भारत सरकार – रेल मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

डब्ल्यू०डी०पी०$_{4B}$ (४५००) एसी–एसी लोकोमोटिव का रेखाचित्र पुस्तिका

DIAGRAM BOOK OF WDP4B (4500 HP) AC - AC LOCOMOTIVE

रिपोर्ट सं० एम०पी०.मिस्ले०. – २९३ (संसो० – ०.००), अक्टुबर'२०१४
Report No. MP-MISC – 293 (REV. – 0.00), October' 2014

अनुसंधान अभिकल्प एवं मानक संगठन
मानक नगर, लखनऊ . २२६ ०११
RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW - 226 011

WDP4B (4500 HP) 3-PHASE (AC-AC) CO-CO DIESEL ELECTRIC LOCOMOTIVE

BRIEF DESCRIPTION OF THE LOCOMOTIVE

The WDP4B locomotive is equipped with a turbocharged 16-cylinder 2-stroke 710 G3B diesel engine. This engine has high fuel efficiency and requires low maintenance. The fuel efficiency of this locomotive is better than the existing locomotives. This engine has many modern features like, laser hardened cylinder liners, unit fuel injectors which eliminate the problematic HP tube, Inconel valves, hydraulic valve adjuster, durable crankcase and piston structure. The diesel engine drives the main alternator.

This locomotive is fitted with Six traction motors which is improved higher tractive effort in comparison of WDP4 (4000 HP). The tractive effort limiting switch has been provided in the driver cab of the locomotive & may be operated by the crew at the time of requirement.

The main alternator TA17 is a 3-phase, 10 pole, 90 slots machine equipped with two independent and interwoven sets of stator winding. The main alternator construction is such that it is basically two alternators in one - two sets of stator windings, permanently connected in series, work with a rotating field common to both the windings in order to provide higher alternator output voltage, which is a basic requirement of a low current high voltage alternator used on AC-AC locomotives. The main alternator converts the mechanical power of diesel engine into 3 Phase Electrical Power alternating current. The internal rectifier bank of the main alternator converts 3 Phase AC Power into DC Power (alternating current into direct current) there by providing a DC power output. The DC voltage output from the main alternator is called the DC link voltage and is applied to the traction inverters. DC link voltage varies with the throttle position from 600 V DC at Throttle - 1 to 2600 V DC at Throttle - 8. The inverter changes DC power into variable frequency variable voltage 3 phase AC power for traction requirement as per the feedback control signals received from LCC & TCC. **WDP4B locomotive is provided with self load test feature, capable of testing full output of the engine.**

The Main Alternator Blower and Traction Motor Blower share a common housing mounted on the front side of the auxiliary generator. Although both the blowers are mounted on the auxiliary generator shaft an internal partition separates the two blower portions. Air is drawn from the central air compartment into the alternator blower close to the auxiliary generator and pass through a duct to the main alternator air box. Air from alternator blower first cools the main alternator rectifier banks then passes internally through the alternator and companion alternator to the engine room. This creates a slight positive pressure to keep the dirt from entering the engine room.

Companion alternator CA6B is a three phase AC steady state alternator of 250 kVA rating, which is physically connected but electrically independent of the main alternator. The companion alternator rotor field is excited directly by auxiliary supply of the locomotive (74±4 V DC). It receives the excitation current from the auxiliary alternator through a pair of slip rings which are located adjacent to the slip rings of the main alternator. The companion alternator develops power whenever the diesel engine is running. The output voltage is directly proportional to the speed of rotation but varies to some extent with change in alternator temperature and load. It is used for excitation of the main alternator as well as for supply to Inertial (dustbin) blower, TCC1 and TCC2 blower motor, TCC electronic blower, 55-220 V AC for radiator fans and various control circuits. An AC auxiliary alternator of 18 kW rating is used for meeting the auxiliary and control system load.

Outside air is cleaned by Inertial (dustbin) blower, before it enters central air cabinet. In the Inertial blower there are two inertial filter panels, one mounted on either side of the locomotive. Outside air is drawn rapidly through the tubes which contains specially designed vanes that induce a spinning motion to the contaminated incoming air. Dirt and dust particles, because they are heavier than air are thrown to the outer wall of the tube and carried to the bleed duct where it is removed by the scavenging action of the Inertial blower and expelled through the roof of the locomotive. The resulting clean air continues on through the smaller diameter portion of the tube where the air is again caused to swirl by internal vanes. The particles are carried to the bleed duct and the resulting clean air enters the central air compartment.

AC-AC transmission has the advantage of high adhesion and high tractive effort, maintenance free 3 - phase AC traction motors, high reliability and availability and higher energy efficiency. Specialty of this motor is that there is no separate stator frame resulting in reduction of weight. In dynamic braking mode, the three-phase motors act as generators and power is fed back to the DC link via the two inverters and gets dissipated in BDR grids.

The Traction Motor Blower mounted on the auxiliary generator, supplies air for traction motor cooling, generator pit aspirator operation, main electrical cabinet pressurisation and traction computer cooling. Air is drawn through a movable inlet guide vane through the blower, and delivered into a duct to the traction motors. A portion of this air is diverted through a set of filters for delivery to the computer module portion of traction inverter cabinets for module cooling. Another set of filters cleans the air used to pressurise the main electrical cabinet.

In EMD and Siemens systems, the locomotive has two traction inverters TCC1 and TCC2 (one inverter per 3 traction motors of a bogie) whereas in Medha systems it has 6 traction inverters (one inverter per traction motor). The output of inverters (pulse width modulated PWM output voltage) is responsible for providing the variable frequency and the variable terminal voltage for the three-phase motors. The main alternator feeds electrical power to the DC link via two series connected diode rectifiers. The TCC blowers defuse heat produced by losses generated in TCCs.

Radiator Cooling Fan Motors are of the inverted squirrel cage induction motor type and are integral part of the cooling fan assembly. Each cooling fan (total two per locomotive) is driven by a two-speed AC motor, which in turn is powered by the companion alternator. Cooling fans are powered through contactors, which are controlled by the locomotive control system. Each fan motor circuit consists of one slow-speed and two fast-speed contactors that are located in the AC cabinet.

The WDP4B locomotive is equipped with a microprocessor based computer control system. It provides fault detection of components and systems, it contains 'self tests' to aid in trouble shooting locomotive faults. It has basic features like, significant reduction in number of control modules, better fault detection of components, memory archive and data snap shot. This system is equipped with a diagnostic display system in the cab to provide an interface between the maintenance personnel and the computer. The computer is programmed to monitor and control locomotive traction power, record and indicate faults that have been incorporated in control system. **One of the special features of the locomotive is that, it is provided with event recorder, which downloads various parameters in control system for later use.**

The locomotive is equipped with computer controlled braking system as per RDSO specification no. MP.0.01.00.20 or MP.0.01.00.24. This system is an electro-pneumatic microprocessor based system. The overall purpose of using a computer (microprocessor) to control the air brake system is to eliminate as many of the electrical and mechanical devices as possible, there by reducing periodic maintenance, simplifying trouble shooting, fault diagnostics etc. It allows greater reliability and flexibility for future system upgrade.

WDP4B locomotives are provided with a special feature called blended brake. The purpose of blended brake system is to maximize the use of dynamic braking. This is accomplished by causing dynamic braking to go its maximum value whenever blending is requested. Once the amount of asking brake effort is determined, the maximum amount of dynamic brake effort is determined from the flat top portion of dynamic brake curve. The amount of dynamic brake effort present at that time, then determines how much air brake cylinder pressure must be applied to complement the dynamic brake effort. This becomes the air brake cylinder reference value, which in turn, maintains the asking locomotive brake effort.

Each unit of the Dynamic Brake Grid Blower Assembly consists of fan assembly powered by a 36 HP series wound DC motor. During dynamic braking, a portion of the current (rectified DC) from the traction motors is shunted around one of the resistor grids and used to power the grid blower motor. Air driven by the grid blower drives grid heat to atmosphere.

The WDP4B locomotive is equipped with a **high adhesion HTSC (High Tensile Steel Cast) truck or bogie**. The bogie assembly supports the weight of the locomotive and provides the means for transmission of power to the rails. The HTSC bogie is designed as a powered 'bolsterless unit'. Although the bogie or truck frame itself is rigid, the design allows the end axles to move or "yaw" within the frame. This movement will allow the wheels to position themselves tangent to the rails on curves for reduced wheel and rail wear. Axles 1 and 3 can move or kink a little bit to negotiate a curve from 0-8 degree deflection, increases the tractive effort and improves the rolling resistance. Traction loads are transmitted from the truck or bogie to the locomotive underframe through the carbody pivot pin assembly. **Each bogie is equipped with Three unidirectional AC traction motors for better adhesion characteristics**. The motors are geared to the driving axles, which in turn apply rotational force to the rails through the wheels. The driving force is transmitted to the bogie through tractive rod attached to the journal-bearing adapter in the frame. From the truck / bogie frame the driving force is transmitted to the locomotive carbody through the carbody pivot pin.

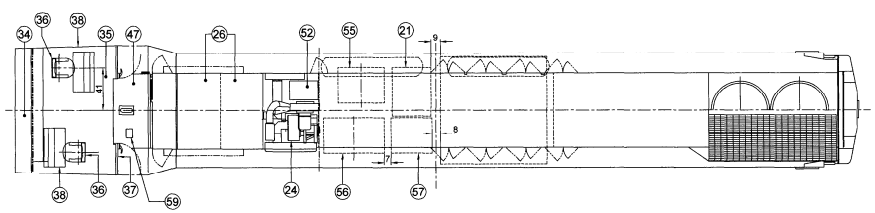
Each locomotive is an independent power source. Several units may be combined for multiple operations to increase the load capacity.

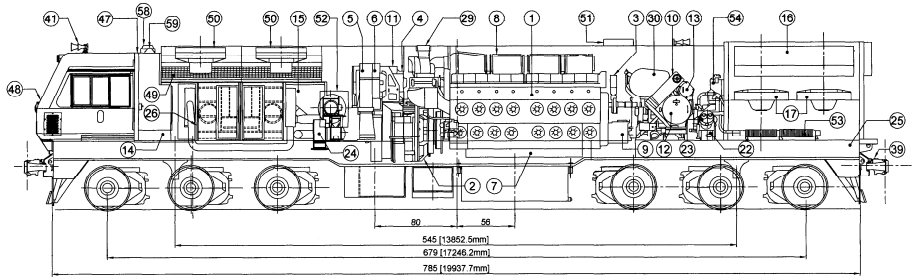
The WDP4B locomotive has been designed on the 'platform' concept which means that the layout and the mounting of equipment is arranged in such a manner that retrofitment of equipment developed in future on existing locomotives as well as equipment changes/upgradation of the existing design of the locomotive can be implemented without any major change in the underframe, structure and even layout.

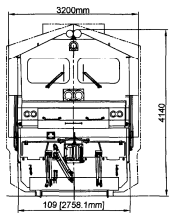
Total no. of locomotives turned out by DLW is 77 (Medha 55 locos, EMD 13 locos and Siemens 5 locos).

Some special features:

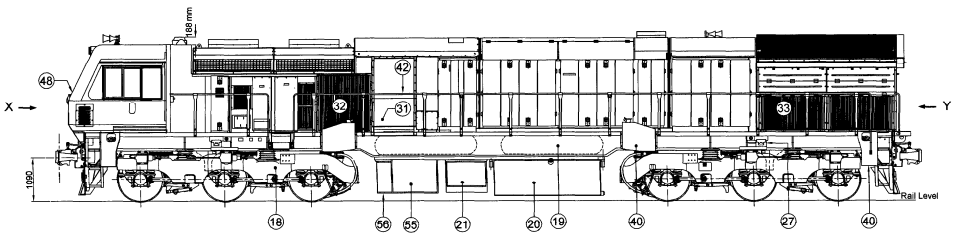
- Cattle guards have been fitted in both side of the locomotive
- E –type coupler & long life side buffer
- Parking brake has been provided in rear bogie.
- Single block brake system which utilizes one composition block at each wheel.
- Flasher light have been provided in locomotive
- LCC drives the load ammeter, VCD & speedometer mounted on the drivers control desk. These outputs are electrically isolate from CPU & have short circuit protection.
- The loco has been provided with wheel slip control device, which maximize the adhesion performance by using creep control philosophy. Speed sensor mounted on the traction motor provided speed signals.







VIEW FROM DIRECTION 'X'



	REF. NO.	DESCRIPTION	REF. DRG. NO.
(b)	59.	REMMLOT ANTENNA HOOD	-
(b)	58.	DPC ANTENNA HOOD	-
(b)	57.	CONTACTOR UNIT	-
(b)	56.	CHOPPER UNIT	-
(b)	55.	INVERTER UNIT	-
	54.	FLANGE LUB RESERVOIR	10633402
	53.	FINNED AFTER COOLER	10633915
	52.	INVERTER & CHOPPER UNIT BLOWER	-
	51.	VENT	9510360
	50.	DYNAMIC BRAKE FANS	9518890
	49.	DYNAMIC BRAKE GRIDS	10634215 & 10634216
	48.	HEAD LIGHT	8247096
	47.	ELEC. CONTROL CABINET (ECC#1)	10635207
	46.	HATCH GEN/TURBO (REMOVABLE)	10631906
	45.	HOOD INERTIAL FILTER	10630495
	44.	HOOD COOLING	10630497
	43.	HOOD ENGINE (REMOVABLE)	10630496
	42.	HAND RAILS	10630508
	41.	HORN	10585230
	40.	SAND BOXES	10631707, 10632192 10632193 & 10634876
	39.	E/F TYPE COUPLER	10632625
	38.	ENGINEER'S CONTROL CONSOLE	10630919
	37.	CAB DOOR	LD101052 & LD101206
	36.	CAB SEAT	TPL-3473
	35.	CAB	LD101100
	34.	AIR BRAKE RACK	10631944
	33.	COOLING SYSTEM (AIR INLET)	
	32.	AIR INLET (INERTIAL FILTER)	
	31.	BATTERY SWITCH BOX	10632217
	30.	WATER TANK	10634362
	29.	EXHAUST	10633381
	28.	M.U.RECEPTACLE (BOTH ENDS)	8242444
	27.	JACKING PAD	8179065
	26.	Ref P.Spec No. MP-0.0800-73(Rev-00)	
	25.	UNDERFRAME	LD100851
	24.	DUST BIN BLOWER & MOTOR	10622188
	23.	AIR COMPRESSOR	40017843
	22.	AIR FILTER, COMPRESSOR	10631301, 10632775 & 10632646
	21.	BATTERY BOX	-
	20.	FUEL TANK (5000 ltr)	LD101500
	19.	MAIN AIR RESERVOIRS	40054147
	18.	TRUCKS HTSC (S.S.BRAKES)	
	17.	COOLING FAN	10632019
	16.	RADIATORS	10631855 & 10631856
	15.	FILTER (INERTIAL)	10633569 & 10633570
	14.	FILTER (ELEC. CONTL CABT AIR)	
	13.	FILTER (PRIMARY FUEL)	10636643
	12.	FILTER (LUBE OIL)	10632405
	11.	FILTER (ENGINE AIR)	
	10.	LUBE OIL COOLER	9500308
	9.	LUBE OIL STRAINER	8269263
	8.	EXHAUST MANIFOLD	9316235
	7.	OIL PAN	40061287
	6.	GEN/ALT BLOWER	
	5.	TRACTION MOTOR BLOWER	10631613
	4.	AUX GEN 16KW A/C	10649239
	3.	GOVERNER	
	2.	GEN/ALT (TA17WBA/CA6B)	40046115
	1.	ENGINE ASM 16-710G3B	9547976

NOTE:-

1. ALL RELATIONSHIP DIMENSIONS ARE AS PER RESPECTIVE GM APPLICATION DRAWING.
2. THIS DRAWING SHOULD BE READ IN CONJUCTION WITH RDSO PARTICULAR SPEC. NO.MP-0.0800-73(REV-01) FOR ANY DETAIL NOT PRESENT IN DRG.
3. THIS DRAWING IS ALSO APPLICABLE FOR THOSE LOCOMOTIVES WHICH ARE NOT FITTED WITH DPC/REMMLOT OR HOTEL LOAD OR ROTH.(ITFM N/O -55,56,57,58,59)
4. *FUEL TANK AND BATTERY BOX REPOSITIONED DUE TO FITMENT OF HOTE LOAD EQUIPMENT.

D	Sd- Sanjay						
C	Sd- A.C.Tripathi						
DO	Sd- A. MISRA						
APPD.	Sd- Anil Kumar						
DT.	Nov-07						

ALT	NO.OF PLACES	REF. NO.	DESCRIPTION	ALT.NOTE NO.	SIGN.	DATE
b	-	-	*DPC/REMMLOT & HOTEL LOAD FEATURE ADDED	L2-1012		07-10
a	-	-	DRAWING REVISED	L2-997	Sd-	01-08

APPLICABLE FOR	WDP4B LOCO
GENERAL ARRANGEMENT	
SCALE NTS	REF.
FIRST ISSUED	
INDIAN RLYS.	
R.D.S.O. (M.P)	
DRG. NO.	SK.DL - 4684
SUPERSEDES	
SUPERSEDED BY	

DIFFERENCES BETWEEN WDP4 & WDP4B				
Sl. No.	**WDP4**	**WDP4B**		
1	Horse Power - 4000	Horse Power - 4500		
2	Max. speed – 160 Km/h	Max. speed – 140 Km/h		
3	Axle load – 19.5 T	Axle load – 20.2T		
4	No. of Motors - 4	No. of Motors - 6		
5	Max. Tractive effort – 27550 Kg.	Max. Tractive effort – 40775 Kg.		
6	A-A-I I-A-A Bogie	CO – CO Bogie		
7	Siemens traction motor 1TB – 2622 - 0TB02 • *Gear ratio : 17:77* • *Max. power – 765 kW,* • *Max. speed – 3776 rpm*	**Make**	**Siemens**	**EMD**
		Type	1TB-2622-0TA02	A 2916-8
		Gear Ratio	17:77	17:77
		Max Power	600 KW	630 KW
		Max speed	3320	3200
8	Traction Motor Blower • *Air flow requirement – 1.2 m³/s* • *Cfm - 12450* • *Static pressure – 14.3 inch w.g.* • *BHP – 65*	**Traction Motor Blower**		
		Air flow requ.	1.2 m³/s	1.42 m³/s
		CFM	15400	16800
		Static pressure	13.7 inch	17.5
		BHP	113	120

MAIN PARTICULARS OF WDP4B LOCOMOTIVE

GENERAL		Injection System		
Weight of loco in Working Order (T)	121.2	Type	Direct unit injector	
Adhesive weight in Working Order (T)	121.2	Displacement / cyl.	11635 cm²	
Axle load (T)	20.2	**Turbo Supercharger**		
Wheel dia (new) Driving mm.	1092	Make and type	EMD Model G	
Tractive effort (Kg.), Maximum	40775	Weight of turbocharger	953 Kg.	
		TRANSMISSION (ELECTRICAL)		
Speed (Km/h) Maximum	140	**Traction Alternator**		
		Make and type	GM TA-17	
Transmission	AC – AC	Number per locomotive	One	
ENGINE		Maximum speed	954 rpm	
		Max. Voltage	2600 V DC	
Make and type	710 G3B	Max. continuous current	1250 A DC	
No./Loco	One	**Companion Alternator**		
Governor	Woodward	Make and type	CA 6B	
Weight of engine (dry)	17963 Kg.	Max. Voltage	230 V AC	
Number of cylinders	16	Frequency at 954 rpm	127 Hz	
Cylinder formation	45 degree V type	Max. power	250 kVA	
Bore and stroke in mm	230.19 x 279.4	Unit weight(TA & Comp. alternator assly.)	8709 Kg approximately	
Mean piston speed m/sec	8.38	**Traction Motor**		
BMEP at rated output	11.23			
Compression ratio	16 : 1	**Make**	**Siemens**	**EMD**
Lube oil sump capacity	1073 Litre	Type	1TB2622- 0TA02	A 2916-8
Lube oil pan, from bottom to top dipstic	371 Litre	Number per locomotive	6	6
Horse Power		Continuous voltage/Current/ Nominal rating	1520V/202A/425 KW	1550V/265A/630 KW
AAR condition	4500			
At Site (47°C – 600m)	4400	Maximum speed	3320 RPM	3200
Input to traction	4150	Gear ratio	17:77	17:77
RPM		Suspension	Axle hung	Axle hung
Rated	954	Motor, Complete weight	2120 Kg	2061.58 Kg
Idle / Low idle	269 / 200	**AUXILIARIES**		
Cooling system		**Auxiliary generator**		
Water Pump type	Centrifugal	Make and type	GM, 5A – 8147	
Water pump capacity	3411 l/m at 900rpm	HP absorbed	18 kW	
No. of radiator fans	Two	Rating	74 V DC, 904 rpm	
Fan drive	AC motor			
Fan power	113.4HP			

MAIN PARTICULARS OF WDP4B LOCOMOTIVE

BATTERIES		COMPRESSOR	
Make and type	SURRETTE, 16 CH-25 Unitized	Make	GARDENER DENVER (GD) & ELGI
Number of cells	10	Type	Water – cooled, two stage, 3 cylinder (Model – WLNA 9BB & RR66101 W
Arrangement	2 series connected 5 cell Ni-Cadmium Shaft-Nife SRX1500P batteries	Free Air Delivery (FAD)	GD make – 170 SCFM at 900 rpm & 35 CFM at 200 rpm ELGI make – 200 CFM at 950 rpm & 35 CFM at 200 rpm
Voltage	72.5 VDC	Lube oil capacity	GD : Maximum -11.63 lit ELGI: Maximum 12 lit & 6 lit minimum.
Capacity	150 AH	Weight	1043 Kg
Head light	200W, 30V PAR-56 standard bulb		
BRAKES			
Locomotive	Air, Hand, Dynamic Brakes fully Blended with Automatic Brakes.		
Train	Pure air brake system.		
System	KNORR/NYAB CCB equipment.		
CONTROL SUPPLIES			
Fuel tank (detachable)			
Number per locomotive	One		
Total capacity	5000 litres		
Sand			
Number of boxes / Locomotive			
Total capacity	0.028m^3 Box (1.0 cubic ft. / box)		

Comparative study of TCC's of different make on WDP4B locomotive

Features	MEDHA	SIEMENS	EMD
Type of control	Individual motor control Six traction invertors for each traction motor	Individual bogie control Two traction invertors one for each bogie, PWM Invertor, 3KV, 900Amps	Individual bogie control Two traction invertors for each bogie
IGBT Devices	ABB make, 5SNA 0600G650100, VCES =6.5 KV, IC=600Amps. 2 devices/phase module	ABB make, 5SNA1200G450300, VCES =4.5 KV, IC= 1200 Amps. 6 devices /phase module	Mitsubishi make, SD70 Ace, VCES =4.5 K V, IC=1200Amps, 4 devices /phase module
Device Cooling	Primary: Through heat pipe liquid circulation Secondary: Air cooling by TCC Blower	Air cooling by TCC Blower	Air cooling by TCC Blower
TCC Blower	6	2	2
DC Link isolation	DC link isolator within TCC	DC link disconnector is within TCC Q8,Q9 (2 Nos)	DC link CB is in ECC#1
LCC	Loco Control Computer is in ECC#1 (MLC- 691) Traction Control Computer is in TCC (MTCC)	Loco Control Computer H/w (SIBAS 32S) & S/w and Traction Control Computer H/w & S/w – both are in TCC	Loco Control Computer EM2000 Traction Control Computer (MPU) both are in ECC#1
DC Link Capacitors	6	4 (C1,C2,C3,C4)-1.75 mf	8 (each 550 µF)
Hotel Load Invertor	Under slung if provided	In TCC	-
Crow bar protection	Brake Chopper	Yes	Yes
Display Unit	VFD	Graphical Display Unit with TFT Screen.	VFD

HAULAGE CAPACITY (PASSENGER)

Locomotive:- WDP4B (4500 HP) | **Track condition: Dry Rail** | **WT OF LOCO : 121.2 t**

Trailing load in tonnes at Km/h on tangent track, ICF stock (With 0.005m/sec² acceleration reserve)

GRADE	20	30	40	50	60	70	80	90	100	110	120	130	140
LEVEL	22920	16065	10515	7390	5445	4140	3230	2560	2060	1675	1375	1135	940
500	10385	7825	5445	4040	3115	2470	1995	1635	1350	1125	945	795	665
400	9125	6925	4855	3620	2810	2240	1815	1495	1240	1040	870	735	620
200	5665	4385	3125	2370	1870	1510	1245	1035	870	735	620	530	445
150	4505	3510	2515	1915	1515	1230	1015	850	715	605	515	440	370
100	3185	2495	1795	1375	1090	890	735	615	520	440	375	315	265
50	1660	1300	930	710	560	450	370	305	255	210	175	145	115

NOTE :

- Values of trailing tonnages given in the chart are the maximum permissible values. Values are applicable for straight track only. On a curved section actual permissible load will be less than the values specified above. Actual permissible loads should be fixed based on load trial.
- Trailing loads fixed by load trail should be confirmed by load factor trial also and the loads recommended should be such that the load factor does not exceed 60%.

D	Sudhakar Kumar, SSE (D)
C	Pankaj Saxena, ADE/EM
APPD.	S. Panwar, Dir/MP/EM
Date	04.04.2014

RDSO (MP)	**DE/T – 409 (A) (Rev. – 01)**

Tractive Effort Vs Speed characteristics(AAR Condition)

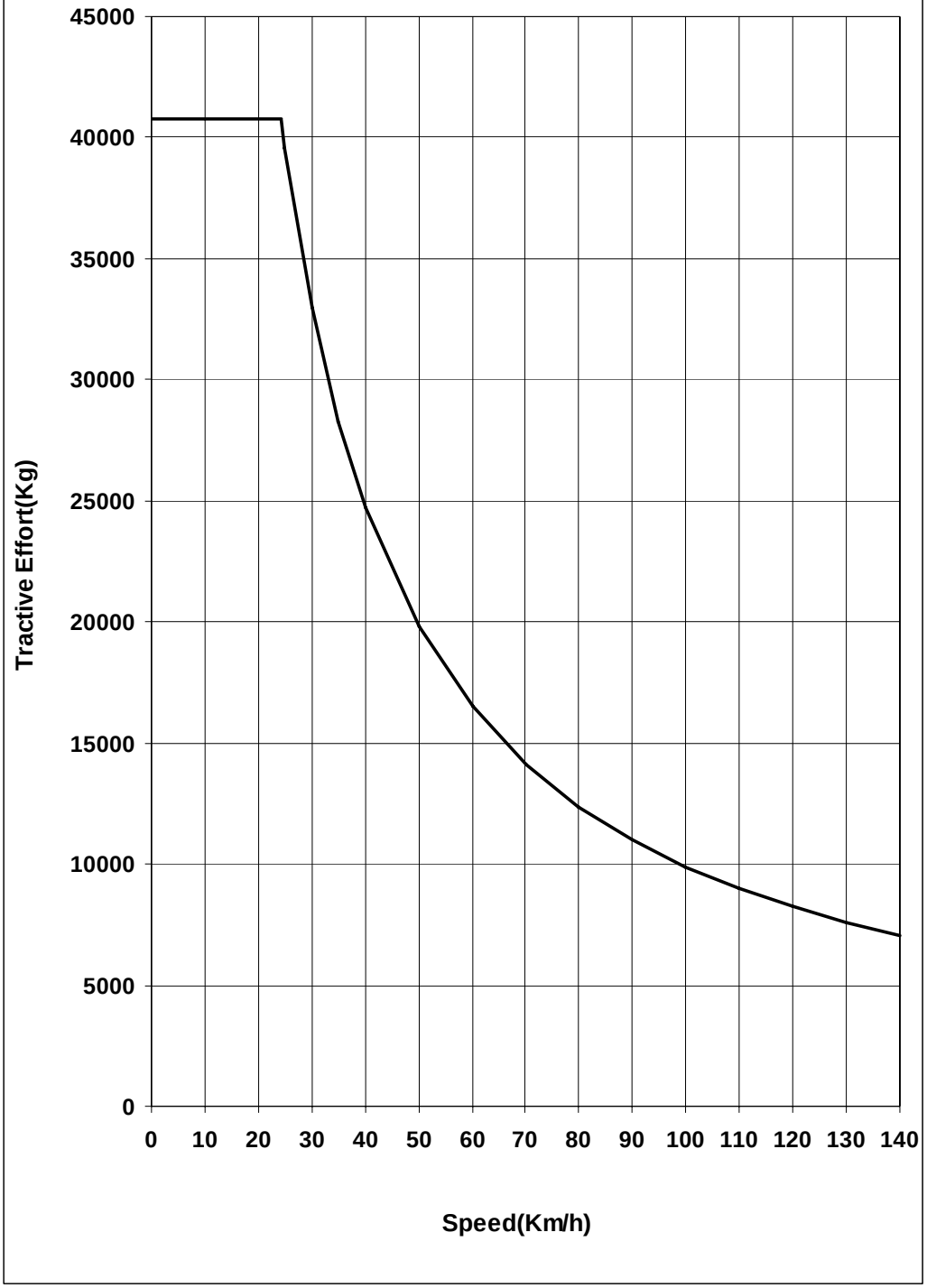
4500 GHP WDP4B Diesel Electric Locomotive

One Traction Alternator type TA17

Six Traction Motor type ITB 2525 or equivalent

Gear ratio : 17:77, Wheel Dia. : 1054mm (Half Worn)

Starting Tractive Effort : 40775 Kg.

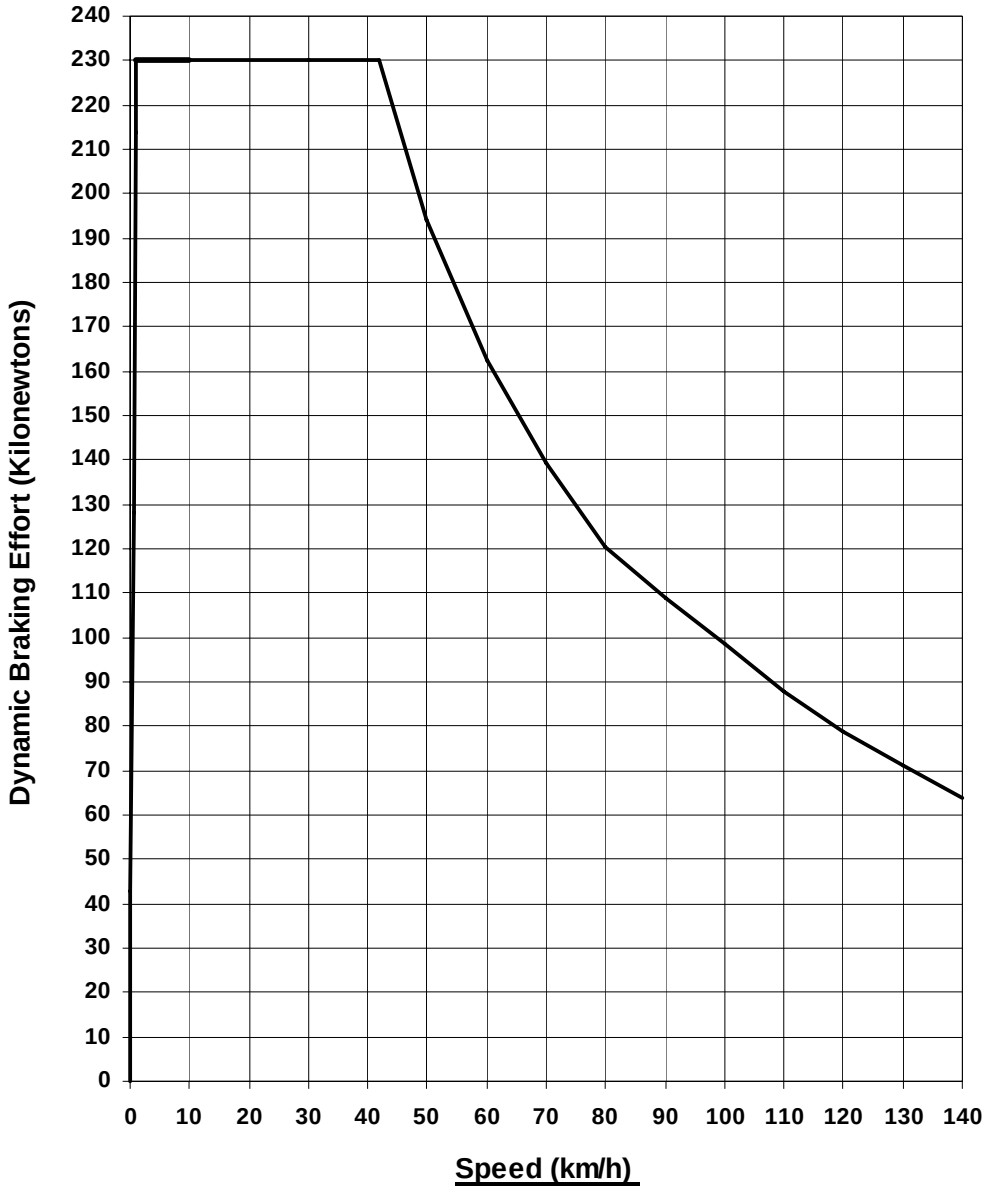


DYNAMIC BRAKING CHARACTERISTICS OF 4500 HP BG DE WDP4B LOCOMOTIVE

Traction Alternator: TA17 at 950 rpm

Traction Motor: 1TB- 2525-0TA02(six)or Equivalent

Gear Ratio: 77:17, Wheel Dia: 1055 mm (HW)



Note: **The maximum dynamic braking effort estimated in the chart is based on electrical parameters of the loco. Actual effort may vary slightly depending upon the adhesion.**