R.D.S.O

भारत सरकार, रेल मन्त्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

SPECIFICATION FOR

DUAL MODE GOODS LOCOMOTIVE

Specification No. MP.0.0800-109

(Revision - 00)

October- 2016

अनुसंधान अभिकल्प और मानक संगठन
लखनऊ–**226 011**
RESEARCH DESIGNS & STANDARDS ORGANISATION
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DD/MP	JD/MP	EDSMP
Prepared By	*Checked By*	*Approved By*

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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 platform with a view to develop the dual mode goods locomotive.

It is proposed to design new locomotive on 4500 HP (diesel) 6000 HP(Electrical) suitable sturdy platform with motorized bogies using existing 710-16 cylinder diesel engine coupled with TA17 alternator. For operating under OHE, a traction transformer of suitable rating containing main traction windings and filter windings for line harmonic filtering (if required). 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 proposed locomotive were examined to keep the overall weight of the locomotive to less than 138 tonnes and achieve a target speed of at least 100 km/h, with the following would be the key modifications –

- Use of Fabricated bogie with TBU.
- AC-AC traction system (E locker) 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
- Modified/strength under frame
- Modified car body design to accommodate panto graph and associated roof equipments

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 6000 HP in electric traction mode with combined AC-AC transmission and two HTCF Co-Co bogies for goods service. The specification basically covers the integration kit required for development of a dual mode loco on the suitably designed platform. The integration kit mainly comprises of additional items required for electric traction and the items of existing HHP Locomotive 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 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 HHP locomotive shall be suitably modified from diesel electric locomotive to dual mode with a new General Arrangement, duly incorporating the proposed changes.(See annexure-I)

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	138 T (Max.) 23.0 T
Wheel diameter (mm)	1092 mm (new) 1016 mm (condemning)
Gear ratio	91:20
Maximum operating Speed	100 km/hr
Starting Tractive Effort	560KN
Nominal Brake Effort	8-12 % (Max.)
Diesel Traction Mode	
Installed power under standard conditions	4500 HP
Power input to traction under site conditions	4150 HP
Tractive effort Vs Speed characteristics	To be decided
Load to be hauled	5400 T+ load
Electric Traction Mode	
Power to the wheels	5500 HP (Min.) to 6000 HP (Max.)*

* The power to the wheels shall be min. 5500 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 23T.

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 strength and 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 5000 litre capacity shall be provided tentatively.

3.7 Coupler, Draft gear & Side buffers

3.7.1 The locomotive shall be fitted with AAR approved E-type centre buffer coupler and draft gear assembly to EMD drawing no.8420236(NC-390) 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) 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. RDSO approved make Air Dryer may be used in accordance to RDSO specification no.MP.0.01.00.06 (Rev 05) March 2011.

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. Parking brake should be capable of holding 3 locos on 1 in 37 ruling gradients.

3.10 Compressor

Compressor of required capacity shall be motor driven with a 3-phase inverter based motor drive arrangement conforming to DLW specification no Misc 323.The motor shall be suitably designed for working with variable frequency ranging from 20 Hz to 140 Hz should be selected.

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 as per RDSO specification.

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) RDSO Specification no. for horn is MP.0.99.00.04 of November 1990.

3.14 Journal Bearings

Locomotive journals shall be equipped with CTRB class K 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-should be sturdy enough so that in running of the locomotive grill should not vibrate and damage the radiator fins/tubes and identify some other areas where FRP can be used to reduce the weight.

Stainless steel pipe/fitting may be used for compressed air brake system.

3.17 Loco should be equipped with feature to switch 'ON' flasher light automatically in the event of

Train parting /ACP (ACP may not be applicable being goods loco) and VCD.

3.18 Modifications to the structural design

The modification to the structural design, i.e. car body and under frame 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 in house 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
Notchwise 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	5000 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.

4.3 Controls

4.3.1 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.

4.4 Cables

4.4.1 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 micro-wave 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 sued 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 limits 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

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.

vi) 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
- Two conservator tanks 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
Maximum Alternator output voltage	3200 VDC
Nominal power rating of Alternator	2750 VDC x 1150 ADC =3162.5 KW
Maximum power Rating of Alternator	3250 KW
Temperature rise limit	IEC – 60349-2
Insulation	Class H
Ventilation	Forced / Self-ventilated Excitation
Excitation control	Microprocessor control
Output voltage vs speed curve	See Annexure-III (The curve is for 4000 hp HHP locomotive equipped with EMD TA17-CA6 Alternator. Same is proposed for dual Mode locomotive.)

5.10 Traction Motors

Parameter	Type
Model	EMD WDG5 -A2921-6* or Equivalent suitable for 6000 Wheel HP in electric mode**. * This Traction Motor is used for 5000 hp only.

	**Higher version of Traction Motor is desirable to cater electric mode operation at 6000 hp.
Gear Ratio	91: 20
Drawing No.	40170048
Specification No.	MP.0.2400.72
Weight	2386 kg
Airflow required	1.23 m^3/sec
Stall Torque	10811 Nm
Nominal Torque	7960 Nm
Maximum Speed	2675 RPM
Nominal Speed	719 RPM
Maximum Power	645 KW
Nominal Power	630 KW
Gear box efficiency	98 %

5.11 Storage Battery

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

Specification	DEL/SPN/193 (Rev. 3 or Latest)
Arrangement	8 battery units (4 cells in each Battery Unit) connected in series
Total quantity of cells	32
Total potential of Batteries	64 Volts
Electrolyte	Aqueous solution of sulphuric acid 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 70ºC In shade 50ºC Temperature inside locomotive may reach 60 ºC at turbocharger inlet.
2.	Humidity	100% saturation during rainy season
3.	Reference site conditions	(i) Ambient Temp. 47ºC (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:	BG Main Line	BG High Speed Route (C&M 1 Vol 1)
	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-II.

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 suitably designed 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.

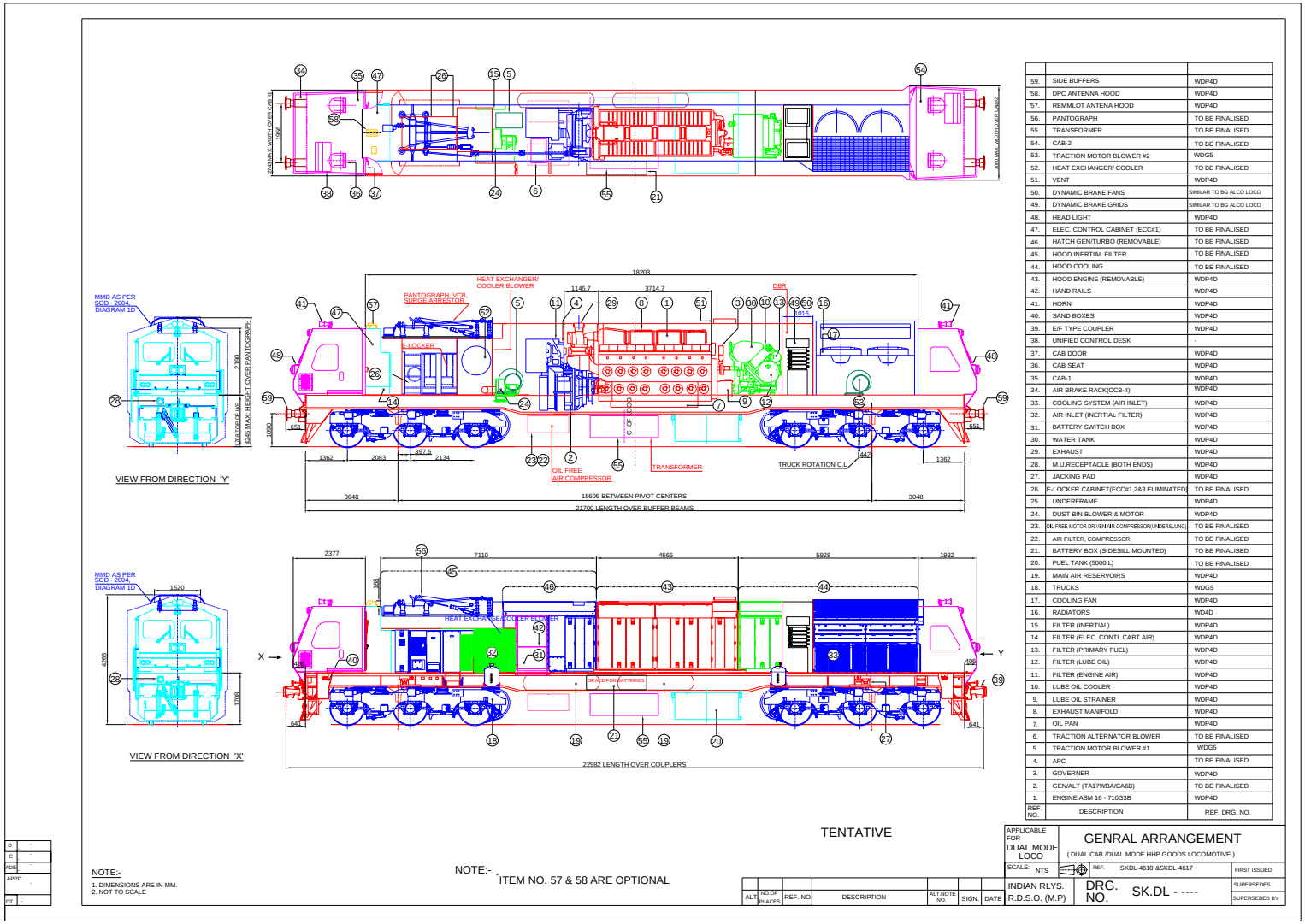
One copy of each of test certificate, Maintenance Instructions, Equipment data, Spare Parts Lists of the locomotives shall be supplied to the consignee Railway.

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 General Arrangement of Proposed Dual Mode Goods Locomotive



59.	SIDE BUFFERS	WDP4D
*58.	DPC ANTENNA HOOD	WDP4D
*57.	REMMLOT ANTENA HOOD	WDP4D
56.	PANTOGRAPH	TO BE FINALISED
55.	TRANSFORMER	TO BE FINALISED
54.	CAB-2	TO BE FINALISED
53.	TRACTION MOTOR BLOWER #2	WDG5
52.	HEAT EXCHANGER/ COOLER	TO BE FINALISED
51.	VENT	WDP4D
50.	DYNAMIC BRAKE FANS	SIMILAR TO BG ALCO LOCO
49.	DYNAMIC BRAKE GRIDS	SIMILAR TO BG ALCO LOCO
48.	HEAD LIGHT	WDP4D
47.	ELEC. CONTROL CABINET (ECC#1)	TO BE FINALISED
46.	HATCH GEN/TURBO (REMOVABLE)	TO BE FINALISED
45.	HOOD INERTIAL FILTER	TO BE FINALISED
44.	HOOD COOLING	TO BE FINALISED
43.	HOOD ENGINE (REMOVABLE)	WDP4D
42.	HAND RAILS	WDP4D
41.	HORN	WDP4D
40.	SAND BOXES	WDP4D
39.	E/F TYPE COUPLER	WDP4D
38.	UNIFIED CONTROL DESK	-
37.	CAB DOOR	WDP4D
36.	CAB SEAT	WDP4D
35.	CAB-1	WDP4D
34.	AIR BRAKE RACK(CCB-II)	WDP4D
33.	COOLING SYSTEM (AIR INLET)	WDP4D
32.	AIR INLET (INERTIAL FILTER)	WDP4D
31.	BATTERY SWITCH BOX	WDP4D
30.	WATER TANK	WDP4D
29.	EXHAUST	WDP4D
28.	M.U.RECEPTACLE (BOTH ENDS)	WDP4D
27.	JACKING PAD	WDP4D
26.	E-LOCKER CABINET(ECC#1,2&3 ELIMINATED)	TO BE FINALISED
25.	UNDERFRAME	WDP4D
24.	DUST BIN BLOWER & MOTOR	WDP4D
23.	OIL FREE MOTOR DRIVEN AIR COMPRESSOR(UNDERSLUNG)	TO BE FINALISED
22.	AIR FILTER, COMPRESSOR	TO BE FINALISED
21.	BATTERY BOX (SIDESILL MOUNTED)	TO BE FINALISED
20.	FUEL TANK (5000 L)	TO BE FINALISED
19.	MAIN AIR RESERVOIRS	WDP4D
18.	TRUCKS	WDG5
17.	COOLING FAN	WDP4D
16.	RADIATORS	WD4D
15.	FILTER (INERTIAL)	WDP4D
14.	FILTER (ELEC. CONTL CABT AIR)	WDP4D
13.	FILTER (PRIMARY FUEL)	WDP4D
12.	FILTER (LUBE OIL)	WDP4D
11.	FILTER (ENGINE AIR)	WDP4D
10.	LUBE OIL COOLER	WDP4D
9.	LUBE OIL STRAINER	WDP4D
8.	EXHAUST MANIFOLD	WDP4D
7.	OIL PAN	WDP4D
6.	TRACTION ALTERNATOR BLOWER	TO BE FINALISED
5.	TRACTION MOTOR BLOWER #1	WDG5
4.	APC	TO BE FINALISED
3.	GOVERNER	WDP4D
2.	GEN/ALT (TA17WBA/CA6B)	TO BE FINALISED
1.	ENGINE ASM 16 - 710G3B	WDP4D
REF. NO.	DESCRIPTION	REF. DRG. NO.

APPLICABLE FOR: DUAL MODE LOCO

GENRAL ARRANGEMENT

(DUAL CAB /DUAL MODE HHP GOODS LOCOMOTIVE)

SCALE: NTS | REF: SKDL-4610 &SKDL-4617 | FIRST ISSUED

INDIAN RLYS. R.D.S.O. (M.P) | DRG. NO. SK.DL - ---- | SUPERSEDES | SUPERSEDED BY

Annexure-II

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	Contactor Filter ON/OFF	1
12	Contactor filter adaption	1
13	Resistor harmonic filter resistor	1
14	Capacitor bank harmonic filter	1
15	Contactor 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

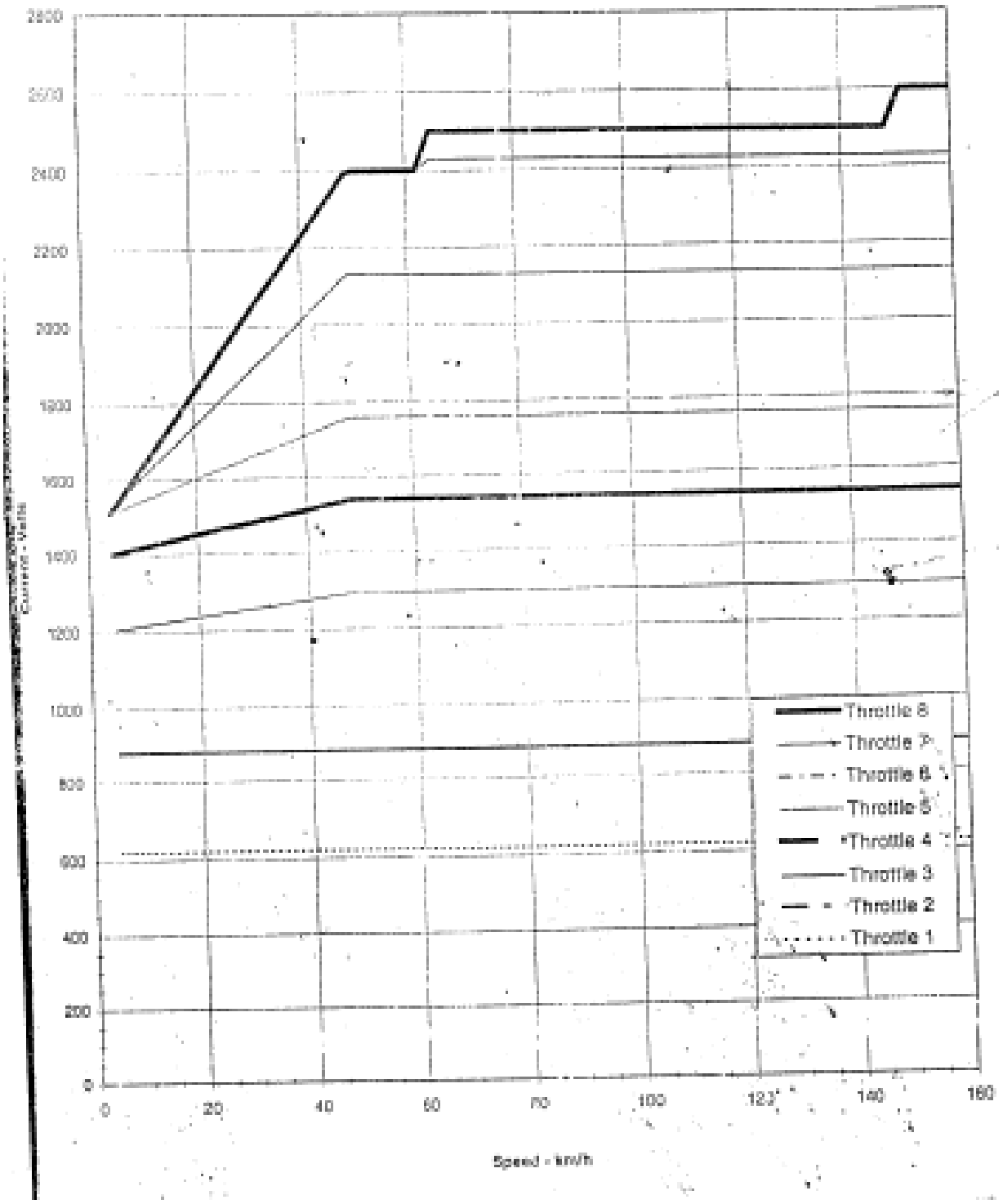
Major uncommon items w.r.t. HHP Locomotive

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

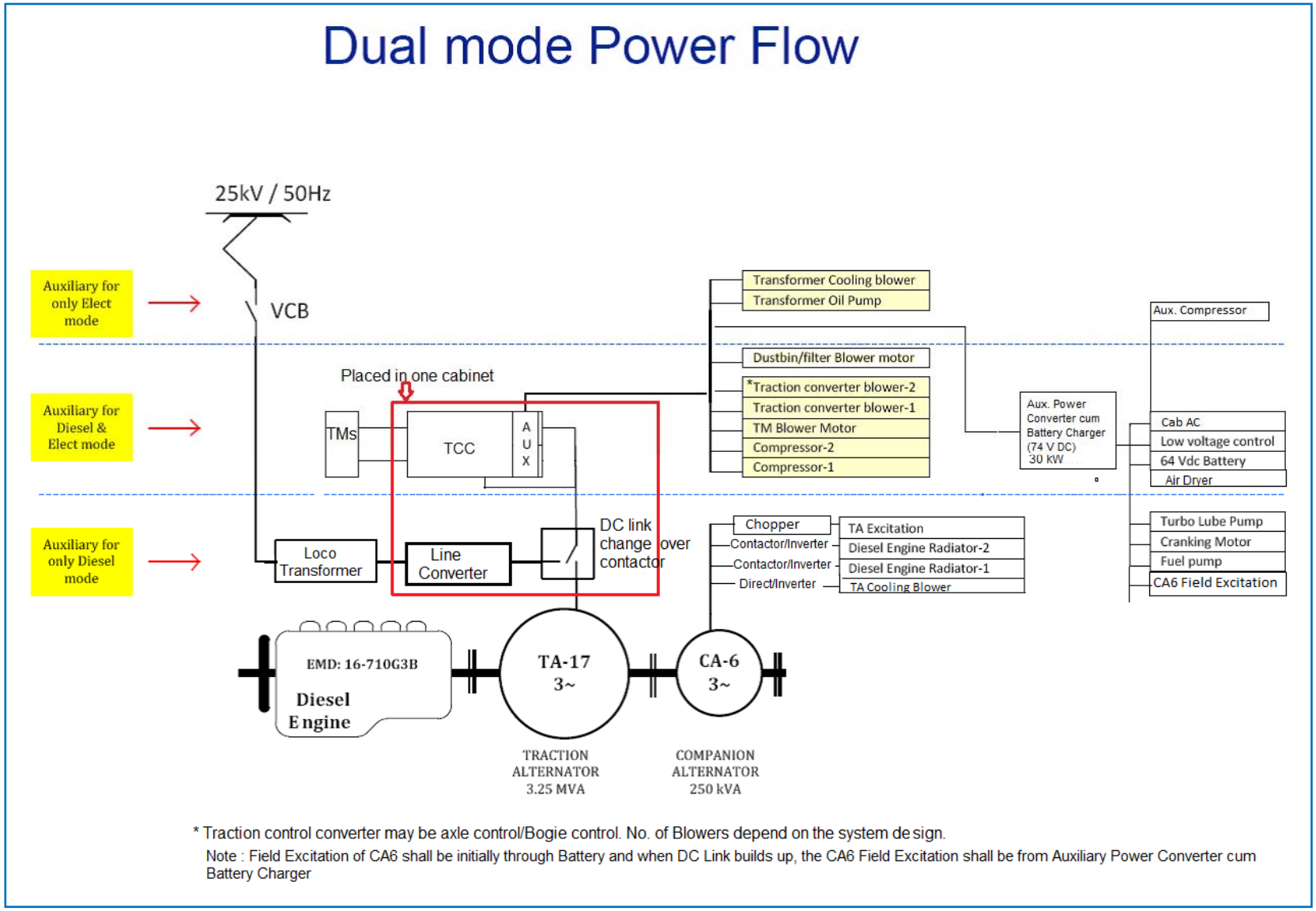
The integration kit furnished above is indicative subject to changes during the concept design review (CDR) and detailed design review (DDR). The integration kit would be frozen jointly by industry partner, DLW and RDSO during the detailed design review (DDR).

Annexure -III

DC Link Voltage versus Train Speed **For 4000 HP EMD Loco**



Annexure -IV



* 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

Annexure –V

Tentative Weight Reduction /Additional in the proposed platform locomotive to keep the axle load of dual mode locomotive within 23T.

To be decided