

***INTRODUCTION
TO
ELECTRIC
LOCOMOTIVE***

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1st Generation Electric Loco

	WAM1	WAM2	WAG3	WAG4
Year of Comm.	1960	1961	1965	1967-69
HP	2870	2790	3150	3150
Axle Load	18.64 T	19.17 T	21.8 T	21.9 T
Hauling Capacity	25.0 T (Max.)	25.24 T (Max.)	30.0 T (Max.)	30.0 T (Max.)
Max. Speed	100	110	80	80
Other features	15.9 mt in length, AC Aux.	15.0 mt in length, AC Aux.	17.0 mt in length, DC Aux.	17.2 mt in length, AC Aux.

2nd Generation Electric Freight Loco

	WAG5	WAG5 (HB)	WAG7	WAG9
Year of Comm.	1980	1980-83	1992	1996
HP	3850	3850	5000	6000
Axle load	19.8 T	19.8 T	20.5 T	20.5 T
Hauling Capacity	33.5 T (Max.)	33.5 T (Max.)	42.0 T (Max.)	46.8 T (Max.)
Max. Speed	100*	80	100*	100
Other features	19.97 mt in length, TAO 659 motor	19.97 mt in length, HIT motor	20.4 in length, CLW motor	3 - Ph AC drive, Regeneration
* For Passenger, 80 for Goods				

2nd Generation Electric Passenger Loco

	WAM4	WAP1	WAP4	WAP5
Year of Comm.	1971	1981	1994	1996
HP	3640	3800	5000	5440
Axle Load	18.8 T	18.0 T	18.8 T	19.5 T
Hauling Capacity	30 T (Max.)	22.4 T (Max.)	30.8T (Max.)	26.3 T (Max.)
Max. Speed	110	130	130	160*
Other features	TAO motor	TAO motor	HIT motor.	Bo-Bo type, 3Ph. AC, Regn

* At present working at Maximum speed of 130 Kmph.

Equipments of Tapchanger Locos

(WAG7 – WAP4)

➤ ARNO

➤ TRANSFORMER

➤ RECTIFIER

➤ SMOOTHING REACTOR

➤ TRACTION MOTOR

➤ CIRCUIT BREAKER

ARNO

1. Rating	120/150 KVA, 415 Volt. 3-Phase (Output)
2. Utility	Converts Single Phase 415 volts to 3-Phase
3. Functioning	A 3-phase stator winding with 1-phase having 20% more resistance – this helps in starting with single phase.
4. Location	Provided in the H.T.Compt. near Cab-2 side
5. Physical parameter	This is vertically mounted on the floor with self cooling fan.

TRANSFORMER

1. Rating	5670 KVA – 20.5 KV / 1000 Volt. Single phase forced oil air cool.
2. Utility	Supply low voltage high current at start to traction motors through rectifier.
3. Functioning	It has 4 windings – Auto, Primary, Secondary & Auxiliary mounted on 3 legs.
4. Type	HETT - 5400
5. Location	At the centre of the H.T.Compartment.
6. Physical parameter	Weighs 12.2 T & has 32 tap positions on Auto transformer.

RECTIFIER

1. Rating	2700 Amps. Each block, 1050 Volt.
2. Utility	Supplies DC power to the traction motor.
3. Functioning	64 diodes per bridge. 2 series, 8 parallel,
4. Type	S18 FN350
5. Location	In H.T.Compartment near to transformer.
6. Physical parameter	2 blocks connected in parallel (AC side)

SMOOTHING REACTOR

1. Rating	1250 Volt, 1050 Amp.
2. Utility	To reduce ripple content from rectified DC
3. Functioning	Provided with inductive coils with low resistance and high inductance.
4. Type	SL- 30
5. Location	Under Slung
6. Physical parameter	Inductance 2.68 milli Henry.

TRACTION MOTOR

1. Rating	630 KW, 750 Volt, 900 Amps continuous rating.
2. Utility	Axle hung nose suspended forced cool motor with H-Class insulation.
3. Functioning	All traction motors are in parallel in a bogie.
4. Type	HS 15250A
5. Location	Bogie mounted Axle hung.
6. Physical parameter	Bull gears of each bogie are oppositely aligned.

Equipments of 3-Phase Loco

- ❖ Main Transformer
- ❖ Line Converter (GTO)
- ❖ DC Link Capacitors
- ❖ Driver Converter (GTO)
- ❖ Traction Motor
- ❖ 3 Stage Control Electronics

Main Transformer

- 25 Kv Primary, 1269 Volt Traction Secondary, 1000 Volt Auxiliary & Harmonic Filter winding.
- Forced Oil & Air Cooling.
- Mineral Transformer oil is used, maximum allowed oil temperature is 150 °C.

Line Converter

- Converts constant frequency AC voltage from Transformer into DC voltage.
- GTO thyristors are used.
- Semi conductors and all snubber circuits are installed in the valve set tank, which is oil cooled.
- Reverses function during regeneration. Inverts DC voltage to 50 Hz AC voltage.
- Regenerated voltage is kept leading w. r. t. line voltage.

DC Link Capacitor

- Consists of 14 nos. of electrolytic capacitor of 2.8 kV DC capacitors connected in parallel.
- DC Link capacitors maintain constant DC link voltage and are protected against over voltage.
- Capacitance value is $11.4 \text{ mF} \pm 0.6 \text{ mF}$.

Drive Converter

- This connects DC link to 3-phase traction motors.
- While on traction/regeneration it can set variable voltage and frequency.
- It has seven GTOs including a protection GTO for DC link over voltage.

Traction Motors

- Asynchronous Squirrel cage traction motor.
- 3 traction motors of one bogie are connected to one converter unit.
- One traction motor blower for cooling of 3 traction motors.
- Each traction motor equipped with two temperature and two motor speed sensors.
- Horse Power to weight ratio is 0.54, each motor is rated 1156 HP, 2180 Volt, 270 Amps.

3-Stage Control Electronics

- **Train Bus** : Highest level - information regarding train formation etc.
- **Vehicle Bus** : Mid level – information regarding vehicle control.
- **Converter level** : Lowest level – controls power to be remitted at rail wheel interface – exchange information with the two upper levels.

Advantage – 3 Phase

Item	3 Phase loco	Tap Changer loco
Traction	Smooth, Co.of.adh highest.	In steps of 32 volts. Low Co.of.adh.
Braking	Regenerative, braking effort same as tractive effort. BE increases as speed decreases.	Rheostatic- current in resistance grid limits braking effort. BE Low at low speeds.
Acceleration	High HP/WT ratio of TM & higher Co.of. adh lead to higher capacity of locomotive. (0.54)	Limitation of size of TM due to low HP/WT ratio of TM. (0.23)

Advantage – 3 Phase Cont.

Item	3 Phase locomotive	Tap Changer loco
Driving	Driver friendly. Most of the functions are automatic.	Driver interference at each stage.
Diagnostic feature	Displays relevant parameter on run. Stores all data during any failure. It can display fault message.	Diagnostic feature Absent.
Economy in operation	Saves energy while braking 16-18%. Draws power at unity p.f	It can not regenerate. Draws power at 0.85 p.f.

Maintenance Schedule of Electric Locomotive

Nature of Inspection	Approx.Time Required	Place of Maintenance
Trip Inspection	02 Hours	Out pit / Out station
Monthly Inspection IA	06 Hours	Home shed
Bi - Monthly Inspection IB	08 Hours	Home shed
Before Quarterly Inspection IAC	06 Hours	Home shed
Quarterly Inspection IC	12 Hours	Home shed
Annual Inspection AOH	07 Days	Home shed
Intermediate Overhauling IOH	15 Days	Home shed
Periodic Overhauling POH	30 Days	Nominated Work shop

Thank You

