

3.4.4 The control desk to DLW specification No.ELPS 34 shall be provided in each cabin. Control desk shall be suitably modified to accommodate additional switches and indicators required for electric mode such as Panto raising switch, VCB opening/closing switch, OHE voltage, etc. A TFT LCD display for driver's cab called DIALS (Digital into Analogue LCD - based System) shall be provided as per RDSO specification No.MP.0.0400.10 (Latest version). It is preferable to have Two DIALS units on the loco pilot side and one DIALS unit on the assistant loco pilot side of the control desk. If there is a space constraint on the control desk due to provision of additional arrangements on account of dual mode requirements, minimum of two DIALS units on each control desk is acceptable. Display of DIALS shall be suitably be modified to incorporate additional indications required for electric traction

#### **3.5 Superstructure**

Semi monocoque bonnet type superstructure shall be used; removable roof and hatches shall be provided to enable easy maintenance of top deck equipments. The superstructure shall be made of stainless steel to achieve weight reduction.

#### **3.6 Fuel tank**

A detachable type Fuel Tank of 3000 litre capacity shall be provided tentatively.

#### **3.7 Coupler, Draft gear & Side buffers**

3.7.1 The locomotive shall be fitted with AAR approved H-type 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 side buffers to RDSO drawing no. SKDL- 4561 or SKDL-4748.

#### **3.8 Cattle guard**

Cattle guard design as per WDG5 locomotive (obstacle deflector type).

#### **3.9 Brakes**

3.9.1 Locomotive will be equipped with CCB 2.0 (computer controlled air brake) system to RDSO Specification No.MP.0.01.00.24 (Rev.01) January 2010. The responsibility for interfacing and integrating the kit components/systems with all existing third party systems onboard (including



CCB-II(IR) Brake system) shall lie with the vendor and the vendor shall be responsible for complete integration of all the systems onboard for performing to the desired performance standards. RDSO will extend the necessary assistance in integration of the AC-AC system with CCB 2.0.

3.9.2 Suitable and proven design of air dryer shall be provided for the supply of dry and good quality air to brake system and other systems / sub-systems using compressed air.

3.9.3 Spring-actuated air release type parking brake shall be provided for use on stabled locomotive and for holding a locomotive on grade in emergency.

### 3.10 Compressor

Compressor of required capacity shall be motor driven with a 3-phase inverter based motor drive arrangement. FAD of minimum 4800 LPM at rated power and minimum 900 LPM at idle notch in diesel mode is required.

### 3.11 Piping

"Bundy weld" copper brazed steel will be used on the piping of 5/8" nominal diameter and less. In other cases, Wrought Steel shall be used. This shall be pickled and oiled for pipes of 3/4" nominal diameter and above in the air system.

Existing piping arrangement with suitable modification shall be adapted. Heavy-duty seamless pipes to IS: 1239 shall be used for pneumatic brake system.

### 3.12 Sanding

Automatic sanding during wheel slip shall be provided. Eight No's side sill mounted sand boxes shall be provided with 0.4 cubic meter sand capacity.

### 3.13 Horns

Locomotive will be provided with Dual tone horns air horns on both cab end with Provision for operating horns for either of the directions from both control stands.

The two horns shall have different tones but shall be in harmony with each other when blown together. Push buttons will be provided for operation of both of the horns at any time by the driver or his assistant. (Total of four buttons - two per cab)

### 3.14 Journal Bearings

Locomotive shall be equipped with cartridge type grease lubricated journal bearings.

### 3.15 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.

### 3.16 Use of lightweight material for weight reduction

It is proposed to use air reservoir, air intake grills in radiator assembly made of aluminium alloy and identify some other areas where FRP can be used to reduce the weight.

### 3.17 Modifications to the structural design

The modification to the structural design, i.e. carbody and underframe, is a joint collaborative effort of DLW, RDSO and industry partner based on the envelope sizes, weight schedule of the integration kit. The industry partner (vendor) shall be fully involved in structural design modification/ validation either through their inhouse expertise or through a third party. RDSO / DLW shall fully involve and assist the industry partner in the structural modification with all the necessary inputs.

**CHAPTER - 4****Power Equipment****Diesel Traction****4.1 Detail of Diesel Engine**

Model 710G3B

Turbo charged two-stroke

Number of cylinder 16

Full speed at 8 notch - 954 RPM

Idle Speed Normal - 269 RPM

Idle Speed Low - 200 RPM

Notch-wise engine rpm Vs BHP (for guidance purpose)

Notch	Engine Speed (RPM)	BHP
Low Idle	200	---
1	270	259
2	354	607
3	486	1148
4	572	1573
5	675	1916
6	764	2960
7	863	3822
8	954	4500

**4.2 Supplies/Capacities**

1	Lube oil system capacity	950 Litres (TBD)
2	Cooling System Capacity	1045 Litres (TBD)
3	Fuel oil capacity	3000 Litres

4.2.1 Mechanically bonded, 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.

**4.4 Controls**

4.4.1 The locomotive shall be provided with microprocessor based locomotive control system (LCC, i.e. similar to EM 2000 of EMD), which will be suitably configured to meet the provision of six traction motors, and modified TE versus Speed performance to work successfully on both modes of traction.

**4.5 Cables**

4.5.1 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 respectively.

**CHAPTER - 5**

**Control system, Electrical Equipment & Power Supply System**

**5.1 General**

All electrical machines and control equipment shall generally conform to relevant IEC standards and shall be tested as per RDSO approved test program.

**5.2 AC-AC Traction Control System**

**5.2.1 Functional Requirement of Locomotive Control System:**

- i) All applicable requirements such as Traction control, Brake Blending, Event Recorder, VCD, User settable parameter, not specifically mentioned in this specification for working under diesel mode shall be adhered as per WDP4D, RDSO Specification No.MP.0.2400.43 (Rev.05/latest).
- ii) All applicable requirements for working under OHE traction shall be similar to the guidelines given in the Contract No.IR GP-140R.

**5.2.2 Functional requirements of Traction Converter**

- i) Individual axle control shall be provided (one inverter driving one motor). If each inverter cannot be individually isolated, physical isolation device (contactor, isolation switch) can be provided at bogie level. However motor cut-out through software should be possible at each motor level. (or) As an alternative method Truck control similar to the S3/EMD HHP Diesel Electric loco is also acceptable.
- ii) Suitable redundancy shall be provided so that locomotive failure, degradation in performance and disabling the train is minimized in the event of their failure.
- iii) Traction Converter shall use either forced air cooling or water cooling.

**5.2.3 Functional requirements of Auxiliary Converter:**

Auxiliary load specific to Diesel Mode shall work on power taken from Companion alternator using auxiliary inverter. In diesel mode and electric mode, common auxiliary load and auxiliary load specific to Electric mode shall be taken from power tapped from DC Link using Auxiliary Converter. The galvanic isolation for the auxiliary AC output should be provided.

Auxiliary loads are Engine Radiator cooling, Traction Motor cooling, Transformer cooling, Traction Converter cooling, Auxiliary converter cooling, electrically driven compressor, battery charging and auxiliary voltage to all auxiliaries, etc.

The auxiliary load and source for power is tabulated below for guidance purpose.

Auxiliary load	Description	Diesel Mode only	Electric Mode only	Common for Diesel and Electric mode
Engine Radiator cooling fan	2 x 75 hp, three phase, Inverter based VVVF Drive or Contactor based Two speed Drive at each notch	Companion Alternator	---	----
Engine Dust Bin blower	7.5 HP VVVF drive/Fixed Drive	---	---	DC Link with Galvanic isolation
Traction Alternator Excitation	21 HP, Chopper Drive	Companion Alternator	---	----

Traction Alternator Cooling	28 Hp, three phase, Inverter based VVVF Drive/Direct Drive	Companion Alternator	---	---
Traction Motor Cooling	85 HP, VVVF Drive	---	---	DC Link with Galvanic isolation
Traction Converter cooling	20 HP, VVVF Drive	---	---	DC Link with Galvanic isolation
Electrically driven compressor	2 x 25 HP, VVVF Drive/Fixed Drive	---	---	DC Link with Galvanic isolation
74 V Battery charging	24 HP DC fixed output	---	---	DC Link with Galvanic isolation
Transformer cooling (heat exchange and oil pump)	VVVF Drive/Fixed Drive	---	DC Link with Galvanic isolation	---
Other associated pump/blowers/motor	VVVF/Fixed drive	---	DC Link with Galvanic isolation	---

In the above table:

- VVVF drive means, output voltage and frequency is dependent on input voltage (indirectly notch of the diesel engine).
- Fixed frequency drive means fixed voltage and fixed frequency drive.

Schematic of Power and Auxiliary interfacing circuit proposed as per Annexure – V.

#### 5.2.4 Interference current limits:

The electric and electronic apparatus used in propulsion system shall comply emission and immunity aspects of EMC according to CENELEC standard EN-50121-3-2. The internal EMC shall cover a combination of earthing, shielding and isolation of interference sources so that conducted and radiated noises are properly segregated or suppressed and no other equipment is affected due to operation of propulsion equipments.

The tracks over which the offered locomotive propulsion system shall work shall be equipped with DC track circuits, 83-1/3 Hz track circuits as well as track circuits at higher frequencies. Similarly, other devices like axle counters, block instruments, point machines, etc., shall also be employed. On the communication network, control circuits, teleprinter circuits, as well as VHF/UHF and microwave circuits are employed.

The harmonic currents injected in the overhead supply system (as also the track return current) can introduce voltage harmonics on power supply and can interfere with signal and telecom circuits. The design of the traction transformer, power electronics and control electronics provided on the propulsion system shall be such as not to cause levels of interference exceeding the levels specified below at any point in the operating envelope of the locomotive:

Sl.	Interference Current	Overall limit
1.	Psophometric current AC traction	10.0A
2.	DC components in AC mode	4.7A
3.	Second Harmonic component (100Hz) in AC traction	8.5A
4.	Frequencies 1400Hz to 5000Hz	400 mA

5.	Frequencies 5000 to 32000 Hz	-270 mA
6.	Frequencies 39500Hz to 43500Hz	270 mA

- The Supplier shall undertake FFT (Fast Fourier Transformation) analysis of the total current from 1400Hz to 5000Hz and 5kHz to 50kHz separately to find out the frequencies which produce the highest currents within each bandwidth. In the frequency bands >32000Hz to <39500Hz and >43500Hz to 50000Hz the frequencies at which the current values exceed 270mA shall be identified. This test shall be included within the tests listed within Chapter 5 and the results shall be provided in type test report.
- EN 50238 includes interference current limits for track circuits and axle counters. Where these overall interference current limits are more onerous than those stated above, these limits shall be applied.

5.2.5 The following audio-visual signals or indication(s) shall be provided in both the cabs for single and multiple operation of the locomotives as per RDSO specification No. MP.0.0400.10 (Latest).

1. Sanding
2. Wheel slip
3. Auto-flasher
4. TE limit
5. Alerter
6. PCS Open
7. Brake Warning

5.2.6 All special purpose cables other than regular control cables shall also be in the scope of supply of the supplier of TCC.

### 5.2.7 Prototype test standard:

The prototype of the equipment or sub assembly shall be tested as per following test standard.

1.	Inverters (Traction Inverter, Auxiliary Inverter, Line Converter, etc.)	IEC 61287-1
2.	Electronics and Control System	IEC 60571
3.	Transformer	IEC 60310, Type test as per Spec No. CLW/ES/3/0456
4.	System Integration test	As per test protocol submitted by Propulsion supplier duly approved by RDSO

### 5.3 Power Supply System for 25 kV AC Traction:

General	The Power supply system adopted is 25 kV, 50 Hz, single phase AC, 25 kV, being the nominal voltage of the system. The design calculations and guaranteed performance will be based on voltage of 22.5 kV.
Variation in Voltage of supply	19 kV to 27.5 kV Occasional max. 31 kV Occasional min. 16.5 kV The occasional maximum and Occasional minimum voltage may persist for 30 min.
Variation in frequency	± 8 % (46 to 54 Hz)

Stagger of the contact wire	± 200 mm on straight track Up to 300 mm on curves
Normal contact wire height in mid span	5.5 m
Max. contact wire height	5.8 m
Min. contact wire height	4.65 m

#### 5.4 Pantograph

- i) The locomotive will be equipped with one pantograph. The pantograph selector switch will be provided in the Driver's desk for raising the pantograph. Raising or lowering of pantograph with locomotive in motion will not cause any undue disturbance to OHE.
- ii) It will be possible for the pantograph to be disconnected from roof equipment and earthed in case of damage.
- iii) The wearing strips to be used on the pantograph will be of proven design and made from steel such as will cause least wear on the overhead contact system as well as to the strips themselves.

#### 5.5 Main Transformer

- i) The kVA rating of the transformer will be specified at a line voltage of 22.5 kV and will be designed to deliver a total power corresponding to the continuous rated traction motor currents at 22.5 kV. The transformer traction winding will also be designed to deliver the rated power at the maximum the voltage of 27.5 kV.
- ii) The Transformer will be designed with adequate overload capacity to permit full utilisation of the traction motor capacity during starting as well as running.
- iii) The transformer will be designed to conform to IEC 60310 and the temperature rise limits on the windings and the oil will correspond to IEC 60310 limit under all conditions of operation.
- iv) The transformer will be oil immersed and forced oil cooled by means of oil circulating pump and radiator. The oil cooler (radiator) will be air blast cooled by means of a motor driven blower set. The transformer will be equipped with an expansion tank in the machine room. Explosion valves will prevent mechanical damages of transformer set. Means will be provided for letting out the oil from the transformer to the underside of the locomotive, in event of any fault / electrical disturbance in the transformer causing oil to rush out.

#### v) Standards

The following specifications shall generally be followed for manufacture and testing of the transformer and reactor units:-

- IEC-60310 - Rules for traction transformers and reactors
- IEC-60076 - Recommendations for power transformers
- IEC-61373 - Rules for Electrical Traction Devices
- EN 50163 - Standard voltages
- IEC-60296 - Transformer Oil

#### vi) Description

Each locomotive requires one transformer for feeding supply to traction converters / traction motors. This transformer will consist of Primary winding, four traction windings and one auxiliary winding (on requirement). In addition, if required it can include psophometric filter winding.

The transformer tank also contains 02 series resonant chokes (one for each converter).

Transformer is oil cooled and external cooling of the oil is designed with at least one independent oil circuits with cooling units located within the machine room of locomotives. However, the cooling units / circuit component do not form part of transformer supply.

The special features of the transformer are

- Transformer is mounted under slung on under frame
- Transformer is designed for feeding IGBT based Power and Auxiliary converter load.
- Suitable impedance between primary & traction windings to fulfill line harmonic limits
- High de-couplings between windings
- Use of continuous transposed conductor for windings
- Transformer and conservator tank made of appropriate material as required by the magnetic properties of the transformer and the chemical properties of the coolant
- Rapid action coupling between transformer and conservators in oil circuit

vii) **Additional apparatus of the transformer**

- Overflow valve (In case of over pressure, the tank must not be damaged and overflowing oil shall be drained off the transformer cover)
- Oil drain tap, oil level screw
- Slide of oil intake and drainage
- Transformer tank fastening
- At least one conservator tank including
  - Air dehumidifier including valve
  - Oil level gauge
  - Connection to the transformer including rapid action coupling
  - Oil filler tap
  - Oil drainage screw
- Earthing.

General arrangement of transformer will be similar to CLW Drawing No.CLW/ES/3/SK-I/0135 of WAP7/WAP5 loco transformer.

## **5.6 Main Circuit Breaker**

Vacuum circuit breaker of proven design will be provided.

## **5.7 Lightning Arrestor**

A gapless type lightning arrestor of well proven design will be provided on the roof of the locomotive for protection against the line voltage transients caused by lightning or system switching.

## **5.8 Safety measures**

- i) All equipment will be adequately earthed, insulated, screened or enclosed and provided with essential interlocks and keys as may be appropriate to ensure the protection of the equipments and safety of those concerned with its operation and maintenance.
- ii) Earth fault detection will be provided by the Contractor.
- iii) All electrical circuits will be fully insulated from the superstructure on both the positive and negative sides and the super-structure will not be used as a portion of an earth return circuit.
- iv) Fire prevention measure: The design of equipment will incorporate all measure to prevent fires and will be such that should may fire take place, the effects will be minimised and no spread of

fire should take place. Materials which are not fire- retardant will not be used. The locomotive will be provided with suitable fire detection and extinguishing equipment of proven design. The extinguishing equipment will be operated manually.

v) Protective / Safety devices

1. The locomotive will be provided with a manually operated two position earthing switch. The operation of the switch will enable earthing of the power circuit of the locomotive and attention the HT equipment by releasing interlocked keys from a box fitted the earthing switch.
2. Standard protective systems for protection of the electrical equipments against abnormal currents, excessive voltages etc. as well as indication of normal and abnormal conditions so as to ensure safe and correct operations will be provided. While working in multiple, the faults in the trailing locomotive will be indicated in the leading locomotive.

**5.9 Traction Alternator - Rectifier for diesel traction**

5.9.1 Alternator Data:

Make and Type	TA 17-CA6B
Continuous Rating	2600 VDC 1250 Amp
Temperature rise limit	IEC – 60349-2
Insulation	Class H
Ventilation	Forced / Self-ventilated Excitation
Excitation control	Microprocessor control

**5.10 Traction Motors**

Parameter	<b>GT 46 PAC</b>
Model	1TB2622 - OTB02
Gear Ratio	17 : 77
Airflow Req	1.2 m <sup>3</sup> /sec
Weight	2120 Kg
Stall Torque	8320 Nm
Nominal Torque	5949 Nm
Maximum speed	3776 RPM
Nominal speed	1024 RPM
Maximum Power	765 KW (1025 HP)
Nominal Power	638 KW (855 HP)
DC link Power	689 KW (924 HP)

**5.11 Storage Battery**

155 AH Ni - Cd battery shall be used with following details.



Specification	MP.0.51.01.02 (Rev. 2/Latest)
Arrangement	10 battery units (5 cells in each Battery Unit) connected in series
Total quantity of cells	50
Total potential of Batteries	64 Volts
Electrolyte	Aqueous solution of potassium hydroxide in distilled water

**5.12 Dynamic braking grids**

Dynamic braking grids suitable for dissipation of part load power (2450 HP) for self load testing shall be provided.

**CHAPTER - 6****Dimensions, Clearances and Track Geometry**

6

**6.1 Dimensions, Clearances and Track Geometry****6.1.1 Overall Carbody Dimensions**

Locomotives dimensions and profile shall within or fully conform to IR SOD 1D-clearance diagram (EDO T-2202) latest revision.

**6.1.2 Climatic and environmental conditions**

1.	Maximum Temperature (Atmospheric)	Under sun 70°C In shade 50°C Temperature inside locomotive may reach 60 °C at turbocharger inlet.
2.	Humidity	100% saturation during rainy season
3.	Reference site conditions	(i) Ambient Temp. 47°C (ii) Humidity 60% (iii) Altitude 600 m
4.	Rainfall	Very heavy in certain areas. The locomotive shall be designed to permit its running at 10 km/h in a flood water level of 102 mm above rail level.
5.	Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas. (Air filtration system of engine to be designed accordingly)
6.	Coastal area	Locomotive and equipment shall be designed to work in coastal areas in humid and salt laden atmosphere.
7.	Vibration	The equipment, sub-system and their mounting arrangement shall be designed to withstand satisfactorily the vibration and shocks encountered in railway traction, unless otherwise prescribed or specifically defined in the manufacturer's design criterion.

**6.1.3 Track Geometry**

1	Gauge	Broad Gauge (BG) 1676 mm (nominal)
2	Track structure	The track is to a standard of 60 kg, 90 UTS rails on Pre-stressed concrete sleepers of 1660 per km 300 mm depth of ballast cushion below the sleepers Or 52 kg, 90 UTS rails on Pre-stressed concrete sleepers of 1540 per km 250 mm depth of ballast cushion below the sleepers.
3	Sharpest curve and turn out to be negotiated	174 m radius. The locomotive shall also be checked for passage in both directions over standard BG 1 in 8-1/2 turnouts. Vogel's layout or its internationally-accepted equivalent for negotiability, throw over at head stock and coupler movement with details of clearances shall be submitted.
	Maximum Super elevation	185 mm

	Maximum cant deficiency	100 mm	
4	Schedule of dimensions	Indian Railways 'Schedule of Dimensions' for Broad Gauge (1676 mm), 2004	
5	Overall moving dimensions	The locomotive with new wheels and in empty condition shall be within the dimensions shown in IR MMD as per diagram EDO/T-2202.	
6	Clearance above the rail level	The locomotive shall be so designed that no component shall infringe minimum clearance of 95 mm above rail level with the locomotive fully loaded and wheels in fully worn condition.	
7	Permissible track tolerances:	<b>BG Main Line</b>	<b>BG High Speed Route (C&amp;M 1 Vol 1)</b>
	Unevenness (3.6 m base)	< 15 mm	< 10 mm
	Twist (3.6 m base)	< 2.78 mm/meter	< 2.08 mm/meter
	Gauge variation	<± 6 mm	<± 3 mm
	Alignment (versine on 7.2 m chord)	< 5 mm	< 5 mm
	Gauge widening:		
	On curves of > 350m radius	-5mm to +3mm	
	On curves of < 350m radius	Up to +10mm	

## **CHAPTER - 7**

### **Miscellaneous**

7

#### **7.1 Tentative list of additional items for dual mode loco**

Tentative list of additional items for dual mode loco is given at Annexure-IV.

#### **7.2 Development and Design clearance**

The integration kit for design details of additional and uncommon items along with weight and envelope size required for building dual mode loco on WDP4D platform shall be furnished for design clearance of DLW/RDSO before the successful tenderer start manufacturing of the items. These items shall be designed / manufactured and supplied as an integration kit. The integration kit shall consist of all the uncommon and additional item irrespective whether indicated in the specification or not. The firm shall work jointly for development of GA and other changes required in consultation with DLW/RDSO.

#### **7.3 Maker's test certificate, MI etc.**

One copy of each of test certificate, Maintenance Instructions, Equipment data, Spare Parts Lists of the locomotives shall be supplied to the consignee Railway.

#### **7.4 Inspection**

Inspection at various stages of locomotive manufacture including final inspection shall be done by DLW. Necessary inspection plan will be jointly worked out by DLW and RDSO.

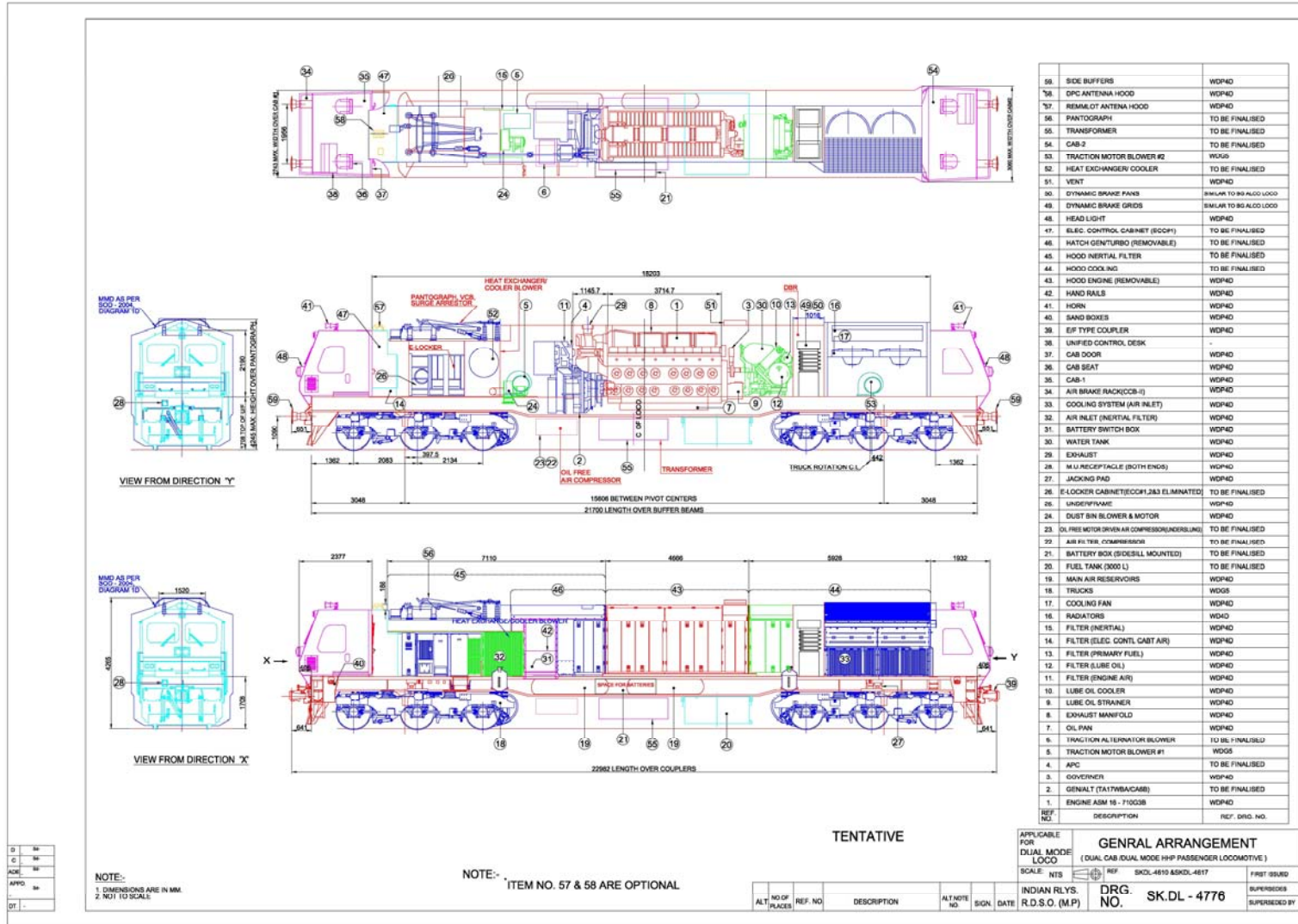
## Annexure-I

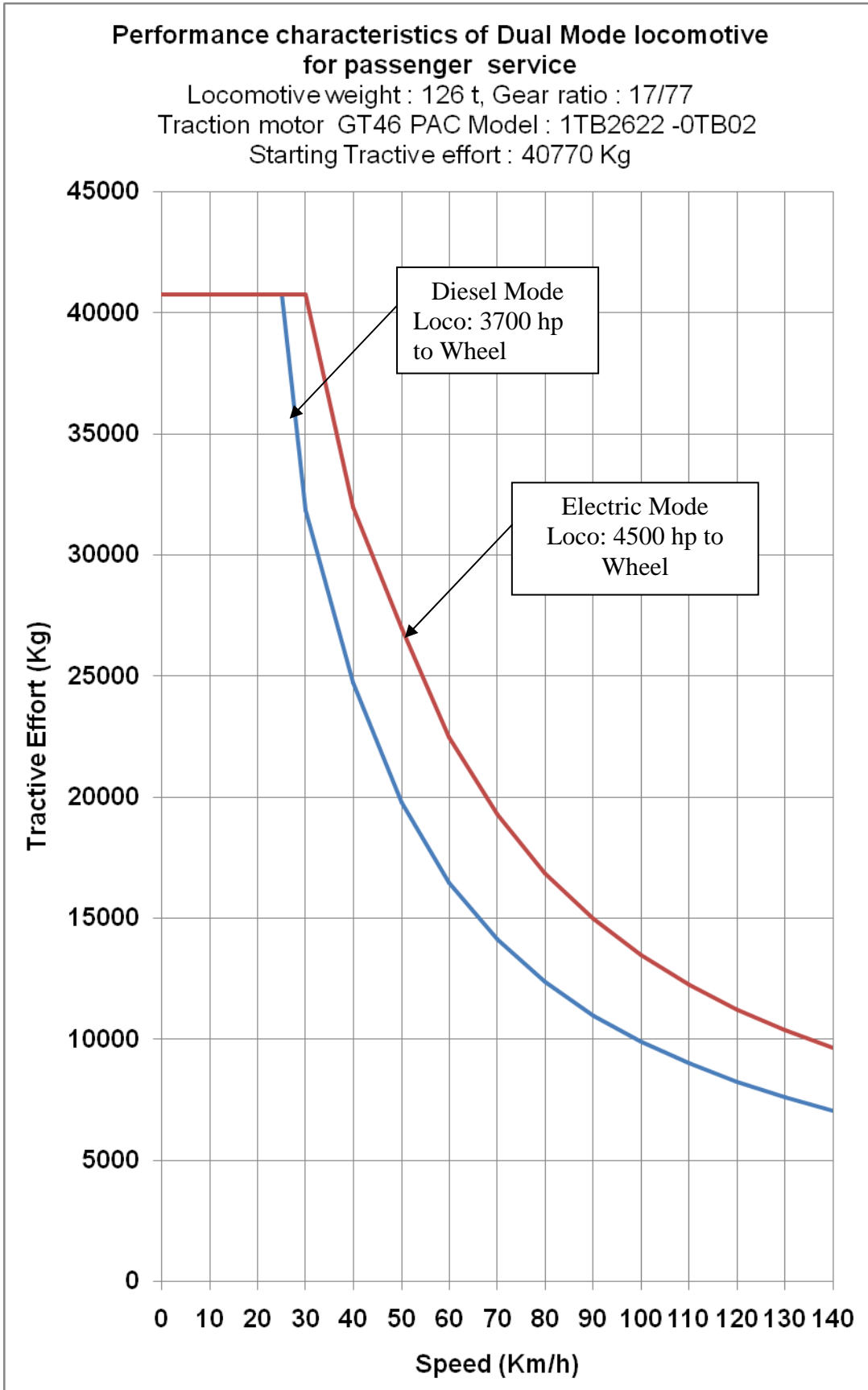
Tentative Weight Reduction / Additional in the proposed trade off on WDP4D platform to keep the axle load of dual mode locomotive within 21 T

Sl.	Item Description	Likely Weight Addition (Kg)	Likely Weight Reduction (kg)	Net Effect (Kg)
1.	Fuel Tank reduction of fuel by 3000L		-3000	-3000
2.	Auxiliary Generator and Blower		-647	-647
3.	Electrically Driven TM Blower	600		600
4.	Electrically Driven Compressor	700		700
5.	Engine Driven Compressor		-1043	-1043
6.	Weight Optimi of Superstr and CABs with use SS in place of Steel		-1500	-1500
7.	Weight Reduction in Cattle Guard, Al reservoirs , Al grills, other misc savings		-1200	-1200
8.	Use of WDG5 bogie (With TBU)*		-2800	-2800
9.	Use of G5 Equipment Rack instead of WDP4D		-	-
10.	Compact converter for Dual Mode consisting of ECC#1,2,3, 4 TCC, Auxiliary Inverters with Sine Filter and Battery Charger	1750		1750
11.	Transformer	6000		6000
12.	VCB	200		200
13.	Pantograph	300		300
14.	Earthing Switch	100		100
15.	Heat Exchanger for Transformer and Traction Inverter(* may use existing heat exchanger of diesel version)	1000		1000
16.	Likely increase in the weight due to modification to superstructure and underframe	2000		2000
<b>Total increase in Weight (kg)</b>				<b>2160</b>
<b>Net increase in Axle Load (t)</b>				<b>0.36</b>
<b>Existing WDP4D Axle Load</b>				<b>20.50</b>
<b>Expected Dual Mode Loco Axle Load(t)</b>				<b>20.91</b>

\* To maintain the required speed potential it is essential that axle load be maintained within 21.0 T. Efforts are being made to reduce the axle load by using light weight WDG5 fabricated bogie in place of Fab-II.

Tentative General Arrangement of Proposed Dual Mode Locomotive on WDP4D platform



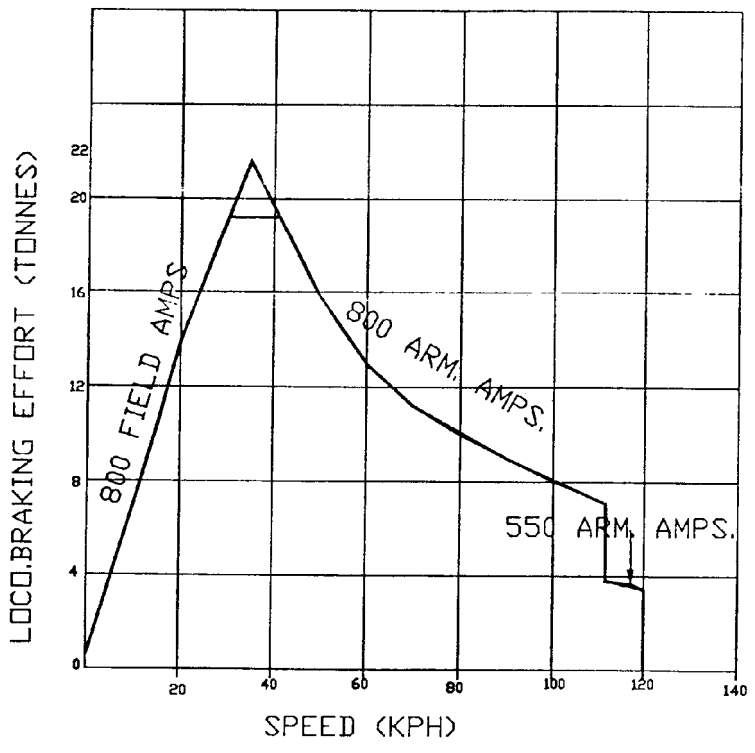


**DYNAMIC BRAKING CHARACTERISTIC  
OF  
2600/2400 HP BG DE LOCO. TYPE WDM2  
(1000V AC/DC SYSTEM, TYPE 'E' EXCITATION CONTROL & WOODWARD GOVERNOR)**

1 - TA 10102 BX ALTERNATOR  
 1 - AG 3101 AY EXCITER  
 6 - TM 4906 AZ TRACTION MOTOR

WHEEL DIA. - 1092 mm (NEW)  
 GEAR RATIO - 18:65  
 MOTOR RPM - 17.5 \* SPEED IN KPH

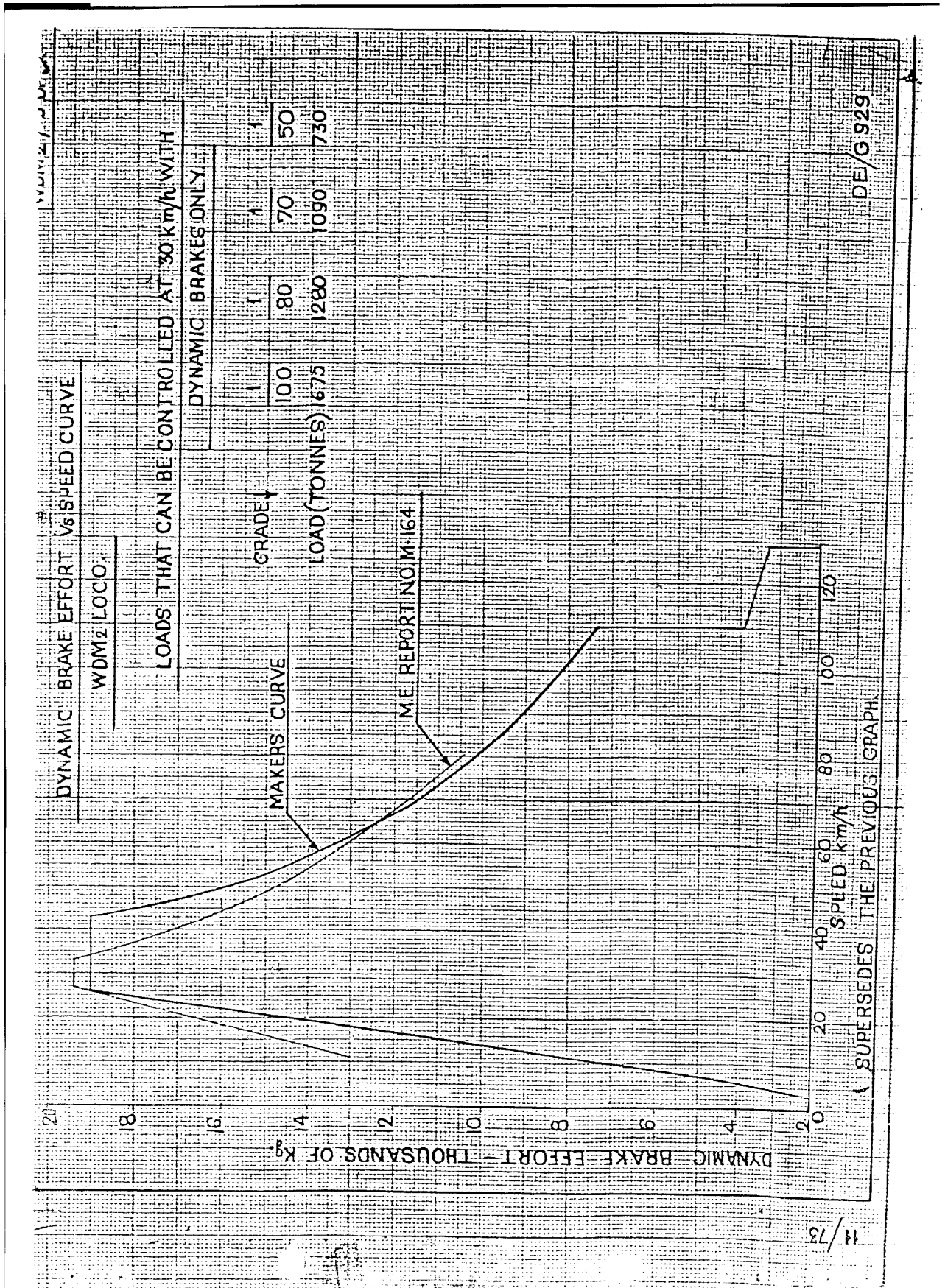
RESISTANCE PER MOTOR :-  
 LOAD : 0.500 Ohms  
 ARM+CPS : 0.0221 Ohms  
 TOTAL : 0.5221 Ohms



D	K. Bhattacharya
TC	K. Bhattacharya
APPD.	
DT:	

RDSO (MP)	RET.-INEL. CURVE NO. THE/SK/274	
	G.D.P.- 1067	
FIRST ISSUED	SUPERSEDES	SUPERSEDED BY





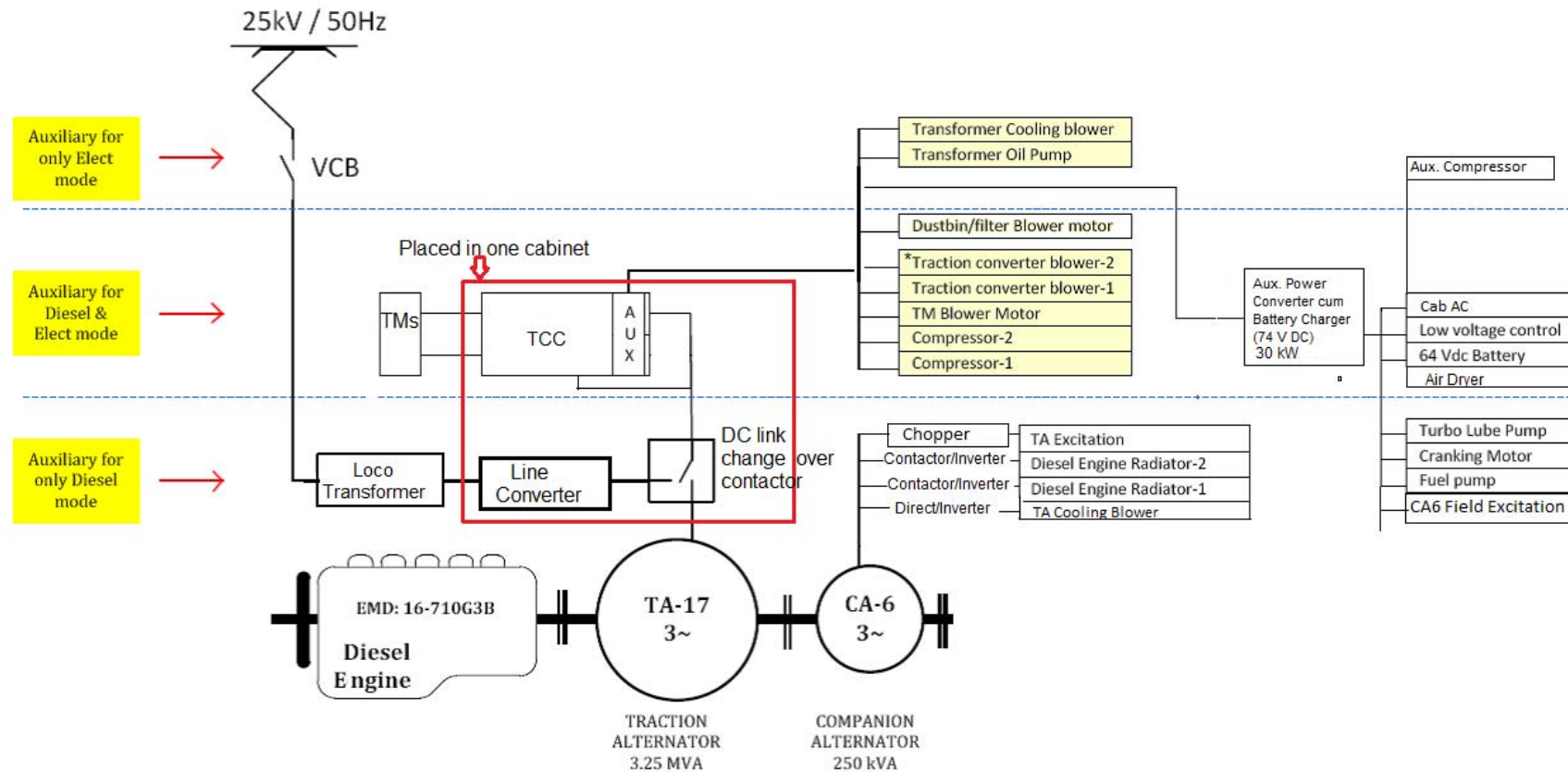
Tentative list of additional Items to be fitted on locomotive for Dual mode Operation		
Sl. No.	Item Description	Qty
1	Pantograph	1
2	Panto disconnecting + Earthing device isolation switch	1
3	Primary voltage transformer	1
4	Earthing switch VCB	1
5	Main Circuit breaker(VCB)	1
6	Primary current transformer	1
7	Resistor primary current transformer	1
8	Primary current sensor (return path)	2
9	surge arrestor across primary current sensor	1
10	Traction Transformer	1
11	Contactator Filter ON/OFF	1
12	Contactator filter adaption	1
13	Resistor harmonic filter resistor	1
14	Capacitor bank harmonic filter	1
15	Contactator for discharging resistor	1
16	Discharging resistor for harmonic capacitor bank	1
17	current sensor harmonic filter	2
18	Resistor earth fault detect Harmonic filter	2
19	Surge arrestor	2
20	earth return brush	4
21	earthing choke	1
22	Oil Pump for transformer	2
23	Heat exchanger (Oil Cooling unit)	2
24	High voltage bushing	1

#### Major uncommon items w.r.t. WDP4D

1.	AC-AC System with Traction Converter
2.	Electrically driven compressor
3.	Traction Motor Blower
4.	Traction Alternator Blower
5.	Unified Control desk in complete including Master Controller
6.	Stack type DB Grid with Blower Motor

The integration kit furnished above is indicative subject to changes during the concept design review (CDR) and detailed design review (DDR). The integration kit would be frozen jointly by industry partner, DLW and RDSO during the detailed design review (DDR).

# Dual mode Power Flow



\* Traction control converter may be axle control/Bogie control. No. of Blowers depend on the system design.

Note : Field Excitation of CA6 shall be initially through Battery and when DC Link builds up, the CA6 Field Excitation shall be from Auxiliary Power Converter cum Battery Charger