

## Lesson No. 1

### HEAT ENGINE

**Heat engine** - Heat engine is the machine which converts heat energy into mechanical energy. Heat engine are of two types.

**a. External combustion engine** - In External combustion engine fuel is burnt or ignited outside the engine cylinder. So it is called as external combustion engine e.g. Steam engine.

**b. Internal combustion engine** - In internal combustion engine fuel is burnt or ignited inside the engine cylinder so it is called internal combustion engine e.g. Petrol engine, diesel engine.

They are of two types

**a. Spark ignition engine** - In this type of engine fuel is injected along with air in the cylinder and after compression this mixture is given electric spark due to which fuel starts burning and produces power. e.g. Petrol engine

**b. Compression ignition engine** - It is an engine in which the fuel is ignited in to charge of compressed air and ignited spontaneously by the high temperature of the air induced by the heat of compression. e.g. Diesel engine.

**Combustion** - Burning of fuel with air is called combustion.

**Piston stroke** - The movement of piston from top dead centre to bottom dead center is called the piston stroke.

**Dead centre** - The place beyond which the piston cannot move further in a cylinder is called dead center.

**Top dead centre** - The end towards the head of the cylinder is called top dead center.

**Bottom dead centre** - The end towards the base of the cylinder is called top dead center.

**Total Volume** - The area between piston and cylinder head when the piston is at BDC is called total volume.

**Swept Volume** – When the piston travel during one stroke then the area covered by it, is called swept volume.

**Clearance Volume** – The area above piston when it is at TDC is called Clearance Volume.

**Compression ratio** - The ratio of total volume and clearance volume is called compression ratio.

$$\text{Compression Ratio} = \frac{\text{Total volume}}{\text{Clearance Volume}}$$

Total volume = Swept volume + clearance Volume

**Diesel cycle** - In the compression ignition engine to convert heat energy into mechanical energy the following actions takes place in fixed sequence, when this action is completed once is called Diesel cycle.

- a) **Suction** – In this atmospheric air enters in to the cylinder.
- b) **Compression** - The air inside the cylinder is compressed with the help of piston due to which pressure increases resulting in rise in temperature.
- c) **Fuel injection** - Injection of fuel in atomized form at right time when air is at high temperature.
- d) **Power** - When fuel burns inside the cylinder the heat energy is discharged leads piston to move downwards.
- e) **Exhaust** – The gasses produced in cylinder is exhausted to atmosphere.

**Depending upon the cycle diesel engine is classified into two types.**

**1) Two stroke Engine** - In this engine one cycle is completed by two piston strokes. All four actions (Suction, compression, power and Exhaust) are completed in one revolution (  $360^{\circ}$  ) of the crankshaft  
In this cycle piston starts from BDC and every downward stroke is power stroke, to complete one stroke the crankshaft rotates  $90^{\circ}$  only.

- a) **Suction** - when piston is at BDC fresh air or mixture (petrol and air) is admitted into the cylinder from ports specially provided in cylinder liner.
- b) **Compression** - when piston travel in upward and cover the ports, compression starts and completes when piston reaches TDC.
- c) **Power** - When the piston reaches TDC at this time fuel is injected into the cylinder in atomized form, exhaust gases are produce and push the piston downwards. In this stroke piston travels from TDC to BDC.
- d) **Exhaust** - When piston travel half distance during downward stroke either exhaust valve or exhaust port open and exhaust gases goes out. This stroke completes when piston reaches BDC.

**2) Four stroke Engine** - In this type of engine the cycle completes in two revolution of the crankshaft ( $720^{\circ}$ )

a) **Suction stroke** - In this stroke piston moves from TDC to BDC during this time inlet valve is open and exhaust valve remains closed and the air from the V gallery enters into the cylinder through inlet valve.

**b) Compression stroke** - In this stroke the piston moves from BDC to TDC both inlet and exhaust valve will remain close. Air in the cylinder is compressed due to which the temperature and pressure increases. Before the piston reaches at TDC the fuel is injected into the cylinder through injector in atomization form, fuel starts burning.

**c) Power stroke** - when the fuel burnt gases are created this tends the piston move from TDC to BDC. In this stroke both exhaust and inlet valve close. Before reaching to the BDC, Exhaust valve opens.

**d) Exhaust stroke** - In this stroke piston travels from BDC to TDC this time inlet valve remains closed but exhaust valves are opened and gases go out.

**Scavenging:** It means kick out the residual exhaust gases from cylinder with the help of fresh charge air. It is essential in super charged engine that the cylinder be adequately scavenged before the fresh air charge is compressed otherwise such charge is contaminated by the residual exhaust gases from the previous cycle.

### Different between two stroke and four stroke engine

| Two stroke  | Four stroke   |
|---|---|
| The cycle of operation is completed in 2 stroke of the piston i.e. one revolution of the crankshaft | The cycle of operation is completed in four stroke of piston i.e. in two revolution of crankshaft |
| Every revolution of crankshaft have power stroke  | One power stroke is obtained into two revolution of crankshaft.                                   |
| Lube oil consumption rate is high.  | Lube oil consumption rate is low.   |
| Engine working capacity is less.  | Engine working capacity is more.  |
| Two strokes are noisier and wear & tear is more.  | It makes less noise and wear & tear.  |
| It is light in weight.  | It is heavy in weight   |
| Compression ratio is less.  | Compression ratio is more   |
| Thermal efficiency of engine is less.   | Thermal efficiency of engine is more.   |
| It requires less space.   | It requires more space.   |
| Ports are available on cylinder liner.  | Ports are not available on cylinder liner.  |
| Less vibration.   | More vibration.   |
| Its design is simple  | Its design is complicated.  |

## Lesson No. 2

### POWER PACK

#### Specialty of WDG/3A loco engine

1. 251-B Up rated type
2. 'V' type cylinder arrangement
3. Total 16 cylinder
4. Four stroke cycle
5. Single acting
6. High speed
7. Water cooled
8. Force lubricated
9. Super charged
10. Quality governor
11. Solid injection fuel supply

#### Main parts of engine block

1. Cylinder blocks
2. Main crank shaft
3. Cylinder liner
4. Piston rings & connecting rod
5. Camshaft & camshaft gear
6. Push rod
7. Main Bearing
8. Cylinder liners
9. Cylinder head & valve
10. Piston rings & connecting rod
11. Fly wheel
12. Rocker arm assembly
13. 'V' gallery
14. Vibration damper
15. Exhaust manifold

#### Description

In WDG-3A locomotive 251-B up rated engine is fitted. Cylinder block of these engine posses by sixteen cylinders, eight on each side (left and right) and arranged in "V" shape. This cylinder block is made of steel plates welded together and mounted on crankcase with the help of nuts and bolts. This cylinder block support main crank shaft and two cam shaft inside. Engine block having V gallery, it is called air intake manifold, each cylinder is connected to manifold with the help of inlet elbows. Each cylinder has a cylinder liner, piston and connecting rod, cylinder head with two inlet and exhaust valves, one fuel injector and rocker arm assembly.

In engine block a main crank shaft made up of steel alloy is fitted in one piece. It has 9 main bearings and 8 crank pins. On every crank pin two connecting rods are connected, the other end of connected rod is connected with Piston with the help of piston pin. Fly wheel is fitted on one end of the main crank shaft and vibration damper on the other end. On fly wheel end main generator is connected, this end is called power take off end and opposite end is called free end.

Two cam shafts are provided in engine block on both sides, each shaft has made of four pieces and each piece has two pairs of three lobes. Camshaft is driven by its gear (104 teeth) matching with split gear (52 teeth). Split

gear is provided on main crank shaft at power take off end. In 3 cam lobes, left side cam operate inlet valves, right side cam operate exhaust valves and middle cam operates fuel injection pump.

Each cylinder has a piston which is made of Aluminum with steel cap, piston has two ends, top end is called piston crown and bottom end is piston body. Piston body has three compression rings and two oil scraper rings. Piston is connected to connecting rod with piston pin. Oil grooves are provided to cool the piston with lube oil.

Cylinder liner made of cast iron is fitted in each cylinder. Honey combs are provided on the inside surface of the liner for lubrication purpose. Liner is covered with water externally, 'O' ring is provided in between liner and cylinder block to avoid water leakage.

In each cylinder head two inlet valve, two exhaust valve, one fuel injector and rocker arm assembly is fitted. Cylinder head kept cool with water. Cylinder head is covered with Tapped cover. Inlet valve is connected to "V" gallery through inlet elbows. Exhaust valve is connected to exhaust manifold through exhaust elbows. Rocker arm assembly operates inlet and exhaust valve. Inlet valve, exhaust valve and fuel injection pumps are operated according to their valve timing.

Crank case sump is provided below engine block, which called lube oil sump. Crank case explosion door, crankcase exhaustor motor and OSTA are provided to safeguard engine block.

### **Working:**

When main generator works as a motor and main crank shaft rotate than piston gets movement through crank pin, connecting rod. Cam shaft rotate with the help of cam shaft gear and inlet valve, exhaust valve, fuel injection pump are operated according to valve timing.

When piston moves from TDC to BDC inlet valve will open and fresh air from "V" gallery enter in cylinder it is called suction stroke.

When piston moves from BDC to TDC that time inlet and exhaust valve remain closed and air gets compressed and temperature raised is called compression. Before reaching to TDC fuel inject in the cylinder through fuel injector.

Fuel starts burning and compels the piston to move from TDC to BDC which makes connecting rod, crankpin to rotate main crank shaft, it is called power stroke.

When piston at BDC exhaust valve will open and piston moves from BDC to TDC and piston pushes the exhaust gasses to evacuate through exhaust valve, exhaust elbow, manifold and TSC chimney.

Before piston reaching to TDC inlet valve also opened and fresh air enter in cylinder to push exhaust gasses and makes piston to cool, it is called scavenging. Time interval, when Inlet and exhaust valve are in opened condition is called crankshaft overlap period.

All 16 cylinder power firing order is 1-4-7-6-8-5-2-3 from Right to left for steady rotation of main crankshaft.

Governor is provided for controlling of fuel oil supply. Cooling water system is provided to cooling of diesel engine. Lube oil system is providing to lubricate diesel engine equipment. TSC is provided for diesel engine super charging.

### Lesson No. 3

#### General Data of Various Locomotives

| Description       | WDG <sub>3</sub> A  | WDM <sub>2</sub> | WDM <sub>3</sub> A | WDG <sub>4</sub> | WDP4            |
|-------------------|---------------------|------------------|--------------------|------------------|-----------------|
| Service           | Goods               | Mixed            | Mixed              | Goods            | Passenger       |
| Engine HP         | 3100                | 2600             | 3100               | 4000             | 4000            |
| Loco HP           | 2900                | 2400             | 2900               | 3939             | 3939            |
| Weight (T)        | 123                 | 112.8            | 112.8              | 126              | 119.5           |
| Axle load (T)     | 20.50               | 18.80            | 18.80              | 21               | 20              |
| Boogie            | Co-Co high adhesion | Co-Co tri mount  | Co-Co tri mount    | Co-Co HTSC       | Bo-1- 1-Bo HTSC |
| adhesion          | 30%                 | 27%              | 27%                | 43%              | 35%             |
| Transmission      | AC-DC               | DC-DC            | AC-DC              | AC-AC            | AC-AC           |
| Tractive effort   | 37.8                | 30.5             | 30.5               | 540 KN           | 270 KN          |
| Gear ratio        | 18:74               | 18:65            | 18:65              | 17:90            | 17:77           |
| Max speed         | 105(km/h)           | 120(km/h)        | 120(km/h)          | 120(km/h)        | 160(km/h)       |
| Length (mm)       | 17850               | 17120            | 17120              | 21244            | 21244           |
| Engine            | 251B up rated       | 251B             | 251B up rated      | 710 G3B          | 710 G3B         |
| No. of cylinder   | 16                  | 16               | 16                 | 16               | 16              |
| Engine Idle RPM   | 400                 | 400              | 400                | 269              | 269             |
| Engine Max. RPM   | 1050                | 1000             | 1050               | 904              | 904             |
| OSTA setting      | 1180 ± 20           | 1130 ± 20        | 1180 ± 20          | 960-1045         | 960-1045        |
| Compression ratio | 12.5:1              | 12.5:1           | 12.5:1             | 16:1             | 16:1            |
| Governor          | EH/ WW              | EH/ WW           | EH/ WW             | WW               | WW              |
| Brake system      | 28LAV1/ IRAB1       | 28LAV1           | 28LAV1/ IRAB1      | KNORR CCB        | KNORR CCB       |
| Driving           | LH                  | RH               | RH/LH              | LH               | LH              |

## Lesson No. 4

### GENERAL DATA OF WDG-3A LOCOMOTIVE

|     |                                    |                       |
|-----|------------------------------------|-----------------------|
| 1.  | Loco Series                        | 13, 14500 and above   |
| 2.  | Loco horse power                   | 2900 HP               |
| 3.  | Weight                             | 123 T                 |
| 4.  | Track gauge                        | 1676 mm               |
| 5.  | Wheel diameter                     | 1092 mm               |
| 6.  | Length                             | 17850 mm              |
| 7.  | Width                              | 3016 mm               |
| 8.  | Height                             | 4162 mm               |
| 9.  | Maximum speed                      | 105 km/hr             |
| 10. | Gear ratio                         | 18:74                 |
| 11. | Wheel arrangement                  | Co-Co                 |
| 12. | Bogie                              | High Adhesion         |
| 13. | Traction motor                     | 06 DC Series          |
| 14. | Axle load                          | 20.5 T                |
| 15. | Number of wheels                   | 12                    |
| 16. | Number of axles                    | 06                    |
| 17. | Number of axle boxes               | 12                    |
| 18. | Brake system                       | IRAB1/Dual brake      |
| 19. | Number of batteries                | 8                     |
| 20. | Main generators voltage            | 1130 V DC             |
| 21. | Type of diesel engine              | 251B Up rated         |
| 22. | Engine horse power                 | 3100 HP               |
| 23. | Engine speed Idle                  | 400 RPM               |
| 24. | Engine speed 8 <sup>th</sup> notch | 1050 RPM              |
| 25. | Firing order                       | 1,4,7,6,8,5,2,3 R – L |
| 26. | Fuel capacity                      | 6000 Ltrs             |
| 27. | Lube oil capacity                  | 1210 Ltrs             |
| 28. | Cooling water capacity             | 1210 Ltrs             |
| 29. | Governor oil capacity EH / WW      | 3.79/2.5 Ltrs         |
| 30. | Compression ratio                  | 12.5 : 1              |
| 31. | Compressor oil capacity            | 20 Ltrs               |
| 32. | Piston stroke                      | 10.5 Inch             |
| 33. | Bull gear                          | 102 teeth             |
| 34. | Auxiliary generator gear           | 43 teeth              |
| 35. | Exciter generator gear             | 43 teeth              |
| 36. | FTTM gear                          | 43 teeth              |
| 37. | Split gear                         | 52 teeth              |
| 38. | Cam shaft gear                     | 104 teeth             |
| 39. | Extension shaft gear               | 79 teeth              |



|     |                          |                 |
|-----|--------------------------|-----------------|
| 40. | Lube oil pump gear       | 67 teeth        |
| 41. | Water pump               | 46 teeth        |
| 42. | RTTM belt numbers        | 06              |
| 43. | Fuel pump motor          | 1/1.5 HP        |
| 44. | Crank case exhaust motor | 0.33 HP         |
| 45. | Sand capacity            | 0.4 cubic meter |

### WDG3A Diesel Electric locomotive

W – Broad gauge

D - Diesel Engine

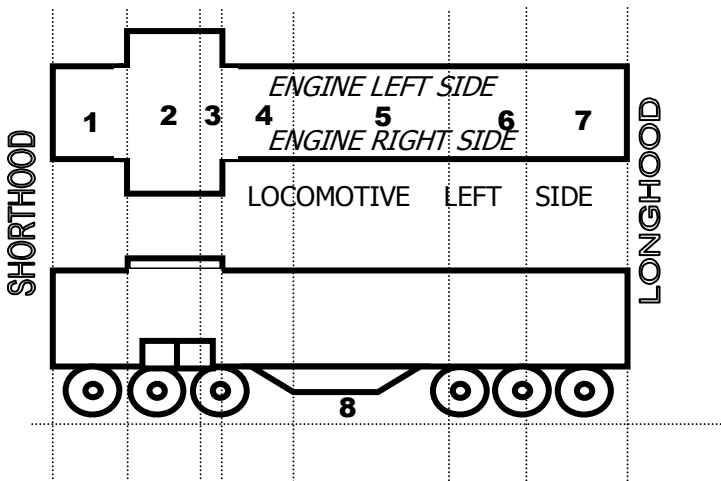
G – Goods Service

3A –Engine Horse Power -3100 HP

This loco is having up rated Diesel engine fitted with fuel efficient kit, Napier or GE make TSC, incorporated IRAB1 and facilitated with AC – DC transmission.

### Main compartments of WDG3A Loco from short hood to long hood

1. Nose compartment
2. Loco Pilot cab
3. Control compartment
4. Alternator Room
5. Engine Room
6. Compressor Room
7. Radiator Room
8. Under truck



**Short hood** - Nose compartment end is called short hood.

**Long hood** - Radiator room end is called long hood.

**Loco Right and Loco left** - In loco pilot cab when you stand and facing towards nose compartment, your right hand side is loco right and your left hand side is loco left.

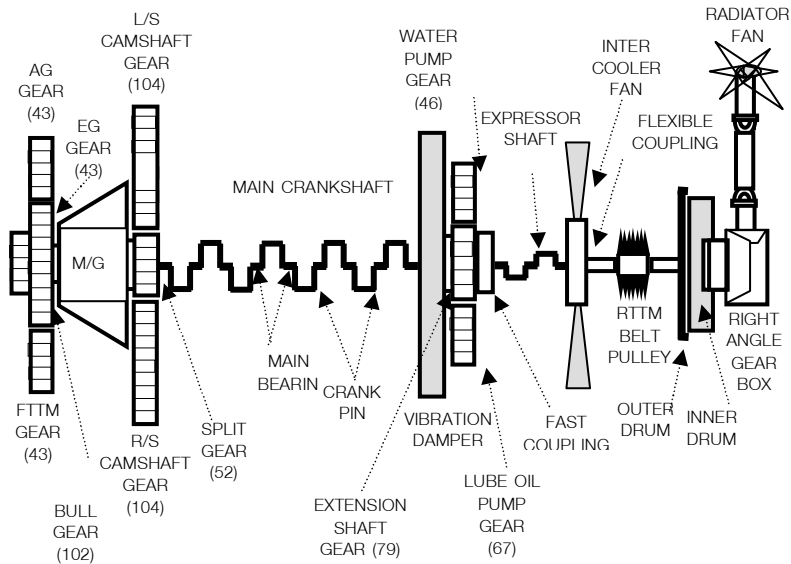
**Engine right and engine left** - In loco pilot cab when you stand and facing towards engine room, your right hand side is engine right and your left hand side is engine left.

**Power take off end** - In engine room alternator end is called power take off end.

**Free end** - In engine room compressor end is called free end.

Note-

1. Counting of parts of Alternator room, Engine room and compressor room as per Engine left and Engine right.
2. Counting of parts of Locomotive parts from short hood to long hood.
3. counting of parts of Engine from free end to power take off end.



## **Different major parts in compartments**

### **1. Nose Compartment**

|                                      |                           |
|--------------------------------------|---------------------------|
| Dynamic Braking Blower motor ( BKBL) | Dynamic braking Grids     |
| NS-1 Reducing valve and its COC      | Battery knife switch (BS) |
| Control Reservoir with drain cock    | Horn and wiper COC        |

#### **a. On brake panel**

MU2B valve, 3/4" COC, C3W distributor valve, F1 selector valve, C2 relay valve, Addl. C2 relay valve, N1 limit valve, D24B valve, 24AD check valve, EPG pressure switch, EPG COC, MR pressure gauge, Power cut off pressure switch, Air flow measuring valve, 1¼" COC, Duplex valve, EPG toggle switch, 110 cubic inch reservoir.

On outer wall of Nose compartment head light, flasher light marker light and multiple unit jumper couples are provides.

### **2. Loco Pilot Cab**

#### **a. On both control Desk**

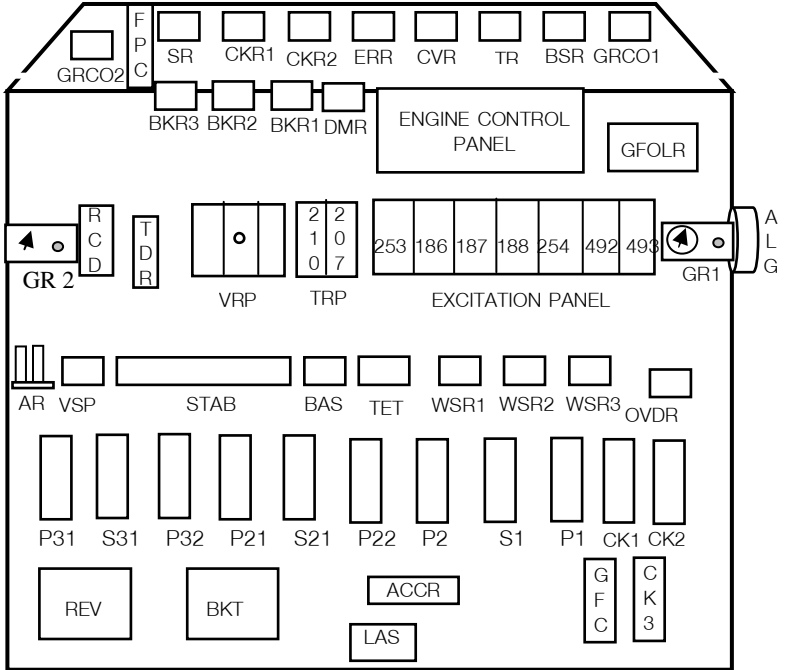
|                                       |                          |
|---------------------------------------|--------------------------|
| A-9 valve with COC                    | SA- 9 valve with COC     |
| Master Handle (MH)                    | Selector Handle (SH)     |
| Reverser Handle (RH)                  | Load meter               |
| Brake pipe Pressure Gauge             | Air flow indicator       |
| MR pressure Gauge                     | BC pressure gauge        |
| Lighting switches                     | Speedometer              |
| Head light switch (HLS)               | PATB                     |
| Flasher light control box             | Foot paddle switch       |
| Multiple unit shut down switch (MUSD) | Sander push button       |
| Master Fuel pump Breaker (MFPB)       | Main control breaker MCB |
| Generator Field cut out switch (GFCO) | Indication Lamp panel    |
| Horn push button                      |                          |

Other than above Loco Pilot Cab has Emergency flap valve, Hand Brake, Wiper servo motor, Dom light.

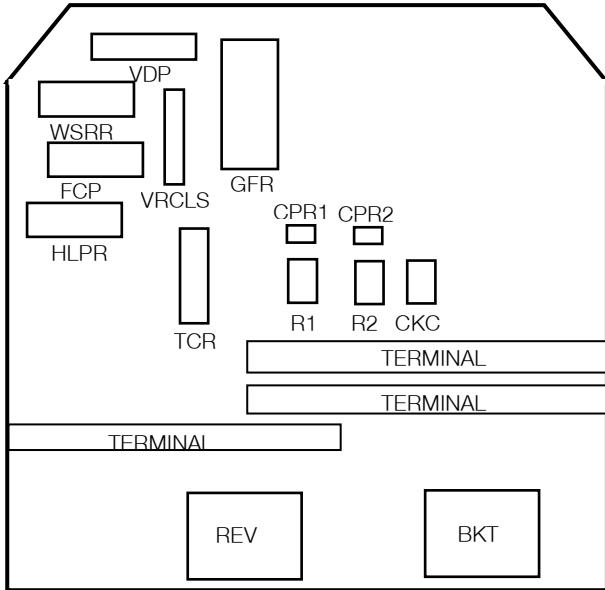
#### **b. On front panel wall**

|                                   |                            |
|-----------------------------------|----------------------------|
| Cab light circuit breaker         | Head light circuit breaker |
| Engine room light circuit breaker | Dom light circuit breaker  |
| Cyclone motor circuit breaker     | MB-1                       |
| MB-2                              | FPB                        |
| AGFB                              | CEB                        |
| Alarm push button                 | ECS                        |
| GR1                               | GR2                        |
| Alarm gong                        | MCO                        |
| Indication panel                  | Start button               |
| Stop button                       | GFOLR reset button         |

### 3. Control Compartment a. Front panel



### Back panel



#### **4. Alternator Room**

Traction Alternator, Auxiliary Generator,  
Exciter Generator, FTTM,  
Generator Gear Case and its dip stick gauge, rectifier panel.

#### **5. Engine Room**

251-B up rated with fuel efficient kit type diesel engine  
Fuel injection pump, High Pressure Line, Water Jumper pipe, Water riser  
pipe, Inlet elbow, Exhaust elbow, Exhaust manifold, Cross over pipe

##### **On engine right side**

Engine Governor, Tacho Generator, Lube oil Dipstick gauge  
Crankcase Explosion Door , Primary filter, Secondary filter, OSTA  
Fuel oil Relief valve, Bubble collector, Lube secondary Header,  
Centrifugal filter, Right side fuel oil gallery

##### **On engine left hand side**

Crank case Exhauster Motor& Blower, Fuel oil Regulating valve  
Lube oil strainer, Bubble collector, Lube oil Main Header  
Lube secondary Header, Left side fuel oil gallery

##### **On free end**

Turbo super charger, After cooler, Water pump ,Lube oil pump

#### **6. Compressor Room**

Compressor unit, Cyclonic filter, Fuel pump motor(Fuel pump,  
Gov. pump), Water drain cock, Car body filter, ETS-1, 2, 3.  
Water temperature gauge, LWS& its Test cock, Lube oil relief valve  
Lube oil regulating valve, EPG's EP valve and its COC with dirt collector

#### **7. Radiator Room**

|  |                           |
|--|---------------------------|
| Lube oil filter drum and its drain cocks | Lube oil by pass valve    |
| Lube oil cooler                          | Radiator core             |
| Radiator fan                             | Rear Truck Traction Motor |
| Blower (RTTM)                            | Expansion tank no. 1&2    |
| Right Angle Gear Box<br>(ECC)            | Eddy current clutch coil  |

On outer wall of radiator Room Head light flasher light, water level  
gauge, marker light and multiple unit jumpers are provided.

#### **8. Under Truck**

|                             |                                |
|-----------------------------|--------------------------------|
| CO-CO high adhesion bogie   | Front truck                    |
| Rear Truck                  | Center Pivot                   |
| Side load Bearer            | Helical Spring                 |
| Vertical Shock absorber(08) | Horizontal shock absorber (04) |
| Equalizing beam             | Axle Box                       |
| Compensating beam           | D shackle (08)                 |
| Axle Journal                | Traction motor                 |

|                               |                          |
|-------------------------------|--------------------------|
| Nose pad                      | Pinion Gear              |
| Axle Gear                     | Traction Motor Gear case |
| Brake cylinder                | Brake assembly           |
| Wheels                        | Sanding Arrangement      |
| Rail Guard                    | Cattle Guard             |
| Pipes of Brake System         | Buffers                  |
| Center Buffer coupler         | Fuel Tank                |
| MR Tank                       | Axle Generator           |
| Mechanical speedometer sensor | Hand brake chain         |
| Bogie COC                     |                          |

### **Front Truck Traction Motor Blower (FTTM)**

Location – Alternator room

Function – To cool Traction motor no 1, 2 and 3 by air, its shaft having 43 teeth gear which is driven by Main Alternator bull gear. In case of abnormal sound from FTTM, fail the loco.

### **Rear Truck Traction Motor Blower (RTTM)**

Location- Radiator room

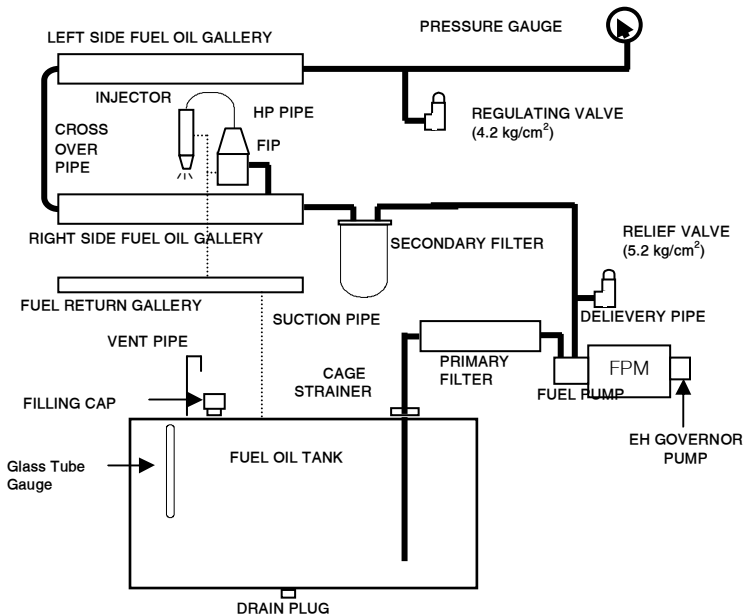
Function - To cool Traction motor no 4, 5, and 6 by air. Its shaft is having a pulley which has 6 “v” belts, these belts are driven by a pulley on extension shaft No. 2. Minimum 4 belts are required. Engine must be shutdown to check the belts and its tension. If the number of belts is less than 4, fail the loco.

## Lesson No. 5

### FUEL OIL SYSTEM

The purpose of fuel oil system is to suck the fuel oil from the tank, filter it and supply to cylinder with adequate pressure and quantity at appropriate time.

**Description:** A detachable fuel oil tank is provided in between two bogies of under truck. Its capacity is 6000 liters. Fuel used in this system is HSD (High Speed Diesel). Two oil filling caps are provided on both sides of the loco. Two vent pipes are provided on tank to evacuate the gasses. One drain plug is provided at bottom of the tank. There are two glass tubes with gauge on both side of loco to check fuel oil balance in the tank, gauge having marking from 600 to 6000 liters, each dot shows 25 liters. Minimum fuel oil level should be 1000 liters.



Fuel pump motor (AC single phase) is fitted on engine right side in Compressor room; its horsepower is 1/1.5. On either side of Fuel pump motor, fuel pump (engine room side) and governor pump (radiator room side) are provided. Initially it is started by battery and after starting engine by auxiliary generator. Necessary circuit breakers are required to close for starting the fuel pump motor. When fuel oil pump starts, it sucks fuel oil from the tank through cage strainer and primary filter (paper

type), goes to delivery pipe, relief valve (setting 5.2 Kg/cm<sup>2</sup>). Relief valve protect the fuel pump from overloading and excess oil returned to fuel tank, then fuel oil goes to the secondary filter(paper type), provided on delivery pipe. Both the filters are provided on engine right side free end near cylinder no.R1

The filtered fuel goes to right side fuel oil gallery and through cross over pipe to left side fuel oil gallery, one copper pipe connection given to regulating valve (setting 4.2 kg/cm<sup>2</sup> ) and fuel oil pressure gauge. From both side gallery fuel is supplied to fuel injection pumps with the help of jumper pipes.

FIP is a reciprocating pump operated by camshaft. The FIP increase the fuel oil pressure and sends to the fuel injector through a high pressure pipe. FIP fuel rake having marking from 0 to 30 mm. FIP can be dummied with help of locking device if required.

Fuel injector is fitted in the cylinder head. At the end of compression stroke the fuel oil is injected in atomized form into the cylinder to get power stroke.

Leak off gallery is provided on both side of the engine. Oil leakage of FIP and injector collected in leak off gallery and return to fuel oil tank.

### **Fuel pump motor is not working.**

| Cause                                | Remedies                |
|--------------------------------------|-------------------------|
| Battery voltage not available        | Check connections       |
| Battery knife switch is off          | Put ON                  |
| MB1/ MB2 in off/trip                 | ON/reset it             |
| MFPB1/ MFPB2 in off/trip             | ON/reset it             |
| FPC not picking up                   | wedge it or put ON FPB3 |
| FPB off/tripped                      | ON/reset it             |
| FPM wire are loose/disconnected      | secure it properly      |
| Carbon brushes are worn out          | Packing to be provided  |
| If still FPM not working inform PCOR |                         |

### **Fuel oil pressure not builds up.**

| Cause   | Remedies  |
|---|---|
| Insufficient fuel in the tank   | Arrange for fueling.                                  |
| Fuel pump motor is not working  | Check the relevant circuit breakers & Battery voltage |
| Fuel pump is not working  | Check Love-Joy coupling                               |
| Primary filter may be choked  | Remove the filter element.                            |
| Relief / regulating valve stuck-up  | Tap it.   |
| Leakage in system   | Try to arrest the leakage.                            |
| If hauling power not affected it means gauge is defective, work in same condition and inform PCOR |   |



**Air lock in fuel oil system** - Air lock in fuel oil system is indicated by fluctuation of fuel oil pressure gauge needle OR dropping of FOP.

Action to be taken - Loose delivery pipe coupler of fuel pump and allow draining till thick oil flow, further tied the coupler. Book in repair book.

**High pressure pipe line burst** – If high pressure pipe line is broken then isolate concern cylinder. Maximum two cylinders can be isolate at time, one from each side.

### **Fuel Oil Economy:-**

1. Tank should not be filled fully.
2. Ensure proper handing over and taken over of fuel oil balance.
3. Poor hauling power and leakage of system should be checked and booked.
4. Ensure adequate amount of BP pressure/vacuum in loco and releasing of train brake.
5. Open throttle notch by notch and achieve maximum speed in minimum time. Observe sectional temporary /permanent caution order.
6. Always work on higher notches.
7. If black thick smoke is coming out from chimney, check the reasons.
8. Drive the train as per road and load.
9. Use maximum dynamic brakes.
10. Maximum coasting on down gradient.
11. Engine to shut down on receiving the memo from PCOR.
12. While working light load with multiple unit keep rear loco on idle.

### **Fuel Efficient Kit**

The following changes are made in loco for saving fuel on higher notches.

1. Maximum fuel rack opening is 25-27 mm on 8<sup>th</sup> notch.
2. 15 mm dia of FIP plunger is increased to 17 mm.
3. Steel cap piston is used.
4. Over lap period of main crank shaft is increase from 123<sup>0</sup> to 140<sup>0</sup>
5. Alco TSC is replaced by ABB/GE TSC
6. Size of After Cooler is increased.
7. Air maize oil bath filter and car body filter are replaced by cyclonic filter.
8. Size of Radiator core is increased.
9. Lube oil relief valve setting is increased to 135 psi and regulating valve 75 psi.

## Lesson No. 6

### AIR INTAKE SYSTEM

**Supercharging** – The process of increase air pressure more than atmospheric pressure and deliver in cylinder for fuel combustion is called supercharging. It increases efficiency of the engine up to 50 % in this type of engine fuel burn with atmospheric air having pressure. In diesel loco Turbo Super Charger is provided for supercharging.

**Turbo Super Charger** – TSC is provided at free end, above after cooler. It works with the help of exhaust gasses.

TSC having four casing

1. Gas inlet casing
2. Turbine casing
3. Intermediate casing
4. Blower casing

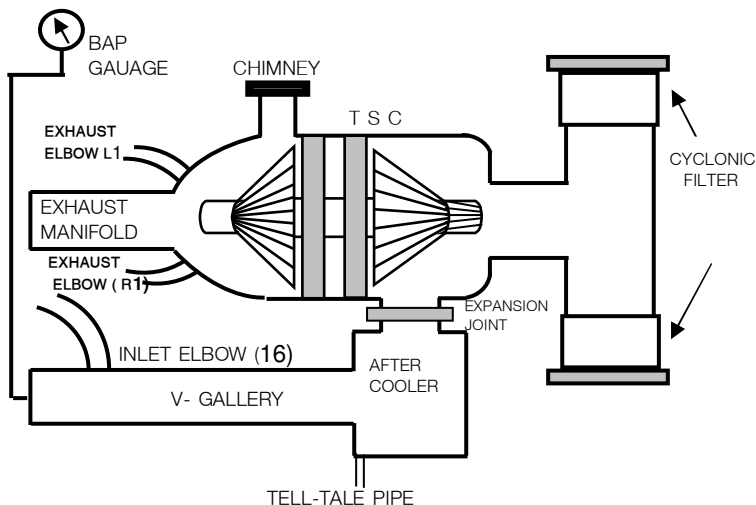
Gas inlet casing is connected with exhaust manifold. 14 exhaust elbows connected in exhaust manifold. R1 & L1 exhaust elbow are connected directly to gas inlet casing. One dome is provided in this casing. Rotor shaft is fitted in intermediate casing; turbine and blower are fitted on this shaft. Turbine is fitted in turbine casing and blower in blower casing. Gas inlet casing is connected to turbine casing through nozzle ring. One side of blower casing connected with cyclonic filter and other with expansion joint to after cooler. TSC cooled by engine coolant. Rotor shaft bearing is lubricated by engine lube oil system.

**Working** - Exhaust gases discharged by engine goes to gas inlet casing of TSC through exhaust manifold. In this casing gasses gets the direction with the help of dome and nozzle ring and hit the turbine blades and goes off to atmosphere through chimney. When turbine starts rotating same time blower also starts rotating since fitted on the common shaft. Partial vacuum is creating in blower casing hence atmospheric air flow from cyclonic filter.

Blower compress the air into after cooler, where it cools with water hence its density is increased. The other end of after cooler is connected to 'V' gallery where the pressurized air is collected and collected air pressure is called Booster Air Pressure. Booster Air Pressure gauge is provided in Loco Pilot cab. Maximum BAP is  $1.97 \text{ kg/cm}^2$ . At the time of suction stroke each cylinder is charged with super charged air through inlet elbow.

**After cooler** - To increase the density and reduces the temperature of air, this is provided below TSC on engine free end. It has U shaped pipes, through which water passes from inlet to outlet. The air is cooled around

the U shaped pipes through radiation process. The cooled and dense air is stored in 'V' gallery. Tale - tell pipe provided in bottom of after cooler, if water leakage through it, fail the loco and inform the PCOR.



### Booster air pressure not building up

| Cause  | Remedies                                 |
|--|--|
| Insufficient FOP   | Check relevant cause                     |
| Governor linkage jam   | Operate 2 – 3 times manually             |
| Leakage in exhaust elbow/manifold  | Try to arrest.                           |
| After cooler dummy, inspection cover, expansion joint is loose.  | Tight them.                              |
| Leakage from inlet elbows.   | Try to arrest                            |
| In WW governor BAP connection is loose.  | Try to arrest                            |
| BAP sensor defective in MCBG Gov.  | Put BAP by pass switch on BAP by pass    |
| Parallel transition not coming   | Take manual transition                   |
| Excitation card may be loose   | Tight them                               |
| Defect in TSC  | Confirm the free rotation of rotor shaft |
| If hauling power is not affected it means BAP gauge is defective, work the train in same condition and inform the PCOR |  |

## Lesson No. 7

### LUBE OIL SYSTEM

**Purpose** -To lubricate and cool the diesel engine equipment with filtered, cooled and pressurized lube oil.

**Description** – Forced lubrication system is used in diesel locomotive, detail of system is as -

Lower portion of engine crank case, it termed as lube oil sump, its capacity is 1210 liters. To fill the lube oil filling cap is provided on free end engine right side. Dipstick gauge is provided near R5 cylinder for measuring lube oil level. Dipstick gauge having 0-600 liters marking each mark of 20 liters. While checking lube oil level engine should be on idle condition and crank case exhaust motor should be in ON position.

Lube oil pump is "Positive displacement type" and located in engine room right side free end. It gets drive from main crank shaft extension shaft no. 1 gear. When diesel engine starts, lube oil pump also starts working; it sucks oil from the sump and sends to delivery pipe, on delivery pipe relief valve (setting 9.5 kg/cm<sup>2</sup>) is provided. Oil from delivery pipe goes to filter drum & centrifugal filter. After filtration of oil from centrifugal filter return to sump and oil from filter drum goes to system for lubrication

Filter Drum has two zones, filtered and unfiltered. Each zone having separate drain cock it should be tied and sealed. One by pass valve (setting 20psi differential pressure) is provided near filter drum, it by pass filter drum at the time of engine starting or when filter is chock up.

Filtered oil from lube oil filter drum goes to lube oil cooler, it is located in radiator room here oil gets cool with water tubes. Out going pipe of lube cooler has regulating valve (setting 5.2 kg/cm<sup>2</sup>). Before this valve one connection given to TSC through micro filter to lubricate bearing in intermediate casing.

The oil coming from lube cooler goes to lube oil strainer (location engine room left side), strainer has one drain cock it should be tied and sealed. From strainer filtered oil goes to main header (location in lube oil sump).

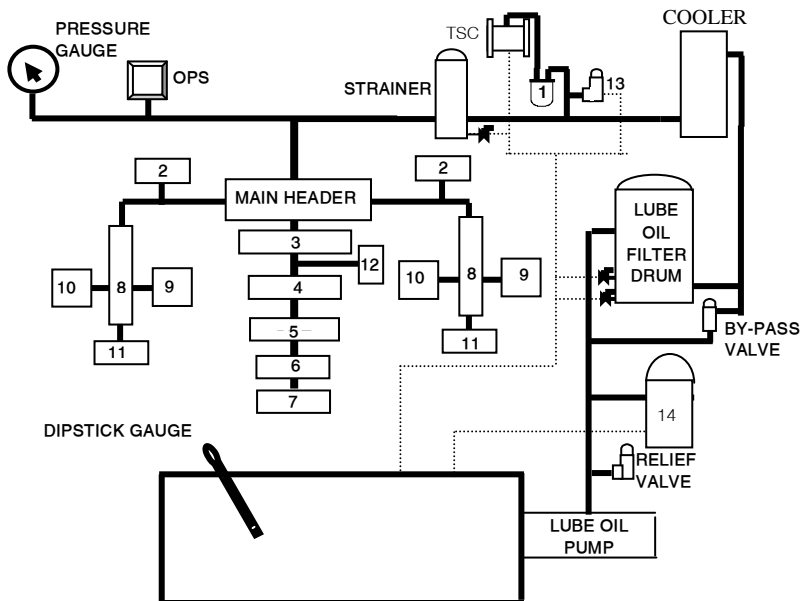
Main header having 9 S-type jumper pipes and each pipe is connected to main bearing. After lubricating main bearing oil goes to crank pin and lubricates connecting rod bearing. Through connecting rod oil goes to piston pin and lubricated it and also cools the piston crown, further oil dropped in the sump through return passage, while dropping oil splash and lubricate the cylinder liners.

Two pipe connections were given from main header to sub header and one 'T' joint on each pipe given for cam shaft, which helps in lubricating cam shaft bearings. From both sub header two pipe

connections are provided for each cylinder to lubricate rocker arm assembly and fuel pump lifter. At the end of both sub header on power take off end one nozzle is provided to lubricate cam shaft gear as well as split gear in spray form.

From main bearing no. 1 oil goes to vibration damper, it reduces the main crank shaft vibrations.

From main header one connection given to lube oil pressure gauge and oil pressure switch in loco pilot cab.



- |                       |                        |                        |
|-----------------------|------------------------|------------------------|
| 1-MICRO FILTER        | 6-PISTON CROWN         | 11-SPRAY NOZZLE        |
| 2- CAM SHAFT BEARINGS | 7-CYLINDER LINER       | 12- VIBRATION DEMPER   |
| 3-MAIN BEARINGS       | 8.SUB HEADER           | 13- RELUGULATING VALVE |
| 4- CRANK PIN          | 9. ROCKER ARM ASSEMBLY | 14- CENTRIFUGAL FILTER |
| 5-PISTON PIN          | 10. FIP LIFTER         |                        |

**Crank case exhauster motor-** It is located on engine left side power take off end. Initially it starts on battery further it work on auxiliary generator out put. A blower is fitted on its shaft which creates partial vacuum and evacuated gasses from crank case sump. Working of motor is confirmed from its indication lamp provided on both control desks. If CCM not work, find the causes if not successes clear the section and fail the loco.

**Crank case explosion door-** Due to any reason if pressure of the gasses in side the engine block is increased which leads to damage engine block.

To avoid the damage crank case explosion doors are provided. When pressure increased more than prescribed level explosion door gets burst and safe guard the engine block. On each side of crank case one spring loaded type explosion door is provided in place of crank case cover (normally on R7, L2). When explosion door is burst, gasses come out along with lube oil but due to spring action the door sets on its normal position. In this situation shut down the engine and crank case exhaustor motor should be kept on and fail the loco.

**CCM not working-**

| Causes   | Remedies               |
|--|------------------------|
| CEB trip/off   | Reset/ON it            |
| Wire connection on junction box of motor loose/ uncoupled            | Secure properly.       |
| Motor defective  | Check the carbon brush |
| If not success clear the section, inform the PCOR and fail the loco. |                        |

**Lube oil pressure in not building up.**

| Causes   | Remedies   |
|--|--|
| Low oil level in the sump                            | Inform PCOR  |
| Drain cock of filter drum/strainer in open condition | Tied and seal it                                   |
| Pressure relief/ regulating valve stuck up.          | Tap it gently.                                     |
| High temperature of engine                           | Raise the engine.                                  |
| Leakage in lube oil system.                          | Try to arrest the leakage.                         |
| Water mixing in lube oil.                            | Shut down the engine fail the loco and inform PCOR |
| Fuel oil mixing in lube oil.                         | Inform PCOR.                                       |

**Lube oil level increasing in lube oil sump -**

Two reasons of lube oil increasing in the sump are

1. Water is mixing in lube oil - Check CCM exhaust pipe if steam/drop Of water coming, its means water is mixing in lube oil. Shut down the engine, fail the loco and inform PCOR.
2. Fuel oil mixing in lube oil - Fuel oil smell will come on lube oil dipstick gauge; it means fuel oil mixing in lube oil. Inform PCOR.

## Lesson No. 8

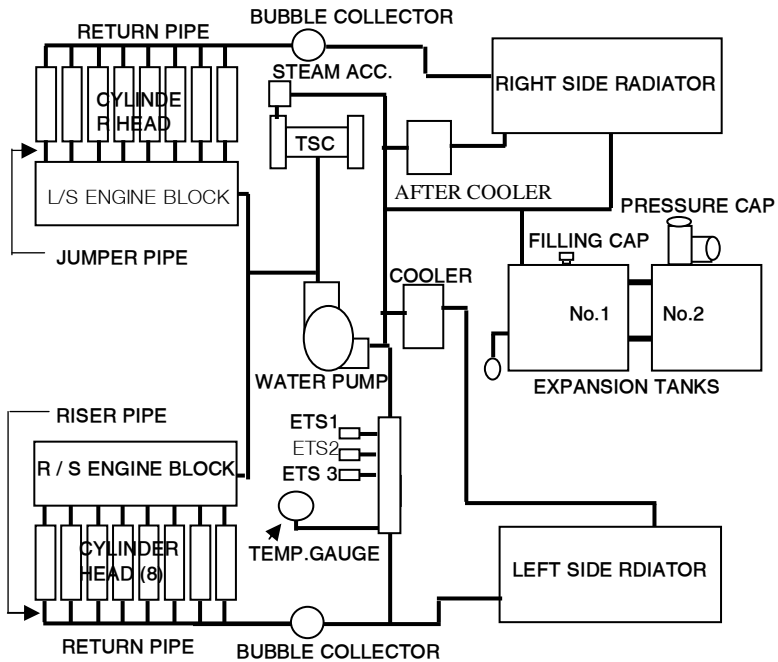
### COOLING WATER SYSTEM

The purpose of cooling water system is to cool engine equipment as well as engine block, inlet air, lube oil and TSC.

**Description** - Chemical treated water is filled in this system to avoid corrosion, scaling forming and leakages will visible easily.

On WDG<sub>3A</sub> loco pressurized water cooling system is provided. Centrifugal water pump is provided on left side free end of the engine, which gets drive from extension shaft no. 1 gear. System capacity is 1210 liters. Filling cap provided on expansion tank No.1.

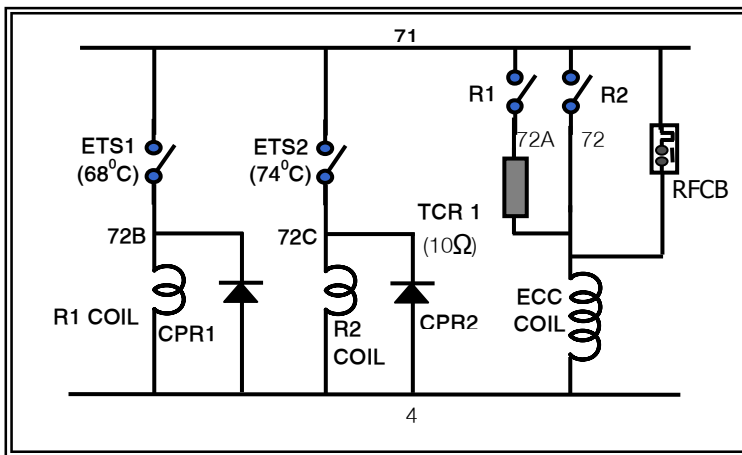
When diesel engine starts, water pump sucks water from four places viz. expansion tank No.1, TSC water return pipe, right side radiator core via after cooler, and left side radiator core via lube oil cooler. Water is pumped at three places viz. right side engine block, left side engine block and TSC.



**Right/Left side engine block** -The water in right and left side engine block, cools the cylinder liner and after wards rises through jumper pipe to cylinder head to cool it and rises through riser pipe to the respective water return pipe i.e. right side water return pipe and left side water return pipe.

Through right side water return pipe water goes to the left side radiator core via bubble collector and left side water return pipe goes to right side radiator core through bubble collector. In the radiator core water is cooled by radiator fan. Cooled water goes from left side radiator core to lube oil cooler, after cooling lube oil mixes with water of right side radiator core and goes to the water pump again.

**Turbo supercharger-** Here water cools the intermediate and turbine casing, further it will go to suction side of pump through steam accumulator.



**Radiator fan working** –Radiator fan works according to the water temperature. Temperature is measured by thermostatic switches viz. ETS1, ETS2 provided in expresser room on water junction box.

The outer drum is coupled with extension shaft No.2 and inner drum is coupled with right angle gear box. There is gap between outer drum and inner drum. Outer drum rotates continuously with main crankshaft. Radiator fan is coupled with right angle gear box with the help of universal coupling.

When water temperature increases up to 68<sup>0</sup>C, ETS -1 operate, R1 contactor will pick up located on back panel. Battery /auxiliary generator current goes to ECC coil through TCR, ECC coil energized, inner drum starts rotating along with outer drum, which in turn rotates radiator fan with the help of right angle gear box, radiator fan works at slow speed and cools the water.

When the water temperature further increases up to 74<sup>0</sup> C, ETS2 operates, R2 contactor will pick up by pass TCR, radiator fan rotates with full speed and cools the water.

**ETS3-**When water temperature increases up to 94<sup>0</sup>C, ETS3 operates, hot engine indication lamp will glow on both control desk and alarm bell will



ringing, it indicates that engine water temperature is above safe level and requires loco pilot attention to cool down the water temperature. Loco pilot should race the engine to cool down the water temperature according to road and load.

**LWS-** It is provided in compressor room on radiator room wall, the level of water in expansion tank is 14 inches (water capacity of each tank is 155 liters). Whenever water level is remained 1 inch due to leakage or any other reason in expansion tank that time LWS will operate, engine will shut down with hot engine indication on both the control desk and alarm bell will ring.

A pressurized valve is fitted on any one of expansion tank and water level gauge provided on expansion tank No.2 near long hood headlight. Water level gauge having three zones viz. Green, Yellow and Red.

**Water leakage from tell-tale pipe of water pump-** Keep watch on the water level, if level goes down inform to PCOR.

**Lube oil comes from tell-tale pipe of water pump.** It is due to the damage of lube oil seal of the water pump.

1. If leakage is drop by drop, watch oil level and work the train, book for repair.
2. If leakage is heavy inform to PCOR.

**Engine shut down/not starting with hot engine indication**

| Cause  | Remedies  |
|--|---|
| Water level decreasing   | Arrange to fill the water & arrest leakages.                      |
| LWS test cock is closed  | Open it.  |
| LWS defective  | Short LWS wire on back panel and keep sharp watch on water level. |
| To bypass LWS short wire no. in EH governor 50D – 50J and in WW governor 16E – 16H |   |

**Radiator fan not working**

| Cause   | Remedies                            |
|---|-------------------------------------|
| Defect in ETS1, ETS2 or R1, R2.   | Put ON RFCB.                        |
| Carbon brush of ECC defective.  | Check carbon brushes & its packing. |
| Slip rings are dirty.   | Clean it.                           |
| ECC coil wire connection loose/ disconnected.   | Try to tight/couple it.             |
| Still if not success then inform PCOR.<br>Caution – Before enter in radiator room shut down the engine. |                                     |

## Lesson No. 9

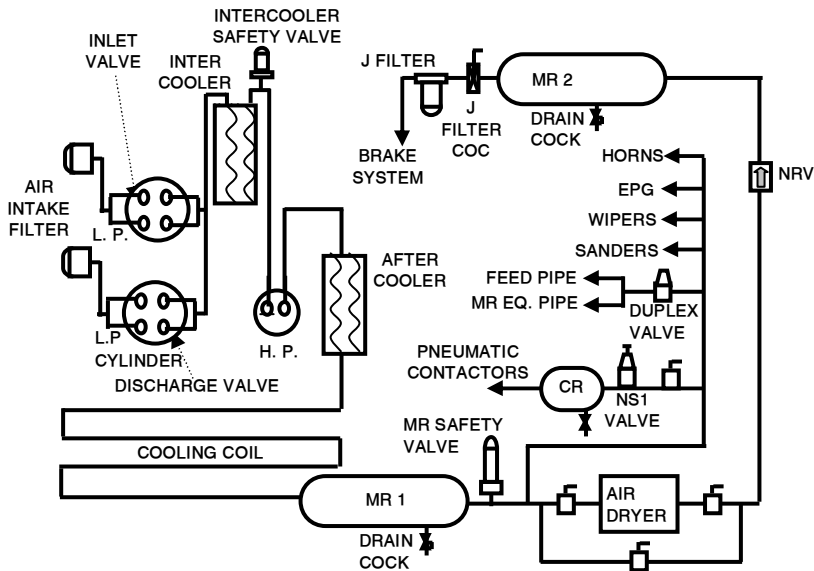
### COMPRESSOR

In IRAB1 (straight air brake) fitted loco have only compressor. It is provided in the compressor room. The main function of compressor is to provide compress air for various purposes.

It has one crankshaft and two bearings. One end of crank shaft is connected to engine main crankshaft with fast coupling and other end to extension shaft no.2 with flexible coupling. It has 03 cylinders, 02 low pressure cylinders in 'V' shape and 01 high pressure cylinder in vertical position. Breather valve is provided in the sump to avoid pressurization of sump. 20 liter lube oil filled in compressor sump for lubrication. For circulation of lube oil one chain and sprocket driven pump is provided in sump. Filling cap is provided for lube oil filling and spy glass/dipstick gauge for checking of oil level.

#### Compressor and MR Charging:-

Compressor charges the main reservoir with pressurized air. Each cylinder have inlet and discharge valve working on principle of differential pressure.



It's working to charge main reservoir with pressurized air, has 03 cylinders, two big cylinders are called low pressure cylinders and small is called high pressure cylinder. Low pressure cylinders having 02 inlets and 02 discharge valves, inlet valve is connected to air intake filter and

discharge valve to intercooler. High pressure cylinder having 01 inlet and 01 discharge valves, inlet valve is connected to inter cooler and discharge valve to cooling coil through after cooler. Inlet valves have un-loader assembly, its connection given to EPG.

When piston travel from TDC to BDC in low pressure cylinder inlet valve opened and filtered atmospheric air entered in cylinder. When piston travel from BDC to TDC inlet valves close and pressure is increased in cylinder hence discharge valve gets open and air goes in inter cooler where it cools by air. Safety valve (setting 4.2 kg/cm<sup>2</sup>) is provided on inter cooler to safeguard it.

When piston travel from TDC to BDC in high pressure cylinder inlet valve open hence air from inter cooler entered in cylinder. When piston travel from BDC to TDC inlet valves close and pressure is increased in cylinder hence discharge valve gets open and air goes in cooling coil through after cooler where it gets cool by air and charged MR1. Safety valve (setting 10.5 kg/cm<sup>2</sup>) is provided on outlet pipe of MR1, it discharge over pressure and safe guard the MR tank. From MR1 air goes to MR2 through air dryer and NRV. MR1 is provided in under truck between fuel tank and rear truck and MR2 between fuel tank and front truck.

**MR1 pressure is used on different places as below:**

**Control air pressure reservoir** – It is charged with 5 kg/cm<sup>2</sup>. NS1 reducing valve and COC is provided in nose compartment to convert MR pressure into 5 kg/cm<sup>2</sup>. This pressure is used to operate electro pneumatic contactor. It has drain cock and pressure gauge mounted on nose compartment wall in loco pilot cab.

**Sanders** - Sanding between wheel and rail, sanders valve are provided.

**Wipers** - Both side looking glass having wipers which are operated by its servo motor.

**Horns** - Horn switches are provided on both control stand and its coc in nose compartment.

**MR1 equalizing pipe** - In multiple unit MR pressure is equalizing when MR equalizing pipe is connected between the loco which is charged by duplex valve.

**Feed pipe** - In twin pipe brake system feed pipe is charged with 6kg/cm<sup>2</sup> through D24B valve, its 1<sup>1</sup>/<sub>4</sub>” coc.

**EPG** - Its main function is to maintain MR pressure between 8 to 10 kg/cm<sup>2</sup>. Its EP valve and cut out cock is provided in compressor room on the radiator room wall. Pressure switch, pressure gauge and COC is provided in nose compartment, its toggle switch is provided on nose compartment.

When MR pressure reach to 10 kg/cm<sup>2</sup>, EPG operates and send air pressure on un-loader assembly as well as auto drain valve. Due to air pressure on un-loader assembly inlet valve remains in opened condition

and air will not compressed. This process is called unloading / governor cut out. Auto drain valve drains moisture from MR1.

When MR pressure drops up to 8kg/cm<sup>2</sup>, EPG comes in its balance/cut in position and its exhaust port opened, which vents the air from un-loader assembly as well as auto drain valve. Due to no air pressure on un-loader assembly, inlet valve closed and restarts the air compression. This process is called loading / governor cut in. Auto drain valve drains moisture from MR1.

In multiple unit EPG helps in loading and unloading of MR in all locos at a time. Normal position of EPG toggle switch is ON and in case of MU in trailing loco it is in OFF position.

**MR2** - It is located between fuel tank and front truck. MR2 air is used to operate different valves of brake system. J-filter and its coc provided on MR2 outlet pipe.

Drain cocks are provided on MR1, MR2, J-filter, control reservoir to drain moisture.

**Lubrication of compressor** - Compressor sump has filled with 20 liters Lube oil, it has a positive displacement type pump provided in the sump which is rotates through chain and sprocket. Compressor shaft rotating pump starts work and distribute pressurized oil on following places.

1. Relief valve
2. Needle valve
3. Distribution ring.

From distribution ring following equipments are lubricate

1. Crank pin
2. Piston pin
3. Cylinder liner

Brass needle valve is provided to check the working of pump when engine in working condition. Due to oil pressure needle valve spindle projected.

Compressor sump is connected breather valve sump.

**Checking of Compressor oil-** Spy glass and dipstick gauge are provided to check oil level in the sump. While checking oil level through dipstick gauge, Engine to be shut down.

**Brass Needle Valve Not Project Out** - It is provided to check the working of pump when engine in working condition. If it project out on Engine raise, note in Loco repair book. If it does not project out, loose check nut on needle valve if oil comes from it, it means pump is working but needle valve defective book in repair book. If oil does not comes out check the oil level in sump if oil level is satisfactory, it means pump is defective, fail the loco. If oil level is below minimum mark then inform PCOR.

## MR pressure not buildup/dropping

| Causes   | Remedies   |
|--|--|
| Inter cooler safety valve blowing continuously                               | Tap it.  |
| Inter cooler tube broken   | To maintain the MR pressure by keeping engine in raise condition if possible.                  |
| MR safety valve blowing continuously   | Tap it.  |
| MR1, MR2, J-filter and control reservoir drain cock are in opened condition. | Close the concern drain cock.  |
| Auto drain valve blowing continuously.                                       | Tap / isolate it.  |
| Leakage from MR/BC equalizing COC or BP/FP angle cock.                       | Close it properly.   |
| Leakage in the system.   | Try to arrest.   |
| EPG is defective.  | Tap EP valve or switch off toggle switch and close EP valve COC, create slight leakage in MR1. |
| J-filter coc in closed condition   | Open it.   |
| Air dyer unit defective  | By pass it.  |

## MR safety valve blowing continuously

| Causes  | Remedies  |
|---|---|
| EPG defective   | Tap EP valve of EPG, if its switch in OFF position ON it. |
| EPG pressure switch COC is closed                       | Open it   |
| EPG, EP valve COC is closed                             | Open it   |
| MCB-1,2 in off condition                                | ON it.  |
| If not success create leakage in MR1 through drain cock |   |

**MR pressure dropping on run** – In this situation loco pilot will not leave control stand and keep sharp watch on MR & BP pressure gauge, work the train and follow traffic rules. When MR pressure comes below 6 kg/cm<sup>2</sup> apply A9 to stop the train and keep A9 in emergency & SA9 in application position and also secure the train as per requirement. Blow the whistle code to protect/secure the train from rear by Guard as per traffic rule. Further do the trouble shooting.

## EXPRESSER

In dual brake loco expresser is provided instead of compressor. The combination of exhauster and compressor is called expresser; it is provided in the expresser room. The main function of expresser is to provide compress air and vacuum for various purposes.

It has 6 cylinders, 3 for compressor and 3 for exhauster. Two crank pin provide on expresser crank shaft, each pin has 3 connecting rods.

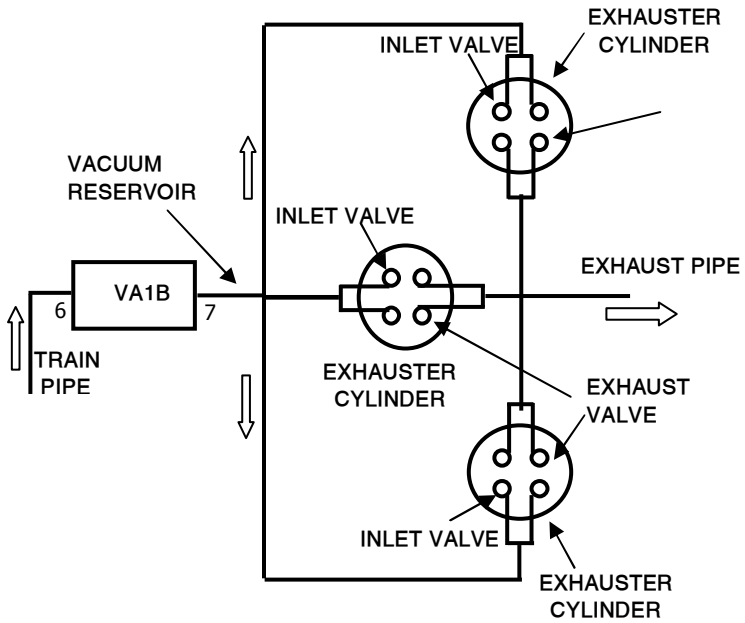
Each cylinder head of exhauster has two inlets and exhaust valve, all inlet valves of 3 cylinders are connected with inlet pipe and inlet pipe is connected with VA1B control valve, the inlet pipe is called vacuum reservoir. Similarly exhaust valves are connected with exhaust pipe in under truck.

When exhauster cylinder piston travel from TDC to BDC, inlet valve open and train pipe air entered into the cylinder through VA1B control valve and vacuum reservoir. Piston travels from BDC to TDC, inlet valve closed and exhaust valve opens due to air pressure, evacuated through exhaust pipe into atmosphere hence vacuum created in train pipe.

To check the vacuum level in train pipe, vacuum gauge is providing on both control desk. Vacuum check valve is connected with vacuum reservoir to maintain the certain level of vacuum in expresser sump.

### Oil coming with smoke from expresser exhaust pipe

| Causes                                    | Remedies   |
|---|--|
| Oil level is more in sump                 | Work the loco, as oil consumed, oil throwing stops |
| Vacuum check valve is not fitted properly | Fit it properly otherwise inform PCOR              |
| Oil filling cap is loose.                 | Fit it properly                                    |
| Dip stick gauge not fitted properly       | Fit it properly                                    |
| Above situation must be inform to PCOR    |  |



## Lesson No. 10

### ENGINE GOVERNOR

It is located on engine right side at power take off end. Its main work is to keep engine RPM stable as per throttle notch position irrespective of load and road. It also work the following-

1. Controls fuel oil supply
2. Co-ordinate between main generator and diesel engine HP.
3. Brought engine speed to idle or shut down when any safety device operates.
4. Helps in engine starting and stopping

Three types of governor are used in Diesel locomotive.

1. Electro Hydraulic Governor (EH)
2. Wood Ward Governor (WW)
3. Microprocessor Control Based Governor (MCBG)

#### **Electro Hydraulic Governor (EH) – Main parts are**

|                           |                       |
|---------------------------|-----------------------|
| Pilot valve assembly      | Speed coil            |
| Stabilizing coil          | Slave piston no. 1    |
| Slave piston no. 2        | Clutch coil           |
| Arm A                     | Arm B                 |
| Reference spring          | main shaft            |
| Output shaft              | Oil sump              |
| Pressure relief valve     | Strainer              |
| Fuel limit cam            | Load control rheostat |
| Stabilizing potentiometer | two spy glass         |

#### **Working system**

Outside the governor body other then above equipment governor pump is provided in expresser room at engine right side. The governor pump is driven by FPM. Governor sump is filled with 3.79 liter oil. When pump starts working, it sucks oil from governor sump and builds 135 psi pressure and sends to governor hydraulic system.

Fuel rake control shaft is connected to governor output shaft (which is out side of governor body) through linkage pin. Fuel rake of 16 cylinders is controlled by output shaft. Arm B is connected to output shaft in side the governor. Main shaft is connected to arm A inside of governor body. Clutch coil is provided in between arm A and arm B. Minimum 50V is required to energize the clutch coil, this supply is given by battery/AG. Original position of arm A is full fuel position and arm B is no fuel position when engine is shut down.



Speed pilot valve controls oil supply in governor hydraulic system, two forces work on this valve, reference spring which pulls pilot valve upwards and stabilizing coil/speed coil which push the valve downwards. When pilot valve lifted up, 135psi pressure oil goes to bottom of slave piston No.1. When balance current is 475 mA in speed coil, speed pilot valve balanced and flow of oil to slave piston no.1 is stopped.

**While engine starting** - When FPB kept ON governor pump starts and stabilizing coil energize hence oil will go on the top of slave piston no.1 and pressed it downward due to which main shaft rotate clock wise, arm A will go on arm B and LCR change its position from 1 o' Clock to 4 o' Clock and SP from 3 O' Clock to 6 O' Clock.

Clutch coil energize when engine start button is pressed, arm A and B will magnetically lock and stabilizing coil de-energize, pilot valve lifted up and oil goes to bottom of slave piston no.1. Main shaft rotate anti clockwise hence arm A, arm B and out put shaft moves toward full fuel position. Governor linkage pressed downwards and fuel racks opened. Fuel is injected in the cylinder, fuel combustion starts.

As fuel combustion starts in cylinder, main crank shaft speed increase, out put current of Tacho generator goes to speed coil. When speed coil gets 475 milliamps current, reference spring brings speed pilot valve in balanced position. This position occurs when main crank shaft rpm is 400, fuel rack stable and due to fixed fuel oil supply engine achieved idle speed.

**Increasing/decreasing of engine speed** - when throttle notches opened, engine speed relay (ESR) picks up according to notch position and add resistance in series of speed coil. Current in speed coil decreases below 475mA, reference spring pulls the pilot valve upwards. More oil will go in the bottom of slave piston no.1. Main shaft rotate anti clockwise and arm A, arm B and out put shaft travel towards full fuel position, Engine racks opens further hence fuel supply in the cylinder is increased.

Tacho generator out put increased due to increasing in engine speed as per notch and 475mA current goes to speed coil even though resistance were added and fuel rack stable.

When throttle notch decreases engine speed also decreases and reverse action takes place as per notch position.

**To stop the engine** - When stop button or MUSD pressed, stabilizing coil energize and pilot valve goes downward, governor oil goes on top of slave piston no.1 and press piston downwards hence main shaft rotate clockwise and arm A and arm B both comes on no fuel position. Engine shut down due to no fuel supply.

**Engine shut down through safety device** – Whenever any one of MFPB-1, 2, MB-1, 2, FPB circuit breakers trips or OPS, SAR, LWS safety device operated that time clutch coil de energized, arm A & arm B

separated. Arm B comes to no Fuel position and engine stopped due to no fuel supply.

**Working of LCR** - It protect the engine from bough down. When train is running with excess load on up gradient with full notch, main generator demands increases and same time engine rpm decreases. In this situation balanced current decreases in speed coil due to decreasing speed of Tacho generator. More oil goes in the bottom of slave piston no.1, maximum fuel rack (29.5mm) opened after that main shaft rotates more in anti clockwise hence LCR comes in active zone (11 - 8 O' Clock) which decreases main generator excitation and main generator demands reduced hence load on engine decreases, engine rpm maintain as per notch and engine safe guard from bough down.

**Duties towards EH governor –**

1. Check oil level in governor sump
2. Tightness of empanel plug
3. There should not any leakage in governor hydraulic system
4. Governor linkage pin should be fitted properly
5. Check the position of LCR and SP

## WOOD WARD GOVERNOR

**Main parts of WW governor**

|                            |                             |
|----------------------------|-----------------------------|
| Drive shaft                | Pump                        |
| Fly weight                 | Main rotating bush          |
| Speeder spring             | Main pilot valve plunger    |
| Buffer piston              | Speed setting valve plunger |
| Power piston               | rotating bushing            |
| Speed setting piston       | Triangular plate            |
| Oil sump                   | A, B, C, D solenoid         |
| Air sensing device         | vain servo motor            |
| Load control potentiometer | shut down plunger assembly  |
| Tail rod                   | over riding solenoids       |
| Glass tube                 | Empanel plug                |

**Description** - Its sump capacity is 2.5 liters. A glass tube is provided to check the oil level. Governor pump is fitted inside the governor body. It maintains the oil pressure at 100psi in the system. The pump and rotating bushing get drive by right side camshaft. Fuel rake control shaft is connected to power piston through linkage and all 16 cylinder fuel rake is controlled by control shaft. Engine fuel rake opens when power piston lifts up.

Speed setting valve plunger is provided in governor speeder section, it controlled by triangular plate. A, B, C, D solenoids valve are fitted on triangular plate, according to notches these solenoids valves are picked up and press triangular plate and speed setting valve plunger

downward it is called increment. Opening of fuel rakes are proportionate to increment and engine speed increases.

**During the engine starting** – When engine starts governor pump also starts working hence rotating bushing starts rotating with the help of drive shaft and oil passage open for buffer piston. Oil pressure is increased between buffer piston and power piston hence power piston lifts up and due to lifting of power piston fuel rakes opened, fuel supply starts in engine cylinder.

Fly weights are connected to main rotating bushing, they are balanced when engine RPM stable on idle (400 rpm) through compensating beam. Passage of oil to buffer piston stopped, power piston stable and idle rpm is maintained.

**Increasing/Decreasing of engine speed** – According to throttle notches A, B, C, D solenoids picks up sequentially and pressed the triangular plate, Speed setting valve plunger comes downward and pressure mounted on speed setting piston results in compression in speeder spring, fly weights bend inside hence main pilot valve plunger goes downward. Oil passage open for buffer piston and power piston lifts up, fuel rake opening increased and engine rpm increased. Fly weight comes in balanced position, again engine speed stabled as per notch position and fuel rakes also stabled.

When throttle notch decreases, reverse procedure starts and due to less fuel supply engine speed decreases.

**To stop the engine** – When stop button/MUSD pressed or LWS operated D valve energizes. Due to D valve energizing alone minus two (-2) increment comes and rotating bushing pressed. Oil on speed piston and speeder spring goes to sump and fly weight goes away from balance position, hence oil from buffer piston also goes in to sump and fuel rack comes on no fuel position and engine shut down.

**Low lube oil shut down plunger** - In WW governor OPS fitted inside the governor, when ever due to any reason lube oil pressure drops to 1.1kg/cm<sup>2</sup> shut down plunger operates due to which oil on speed piston and speeder spring goes to sump through shut down plunger assembly and fly weight goes away from balance position and oil from buffer piston also goes to sump, fuel rack comes on no fuel position and engine will shut down.

#### **Duties towards WW governor -**

1. Check oil level in glass tube.
2. Check tightness of empanel plug
3. Check linkage pin
4. Resetting of shut down plunger
5. Check oil leakage on governor body
6. Check connection of booster air and lube oil pipe.

## Difference between EH and WW governor-

| EH governor                                     | WW governor  |
|---|--|
| Sump capacity is 3.79litres.                    | 2.5litres.   |
| Two spy glasses are provided to check oil level | Glass tube is provided                               |
| Governor oil pressure is 135psi.                | 100psi.  |
| Pump is driven by the fuel pump motor(FPM)      | Pump driven by right side cam shaft gear.            |
| Engine speed controlled by ESR1, 2, 3, 4.       | A,B,C,D solenoids                                    |
| ESR1, 2, 3, 4 are fitted in front panel.        | A, B, C, D solenoids are fitted inside the governor. |
| It has LCR & SP                                 | It has Vain servo motor                              |
| OPS is provided in loco pilot cab               | It is inside the governor body                       |
| It does not have shutdown plunger.              | It has shutdown plunger                              |
| SP is provided to avoid engine hunting.         | Engine hunting is not possible.                      |
| It hasn't BAP and LOP connection.               | It has BAP and LOP connection.                       |

### Micro control based governor ((MCBG)

It is provided on some locomotives, its working is-

1. To maintain engine speed as per throttle notches.
2. Matching the horse power of engine and main generator.
3. To control the fuel rack in proportionate to booster air pressure.
4. Shut down the engine due to low lube oil pressure.
5. Reduce the excitation during the wheel slip

**Description** –This governor has two units' viz. control and actuator

Both the units are connected through cable

**Control unit** – It is provided in loco pilot cab, it has important electronic circuits and display unit. It has following module/ cards.

1. Control card
2. Input card
3. Load and clutch card
4. Motor control card-2 no.
5. Display control card
6. Power supply module

**Display screen** – It is provided on control unit and it shows following data/position

1. Notch position
2. Engine speed
3. Fuel rack opening position

4. Booster air pressure
5. Lube oil pressure
6. Fuel oil pressure
7. LCP position

It also displays the defect messages. This unit has reset button, acknowledge button, booster air pressure measuring bypass switch, OSTA testing switch.

## Control unit



## ACTUATOR UNIT



When defect comes in loco, relevant messages display and buzzer start sound if it is normal defect buzzer will stop and message will clear automatically after some time. If it is major defect in engine, message will not clear automatically, it require to press acknowledge button to clear the message, these types of messages are –

1. OSTA tripped
2. Low lube oil
3. Tacho generator failed
4. Over current in fuel rack drive motor
5. Fuel rack drive motor failed
6. Lube oil pressure sensor defective
7. Fuel oil rack position sensor defective

**Actuator unit** – It is located at engine right side power take off end; it has stator motor, gear box and clutch, spring to control fuel rack; fuel rack position and pressure sensor. It is connected through cable to control unit.

**Working-** The input card fitted in control unit senses engine cranking or status of Loco / Engine and give signals to control cards accordingly.

**Engine Starting-** The input card send signals to Load and Clutch control card, Motor control card at the time of engine starting.

Electromagnetic clutch fitted in actuator unit will operated by Load and Clutch control card due to which stepper motor connects with Rack and pinion. The rack and pinion is connected with fuel linkage.

Motor control card supplies current to stepper motor and the motor opens engine fuel rack due to which engine will start.

**Engine Speed Control** – On opening throttle, the input card sense signals and send it to control card. The control card gives signals to motor card accordingly it increases current level of stepper motor due to which fuel rack opens further and engine speed will increase.

Input card gets signals of engine speed continuously from Tacho generator, accordingly current of stepper motor controlled by control card and Motor control due to which engine speed will maintain.

## Lesson No. 11

### BRAKE SYSTEM

Braking: dissipation of amount of kinetic energy into heat energy so as to retard wheel motion is called breaking.

**IRAB-1 brake system** - Locomotive fitted with IRAB-1 brake system can work only on air brake stock.

**Various valves and cocks are provided in IRAB1 brake system**

**A9 Valve** - It is pressure reducing, pressure maintaining and self lapping valve. It is provided on both control stands; it reduced main reservoir pressure 8-10 kg/cm<sup>2</sup> to 5 kg/cm<sup>2</sup> and has 4 ports 30, 5, 1 and exhaust. Its handle has 5 positions -

1. Release
2. Minimum reduction
3. Full service
4. Over reduction
5. Emergency

| S. No | Position       | BP dropping            | BP maintaining         |
|-------|----------------|------------------------|------------------------|
| 1     | Release        | 0                      | 5 kg/cm <sup>2</sup>   |
| 2     | Min reduction  | 0.5 kg/cm <sup>2</sup> | 4.5 kg/cm <sup>2</sup> |
| 3     | Full service   | 1.5 kg/cm <sup>2</sup> | 3.5 kg/cm <sup>2</sup> |
| 4     | Over reduction | 2.5 kg/cm <sup>2</sup> | 2.5 kg/cm <sup>2</sup> |
| 5     | Emergency      | 5 kg/cm <sup>2</sup>   | 0                      |

**SA9 Valve** - It is pressure reducing, pressure maintaining and self lapping valve. It is provided on both control stands; used for applying locomotive brakes and has two positions

- 1- Release
- 2- Application

It has five ports 30, 20 and exhaust.

**MU2B Valve** - It is provided on air brake panel in Nose Compartment have 2 positions lead and trail/Dead. It is provided for Loco brake operation, BP charging, F-1 selector valve. It has eight ports 2, 20, 3, 13, 63, 53, 30 and Exhaust. It should be kept in lead position in leading loco and in trail position on trailing loco in MU operation.

The following ports are connected when it is in lead position port No. 2-20, 3-13, 63-53 and 30 with Exhaust port and in trail position port No. 63-30 and 53 with Exhaust.

**24AD Check Valve** - This valve is also called double acting check valve. It is used where possibility of two different pressure coming to operate single valve.

**C2 Relay Valve** - This valve is provided on air brake panel in Nose Compartment. It is used to charge brake cylinders and brake cylinder equalizing pipe. It has four ports 1, 2, 3 and Exhaust port.



**Add C2 Relay Valve** - This valve is provided on air brake panel in Nose Compartment. When A9 in release position it charges the brake pipe. It has four ports 1, 2, 3 and Exhaust.

**¾” COC** - It is provided on air brake panel in Nose Compartment. It also called brake pipe isolating cock. In single loco and leading loco of multiple units it should be in open position and closed in trailing loco.

**F1 Selector Valve** - This valve is provided on air brake panel in Nose Compartment. It is controlled by MU2B valve. It helps in charging brake cylinder equalizing pipe and loco brake application in conjunction working.

When loco parts while working multiple unit light engine MR EQ. pressure dropped which makes F-1 selector valve partially in lead position on trailing loco and loco brake applied in conjunction working.

This valve has nine ports 30,14,4,16,20,12,15,63,53.

**Power cut off pressure switch** - It is provided in nose compartment with COC. When ever BP pressure less then 2.8kg/cm<sup>2</sup> due to any reason this pressure switch operates and de-energize DMR. This valve is provided in nose compartment on brake panel.

**D24B Feed Valve** - This valve is provided on air brake panel in Nose Compartment. It is a pressure reducing self lapping valve. It reduced MR1 pressure in to 6 kg/cm<sup>2</sup> to charge feed pipe.

**1 ¼ COC** - It is provided on air brake panel in Nose Compartment. It is used to isolate D24B feed valve.

**Duplex check valve** - This valve is located near MR1. It works as a non return valve. When MR pressure is built up more than 5kg/cm<sup>2</sup>, it operates and allows the pressure to charge MR equalizing pipe and feed pipe pressure.

**D-1 Emergency Flap Valve** – It is provided behind both driving seats. This valve is directly connected to brake pipe. When this valve is lifted brake pipe pressure drops. It is used in emergency conditions.

**N1 Limit Valve** - It is provided on air brake panel in Nose Compartment. It reduced MR pressure up to 1.8 kg /cm<sup>2</sup>.

**C3W distributor valve-** It is located in nose compartment. It controls conjunction working in IRAB-1 System. This valve having 4 ports viz. BP, MR, EX, SP. The BP chamber is connected to control chamber through non return chock, chock allowed air from BP chamber to control chamber. It has one isolating handle having two positions service and isolation. It has also ‘P’ & ‘G’ handle, while working passenger train this handle should be on ‘P’ position and with goods train it should be on ‘G’ position. According to the position of handle loco brake application and releasing time is fixed.

This valve has one manual release handle which is used to release loco brake manually in conjunction braking.

**Foot paddle switch-** It is provided in front of both loco pilot driving seat ,used to release loco brake during conjunction braking by pressing foot paddle switch.

### **Application and releasing of Loco brake**

SA9 valve is fitted for independent application and release of loco brakes in IRAB1 brake system. SA9 valve has 2 positions.

Application - In this position loco brakes are applied.

Release - In this position loco brakes are released.

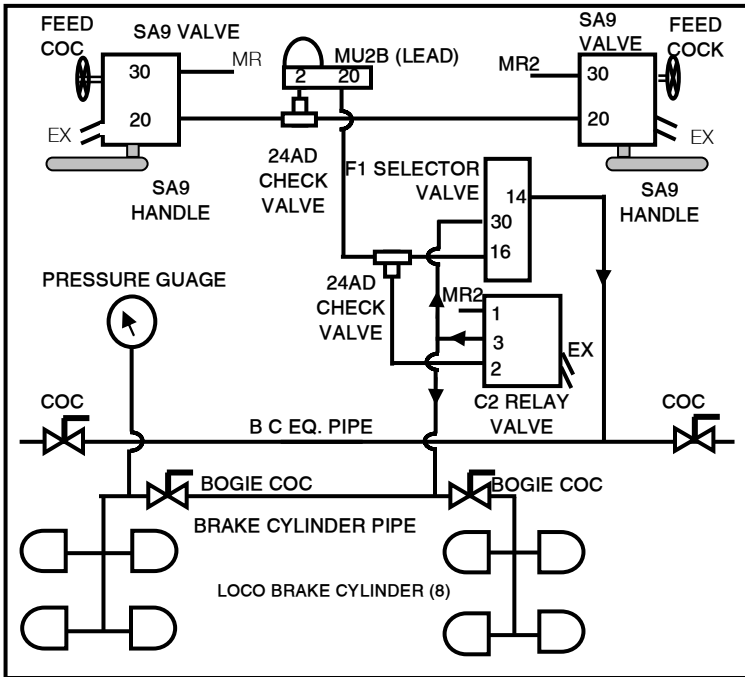
**Loco brake application** - When SA-9 valve handle is kept in application position its port no. 30 and 20 connected, adjusted pressure of  $3.0 \text{ kg/cm}^2$  by feed cock discharge from port no. 20 and goes to MU2B valve port no. 2 through 24AD check valve. Since MU2B valve is in lead position, its port no. 2 is connected to 20, the pressure comes out from port no.20 and goes to C2 Relay valve port no.2 through 24AD check valve and C2 relay valve operated. C2 Relay valve port no.1 and 3 connected, waiting pressure of MR2 on port no. 1 will discharge from port no. 3 in proportionate to the pressure of port no. 2 which is  $3.0 \text{ kg/cm}^2$  and goes to following places

1. Through boogie cut out cock to brake cylinder and operates loco brakes.
2. To charge brake cylinder equalizing pipe through F1 selector valve port no. 30 and 14

**Loco brake releasing** - When SA-9 handle is kept in release position, its port no. 20 disconnected from 30 and gets connected to exhaust port. Air pressure in C2 relay valve port no. 2 will exhaust through MU2B and SA9 valve exhaust port. As there is no pressure in C2 relay valve port no.2, its port no. 3 is disconnected from 1 and gets connected to its exhaust port, brakes cylinder pressure exhaust from C2 relay valve exhaust port and loco brake will released.

### **Note -**

1. In some locos SA9 COC is provided in control stand, Working control stand COC should be kept open and non working control stand in close position.
2. Brake cylinder pressure gauge is provided on both the control stand to show brake cylinder pressure.
3. Boogie isolating cock is provided on loco right side in under frame for both boogies to isolate loco brake.
4. Brake cylinder pressure gauge will not show if front boogie is isolated.



### Procedure of brake cylinder pressure adjustment –

1. Ensure MR pressure should be 8 to 10 kg/cm<sup>2</sup>
2. Ensure MU2B on lead position
3. Both bogies isolating cock should be in open condition.
4. Both end brake cylinder equalizing pipe COC should be in close condition.
5. Keep SA9 handle of working control stand in application and adjust 3.0 kg/cm<sup>2</sup> with the help of its feed cock.

### Loco brakes not applying

| Reason                                     | Remedy   |
|--|--|
| In sufficient MR Pressure                  | Charge it upto 8 to 10 kg/cm <sup>2</sup>          |
| MU2B is not in lead position               | Keep it on lead position.                          |
| C2 relay valve stuck up                    | Tap it.  |
| Brake cylinder equalizing pipe COC is open | Close it.  |
| Bogie COC is closed                        | Open it  |
| Brake cylinder pressure is not adjusted    | Adjust it 3.0 kg/cm <sup>2</sup> by SA-9 feed cock |

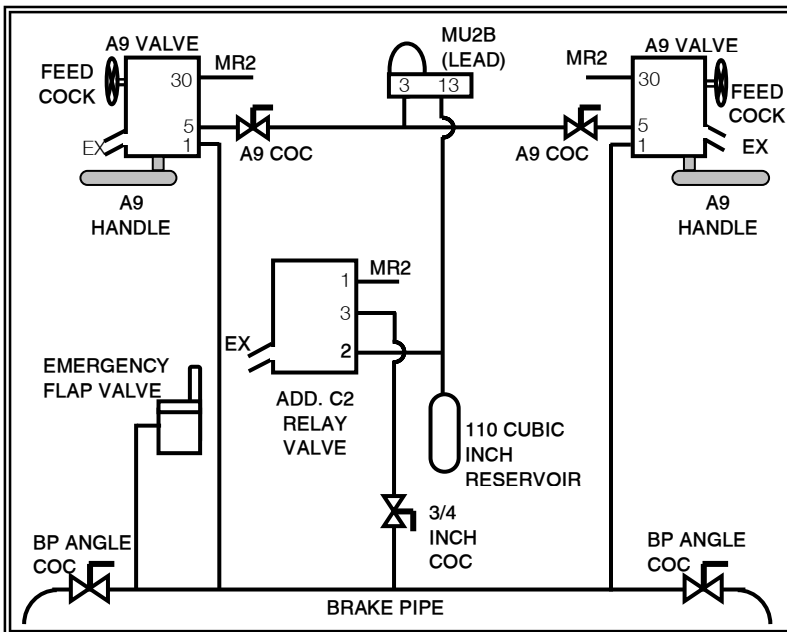
## Brake pipe charging

Waiting MR2 pressure on port no. 30 of A9 valve goes to port no. 5 when A9 handle kept on release position. Adjusted pressure of 5 kg/cm<sup>2</sup> by A9 feed cock will discharge from port no. 5 to MU2B valve port no. 3 through A9 COC (when it is in open condition). Since MU2B valve in lead position hence its port no. 3 & 13 are connected and pressure on port no. 3 will discharge from port no. 13 and will go to Add.C2 relay valve port no.2, also charged the 110 cubic inch reservoir.

Add. C2 relay valve gets operated when air comes on its port no.2 hence its port no.1 & 3 are connected and waiting pressure of MR2 will reduced proportionately and discharged from port no. 3 and charged BP pressure 5.0 kg/cm<sup>2</sup> when 3/4" coc in open condition.

### BP Discharging (dropping)

When A9 valve handle kept on application position, its port no.5 is disconnected from port no.30 and connected to exhaust port hence Add C2 relay valve port no.2 air will return via same passage to exhaust port, as per A9 handle position. Add C2 relay valve disturb from its lap position and port no.3 will connect to exhaust port, BP pressure will exhaust and its pressure dropped.



### Procedure of BP pressure adjusting-

1. Ensure MR pressure should be 8 to 10 kg/cm<sup>2</sup>
2. Working control stand A9 COC should be in open condition and None working in closed
3. Ensure MU2B on lead position
4. Ensure ¾ inch coc in open condition
5. Ensure both end of BP angle cock of loco is in closed condition
6. Ensure both emergency flap valve in closed condition
7. Keep A9 handle of working control stand in release position and adjust 5.0 kg/cm<sup>2</sup> by feed cock.

### BP pressure not builds up-

| Reason  | Remedy   |
|---|--|
| 1. Inadequate amount of MR pressure                     | Charge the MR up to 8-10 kg/cm <sup>2</sup>                        |
| 2. Both control stand A9 coc are in closed condition    | Open on working control stand                                      |
| 3. Both control stand A9 handle not in release position | Kept in release  |
| 4. MU2B valve is not in lead position                   | Keep it in lead position   |
| 5. ¾ inch COC is close                                  | Open it  |
| 6. BP angle cut out cock is open                        | Close it   |
| 7. Add C2 relay valve is stuck up                       | Tap it gently  |
| 8. One of the emergency valve is open                   | Close it   |
| 9. BP pressure not adjusted properly                    | Adjust it by A9 feed cock  |
| 10. In MU ¾" COC opened in trailing loco                | Close it   |
| 11. A9 valve stuck up in emergency position             | Operate it from release to emergency position till reset or tap it |

**BP pressure not dropping by A9** -In this condition stop the train by using emergency flap valve and trouble shoot the following

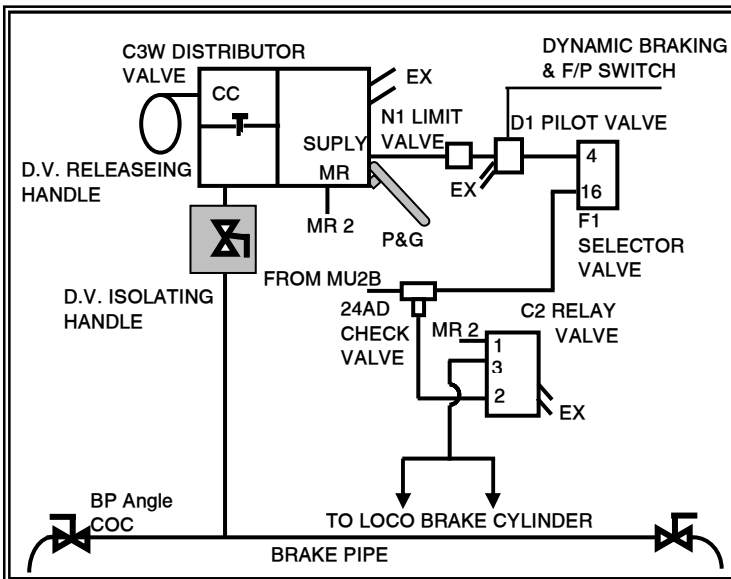
| Reason  | Remedy   |
|---|--|
| 1. Both control stand A9 coc are in open condition                | Closed on non working control stand                                  |
| 2. ¾ inch coc of banker loco is in open condition                 | Closed it  |
| 3. In multiple unit, wrong position of coc/valve in trailing loco | Ensure in trailing loco both A9 and ¾ " coc is closed, MU2B on trail |

**Conjunction braking-** When BP pressure is  $5.0\text{kg/cm}^2$  that time BP chamber and control chamber of C3W valve also charged with  $5.0\text{kg/cm}^2$ , in this position distributor valve is in balance position and loco brake are in released position.

**Application position** - when train brakes applied through A9, BP chamber of C3W drop and distributor valve is operated hence MR port is connected to SP port. Air from SP port goes to N1 limit valve which is set on maximum  $1.8\text{kg/cm}^2$  pressure. From here air goes to C2 relay valve port no.2 through D1 pilot valve, F1 selector valve port no. 4-16 and loco brake applied.

**Release position** - When A9 handle kept on releases position to release train brake that time C3W distributor valve BP chamber and control chamber charged with  $5.0\text{kg/cm}^2$  pressure and valve comes in balanced position. Hence air of C2 relay valve port no.2 will exhaust from C3W distributor valve exhaust port through same passage and loco brake also released.

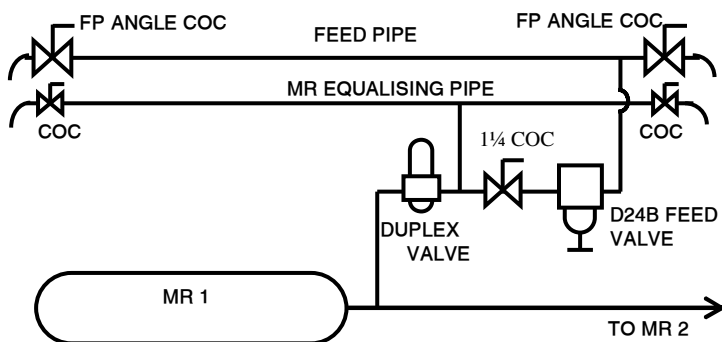
Note- During dynamic brake application or on pressing foot paddle switch D1 pilot valve gets energize and air from C2 relay valve port no.2 will exhaust from D1 pilot valve exhaust port hence applied loco brake in conjunction braking get released.



### Feed Pipe Charging

Twin pipe brake system is developed to increase the efficiency of air brake system it include FP along with the BP. Feed pipe is charged with  $6.0\text{kg/cm}^2$  pressure, all auxiliary reservoir of wagon/coaches are charged

by feed pipe in twin pipe brake system. In loco feed pipe is charged by 6.0kg/cm<sup>2</sup> from MR1 through duplex check valve, 1<sup>1</sup>/<sub>4</sub> inch, D24B feed valve and both end FP angle cock should be in close position.



### Feed pipe pressure is not build up

| Reason   | Remedy   |
|--|--|
| 1. MR pressure is less than 8 kg/cm <sup>2</sup>       | 1. Maintain MR pressure up to 8-10 kg/cm <sup>2</sup>  |
| 2. 1 1/4 " COC is close                                | 2. Open it   |
| 3. Feed pipe pressure is less than 6kg/cm <sup>2</sup> | 3. Adjust it by D24B Feed valve OR Close the 1 1/4 " COC and work the train with single pipe |

### Loco Brakes are not releasing by A9 & SA9

| Reason   | Remedy   |
|--|--|
| 1. In adequate BP pressure   | Trouble shoot accordingly                              |
| 2. Brakes applied in conjunction working are not releasing           | Keep SA9 on quick release or operate foot pedal switch |
| 3. C2 Relay valve stuck up.  | Tap it   |
| 4. C3W valve defective.  | Tap it, pull C3W release handle.                       |
| 5. SA9 of other control stand is in application                      | Release it   |
| 6. Any one of brake cylinder not releasing                           | Isolate the same.                                      |
| Still loco brakes are not releasing                                  | Close bogie coc. If loco brake released work further.  |
| Note-do not work light engine when bogie is isolated and inform PCOR |  |

## **IRAVB1 (DUAL BRAKE)**

**IRAVB1** brake system is provided in some WDG3A locos. IRAVB1 brake system fitted loco can work with both air and vacuum brake trains.

**VA1B Control Valve** - It is provided in nose compartment. It helps in vacuum creation and destruction. It connects train pipe with exhaustor or atmosphere as required. It has one dumble, when it is in balance position train pipe is connected to the exhaustor and in unbalanced position connected to atmosphere. It has nine ports 3, 6, 7, 8, 2, 1, 11, 13 and exhaust.

**HS4 Valve** - It is provided in nose compartment. MR2 pressure is reduced by its feed cock to  $24\pm 1$  psi which goes at the bottom of VA1B valve to balance dumble. This pressure is called vacuum control air pressure.

**GD80D & GD80E Filter** - These filters are located in Nose compartment to clean atmosphere and train pipe air.

**Check Valve** - It is located in Nose compartment. It allows atmospheric air into the train pipe but not vice versa. It is also called non return valve.

**Banking cock (ghat cock)** - It is located in nose compartment. In normal working it should be in open position and closed in banking/ dead loco.

**D1 Pilot Valve** - It is provided in nose compartment. It is electro-pneumatic valve, during dynamic braking it gets energies and keeps the loco brake in release position in conjunction working. It has four ports IN, OUT, MR and Exhaust.

**HB5 Valve** - It is located in nose compartment. While working vacuum brake train when vacuum drops up to 35cm without dropping BP pressure, it operates PCS. This valve has six ports 9, 10, 11, 12, 13 and Exhaust.

**PCS 1** - It is located in nose compartment, it is operated by HB-5 valve. When it operates DMR de-energize.

**A1 Differential Pilot Valve** - It is located in nose compartment. Its working is

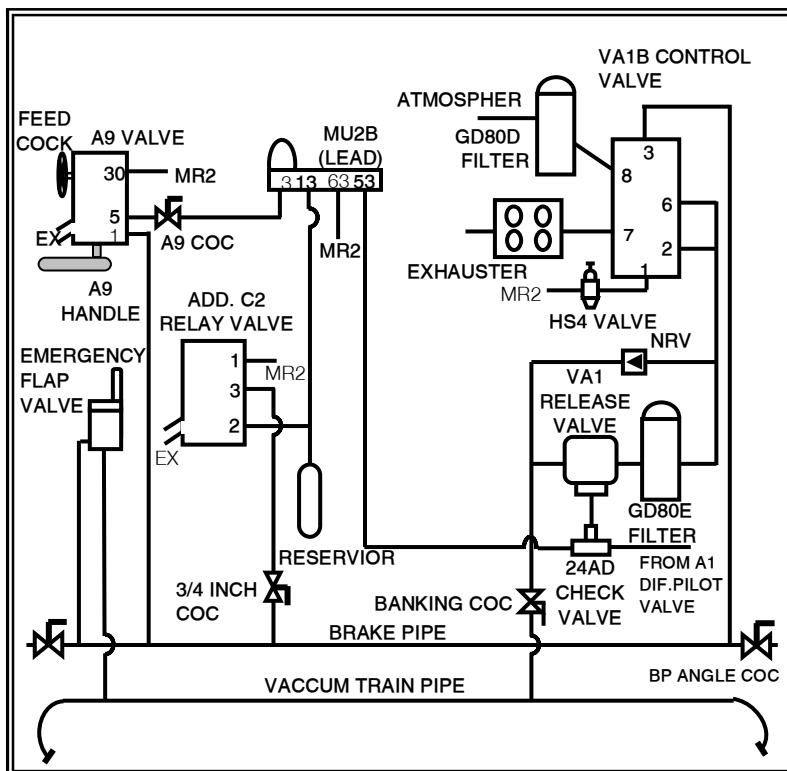
1. While working multiple unit, trailing loco helps in vacuum creation for short time after releasing A-9.
2. It avoids operating HB-5 valve after releasing A-9.

**D-1 Emergency Flap Valve** - It is provided behind both driving seats. This valve is directly connected to train pipe and brake pipe. When this valve is lifted up to  $45^\circ$  train pipe vacuum drops and on  $90^\circ$  brake pipe pressure drops. It is used in emergency conditions.



### Vacuum adjustment –

1. Ensure BP pressure is 5.0 kg/cm<sup>2</sup>
2. Banking coc should be open.
3. Emergency flap valve should be close.
4. Both hosepipes should be on dummy.
5. Adjust HS4 pressure 24 ± 1 psi by its feed cock.



### Vacuum creation in train pipe-

When A9 handle is kept in release position, BP pressure (5.0 kg/cm<sup>2</sup>) will go to VA1B valve port no.3 i.e. on the top diaphragm and from HS4 valve 24±1 psi pressure goes to port no.1 i.e. under the bottom diaphragm hence VA1B valve comes in balance position. In this condition port no.6 of VA1B valve is connected to 7. VA1B valve port no.6 is connected to train pipe and port no.7 to exhauster through vacuum reservoir.

Exhauster sucks air of train pipe through banking cock, VA1 release valve, GD80E filter, VA1B control valve, vacuum reservoir and throw it

to atmosphere through exhaust pipe due to this vacuum create in train pipe, amount of vacuum can be seen in gauge on both control stands.

Note – Two pressures operates VA1 release valve, one is from port no.53 of MU2B valve when it is in lead position and/ from A1 differential valve.

**Destruction of vacuum of train pipe-** When A9 handle kept in application position, BP pressure drops. Due to reduction in BP pressure, pressure reduced on VA1B control valve top diaphragm hence valve gets unbalance and its port no.6 gets connected to 8. Atmosphere air enters from GD80D filter, VA1B control valve, vacuum check valve, banking cock and destroy the vacuum in train pipe.

**Recreation of vacuum in train pipe-** After application of brake when A9 kept on release position to release the train brakes, BP pressure will charge again 5.0 kg/cm<sup>2</sup> and VA1B control valve comes in balance condition. Recreation of vacuum will start in train pipe

### **HB5 Valve -**

While working vacuum brake, A9 in release position and train parts / vacuum hose pipe uncouples / emergency flap valve open / brake applied by guard then atmospheric air enters in train pipe , air comes in VA1B control valve port no.2 and press the bottom diaphragm downward. In this condition VA1B control valve port no.1 is connected to port no.11 and 24 psi pressure goes to HB5 port no.10 through port HB5 valve operates due to which its port no.12 is connected to 11. On MR Pressure waiting of port no.12 goes to PCS through 24AD check valve and operates PCS hence DMR de-energize and changes takes on loco-

1. Electric brake warning lamp (PCS) will glow on both control stands.
2. Engine speed comes to idle.
3. If dynamic brakes were in applied condition it will cut off.
4. If throttle handle on notches first notch current will go to TM.

After necessary trouble shooting when vacuum recreate in train pipe HB5 valve reset and air exhaust from VA1B control chock. Since HB5 valve reset its port no.11 disconnected from port no.12 and connected to exhaust port hence PCS will reset. One isolating cock is provided to isolate this valve.

**A1 differential valve:-**This valve is fitted in nose compartment; one reservoir is connected to it through COC. When COC is in open condition its port no.1 is connected to BP and port no.2 is connected to -

1. VA1 Release valve through 24AD check valve
2. Port no.13 of HB5
3. Port no.12 of VA1B control valve

When A9 is in release position, then port no.1 of A1 differential pilot valve and its reservoir is charged by BP pressure.

Whenever A9 handle kept on release position after application that time its port no.1 &2 is connected till reservoir is recharged up to 5.0kg/cm<sup>2</sup>, in between following action will take place –

1. In multiple unit loco, MU2B of trailing loco is in trail/dead position hence VA1 release valve does not operate due to any air, where as VA1B valve in balance position but not creating vacuum. When A9 handle kept on release position after application, A1 Differential pilot valve operates and send air to VA1 release valve hence trailing loco helps in creating vacuum for some time.

2. When vacuum drops in train pipe through A9 and further A9 kept on release position that time circumstances arise to operates HB5 but in this situation HB5 does not operates since on its port no.13 air comes from A1 differential pilot valve.

Above all action will take place till the A1 differential pilot valve reservoir is charged by 5kg/cm<sup>2</sup>

When reservoir is charged port no.1 &2 are disconnected and pressure of port no.2 is exhaust through VA1B control valve chock.

### **Vacuum is not creating in train pipe**

| Reason   | Remedy                              |
|--|-------------------------------------|
| 1. Brake pipe pressure is less than 5 kg/cm <sup>2</sup> | Charge BP upto 5 kg/cm <sup>2</sup> |
| 2. Vacuum control pressure is more than 24 ± 1 PSI       | Adjust it by HS4 valve              |
| 3. Vacuum hose pipe is not on dummy                      | Put it on dummy                     |
| 4. Banking COC is close                                  | Open it                             |
| 5. Leakage from emergency flap valve                     | Try to arrest the leakage           |
| 6. VA1B control valve or VA1 release valve stuck up      | Tap it                              |

### **Vacuum comes too fast**

| Reason                                       | Remedy  |
|--|---|
| 1. Obstruction in train pipe                 | Test the blockage on Loco and inform the power controller |
| 2. Vacuum control pressure is less           | Adjust it by HS4 feed cock                                |
| 3. Banker loco banking coc in open condition | Close it  |

## Various test of brake system

### Vacuum test

Purpose - To check the vacuum creation capacity of the Exhauster

Apparatus - Test plate of 8mm dia leak hole.

Procedure -

1. Ensure the BP pressure; it should be  $5\text{kg/cm}^2$ .
2. Ensure vacuum control pressure; it should be  $24\pm 1\text{psi}$ .
3. Keep both side hose pipe on dummy and ensure that vacuum in train pipe is 58 cm.
4. Keep A9 handle in emergency position.
5. Remove the hose pipe in rear and put 8mm dia hole test plate on it.
6. Keep A9 handle in release position
7. After keeping A9 handle in release position 53 cm vacuum should be created in 45 sec
8. If 53cm vacuum is not created with in 45 seconds, then the loco to be considered fail for vacuum brake train.

### Orifice test

Purpose - To check the capacity of compressor.

Instrument - Dummy palm with 7.5mm leak hole.

Procedure -

1. MR pressure should be  $8-10\text{ kg/cm}^2$
2. BP Pressure should be  $5\text{kg/cm}^2$
3. Open BP angle cock slightly of one end to drain moisture and close it.
4. Fit the Orifice test Instrument on BP palm and open its angle cock.
5. In Auto flasher unit fitted loco after opening angle cock,
  - a. With pressing SP-1/SP-2, BP pressure drops up to  $0.6\text{ kg/cm}^2$  in 1minutes.
  - b. With out pressing SP-1/SP-2, BP pressure drops  $1.5\text{ to }2.5\text{ kg/cm}^2$  in 1minutes.

**Note** :- With out auto flasher unit fitted loco, after opening angle cock BP pressure should not drop more than  $1\text{ kg/cm}^2$  in one minute.

### Leak off test

Purpose: To check the leakage of Brake pipe in the loco

Procedure:

1. MR pressure should be  $8-10\text{ kg/cm}^2$
2. BP pressure should be  $5\text{kg/cm}^2$
3. Drop BP pressure up to  $1\text{ kg/cm}^2$  by A9 handle and let it be stable.
4. Close the  $\frac{3}{4}$  "COC, BP pressure should not be drop more than  $0.7\text{ kg/cm}^2$  in 5 minutes after closing the COC.
6. If the BP pressure drops more than  $0.7\text{kg/cm}^2$  then this loco is considered fail for air brake train.

## **Hand brake**

It is provided in loco Pilot cab. It is used to apply on stable loco, dead loco, on down gradient etc to avoid roll down. It has two handles -

**Operating handle** - It is used to apply hand brake, handle to be operate to up-down direction till the chain is tide on R1 brake cylinder piston, piston will came out and three brake blocks of R 1 & R 2 operated.

**Release Handle** - It is in small size, to release hand brake it required to pull the handle in one stroke.

Note-1. Before starting the train or loco ensures hand brakes are in release condition.

2. In some loco modified hand brake provided with wheel handle for operation of hand brake.

## Lesson No. 12

### Basic Electricity

**Electricity** - We cannot see it, but we can sense its effects like heating, chemical, magnetic etc.

**Electric Current** - The flow of electrons is called current. The unit of current is Ampere and measured by ammeter. It is denoted by 'I'.

**Voltage** - Voltage can be defined as the difference of potential between two points of a circuit. One volt is the electric pressure which allows flow of one ampere of current against one ohm resistance. It is measured by voltmeter. Unit of voltage /potential difference is Volt. It is denoted by 'V'.

**Direct current** - The current which does not change its direction and magnitude all the time is called direct current.

**Alternate current** - The current which alternate its direction and magnitude with respect to time is called Alternating current.

**Resistance** - The property of a material which opposes the flow of current through it is called resistance. It is denoted by 'R' and its unit is ohm. It is measured by ohm-meter.

**Ohms law** - Ohm's law states that in any electric circuit if the physical condition (Temperature and pressure) remains constant than the current is directly proportional to the voltage and inversely proportional to the resistance.

$$I = V/R$$

Where I = current in amps

V = Voltage in volts

R = Resistance in ohms.

**Conductor** - The material, which allows the current to flow, at a given electrical pressure is called conductor.

Example - Silver, copper, Aluminum etc.,

**Insulator** - The material which does not allow the current to flow through it easily is called as Insulator.

Example - rubber, paper, wood, mica etc.

**Voltmeter** - It is used to measure the voltage of the circuit, it is connected in parallel in the circuit across the load.

**Ammeter** - It is used to measure the current of the circuit, it is connected in series in the circuit with the load.

**Watt** - It is the unit of power, Electric power is measured by wattmeter and is denoted by 'P'

$$P = VI \text{ (1HP=746 watts)}$$

**Magnet** - A Magnet is a substance which has the properties of attraction to iron pieces, it has two poles (north & south). Unlike poles attract each other where as like pole repel each other. Magnet lost its property if heated, hammering or fall from height.

These are of two types -

**1. Permanent** – It has fixed magnet power in different sizes, used as per requirement. Its magnetic power can not be change easily e.g. Bar, Compass needle, Horse shoe etc

**2. Temporary** - Its magnetic power can be increase/ decrease/zero. If electrical supply given in coil of copper wire winded on iron rod, iron rod produced magnetic power as electrical supply cut off magnetic power will lost. It is also called electro magnet, it is usually used in electric machines e.g. Generators, motors etc.

**Switch** - Switch is used in the electrical circuit to open or close the circuit. In locomotive toggle, Rotary and knife switches are used.

**Fuse** - It is weakest part of electrical circuit. It melts and opens the circuit when the current increases beyond the specified value; it safe guards the circuit from over current.

**Circuit breaker** - It is safety device fitted in the close circuit to protect it from over current. Circuit breaker trips and opens the circuit when the current increases beyond the specified value; it safe guards the circuit from over current.

It has three positions ON, OFF & Trip. In OFF position toggle is downward position, in ON upward position and when trips it will in middle position.

If circuit breaker tripped and there is no defect in the circuit, then it is to be reset. To reset it first bring the toggle to OFF Position then take it to “ON”

In loco the following circuit breaker are used

1. MB1- Main Battery breaker - 200 Amps
2. MB2 – Main Control Breaker – 150 Amps
3. CEB – Crankcase Exhauster Breaker – 15 Amps
4. FPB – Fuel Pump Breaker – 30 Amps
5. AGFB – Auxiliary Generator Field breaker – 15 Amps
6. HLB - head Light breaker - 30 Amps
7. Engine, Cab, Dome Light Circuit Breaker – 15 Amps
8. MFPB-1 & 2- Master Fuel pump breaker – 30 Amps
9. MCB 1, 2- Master control Breaker – 15 Amps

**Relay** - Relay is an electro-magnetic remote control device, it is used to open or close the control circuit. Control circuit is operated by interlocks which are in the relay itself.

**Normally Open Interlock (NOI)** - when the relay in de-energies condition, the contacts which are in open position are known as NOI

**Normally Close Interlock (NCI)** - When the relay in de-energies condition, the contact which is in close position are known as NCI

**Contactors** - Contactors are of two types

**1. Electro magnetic contactor** - In this contactor when current flows through the coil, coil gets magnetized (becomes temporary Magnet) due to this armature (Movable jaw) will be attracted towards fixed jaw. It is called contactor picks-up. When current flow cutoff the coil, coil gets de-magnetized. due to this armature (Movable jaw) will be separate from fixed jaw. It is called contactor drops. In Loco the following electromagnetic contactors are fitted -

- R1, R2 - Radiator fan contactors on back panel
- CK1, CK2, CK3- Cranking Contactors on Front panel
- GFC -Generator Field Contactor on Front panel
- FPC -Fuel pump contactor on Front panel

**2. Electro Pneumatic Contactors** - The contactors which required electrical current and compressed air to pick up, they are called as Electro pneumatic contactors. There are 11 Electro Pneumatic Contactors (Power contactors-9, BKT-01 and Reverser-01)

**Power contactors:** 3 contactor for series and 6 for parallel and they are connected with the following Traction motors.

- S1 - Traction motor -1 & 4
- S21- Traction motor -3 & 6
- S31 - Traction Motor- 2 & 5
- P1 - Traction Motor – 4
- P21- Traction Motor -6
- P31- Traction motor – 5
- P2 - Traction Motor – 1
- P22 - Traction Motor – 3
- P32 - Traction Motor – 2

**BKT (Braking and Traction Switch)** – It is Electro pneumatic contactor BKT is fitted on front panel. BKT has two positions Motoring and Braking. To move the loco, BKT should be in motoring position and it should be in Braking position at the time of dynamic braking.

**Reverser** – It is Electro pneumatic contactor. REV is fitted on front panel each reverser has two EP valves, forward & Reverse; these are controlled by RH which is located on control stand. It has two positions, Forward & Reverse.

**Excitation cards** - They are seven in number provided in excitation panel

- 186 Reference Mixer card
- 187 Miscellaneous card
- 188 Pulse with modulator card
- 253 Oscillator card
- 254 Power transistor card
- 492 Voltage Control card
- 493 Function Generator card



**Generator** - It is a machine which converts mechanical energy into electrical energy. They are of two types

1. **Separately excited generator** - The generator in which the field is excited by external source is called separately excited generator.

2. **Self excited generator** - In this type of Generator field gets excited by its own armature current. Initially this type of generator produces electricity on the principle of residual magnetism. These are of three types

a. **Series generator** - It is a Generator in which the field winding is in series with the armature.

b. **Shunt generator** - It is a Generator in which the field winding is in parallel with the armature.

c. **Compound generator** - This Generator is the Combination of both series and shunt generator.

**Alternator** - This is an A.C. Generator, it generates A.C. current. In alternator field winding is in rotor and armature winding in stator. Slip rings and carbon brushes are used to give current to the rotor for excitation. The rotor when rotated by an external mechanical source produces alternating current in stator.

It may be 3 phase or 1 phase. It produces higher voltage and requires less maintenance.

**Motor** - It is an electrical machine which converts electrical energy into mechanical energy. DC motors are of three types

1) **DC series motor** - In this motor the field winding is connected in series with the armature. It is used in traction because of its high starting torque.

2) **Shunt motor** - In this motor the field is connected in parallel with the armature.

3) **Compound motor** - In this motor the field is connected in both series and parallel with the armature.

## Lesson No. 13

### Abbreviation

| S.No | Abbreviation         | Full Name                                 |
|------|----------------------|---|
| 1.   | A <sub>9</sub>       | Automatic brake valve                     |
| 2.   | AG                   | Auxiliary Generator                       |
| 3.   | AC                   | Alternating current                       |
| 4.   | ACCR                 | Armature current control reactor          |
| 5.   | AGFB                 | Auxiliary Generator field breaker         |
| 6.   | AFPB                 | Additional fuel pump breaker              |
| 7.   | AR                   | Auxiliary reservoir                       |
| 8.   | BA                   | Battery ammeter                           |
| 9.   | BAS                  | Battery ammeter shunt                     |
| 10.  | BAP                  | Booster air pressure                      |
| 11.  | BC                   | Brake Cylinder                            |
| 12.  | BHEL                 | Bharat Heavy Electricals Ltd.             |
| 13.  | BKBL                 | Dynamic braking blower motor              |
| 14.  | BKR                  | Braking relay                             |
| 15.  | BKT                  | Braking and Traction switch               |
| 16.  | BP                   | Brake pipe                                |
| 17.  | BS                   | Battery knife switch                      |
| 18.  | CB                   | Circuit breaker                           |
| 19.  | CBC                  | Centre buffer coupler                     |
| 20.  | CCM                  | Crank case exhaust motor                  |
| 21.  | CEB                  | Crank case exhaust breaker                |
| 22.  | CK <sub>1,2,3</sub>  | Cranking contactor                        |
| 23.  | COC                  | Cut out cock                              |
| 24.  | CKC                  | Main Cranking contactor                   |
| 25.  | CKR <sub>1,2</sub>   | Cranking relay                            |
| 26.  | CPR <sub>1,2</sub>   | Arc separation rectifier                  |
| 27.  | CVR                  | C-valve relay                             |
| 28.  | DBB/DEB              | Dust blower breaker/ Dust Exhaust breaker |
| 29.  | DC                   | Direct current                            |
| 30.  | DLCB                 | Dome light circuit breaker                |
| 31.  | DLW                  | Diesel locomotive workshop Varanasi       |
| 32.  | DMW                  | Diesel Modernization workshop, Patiala    |
| 33.  | DMR                  | Dead men's relay                          |
| 34.  | ECC                  | Eddy current clutch coil                  |
| 35.  | ECP                  | Engine control panel                      |
| 36.  | ECS                  | Engine control switch                     |
| 37.  | EH                   | Electro hydraulic                         |
| 38.  | ETS <sub>1,2,3</sub> | Engine temperature switch                 |

|     |                         |  |
|-----|-------------------------|--|
| 39. | ERR                     | Engine running relay                             |
| 40. | ESLP                    | Engine start lamp                                |
| 41. | ESR <sub>1,2, 3,4</sub> | Engine speed relay                               |
| 42. | FP                      | Feed pipe  |
| 43. | FPB                     | Fuel pump breaker                                |
| 44. | FPC                     | Fuel pump contactor                              |
| 45. | FPM                     | Fuel pump motor                                  |
| 46. | FS <sub>21-26</sub>     | Field Shunt Contactor                            |
| 47. | FSR                     | Field Shunt Relay                                |
| 48. | FIP                     | Fuel Injection Pump                              |
| 49. | FL                      | Flasher Light                                    |
| 50. | FTTM                    | Front Truck Traction Motor ( Blower)             |
| 51. | GFC                     | Generator Field Contactor                        |
| 52. | GR                      | Ground Relay                                     |
| 53. | GRS/GRCO <sub>1,2</sub> | Ground Relay Switch/ Ground Relay cut out Switch |
| 54. | GFCO                    | Generator Field Cutout Switch                    |
| 55. | GFOLR                   | Generator Field Over Load Relay                  |
| 56. | HLB                     | Head Light Breaker                               |
| 57. | HL                      | Head Light                                       |
| 58. | HLPR                    | Head Light Resistance                            |
| 59. | HP                      | Horse Power                                      |
| 60. | IRAB <sub>1</sub>       | Indian Railway Air Brake System                  |
| 61. | Kmph                    | Kilometer per hour                               |
| 62. | LA                      | Load Meter                                       |
| 63. | LAS                     | Load Ammeter Shunt                               |
| 64. | LCP                     | Load Control Potentiometer                       |
| 65. | LPB <sub>1,2</sub>      | Cab Light Circuit Breaker                        |
| 66. | LWS                     | Low Water Switch                                 |
| 67. | MH                      | Master handle                                    |
| 68. | MB <sub>1</sub>         | Main Battery Breaker                             |
| 69. | MB <sub>2</sub>         | Main Control Breaker                             |
| 70. | MCB <sub>1&amp;2</sub>  | Master Control Breaker                           |
| 71. | MCO                     | Motor Cutout Switch                              |
| 72. | MFPB <sub>1&amp;2</sub> | Master Fuel Pump Breaker                         |
| 73. | MR                      | Main Reservoir                                   |
| 74. | MTR                     | Manual Transition Switch                         |
| 75. | MU                      | Multiple Unit                                    |
| 76. | MUSD                    | Multiple Unit Shutdown Switch                    |
| 77. | NCI                     | Normally Close Interlock                         |
| 78. | NOI                     | Normally Open Interlock                          |
| 79. | OPS                     | Oil Pressure Switch                              |
| 80. | OSTA                    | Over Speed Trip Assembly                         |
| 81. | PC                      | Power Contactor                                  |

|      |                              |                                      |
|------|------------------------------|--------------------------------------|
| 82.  | PCS                          | Pneumatic Control Switch             |
| 83.  | P <sub>1,31,21,2,32,22</sub> | Parallel Power Contactor             |
| 84.  | PDR                          | Power Diode rectifier Blower         |
| 85.  | PWM                          | Pulse Width Modulator                |
| 86.  | R <sub>1&amp;2</sub>         | Radiator Fan Contactor               |
| 87.  | RCD                          | Reverse Current Diode                |
| 88.  | REV                          | Reverser Contactor                   |
| 89.  | RFCB                         | Radiator Fan Circuit Breaker         |
| 90.  | RH                           | Reverser Handle                      |
| 91.  | RPM                          | Revolution Per Minute                |
| 92.  | RTTM                         | Rear Truck Traction Motor ( Blower)  |
| 93.  | S <sub>1,31,21</sub>         | Series Power Contactor               |
| 94.  | SAR                          | Safety Auxiliary Relay               |
| 95.  | SAR <sub>1,2,3,4,5</sub>     | Speed Adjusting Rheostat             |
| 96.  | SR                           | Signal Relay                         |
| 97.  | SLP                          | Signal Lamp                          |
| 98.  | SH                           | Selector Handle                      |
| 99.  | SPM                          | Speedometer                          |
| 100. | TA                           | Traction Alternator                  |
| 101. | TG                           | Traction Generator                   |
| 102. | TH                           | Throttle Handle                      |
| 103. | TM                           | Traction Motor                       |
| 104. | TR                           | Transition Relay                     |
| 105. | TRP                          | Transition Panel                     |
| 106. | TSC                          | Turbo Super Charger                  |
| 107. | TSSR                         | Transition Speed Sensing Relay       |
| 108. | TET                          | Transition Excitation Transformer    |
| 109. | VCR                          | Voltage Control Reactor              |
| 110. | VRP                          | Voltage Regulating Panel             |
| 111. | WW                           | Wood-Ward                            |
| 112. | WSR                          | Wheel Slip Relay                     |
| 113. | WSRR                         | Wheel Slip Relay Resistance          |
| 114. | TCR                          | Température control Resistance       |
| 115. | MPCB                         | Microprocessor circuit breaker       |
| 116. | PLPB                         | Pre-lubrication pump breaker         |
| 117. | ADB                          | Analog distribution box              |
| 118. | RDB                          | RPM distribution box                 |
| 119. | EXPR                         | Exciter Generator Protection Relay   |
| 120. | AGPR                         | Auxiliary Generator Protection Relay |
| 121. | CMR                          | Compressor relay                     |
| 122. | AFLR                         | Auto flasher light Relay             |
| 123. | VCD                          | Vigilance control device             |
| 124. | VCDR                         | Vigilance control device Relay       |
| 125. | SLBR                         | Self load Box relay                  |

|            |  |
|------------|--|
| 126. MVR   | Magnet valve Relay                                   |
| 127. TANGI | Traction alternator neutral to ground current sensor |
| 128. BANGI | Battery negative to ground current Sensor            |
| 129. EOT   | Engine oil temperature sensor                        |
| 130. BATI  | Battery current sensor                               |
| 131. AAT   | Ambient air temperature sensor                       |
| 132. MRPR  | Main Reservoir pressure sensor                       |
| 133. TMAI  | Traction motor armature current sensor               |
| 134. TAAI  | Traction Alternator armature current sensor          |
| 135. APR   | Altitude pressure sensor                             |
| 136. TAV   | Traction Alternator voltage sensor                   |
| 137. EXAI  | Exciter generator armature current sensor            |
| 138. EXFI  | Exciter generator field current sensor               |
| 139. LCPV  | Load control potentiometer voltage sensor            |
| 140. EWT   | Engine Water temperature sensor                      |
| 141. ESS   | Engine Speed sensor                                  |

## Lesson No. 14

### Electrical Rotating Machines

There are 11 rotating machines provided on loco.

1. Traction Alternator
2. Auxiliary Generator
3. Exciter Generator
4. Techo Generator
5. Axle Generator
6. Traction Motor
7. Fuel Pump Motor
8. Crank Case Exhauster Motor
9. Dynamic Braking Blower Motor
10. Eddy Current Clutch Coil
11. Cyclonic Motor

#### 1. Traction Alternator-

1. It is a 3 $\phi$  AC Generator.
2. It is located in Alternator room.
3. It converts mechanical energy into electrical energy.
4. Alternator field (rotor) is connected to diesel engine crank shaft. Its field is excited by exciter generator through two slip rings and carbon brushes. Current produced by alternator armature (stator) is given to rectifier block; it converts AC into DC. Through power circuit DC supply given to Traction motor.
5. It is a self cooled through fly wheel.
6. Maximum rpm of rotor is 400 -1050 rpm, and no load voltage is 1130 volt DC.

#### 2. Auxiliary Generator

1. It is a self excited DC shunt Generator.
2. It is located at engine left side in Alternator room.
3. It is driven by the bull gear of main generator
4. Auxiliary generator works as follows-
  - a) Charges the battery
  - b) Excites the field of exciter generator
  - c) Gives supply to FPM, CCM and ECC
  - d) Gives supply to control and lighting circuits
  - e) Auxiliary generator works as a motor at the time of engine cranking.
5. When auxiliary generator is not working, AGFL glows on control panel.
6. Auxiliary Generator junction box having 4 wires AGA1, AGA2, AGF1 and AGF2.

7. AGFB circuit breaker is provided to safe guard Auxiliary generator field winding.
6. Its output voltage  $72\pm 1$  volt which is controlled by VRP (Voltage Regulating panel)

### **3. Exciter Generator**

1. It is a separately excited DC Generator.
2. It is located in Alternator room.
3. It is driven by the bull gear of Traction Alternator.
4. The field of the exciter generator is excited by either Auxiliary generator or battery. It excites the field of Traction Alternator. If the exciter generator is defective, Traction alternator does not generate the current.
5. It works as motor at the time of engine cranking.

### **4. Techo Generator**

1. It is permanent magnet  $3\phi$  delta connected AC generator
2. It is located at engine right side power take off end.
3. It is driven by the right side cam shaft gear.  
Its function is -
  - a) In EH governor loco gives current to speed coils to control engine speed and SAR coil.
  - b) In WW governor loco, gives current to function generator card (excitation system).

There are 3 terminal connections 31L, 31M and 31N in the junction box. If any connection is loose, engine will shut down without any indication in EH governor loco.

### **5. Axle Generator**

1. It is a permanent magnet single phase AC Generator.
2. It is fitted on L2 axle box.
3. It gives current to transition panel.
4. It is driven by the Spline shaft which is fitted on the L2 axle. Its rotor rotates in proportionate to the speed of the loco. The output of the axle generator is connected to TET by the two terminals of wire No. 45B, 45C. TET is connected to Transition Panel by wire No. 46, 46A. If wire connections are loose on axle generator automatic transaction will not come.
5. Ensure the foundation bolt and safety chain of axle generator is intact.

## 6. Traction Motor (TM)

1. It is DC series motor.
2. It is fitted on each axle in under truck of loco with the help of suspension bearing and nose pad. (06 TM are provided on loco)
3. It converts electrical energy of traction alternator into mechanical energy which rotates the wheels of Loco.
4. Its pinion gear has 18 teeth matched with axle gear having 74 teeth.
5. At the time of traction the armature and field of motor are connected in series with the help of BKT.
6. During dynamic braking all TM field and armature are separated with the help of BKT, fields are connected in series with each other across the main generator and armatures are connected in groups (1-4, 2-5, 3-6) with the grids. It works as separately excited generator.
7. For cooling the TM there are 2 blowers. FTTM blower cools TM No.1, 2, 3 and RTTM blower cools TM No.4, 5, 6.
8. Non explosive power takes place when earth fault in traction motor.
9. One MCO is provided on front panel to isolate the defective traction motor.
10. Load meter is provided on both control stands to show the TM current.

## 7. Fuel Pump Motor

1. It is a DC compound motor.
2. It is Located in the compressor room engine right side.
3. It gives drive to the fuel oil pump and EH governors pump.
4. Initially it gets supply from battery and after engine starting from Auxiliary Generator
5. FPB breaker is provided on control panel to safe the fuel pump motor from over current
6. There are two terminals in the junction box of FPM, wire No.71 and 4. In case of fuel pump motor failure, the fuel oil pressure drops to zero and engine will shut down.

|                   |            |
|-------------------|------------|
| Speed of Armature | 1725 rpm   |
| Horse Power       | 1 HP/1.5HP |

## 8. Crankcase Exhauster Motor

1. It is a DC compound motor
2. It is located on engine left side at power take off end.
3. It is provided to exhaust the fumes from the crank case sump and creates a partial vacuum.



4. Initially it gets supply from battery and after engine starting from auxiliary generator.
5. CEB circuit breaker is provided on front panel to protect CCM from over current.
6. There are two wire terminals in the junction box, wire no 70A and 4.
7. To ensure the working of CCM the indication lamp is provided on both the control stands, it will glow when CCM not working.
8. If CCM is not working, first clear the section and inform to PCOR and fail the loco.

### **9. Dynamic Braking Blower Motor (BKBL)**

1. It is a DC series motor.
2. It is located in Nose compartment.
3. Two blowers are fitted on each side of its armature shaft, during dynamic braking it starts and cools the braking grids. At the time of dynamic braking, electric supply generated by traction motors is used to rotate BKBL.

If BKBL is not working, do not use dynamic brakes.

### **10. Eddy Current Clutch Coil (ECC) Assembly**

1. It is located in the radiator room.
2. It controls the speed of radiator fan.
3. In this assembly there are two drums, inner drum and outer drum. Outer drum is connected to extension shaft No.2 and rotate with main crank shaft and inner drum is connected with the radiator fan through the right angle gear box. ECC coil is fitted on Inner Drum and works on the principle of eddy current. There are two wires connected in its junction box wire No.72 and 4. Two slip rings with four carbon brushes are fitted on inner drum. When supply is given to ECC, inner drum also starts to rotate with outer drum thus radiator fan start rotating and cools the water.

### **11. Cyclonic Motor**

1. It is provided under truck near wheel no.6 both side of Loco.
2. A blower is fitted on Cyclonic Motor shaft which sucks the dust from cyclonic filter dirt collector and through the same in atmosphere.
3. One circuit breaker DEB is provided in loco pilot cab.
4. One indication lamp is provided on indication panel of front panel.
5. It starts working from 5<sup>th</sup> notch when DEB ON.
6. When cyclonic motor fails inform to PCOR.

**Note** - In 11 and 13 series Loco two additional Cyclonic Motors are provided on both side of alternator.

## Lesson No. 15

### Battery and Battery charging circuit

#### Battery

Battery - It is a device which converts chemical energy into electrical energy. It is a combination of two or more cells.

Primary Cell – It can not be recharged.

Secondary Cell – It can be recharged.

Charging – During this process electrical energy is converted into chemical energy.

Discharging – During this process chemical energy is converted into electrical energy.

In WDG3A loco, there are two types of batteries are used –

1. Lead Acid Battery
2. Nickel Cadmium Battery

**1. Lead Acid Battery:** In Diesel loco 8 Lead acid batteries are provided, each battery contains 4 cells of 2 volt and each battery voltage is 8 volts. All the 8 batteries are connected in series therefore total battery voltage is 64 volts.

In 14 series loco battery No.1, 2, 3 are located at the left side and 4, 5, 6 batteries are located at right side of loco near alternator room and battery No.7, 8 are fitted in loco left side near nose compartment.

In 13 series loco battery No.1, 2, 3,4 are located at the right side near alternator room and 5, 6,7, 8 batteries are located at left side of loco near nose room.

The positive terminal of battery No. 1 and negative terminal of battery No. 8 is connected to battery knife switch.

The capacity of battery is 450 ampere hour and its normal charging current rate is 10 - 20 amps approx.

In each cell of the lead acid battery positive plate is made of lead oxide (PbO<sub>2</sub>) and negative plate is of lead (Pb).Both plates are separated by separator plate and immersed in electrolyte. The electrolyte level should be 1.25 inch above the separator plate. The vent plug is provided for each cell.

Use of battery before engine starting –

1. To crank the engine.
2. To charge the control circuit of Loco.
3. To start FPM and CCM.
4. To charge the lighting circuit of Loco.

Battery is charged by Auxiliary Generator after engine starting.

## 2. Nickel Cadmium Battery/ Alkaline Battery

As a modification 11 Nickel Cadmium batteries are fitted in some Loco. Out of 11 batteries, seven batteries are of 4 cells and remaining is of 5 cells. Each cell is of 1.2 Volt and total voltage of batteries is 58 volts.

The capacity of battery is 240 ampere hour and its normal charging current rate is 24 - 48 amps approx.

In each cell anode (+ve) is made of Nickel oxide and cathode (-ve) is made of cadmium. The both plates are immersed in electrolyte. Use of these batteries in the loco is same as lead acid batteries. It is charged by Auxiliary Generator after engine starting but its initial charging current is high which is become normal after some time. It is not necessary to check the electrolyte level in the battery.

Advantages of Nickel Cadmium battery –

1. Less time is required for charging.
2. Maintenance cost is less.
3. Long life.
4. No need to check electrolyte level.

### Battery charging circuit

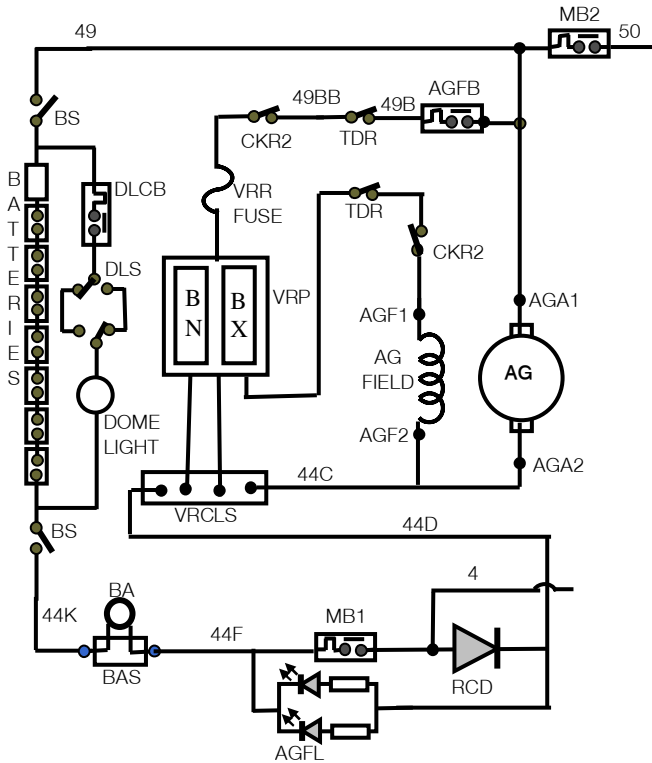
The batteries in Diesel loco are charged by the Auxiliary generator with constant voltage i.e.  $72 \pm 1$  volt. The Voltage Regulating Panel (VRP) controls output of auxiliary generator with the help of VRCLS, irrespective of engine speed. VRCLS is provided to limit the current; its setting is 160 Amp.

**Description of circuit** – At the time of Engine starting , when BS is ON battery supply goes to wire no. 49, AG armature, wire no. 44c, VRCLS, wire no. 44D, AGFL, wire no. 44F, BAS and wire no. 44k (battery negative) and circuit completed. After this AGFL will glow.

After engine starting AG starts to generate current initially on the principle of residual magnetism. This current goes to excite the field of AG through VRP when AGFB is put 'ON'. As AG output more than battery voltage then the current starts flowing in wire no. 49. This current starts to charge battery via wire no. 49, BS (+ve), Battery, BS (-ve), wire no. 44k, BAS, wire no. 44F, MB1,4, RCD, 44D and VRCLS, wire no. 44C. As soon as battery starts charging, AGFL lamp will extinguish.

AGFL lamp will glow when battery is discharging or AG is failed.

The battery ammeter is provided on front panel to show charging/ discharging of battery. It has marking of 0-200 Amp both side. Each mark is of 10 Amp. It shows charging current when needle is in the right side of zero and in the left side it shows discharging current.



**Auxiliary generator is failed/ Battery is discharging -** (In this condition Auxiliary generator failure lamp glows continuously and Battery ammeter shows discharging current.)

| Cause                                 | Remedy  |
|---------------------------------------|---|
| AGFB is OFF or tripped.               | Put ON / Reset it   |
| BN/BX cards are loose on VRP.         | Fix it properly.  |
| VRR fuse is melted.                   | Replace it with spare fuse.   |
| Carbon brushes of AG are loosed.      | Fix it properly.  |
| Wire in AG junction box is uncoupled. | Couple it properly.   |
| Even though AGFL is glowing.          | Inform to power controller and can be worked 3 to 5 hrs with the help of battery. |

### **Battery over charging**

If BA showing excessive charging current and smell of acid is coming, it indicates that battery is over charging. In this condition following items to be check –

1. If battery is over charging only on higher notches than the VRP is faulty. In this condition open the BS on higher notches and close it on lower notch / Idle.
2. Check the electrolyte level in battery if less, than inform to PCOR.
3. If any battery is faulty, try to isolate it.

### **Battery is not charging –**

| Cause                               | Remedy                  |
|-------------------------------------|-------------------------|
| 1. MB1 is OFF or tripped.           | 1. Put it ON / Reset.   |
| 2. BS is OFF.                       | 2. Close it.            |
| 3. Battery connection is uncoupled. | 3. Connect it properly. |

## Lesson No. 16

### Engine starting circuit

Traction alternator armature shaft is connected to main crank shaft with the help of flange joint. On the other end of Traction alternator armature shaft bull gear is fitted. This bull gear is massed with auxiliary generator and exciter generator gear. Rotation of main crank shaft by auxiliary generator and exciter generator is called engine cranking. Auxiliary generator and exciter generator works as motor at the time of engine cranking and when fuel combustion starts in the cylinder then engine will start for this purpose the engine starting circuit provided.

#### Description of engine starting circuit (EH Gov.) –

1. Close the battery knife switch, battery +ve connect to wire no. 49 and –ve to 44K.
2. Put ON MB1 on the front panel, supply of wire no. 44K goes to wire no 4 through BAS and MB1.
3. Put ON MB2 on front panel, supply of wire no. 49 goes to wire no 50. Due to supply in wire no. 50 and 4, any light will glow on switching ON its concern switch except Dome light.
4. Put ON MFPB1 on left control stand. Supply of wire no. 50 goes to wire no. 13C then put ON MFPB2 on right control stand, supply of wire no 13C goes to wire no 13.
  - a) FPC coil will be energized by wire no 13 +ve and 4 –ve.
  - b) When FPC picked up then supply of wire no. 50 goes to wire no.70, CCM indication lamp, wire no. 70A, CCM field winding, wire no.4 and completes the circuit, CCM indication lamp will glow on both control stands.
  - c) Electric brake warning (PCS) lamp will glow on both control stands.
5. Put ON CEB on front panel, supply of Wire no 70 directly goes to wire no. 70A due to which CCM indication lamp will extinguish and CCM motor will start. When CCM motor fails CCM failure lamp will glow.
6. Put ON FPB on front control panel. Supply of wire no. 70 goes to wire no. 71 due to which fuel pump motor will start; fuel oil pressure will build up to 4.2 kg/cm<sup>2</sup>. The governor pump also gets start by FPM and governor oil pressure build up to 135 psi. Supply of wire no. 71 goes through OPS NCI (71-50F), CRT2, CK2 NCI (50N-50P), and ECR3 to governor stabilizing coil. Stabilizing action will taken place due to which position of LCR and SP will be changed. Supply of wire no. 50 F goes to ESLP through ESLPR; wire no. 50 AC and 4, ESLP will glow.

7. On pressing Start Button –

a) Supply of wire no. 71 goes to governor clutch coil through start button contact (71-50D), LWS NCI (50D-50J) and coil gets energized, due to which arm A and B of governor will magnetically locked.

b) Due to closing of other contact of start button (50C-43) Supply of wire no. 71 goes to CK1 coil through ESR4 NCI (71-50T), ECS Idle (50T-50C), start button contact (50C-43), P22 NCI (43-43A), S1 NCI (43A-43B) and CKR1 and CKR2 coil get energized.

When CKR1 picks up –

1. Exciter generator field is isolated from armature.
2. GR2 comes in service.
3. CKC picks up.

When CKR2 picks up Auxiliary generator field disconnected from armature.

Due to CKC contact CK1, CK2 will pick up.

When CK1 and CK2 picked up their NOI will be close on branch of CK3 coil due to which CK3 coil get energized.

When CK2 picks up its NCI (50N-50P) will be open on stabilizing coil branch then this coil will de-energized. Magnetically locked Arm A and arm B of Governor moves towards full fuel position due to which fuel supply in cylinder will be start.

8. When CK1, CK2 and CK3 picked up then supply of battery goes to auxiliary generator and exciter generator and it starts to rotate as a motor. The main crank shaft gets drive from auxiliary generator and exciter generator. This is called engine cranking. Due to engine cranking and starting of fuel supply in engine cylinder according to firing order, engine will start with its own power. It is called engine starting.

When engine speed increases up to 280 rpm then SAR gets supply from TG due to which its NOI (50K-50D) will be closed on the branch of governor clutch coil.

When lube oil pressure builds up to 1.6 kg/cm<sup>2</sup> OPS will pick up, its NOI (71-50K) will be closed and NCI (71-50F) will be opened. Due to opening OPS NCI, ESLP will extinguish.

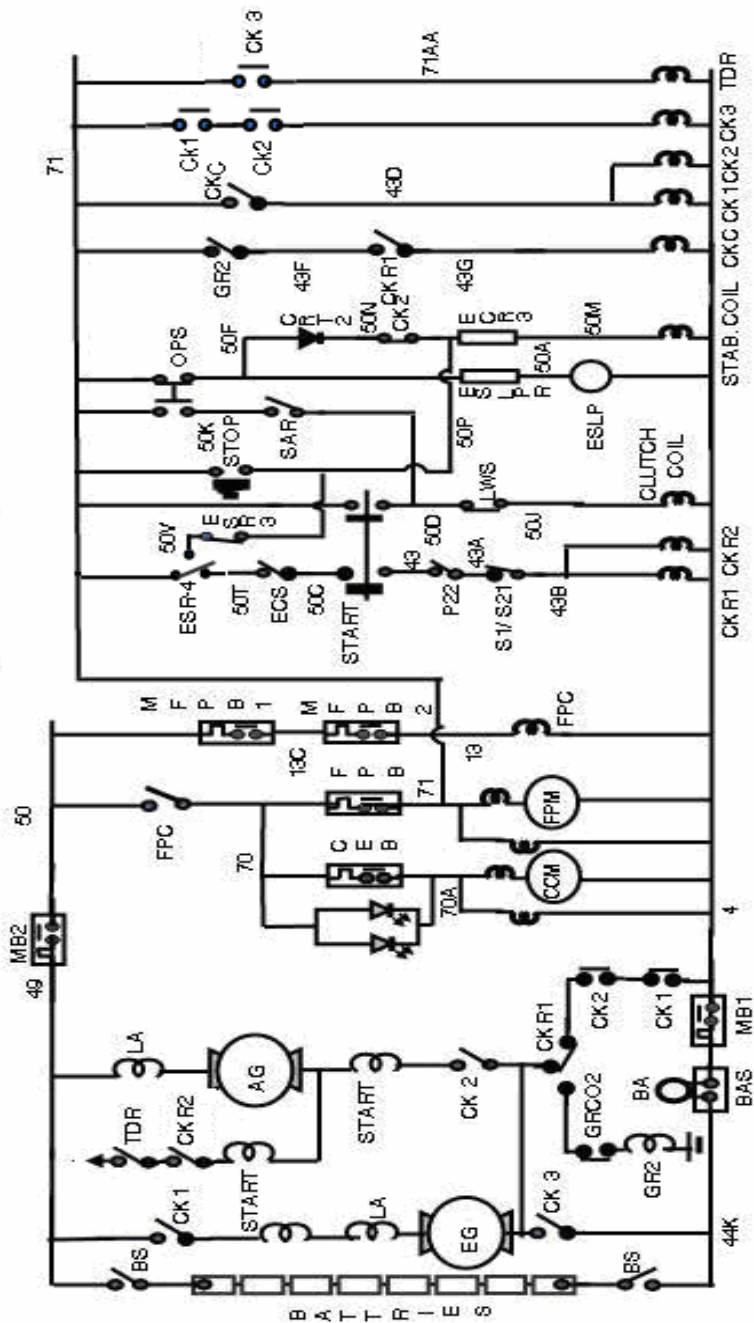
After releasing of start button supply of governor clutch coil is maintained by NOI of SAR and OPS, due to which clutch coil remain energized. And CKR1, 2, CKC, CK1, CK2 and CK3 will be drop.

9. Engine will run till governor clutch coil is energized.

#### **Engine Stopping circuit (EH and GE Gov.)-**

By pressing the stop button current of wire no.71 goes to wire no.50M through stop button contact wire no.50P-ECR3 resistance, due to which the stabilizing coil will energize, fuel rack comes to zero and engine will shut down.

STARTING CIRCUIT (EH GOVERNOR)





## Engine starting circuit (WW Gov.)

Traction alternator armature shaft is connected to main crank shaft with the help of flange joint. On the other end of Traction alternator armature shaft bull gear is fitted. This bull gear is massed with auxiliary generator and exciter generator gear. Rotation of main crank shaft by auxiliary generator and exciter generator is called engine cranking. Auxiliary generator and exciter generator works as motor at the time of engine cranking and when fuel combustion starts in the cylinder then engine will start for this purpose the engine starting circuit provided.

### Description of engine starting circuit –

1. Close the battery knife switch, battery +ve connect to wire no. 49 and –ve to 44K.
2. Put ON MB1 on the front panel, supply of wire no. 44K goes to wire no 4 through BAS and MB1.
3. Put ON MB2 on front panel, supply of wire no. 49 goes to wire no 50. Due to supply in wire no. 50 and 4, any light will glow on switching ON its concern switch except Dome light.
4. Put ON MFPB1 on left control stand. Supply of wire no. 50 goes to wire no. 13C then put ON MFPB2 on right control stand, supply of wire no 13C goes to wire no 13.
  - a) FPC coil will be energized by wire no 13 +ve. and 4 –ve.
  - b) When FPC picked up then supply of wire no. 50 goes to wire no.70, CCM indication lamp, wire no. 70A, CCM field winding, wire no.4 and completes the circuit, CCM indication lamp will glow on both control stands.
  - c) Electric brake warning (PCS) lamp will glow on both control stands.
5. Put ON CEB on front panel, supply of Wire no 70 directly goes to wire no. 70A due to which CCM indication lamp will extinguish and CCM motor will start. When CCM motor fails CCM failure lamp will glow.
6. Put ON FPB on front control panel. Supply of wire no. 70 goes to wire no. 71 due to which fuel pump motor will start; fuel oil pressure will build up to 4.2 kg/cm<sup>2</sup>.
7. Put ON MCB1&2.
8. Press the alarm push button three times on front panel.
9. On pressing Start Button –
  - a) Supply of wire no. 71 goes to CKR1 and CKR2 coil through BSR NCI, ECS (I), P22 NCI, and S1 NCI through start button contact. CKR1 and CKR2 will pick up.
  - b) When CKR1 picks up –
    1. Exciter generator field is isolated from armature.
    2. GR2 comes in service.

3. CKC picks up.

c) When CKR2 picks up Auxiliary generator field disconnected from armature.

d) Due to CKC contact CK1, CK2 will pick up.

When CK1 and CK2 picked up their NOI will be close on branch of CK3 coil due to which CK3 coil get energizes.

e) When CK3 picks up TDR will pick up.

f) When CK1, CK2 and CK3 picked up then supply of battery goes to auxiliary generator and exciter generator and it starts to rotate as a motor. The main crank shaft gets drive from auxiliary generator and exciter generator. This is called engine cranking. Due to engine cranking and starting of fuel supply in engine cylinder according to firing order, engine will start with its own power. It is called engine starting.

When lube oil pressure build up 1.6kg/cm<sup>2</sup> then release start button. CKR1, CKR2, CKC, CK1, CK2, CK3 and TDR will drop. Engine will run on its own power.

**Engine Stopping circuit (WW Gov.)** -By pressing the stop button its contact (16C-16E) opens on the branch of ERR due to which ERR will de-energize and it's NCI (50T-3A) close on D valve branch.

The other contact of stop button (71-50T) gets close and current of wire no.71 goes to wire no.3A through wire no.50T, ERR (NCI) due to which only D valve will energize, fuel rack comes to zero and engine will shut down.



### **Engine starting procedure:**

Before engine starting check the locomotive (safety fittings, oiling points, water level, etc.) and ensure wooden wedge & hand brake in applied condition. Then start the Diesel engine by following sequence -

1. Put ON Dome light breaker and Dome light switch.  
Indication - Dome light will glow.
2. Close the BS in Nose room.  
Indication - AGFL lamp will glow on both control stands.
3. Put ON MB1 on front panel.
4. Put ON MB2 on front panel.  
Indication - No indication but any light will glow on switching ON its concern switch except Dome light.
5. Put ON MFPB1 on left control stand.
6. Put ON MFPB2 on right control stand.  
Indication-
  - a) FPC will pick up.
  - b) CCM indication lamp will glow on both control stands.
  - c) Electric brake warning (PCS) lamp will glow on both control stands.
7. Put ON CEB on front panel.  
Indication - CCM indication lamp will extinguish and CCM motor will start to work.
8. Put ON FPB on control panel.  
Indication - Fuel pump motor will start and fuel oil pressure gauge shows 4.2 kg/cm<sup>2</sup>.
9. Put ON MCB1&2.
10. Press the alarm push button three times on front panel for ringing bell.
11. Put MUSD1, 2 on RUN and ECS on IDLE.
12. Press the Start Button -
  - a) CKR1 and CKR2 will pick up.
  - b) CKC will pick up.
  - c) CK1, CK2 will pick up.
  - d) CK3 will pick up.
  - e) TDR will pick up
  - f) Engine will crank. When lube oil pressure builds up to 1.6 kg/cm<sup>2</sup>, then release start button.
13. Put ON AGFB on front panel.

### **Engine stopping procedure-**

1. Secure the Loco.
2. Keep MH handle on Idle and reverser handle in neutral.
3. Keep ECS on Idle position.
4. Ensure that all CB are ON.
5. Press stop button, till main crank shaft will stop.

## Engine is not cranking

Before Engine cranking fuel oil pressure to be checked. If fuel oil pressure is not available, check its reason. If fuel oil pressure is available check following items.

| <b>A) CKR1, CKR2 not picking up after pressing start button.</b> |   |
|--|---|
| Cause  | Remedy  |
| MUSD-1/2 is not in RUN position.                                 | Kept it on run position   |
| ECS is in run position.  | Kept on idle position.  |
| Shut plunger operated  | Reset it.   |
| Start button faulty  | Operate properly two to three times and check wire connections. |
| P22 /S1 is welded or its NCI Faulty.                             | Remove welding or Clean interlocks.                             |
| CKR1, CKR2 Coil connection is loose/uncouple.                    | Tight/couple it.  |
| Even though CKR1, CKR2 are not picking up.                       | Inform to the power controller.                                 |

## **B) If CKR1, CKR2 is picks up after pressing start button.**

CK1, CK2 and CK3 coil connections to be checked. If found OK, take manual control of CK1 and CK2.

## Engine cranking but not starting

| Cause   | Remedy   |
|---|--|
| OSTA tripped  | reset it   |
| Fuel oil pressure not build up                                | Trouble shoot accordingly                          |
| Low oil level in Gov.   | Inform PCOR  |
| EH governor empanel plug loose/uncouple                       | Fix it properly                                    |
| EH governor pump is not working                               | ensure the love joy coupling                       |
| Governor linkage is not operating after pressing start button | check the governor linkage pin and fix it properly |
| LWS defective   | By pass LWS  |
| Weak battery  | Start the engine with weak batteries               |

## **Engine starting procedure with weak battery**

If cranking contactors are chattering at time of engine starting, it means battery is weak. In this condition three persons are required to start the diesel engine. One will press start button, second will take manual control of cranking contactor and third will take manual control of governor linkage.

## **Engine shutdown without indication –**

1. OSTA tripped
2. Fuel oil pressure is less/ zero.
3. Shut down plunger of WW governor came out
4. SAR defective
5. MB2/MFPB1/MFPB2/FPB breaker tripped
6. Emphenol plug of EH governor may be loose or uncouple
7. Governor linkage pin may be un couple
8. In sufficient oil in governor
9. When Loco works on battery, if MB1 tripped or battery voltage dropped below 50 volt.

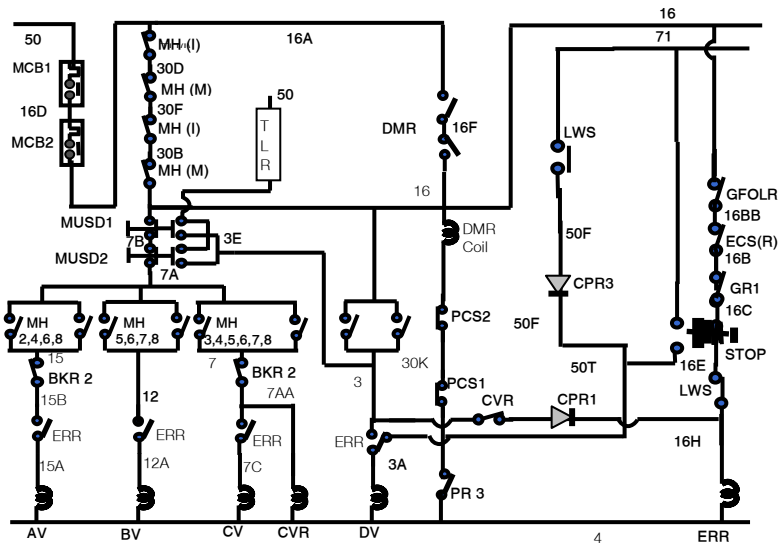
## Lesson No. 17 Engine Speed Control (WW Governor)-

**Throttle and DMR circuit** - This circuit starts from wire no. 50 which energizes when MB2 is kept ON. Supply of wire no. 50 goes to wire no.16D - 16A when MCB1 & 2 kept ON. Supply of wire no.16A goes to 16 through MH Idle & MH in Motoring position of both control stands. When wire no.16 gets energize, DMR coil gets +ve supply.

DMR coil gets -ve supply through NCI of PCS2, PCS1, PR3 and DMR will pick up. Due to which DMR self interlocks (16A-16F-16) gets closed. These interlock maintains +ve supply of DMR coil even after opening TH Notch. As we keep ECS on RUN ERR will get supply from wire no.16 through GFOLR NCI, ECS (RUN), GR1 NCI, Stop Button NCI, and LWS NCI and ERR picks up. Due to which NOI of ERR gets close on the branch of A, B, C, D solenoids.

Supply of wire no.16 goes to wire no.7A through 7B when MUSD1 and MUSD2 of respective control stand are in run position. On opening MH notch, its interlocks close on the branches of A, B, C, D solenoids. A, B, C, D solenoids coil get energize by wire no. 15A - 4, wire no. 12A - 4, wire no. 7C - 4, wire no. 3A - 4 respectively. As Solenoid picks up Engine speed increases as per throttle notches.

THROTTLE DMR CIRCUIT (W. W.GOVERNOR)



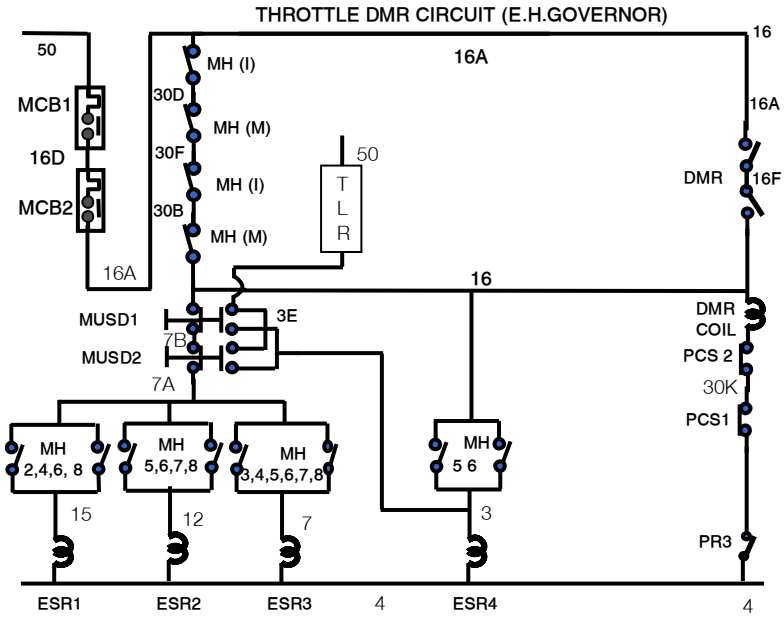
## Engine speed chart

| MH Position | Solenoid Operation | Speed (rpm) |
|-------------|--------------------|-------------|
| Idle        | ----               | 400         |
| 1           | ----               | 400         |
| 2           | A                  | 493         |
| 3           | C                  | 586         |
| 4           | A,C                | 679         |
| 5           | B,C,D              | 782         |
| 6           | A,B,C,D            | 865         |
| 7           | B,C                | 958         |
| 8           | A,B,C              | 1050        |

**Engine speed control (GE/EH)** - To increase the engine speed, balance current (475 mA) of speed coil is to be decreased and vice-versa to reduce speed according to the Notch position. ESR1, 2, 3, and 4 energizes or de energizes in combination according to the Notch position accordingly its NCI open or close in governor speed coil circuit.

**Throttle and DMR circuit** - This circuit starts from wire no. 50 which energizes when MB2 is kept ON. Supply of wire no. 50 goes to wire no.16D - 16A when MCB1 & 2 kept ON. Supply of wire no.16A goes to 16 through MH Idle & MH in Motoring position of both control stands. When wire no.16 gets energize, DMR coil gets +ve supply. DMR coil gets -ve supply through NCI of PCS2, PCS1, PR3 and DMR will picks up. Due to which DMR self interlocks (16A-16F-16) gets closed. These interlock maintains +ve supply of DMR coil even after opening TH Notch. Supply of wire no.16 goes to wire no.7A through 7B when MUSD1 and MUSD2 of respective control stand are in run position. On opening MH notch, its interlocks close on the branches of ESR1, 2, 3, 4 coil get energize by wire no. 15 - 4, wire no. 12 - 4, wire no. 7 - 4, wire no. 16 - 4 respectively. As ESR picks up according to notch position then resistance of various values get connected in series of Governor Speed coil. Due to which current of speed coil will decrease and engine speed will increase. But when the speed coil get balance current 475 mA than engine speed will be maintained constant as per notch position. In vice-versa when notches reduced then current of speed coil will be increased due to which engine speed will decrease.





**Engine Speed Chart**

| Th. Position | ESR Operation | Engine speed (rpm) |
|--------------|---------------|--------------------|
| Idle         | ----          | 400                |
| 1            | ----          | 400                |
| 2            | ESR1          | 485                |
| 3            | ESR3          | 595                |
| 4            | ESR1,3        | 680                |
| 5            | ESR2,3,4      | 780                |
| 6            | ESR1,2,3,4    | 865                |
| 7            | ESR2,3        | 965                |
| 8            | ESR1,2,3      | 1050               |

## Engine speed is not increasing on opening throttle

| <b>A) DMR not picking up</b>                           |   |
|--|---|
| Cause  | Remedy  |
| MCB-1 & 2 is OFF/tripped                               | ON it / Reset it  |
| Both MH is not on Idle.                                | Keep it on Idle position                                    |
| In adequate amount of BP / Vacuum level.               | Build up BP/Vacuum  |
| PCS1,2 is defective                                    | Put ON PCS bypass switch                                    |
| Still DMR is not picking up                            | Put ON the emergency switch or wedge it with precautions.   |
| <b>B) DMR picks up but engine speed not increasing</b> |   |
| DMR drops while opening the throttle                   | Put ON DMR switch   |
| ESR not picking up                                     | Check MUSD wire connection OR work from other control stand |
| ECS is Idle position                                   | Keep it on RUN  |
| GR1 is not reset properly                              | Reset it properly   |
| ERR not picking up in WW governor loco                 | Wedge the ERR and keep watch on water level, Inform PCOR    |
| Emphenol plug is loose or disconnected in WW gov.      | Connect it properly   |
| BKT is not in motoring position                        | Keep it on motoring position                                |
| GFOLR is not reset properly                            | Reset it properly   |

### Precautions after wedging ERR:-

1. Keep attention on water level.
2. Bring MH to Idle when GR1/GFOLR operates.
3. Use MUSD for shut down the engine.
4. Engine not comes to Idle by ECS (I)

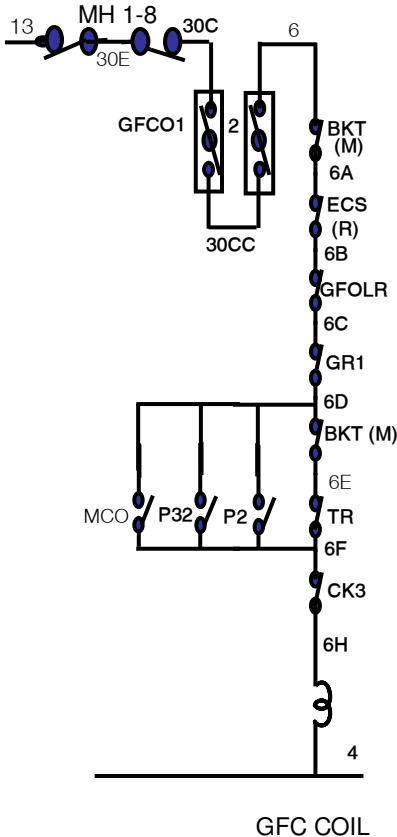
**Note:** 1. If MUSD wire is uncouple / loose engine speed will not increase upto 4<sup>th</sup> notch, on opening the 5<sup>th</sup> notch engine will shut down. At this time check its wire connection.

2. If MH interlock is defective, change the control stand and work further.

## Lesson No. 18

### GFC CONTROL CIRCUIT

To move the loco, field of Traction Alternator is to be excited by exciter generator. This work is done with the help of GFC contactor. It is electro magnetic contactor. To pickup this contactor GFC coil circuit is designed.



This circuit starts from wire no. 13. When both control stand GFCO kept in close and MH closed (MH 1 – 8), the supply of wire no. 13 goes to wire no. 6 via wire no. 30E, 30C, and 30CC. Supply of wire no. 6 goes to GFC coil through following normally close interlocks-

|         |     |       |
|---------|-----|-------|
| BKT (M) | NCI | 6-6A  |
| ECS(R)  | NCI | 6A-6B |
| GFOLR   | NCI | 6B-6C |
| GR1     | NCI | 6C-6D |
| BKT (M) | NCI | 6D-6E |
| TR      | NCI | 6E-6F |
| CK3     | NCI | 6F-6H |

GF coil will energize by wire 6H positive and wire 4 negative and GFC contactor pick up.

Other than this following interlocks are provided parallel to BKT (M) & TR (NCI).

NOI of P32 (6D-6F), NOI of P2 (6D-6F) will close at the time of parallel transition.

MCO NOI (6D-6F) will close at the time of TM isolation.

## Lesson No. 19

### Propulsion Control Circuit

To move the locomotive, supply of Traction Alternator is send to traction motor through Power contactor, BKT, Reverser. This circuit is design to pickup above electro pneumatic contactor as and when require. In this circuit as per speed of locomotive two combination of traction motor are changed and during dynamic brakes traction motor convert into generator. Traction motor has following combination:

- a) Series Parallel combination
- b) Parallel combination

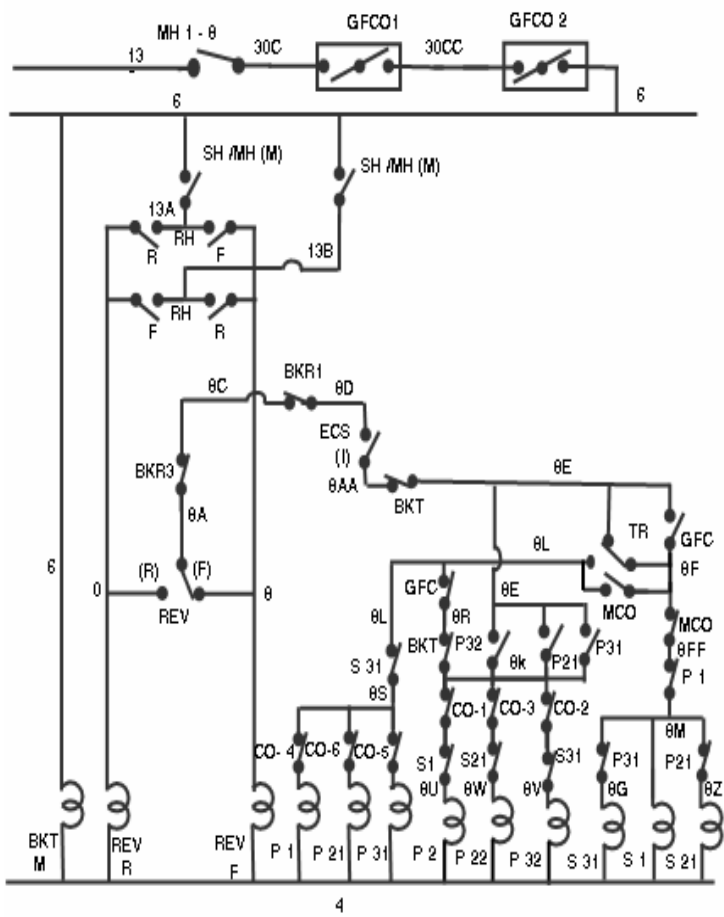
**Reverser Contactor Control** – To move the locomotive, keep reverser handle in desired direction, put ON GFCO-1&2 and on opening master handle reverser contactor coil will energize as per working control stand-

|                   |     |                |       |
|-------------------|-----|----------------|-------|
| MH(M)             | NOI | 6-13A          | L/C/S |
| MH(M)             | NOI | 6-13B          | R/C/S |
| RH(F)             | NOI | 13A-8          | L/C/S |
| RH (R)            | NOI | 13A-0          | L/C/S |
| RH (F)            | NOI | 13B-0          | R/C/S |
| RH (R)            | NOI | 13B-8          | R/C/S |
| Rev. Forward coil |     | Wire no. 8& 4  |       |
| Rev. reverse coil |     | Wire no. 0 & 4 |       |

**Series parallel combination-** series power contactors coil will get

|           |                |          |
|-----------|----------------|----------|
| Rev(F)    | NCI            | 8-8A     |
| Rev(R)    | NOI            | 0-8A     |
| BKR3      | NCI            | 8A-8C    |
| BKR1      | NCI            | 8C-8D    |
| ECS(Idle) | NOI            | 8D-8AA   |
| BKT(M)    | NCI            | 8AA-8E   |
| TR        | NCI            | 8E-8F    |
| GFC       | NOI            | 8E-8F    |
| MCO       | NOI            | 8F-8FF   |
| P1        | NCI            | 8FF – 8M |
| S1        | Contactur Coil | 8M-4     |
| P21       | NCI            | 8M-8Z    |
| S21       | Contactur Coil | 8Z-4     |
| P31       | NCI            | 8M-8G    |
| S31       | Contactur Coil | 8G-4     |

In this way S1, S21, S31 series power contactor pickup.



**Parallel Combination (1<sup>st</sup> transition)** -When loco speed increases up to 41.5 km/h at that time TSSR energize and its contact 6AA-18A close and TR relay picks up through MCO, NCI 6-6AA and TSSR NOI 6AA-18A, due to which following changes will take place –

1. TR NCI 6E-6F open and GFC will drop.
2. TR NCI 8E-8F open and S 1, S21, S31 will drop.
3. TR NOI 8E-8L close and P1, P21, P31 will pick up through S31 NCI 8L-8S.

P2, P22, P32 will pick up in following way -

|         |     |       |
|---------|-----|-------|
| TR      | NOI | 8E-8L |
| GFC     | NCI | 8L-8R |
| BKT (M) | NCI | 8R-8K |

|                               |     |        |
|-------------------------------|-----|--------|
| MCO1                          | NCI | 8K-8KA |
| S1                            | NCI | 8KA-8U |
| P2 contactor picks up (8U-4)  |     |        |
| MCO3                          | NCI | 8K-8KB |
| S21                           | NCI | 8KB-8W |
| P22 contactor picks up (8W-4) |     |        |
| MCO2                          | NCI | 8K-8KC |
| S31                           | NCI | 8KC-8V |

P32 contactor picks up (8V-4)

As P32, P2 NOI (6D-6F) closes than GFC will pick up.

As P32 picks up its NOI (8E-8K) will close in parallel to P21, P31 NOI (8E-8K) and P2, P22, P32 supply will maintained.

In this way all six parallel power contactor pickup.

### Throttle Not Responding to Loco/Load Meter Not Showing Current

| <b>A) GFC not picking up</b>                                    |   |
|---|---|
| <b>Cause</b>  | <b>Remedy</b>   |
| GFCO-1 & 2 is in 'OFF' position                                 | Put 'ON'.   |
| ECS is on idle position   | Put on 'RUN'.   |
| GR1 is not reset properly.                                      | Reset it.   |
| GFOLR is not reset properly.                                    | Reset it.   |
| BKT is not in motoring position.                                | Bring it to motoring by pressing the magnet valve or manually by 'L' rod.         |
| CK3 are welded.   | Remove the welding by taking precautions. {BS Open}                               |
| MH Interlock defective.   | Work from other control stand.  |
| Defect in GFC coil.   | Check its wire connection.  |
| If still GFC not picking up wedge it by taking all precautions. |   |
| <b>B) All power contactors not picking up</b>                   |   |
| Inadequate control air pressure.                                | Adjust it 5.0 kg/cm <sup>2</sup> by NS-1 reducing valve.                          |
| RH is not in desire direction                                   | Kept it in desire direction   |
| REV is not in desire direction as per RH Position.              | Bring it to desire direction by pressing the magnet valve or manually by 'L' rod. |
| P1 NCI (8FF-8M) is defective.                                   | Clean it.   |
| Still S1, 21, 31 not pick up.                                   | Work in parallel combination.   |
| <b>C) still loco not moving , check following</b>               |   |
| Excitation card may loose                                       | Press them.   |
| Exciter generator wire may loose                                | Tight it.   |

**Precaution To Be Taken Before Wedging GFC:-**

1. Ensure that current available in wire no. 6 (If BKT are change its position from braking to motoring it means current is available in wire no.6)
2. Ensure that cranking contactors are in open condition.
3. Ensure that BKT is in motoring position.

**Precaution To Be Taken After Wedging GFC:-**

1. First notch current will be excess, so in order to avoid the jerk on the Loco, First open the MH then release loco brakes.
2. Parallel transition will not come, take manual transition.
3. Whenever GR/GFOLR operate bring throttle to idle immediately.
4. Do not use dynamic brakes.

## Lesson No. 20

### Transition

Combination of traction motors are changed automatically on predetermined speed of Loco is called Transition. It is required to increase traction motor speed so that Loco speed can be increased.

Back EMF of traction motor restrict Loco speed even on eighth notch. To increase speed Back EMF is controlled by following method -

#### Increasing the voltage of traction motor:-

This is possible in parallel combination. Axle generator is provided on L2 Axle box for automatic transition, it gives supply to TR panel. This panel has card No. 210 & 207. All cards should be fixed properly otherwise transition will not take place.

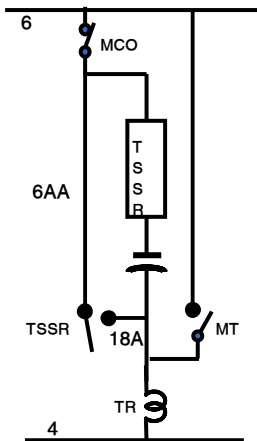
Transition chart -

| Speed (Kmph)  | Transition | Relay operation | Contactors operation  | TM combination  |
|---------------|------------|-----------------|---|-----------------|
| From starting | -          | -               | S <sub>1</sub> , S <sub>31</sub> , S <sub>21</sub>  | Series-Parallel |
| 41.5          | First      | TR              | P <sub>2</sub> , P <sub>32</sub> , P <sub>22</sub> , P <sub>1</sub> , P <sub>31</sub> , P <sub>21</sub> | Parallel        |

#### Transition Not Coming -

| Cause   | Remedy           |
|---|------------------|
| Axle generator wire is loose/uncouple   | Tight/couple it. |
| TET wire connection is loose/uncouple   | Tight/couple it. |
| Transition cards are loose  | Fix it properly  |
| TR wire connection is loose/uncouple  | Tight/couple it. |
| Still transition is not taking place, put ON the manual transition switch and informs the power controller. |                  |

- Note-** 1. Reverse transition comes at 3kmph less speed than forward transition speed.  
 2. Reduce one notch to avoid OSTA tripping at the time of transition.





## Lesson No. 21

### Dynamic Braking

It is an electrical brake, used only when loco is in motion. During dynamic braking, traction motor works as generator, hence retardation torque is developed on axle which opposes the movement of wheel and speed of loco is reduced.

#### **Advantages of dynamic braking-**

1. No wear and tear in brake block and wheels.
2. Speed of train can be maintained constant on down gradient.
3. Train can be controlled easily with out jerk.
4. Fuel saving.
5. To Maintain train punctuality.

#### **Procedure of Applying Dynamic Brake –**

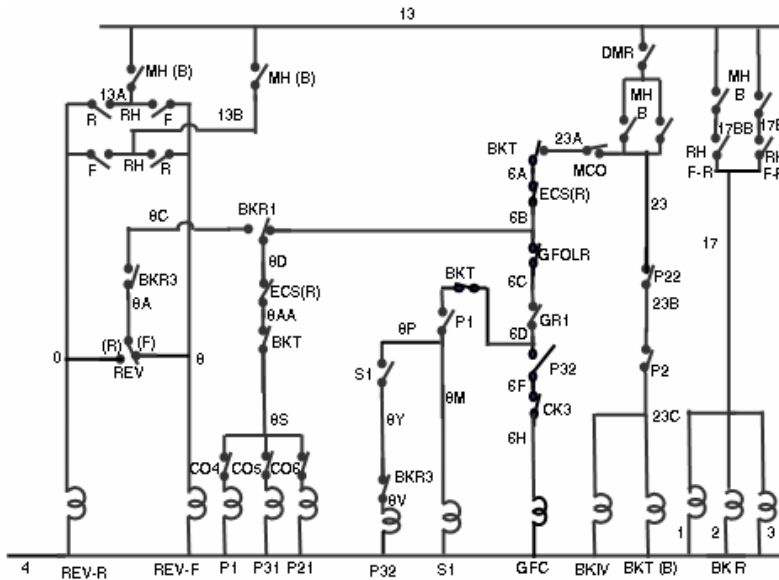
1. Bring MH to idle position gradually.
2. Apply train brake by A9.
3. Bring MH on 'IDLE' position and then SH kept on "Braking" position. After this MH kept on "o" and then braking position and wait for some time, then move the master handle slowly towards the 'MAX' positions of braking.
4. Keep watch on load meter.
5. To release the dynamic brake, bring the MH slowly to "Braking" position and then "o" position.
6. After waiting for some time, MH handle kept on "Idle" Position and then SH kept on "Motoring" position.

#### **Precautions to be taken During Dynamic Braking -**

1. Operate the master handle smoothly.
2. Do not apply independent loco brakes during Dynamic Brake.
3. Do not apply emergency train brakes.
4. Do not apply dynamic brakes when BKBL is not working
5. During dynamic braking if GR operates, don't apply dynamic brakes.
6. If GFC is wedge do not use dynamic brake.
7. If the locomotive speed exceeds more than 90 km/h, braking current should not exceed 600 amps.
8. If the speed of the locomotive is less than 90 km/h then -  
Maximum braking current is limit up to 800 amps.

## Changes take place during Dynamic Braking –

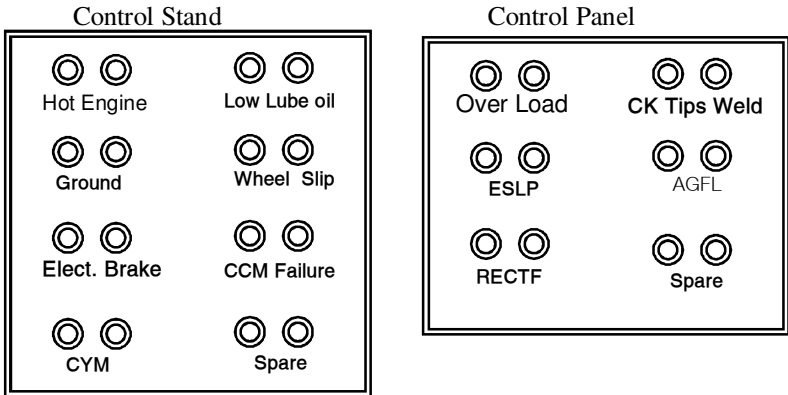
1. BKT position will change to braking.
2. BKR1, 2, 3 energized.
3. The loco brakes applied in conjunction braking will be released due to D<sub>1</sub> pilot valve energized.
4. GFC will pick up.
5. Engine RPM increases to 4<sup>th</sup> notches RPM.
6. Reverser coil energize.
7. All power contactors will pick up except P2, P22, S21 and S31 due to which following changes takes place.
  - a) All TM field coil will be connected in series across the Traction Alternator and get excitation current.
  - b) All TM armatures will be in group of two and connected across the braking grids.
  - c) All TM will work as separately excited generator and generated current goes to braking grids and BKBL. BKBL cools the braking grids.
  - d) Retardation torque produced in TM which opposed the wheel movement.



## Lesson No. 22

### Indication Lamp Circuit

This circuit is provided in the diesel loco to give warning/indication to loco pilot in case of any failure in various system/circuit , a LED (Light emitting diode) indication panel is provided on both control stand and control panel having following indication lamps -



One electrical bell (ALG) provided on the right side control panel for audio warning and Buzzer is provided in control stand for wheel slip.

**Low Lube Oil** -Alarm gong is also ring with this indication, it means lube oil pressure is below 1.3 kg/cm<sup>2</sup> and OPS dropped. Trouble shoots accordingly. Lamp will extinguish when OPS picks up.

**Hot Engine** -Alarm gong is also ring with this indication, it gives following information -

1. If bell is ringing with indication and engine is run position, it means ETS3 is picked up and water temperature is 94<sup>0</sup>. Cool the water.
2. If bell is ringing with indication and engine is shut down, it means LWS is operated and water level is below one inch. Trouble shoots accordingly.

**Ground Relay** - Alarm gong is also ring with this indication, engine speed will comes to idle and power cut off, it means earth fault in power circuit. After trouble shooting, lamp will extinguish when GR reset knob pressed.

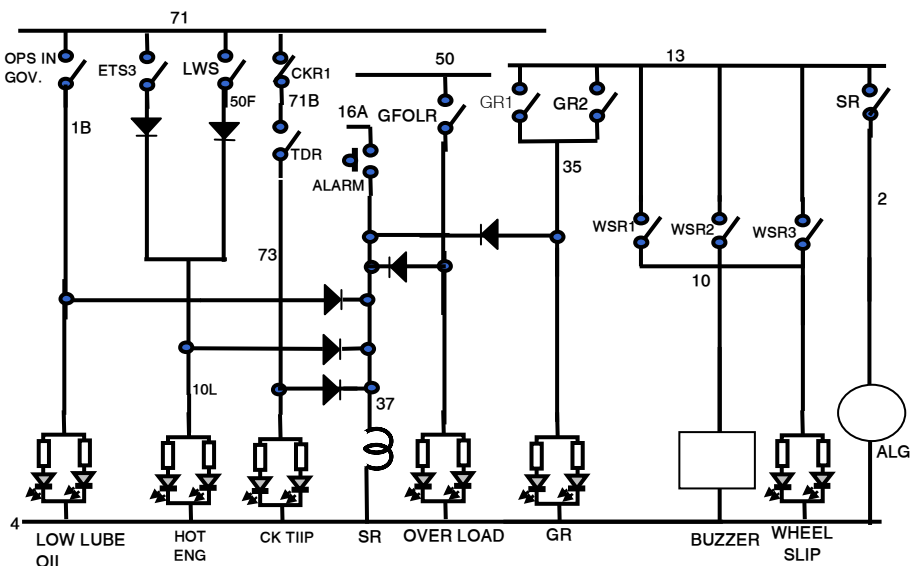
**Wheel Slip** -Buzzer is also sound with this indication, lamp will extinguished after trouble shooting.

**Electric Brake Warning** -Whenever this lamp will glow it means the DMR is de-energized. After necessary trouble shooting lamp will extinguish when DMR picks up.

**Auxiliary Generator Failure Lamp** - Battery ammeter shows discharging side with this indication, it means Auxiliary Generator fails. Whenever auxiliary generator is giving out put lamp will extinguish and Battery ammeter shows charging side.

**Crank Case Exhauster Failure Indication Lamp** - This lamp will glow when CCM is not working, Lamp will extinguished when CCM starts working.

### INDICATION LAMP CIRCUIT



**Over load:** - When over current flows in Alternator field winding more than  $280 \pm 5$  GFOLR will energize. Over load lamp will glow on front panel and alarm bell will ring. Whenever GFOLR reset this lamp extinguished.

**Cranking Tip Weld:-** This lamp is provided on front panel . When any cranking contactor welded this lamp will glow continuously and alarm bell rings. Shut down the diesel engine, open battery knife switch and remove welding.

**CYM:-** This lamp is provided on front panel and it glows up to 4<sup>th</sup> notch. After 5<sup>th</sup> notch cyclonic motor starts and this lamp is extinguished.

**Rectifier** - This lamp is provided on front panel. It glows when VAPR operates at this time bell will ring, GFC will drop and engine speed comes to Idle.

**Work the Loco With Out Indication Lamp i.e. Indication lamp circuit is faulty –**

1. If bell rings and engine get shuts down
  - a) If keeping ECS on idle, ringing will not stop it means LWS operates or in WW GOV shut down plunger project out.
  - b) If keeping ECS on idle, ringing will stop it means engine shut down due to low lube oil pressure (only in EH Gov. Loco.)
2. Incase of hot engine there is no effect on engine, only bell rings.
3. When GR/GFOLR is operated, bell rings and engine speed will come to idle with all indications related to GR/GFOLR.
4. Incase of wheel slip, buzzer will sound with load meter fluctuation.
5. Incase of AG failure, BA will shows discharge side.
6. If crank case exhaustor motor does not work, no smoke from its exhaust pipe.
7. When DMR is de energized, engine speed comes to idle and load meter will show 1<sup>st</sup> notch current, engine speed will not increase.

## Lesson No. 23

### Multiple Unit

When two or more locomotive are coupled mechanically, electrically and pneumatically with each other and controlled by a single loco pilot, it is called multiple unit.

#### Procedure:

1. Check and engine start the locos individually before making multiple unit.
2. Adjust all the pressure related to break system.
3. Carry out vacuum test, orifice test and leak off test separately of each loco.
4. Couple the all locos with CBC and lock it with lock pin.
5. Couple electrical jumper cable between the locos.
6. Couple following pipes between the locos –
  - Brake pipe
  - Feed pipe
  - Brake cylinder equalizing pipe
  - MR. equalizing pipe
  - Vacuum hose pipe
7. Open the following cut out cocks between the locos –
  - Brake pipe angle cut out cock
  - Feed pipe angle cut out cock
  - Brake cylinder equalizing pipe cut out cock
  - MR equalizing pipe cut out cock
8. Change the position of following cut out cock and valves in loco pilot cab -
  - Open A9 COC of Working control stand and rest of all other non working control stand to be closed.
  - Open SA9 COC of Working control stand and rest of all other non working control stand to be closed.
  - Open the ¾” COC in leading loco and close in rest of all trailing locos.
  - Keep MU2B in lead position of leading loco and in trail position of all trailing locos.
  - Open the A1 differential pilot valve and HB5 COC of all locos.
  - Open banking cut out cock in all locos.

9. Keep the position of circuit breakers and switches in loco pilot cab as

| <b>Switch/Circuit breaker</b>             | <b>Leading loco</b> | <b>Trailing loco</b>       |
|---|---------------------|----------------------------|
| Battery knife switch (BS)                 | ON                  | ON                         |
| Engine control switch (ECS)               | RUN                 | RUN                        |
| Main Battery breaker (MB1)                | ON                  | ON                         |
| Main Control breaker(MB2)                 | ON                  | ON                         |
| Fuel Pump Breaker(FPB)                    | ON                  | ON                         |
| Crank case Breaker (CEB)                  | ON                  | ON                         |
| Auxiliary Generator Field Breaker (AGFB)  | ON                  | ON                         |
| Master Fuel Pump breaker (MFPB 1&2)       | ON                  | OFF                        |
| Main control breaker (MCB 1&2)            | ON                  | OFF                        |
| Generator field cut out Switch (GFCO 1&2) | ON                  | OFF                        |
| Reverser Handle (RH)                      | Desired direction   | Remove in Neutral position |
| EPG Toggle switch                         | ON                  | OFF                        |

10. Following to be checked after preparing the MU.

- a. Dropping of the BP pressure by A9 and its recreation.
- b. Dropping of the vacuum by A9 and its recreation.
- c. Application and releasing of loco brakes by SA9.
- d. As per throttle notch position, the speed of all engines should be increase and decrease simultaneously.
- e. Movements of all loco as per reverser handle position.
- f. Raising of all engines when selector handle kept in braking position.

### **Working of Train with Dead Leading Loco -**

While working MU if leading loco failed (No problem in under truck and brake system) then train can be worked from the dead leading loco by adopting following procedure –

1. On dead leading loco, put OFF all the circuit breakers of front panel except MB1, 2.
2. Put ECS in idle position.
3. No any change in position of switch, circuit breakers of control stand in leading loco.
4. Do not change position of circuit breakers/switches of trailing loco.

5. In air brake train, do not change position of valves / COC of brake system.
6. In vacuum brake train, Keep MU2B in lead position of trailing loco and close BC equalizing cock between the locos. Do not change position of valves / COC of brake system of leading loco.
7. Before starting the train ensures dropping /recreation of BP pressure and vacuum by A9.

### **Driving Cab Changing Procedure in Multiple Unit:**

#### **A) On incoming leading loco which is require to make trailing**

1. Apply loco brake by SA9 and remove its handle.
2. Close the A9 COC and remove its handle in release position.
3. Remove reverser handle in neutral position.

#### **B) On incoming trailing loco which is require to make leading.**

1. Insert SA9 handle on working control stand and apply loco brake by it. (Open SA9 COC of working control stand if provided)
2. Insert A9 handle in release position of working control stand and open its COC.
3. Put MU2B on lead position.
4. Open ¾" COC.
5. Put ON MCB-1 & 2.
6. Put ON MFPB- 1 & 2.

#### **C) On incoming leading loco which is require to make trailing**

1. Release the SA9.
2. Close SA9 COC of working control stand if provided.
3. Put MU2B on trail position.
4. Close ¾" COC.
5. Put OFF GFCO- 1 & 2.
6. Put OFF MCB-1 & 2.
7. Put OFF MFPB- 1 & 2.

#### **D) Insert reverser handle on leading loco.**

#### **E) Ensure normal working of all the Loco.**



## Indications on Leading Loco When Defect in Trailing Loco of Multiple Unit -

| Defects          | Indication on leading loco   | Indication on trailing loco  |
|------------------|--|--|
| Low lube oil     | Alarm bell rings & load meter shows excess current.  | Alarm bell rings, low lube oil lamp glows & engine will shut down.                             |
| LWS operated     | Alarm bell rings & load meter shows excess current.  | Alarm bell rings, hot engine lamp glows and engine will shut down.                             |
| Power ground     | Alarm bell rings & load meter shows excess current.  | Alarm bell rings, GR lamp glows, engine speed come to idle and load meter comes to '0'.        |
| Hot engine       | Alarm bell rings.  | Alarm bell rings and hot engine lamp glows.  |
| Wheel slipping   | Buzzer sounds, wheel slip lamp glows & load meter fluctuates between normal to excess current. | Buzzer sounds, Wheel slip lamp glows and load meter fluctuates between normal to zero current. |
| DMR De energized | Electric brake warning lamp glows and load meter shows excess current.                         | Electric brake warning lamp glows and engine comes to idle.                                    |
| GFOLR operates   | Alarm bell rings & load meter shows excess current   | Alarm bell rings, Over Load lamp glows, engine speed come to idle and load meter comes to '0'. |
| VAPR operates    | Alarm bell rings & load meter shows excess current   | Alarm bell rings, Rectifier lamp glows, engine speed come to idle and load meter comes to '0'. |

## Lesson No. 24

### Safety Devices

Safety devices are provided for the safety of the engine & loco. They are

1. **Over Speed Trip Assembly (OSTA)** - It is located on engine right side free end. It protects the engine from over speeding.

On 8<sup>th</sup> notch the engine rpm is 1050. Due to any reason engine speed exceeds up to  $1180 \pm 20$  rpm, OSTA will operate, fuel rack comes to zero and engine will shut down without any indication.

Two handles are provided on OSTA, small is trip handle and big is reset handle. To reset OSTA, pull reset handle gently.

#### Note -

1. If OSTA trips during transition, reduce one notch.
  2. If OSTA trips on higher notches, work on lower notches.
  3. If OSTA trips repeatedly, check the wire connections of Techo generator and inform the power controller.
  4. Ensure that OSTA is reset before starting the engine and press the governor linkage.
2. **Oil Pressure Switch (OPS)** - In EH governor it is located in loco pilot cab on nose compartment wall, whereas in WW governor loco, it is inside the governor. It protect engine from low lube oil pressure.

In EH governor loco OPS pick up at  $1.6 \text{ kg/cm}^2$  and drop at  $1.3 \text{ kg/cm}^2$ . When oil pressure drops to  $1.3 \text{ kg/cm}^2$ , OPS operate and engine will shut down with following indication -

1. Low lube oil lamp will glow on both control stands.
2. Alarm bell will ring.
3. In WW governor shut down plunger will came out.

In WW governor OPS pick up at  $1.3 \text{ kg/cm}^2$  and drop on  $1.1 \text{ kg/cm}^2$ . Engine will not crank till shut down plunger reset properly.

3. **Low Water Switch (LWS)** - It is located in Expresser room below expansion tank no.1. It protects the engine from low water.

Each expansion tank capacity 155 liters and its level is 14 inch. Whenever water level remain 1 inch LWS will operate, engine will shut down with following indication

1. Alarm bell will ring.
2. Hot engine lamp will glow on both control stands.

**Note** - If LWS defective, check the water level, if it is sufficient then short the wire 50D - 50J in EH governor and 16E - 16H in WW governor and inform the power controller.

**4. Circuit Breaker (CB)** – Circuit breaker is located on the front panel and on both control stands. It protects the electrical circuit from over current.

It has three positions ON, OFF and Trip. In OFF condition the knob of the circuit breaker will be in down position, in ON condition the knob will be in upper position and during TRIP the knob will be in the Centre. To reset the circuit breaker first kept in OFF then in ON position.

WDG-3A is equipped with following circuit breaker –

1. MB1 Main Battery breaker (200A)
2. MB2 Main Control Breaker (150A)
3. MFPB1 Master Fuel Pump Breaker No.1 (30A)
4. MFPB2 Master Fuel Pump Breaker No.2 (30A).
5. CEB Crank Case Exhauster Breaker (15A)
6. FPB Fuel pump Breaker (30A)
7. MCB1 Master Control Breaker No.1 (15A)
8. MCB 2 Master Control Breaker No.2 (15A)
9. AGFB Auxiliary Generator Field Breaker (15A)
10. RFCB Radiator Fan Circuit Breaker (30A)
11. Cab Light circuit Breaker (15A)
12. Dome Light Circuit Breaker (30A)
13. Head Light Circuit Breaker (30A)
14. DEB Dust exhauster blower Breaker (15A)
15. Air Dryer Breaker (15A).

**5. Safety Auxiliary Relay (SAR)** - It is located in front panel of EH Gov. Loco. It protects the auxiliaries from over speeding.

The SAR coil is connected in series with governor speed coil. If the governor speed coil supply is interrupted due to any reason the engine speed will suddenly increase, it is protected by SAR coil. When the supply to speed coil is interrupted, SAR will de-energize and it's NCI 50K-50D on governor clutch coil branch will open. Due to this, clutch coil de-energize and engine will shut down without indication.

**6. Ground Relay (GR1)** - It is located on front panel. It protects the power circuit from grounding. Its coil is connected to main generator armature circuit and loco body. In case of grounding in the power circuit GR1 will energize, Due to this following changes are take place.

- a) Engine speed comes to idle.
- b) GFC will drop.

And following indications

- a) GR lamp glows on both control stands.
- b) Alarm bell rings.
- c) GR1 knob comes out.
- d) GR1 pointer will go on red point.
- e) Load meter will show zero.

Before resetting GR1, check power circuit, keep MH and ECS on Idle, and then press the reset knob.

**Note-** In WDG3A loco two GR are provided, GR1 for power circuit and GR2 for starting circuit. When GR2 operates it is called starting ground and when GR1 operates it is called power ground.

**7. Dead Men's Relay/ Pneumatic Control Switch (DMR/PCS) - DMR is located on front panel and PCS1&2 in nose compartment**

- When due to any reason HB5 valve operates, PCS1 will also operate; its NCI will open on the branch of DMR coil.
- When due to any reason BP pressure drops up to 0.6kg/cm<sup>2</sup>, PR3 operates; its NCI will open on the branch of DMR coil.
- When loco pilot apply A9 in emergency or BP pressure drops up to 2.2kg/cm<sup>2</sup> PCS2 operates, , its NCI will open on the branch of DMR coil

DMR de-energize with following indication-

- a) Electric brake warning (PCS) lamp glows on both control stands.
- b) Engine speed comes to idle.
- c) TM will get 1<sup>st</sup> notch current even if TH is on notches.
- d) Dynamic brakes will cut off automatically, if applied.

**8. Generator Field Over Load Relay (GFOLR) - It is provided only in alternator loco on front panel. It protects the field winding of the alternator from over current.**

When over current flows in field winding of alternator. GFOLR will energize with following indications-

- a) Engine speed comes to idle.
- b) GFC will drops & Load meter shows zero.
- c) Alarm bell rings.
- d) Over Load lamp glows on front panel.

To reset GFOLR, bring MH On idle and press push button on front panel. Do not reset it more than 2 times. If again it trips then declare the loco failed and inform the power controller.

**Note -** Setting of GFOLR is 280 ± 5 amps

**9. Vent Air Pressure Relay (VAPR) - It is provided only in alternator Loco on front panel. It protect rectifier block from insufficient air supply. Air given by PDR motor. If PDR motor fails, VAPR will energize with following indication-**

- a) Alarm bell rings.
- b) Vent air flow (Rectifier) lamp will glow on front panel.
- c) Engine speed comes to Idle.

d) GFC will drop.

Check PDR wire connection and its circuit breaker, inform PCOR. To reset VAPR keep throttle handle and ECS on idle.

**10. Wheel Slip Relay (WSR)** - It is provided on front panel above power contactors. It protect rail and traction motors from slipping.

When current difference between two respected traction motor is more than prescribed limit, then WSR energized with following indications -

- a. Buzzer sounds.
- b. Wheel slip indication lamp glows on both control stands.
- c. Load meter needle fluctuates.
- d. Auto sanding takes places under the wheels.

Each WSR has two coils, connected in SP and P combination as under –

| WSR No. | TM No. in SP | TM No. in P |
|---------|--------------|-------------|
| 1       | 1 - 4        | 1 – 5       |
| 2       | 2 – 5        | 2 – 3       |
| 3       | 3 – 6        | 4 - 6       |

During dynamic all WSR are ineffective

**11. Engine Temperature Switch No. 3 (ETS-3)** - It is located on engine right side in expresser room. It gives indication of hot engine alarm.

When water temperature rises to 94°C, ETS-3 pick up with following indications –

- a. Hot engine lamp will glow on both control stands.
- b. Bell ringing.

In such condition, if load and road permitted, reduce the notch up to 2-3, switch off GFCO and raise the engine. When temperature reduced to 91°C, ETS-3 will drop. Work the train as normal procedure.

## **Safety Fittings**

1. Head light (with proper focus)
2. Flasher light
3. Marker light (with red glass)
4. Rail Guard
5. Cattle Guard
6. Foundation bolts of Buffer.
7. CBC locking pin
8. Horns
9. Wipers
10. Sanders (with pipe fitment)
11. Speedometer (with speed recorder)
12. Equalizing beam (Equalizer) and beam plate bolts.
13. Brake blocks hanger pins and its retaining bolts.
14. Safety strips of Pull Rod and slack adjuster.
15. Safety chain of brake cross tie bar.
16. Axle box stay plate and its bolts.
17. Traction motor gear case foundation bolts.
18. Traction motor Gear case 'C' clamp and its flange bolts.
19. Suspension bearing housing bolts.
20. Traction motor nose suspension guide bolts.
21. D-Shackle pin.
22. Shock absorber retaining bolts.
23. Hand brake.

## **SAFETY ITEMS**

Following safety items are provided on loco & with loco pilot

1. Fire Extinguisher (04 Nos.)
2. Wooden wedge (04 Nos.)
3. Spare hose pipe, brake pipe, feed pipe
4. 'L' rod
5. Spare head light and dome light bulb
6. Spare VRR fuse
7. Portable field telephone set
8. Tri colour torch
9. Two red, one green flag
10. Spare screw coupling
11. Detonators

## Lesson No. 25

### Power Ground

Earth fault occur in power circuit is called power ground.

When earth faults in traction motor, traction motor cables, BKT, REV, power contactors, GR1 operates with indications. Check following items -

1. Traction motor cables are tightened properly.
2. If there are any metal or wire pieces in between BKT/Rev./Power contactors, remove it.
3. Check the wire connection of load meter.
4. If there is smell or smoke from any TM, isolate it.

#### Note-

1. If power ground comes on higher notches, work on lower notches.
2. TM 4, 5, 6 can be isolate through MCO, if additional contactors (AC1, AC2, AC3) are provided on back panel, then TM 1, 2, 3 can be isolated through MCO in case of power ground.
3. When GR1 operate during dynamic braking don't use DB.
4. Loco is provided with GR1 and GR2 and during engine starting, if GR2 operates. In this condition first start the engine, then reset it.
5. One GR is provided in WDM-2 loco. At the time of engine starting, if GR operates. In this condition first start the engine, then reset it and note down in the repair book.

-----

### Wheel Slip

The process of wheel slipping is called wheel slip. When the difference of current occurs between two traction motors then related WSR will energize with the following indications –

1. Wheel slip lamp will glow.
2. Buzzer sounds.
3. Automatic sanding takes place.
4. Load meter fluctuates.

**Momentary Wheel Slip** - Momentary wheel slip occurs whenever there is oily and wet track, during transition, while opening notches quickly. To avoid this reduce the notch and apply sanders.

## Continuous Wheel Slip –

| S.No. | Defect                                | Remedy  |
|-------|---------------------------------------|---|
| 1.    | Locked Axle                           | Fail the loco   |
| 2.    | Slip Pinion                           | Isolate the concern TM & clear the section with restricted speed and inform PCOR. |
| 3.    | Defect in BKT/REV                     | Operates 2-3 times manually   |
| 4.    | Defect in TM                          | Isolate the defective TM.   |
| 5.    | P2, P22, P32 are in welded condition. | Remove the welding or Put “ON” Manual Transition switch and work in parallel      |
| 6.    | WSSR defective                        | Put “ON” Manual Transition switch and work in parallel.                           |

### Motor Cut out Switch

It is a rotating type switch provided on front panel. It is used to isolate the TM. It has 7 positions.

| Position of MCO | Condition of power contactors                     | Isolated TM          |
|-----------------|---|----------------------|
| All-IN          | All power contactors picks up as per combination. | Nil (All in service) |
| CO-1            | P2 Not picking up                                 | TM1                  |
| CO-2            | P32 Not picking up                                | TM2                  |
| CO-3            | P22 Not picking up                                | TM3                  |
| CO-4            | P1 Not picking up                                 | TM4                  |
| CO-5            | P31 Not picking up                                | TM5                  |
| CO-6            | P21 Not picking up                                | TM6                  |

### How to Operate MCO-

1. MH should be kept to idle position
2. Break the MCO seal.
3. Rotate the MCO from All IN position to CO1, CO2, CO3, CO4, CO5, CO6 position.

### After Isolating TM By MCO:

1. Series power contactor will not pick up.
2. Only five parallel power contactors will pick up.
3. Transition will not come.
4. Dynamic brake isolated.
5. Load meter will not showing current, if TM-1 is isolated.



## Load Meter

It is provided on both control stands. It shows current in TM. During dynamic braking load meter shows generated current.

It has two colour strips on the scale, green colour strip shows unrestricted zone and red shows restricted zone. Each marking on scale shows 100 amps. Green strip shows up to 1000 amp. Red colour strip having 60, 12, 6, 4 it shows minute. When load meter needle goes in restricted zone, observe time restriction shown by needle.

Load meter shows  $1/3^{\text{rd}}$  part of total current in SP combination and  $1/6^{\text{th}}$  part in parallel combination.

Load meter have yellow/Red dot on 600 amps. During dynamic braking, when loco speed more than 90 km/h, load meter needle should not exceed yellow/Red dot, when loco speed is less than 90 km/h current should not exceed 800 amps.

### Note-

1. Load meter shows I<sup>st</sup> notch current 300 amps.
2. Load meter is connected with TM-1. It will not show current reading if TM -1 isolate.
3. If both load meter showing different reading. Which one showing, 300 amps I<sup>st</sup> notch current is correct.
4. If both load meters are defective then open the higher notch, after loco speed on/above 23 km/h.

-----

## Lesson No. 26

### To Avoid Wheel Skidding

| <b>Do's</b>  | <b>Don't</b>   |
|--|--|
| Use A9 brake valve with load.  | Do not apply SA-9 with A9 while working load.  |
| Apply SA-9 with pause while working light engine.  | Don't apply SA-9 continuously, while working light engine.   |
| During shunting required BP pressure/vacuum should be available.                             | Avoid shunting when the hose pipe are not coupled and do not apply only SA9                                  |
| Loco brake cylinder pressure should be $3.0 \text{ kg/cm}^2$                                 | Do not adjusted brake cylinder pressure more than $3.0 \text{ kg/cm}^2$                                      |
| While working Air brake train, isolate the C3W distributor valve of the air brake dead loco. | Do not work without isolating C3W distributor valve of the dead loco in air brake train.                     |
| Change the direction of reverser handle when loco is dead stop.                              | Never change the direction of reverser handle when loco is moving condition.                                 |
| Use maximum dynamic brake to control the speed of train.                                     | Do not apply SA9 along with dynamic brake.   |
| Isolate the conjunction braking if found defective.  | Do not use conjunction brake when it is defective.   |
| Keep P & G handle of C3W as per nature of load.  | Do not keep P & G handle opposite to nature of load.   |
| When wheel slip relay operates reduce the notches.   | Do not increase the notches when wheel slip relay operates.  |
| Ensure loco brake/hand brake are released before starting the train.                         | Do not start the train if loco brakes/hand brake are not releasing.  |
| Fail the loco if axle locked.  | Do not work if axle is locked.   |
| Use foot pedal switch before, starting the train when stopped with conjunction braking.      | Do not forget to operate foot pedal switch, before starting the train when stopped with conjunction braking. |

## Lesson No. 27

### Gauges

Following gauges are provided in loco

#### 1. Brake Cylinder Pressure Gauge

It is provided on both control stands. Brake cylinder pressure gauge shows 3.0 kg/cm<sup>2</sup> pressure on loco brake application.

#### 2. Brake Pipe Pressure Gauge

It is located on both control stands. BP pressure gauge shows 5.0 kg/cm<sup>2</sup> on A9 release condition.

#### 3. MR and FP Pressure Gauge

It is a duplex gauge and provided on both control stand. Left side needle shows MR pressure and right side shows FP pressure.

MR pressure gauge shows 8-10 kg/cm<sup>2</sup> and FP pressure gauge shows 6.0 kg/cm<sup>2</sup>.

#### 3. Vacuum Gauge

It is provided on both control stands in dual brake loco. It shows Train Pipe vacuum level.

#### 4. Vacuum Control Pressure Gauge

It is provided on right control stand. It shows  $24 \pm 1$  psi (1.7kg/cm<sup>2</sup>) when adjusted by HS-4 valve.

#### 5. Control Air Pressure Gauge

It is provided in Nose compartment or in loco pilot cab, it shows 5.0 kg/cm<sup>2</sup> when adjusted by NS-1 reducing valve.

#### 6. Fuel Oil Pressure Gauge

It is provided on Nose compartment wall in loco pilot cab, it shows fuel oil pressure in fuel oil system i.e. 4.2 kg/cm<sup>2</sup>.

#### 7. Lube Oil Pressure Gauge

It is provided on Nose compartment wall in loco pilot cab, it shows lube oil pressure in lube oil system i.e. 5.2 kg/cm<sup>2</sup>.

#### 8. Booster Air Pressure Gauge

It is provided on Nose compartment wall in loco pilot cab, it shows 'V' gallery air pressure i.e. 1.97 kg/cm<sup>2</sup>.

#### 9. Air Flow Indicator

It is provided on both control stands, connected with air flow measuring valve. It shows rate of air flow between MR2 and brake pipe. It has 0-100 (no. of wagon) marking. It has 2 needles white & red. White shows air flow and red is a reference pointer. When loco coupled with load and BP shows 5.0 kg/cm<sup>2</sup>, that time red needle to be set with white needle. Whenever air flow increase to charge BP, white needle shoot up, do not open the notch till the white needle comes to its original position (on red pointer).

## **10. Battery Ammeter**

It is provided on front panel, it shows charging or discharging rate of battery. It has 0 in center and on either side marking of 200 Amp. On right side it shows charging and on left discharging.

## **11. Load Meter**

It is provided on both control stands, it shows the of current in TM, having each marking of 100 amps.

## **12. Water Temp. Gauge**

It is provided in expresser room engine right side, shows water temperature of cooling water system. It has marking of 0 to 120<sup>0</sup>

## **Switches on Loco**

**1. GFCO** - It is provided on both control stands having two positions on & off. When these are in on position and throttle on notches wire no.6 gets energize and GF contactor will pick up.

**2. MUSD** - It is provided on both control stands having two positions run & stop. It is used to shut down all the loco simultaneously while working multiple units.

**3. Head Light Switch** - It is a rotating switch and provided on both control stands having six positions 1.Both 'OFF' (front & rear), 2. Bright rear, 3. Bright front, 4.Dim rear, 5.Dim front, 6.Both dim (front & rear).

**4. Gauge Light Switch** - It is provided on both control stands having two positions ON &OFF.

**5. Marker Light Switch** - It is provided on both control stands having two positions ON & OFF.

**6. Compartment Light Switch** - It is provided on both control stands having two positions ON &OFF.

**7. Flasher Light Switch** - It is provided on flasher light control unit on both control stands. Each box having two switches

a. Main switch - having two positions ON & OFF.

b. Filament switch - having two positions F1 & F2.

**8. Battery Knife Switch** - It is provided in Nose compartment having two positions CLOSE & OPEN

**9. Engine Control Switch (ECS)** - It is provided on front panel having two positions IDLE and RUN.

**10. Motor Cut Out Switch (MCO)** - It is provided on front panel having seven positions and use for isolation of TM.

**11. Manual Transition Switch-** It is provided on front panel. This switch is used when automatic transition not coming.

## **Circuit Breaker**

**Cab Light circuit breaker** - It is provided on front panel and protects the cab light circuit.

**Engine room light circuit breaker** – It is provided on front panel and protects the engine room light circuit.

**Dome light circuit breaker** – It is provided on front panel and protects the dome light circuit.

**Head light circuit breaker** – It is provided on front panel and protects the head light circuit.

**MB1** – It is provided on front panel, gives battery + ve supply to control circuit and also protects it.

**MB2** – It is provided on front panel, gives battery - ve supply to control circuit and also protects it.

**MFPB** – It is provided on both control stands.

**FPB** – It is provided on front panel and protects the fuel pump motor.

**CEB** – It is provided on front panel and protects the crank case exhaust motor.

**AGFB** – It is provided on front panel and protects the auxiliary generator field.

**RFCB** – It is provided on front panel and protects the radiator fan circuit.

**DEB** – It is provided on front panel and protects the cyclonic motor.

**RBB** – It is provided on front panel and protects the rectifier blower motor.

**FPB<sub>3</sub>** – It is provided on front panel/left control stand and protects the fuel pump motor and used to bypass FPC and FPB.

## **Relay**

It is an electromagnetic remote control device, is used to make and break the control circuit. Different types of relay are used as per requirement. Control of circuit is done by interlocks. In de-energized condition of relay the interlocks which are in opened condition are called normally open interlocks (NOI) and which are in closed condition are called normally close interlocks (NCI).

Diesel locos have following relays

**GR1 (Ground Relay)** – It is provided on front panel and protects the power circuit from grounding.

**GR2 (Ground Relay)** -It is provided on front panel and protects the starting circuit from grounding.

**SAR (Safety auxiliary Relay)** – It is provided on EH type governor loco and protects auxiliary machines.

**DMR (Dead Men's Relay)** – It is provided on front panel. Whenever load part/ACP and A9 applied in emergency position, DMR gets de-energized and engine speed comes to idle.

**WSR 1, 2, 3 (Wheel Slip Relay)** – These are provided on front panel. It operates during wheel slip and protects wheel skidding, TM and rail.

**GFOLR (Generator Field over Load Relay)** – It is provided on front panel and protects from excess current flow in alternator field.

**TDR (Time Delay Relay)** –It is provided on front panel, during cranking, if any one of CK1, CK2, CK3 is welded that time this relay will remain energized and protects voltage regulating panel.

**BSR (Battery Safety Relay)** –It is provided on front panel in WW Governor loco only, it energize when WW governor plunger came out or MUSD on stop position and does not allow the engine to crank hence battery consumption is saved.

**CKR 1 & 2 (Cranking Relay)** –These are provided on front panel. CKR1 separates exciter shunt field and CKR2 separates auxiliary shunt field during cranking.

**ESR 1, 2, 3, 4 (Engine Speed Relay)** – These are provided on front panel in EH governor loco and used for increasing and decreasing engine speed.

**TR (Transition Relay)** –It is provided on front panel for parallel transition.

**BKR1, 2, 3 (Braking Relay)** – These are provided on front panel and it used during dynamic braking.

**SR (Signaling Relay)** – It is provided on front panel and it is used for alarm circuit.

**ERR (Engine Run Relay)** – It is provided on front panel in WW governor loco only. At the time of power ground, Generator field over load, ECS (Run) ERR de-energize and engine comes to idle.

**VAPR (Vent Air Pressure Relay)** – It is provided on front panel in alternator loco and protects the rectifier block from insufficient air supply.

## Lesson No. 28

### How to Move the Loco

First of all check the locomotive after ensuring every thing is normal then starts the engine systematically. All pressure to be adjusted and ensure loco brake in applied condition, then release hand brake, remove wooden wedges. Move the Loco with following procedure –

1. Put ECS on RUN.
2. Put RH in desired direction.
3. Put 'ON' MCB1&2.
4. Put 'ON' GFCO-1&2.
5. Open one throttle notch, load meter shows 300 Amp current.
6. Release the loco brake.
7. Loco start to move.

### Procedure of Changing the Control Stand

**Changes to be done on a control stand which is to be leave –**

1. Ensure MR pressure is between 8-10 kg / cm<sup>2</sup>.
2. Remove SA9 handle in application position.(Close it's COC if Provided) and ensure loco brake is in applied condition.
3. Remove A9 handle in release position and closed its COC.
4. Ensure both control stand TH in idle and SH in motoring position.
5. Remove RH after keeping it in neutral position.

**Changes to be done on a control stand which is to be used as working control stand**

1. Insert SA9 handle and put it in application position. (Open its coc if provided)
2. Insert A9 handle in release position and open its coc.
3. Insert RH and put it in desired direction.
4. Release the SA9 of other control stand.

**Note-** SA9 coc is provided in 13, 11 series loco.

## **Lesson No. 29**

### **Procedure for Stabling Loco**

1. Loco to be stop after clearing fouling mark.
2. Apply loco brake by SA-9.
3. Apply hand brake.
4. Apply wooden wedges/Iron skids.
5. Shut down the engine properly and put off all circuit breakers and switches.
6. Remove A9, SA9 handle in application position and RH in neutral position.
7. Entries to be made in repair book and trip card.
8. Handover repair book, trip card, A9, SA9 and Reverser handle to on duty authorized employee. Authorized employee is lobby, station, yard, shed supervisor.

### **Hauling Of Dead Loco**

Whenever loco is not able to move with its own power is called dead loco. To clear dead loco with working loco, attach it with working loco through CBC and following changes to be done on it-

1. Drain out all reservoir pressure.
2. Keep MU2B on 'DEAD'.
3. Close  $\frac{3}{4}$ " coc.
4. Remove A9, SA-9 handle in release position.
5. Remove RH in neutral position.
6. Close banking coc.
7. Put 'OFF' all circuit breakers and switches.

Couple BP, FP, BC & MR equalizing and vacuum hose pipes and open COC, angle COC between the working and dead loco . Ensure application and releasing of loco brake in both the loco.

If BC & MR equalizing pipe is not available then work the dead loco as a piped vehicle.

### **Procedure for Clearing Dead Loco in Rear of Train** **(Letter no. 2000/M [L]/466/803/Pt. Dated 28/06/2006)**

Whenever vacuum train pipe/ BP or its angle cock is broken in dead loco, if straight air brake dead loco is required to couple with vacuum brake train then it can not be worked as a piped vehicle. Such type of locos is required to couple in rear of train and fulfill following condition-

1. Only one dead loco is to be coupled.
2. Sectional gradient should not be more than 1:100.



3. On dead loco minimum one ALP or a person above this grade is nominated who belongs to running cadre with walkie-talkie, hand flag, detonator. The nominated person should put on flasher light and apply hand brakes if dead loco is uncoupled.

### **Oil Checking Points in loco**

1. Fuel oil tank capacity is 6000 liter and both side fuel oil glow rod is provided having marking from 600/1000 to 6000 liter. Average of both side glow rod oil level to be noted, minimum fuel oil level should not be less than 1000 liter.
2. Each axle having two suspension bearing, housing, each housing has oil cap and it is to be ensured that oil is available in the cap.
3. Each traction motor gear case having filling cap which should be tied with nut and bolt and no oil leakage.
4. Dipstick gauge is provided on engine right side in generator room to check the generator gear case oil level; it should be above minimum mark.
5. EH governor has two spy glasses, bottom one should be full and top one should be more than half. WW governor has glass tube to check oil level it should be above marking provided on the tube.
6. A dipstick gauge is provided to check oil level of engine lube oil sump. It has marking from 0 to 600 liter. To check oil level engine should be on idle and CCM is in running.
7. Spy glass and dipstick gauge are provided in compressor, dipstick having 5 marking oil should be above three marks. Engine should be shut down before checking the oil level while checking with dipstick gauge.

## Lesson No. 30

### Twin Beam Head Light

On WDG3A loco two head lights are provided on each side of Loco viz. short hood and long hood. HLB (head light circuit breaker) is provided on front panel. Head light rotating switch is provided on both control stand having 6 positions. To glow head light following switches should be in on position

1. Battery knife switch (BS)
2. Main battery circuit breaker (MB1)
3. Control circuit breaker (MB2)
4. Head light circuit breaker(HLB)

There are two bulbs in twin beam head light and in each bulb two filaments are provided. The rating of these filaments is 24V and 90W, 100W respectively. One DC-DC converter unit is provided in loco pilot cab to convert 74V DC supply in 24V DC. In this unit two DC-DC converters are provided. One program switch having 2 positions is provided on this unit.

Position No.1- For converter No.1

Position No.2- For converter No.2

#### Note –

1. When any of head light rotating switch is put ON then ensure that Head light will glow with respect to its position.
2. If head light is not working then change the position of Converter Program switch.
3. Follow traffic rules while working loco with head light not working.

### Flasher Light

Two flasher lights are provided on each side, one near short hood head light and other near long hood head light. Individual control box is provided for each side flasher light.

Control box provided on right control stand is for short hood side flasher light and on left control stand for long hood side control stand.

Each control box has two toggle switches.

1. Main switch - two positions (on & off)
2. Filament switch - Two positions (F1 & F2)
3. To glow Flasher light following switches/breakers should be in 'ON' position.
4. Battery knife switch (BS)
5. Main battery circuit breaker (MB1)
6. Control circuit breaker (MB2)
7. Flasher light control box (Main switch)
8. Flasher light control box Filament switch (F1 / F2)

## **Auto Flasher Light**

This modification is done to facilitate loco pilots and assistant loco pilots however in abnormal condition both the crews are bounded to do there duty as per GR & SR rule.

In diesel loco some changes in pneumatic (BP charging) and electrical control circuit is carried out in modified AFL.

Whenever A-9 handle in release condition , RH is in forward or reverse direction and BP/vacuum drops in any reason, such as hose pipe uncoupled/ load part/ ACP or emergency brake applied by guard, Auto flasher light will glow automatically with following indication –

1. LED lamp will glow.
2. Buzzer sounding on control unit.
3. Engine speed comes to idle.

When flasher light glows automatically then SW1/SW2 push button is provided on both control stands to turn off it. While pressing SW1/SW2, AFL will extinguish and buzzer will stop, but LED does not extinguish till BP will not recharged up to 4.7 kg/cm<sup>2</sup>. Before pressing SW1/SW2 switch, keep 'ON' the manual flasher light switch.

While working train if AFL glows automatically, LED glows, buzzer sounds and engine speed comes on idle that time loco pilot should take this incident as an abnormal condition and work as per GR&SR rules.

PR-1 relay (60 sec. time delay relay) is provided in a circuit to avoid the glowing of AFL on releasing of A9 after breaking. AFL will glow automatically if BP will not restore to 4.7 kg/cm<sup>2</sup> within 60 seconds after releasing A9.

Normally BP charging takes place through 5.5 mm diameter choke, it is fitted between MR-2 and additional C2 relay valve. Initially or while recharging BP after application, the charging rate of BP is very slow through this chock therefore SP1 & SP2 switches are provide on both control stand for quick charging of BP. Whenever this push button is pressed a magnet valve will energize and BP will charged through 19 mm chock.

Loco pilot should ensure the working of Auto Flasher Light while taking charge.

### **Trouble Shooting of Auto Flasher Light**

1. Auto flasher light glow without effecting engine speed – it means FLR is defective, wedge it in energize condition.
2. Auto flasher light is glowing and engine speed not increasing –
  - A) If PR3 is defective (energized), remove one wire of P2 and tape it.
  - B) If PCS-1 is defective, short it.

### **In following condition flasher light should be made ON immediately-**

1. Sudden drop of vacuum / BP or fluctuation in AFI.
2. Sudden experience of jerk / lurch.
3. When noticed rail fracture / weld fracture.
4. Train parting.
5. Loco failed.
6. Derailment.
7. When opposite line is required to protect.

### **Marker Light**

Two marker lights are provided on each side of Loco viz. short hood and long hood. Marker light gets supply from battery / auxiliary generator. To glow Marker light following switches/ circuit breakers should be in on position

1. Battery knife switch (BS)
2. Main battery circuit breaker (MB1)
3. Control circuit breaker (MB2)
4. Lighting circuit breaker
5. Toggle switch on control stand

Each marker light has two glasses one is red and other is white colour, it can be changed by slider knob. To work light engine put front side white glass and rear side red.

**Note-** Some loco fitted with LED type marker light.

Lesson No. 31

**Repair Book**

Central Railway .

Mech. 196/B.

Loco No. ....  
 Date .....  
 Loco Pilot ..... HQ .....  
 Asstt. Loco Pilot ..... HQ. ....  
 Train No. ....  
 From ..... To ..... Km .....  
 Time Charge T/O ..... H/O .....  
 Min. LOP..... kg/cm<sup>2</sup>  
 Min. FOP ..... kg/cm<sup>2</sup>  
 Max. BAP..... kg/cm<sup>2</sup>  
 Load .....

Performance of

Speedometer PATB Wipers Sanding gears

Half hourly observation When loco is working

| Time           | FOP | LOP | BAP          | Water Temp. | Battery. Charging. |
|----------------|-----|-----|--------------|-------------|--------------------|
|                |     |     |              |             |                    |
|                |     |     |              |             |                    |
|                |     |     |              |             |                    |
|                |     |     |              |             |                    |
|                |     |     |              |             |                    |
| Repairs booked |     |     | Action Taken |             |                    |

Loco Pilot's Sign.....

Mech. Sup. Sign .....

Elect. Sup.'s sign.....

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## Trip Card

Mechanical-171 F/ P1

Central railway

Trip card

### INSTRUCTIONS TO LOCO PILOTS

1. Loco Pilots should record Lube Oil level at Engine Idling and Crank Case Exhauster Motor in ON position.
2. At the time of handing over charge of loco in shed, this card should be handed over to Engine Examiner on Duty.
3. In Case of Loco hauled DEAD the reason, time and place must invariably be recorded by the Loco Pilot handing / taking over charge of dead loco.
4. If any Loco Pilot fails to record entries in the form the next Loco Pilot taking over must record the name and Depot of the defaulting Loco Pilot for initiating action.

### COMBINED GUARD'S AND LOCO PILOT'S REPORT

#### TO BE FILLED BY LOCO PILOT

Engine No.....

Class of Engine ..... Home shed .....

Train No. .... Service.....

Date .....

How employed on previous trip .....

Engine No. of assisting required/assisting not required, engine attached to train (if any) .....

Name of Guard .....

Name of Loco Pilot .....

Staff No. .... HQ. ....

Name of Assistant Loco Pilot .....

Staff No. .... HQ .....

**TIMINGS**

Time engine left shed or was taken over.....  
Time engine coupled to train .....  
Time engine uncoupled form train .....  
Time engine arrived at station /shed on completion of duty  
.....  
Total time Engine was employed on service .....  
Time train engine was employed on shunting .....  
1. At starting station before departure of the train.....  
2. At terminating station after arrival of the train.....  
Time Loco Pilot came on duty .....  
Time Loco Pilot went off duty.....

**FUEL CONSUMPTION**

Fuel Oil Taken Over .....  
Added On Run .....  
Fuel Oil Handed Over .....  
Lube Oil Taken Over .....  
Added On Run .....  
Lube Oil Handed Over .....

**DRIVER'S SPECIAL REPORT**

No. of vacuum braked wagon operative .....  
Nos. of caution orders attached .....  
Nos. of authority, etc. attached .....  
Drooping signal .....  
Dim signals at night .....  
Signals which have become obscured by trees or have bad  
background .....  
Bad spots in the track .....  
Irregular working of railway staff.....  
Total No. of documents attached.....  
  
Signature of Loco Pilot .....  
Signature of Loco Foreman .....

## Lesson No. 32

### Checking Of Locomotive

Checking of loco is essential for safe operation. It should be carried out with in specified condition and time. It is carried out united by Loco pilot and Assistant loco pilot in following ways -

#### A) Examination Of Locomotive Before Leaving The Shed While Engine Is In Shut Down Condition -

##### a) In Loco Pilot Cab -

1. Read the repair book and trip card.
2. Check the following safety items-
  - Wooden wedges-4
  - Fire extinguisher-4
  - Spare Hose pipe, BP pipe, feed pipe
  - Spare screw coupling
  - Spare dome light bulb.
  - L-rod
  - Portable field telephone set.
  - Look out glass should be clean and intact.
  - Speedometer with graph roll.
  - Spare VRR Fuse.
3. Read all the instructions pasted on loco.
4. Ensure that hand brake is applied.
5. Ensure both MH on idle and RH is removed.
6. Ensure all gauges are intact with glass.
7. All switches of emergency trouble shooting box should be in normal position.
8. GR switches should be sealed.
9. Ensure availability of spare VRR fuse.
10. MCO should be in 'All-in' position and sealed.

##### b) In Nose Compartment -

1. COC of NSI reducing valve should be open.
2. COC of Horn and wiper should be open.
3. Ensure drain cock of control reservoir is closed.
4. C3W distributor valves isolating handle is in service and check P&G handle position.
5. Ensure that MU2B valve in LEAD position.
6. Ensure that 3/4 inch COC in OPEN position



**c) In Alternator Room -**

1. Ensure that oil level is sufficient in generator gear case.
2. Ensure sufficient electrolyte level in battery.

**d) In Engine Room -**

1. Check items related to engine governor.
2. Check level of lube oil.
3. Ensure that OSTA is in reset condition.
4. All tappet and FIP cover should be intact and tight.
5. Cross over linkage pin is intact.
6. Lube oil strainer drain cock is closed and tied with wire.

**e) In Compressor Room -**

1. Check the oil level in compressor sump.
2. LWS test cock is open.
3. EPG Gov. COC is open.
4. Water drain cock is closed and tied with wire.

**f) In Radiator Room -**

1. Check the water level in expansion tank.
2. Drain COC of Lube oil filter drum are closed and tied with wire.
3. Number of belts of RTTM is six.

**g) In Under Truck -**

1. Marker light is intact.
2. Operate CBC and check its working.
3. Ensure COC of BP, FP, BC EQ, MR EQ pipe is intact, closed and their washers are fitted properly.
4. Vacuum hose pipe washer is properly fitted and kept on dummy.
5. Ensure bolts of Rail guard are tight.
6. Ensure Cattle guard foundation is intact and there should be no crack.
7. Ensure buffer foundation bolts are intact.
8. Ensure all the sand pipes are fitted with proper fitment.
9. Ensure availability of sand in all sand boxes.
10. Ensure axle box stay plate bolts are intact.
11. Safety sling of brake cross tie bar should be intact
12. Brake hanger pin should be intact.
13. Brake pull rod J. bracket is intact.
14. Helical springs are intact.
15. D-shackle.
16. Equalizer safety pin.
17. Safety pin of Equalizer link pin.
18. TM nose suspension pad and its guide bolts.

19. TM gear case 'C' clamp and its flange bolts.
20. TM foundation bolts.
21. Suspensions bearing housing bolts.
22. Both bogies COC is open.
23. No skidding marks on wheel tyre
24. Check 1¼" COC.
25. J filter COC is open.
26. MR-1, MR-2, J-filter and Add. J-filter drain cock is closed.
27. Axle Generator foundation bolt are tied and secured with chain.
28. Condition of TM air bellows.
29. Ensure proper fitting of all brake block, brake shoe and slack adjuster.
30. Ensure screw coupling are available at both end.
31. Ensure there should be no leakage from fuel tank and its drain plug.
32. Ensure both filling cap of fuel tank are tied.
33. Air dryer should be in service.
34. Check all oiling points.

### **Start the Engine and Check The Following**

#### **a) In loco pilot cab**

1. Ensure Fuel oil pressure – 4.2 kg/cm
2. BA should indicate charging side.
3. Ensure no indication lamp is glowing.
4. MR pressure should be regulating between 8 to 10 kg/cm<sup>2</sup>.
5. Adjust BC pressure on 3.0 kg/cm<sup>2</sup>.
6. Adjust BP pressure on 5.0 kg/cm<sup>2</sup>.
7. Ensure FP pressure is 6.0 kg/cm<sup>2</sup>.
8. There should be no air leakage in control stand.
9. Ensure Head light, flasher light and marker light are working.
10. Ensure wipers, horns and sanders are working condition.
11. Ensure dropping and recreation of BP pressure.
12. Ensure application and releasing of Loco brake.
13. Check hand brake operation.
14. Ensure control air pressure is 5 kg/cm<sup>2</sup>.

#### **b) Nose compartment**

There is no air leakage.

#### **c) Generator Room**

There is no any abnormal sound.

#### **d) Engine Room**

1. There is no any abnormal sound.
2. Ensure is no leakage from Exhaust elbow.
3. There is no leakage of oil.
4. Checks lube oil level.
5. There is no leakage of water.

#### **e) compressor Room**

1. Ensure there is no abnormal sound.
2. Ensure needle valve is projected.
3. There is no oil and water leakage.
4. Check water temperature.

#### **f) Radiator Room**

1. There is no any abnormal sound.
2. There is no oil and water leakage

#### **g) Under Truck**

1. Check the operation of loco brake cylinder.
2. Check CCM exhaust.
3. Remove all wooden wedges and kept in cab.

#### **Perform the Following Operation in Pilot Cab**

1. Insert the reverse handle.
2. Raise the engine and ensure there is no abnormal sound from generator, engine, and Expresser and radiator room, also ensure that there is no leakage of water and oil.
3. Check the fuel oil and lube oil pressure.

#### **Following Test to Be Done**

1. Leak off test
2. Orifice test
3. Loco brake test
4. Changes taking place during dynamic braking.
5. Loco movement according to reverser handle.

#### **In Moving Train**

Ensure speedometer is working.

Observe after every half an hour

1. Fuel oil pressure
2. Lube oil pressure
3. Booster air pressure
4. BA reading.
5. Water temperature.

6. Loco motive speed.
7. Ensure no indication lamp is glowing.
8. Keep watch on all the gauges.
9. Watch any hammering sound from under truck.
10. During the time of transition check the speed.
11. Observe the smoke coming out of chimney.
12. Ensure that MR pressure cut in, cut out is properly.
13. Look back frequently.

### **After The Train Is Stopped**

1. Check coupling between Loco and load.
2. Check temperature of all axle boxes.
3. Drain out the moisture of MR1, MR2 and J-filter.
4. Ensure Loco brakes are applied.
5. Check CCM exhaust pipe.
6. Check Engine fuel oil and lube oil level.
7. Check Water level.
8. Check all the safety fittings.
9. Check any leakage from any where.
10. Check needle valve is projected.

## Lesson No. 33

### Duties of Assistant Loco Pilot

#### General duties

1. While report on duty he must be in proper uniform and well disciplined.
2. He should be aware of rules related to his duty, whether he is in possession or not a copy of rules or translated copy of rules.
3. He should be present on the time, at the place for duty which is assigned by administration, more ever if required on other place and time for his services. He should always alert and cautious while on duty.
4. In all conditions he should obey all lawful orders of his loco pilot.
5. He should have the knowledge of the following -
  - a. Lay out of all types of loco, its system and their sub systems, its subsidiary equipments with locations.
  - b. While on run able to trouble shoot the troubles of coaching and goods wagon like brake-binding, isolation of distributor valve, single/double pipe air brake working, changing of hose pipes etc.
  - c. Modern loco and operating instructions.
  - d. Safety rules related with track and train.
  - e. Connections, disconnection of multiple units, wedging of relay and contactor.
  - f. Rules and procedure of locomotive condition while taking charge from shed, from incoming staff, taking charge of dead locomotive.
  - g. Use of whistle code during various conditions as prescribed in GR&SR.
  - h. Speed limits in various conditions i.e. passing facing point, horn failure, head light failure, foggy weather, poor visibility, abnormal condition etc.
  - i. Various forms and authorities used in train operation.
6. He should take charge or hand over charge of equipment if given by lobby in charge/ crew controller for train operation

#### While Sign ON

1. He should sign on after breath analyzer test.
2. He should have two pair of spectacle to use on duty if required.
3. He should read all general and local instructions.
4. While on duty, he should note all speed restrictions related with section in which he is to be worked.
5. He ensure that safety equipment like torch, flag, detonator and flair signal, supplied to running staff is in working condition.

#### While Taking Charge

1. Check the equipments of under truck.

2. Check the level of fuel oil, lube oil, water, governor oil and water temperature etc. Ensure loco should be is on non electrified track while checking water level.
3. Check the hand brake working and ensure it should be released on train starting.
4. Check the availability of sand in sand box; it should be sufficient and dry.
5. ALP will detach/attach the loco with load in following condition-
  - a. On starting station.
  - b. On intermediate point.
  - c. While loco checking.
  - d. On station/yard where it is essential to detach loco. This work is done with the help of shunting staff while train leaving from yard.
6. Ensure the working of safety item and equipment like head light, flasher light, level of BP pressure/vacuum and take care of look out glass for better visibility.
7. He should assist to loco pilot in trouble shooting, leakage arresting and loco checking.
8. He should ensure following safety items are available on loco-
  - a) Spare VRR fuse
  - b) Multiple unit cables
  - c) Spare coupling
  - d) Spare hose pipes
  - e) Wooden wedges
  - f) Coupling clamp
  - g) Fire extinguishers
9. He should ensure adequate amount of MR and BP pressure.
10. When ever crew control/ lobby in charge will hand over portable field telephone, ALP will collect it and keep in safe custody while on run and hand over it in lobby while signing off.

### **While on Run**

1. He should help to loco pilot in signal sighting. He should call out signals, caution board, speed board from adequate distance. He should not keep himself busy in any work while approaching to cautious signal region.
2. During train running he should look at back on curve and ensure that train is running intact and safe, especially on curve where full train is visible. When train is passing from working spot on track/ manned gate he should look out back to ensure that the train is all right and if any signal is exhibited regarding information of accident.
3. Keep watches on train passing on opposite track if notice any abnormality should report to loco pilot, if necessary show the danger signal to stop the opposite train.

4. Whenever deputed by loco pilot, he should exchange the signal on behalf of loco pilot.
5. He should be responsible for keeping watch on abnormalities such as ACP; hose pipe disconnection, brake binding, hot axle, on line.
6. He should be more alert and vigilant while all type of abnormal working such as TSL, all communication failure, defective signal, load parting, load dividing, accident etc.
7. On hault he will drain out the moisture from MR1, MR2, J-Filter and check the fuel oil level and safety fittings. He will also check the temperature of axle boxes if train is stopped more than 15 minute. (Time limit is not applicable incase of mail express and passenger.)
8. He should note down the reading of various oil/air pressure, speed Notch position, etc. in every 30 minute. He should also record train running time.
9. He will keep loco pilot cab neat & clean to maintain cab environment.
10. He will uncouple the loco when loco is required detach for maintenance work.
11. If the loco pilot is not able to drive the train, he should stop the train by applying A-9 gradually & protect the train as per G&SR, then inform to guard & try to inform SM/SCOR immediately. If he is competent and having loco pilot competency certificate then he should clear the section after informing guard, that he should be alert.
12. In single line section where ball token is exchanged he should ensure that ball token is handed over to authorized station employee of previous station and new functional ball token is collected properly.
13. If loco is shut down or failed in section, he will apply the hand brake, wooden wedges and pin down the wagons to prevent from rolling down, after consulting with loco pilot.
14. If train is derailed or capsized, he will assist the LP in following manner-
  - a. Put on flasher light.
  - b. If flasher light is defective, put on /off repeatedly head light switch.
  - c. By protecting opposite line in double line section , from front direction in single line section and he should help to LP for informing to controller / nearest station master by field telephone/nearest gate/ loco pilot of opposite train/with the help of other railway employee.
15. He will apply emergency brake instead of informing loco pilot to stop the train if he noticed any abnormality in running train after passing last signal or there is obstruction in running train.

Above duties are not sufficient, he will also follow the GR & SR or instructions issued by local officers and instructions issued by headquarter officers time to time with any mean.

## Lesson No. 34

### Modifications

#### Digital Water Level Indicator

It is provided in loco pilot cab, its sensor is fitted in expansion tank no. 1, it shows water level in the tank. On this indicator colour indication lamp are provided

1. Green (full)
2. Yellow (half) (danger below 50 %)
3. Red (danger below 20%)

Auto manual switch and fuse is provided on indicator unit, it is related with electronics LWS. This LWS is operate when water level remains 3 inch in expansion tank, that time keep auto/manual switch on manual position and start the engine for clearing the section and inform to PCOR.

-----



## Lesson no. 35

### WDM2 Locomotive

This loco is designed for mixed service.

#### General data-

|                                    |                     |
|------------------------------------|---------------------|
| Engine Horse Power                 | 2600 HP             |
| Loco Horse Power                   | 2400 HP             |
| Maximum Speed                      | 120 km/h            |
| Weight                             | 112.8 T             |
| Axle Load                          | 18.8 T              |
| Tractive Effort                    | 30.5 T              |
| Brake System                       | 28LAV1              |
| Transition                         | 30, 50, 80 km/h     |
| Generator                          | DC                  |
| Type of Diesel Engine              | 251B                |
| Engine Idle Speed                  | 400 rpm             |
| Engine 8 <sup>th</sup> notch Speed | 1000 rpm            |
| OSTA Setting                       | 1130 ±20 rpm        |
| Power Contactor                    | 9                   |
| Reverser                           | 2                   |
| BKT                                | 2                   |
| Center Pivot                       | 2                   |
| Side Load Bearer                   | 4                   |
| Length of Loco                     | 17120 mm            |
| Buffer height                      | 1030-1105 mm        |
| Locomotive Driving                 | Right Hand          |
| Bogie                              | Co-Co Type Trimount |
| Traction Motor                     | DC Series Motor     |
| Engine Governor                    | EH / WW             |
| Crankshaft Overlap Period          | 123°                |
| Locomotive Series                  | 16, 17, 18          |

### Main Difference between WDG3A and WDM2 Locomotive:

| S.No | WDG3A  | WDM2   |
|------|--|--|
| 1    | It is used only for goods train                | It is used for passenger and goods train       |
| 2    | Its maximum speed is 100 Km/h                  | Its maximum speed is 120 Km/h                  |
| 3    | Engine horse power is 3100 hp                  | Engine horse power is 2600 hp                  |
| 4    | Loco horse power is 2900 hp                    | Loco horse power is 2400 hp                    |
| 5    | It has left hand drive                         | It has right hand drive                        |
| 6    | It is fitted with air brake system only        | It is fitted with dual brake system            |
| 7    | Alternator is fitted                           | In this DC Generator is fitted.                |
| 8    | Total weight of loco is 123T                   | Total weight of loco is 112.8T                 |
| 9    | Axle load is 20.5 T                            | Axle load is 18.8 T                            |
| 10   | Length l of this loco is 17850 mm              | Length of the loco is 17120 mm                 |
| 11   | Capacity of fuel tank is 6000 liters.          | Capacity of fuel tank is 5000 liters.          |
| 12   | Capacity of lube oil tank is 1210 liters.      | Capacity of lube oil tank is 990 liters.       |
| 13   | Compressor unit is fitted in this loco.        | Expressor unit is fitted in this loco.         |
| 14   | EPG Governor is fitted                         | NS16 Governor is fitted                        |
| 15   | 8 <sup>th</sup> notch Engine speed is 1050 rpm | 8 <sup>th</sup> notch Engine speed is 1000 rpm |
| 16   | Engine is 251 B up rated                       | Type of engine is 251B                         |
| 17   | It has Co-Co high adhesion bogie               | It has Co-Co tri-mount bogie                   |
| 18   | Crank shaft overlap period is 140°             | Crank shaft over lap period is 123°            |
| 19   | It is 1 transition Loco                        | It is 3 transition Loco                        |
| 20   | 1 BKT is provided                              | 2 BKT are provided                             |
| 21   | 1 reverser is provided                         | 2 reversers are provided                       |
| 22   | 2 GR are provided                              | 1 GR is provided                               |
| 23   | On each bogie 4 side load bearers are provided | On each bogie 2 side load bearer are provided  |
| 24   | There is no load on Center pivot               | The load on each Center pivot is 30%           |
| 25   | It has D-shackle pin                           | It has bogie safety pin                        |

|    |   |  |
|----|---|--|
| 26 | It has shock absorbers.   | It has snubber.  |
| 27 | The valves of brake system are fitted in nose compartment           | The valves of brake system are located at different places                               |
| 28 | GFOLR setting is 280 amp  | GFOLR setting is 235 amp   |
| 29 | Alternator no load voltage is 1130 VDC.                             | The no load voltage of alternator is 980 VDC.  |
| 30 | OSTA setting is 1180±20 rpm   | OSTA setting is 1130 ±20 rpm   |
| 31 | For engine cranking AG & EG are used as motor                       | For engine cranking the main Generator is used as motor                                  |
| 32 | It has 3 cranking contactors CK1, CK2 & CK3.                        | Two cranking contactors are provided i.e. CK1, CK2.                                      |
| 33 | It has Napier/ABB/GE TSC.   | It has Alco 720 TSC.   |
| 34 | Maximum booster air pressure builds up to 1.97 kg/cm <sup>2</sup> . | Maximum booster air pressure builds up to 1.7 kg/cm <sup>2</sup> .                       |
| 35 | It has C3W distributor valve.                                       | It has 28 VB valve.  |
| 36 | SA9 has 2 positions.  | SA9 has 3 positions.   |
| 37 | It has Foot pedal switch.   | Quick release position of SA9 is provided to release loco brakes in conjunction braking. |
| 38 | Train pipe is provided for continuity purpose only                  | Train pipe is connected with vacuum brake system.  |
| 39 | It has moving handle/joy stick.                                     | It has throttle handle.  |
| 40 | It has control Desk.  | It has control stands.   |
| 41 | Its series starts from 14, 13 and 11.                               | Its series starts from 16, 17 and 18   |
| 42 | MR tank is fitted in front and rear of fuel tank.                   | MR tank is fitted on left and right side of the loco                                     |

### Main Compartments of WDM2 Loco-

- 1 Nose compartment.
- 2 Loco Pilot cab
- 3 Control compartment
- 4 Generator room
- 5 Engine room
- 6 Expressor room
- 7 Radiator room
- 8 Under truck

### Nose Compartment -

The following equipments are provided-

- |                      |                          |
|----------------------|--------------------------|
| Battery knife switch | BKBL motor               |
| Braking grids        | NS1 reducing valve & COC |
| Control Reservoir    | Horn COC                 |
| Wipers COC           | VA1 release valve        |

|                    |                                  |
|--------------------|----------------------------------|
| VA1B Control Valve | Vacuum check valve               |
| GD80D Filter       | GD80E Filter                     |
| 2 Sand Boxes       | Banking COC                      |
| COC with strainer  | A1 Differential Pilot Valve &COC |

On the outer wall of Nose Compartment Head light, Marker light, Flasher light and multiple unit jumper cables are provided.

## Compartments of WDM2 Locomotive

### 1. Nose Compartment

|                                      |                     |
|--------------------------------------|---------------------|
| Battery knife switch (BS)            | VA1 B Control valve |
| Dynamic Braking Blower motor ( BKBL) | VA1 Release valve   |
| Dynamic braking Grids                | Vacuum check valve  |
| GD-80D Filter                        | GD-80E Filter       |
| Banking cutout cock                  | COC with strainer   |
| Two sand boxes                       | Horn and wiper COC  |

A-1 Differential pilot valve, its COC and reservoir  
 NS-1 Reducing valve and its COC  
 Control Reservoir with drain cock  
 On outer wall of Nose compartment head light, flasher light marker light and multiple unit jumper couples are provides.

### 2. Loco Pilot Cab

#### On both control stand

|                         |                           |
|-------------------------|---------------------------|
| A-9 valve               | SA- 9 valve               |
| Throttle Handle (TH)    | Selector Handle (H)       |
| Reverser Handle (RH)    | Load meter                |
| Vacuum Gauge            | Lighting switches         |
| Head light switch (HLS) | Flasher light control box |
| Indication Lamp panel   | Horn & Sander switch      |

Brake pipe or Brake cylinder Pressure Gauge  
 Auxiliary Reservoir and MR pressure Gauge  
 Multiple unit shut down switch (MUSD)  
 Master Fuel pump Breaker (MFPB)  
 Generator Field cut out switch (GFCO)  
 Main control breaker MCB

#### On Right Control

HS4 valve  
 Vacuum control pressure gauge  
 MU2B Valve  
 F1 selector valve  
 Wheel slip buzzer  
 28VB valve  
 ¾” COC, Hand brake, Control air pressure, LOP, FOP, BAP gauges, OPS  
 D1 emergency flap valve

#### On Left Control Stand

HB5 valve & its COC  
 PCS  
 H5A valve& its COC  
 Electrical speedometer  
 Mechanical speedometer  
 D1 Pilot valve

### **3. Control Compartment.**

#### **On front panel**

Dome light circuit Breaker (DLCB)  
Head Light circuit Breaker (HLB)  
Cab light circuit Breaker  
Battery ammeter  
Battery Breaker (MB1)  
Control Breaker (MB2)  
Auxiliary Generator Field Breaker(AGFB)  
Fuel pump Breaker(FPB)  
Crankcase Exhauster Breaker (CCEB)  
Start Button ,Stop Button  
Engine control switch ( ECS)  
Motor cut out switch (MCO)  
Compartment light switch  
Ground Relay reset knob

**Inside front panel** - Signal Relay (SR), Engine speed Relay (1,2,3,4,), Field shunt ,Relay (FSR), Transition Relay (TR), Safety Auxiliary Relay(SAR), Dead Means Relay(DMR), Breaking Relay (BKR), Ground Relay(GR), Generator Field contactor(GFC), Reverse control panel (RCD), Fuel pump contactor(FPC), Voltage Regulating panel(VRP), Transition panel (TRP), Engine Control panel(ECP), Excitation panel, Wheel slip Relay(WSR-1,2,3), Transition Excitation transformer (TET)  
Power Contactors(P31,S31,P22,P21,S21,P32,P2,S1,P1), Cranking contactor (CK1,CK2), Braking and Traction contactor (BKT-1, 2)  
Reverser contactor (REV-1, 2), Load Ammeter shunt (LAS)  
Armature Current control Reactor (ACCR).

**Back Panel-** Radiator fan Contactor (R1&R2), Temperature Control Resistance (TCR), Voltage Dividing Panel (VDP), Gauge Lamp Resistance, Generator Field Resistance (GFR), Wheel slips Relay Resistance (WSRR), Field control Panel(FCP), Field shunt Relay Resistance (FSRR), Head light Resistance (HLPR), Voltage Regulating Current limit shunt (VRCLS), Arc suppression Rectifier(CPR-1,2)

#### **4. Generator Room**

Main Generator, Auxiliary Generator, Exciter Generator, FTTM, Generator Gear Case and its dip stick gauge

#### **5. Engine Room**

251-B type diesel engine  
Fuel injection pump  
High Pressure Line

Water Jumper pipe, Water riser pipe

Inlet elbow, Exhaust elbow, Exhaust manifold, Cross over pipe

### **On engine right side**

Engine Governor

Tacho Generator

Lube oil Dipstick gauge

Crankcase Explosion Door

Primary filter

Secondary filter

OSTA

Fuel oil Relief valve

Bubble collector

Lube secondary Header

Right side fuel oil gallery

### **On engine left hand side**

Crank case Exhauster Motor

Fuel oil Regulating valve

Lube oil strainer

Bubble collector

Lube oil Main Header

Lube secondary Header

Left side fuel oil gallery

### **On free end**

Turbo super charger

After cooler

Water pump

Lube oil pump

## **6. Expressor Room**

Expressor

Fuel pump motor

Water drain cock

Air maize oil bath filter

Car body filters

ETS-1, 2, 3.

Water temperature gauge

LWS& its Test cock

Lube oil relief valve

Lube oil regulating valve

NS-16 governor & its cock, Norton filter

## **7. Radiator Room**

Lube oil by pass valve

Lube oil cooler

Radiator core

Radiator fan

Sand boxes

Expansion tank no. 1&2

Right Angle Gear Box

Eddy current clutch coil (ECC)

Lube oil filter drum and its drain cocks

Rear Truck Traction Motor Blower (RTTM)

On outer wall of radiator Room Head light flasher light, water level gauge, marker light and multiple unit jumpers are provided.

## **8. Under Truck**

CO-CO tri mount bogie

Front truck

Rear Truck

Center Pivot

Side load Bearer

Helical Spring

Equalizing beam

Axle Box

Axle Journal

Traction motor

Nose pad

Pinion Gear

Axle Gear

Traction Motor Gear case

|                               |                     |
|-------------------------------|---------------------|
| Brake cylinder                | Brake assembly      |
| Wheels                        | Sanding Arrangement |
| Rail Guard                    | Cattle Guard        |
| Pipes of Brake System         | Buffers             |
| Center Buffer coupler         | Fuel Tank           |
| M.R Tank                      | Axle Generator      |
| Mechanical speedometer sensor | Brake system valves |
| Hand brake chain              |                     |

Co-Co tri mount bogie is fitted in under truck of WDM2 loco. The short hood side bogie is called front truck and the long hood side bogie is called Rear Truck.

Bogie frame is made of cast steel, on each bogie one center pivot and two side load bearer are provided .The whole load of super structure is divided on these center pivots and side load bearer, each center pivot carries 30% load and side load bearer carries 10% each. On each axle journal, one axle box is fitted. The load is transferred on axle box through helical spring on equalizing beam. There is one set of two equalizing beams, these two beams are tied together by a tie bolt and on each set of the equalizing beam one spring chair is provided on which two sets helical springs are mounted. One set of helical spring having snubber, because of spring and snubber vibration and jerks on the frame are minimized. In this way both bogies having 16 equalizing beams, 16 spring sets and snubber (08 no.).

Traction motor is mounted on each axle with the help of suspension bearing and other end of TM is placed on cross member embarked nose pads. For lubrication of suspension bearing wick pads are provided. Lower end of wick pad is dipped in oil and upper end supplies oil to bearing and axle. On each axle two numbers of suspension bearings are provided, thus total number of suspension bearings is 12.

A 65 teeth drive gear is provided on each axle and a 18 teeth pinion gear fitted on armature of Traction motor is matched with axle gear. This gear assembly is placed in traction motor gear case; it is made up in two parts and fitted together with C-clamp & flange bolts. This gear case is fitted on TM yoke with three foundation bolts; gear assembly is lubricated by servo coat. On each bogie 4 brake cylinder and brake assembly is mounted. Each cylinder operates 3 brake blocks as such 24 nos. of brake blocks are provided.

## **Comparative study of different systems of WDM<sub>2</sub> in comparison with WDG-3A loco**

### **Fuel Oil System**

1. Fuel tank capacity is 5000 lit.
2. Marking on glow rod gauge is 540 -5000 liter.
3. Glow rod gauge is fitted.
4. The tank is welded with superstructure.
5. Regulating valve setting is 3.6 kg/cm<sup>2</sup>.

### **Lube Oil System**

1. Sump capacity is 990 lit.
2. Setting of relief valve is 7.5 kg/cm<sup>2</sup> and regulating valve is 4.2 kg/cm<sup>2</sup>.
3. Marking on dip-stick gauge 0- 400 liter.

### **Cooling Water System**

1. After cooler is connected in delivery side of water pump.
2. Radiator core is small in size.
3. ETS 1,2,3 (Engine Temp. switch) is provided.

### **Air intake System**

1. ALCO-720 TSC is provided.
2. Maximum BAP is build up to 1.7 kg/cm<sup>2</sup>.
3. After cooler is small in size.
4. Air maze oil bath filter is provided in place of Cyclonic filter.
5. Run down test is carried out of TSC.
6. Run down test timing is 90 -180 sec.

### **Compressed Air System**

1. Expressor is provided in place of compressor.
2. There are six cylinders, out of which three exhauster and other three is compressor cylinder.
3. One inters coolers provided.
4. NS16 governor is provided.
5. Vacuum check valve is fitted for the safety of expressor unit.
6. Expressor sump capacity is 30 liters.
7. MR1 & 2 are provided both side of fuel oil tank.

### **Brake System**

1. 28LAV-1 brake system is fitted; both vacuum and air brake train can be worked.
2. In this system SA-9 has three positions.
3. Quack release position is used to loco brake in conjunction working.
4. 28VBvalve is provided in place of C3W.
5. COC with strainer is provided for isolating conjunction braking.



### Difference between 28LAV-1 and IRAB-1 brake system.

| 28 LAV1   | IRAB-1  |
|---|---|
| This system can work both vacuum and air brake trains   | The system can work only air brake trains                 |
| It consists of expresser unit                           | It consist of compressor unit                             |
| This brake system consists of all vacuum related valves | It does not have any Vacuum related valves                |
| 28VB control valve is provided for conjunction braking  | C3W distributor valve is provided for conjunction braking |
| Vacuum train pipe is connected with vacuum brake system | Train pipe is fitted only for continuity purpose.         |
| SA9 has quick release position                          | It doesn't have quick release position                    |
| It does not have foot pedal switch                      | It has foot pedal switch                                  |
| It has COC with strainer                                | It has C3W valve isolating handle                         |
| It has pneumatic control switch                         | It has power cut off pressure switch                      |
| It has HB5 valve  | It does not have HB5 valve                                |

### Engine Starting Procedure-

1. Check and secure the Loco.
2. Put 'ON' Dome light breaker and switch.
3. Close the battery knife switch.
4. Put 'ON' MB-1 breaker.
5. Put 'ON' MB-2 breaker
6. Put 'ON' MFPB-1 breaker.
7. Put 'ON' MFPB-2 breaker.
8. Put 'ON' CEB breaker.
9. Put 'ON' FPB breaker
10. Kept ECS from Idle to run position three times and kept in Idle at last. Alarm will ring in run position, on hearing it the staff working on locomotive will alert and come to know that engine is starting.
11. Press the Start Button
12. CK1 and CK2 will pick up and engine will crank.
13. When lube oil pressure builds up to 1.6 kg/cm<sup>2</sup> then ESLP will extinguish.
14. Release start button and ensure dropping of CK1 & CK2.
15. Put ON AGFB on front panel.

**Note –1.** In WW governor Loco it is necessary to put On MCB1,2 to ring alarm before pressing Alarm push button located on front panel, otherwise alarm bell will not ring.

**2.** During Engine starting all indications is similar as WDG-3A Loco except AGFL will glow on closing of MB-1.

**Engine Stopping Procedure** – Same as WDG-3A Loco.

**Engine Speed Control**

The engine speed is control same as WDG-3A Loco, interlocks of GFOLR and VAPR is not provided in speed control circuit. 8<sup>th</sup> notch speed is 1000 rpm.

**GFC Control Circuit**

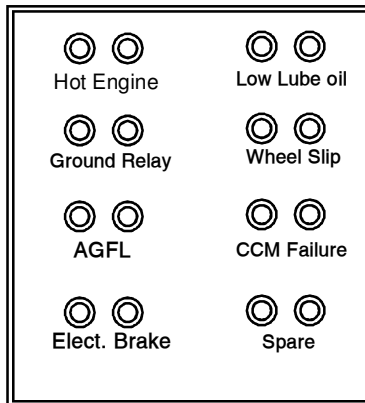
It is same as in WDG-3A Loco, NCI of GFOLR, VAPR is not provided and CK1, CK2 (NCI) is replacement of CK3 (NCI).

**Transition**

1. Three transitions are takes place in WDM-2 loco at the speed of 30, 50, 80 km/h respectively. (SP to SP+FS, SP+FS to P and P to P+FS )
2. FSR, FSRR, FS contactors are provided on this Loco.
3. Four cards (210/1, 210/2,210/3,207) are provided on TRP.

**Indication Lamps**

Following, indication lamps are provided on both control stands in WDM2 Loco.



**Safety Devices**

- |        |       |        |        |
|--------|-------|--------|--------|
| 1. OPS | 2.LWS | 3.OSTA | 4.SAR  |
| 5. DMR | 6.GR  | 7.WSR  | 8.ETS3 |
9. Circuit breakers

**Safety Fittings**

1. Head light (with proper focus)
2. Flasher light
3. Marker light (with red glass)
4. Rail Guard
5. Cattle Guard
6. Foundation bolts of Buffer.
7. CBC locking pin
8. Horns
9. Wipers

10. Sanders (with pipe fitment)
11. Speedometer (with speed recorder)
12. Equalizing beam tie bolts and its split cutter.
13. Equalizing beam safety bracket.
14. Brake blocks hanger pins and its retaining bolts.
15. 'J' bracket of brake pull rod.
16. Safety chain of brake cross tie bar
17. Axle box stay plate and its bolts.
18. Traction motor gear case foundation bolts
19. Traction motor Gear case 'C' clamp and its flange bolts.
20. Suspension bearing housing bolts.
21. Traction motor nose suspension guide bolts.
22. Bogie safety pin.
23. Hand brake.

### **Oil Checking Points in WDM-2 loco**

1. Fuel oil tank capacity is 5000 liter and both side fuel oil glow rod is provided having marking from 540 to 5000 liter. Average of both side glow rod oil level to be noted, if oil level is less than 540 liter shut down the engine.
2. Each axle having two suspension bearing, each bearing has oil cap and it is to be ensured that oil is available in the cap.
3. Each traction motor gear case having filling cap which should be tied with nut and bolt.
4. Each bogie has two side load bearer with oil cup and it is to be ensured that oil is available in each cup.
5. Each bogie has one center pivot with oil cup and it is to be ensured that oil is available in each cup.
6. Dipstick gauge is provided on engine right side in generator room to check the generator gear case oil level; it should be above minimum mark.
7. EH governor has two spy glasses, bottom one should be full and top one should be more than half. WW governor has glass tube to check oil level it should be above marking provided on the tube.
8. A dipstick gauge is provided to check oil level of engine lube oil sump. It has marking from 0 to 400 liter. To check oil level engine should be on idle and CCM is in running.
9. Spy glass and dipstick gauge are provided in expresser, dipstick having 5 marking oil should be above three marks. Engine should be shut down before checking the oil level while checking with dipstick gauge.
10. Spy glass is provided on air maize oil bath filter having two marking; add and full. Oil level should be above Add mark.

## Lesson no. 36

### WDM<sub>3A</sub> Locomotive

This is mixed service loco made for hauling more load. These are of two types one is rebuilt WDM2 and other is new one. New loco has 14000 series and rebuilt loco has 16, 17, 18 series. In WDM<sub>3A</sub>, 3 stands for 3000 and A for additional 100 HP hence the horse power engine is 3100 HP. It has fuel efficient kit & AC-DC transmission. Equipments of Superstructure are similar to WDG<sub>3A</sub> loco and under truck are similar to WDM<sub>2</sub> loco.

#### General Data

|                                       |                      |
|---------------------------------------|----------------------|
| Engine Horse Power                    | 3100 HP              |
| Loco Horse Power                      | 2900 HP              |
| Maximum Speed                         | 120 Km/h             |
| Weight                                | 112.8T               |
| Axle Load                             | 18.8 T               |
| Tractive effort                       | 30.5T                |
| Brake System                          | IRAB-1               |
| Transition                            | 47.5 Km/h            |
| Generator                             | Only Alternator      |
| Type of Diesel Engine                 | 251B (Up rated)      |
| Engine Idle Speed                     | 400 rpm              |
| Engine Speed on 8 <sup>th</sup> notch | 1050 rpm             |
| OSTA Setting                          | 1180 ± 20 rpm        |
| Power Contactor                       | 9                    |
| Reverser                              | 1                    |
| BKT                                   | 1                    |
| Length of Loco                        | 17120 mm             |
| Locomotive Driving                    | Left Hand/Right Hand |
| Bogie                                 | CO-CO Tri-mount      |
| Traction Motor                        | DC Series Motor      |
| Engine Governor                       | EH / WW/MCBG         |
| Main Crankshaft Overlapping Period    | 140 <sup>0</sup>     |

## Lesson no. 37

### WDS<sub>6</sub> Locomotive

This loco is designed for shunting work hence used on main line for short service. General data of loco is –

| Description                               | WDS6        | WDS6 R     |
|---|-------------|------------|
| 1. Engine horse power                     | 1350HP      | 1400 HP    |
| 2. Loco horse power                       | 1200HP      | 1260HP     |
| 3. Gear ratio                             | 18:65       | 18:74      |
| 4. Maximum speed                          | 62.5 km/h   | 71 km/h    |
| 5. Fuel tank capacity                     | 4100 liter  | 4650 liter |
| 6. No. of engine cylinder                 | 6           |            |
| 7. Lube oil capacity                      | 530         |            |
| 8. Cooling water capacity                 | 555         |            |
| 9. Brake system                           | 28LAV1      |            |
| 10. Height of loco                        | 3975mm      |            |
| 11. Length of loco                        | 16575mm     |            |
| 12. Axle load                             | 21T         |            |
| 13. Weight                                | 126T        |            |
| 14. OSTA setting                          | 1250±10 rpm |            |
| 15. No. of belt in FTTM                   | 4           |            |
| 16. No. of belt in RTTM                   | 4           |            |
| 17. No. of belt in AG                     | 5           |            |
| 18. No. of belt in EG                     | 2           |            |
| 19. Loco driving                          | Right hand  |            |
| 20. No. of TM                             | 6           |            |
| 21. Engine governor                       | WW          |            |
| 22. Firing order                          | 1-4-2-6-3-5 |            |
| 23. Engine speed on idle                  | 400rpm      |            |
| 24. Engine speed on 8 <sup>th</sup> notch | 1100rpm     |            |
| 25. Locomotive series                     | 36---       |            |

## Difference between WDG3A and WDS<sub>6</sub>

| Description                       | WDG3A                         | WDS <sub>6</sub>                    |
|-----------------------------------|-------------------------------|-------------------------------------|
| Service                           | Goods                         | Shunting                            |
| Loco series                       | 13,14                         | 36                                  |
| Loco horse power                  | 2900 HP                       | 1200 /1260 HP                       |
| Engine HP                         | 3100 HP                       | 1350/1400 HP                        |
| No. of cylinder                   | 16 V-shape                    | 6 (Vertical)                        |
| Dynamic brakes                    | Provided                      | Not provided                        |
| Speed                             | 105 km/h                      | 62.5/71 km/h                        |
| BKBL and Grids                    | Nose compartment.             | Not provided                        |
| BKT                               | On control panel              | Not provided                        |
| Engine speed                      | 400 – 1050 rpm                | 400 – 1100                          |
| OSTA setting                      | 1180 ±20 rpm                  | 1250 ±10 rpm                        |
| Governor                          | EH/WW                         | WW                                  |
| Gear ratio                        | 18:74                         | 18:65/18:74                         |
| Transition                        | One (41.5)                    | two (16,26)                         |
| Start and stop button, ECS and BA | On front panel                | On right control stand              |
| AG,EG,FTTM                        | Gear driven                   | Belt driven                         |
| Lube oil filter drum              | Radiator room                 | Engine room                         |
| Lube oil cooler                   | Radiator room                 | Engine room                         |
| OSTA                              | Engine Right side<br>Free end | Engine Left side<br>Free end        |
| RTTM                              | Radiator room                 | Expresser room                      |
| Firing order                      | 1-4-7-6-8-5-2-3<br>R to L     | 1-4-2-6-3-5                         |
| After cooler air                  | Cooling by water              | Cooling by air                      |
| No. of expansion tank             | 2                             | 1                                   |
| Lube oil sump capacity            | 1210 litre                    | 530 litre                           |
| Fuel oil tank capacity            | 6000 litre                    | 4100/4650 litre                     |
| Lube oil dipstick gauge           | 0 – 600                       | 0 – 260                             |
| Cooling water capacity            | 1210 litre                    | 555 litre                           |
| Weight                            | 123T                          | 126T                                |
| Axle load                         | 20.5T                         | 21T                                 |
| Water level gauge                 | On Radiator room<br>wall      | Expresser room<br>engine left side. |

## Lesson no. 38

### Microprocessor Control Loco (MEP-660)

Now days, MEP-660 microprocessor is provided in diesel locomotive and such type of loco are called microprocessor control loco. New 11 series locos WDM3D and retrofitted WDG3A, WDM3A are microprocessor control locos. Their General Data as under -

| Description        | WDM3D              | WDG3A, WDM3A<br>Retrofitted                       |
|--------------------|--------------------|---|
| Engine Horse Power | 3300               | 3100  |
| Loco Horse Power   | 2950               | 2900  |
| Maximum Speed      | 120kmph            | 105/120kmph                                       |
| Weight             | 117T               | 123T/112.8T                                       |
| Axle Load          | 19.5T              | 20.5T/18.8T                                       |
| Tractive effort    | 38.9T              | 37.8T/30.5T                                       |
| Brake System       | IRAB-1/CCB         | IRAB-1/CCB  |
| Transition         | 42, 52 km/h        | 41.5 km/h   |
| Governor           | WW/MCBG            | WW/MCBG   |
| Rectifier          | Alternator mounted | Alternator<br>mounted/self<br>cooled/conventional |

#### Advantages of Microprocessor Control Loco

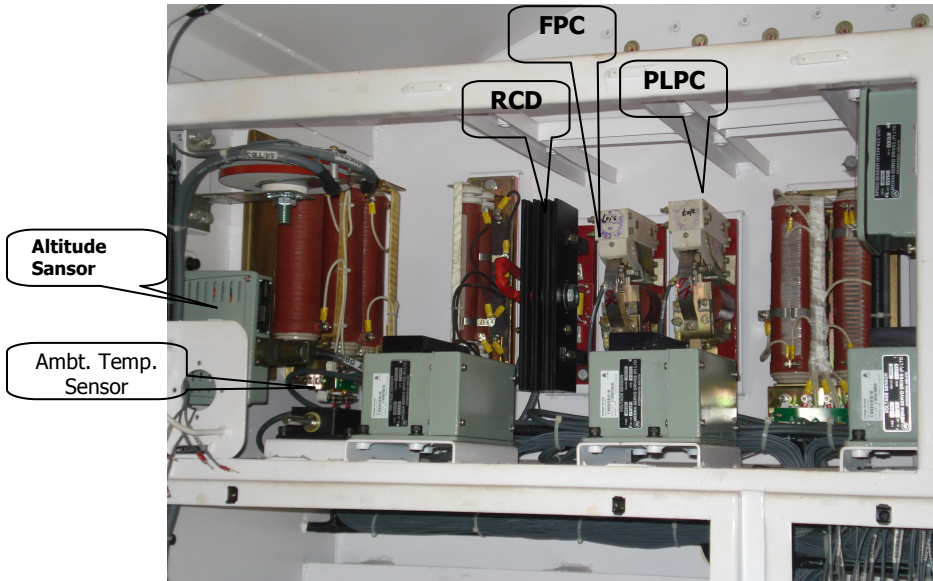
1. All Breakers and switches are similar to WDG3A except additional circuit breaker MPCB and PLPB for easy handling to LP
2. Very low intervention by the LP during faults trouble shooting activities by LP is simplified.
3. No reset of GR1, GR2 and GFOLR because sensors are provided for the same.
4. Pre and post lubrication feature is available.
5. Possibility of load stalling is very less.
6. Cold engine feature is provided.
7. No need to maintain the timings specified in load meter since MEP660 automatically reduces the excitation.
8. No need to regulate the Dynamic brake at high speed since MEP660 automatically reduces the excitation.
9. No slackness of cards on run.
10. Automatic isolation of TM at the time of short/open circuit.
11. More than one TM can be isolated.
12. Automatic reduction of transition speed in case of TM isolation.
13. Detailed audio video fault indications.
14. In case of locked axle system indicate clearly which wheel is locked.

## **Changes in Microprocessor Control over convention WDG3A loco**

1. All Breakers and switches are similar to WDG3A except additional circuit breaker MPCB and PLPB are providing on front panel. While engine starting both breakers should be in ON position
2. The pre-lubrication pump is provided in compressor room; it is use for pre-lubrication of engine before starting.
3. Following equipments are removed in this loco -ECP, VRP, TRP, BSR, TDR, BKR, CVR, TR, VRCLS, OVDR, LAS, TET, GR1, GR2, GFOLR, WSR1, 2, 3, Techo generator, axle generator, Excitation panel.
4. Following new equipments are provided in this loco – MEP-660 microprocessor control unit, display unit, distribution box (RDB & ADB1, 2,3,4), sensors (14current, 5voltage, 3temp, 7speed, 7pressure), TE limit switch, multi reset VCD.
5. Following Relays are provided in this loco – Out of 23 relays 13 relays are eliminated &10 relays retained. DMR, SANDER, VCDR, CMR, SLBR, SR, AGPR, EXPR MVR, AFLR. (FSR in WDM3D only)

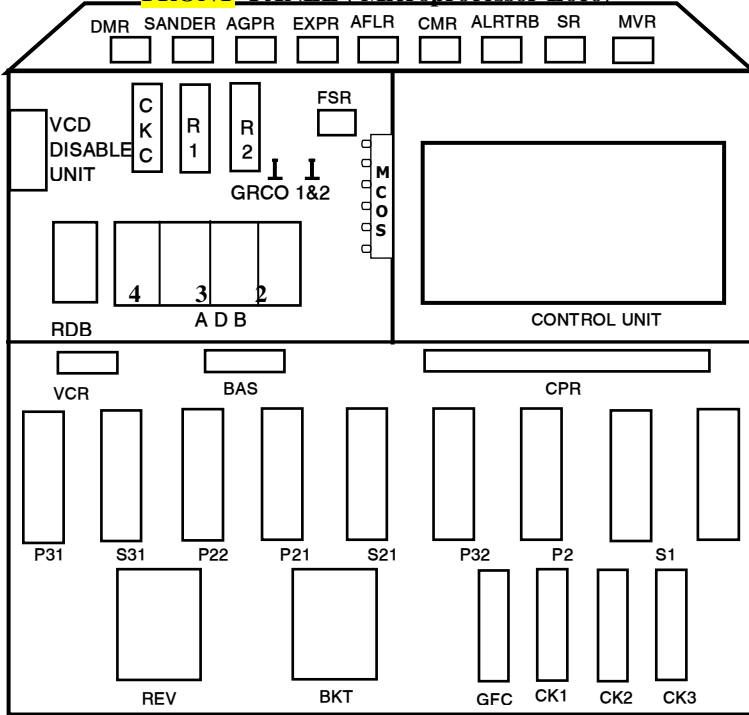


## Back Panel

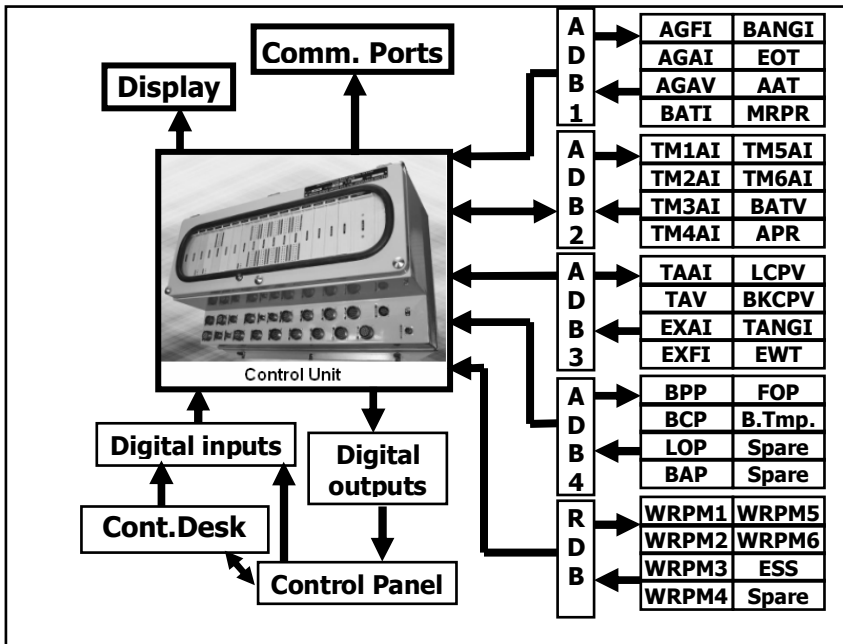


1. DMR- Dead Man Relay. Same as conventional Loco
2. SR- Signal Relay. Same as conventional Loco.
3. MVR- Moisture Vent Relay. Or Magnet Valve relay. Same as Conventional Loco.
4. AGPR- Aux. Gen. Protection Relay. This relay is always be ON when the engine is running. The relay is OFF during cranking.
5. EXPR- Exciter protection relay. This relay is always ON when the engine is running. The relay is OFF during cranking..
6. CMR- Compressor Relay. This relay is ON when the MR pressure is more than 10 Kg./cm<sup>2</sup> . The relay is OFF when the pressure is less than 8 Kg./cm<sup>2</sup>.
7. VCDR- Vigilance control device relay. This relay is normally in ON position. During penalty brake application, this relay is OFF.
8. AFLR- Auto flasher Light relay. This relay is normally ON while running. During un-authorized BP reduction, this relay is OFF and flasher lights are switched ON.
9. SLBR- Self load box relay. This Relay This relay is ON when self load box test is selected from display unit.
10. SANDR-During wheel slip, after 15% power reduction, the sander relay is ON Wheel slip indication is ON to the driver. Automatic sanding is done.
11. FSR- Field shunting Relay. This relay is available in WDM3D Locos only. OFF.

## FRONT PANEL ( Microprocessor Loco )



## Inter connections of MEP-660 sub assemblies



### Engine starting procedure:

Before engine starting check the locomotive (safety fittings, oiling points, water level, etc.) and ensure wooden wedge & hand brake in applied condition. Then start the Diesel engine by following sequence -

1. Put ON Dome light breaker and Dome light switch.
2. Indication - Dome light will glow.
3. Close the BS in Nose room.
4. Ensure MUSD1&2 on RUN and ECS on Idle.
5. Put ON MB1& MB2 on front panel.
6. Put ON MFPB1&2 on control stand.
7. Put ON CEB, DEB, RBB on front panel.
8. Put ON FPB on front panel.
9. Put ON MCB1&2.
10. Press the alarm push button three times on front panel for ringing bell. Then put OFF MCB1&2.
11. Put ON MPCB and PLPB and wait till Idle Screen display on Display Unit

12. Press and hold the Start Button, pre-lubrication is starts. After 60 seconds cranking contactor will pick up and engine will crank. When lube oil pressure builds up to 1.3 kg/cm<sup>2</sup>, then release start button.

13. Put ON AGFB on front panel

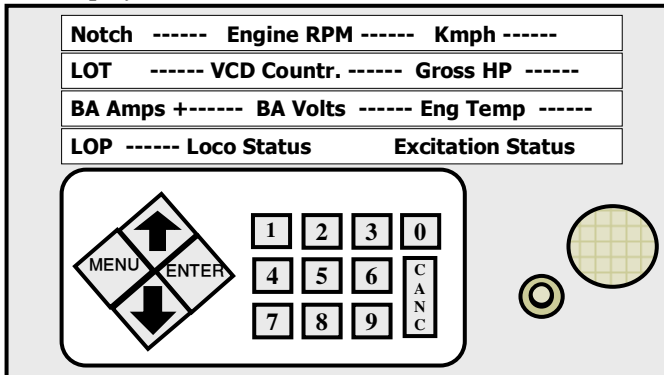
**Engine stopping procedure-**

1. Secure the Loco.
2. Keep MH handle on Idle and reverser handle in neutral.
3. Keep ECS on Idle position.
4. Ensure that all CB are ON.
5. Press stop button, till main crank shaft will stop.
6. “Post lubrication in progress keeps all circuit breaker ON” message will display on display screen for 5 minutes.
7. After completion of post lubrication put all circuit breakers ‘OFF’
8. Put BS in ‘OFF’

**Display Unit**

It is provided on front panel. When MB1, MB2, MPCB kept ON during engine starting it shows idle parameter of loco. Further it changes according to the loco pilot operation i.e. motoring display, braking display. It also shows fault messages when fault comes on loco.

*Display Unit version 2 (Idle Parameters)*



## **Procedure of Fault Resetting**

Maximum faults are reset automatically after fault recovery, some faults are recovered after keeping throttle on idle and other require acknowledging but some required to reset manually.

## **Procedure of Manual Reset of Faults**

1. Following modes will display on display unit after pressing MENU button -
  1. *Faults*
  2. *Display Mode*
  3. *Test Mode*
  4. *Exit*
2. Then pressing no.1 key on key pad following be display -
  - 1) *View active faults*
  - 2) *Clear active faults*

On pressing no. 2 key on key pad fault information will display, on pressing no.0 key on key pad followed by Enter button, fault will reset and next fault will display in this way clear all faults by pressing 0 and Enter key till message will appear *No more fault, press menu button to exit.*

## **Transition**

Two transitions are provided in WDM3D loco, 1st transition takes place on 42 km/h from series parallel to series parallel field shunt and 2<sup>nd</sup> transition on 52 km/h from series parallel field shunt to parallel combination. In retrofitted loco only one transition takes place at 41.5kmph from series parallel to parallel combination.

## **Motor Cut out Switch (MCOS)**

Six toggle switches are provided in front panel to isolate individual TM. For isolation of TM related toggle switch to be made off. With the help of these switches more than one TM can be isolated. Auto transitions also come even though TM isolated. Loco power and auto transition speed setting is reduced proportionate to no. of TM isolate and transition will take place on lower speed.

## **Vigilance control device (VCD)**

VCD alerter is provided on loco to alert loco pilot in every 60 sec, if loco pilot is not alert penalty brakes were applied through VCD. VCD alerter will work if BC pressure is less than 2.0kg/cm<sup>2</sup> and MB1, MB2, MPCB, MFPB1&2, MCB1&2 should be in ON position. VCD can be made inactive by loco pilot if one of the activities is carried out with in 60 sec -

1. Changing the position of throttle

2. Changing the position of A9
3. Application/releasing of dynamic brake
4. Change of DB level.
5. Operation of GFCO
6. Operation of sander switch
7. Pressing of horn switch
8. Changing the position of RH
9. Pressing of VCD reset button

From the above if none of activity is carried out by loco pilot with in 60 sec, VCD lamp will glow and made loco pilot alert for 08 sec. If one of the activities from above is carried out by loco pilot, VCD will reset.

If none of activity is carried out by loco pilot after VCD lamp glowing with in 8 sec then VCD buzzer will sound along with the lamp for next 8 sec and message will be display VCD time out press VCD reset on display unit. In this way 76 sec ( 60+8+8) is given to loco pilot to reset VCD, if he fails to reset, penalty brakes will applied with following changes on loco -

1. BP pressure will drop up to 2.8 kg/cm<sup>2</sup>.
2. Buzzer stops sounding.
3. Engine speed comes to idle.
4. GFC contactor will drop and power contactor will also drop on bring throttle on idle and
5. Message will display VCD applied penalty brakes, press reset button to reset penalty brake.
6. VCD counter on display unit increase by one.

### **Procedure of Resetting VCD (Penalty Brake)**

1. Keep throttle handle on idle
2. Loco should be stand still
3. Wait till VCD lamp is extinguished.
4. Press VCD reset button

Note-

1. MCB1&2 to be kept off before starting the engine otherwise VCD will operate.
2. On hault BC pressure should be more than 2.0 kg/cm<sup>2</sup> to inactive the VCD in standing position of loco.
3. In trailing loco of multiple unit MCB1&2 should be kept in ON position otherwise VCD will operate but penalty brake will not come and throttle will not respond in trailing loco

### Display messages

| <b>Messages</b>   | <b>Trouble</b>                            | <b>Remedies</b>  |
|---|---|--|
| 2022-switch ON<br><i>CEB Breaker</i>                    | CEB tripped                               | Reset CEB & ensure working of CCM otherwise engine will stop after 30 minute.  |
| 1005-LLOB trip<br><i>reset plunger</i>                  | Plunger of WW governor projected          | Reset shut down plunger and start the engine after 20 sec.   |
| 2008-Warning<br><i>engine temp high reduce power</i>    | Water temp is more than 90 <sup>0</sup> C | Do not reduced the notches, on each degree 20% power will reduce automatically   |
| 1006- Hot engine<br><i>can't power up</i>               | Water temp becomes 95 <sup>0</sup> C      | Keep throttle on idle, press acknowledge button, apply train brake and wait till water temp becomes 90 <sup>0</sup> C                          |
| 1007-Power<br><i>circuit ground</i>                     | Power ground                              | Keep throttle on idle Check power circuit and open the notch after 15 sec. in similar way fault can be reset, three times in an hour.          |
| <i>Sander relay operated –auto sanding is applied</i>   | Experience wheel slip                     | Do not reduced the notches, 15% power will reduced automatically   |
| 2582-High Wheel<br><i>Slip Is Occurred</i>              | 40% power is reduced                      | Do not reduced the notches and work further, ensure sanders are working  |
| 1027-Alternator<br><i>Field Over Current</i>            | Excitation current of alternator is more  | Keep throttle on idle; open the throttle after 15 sec. in similar way fault can be reset three times in an hour. TA power circuit to be check. |
| 2000- No battery<br><i>charging due to major faults</i> | Battery discharging                       | Check AGFB and MB1,remove the fault as per instructions of display.  |
| 1061- battery<br><i>voltage low</i>                     | Battery voltage is less than 60V          | As above   |
| 1029- cranking<br><i>contactor stuck closed</i>         | CK1/CK2/CK3 welded                        | Remove welding   |
| 1155-DEB engine<br><i>breaker OFF</i>                   | DEB engine circuit breaker tripped        | Reset circuit breaker and check cyclonic motor near wheel no.3   |



|                               |                                      |  |
|-------------------------------|--------------------------------------|--|
| 1156-DEB car body breaker OFF | DEB car body circuit breaker tripped | Reset circuit breaker and check cyclonic motor near wheel no.6 |
| 1021- Rectifier Blower Failed | RBB circuit breaker tripped          | Reset circuit breaker and check rectifier blower motor         |

**Power Ground :-**

TANGI detected power circuit is grounded. Massage on Display Unit

**“1007 - Power Circuit Ground. Restrictions: Motoring Prohibited. Dynamic Brake Prohibited. Engine IDLE”**

With continuous alarm bell till throttle is brought to IDLE. Power is cut off. Engine RPM is brought to IDLE. Power contactors and GF are dropped out.

Action taken by loco pilot-

Bring the throttle to IDLE and wait for 15 Sec. The fault is cleared automatically. Perform the checks as per the conventional WDG3a loco.

Power circuit ground fault recovered for 5 seconds. If the fault is remain existing. The fault is logged again. Auto reset is permitted up to 3 times within 1 hour. There after manual reset has to be done.

If the fault is occurred more than 3 times contact shed for further advice. Do not forget to write in the repair book.

**Over Load Fault:-** Tr. Alternator Field current is more than 280 Amps. Massage on Display Unit- *1027-Alternator Field over current FAULT. Restrictions: motoring prohibited dynamic brake prohibited”*

With Alarm bell switched on for 30 seconds.

Action by Loco Pilot:-

Bring throttle to IDLE. The fault is reset automatically. Reset message is displayed. Trouble shoots as per GFOLR trip in normal WDG3A locomotives. Alternator field over current is reset for 5 seconds.

If the fault is existing, the fault is logged again. Auto reset is permitted up to 3 times within 1 hour. There after manual reset has to be done.

If the fault is occurred more than 3 times contact shed for further advice. Do not forget to write in the repair book.

## Hot Engine Alarm Fault:-

1. When water temperature raises up to 90° C.

Message on Display Unit -

*2008 - Warning: ENGINE Temperature High. Reduce Power” for 5 seconds.*

Alarm bell is switched ON continuously till temperature is less than 85° C.

Action by Loco Pilot:- If possible do fast pumping manually.

Otherwise

Power is de-rated by 20% per every degree of temperature raise from 90°C onwards.

91°C- 20% power de-rated

92°C- 40% power de-rated

93°C- 60% power de-rated

94°C- 80% power de-rated

Driver can work with reduced power up to 95°C.

2. When water temperature is more than 95° C

Message on Display Unit - *“1006 - HOT ENGINE. Can’t Power UP. Restrictions: Motoring Prohibited Dynamic Brake Prohibited”*

Along with buzzer continuously in addition to alarm bell.

GF and power contactors are dropped out. Engine RPM is automatically raised to 8th notch irrespective of notch position.

If reset button is pressed or after 30 seconds

*“2026 - HOT ENGINE. Can’t Power UP*

*Restrictions: Engine is running at 8th notch. Motoring Prohibited. Dynamic Brake Prohibited. “Along with buzzer.*

Action Taken by Loco Pilot:- Apply train brakes. Wait till the water temperature is reduced below 90°C. Bring the master handle to IDLE. Engine speed reduces to IDLE automatically. Buzzer and message stops.

## Auxiliary Power Unit

### Procedure of Loco Handling and Its Precaution

1. Loco starting and braking system is similar to WDG3A (conventional).
2. Whenever needle of load meter showing restricted zone, do not ease the throttle, microprocessor will reduce power automatically.
3. When ever loco direction is require to change, loco should be stand still. When loco is running and reverse handle is operated, reverser will not change its position.
4. Do not ease the throttle when wheel slip occurs, microprocessor will reduce power automatically. Trouble shooting is similar as WDG3A (conventional). If trouble is because of drizzling /oily track /wet track than reduce the notch as per requirement.
5. When water temp become  $90^{\circ}\text{C}$ , hot engine indication will come, do not reduce the notch, microprocessor will reduce power automatically (20% power will reduce automatically on each degree of rising water temp above  $90^{\circ}\text{C}$ ) when water temp become  $95^{\circ}\text{C}$ , GFC and power contactor will drop automatically and loco power becomes zero, due to this load can be stall, apply train brake to avoid roll down. In this situation engine will race on 8<sup>th</sup> notch automatically for cooling the water, keep TH on idle and acknowledge the fault on display unit, wait till the engine speed comes on idle.
6. Whenever power ground or field over load occur, keep throttle on idle fault will reset automatically , if fault occurs three time in a hour reset it similarly. If fault occurs fourth time inform PCOR and reset it manually, trouble shooting is the same as WDG3A.
7. When there is trouble while train starting, ensure position of TE limit switch it should be in normal position otherwise tractive effort will be limited.
8. The loco which is provided with 'cold engine speed limit feature' is provided in that loco whenever lube oil temp less than  $60^{\circ}\text{C}$  engine speed will not increase.

## **Additional features of Ver. 3.0**

### **Power Setter:**

Power setter is a feature to bring the rear locos to IDLE without going to rear locos and removing the MU cables.

Power Setter Enable Switch is provided like TE Limit Switch. Normally this switch is in 'Disable' position. When the driver wants single loco power, he will simply keep this switch in 'Enable' position. Keeping this switch in 'Enable' position, Train Line Wire TL1 is energized in all the locos. So all the Rear locos work in IDLE, where as lead loco work as per notch position. The driver can work in higher notches and get fuel efficiency. While this switch is in 'Enable' position, 'Power Setter Enabled' message is displayed once in every 5 minutes. However Dynamic brake works normally in all locos and gets full control.

When driver wants both the locos power, he simply keeps this switch in 'Disable' Position. All the locos work normally.

### **Extended Dynamic Braking feature:**

The maximum Dynamic Braking effort in Alco locomotives is in between 30 to 60 Km/h only.

Below 30 KMPH, the braking effort reduces since the grid current reduces due to TM armatures speed drops down.

In some steep gradient sections, the maximum speed is only 30KMPH. So these locos does not provide effective dynamic brake and pneumatic brakes have to be used to control the loco speed.

To achieve higher braking effort in lower speeds this feature is implemented in ALCO locomotives.

At 21.5 Kmph (User settable) MEP energize Extended Dynamic Brake Relay (EDBR) to provide supply to 6 EDBC contactors. These pneumatic contactors are connected across certain portion of the grid resistors. Energizing these 6 contactors, the effective grid resistance will reduce. As the resistance is smaller, the grid current increases and results in higher braking effort at low speeds. To achieve single stage braking effort, 6 PCs has to be provided in the locomotive.

### **Rectifier fuse blown protection:**

In power rectifiers, fuses are provided in series with each diode.

In case of any diode short circuited, this fuse will blowout and the diode is isolated from the circuit.

This fuse is a special type of fuse, having a micro switch.

The micro switch is operated through a lever when ever the fuse is blown out. In Ver.2, the fuse blown status is not monitored by MEP.

Only LED indication is given to driver. In Ver 3.0, one digital input is allotted for rectifier fuse blown protection and is connected to wire No. 111 in rectifier panel.

When this input is HIGH, the system declare a fault message “1066 – Rectifier fuse blown, Restrictions: power limited to 4th notch”.

Along with the message engine rpm and power both will be restricted to 4th notch. Whenever wire no. 111 is low, system will declare “1661- Rectifier fuse OK now”.

After fault recovery, engine rpm and power will raise as per notch position.

### **Power de-ration during power ground:**

In Ver.2 when the TANGI value is more than 0.4 Amps, MEP declares fault message ‘Power Circuit Ground fault’

In Ver. 3 the notch power is de-rated if TANGI current is more than 0.4 Amps and still permit the loco to work with de-rated power.

This feature is very useful to avoid online failures and to protect power circuit from further damages. For every 0.1 Amp increment above 0.4 Amps of TANGI current, 20% of that notch power is de-rated.

The display shows a message “2021 – Power reduce due to power circuit ground”. The de-ration continues up to TANGI value reaches 0.9 Amps (user settable) and thereafter system declares a message “1007 - Power circuit ground fault” along with engine Idling and Power cut off.

### **Integrated Speedometer:**

In Ver 3.0 system, no need of external stand alone speed recorder.

MEP 660 system will generate an analog output signal based on the calculated speed from TM RPMs. The same signal will be fed to external analog meter to indicate the locomotive speed. Even 3 TM speed sensors are declared faulty, the speedometer indicates the loco speed without any trouble.

### **Protection against water pump failures:**

In case of water pump failed, at present in Ver.2, there is no direct detection. Even though indirectly can be identified, there is no protection except power reduction. In Ver.03, water pressure sensor is provided to measure the outlet pressure of water pump. MEP-660 continuously monitors this water pump pressure along with LWS input and accordingly restrictions are implemented.

1. If the Water pressure is less than 0.4 Kg/cm<sup>2</sup>, LWS input status is High and notch is  $\geq 3$ , fault message ‘Water pump not developing Pressure’ is logged.

2. If the water pressure is less than 0.4 Kg/cm<sup>2</sup>, LWS input status is low 'Low water level. Restrictions: Engine shut down'
3. If LWS input status is LOW and water pressure is > 0.6 Kg/cm<sup>2</sup> then 'Low water switch defective' fault message is logged.

### **Interface with Computer Control Braking (CCB):**

Alco locomotives are so far equipped with IRAB brake system which is analog type pneumatic control. Computerized Control Brake system is a new brake system supplied by M/S Knorr Bremes in GM locomotives.

Lot of fail safe features are available with CCB and Railway wants to adopt the same brake system in Alco locomotives. With adoption of CCB in Alco locomotives, the following brake related equipments are removed.

Complete Brake panel is replaced with CCB.

AFL P1 | Eq.Pressure signal from CCB

AFL P2 | BP pressure signal from CCB

When ever Emergency Brake signal is received from CCB or based on EP & BP pressures, Auto flasher lights are switched ON.

BP, BCP pressure sensors. Signals are taken from CCB.

BKIV valve, Foot pedal Switch. PATB. VCD Valve – Penalty brake signal is communicated to CCB

CCB is connected to the MEP system via RS 485 communication.

If any fault in CCB, the same will be indicated in MEP 660 Display unit and it will apply brakes.

In MEP system, only fault message will appear but there is no controlling in CCB related issues.

CCB provides potential free contacts PCR which is equivalent to PCS. When ever CCB requires power cut off, these contacts are operated.

When ever MEP wants brake application, the brake signal is communicated to CCB and the brakes are applied by CCB.

### **Blended Braking system**

So far with IRAB-I brake system on Alco locomotives there is no provision to use both dynamic brake and pneumatic brakes simultaneously.

With computerized brake system it is possible to use combination of pneumatic brake and dynamic brake. Pneumatic brakes is substituted to the extend possible by dynamic brake to reduce wheel wear and cool running of wheels. In CCB fitted locomotives, Blended Brake switch is provided to enable / disable this feature by driver. Blended brake is possible only on lead locomotives. CCB does not permit Blended brake on Trail locomotives.

CCB disable the blended brake active bit under the following:  
CCB is set as trail loco.  
Emergency brake is initiated.  
Dynamic brake is activated by driver.  
Bail-Off request by driver.

### **Intelligent Low IDLE feature**

The diesel Engine runs @ 400 RPM in IDLE and the fuel consumption is proportional to its RPM. Many times locos will be waiting for signal in station yards and they will be running in IDLE for longer periods. If the diesel engine is made to run at lower RPM under such long periods of waiting, lot of fuel saving can be achieved. Low IDLE feature is provided in Ver.2 to reduce the engine RPM to 350. If the engine runs in IDLE mode for more than 10 minutes, and in MEP LOW IDLE Flag is enabled, MEP energizes AV and DV digital outputs. If the Governor supports this combination, the Governor brings the engine RPM to 350.

However lube oil pressure is proportional to engine RPM and in some locos, diesel engine is getting shut down due to low lube oil pressure. To avoid unnecessary line failures, the end user fear to use this feature. To overcome this unwanted engine shut down and still get fuel economy Intelligent Low Idle Feature has been introduced. In this feature

When Engine is running in IDLE for more than 5 minutes, Low IDLE flag is enabled and Lube Oil Pressure is more than 1.7 Kg/cm<sup>2</sup> (User settable Parameter), then only MEP goes into Low IDLE mode. MEP energises AV and DV digital outputs and MCBG brings the engine rpm to 350 rpm (User settable). During Low IDLE mode operation, if Lube Oil Pressure is less than 1.2 Kg/cm<sup>2</sup> (User settable), MEP automatically revert back to IDLE mode. MEP de-energises AV and DV digital output and MCBG brings back engine RPM to 400 and the lube oil pressure increases.

LOW IDLE mode is linked to lube oil pressure value, engine does not shut down due to low lube oil pressure. So End user need not fear for unnecessary shutdown while working in low IDLE mode. There is sure of fuel savings with this feature.

## **Fire Alerter System:**

In MEP-Ver.2 also this fire alerter system is available. Due to lack of digital inputs, single input has been connected to MEP. No identification weather the fire is in lead loco or trail loco.

In Ver. 3, for Fire Alert system two digital inputs are allotted to identify weather it is trail or lead loco.

The fire alerter provides two potential free contacts which energizes digital inputs FAS FB and TL 11 (MU wire).

If both FAS FB and TL 11 are high, system display a message “1073 - Fire occurred in loco. Check for fire and extinguish fire. Restrictions: Engine Shutdown”.

Along with message, power is cut off, engine is shut down and VCDR relay is switched OFF to apply brakes.

If TL 11 alone is high display shows the message “2031 - Fire alarm occurred. Check loco thoroughly and reset fault. Restrictions: Cranking prohibited”.

Along with message, power is cut off, engine is shut down. Brake valve gets supply through TL20 wire.

## **Pre / Post Lubrication feature:**

### **1. Pre Lubrication:**

Both the features are implemented in MEP-660 Ver.2 itself. With field experience, slight logics are changed in Ver.3

Pre Lubrication is avoided if the engine is re-cranked with in 30 minutes from the last shut down time. This is because, sufficient lubrication film will available with in 30 minutes. If 30 minutes is lapsed, engine cranks after pre lubrication. In case of any cranking restrictions, the same is displayed before starting pre-lubrication. A count down timer is shown on the display unit, to indicate the time left for cranking. After completion of pre lubrication, display shows “Pre lubrication completed and engine is ready for cranking”. Engine cranks normally.

### **2. Post Lubrication**

In MEP Ver.2 the Post lubrication is carried out only when the engine shut down through STOP push button.

Where as in MEP Ver.3, post lubrication is carried out for any type of engine shutdown. Post lubrication is for 5 minutes (user settable).

During Post lubrication, display will shows a message “Post lubrication ON. Keep breakers ON”.



## **TM cut out / cut in through Display**

In Ver. 2, MCOS switches are available to isolate a defective traction motor. In Ver. 3, MCOS switches are not available, the same function can execute through Display unit.

Main Menu

4 TM cut out

TM status screen is displayed.

Change / F3 TM1 is highlighted. Use arrow keys to select TM

Cut out / F3 to change the status.

## **Loco operation soft keys**

some digital input channel failure is causing a line failure of the locomotive. There is no fault tolerance for these digital input channel failures in Ver.2. In order to avoid On-line failures due to some digital input channel failure and clearly identify that the problem is with hardware, self check routine for digital input channels is provided in MEP-660 Ver.3. MEPMCC card checks the health status of these channels at regular intervals. Loco operation soft keys:

If any channel is found defective: system logs a fault that particular digital input is defective. If alternate logic is available, the system allows normal operation of loco. Where alternate logic is not available, system permits loco with some restrictions. Where user selection is essential for that input, soft keys are provided through display to toggle the status of that input in the software.

The following are the digital input channels where soft keys are provided:

START, STOP, ECS, VCD Reset, AFL Reset, TE Limit SW.

Display shows the soft key screen automatically.

## Lesson no. 39

### Speedo Meter

It is also called as speed, time, and distance recorder. It is an important safety fitting. Its importance is as following –

1. Due to use of computer, authenticity of speed and distance graph is increased.
2. It can also sense accurate speed below 1 km/h.
3. The watch fitted in it, is battery operated and it can work up to 2 years without fail.
4. It is more reliable and requires less maintenance due to use of computer and stepper motor.
5. It gives audio - visual indication on over speeding.
6. Auto electronic speed signal generator (pulse generator) is provided to sense speed.
7. Its design is such as that it co-ordinate with wheel dia.

#### **In This System following equipments are fitted -**

1. **Speed Sensor-** It is also called pulse generator. It consists of an optical beam and its moment is restricted by a disk having holes. The Generator gives pulse output on each obstruction. The light rays are obstructed by rotating shaft in speed sensor due to which input gets. For this two sensor outputs are there which are follows each other 90 degree apart. Speed and direction is obtained on normal logical power.
2. **Power supply unit** – This unit gets input from battery. It gives supply to computer and DC stepper motor.
3. **Record unit-** Two independent micro computers are provided in it to calculate speed, time and distance covered. DC stepper motor deviate the needle. The graph is prepared on paper of 120 mm width out of which 40 mm having indicator lines of 10 km/h interval and it records speed. Other lines on 20 mm indicate 1 minute interval and this part is called speed calculator, it has battery backup.
4. **Speed Indicator** – Its dial is of 270 degree and divided into 5.0 km/h intervals. Speed is analyzed by computer and controls stepper motor accordingly and the motor deviates needle on the dial. To indicate cumulative distance traveled is also indicated for this electrical auto meter is fitted which is controlled by computer.
5. To indicate over speeding audio visual indicator is provided it has LED which flickers and siren sound.
6. **SP 90 S Speed Indicator** - Speed per second is recorded by it. It has a key board like a computer which having various keys. With the help of keys following information is entered by crew –

**a. I.D. no. of loco pilot –**

- i. Press driver **ID** button
- ii. **ID** of previous driver will display.
- iii. Enter new driver **ID** no. with the help of 0-9 number keys.
- iv. Again press driver **ID** button due to which new number is saved.

**b. Train number** -While taking over charge of train it is to be entered

- i. Press **train number** button.
- ii. Previous **train number** will display.
- iii. Enter new train no. with the help of 0 - 9 number keys.
- iv. Again press **train number** button due to which new number is saved.

**c. Time And Date -**

- i. Press set time button.
- ii. Hours is indicated, adjust it. Save it by pressing **EXEC** button.
- iii. Minute is indicated, adjust it. Save it by pressing **EXEC** button.
- iv. Date/ month/ year is displayed, adjust it. Save it by pressing **EXEC** button.
- v. To check date, press no. **1** key.
- vi. To close display press **0** key and use any key to start it.

Note- while entering data it is to be ensured that loco is stand still other wise normal function of system is to be hampered.

Conventional RT9 recorder has two keys. The right side key is for time setting and left side key is winding key. It is to be ensured that the key is winded while taking over charge. To wind it pull out and rotate anticlockwise and press there after.

To adjust time pull out time setting key and rotate anticlockwise to set correct time then press it there after. While adjusting time note blue /white disk. White colour is displayed between 0-12 O'clock and blue colour between 12-0 o'clock.

## **Lesson no. 40**

### **Horn Failure**

1. If horn is failed at originating station than the loco to be declare failed and other loco is to be arranged.
2. If horn is failed in enroute than inform to station master at first opportunity. The station master will arrange other loco with consult of PCOR. If loco is not available and permitted to work with same loco than train should be worked with speed restriction of 25 Kmph if visibility is clear otherwise 8 Kmph.

### **Cattle Run Over**

If train is running with high speed and Loco pilot sights cattle on the track than he should reduce speed. If cattle is run over than train should stopped and following action is to be taken -

1. Put on flasher light.
2. If track is obstructed than clear it with the help of railway man or volunteers.
3. If other line is obstructed than protect and clear it.
4. Check the loco.
5. If not able to clear the track than give memo to Station master/ Cabin master without clearing block section.
6. Note the event in repair book and inform PCOR.

## Lesson no. 41

### Maintenance Schedules of Diesel Loco

It is necessary to maintain a machine in time for obtaining satisfactory service. Maintenance schedules are of two types.

#### 1. Preventive Maintenance

#### 2. Break down Maintenance

Preventive Maintenance is carried out to avoid Loco failure or break down but Break down Maintenance is done after failure/ break down and it is depend on specific equipment failure. There is heavy loss of time on break down failure.

Schedule of Preventive Maintenance is depending on service and uses of specific equipment. The planning of schedule is done on practical experience and safety of equipment.

**Maintenance schedule of Diesel Loco is as following-**

| Type | Period   | Time       | Shed           |
|------|----------|------------|----------------|
| T-1  | 15 Days  | 4-6 hrs.   | At any shed    |
| T-2  | 30 Days  | 10-12 hrs. | At any shed    |
| M-2  | 60 Days  | 24-30 hrs. | Only home shed |
| M-4  | 120 Days | 4 Days     | Only home shed |
| M-12 | 1 year   | 10 Days    | Only home shed |
| M-24 | 2 years  | 12 Days    | Only home shed |
| M-48 | 4 years  | 14 Days    | Only home shed |
| POH  | 8 years  | 30 Days    | POH workshop   |

## Lesson no. 42

### Train Dynamics

Knowledge of different forces which were developed on loco and load during train working and train handling is called train dynamics.

Importance-

- It reduce train parting cases
- It reduce train stalling cases
- It reduce wear tear of mechanical parts
- Fuel oil saving

#### **Definition –**

**Tractive effort** - The rotating force developed on wheel of loco motive which tends to pull the load. Tractive effort is different for different locomotives.

**Adhesion** - That grip which the wheels have on the rail dependent upon weight, track condition and weather conditions.

**Draft Force** - Force required for pulling other attached coupler / wagon is called draft force. Pulling of the other wagon starts only after complete extension of the couplers attached together.

**Buff Force** - Force required for pushing other attached coupler / wagon is called buff force. Pushing of the other wagon starts only after complete compression of couplers attached together.

**Slack** - Slack movement is the free play in the draw gear and in some draft gear.

There are two kinds of slacks -

1. **Free Slack** - Free slack is the clearance with in the draw gear which can run-in or run-out without compressing the draft gear. Free slack can be as high as one inch between two couplings of the vehicle.
2. **Spring Slack** - spring slack is the additional amount of movement that can occur after the free slack movement is finished and when draft gear is compressed and which then rebounds and drives all slack in opposite direction. Spring slack for conventional draft gear can amount to approximately 5 inches per vehicle when fully compressed.

**Run-In** - It occurs when a rear portion of a train is traveling faster than a forward portion of a train. Run-in may be a combination of slack movement and spring slack dependent upon the forces generated.







**Run-Out** - When a rear portion of a train is traveling slower than a forward portion of a train. Run-out may also be a combination of slack movement and spring slack dependent upon the forces generate

**Coupler Breakages** - The coupler fatigue depends on how many times it has undergone stress & strain during the train travel. The frequent run-in & run-out of wagons (coupler compressions & extensions) with heavy slack speeds increases the coupler fatigue. Thus it is evident that controlled run-in / run-out / slack movement can reduce coupler fatigue.

**Jerk** - It can be felt when sudden changes on coupler force takes place either from Draft force to Buff force or Buff force to Draft force.

**Lurch** - It can be felt when sudden changes in track gradient from level to down & then up (due to track defect).

### Different gradients

|  |  |
|--|--|
| <b>Level</b><br>              | Section of track having no any up & down gradients.  |
| <b>Camel hump / knoll</b><br> | A hump is a rapid increase in grade followed by a decrease in grad.  |
| <b>Sag or Dip</b><br>         | A sag or dip is a rapid decrease in grade followed by an increase in grade.  |
| <b>Undulating</b><br>         | A section of track which changes grade so often that an average train passing over the track has some wagons on three or more alternating ascending and descending grades. |
| <b>Descending</b><br>         | A section of track is having continuous down gradient.   |
| <b>Ascending</b><br>        | A section of track is having continuous up gradient.   |

**Train Parting** - Train parting is a common unusual occurrence affecting the train movement. There are number of contributing factors towards train parting such as poor driving technique, inadequate maintenance, material failure, improper marshalling, loco troubles, etc.

### Reason of Train Parting

1. If the Tractive force exceeds the tensile strength of the coupling system.
2. If any coupling gets opened or works out.
3. If any coupling gets uncouple due to excessive buffer height/ difference in rail level.

Out of the above 3 situation the first one is related to wrong driving technique adopted by loco pilots, provided there is no material failure.

### **Reason of Tractive Effort Exceeds the Tensile Strength**

1. Due to sudden notching up.
2. Sudden application of brakes from rear.
3. Notching up with out proper recreation of vacuum/ air.

### **Procedure of opening the throttle**

1. Advance the throttle with pause of 10 sec
2. Keep watch on load meter
3. Advance the throttle after observing the load meter, its needle should be stable

Note- With the above sudden increase of tensile force can be avoid and also possibility of load parting.

### **Jerk - Following reasons are for sudden increasing/decreasing of Tractive force**

1. Poor driving technique
2. Loco failure like power ground, wheel slip, sudden stopping of engine etc.
3. Brake application from rear

### **Reason of jerks developed by loco pilot**

1. Sudden notching
2. Sudden braking
3. Sudden power cut off

### **Procedure of avoiding the jerk at the time of train starting**

1. All coupling should be intact properly
2. Ensure adequate amount of BP/Vacuum in train and brake should be in release condition
3. After opening 1<sup>st</sup> notch wait for 10 sec to stabilize load meter then release SA9
  - a) For starting on up gradient with full load open the notch accordingly then release the loco brake to avoid wheel slip
  - b) To start on down gradient 1<sup>st</sup> release the loco brake then notching
4. Do not take traction immediately after releasing of dynamic brake.

### **Procedure of avoiding the jerk on run**

1. Update the section road knowledge
2. Advance the throttle with pause
3. Do not open the throttle suddenly and do not apply brake suddenly
4. Apply gradual braking
5. Ensure load is fully released before opening the throttle after application of brakes.
6. Do not apply/release dynamic brakes suddenly.
7. Reduce the notch during wheel slip on up gradient.
8. Keep healthy communication with Guard/Banker loco Pilot.
9. Banker loco pilot open the notch first while starting the train.



### **Procedure of avoiding the jerk on stopping**

1. Apply gradual braking.
2. Apply loco brakes after stand still.
3. Try to stop the train in released condition.
4. Try to stop the train on notches on up gradient (if required) and apply the loco brake after stopping then bring the throttle on idle.
5. Avoid to couple screw coupling load with multiple unit.

### **Train Handling Method**

It is a technique to handle the train operation, it vary person to person. Regarding train operation some guide lines are given below –

Loco Pilot should keep in mind –

1. Load hauling (Tractive effort)
2. Draft force (Draw bar pull)
3. slackness in load
4. Brake power
5. Geographical condition of rail track
6. Fuel saving
7. Punctuality

### **On A Level Section**

#### **A) Starting of train from level section**

1. Keep train brakes in released condition.
2. Take first notch and simultaneously release SA-9.
3. Wait for few seconds until the load meter reading stops increasing and begin to reduce.
4. Advance throttle to notch 2 and again note load meter indication as in (3).
5. If necessary, advance the throttle to 3 or 4 notches but always wait for a few second {as in (3)} between each notch position.
6. When the train is in a stretched condition and in motion, slowly advance the throttle as required {as in (3)} for achieving maximum speed of the train.

#### **B) Negotiating level section**

1. After achieving maximum speed, maintain it by increasing / decreasing the notch.
2. Avoid frequent changing in notches as this develops slack in the train.

#### **C) Stopping of train in level section**

1. At a sufficient distance in advance of point of slowing, ease the throttle notch by notch for the slack to adjust to a bunched condition.
2. Coasting to be done for some distance before braking.
3. Apply Dynamic / train or both brakes as required
4. As the train comes to stop apply SA-9(loco brakes).

## **On up Gradient**

### **A) Starting procedure in ascending (up) grade**

Assuming train brakes are applied

1. Move throttle to take 3 or 4 notches (Keep watch on load meter)
2. Release SA-9 (loco brake)
3. Gradually release A9 (train brake)
4. Wait for few seconds until the load meter reading stops increasing and begin to reduce.
5. Advance throttle, wait for few second as (4) for achieving maximum speed.

### **B) Negotiating ascending grade**

1. Before arriving up gradient, take sufficient momentum of train.
2. Take maximum notches as you reach to the crest (end point of up gradient)
3. Reduce notches after 3/4 of the entire train comes on level track.
4. Maintain maximum speed.

### **C) Stopping of train in ascending grade**

1. At a sufficient distance in advance of point of stopping, ease the throttle notch by notch to allow speed to reduce naturally due to the grade.
2. Stop the train on notches.
3. Apply SA-9 (loco brake)
4. Apply A9 (train brake) to avoid roll back of train.

## **On Down Gradient**

### **A) Starting of train in descending (down) grade**

Assuming train brakes & loco brakes are applied

1. Release loco brakes first then release train brakes.
2. Allow train to move slowly until entire train is moving.
3. Pickup & maintain the maximum speed.
4. If necessary use Train / dynamic brake to avoid over speeding.

### **B) Negotiating descending grade**

1. Start reducing notches after passing 1/4<sup>th</sup> of entire train in the down gradient.
2. Use dynamic/Train brakes to avoid over speeding.
3. Before ending the down gradient train should be in released condition & there should be margin in speed to take few notches.
4. Advance throttle only up to load meter reading starts increasing to avoid high buff force.
5. Advance throttle further to maintain maximum speed.

### **C) Stopping of train in descending grade**

1. Reduce the speed by using Train / dynamic brakes.
2. Train brakes should not be completely released to avoid roll down of train.
3. Apply Loco Brakes.

## **On Undulating Gradient**

### **A) Starting of train in undulating gradient**

1. Apply SA-9 fully, advance the throttle to notch 1 and observe load meter increase.
2. Gradually release SA-9 until locomotive begins to move.
3. After a few seconds pause, advance the throttle to notch 2 and observe load meter. Before advancing throttle further, wait for load meter reading to reduce.

### **B) Negotiating undulating gradient**

1. The most reliable procedure is to reduce speed & power prior to entering the series of undulating grades & to operate at a constant speed throughout the undulating area by throttle manipulation. Concentrate upon the location of the rear end of the train, traction amperage, speed and pull of the train.
2. Reduce power on approach to the undulating grades.
3. Concentrate on the location of the rear end of the train.
4. Increase power when the locomotive approaches an ascending (up) grade.
5. Decrease power when the locomotive approaches to descending (down) grade.
6. Maintain a uniform speed throughout the undulating grade section.

### **C) Stopping the train in undulating gradient**

In undulating grade, stopping procedure of the train should be followed as per ascending or descending grade, where the train has to stop during running.

## **On Hump (Knoll) & Cresting Gradient**

### **A) Starting of train on a hump or cresting grade**

There are no special requirements for starting on a hump or cresting grade. The starting procedure is the same as for starting the train on an ascending (up) grade.

### **B) Negotiating Hump (knoll) gradient**

1. Approach the hump with reduced power thus providing margin for power increase and for stretching the train as the locomotive starts up the hump. Increase power, if possible, to avoid bunching the slack at the leading end and maintain this stretch condition until the locomotive reaches the crest of the hump.
2. As the locomotive passes the hump, and starts to pickup the speed the draw gear will tend to stretch out. To keep slack action to a minimum, reduce power to keep speed constant.
3. Keeps the slack action to a minimum by throttle manipulation to suit loading on the train and the grade.

### **C) Stopping of train on a crest grade**

**1. Avoid draw gear stresses:** - Take all efforts to avoid stopping of train on a cresting grade, for which the Loco Pilot must have a good knowledge of the location of all cresting grade. A stop of a train on a cresting grade can lead to excessive draw gear stress on the wagon at the crest while attempting to restart the train.

**Reducing draw gear stresses:-** If a stop has to accomplish, do so in accordance with the stopping procedures for descending grades. When stopping on a cresting grade, always ensure that the brake application used to stop the train is the lightest possible thereby reducing draw gear forces particularly on the apex of the crest.

### **On Sag or Dip Gradient**

#### **A) Starting of train from sag or dip gradient**

1. Advance throttle to notch 1<sup>st</sup> and note the increase of current on the load meter. Release SA-9 (loco brakes) and wait for the release of the locomotive brakes.

2. After a pause advance the throttle and again observe the load meter. If necessary advance the throttle to position 3<sup>rd</sup> or 4<sup>th</sup> notch.

3. If acceleration is too rapid, reduce notches 1 or more. When the complete train is in a stretched condition & in motion, slowly advance the load meter as required.

#### **B) Negotiating sag or dip gradient**

1. In order to control slack when moving through sag or dip, the train speed must be allowed to reduce before the train moves into the sag or dip & throttle manipulation used to negotiate the sag or dip gradient. This can be achieved by reducing power & speed before reaching such areas.

2. Continue to reduce power to prevent speed increase as the head portion of the train begins descending into the sag.

3. Just before the leading portion of the train reaches the ascending grade, begin to advance notches gradually.

4. Continue to advance the throttle on one notch at a time until the rear portion of the train approaches the base of the sag or dip.

5. Reduce power as the rear portion of the train starts on the ascending grade of the sag or dip thereby permitting slack to adjust gradually.

#### **C) Stopping the train in sag or dip**

1. In advance of the sag or dip, apply A-9 brakes to minimum reduction & engage dynamic brakes.

2. As the brakes gets effective apply A-9 further up to full service.

3. As the speed decrease below 5 KMPH release dynamic brakes as well as A-9.

4. Apply SA-9.