

**Lesson Plan for Induction Course Training for directly recruited Asst. Loco Pilots
(Duration: 103 Working Days)**

Department: Mechanical (STC/KGP)
Activity Centre: STC/KGP
STAGE: Induction / Initial Training of Asst. Loco Pilots
Duration: 103 working days
Rly. Board's Ref: RBE 99/09 (Annexure-‘B’)
Subject : Basic of mechanical & Electrical engg.
Duration: 3 days.
Training Method(s): Lecture, Demonstration.

DAY-1

1st session (01.40Hrs):

BASIC OF MECHANICAL ENGG.

(Definition of engine, types of engines, IC & EC engine, Spark Ignition & Compression Ignition engines)

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) State the definition of an engine.
- b) Explain the differences between IC & EC engine.
- c) Explain the differences between SI (Petrol) & CI(diesel) engine.

DESCRIPTION:

Engine:

An Engine is a mechanical device which converts chemical energy into mechanical energy. There are two types of engines.

1. External Combustion (EC) Engine.
2. Internal Combustion (IC) Engine.

External Combustion Engine: -

In this type of engine, burning of fuel takes place at one place and the work is done at a different place; e.g. Steam Engine.

Internal Combustion Engine: -

In this type of engine the burning of fuel and the use of energy take place inside the engine-cylinder at one place only; e.g. (i). Diesel Engine (ii). Petrol Engine

Internal Combustion Engines are of two types: -

1. Spark ignition engine.
2. Compression ignition engine.

DAY-1

Session-2, (01.40Hrs):

BASIC OF MECHANICAL ENGG.

(Four stroke & two stroke engine, working principle of diesel engine)

Objective(s):

At the end of Training, Trainees will be able to –

- a) Explain the working principle 4-Stroke engine.
- b) Explain the working principle 2-Stroke engine.

DESCRIPTION:

Working Principle of Diesel Engine:

Diesel engine is an internal combustion engine, single acting, turbo super charged, four-stroke engine in WDM₂ loco, two-stroke engine in WDG4/WDP4 loco. It works on the principle of compression ignition. There are 16 cylinders in WDM₂ as well as WDG4/WDP4 locos. Cylinders are fitted in 'V' shaped position on both sides of engine block. Piston of each cylinder is connected with crankpin of crankshaft through connecting rod. Diesel engine starts with the help of external battery.

Four Stroke Engine:

Most four-stroke diesel engines share a similar construction as per the sketch given below:

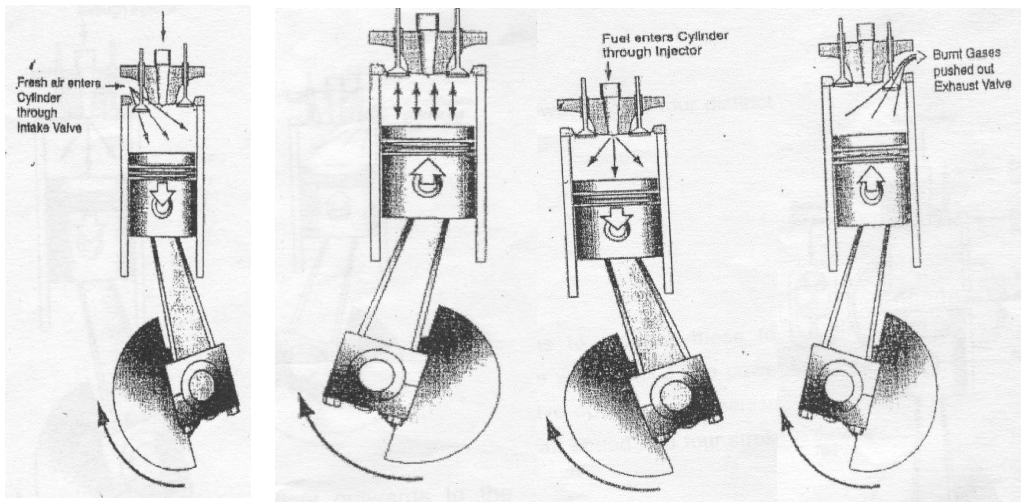
Cylinder is closed on the top by the cylinder head and sealed at the bottom by the moveable piston & piston-rings. Intake and exhaust valves located in the cylinder head allow the flow of gases into and out of the cylinder as required. Reciprocating motion of the piston is converted to a rotary motion on the crank-shaft.

1) Intake Stroke: The four stroke cycle begins with the intake stroke.

Rotary motion of the crank shaft causes the piston in the cylinder to move downwards, increasing the volume of the cylinder. As the volume increases, the pressure decreases below atmospheric pressure.

Fresh air at the higher pressure rushes into the cylinder through the open intake valve to fill the cylinder. This provides a new charge of oxygen for the combustion of the fuel.

As the piston approaches the bottom of the stroke (Bottom Dead Center or BDC), intake valve closes to seal the cylinder. Piston now begins to move upwards on the compression stroke.



2) Compression Stroke:

As the piston moves upwards on the compression stroke, the volume of the sealed cylinder is reduced and causes the pressure in the cylinder to rapidly increase. The reduction in cylinder volume is usually expressed as the compression ratio. This ratio is the difference between the cylinder volume with the piston at Bottom Dead Center (BDC) and cylinder volume with the piston at Top Dead Center (TDC). Diesel engines commonly have compression ratios between 16:1 and 20:1.

It is a property of gases, that as the pressure is increased the temperature also increases. It is this rapid increase in temperature that provides the heat necessary to ignite the fuel.

3) Power Stroke:

The piston moves upwards on the compression stroke increasing cylinder pressure and temperature. Near the top of this stroke, fuel is sprayed into the cylinder by the injector. The fuel is atomized by the injector so that it mixes easily and completely with the hot air. The high cylinder temperature ignites the fuel and air mixture and combustion of fuel begins.

The heat produced by the burning fuel and air mixture causes a further rapid increase in cylinder pressure. As the piston passes through Top Dead Center and begins a downward motion, the increased cylinder pressure pushes the piston down.

The force acting downwards on the piston is many times greater than the force required to initially compress the air. This force is transferred through the

connecting rod by the crankshaft. It is through the actions of the cylinder assembly that the latent energy contained in the fuel is released and converted into a useable mechanical force.

4) Exhaust Stroke:

Before the combustion process can be repeated the cylinder must be purged of the burnt gases and refilled with a fresh air charge. Just before the piston reaches the bottom of the power stroke, the exhaust valve is opened to vent the pressure contained in the cylinder. The piston passes Bottom Dead Center and moves upwards on the exhaust stroke. The motion of the piston moving upwards reduces the volume of the cylinder and increases the pressure.

Since the exhaust valve is open, the burnt gases flow outwards to the atmosphere through the valves. When the piston has reached Top Dead Center, the exhaust valve closes, the intake valve opens, and the cylinder is ready to begin the next intake stroke.

DAY-1
3rd session (1.30 hrs)

Two Stroke Engine — Construction:

There are a great many different designs for two stroke (or cycle) engine; this text will deal only with the design similar to the one used on the General Motors diesel engines.

As in the four stroke engine, the cylinder assembly is sealed at the top by the cylinder head, and at the bottom by the piston and piston rings. Fuel is injected in a similar manner by a fuel injector located in the cylinder head. There are however several very important differences. Instead of utilizing an intake valve located in the cylinder head, a row of ports or openings have been located in the lower portion of the cylinder wall. These ports are surrounded by a chamber known commonly as the air box. Fresh air is pumped into this chamber by an air pump or blower, for use in combustion.

Scavenging (Start):

The two stroke engine uses a different method of introducing a fresh air charge into the cylinder than the four stroke engine. Rotation of the crankshaft causes the mechanically coupled air pump to force fresh air into the airbox that surrounds the air ports on the lower cylinder walls.

With the piston at the bottom of the stroke, this fresh air enters the cylinder through the ports. As the exhaust valves are also open at this time, the air moves upwards through the cylinder, and exits through the open valves.

The air ports are angled slightly from the center line of the cylinder causing the air to swirl in the cylinder as it moves upwards. Thus the cylinder is completely purged and filled with 'fresh air. This action is called scavenging.

Scavenging (Finish):

The crankshaft rotates, moving the piston upwards in the cylinder. The upwards piston movement blocks the flow of fresh air through the liner ports and forces a small amount of air out the exhaust valves. Any remaining exhaust from the previous power stroke is completely removed from the cylinder by this action.

The exhaust valves then close to seal the cylinder and allow compression of the air.

Compression:

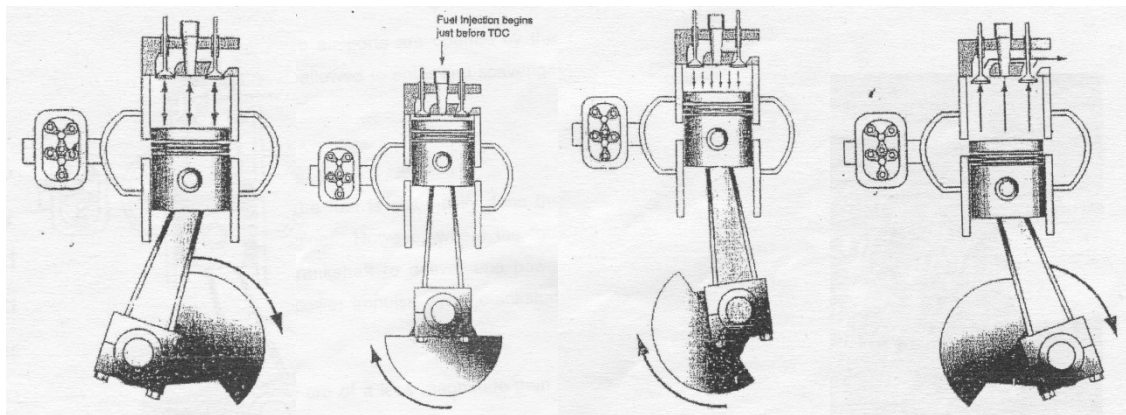
After the exhaust valves have closed, the piston moves upwards compressing the air in the cylinder. As in the four stroke engine when the air is compressed, the temperature and pressure rise.

However, compression in a two stroke engine differs slightly in that the initial cylinder pressure is slightly higher because of the air pump, and the effective stroke is much shorter.

Injection

The injection of fuel into the cylinder of the two stroke engine is handled in the same manner as the four stroke engine.

As the piston nears Top Dead Center (TDC) the fuel injector delivers an atomized spray of fuel into the cylinder. The fuel combines with the air and is ignited by the high temperature.



Rotation of the crankshaft carries the piston past TDC as the fuel begins to combust with the air.

Power:

Combustion of the fuel and air causes the pressure in the cylinder to rise rapidly. This pressure expands in all directions, pushing the piston downwards with a greater force than it took to initially compress the air.

As in the four stroke engine, this force on the piston is converted into a rotary motion on the crankshaft, providing a useable mechanical force.

Exhaust

The piston travels downwards on the power stroke until a point just before the air ports are uncovered. The exhaust valves open to vent cylinder pressure to atmosphere. By opening the exhaust valves slightly before the air ports, a flow of gasses is started through the valves and cylinder pressure is reduced below that of the airbox. By reducing cylinder pressure in this way a back flow of gas (backfire) into the airbox is prevented. Cylinder pressure continues to reduce until the air ports are opened by the piston. At this time the fresh air from the airbox is allowed to enter and scavenge the cylinder to begin the cycle again.

DAY-1

4th session (1.20 hrs)

BASIC OF MECHANICAL ENGG.

(Parts of engine, engine block)

OBJECTIVE:

At the end of Training, Trainees will be able to –

- a) Identify all the parts of the engine block with their appropriate location.

DIESEL ENGINE BLOCK :

On **WDM2** locomotive, **251-B** type diesel engine is fitted. This cylinder block houses 8 cylinders on each side in the V-shape arrangement. This cylinder block is of steel plates welded together and mounted on engine case (engine base) with the help of nuts and bolts. These cylinders on each side are counted from free end towards power take off end. For every cylinder, there is one fuel injection pump and one cylinder head having rocker arm assembly with two inlet and two exhaust valves with one injector.

This cylinder block also supports main crank shaft and two cam shafts. Inside each cylinder, there is one cylinder liner, piston and connecting rod. The V-gallery or inlet manifold is provided inside the cylinder block.

There are 16 openings which are coupled to each cylinder head with the help of inlet valve. Free end side opening is directly coupled with after cooler. Electro-hydraulic governor is coupled with face joint of **R₈** cylinder and crank case exhaust motor is fitted near **L₈** cylinder on the cylinder block. Turbo-supercharger is supported by the after cooler housing which is coupled to the cylinder block above the crank case with the help of gasket joint.

Due to rotation of main crank shaft, there is every possibility that lube oil in the crank case may come out of the cylinder block, crank case or main crank shaft joints. To prevent this leakage, one oil catcher each at power take-off end and at free end are provided. Around all the 16 cylinders of the cylinder block, there is cavity for circulation of water for the purpose of cooling down the cylinders. This water inlet comes from the free end side and after cooling the cylinder liners, this water goes to the cylinder head through the passages provided on the right side of every cylinder liner in the block with the help of jumper pipe to cool down the cylinder head.

Main Crank Shaft

Main crankshaft has nine main bearings. It has got 8 crank pins at different angles. Connecting rods are coupled to main crank shaft.

At power take off end of crank shaft a flange split gear is provided to rotate cam shaft gears. On free end side extension shaft is provided for expresser and also one gear to drive lube oil and water pump. For smooth rotation of main crank shaft a fly wheel is fitted on power take off end and vibration damper on free end is also provided.

Main Bearing

There are nine main bearings. Every main bearing cap has a hole which is having threads at the bottom to facilitate coupling of lube oil jumper pipe from the main header with the help of adapters. Main bearing is having one hole and one groove throughout its round

portion in the centre, due to which the main bearing is lubricated and afterwards through the inside groove, lube oil goes to adjacent crank pin.

Crank Pin

On every crank pin, two connecting rods are coupled for each side. The lube oil passes through the main bearing internal groove, lubricates the crank pin journal and afterwards it goes through the internal hole of connecting rod to piston pin.

Connecting Rod

The big end of connecting rod is connected to crank pin and little end is connected to the piston pin. Lube oil coming from the internal drill hole lubricates piston pin and then goes to piston crown.

Piston Pin (Wrist Pin)

Piston pin is connecting to the connecting rod, and to piston. Piston pin has three holes. Oil from the connecting rod comes to the centre hole in piston pin, passes out through the side holes and lubricates the piston bushes, after lubrication goes to the piston crown and cools down the piston.

Piston

In the piston, there are four grooves, where in four rings are provided above the piston pin, out of these four rings above three rings are termed as compression rings and the lower one is called oil scraper ring. In addition to these rings two rings are provided below the piston pin and called oil scraper ring. Since the fuel is burning on top of the piston, there is maximum temperature on the piston crown. It is essential to protect the piston crown from bad effects of temperature. For this reason inside grooves are made in piston crown in which the lube oil comes via piston pin and absorbs the heat, cools the piston crown and drop down in the crankcase. While dropping on connecting rod and crankshaft, it splashes on the cylinder liner walls, provides lubrication between piston rings & liner, and scrapes down the helps of scraper rings.

Cylinder Head

On every cylinder liner, a cylinder head is fitted. There is a provision of separate chamber, for two-inlet and two-exhaust valve, and one injector. Inlet and outlet valves are activated with the help of rocker arm assembly which is called valve lever mechanism. One inlet passage for fresh air and one exhaust outlet is provided to expel the used air from the cylinder. Since the cylinder head is coming directly in contact with hot gases, it is cooled by water coming from cylinder block through jumper pipe and after cooling it goes back to water return pipe. Valve lever mechanism is lubricated by lube oil coming from respective sub header.

Valve Lever Mechanism

There are two camshafts located on each side of engine block. Camshafts are driven by the split gear fitted on the main crankshaft. Each side camshaft is made in four pieces and bolted together. This is supported at nine places or each side on the cylinder block. There is a drilled passage running throughout the length to provide lubrication at each side bearing. For every cylinder, there are three cams. Left side for inlet valve, right side exhaust valve and centre one for fuel injection pump. Camshaft gear is fixed with the help of lock nut and key. On free end, camshaft is connected to vibration damper housing. At the right side of engine free end an over speed trip device assembly is connected to the camshaft.

Crankcase cover

This is fitted below the cylinder block and it is made of steel plates welding together. This acts as lube oil sump provided with screen to protect metal particles dropping in sump. To clean crankcase one drain hole is provided near cylinder no. 5 which is kept close by a bolt. One explosion door is provided on each side of the engine base at the power take off end for the safety of crankcase from gas explosion.

There are modified spring loaded explosion doors, which are located on any of the inspection cover on crankcase. These explosion doors do not burst but whenever there is an increase in pressure inside crankcase, they get opened and come back to their original position as soon as the pressure is reduced.

Note: Engine block cylinders are numbered from 1 to 8 on WDM₂ counting from free end from right side and counting from left side.

Vibration Damper

It is located at free end of the main crankshaft end of the engine block. It controls the vibration of main crankshaft and extension crankshaft.

DAY-2

1st session (01.40Hrs):

BASIC OF MECHANICAL ENGG.

(Parts of engine, engine block)

OBJECTIVE:

At the end of Training, Trainees will be able to –

Identify all the parts of the engine block with their appropriate location

Their major sub-assemblies:

Main Generator: -

Main Generator is located at the Power-take off end and the Engine Crank shaft directly drives its armature. It is a DC Generator and produces high voltage current (600/750V). The function of this generator is to supply power to the T/Motors for moving Locomotive and it is known as Traction Generator.

Alternator: In AC-DC locos alternator is provided in place of Main Generator, which produces high voltage AC current and after being rectified to DC, through rectifiers, supplied to T/Motors.

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Auxiliary Generator: -

The auxiliary generator is located at the left-hand side of the main generator at the power take-off end. It is gear driven by the main generator's armature shaft gear. It produces low voltage DC and after being regulated to 72 V with the help of VRP (voltage regulating Panel) it is used for charging the batteries and to supply the low voltage circuits, crankcase exhaustor motor, booster motor, lights and control circuits etc.

In AC-DC loco it works as a motor combined with exciter generator, with the help of battery current to rotate the crank-shaft during starting.

Exciter Generator:-

This DC generator is located at the power take-off end and is gear driven by main generator's armature shaft gear. In E-type excitation system, this Generator produces DC and is used to

excite the main Generator field. The governor speed coil is excited by the Tacho generator supply.

In static excitation system, in place of exciter generator, alternator is provided which produces AC and the output of this alternator after being rectified is used to excite the main Generator field. It also supplies AC to governor speed coil circuit.

Front Truck Traction Motor Blower: -

It is located at the power take-off end on the right side in front of the main Generator and is gear driven by main Generator armature shaft. Its function is to draw the air through car body filters and supply the same into three traction motors of the front truck through air ducts for cooling effects.

In some AC-DC locos, rectifier panel is cooled by the air, supplied by FTTM blower through a feed pipe, instead of rectifier blower.

Lube Oil Circulating Pump: -

This pump is located at the right side of the free end on loco and is gear driven by crankshaft extension shaft gear. Its function is to draw lube oil from the lube oil sump and to circulate it in the lube oil system under pressure in order to provide lubrication & cooling for all the frictional parts.

Water Circulating Pump: -

This pump is located at the free end on the left side of the crankcase and is driven by the crankshaft extension shaft gear. Its function is to circulate water to the water-cooling system.

Air Compressor and Exhauster (Expresser): -

This assembly is located at the free end and is driven by extended crankshaft. It is a combined unit of air Compressors and Exhausters. There are four cylinders in this unit. This air compressor draws air from atmosphere through air intake filter and compresses it in the low pressure and high pressure cylinder and stores it in the main air reservoir no. 1 and 2 through air circulating pipe. The exhauster cylinder exhausts air from the train pipe to create vacuum. Exhausters are connected to the train pipe on the other side, so the air by the exhauster is drawn from the pipe through VA-1B control valve.

In some modified locos, only compressor unit is provided in place of expresser.

Intercooler Fan: -

This fan is fitted with the crankshaft and is located behind the intercooler at the free end. The function of fan is to cool intercooler air by blowing atmospheric air directly on the intercooler as well as to the unit also.

Rear Truck Traction Motor Blower: -

This is fitted in the radiator compartment and it is driven by the extension of the Crankshaft. There are six 'V' belts in WDM₂ loco. Its function is to blow air into the three traction motors of the rear truck through air ducts for cooling effect.

Eddy Current Clutch: -

This clutch is connected to the crankshaft in the radiator compartment after rear truck traction motor blower. This assembly consists of one outer drum & one inner rotor. The outer drum is connected to the crankshaft. The inner rotor is provided with electrical circuit and rotates with outer drum according to the water temperature. This electrical circuit receives current as soon as the water temperature rises to 75° C in WDM₂ through ETS switches and R1 contactor. This inner rotor is magnetized as soon as the electrical circuits on it get current and the rotor starts to rotate along with the outer drum due to magnetic effect. As a result the radiator fan rotates which is linked to the inner rotor through right angle gear.

Radiator fan: -

This is located in the radiator compartment on the top. It is driven by extended crankshaft through eddy current clutch, right angle gear and universal shaft. The fan creates partial vacuum

in the radiator compartment. To destroy this vacuum, atmospheric air rushes through the radiators and in this process it comes in contact with water tubes and fins and absorbs the heat. Thus cooling the water of the radiators and this hot air is expelled out through the radiator fan.

Note:

1. Radiator fan does not work below 75° C, radiator fan will work at medium speed above 75° C and full speed above 80° C.
2. The water temperature on the water cooling system must not be dropped below 49° C on WDM₂ in any case.
3. Hot engine indication takes place at a water temperature of 90° C

DAY-2

2nd session (01.40Hrs):

Woodward Governor

This governor is fitted in some WDM₂, WDG₂, WDM_{2C}, WDS₆ locos.

1. This governor is provided with an emergency shut down plunger which trips automatically in case of low lube oil pressure. The diesel engine will not start unless this plunger is reset.
2. It consists its own built in hydraulic pump for building hydraulic pressure driven by cam gear.
3. Most of the Woodward governors possess in built OPS.

Note: Locos fitted with Woodward governor is provided with only fuel pump on booster motor, and not governor oil pump.

Crankcase Exhauster Motor

This exhauster motor is located on the left side over the engine block at the power take off end near L-8 cylinder in WDM₂. It is motor driven. This motor is a low voltage motor and the exhauster works till such time, this crank case motor is fed with low voltage current. Its function is to exhaust the hot gases and vapours from the crankcase during engine working. The accumulation of hot gases in the crankcase would cause damage to the engine bearings. To avoid such damage a safety device is also provided i.e. in case of failure of exhauster motor, the explosion door would explode due to pressure of gases. The working of the exhaust motor is indicated by amber colour light on control panel in WDM₂ loco. The amber colour light remains extinguished till such time crank case exhauster motor works and will glow as soon as the exhauster motor fails to work. If there is any doubt about non working of exhauster motor stop the locomotive, and check if any gas is escaping from the exhaust pipe.

Booster Motor

This motor is located on right side of the diesel Engine in front of expresser on loco frame. It gets current from low voltage circuit. It drives two pumps namely governor pump and fuel pump. Fuel oil pump is towards the main generator and the governor oil pump is towards the radiator room. The governor oil is fed at 130 psi and fuel oil at 3.6 Kg/cm² (EH governor equipped loco governor oil pump not required).

DAY-2

3rd & 4th session (02.50Hrs):

BASIC ELECTRICITY

Electrical symbols, circuits, short ckt, open ckt.

Voltage, current, resistance, Ohms law

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) State the Electrical symbols, circuits, short ckt, open ckt.
- b) State definition of Voltage, current, resistance.
- c) State Ohms law.

Description :-

Electricity: The flow of electrons are called Electricity. The restricted flow of electrons are called Electronics.

Current: Current is defined as the rate of flow of charge. The symbol of current is (I), $I=Q/T$ where Q= amount of charge and T= Time. S.I. unit of current is Ampere (Symbol- A).

Potential: Potential is that electrical state of a conductor which determines the direction of flow of charge when the two conductors kept in contact.

Voltage: The potential difference between two points is defined as Voltage. The symbol of volt is (V)

Resistance: It is defined as the property of a substance due to which it opposes the flow of Electricity through it. Unit of resistance is Ohms.

Ohms Law: The ratio of potential difference (V) between any two points on a conductor to the current (I) flowing between them, is constant, provided the temperature of the conductor does not change.

$V/I = \text{constant}$ or $V/I = R$ R is the resistance of the conductor.

It does not apply all non metallic conductors, such as silicon carbide. It also does not apply to Zener diodes & voltage regulator tubes.

Electrical Circuit: A ckt. is a conducting path through which an electric current either flows or is intended to flow.

Series ckt.: When some conductors having resistances R_1, R_2, R_3 etc. are joined end-on end they are said to be connected in series. i.e one's negative is connected to others positive and finally connected with a source.

- 1. Same current flows through all parts of the ckt.
- 2. Different resistors have their individual voltage drop.
- 3. voltage drops are additive.
- 4. Applied voltage equals the sum of different voltage drops.
- 5. Resistances are additive
- 6. Power are additive.
- 7.

$$V = V_1 + V_2 + V_3 = IR_1 + IR_2 + IR_3$$

$$IR = IR_1 + IR_2 + IR_3$$

$$\text{Or, } R = R_1 + R_2 + R_3$$

Parallel ckt.: When some conductors having resistances R_1, R_2, R_3 etc. are joined their all positive ends with a source's positive supply & all negative ends with a source's negative supply.

1. Same voltage flows through all parts of the ckt.
2. Different resistors have their individual currents.
3. Branch currents are additive
4. Power are additive.

$$I = I_1 + I_2 + I_3 = V/R_1 + V/R_2 + V/R_3$$

$$V/R = V/R_1 + V/R_2 + V/R_3$$

$$\text{Or, } 1/R = 1/R_1 + 1/R_2 + 1/R_3$$

1. No voltage can exist across because $V = IR = I \times 0 = 0$
2. Current through it called short ckted current is very large (theoretically infinite.)

Two points are said to be open ckted when there is no direct connection between them. Obviously an open represents a break in the continuity of the circuit.

Resistance between the points are infinite, There is no flow of current between the points.

Short Circuit :- When two points of a circuit are connected together by a thick metallic wire, they are said to be short ckted. 'Short' has practically '0' resistance.

Shorts in series ckt: Since a short has almost 0 resistance, it causes the problem of excessive current which in turn, causes power dissipation to increase many times & ckt components may burn out.

In fig 1 $V = 12V$, $R = R_1 + R_2 + R_3 = 6$

$$I = V/R = 12/6 = 2A, \quad P = 24W$$

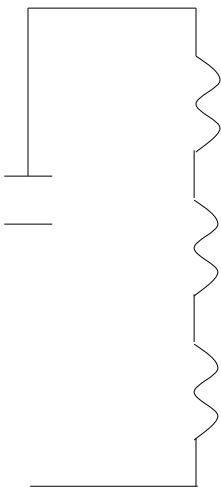
In fig2 Resistor 3 is shorted out by a resistance less copper wire so that $R_{cd} = 0$

Now total ckt resistance $R = 1 + 2 + 0 = 3$, $I = 12/3 = 4A$, $P = 48W$

In fig3, Resistor 2,3 is shorted out by a resistance less copper wire.

$$R = 1, \quad I = 12/1 = 12, \quad P = 144W$$

Because of this excessive current (6 times the normal value) connecting wires & other ckt components can become hot enough to ignite & burnt out.



Shorts in parallel ckt: Suppose a short is placed across R3. It becomes directly connected across the battery & draws almost infinite current because not only its own resistance but that of the connecting wires AC & BD is negligible. Due to this excessive current the wires may get hot enough to burn out unless the ckt is protected by a fuse.



Open Circuit.: - Two points are said to be open ckted when there is no direct connection between them. Obviously an open represents a break in the continuity of the circuit.

1. Resistance between the points are infinite
2. There is no flow of current between the points.

(DAY-3) 1st session (Duration 1.40 Hrs)

BASIC ELECTRICITY

- a) Capacitor, Circuit breaker, conductor/insulator, ammeter, voltmeter. Fuse, relays, contactors & batteries.

Training Objective(s):

At the end of Training, Trainees will be able to –

- 1) Explain the capacitor, Circuit breaker, conductor/insulator, ammeter, voltmeter, Fuse, relays, contactors & batteries.

DESCRIPTION:

a)Capacitor:-A capacitor essentially consists of two conducting surfaces separated by a layer of an insulating medium called dielectric. The conducting surface may be in the form of either circular plates or be of spherical or cylindrical shape. The purpose of a capacitor is to store electrical energy by electrostatic stress in the dielectric. The property of a capacitor to “store electricity” may be called as capacitance. SI unit of capacitance is Farade. One farade = One Coloumb/One volt.

b) Circuit Breaker: This is a safety device provided in a electrical circuit for the protection of circuit and equipment. EveryCircuit Breaker is designed for rated value. When the current exceeds beyond the rated current value due to any defect in electrical circuit, the circuit breaker will trip off so that the damages are avoided. A Circuit Breaker has three positions i.e. CLOSE, OPEN & TRIP. After circuit breaker has tripped off, to reset it first put it in OPEN position and then put it CLOSE.

c) **Relay:** It is a remote control device used for electrical protection and for controlling different circuit at a time. Main parts are : i) Operating coil II) Core III) Moving armature iv) Interlock block v) Interlock fingers i.e. Normally close & normally open interlocks.

Normally close interlocks are normally close when the relay is in de-energized position & the normally open interlocks are open when the relay is in de-energized position

d) **Contactors:** This is used to open or close the electrical circuits. They are of two types contactors used in WDM2 loco, i.e, Electromagnetic contactors & Electro-pneumatic contactors. On WDM Loco following are the Electromagnetic contactors: FPC,GFC,CK1,CK2,R1,R2,FS21 to FS26. And following are the Electro-pneumatic contactors:- All power contactors, BKT, REV.

e) **Conductor/Insulator:-**

f) **Ammeter:-** The measuring instrument of current is called 'Ammeter' . It shall always be connected in series in the circuit

g) **Voltmeter:-** The measuring instrument of voltage is called 'Voltmeter' . It shall always be connected in parallel to the circuit

h) **Fuse:-** An electric fuse is a safety device which used to limit the current in an electrical circuit. The use of fuse thus safeguards the ckt. and the appliances connected in that ckt. from being damage.

(DAY-3) 2nd session (Duration 1.40 Hrs)

BASIC ELECTRICITY

Working principle DC & AC motor, generator & alternator, **Motors in series/parallel&Speed control.**

OBJECTIVES:-

At the end of Training, Trainees will be able to –

a) Explain the working principle Generator, alternator, Motors(AC/DC)

b) Motors in series/parallel & Speed control

DESCRIPTION:-

Working principal of DC Generator:

A generator is a machine which converts mechanical energy (power) into electrical energy. The energy conversion is based on the principle of dynamically (motionally) induced EMF. Whenever a conductor cuts magnetic flux, motionally induced EMF is produced in it according to Faraday's laws of electromagnetic induction. This EMF causes a current to flow if the conductor circuit is closed. Hence, two basic essential parts of an electrical generator are i) a magnetic field & ii) a conductor or conductors which can so move as to cut the flux. Generators are usually classified according to the way in which their fields are excited. a) Separately excited & b) Self excited Generators.

Separately-excited Generators are those whose field magnets are energized from an independent external source of DC current.

Self excited Generators are those whose field magnets are energized by the current produced by the generators themselves. Due to residual magnetism, there is always present some flux in the poles. When the armature is rotated, some EMF will produce and hence some induced current also produced which is partly or fully passed through the field coils thereby strengthening the residual pole flux.

Working principal of Alternator:

AC generators or alternators operate on the same fundamental principles of electromagnetic induction as DC generators. They also consist of an armature winding and a magnetic field. But there is an important difference between the two. Whereas in DC generators, the armature rotates and the field system is stationary, the arrangement in alternators is just the reverse of it. In their case, standard construction consists of armature winding mounted on a stationary element called stator and field windings on a rotating element called rotor.

When the rotor rotates, the stator conductors are cut by the magnetic flux, hence they have induced EMF produced in them. Because the magnetic poles are alternately N & S, they induce as EMF and hence current in armature conductors, which first flows in one direction and then in the other. Hence, an alternating EMF is produced in the stator conductors i) whose frequency depends on the number of N & S poles moving past a conductor in one second and ii) whose direction is given by Fleming's Right hand rule.

Working principal of D.C Motor:

An electric motor is a machine which converts electrical energy into mechanical energy. Its action is based on the principle that when a current carrying conductor is placed on a magnetic field, it experiences a mechanical force. Constructionally there is no basic difference between a DC generator and a DC motor. In fact the same DC machine can be used interchangeably as a generator or as a motor. In fig. is shown a part of multipolar DC motor. When its field magnets are excited and its armature conductors are supplied

with current from the supply mains, they experience a force tending to rotate the armature. Armature conductors are under N pole are assumed to carry current downwards (crosses) and those under S poles, to carry current upwards (dots). Each conductor experiences a force F which tends to rotate the armature in anticlockwise direction. These forces collectively produce a driving torque which sets the armature rotating. It should be noted that the function of a commutator in the motor is the same as in a generator. By reversing current in each conductor as it passes from one pole to another, it helps to develop a continuous and unidirectional torque.

Working principal of A.C Motor:

In AC Motor the rotor does not receive electric power by conduction as in DC motor but by induction in exactly the same way as the secondary coil of a two winding transformer receives its power from the primary. That is why such motors are known as induction motor. In fact an induction motor can be treated as a rotating transformer i.e, one in which primary winding is stationary(Called stator), but the secondary is free to rotate(called rotor)

Speed control :- To vary the speed of motors it is required to regulate the voltage to the motors. To increase the speed of motor it is required to apply more voltage to motors and to decrease the speed of motors it is required to reduce voltage of motors.

(DAY-3) 3rd & 4th session (Duration 1.20 Hrs)

BASIC ELECTRICITY

Converter/rectifier, inverter, Diode, GTO, IGBT etc. Precaution to be taken with various voltages of electricity.

OBJECTIVES:-

At the end of Training, Trainees will be able to –

Explain the Converter/ rectifier, inverter, Diode, GTO,IGBT etc. Precaution to be taken with various voltages of electricity.

DESCRIPTION:-

**Lesson Plan for Induction Course Training for directly recruited Asst. Loco Pilots
(Duration: 103 Working Days)**

Department: Mechanical (STC/KGP)
Activity Centre: STC/KGP
STAGE: Induction / Initial Training of Asst. Loco Pilots
Duration: 103 working days
Rly. Board's Ref: RBE 99/09 (Annexure- 'B')
Subject : Familiarization with the lay out and various types of loco/sub-system/sub-assemblies and related trouble shooting.
Duration: 36 days.

DAY-1

1st session (01.40Hrs):

(Principles & Types of Diesel engine, Principles of working of Diesel loco)

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) Explain the Principles & Types of Diesel engine,
- b) Explain the Principles of working of Diesel loco

DESCRIPTION:

Engine:

Working Principle of Diesel Engine:

Diesel engine is an Internal Combustion engine, single acting, turbo-super-charged, 4-stroke / 2-stroke engine based upon the principle of compression ignition. In a 4-stroke engine, four strokes are completed by two complete revolutions of Crank Shaft where as in case of a 2-stroke engine; the cycle (Suction, Compression, Power & Exhaust strokes) is completed in one complete revolution of Crank Shaft. There are 16 cylinders in WDM₂ loco (4-stroke engine) as well as WDG4/WDP4 locos (2-stroke engine). Cylinders are fitted in 'V'-shaped position on both sides of engine block. Piston of each cylinder is connected with crankpin of crankshaft through connecting rod. Diesel engine starts with the help of external battery (about 72 Volt DC).

Working Principle of the Diesel Locomotive

The Diesel engine is a prime mover which rotates a crankshaft, which in turn drives a generator to generate high voltage current. This current when supplied to the traction motors fitted on individual wheel axles causes movement of the locomotive as each traction motor armature is geared to its corresponding wheel axle through pinion and drive gear.

High voltage current generated by the main generator, when supplied to the traction motor, causes armature to rotate. Traction motor consists of movable coils called armature and fixed coil called field coil mounted on magnetic frame, due to like and unlike polarities causing attraction and repulsion between armature and inductor poles .A pinion is shrunk on the armature shaft which is meshed to the drive gear fitted on axle, so armature rotates the wheels to cause movement of locomotive.

Types of diesel engine :-

Diesel engines are of two types, Four stroke & Two stroke cycle engine.

DAY-1

2nd session (01.40Hrs):

(Four stroke & two stroke cycle)

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) Explain Four stroke & two stroke cycle

DESCRIPTION:

Four Stroke Engine:

Most four-stroke diesel engines share a similar construction as per the sketch given below:

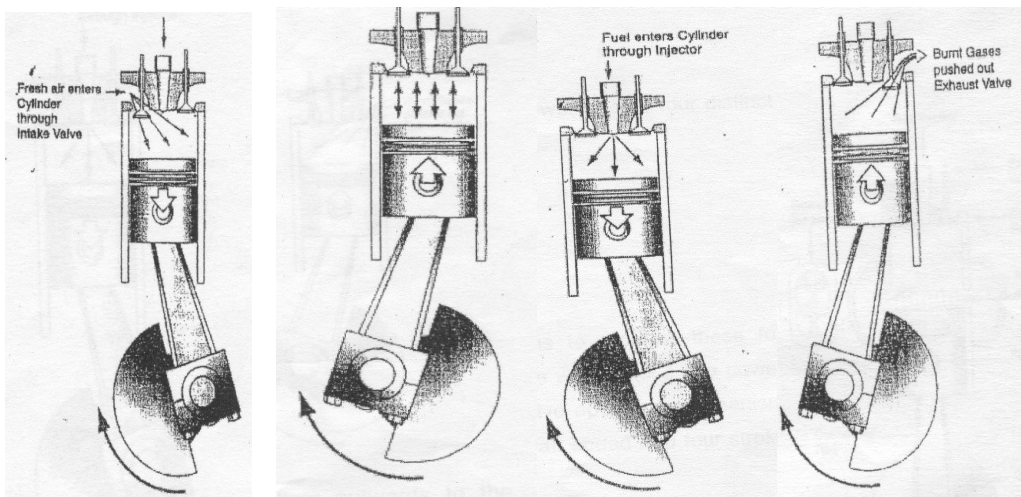
Cylinder is closed on the top by the cylinder head and sealed at the bottom by the moveable piston & piston-rings. Intake and exhaust valves located in the cylinder head allow the flow of gases into and out of the cylinder as required. Reciprocating motion of the piston is converted to a rotary motion on the crank-shaft.

1) Intake Stroke: The four stroke cycle begins with the intake stroke.

Rotary motion of the crank shaft causes the piston in the cylinder to move downwards, increasing the volume of the cylinder. As the volume increases, the pressure decreases below atmospheric pressure.

Fresh air at the higher pressure rushes into the cylinder through the open intake valve to fill the cylinder. This provides a new charge of oxygen for the combustion of the fuel.

As the piston approaches the bottom of the stroke (Bottom Dead Center or BDC), intake valve closes to seal the cylinder. Piston now begins to move upwards on the compression stroke.



2) Compression Stroke:

As the piston moves upwards on the compression stroke, the volume of the sealed cylinder is reduced and causes the pressure in the cylinder to rapidly increase. The reduction in cylinder volume is usually expressed as the compression ratio. This ratio is the difference between the cylinder volume with the piston at Bottom Dead Center (BDC) and cylinder volume with the piston at Top Dead Center (TDC). Diesel engines commonly have compression ratios between 16:1 and 20:1.

It is a property of gases, that as the pressure is increased the temperature also increases. It is this rapid increase in temperature that provides the heat necessary to ignite the fuel.

3) Power Stroke:

The piston moves upwards on the compression stroke increasing cylinder pressure and temperature. Near the top of this stroke, fuel is sprayed into the cylinder by the injector. The fuel is atomized by the injector so that it will mix easily and completely with the hot air. The high cylinder temperature ignites the fuel and air mixture and combustion of fuel begins.

The heat produced by the burning fuel and air mixture causes a further rapid increase in cylinder pressure. As the piston passes through Top Dead Center and begins a downward motion, the increased cylinder pressure pushes the piston down.

The force acting downwards on the piston is many times greater than the force required to initially compress the air. This force is transferred through the

connecting rod by the crankshaft. It is through the actions of the cylinder assembly that the latent energy contained in the fuel is released and converted into a useable mechanical force.

4) Exhaust Stroke:

Before the combustion process can be repeated the cylinder must be purged of the burnt gases and refilled with a fresh air charge. Just before the piston reaches the bottom of the power stroke, the exhaust valve is opened to vent the pressure contained in the cylinder. The piston passes Bottom Dead Center and moves upwards on the exhaust stroke. The motion of the piston moving upwards reduces the volume of the cylinder and increases the pressure.

Since the exhaust valve is open, the burnt gases flow outwards to the atmosphere through the valves. When the piston has reached Top Dead Center, the exhaust valve closes, the intake valve opens, and the cylinder is ready to begin the next intake stroke.

Two Stroke Engine — Construction:

There are a great many different designs for two stroke (or cycle) engine; this text will deal only with the design similar to the one used on the General Motors diesel engines.

As in the four stroke engine, the cylinder assembly is sealed at the top by the cylinder head, and at the bottom by the piston and piston rings. Fuel is injected in a similar manner by a fuel injector

located in the cylinder head. There are however several very important differences. Instead of utilizing an intake valve located in the cylinder head, a row of ports or openings have been located in the lower portion of the cylinder wall. These ports are surrounded by a chamber known commonly as the air box. Fresh air is pumped into this chamber by an air pump or blower, for use in combustion.

Two Stroke Engine — **Scavenging (Start):**

The two stroke engine uses a different method of introducing a fresh air charge into the cylinder than the four stroke engine. Rotation of the crankshaft causes the mechanically coupled air pump to force fresh air into the air box that surrounds the air ports on the lower cylinder walls.

With the piston at the bottom of the stroke, this fresh air enters the cylinder through the ports. As the exhaust valves are also open at this time, the air moves upwards through the cylinder, and exists through the cylinder, and exists through the open valves.

The air ports are angled slightly from the center line of the line of the cylinder causing the air to swirl in the cylinder as it moves upwards. Thus the cylinder is completely purged and filled with 'fresh air. This action is called scavenging.

Two Stroke Engine — **Scavenging (Finish):**

The crankshaft rotates, moving the piston upwards in the cylinder. The upwards piston movement blocks the flow of fresh air through the liner ports and forces a small amount of air out the exhaust valves. Any remaining exhaust from the previous power stroke is completely removed from the cylinder by this action.

The exhaust valves then close to seal the cylinder and allow compression of the air.

Two Stroke Engine — **Compression:**

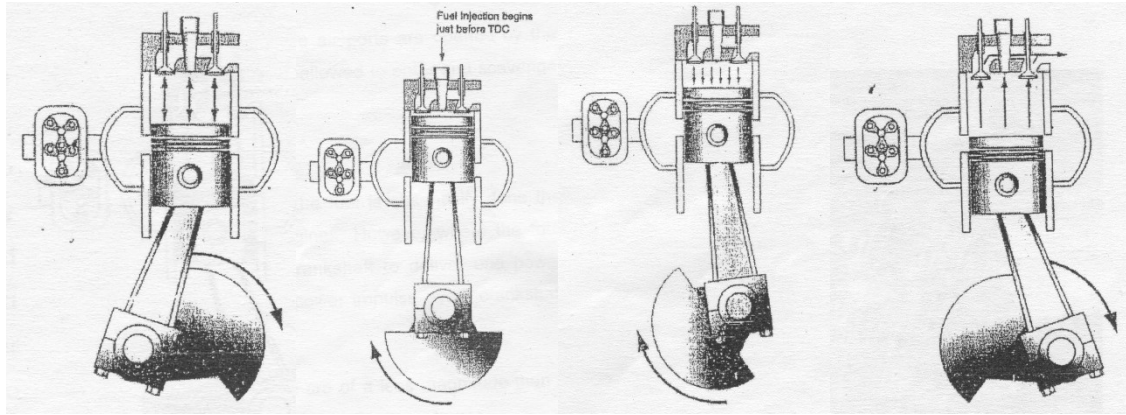
After the exhaust valves have closed, the piston moves upwards compressing the air in the cylinder. As in the four stroke engine when the air is compressed, the temperature and pressure rise.

However, compression in a two stroke engine differs slightly in that the initial cylinder pressure is slightly higher because of the air pump, and the effective stroke is much shorter.

Two Stroke Engine — **Injection**

The injection of fuel into the cylinder of the two stroke engine is handled in the same manner as the four stroke engine.

As the piston nears Top Dead Center (TDC) the fuel injector delivers an atomized spray of fuel into the cylinder. The fuel combines with the air and is ignited by the high temperature.



Rotation of the crankshaft carries the piston past TDC as the fuel begins to combust with the air.

Two Stroke Engine — **Power:**

Combustion of the fuel and air causes the pressure in the cylinder to rise rapidly. This pressure expands in all directions, pushing the piston downwards with a greater force than it took to initially compress the air.

As in the four stroke engine, this force on the piston is converted into a rotary motion on the crankshaft, providing a useable mechanical force.

Two Stroke Engine — **Exhaust**

The piston travels downwards on the power stroke until a point just before the air ports are uncovered. The exhaust valves open to vent cylinder pressure to atmosphere. By opening the exhaust valves slightly before the air ports, a flow of gasses is started through the valves and cylinder pressure is reduced below that of the air box. By reducing cylinder pressure in this way a back flow of gas (backfire) into the airbox is prevented. Cylinder pressure continues to reduce until the air ports are opened by the piston. At this time the fresh air from the airbox is allowed to enter and scavenge the cylinder to begin the cycle again.

3rd session (01.30Hrs):

(Valve timing diagram& Rocker assembly,)

Training Objective(s):

At the end of Training, Trainees will be able to –

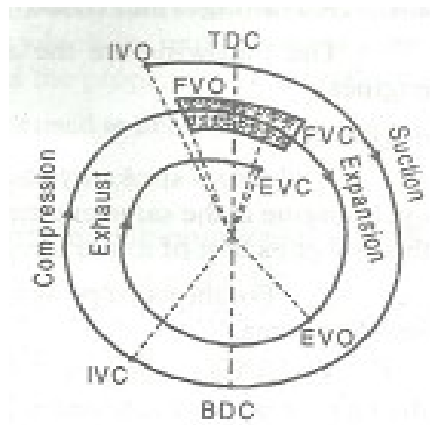
- Explain Rocker assembly, valve timing diagram

Rocker arm assembly

Rocker arm assembly, which is called valve lever mechanism, is used to operate Inlet and Outlet Valves of cylinder-head with the help of cams provided on cam-shaft for individual cylinder. There are two camshafts located on each side of engine block. Camshafts are driven by the split gear fitted on the main crankshaft. Each side camshaft comprises of four pieces and is bolted together. For every cylinder, there are three cams. Left side cam operates the push rod to operate rocker arm for inlet valve, right side for exhaust valve and centre one operates fuel injection pump directly

Valve Timing Diagram of Diesel Engine

Valve Timing Diagram for a Four Stroke Cycle Diesel Engine - The diesel engines are also known as compression ignition engines. The valve timing diagram for a four stroke cycle diesel engine is shown in Figure below:



The following particulars are important for a four stroke cycle diesel engine regarding valve timing diagram:

- The inlet valve opens at $10^\circ - 20^\circ$ before TDC and closes at $25^\circ - 40^\circ$ after BDC.
- The fuel valve opens at $10^\circ - 15^\circ$ before TDC and closes at $15^\circ - 20^\circ$ after TDC.
- The compression starts at $25^\circ - 40^\circ$ after BDC and ends at $10^\circ - 15^\circ$ before TDC.
- The expansion starts at $10^\circ - 15^\circ$ after TDC and ends at $30^\circ - 50^\circ$ before BDC.
- The exhaust valve opens at $30^\circ - 50^\circ$ before BDC and closes at $10^\circ - 15^\circ$ after TDC.

Note: In diesel engines, the fuel is injected in the form of very fine spray into the engine cylinder, which is ignited due to high temperature of the compressed air.

DAY-1

4th session (01.20Hrs):

Piston assembly and Components of diesel engine.

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) State Piston assembly and Components of diesel engine .

DESCRIPTION:

Piston

In the piston, there are four grooves, where in four rings are provided above the piston pin, out of these four rings above three rings are termed as compression rings and the lower one is called oil scraper ring. In addition to these rings two rings are provided below the piston pin and called oil scraper ring. Since the fuel is burning on top of the piston, there is maximum temperature on the piston crown. It is essential to protect the piston crown from bad effects of temperature. For this reason inside grooves are made in piston crown in which the lube oil comes via piston pin and absorbs the heat, cools the piston crown and drop down in the crankcase. While dropping on connecting rod and crankshaft, it splashes on the cylinder liner walls, provides lubrication between piston rings & liner, and scrapes down the helps of scraper rings.

Piston Pin (Wrist Pin)

Piston pin is connecting to the connecting rod, and to piston. Piston pin has three holes. Oil from the connecting rod comes to the centre hole in piston pin, passes out through the side holes and lubricates the piston bushes, after lubrication goes to the piston crown and cools down the piston.

Connecting Rod :

The big end of connecting rod is connected to crank pin and little end is connected to the piston pin. Lube oil coming from the internal drill hole lubricates piston pin and then goes to piston crown.

Crank Pin :

On every crank pin, two connecting rods are coupled for each side. The lube oil passes through the main bearing internal groove, lubricates the crank pin journal and afterwards it goes through the internal hole of connecting rod to piston pin.

DAY-2
1st & 2nd session (03.20Hrs).

Components in power take off end & free end

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) State the location & function of all the major Components in power take off end & free end

DESCRIPTION:

Components in power take off end:

Main Generator:

Main Generator is located at the Power-take off end and the Engine Crank shaft directly drives its armature. It is a DC Generator and produces high voltage (600/750V). The function of this generator is to supply power to the T/Motors for moving Locomotive and it is known as Traction Generator.

Alternator:

In AC-DC locos alternator is provided in place of Main Generator, which produces high voltage AC and after being rectified to DC, through rectifiers, supplied to T/Motors.

Auxiliary Generator:

The auxiliary generator is located at the left-hand side of the main generator at the power take-off end. It is gear driven by the main generator's armature shaft gear. It produces low voltage DC and after being regulated to 72 V with the help of VRP (voltage regulating Panel) it is used for charging the batteries and to supply the low voltage circuits, crankcase exhaustor motor, booster motor, lights and control circuits etc.

In AC-DC loco it works as a motor combined with exciter generator, with the help of battery current to rotate the crank-shaft during starting.

Exciter Generator:

This DC generator is located at the power take-off end and is gear driven by main generator's armature shaft gear. In E-type excitation system, this Generator produces DC and is used to excite the main Generator/Alternator field.

Front Truck Traction Motor Blower:

It is located at the power take-off end on the right side in front of the main Generator and is gear driven by main Generator armature shaft. Its function is to draw the air through car body filters and supply the same into three traction motors of the front truck through air ducts for cooling effects.

In some AC-DC locos, rectifier panel is cooled by the air, supplied by FTTM blower, instead of rectifier blower.

Components in free end:

TURBO SUPER CHARGER (TSC): TSC is a machine, which is mechanically independent of the Diesel engine and gets its input energy from exhaust gases of the Diesel engine. In WDM₂, WDM3A & WDG3A, it is fitted above the after-cooler housing at the free end. When the Diesel engine starts, exhaust gas enters into the exhaust manifold with high internal energy, which moves the turbine fitted on a rotor at one end and centrifugal blower at the other end; hence the blower also starts rotating. Due to differential pressure, fresh air from atmosphere enters into the air inlet casing through cyclonic filters. Now, due to centrifugal force, it is forced into the after-cooler where it is cooled by water, its density increases and it becomes rich in oxygen. Then, it enters into the 'V' shaped air manifold from where it enters into the cylinders through inlet elbow at the time of suction stroke. This

super-charged air is also known as booster air. In case of two stroke engine, TSC is driven by crankshaft from idle to sixth notch & by exhaust gas on 7th & 8th notches.

After Cooler Assembly:-

After cooler is an assembly where Super charged air(Booster air) is cooled by water to increase its density and enrichment of Oxygen. In WDM₂/WDM3A/WDG3A it is located at the free end just after the engine block. There are two after coolers In WDG4/WDP4 loco which are located at the power take off end of the diesel engine.

Lube Oil Circulating Pump: -

This pump is located at the right side of the free end on loco and is gear driven by crankshaft extension shaft gear. Its function is to draw lube oil from the lube oil sump and to circulate it in the lube oil system under pressure in order to provide lubrication & cooling for all the frictional parts.

Water Circulating Pump: -

This pump is located at the free end on the left side of the crankcase and is driven by the crankshaft extension shaft gear. Its function is to circulate water to the water-cooling system.

Air Compressor and Exhauster (Expresser): -

This assembly is located at the free end and is driven by extended crankshaft. It is a combined unit of air Compressors and Exhausters. There are four cylinders in this unit. This air compressor draws air from atmosphere through air intake filter and compresses it in the low pressure and high pressure cylinder and stores it in the main air reservoir no. 1 and 2 through air circulating pipe. The exhauster cylinder exhausts air from the train pipe to create vacuum. Exhausters are connected to the train pipe on the other side, so the air by the exhauster is drawn from the pipe through VA-1B control valve.

In some modified locos, only compressor unit is provided in place of expresser.

Intercooler Fan: -

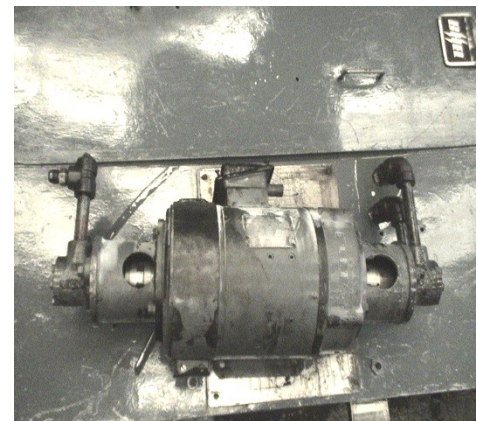
This fan is fitted with the crankshaft and is located behind the intercooler at the free end. The function of fan is to cool intercooler air by blowing atmospheric air directly on the intercooler as well as to the unit also.

Over Speed Trip Device Assembly:

It is a safety device fitted at the free end of engine block near right side cylinder no. 1. It shuts down the diesel engine automatically in case of over speed of the crankshaft i.e., 1110 to 1150 rpm. A spring loaded weight which is normally against the carrier moves out at once and hits the trip lever which in turn pushes back the fuel control shaft to bring the fuel rack to no fuel position and the diesel engine shuts down. This device is provided with tripping and reset handles. In case of emergency, pull the trip handle, which is fitted below this assembly pointing towards the engine block, may shut down the diesel engine. It is small in size. The diesel engine will not start until this assembly is reset to its normal working position. It can be reset by pulling the reset handle, which is fitted, on upper side towards the free end of this assembly. It is larger in size.

Booster Motor:-

This motor is located on right side of the diesel Engine in front of compressor. It gets current from low voltage circuit. It drives two pumps namely governor pump and fuel pump. Fuel oil pump is towards the main generator and the governor oil pump is towards the radiator room. The governor oil is feed at 130 psi and fuel oil at 3.6 Kg/cm² (In case of WW governor/MCBG governor oil pump is not required).



DAY-2

3rd & 4th session (02.50Hrs):

Main drive & Engine speed, OSTA setting & resetting.

Training Objective(s):

At the end of Training, Trainees will be able to –

- Explain the role of crank shaft in IC engine.
- List out the auxiliaries driven by the crank shaft.
- Explain the change in engine speed according to TH notch
- Explain the role of OSTA with respect to speed variations.
- Describe the procedure of resetting OSTA when tripped.

DESCRIPTION:-

Explain Main drive

OSTA, setting & resetting, Engine speed,

OSTA provided to protect the diesel engine from damage. It shuts down the diesel engine automatically in case of over speed of the crankshaft i.e., 1110 to 1150 rpm. This device is provided with tripping and reset handles. In case of emergency, pull the trip handle, which is fitted below this assembly pointing towards the engine block, may shut down the diesel engine. It is small in size. The diesel engine will not start until this assembly is reset to its normal working position. It can be reset by pulling the reset handle, which is fitted, on upper side towards the free end of this assembly. It is larger in size.

Engine speed:- 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

DAY-3 (SUNDAY)

Understanding of Governor functions including MCBG

Training Objective(s):

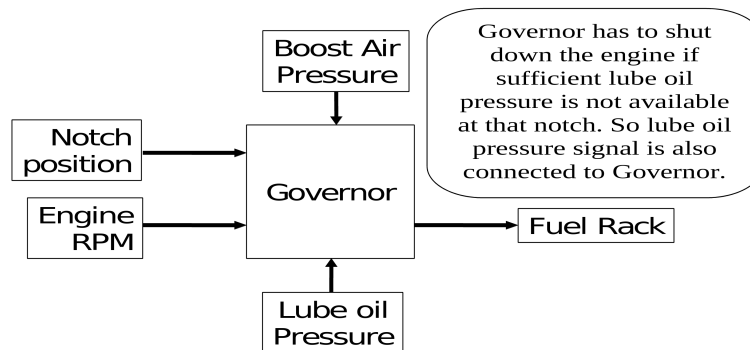
On completion of this lesson, trainees will be able to:

- a) Explain the functions of Governor
- b) Explain the functions of MCBG & difference with conventional governor

Governor and its working principle:

A device that maintains a steady speed in a Diesel engine from no load to full load. The Governor should maintain constant Engine RPM as per Notch signal irrespective of load. So Engine RPM signal is taken to Governor for reference. The governor is located on the right hand side of power take-off end of the engine. The WW type governors are gear-driven from the engine camshaft. Governor action is transmitted to the individual fuel pump racks through a fuel pump control shaft and a system of control linkages. Whenever engine is overloaded Governor generates an output signal proportional to the amount of overloading to maintain constant Engine RPM. This signal is interfaced with excitation system to reduce the load.

Working Principle of Governor



Types of governor

a) Electro-Hydraulic Governor

This governor is located at the right side of the engine block at power take off end and just above the right side cylinder no. 8. All the parts of this governor are assembled in a single steel housing. Bottom portion is called sump and is fitted with one filling plug, two spy glasses to check oil level, one strainer with pressure relief valve set at 135 psi, inlet and outlet pipes of the governor are connected to governor pump fitted on booster motor. Electrical current is supplied through Amphenol plug. When the booster motor is started, the governor pump also starts working due to which oil from governor is sucked and sent back to governor through strainer. This governor has got following main functions:

1. It controls the diesel engine speed according to load, gradient and throttle notch position.
2. It matches the diesel engine output according to the load.
3. It shuts down the diesel engine in case of low lube oil pressure i.e., 1.3 kg/cm².
4. It helps in starting the diesel engine.

b) Woodward Governor

This governor is provided with an emergency shutdown plunger which trips automatically in case of low lube oil pressure. The diesel engine will not start unless this plunger is reset. It provided with its own built in hydraulic pump for building hydraulic pressure driven by cam gear. Most of the Woodward governors possess inbuilt OPS.

Note: Locos fitted with Woodward governor is provided with only fuel pump on booster motor, and no governor oil pump.

c) **Microprocessor based control governor**

CONTROL UNIT



ACTUATOR UNIT



Advantages of MCBG

- Accurate and fully flexible and controls
- Reduced wear and tear
- Minimum maintenance
- Better RPM control
- Diagnostic features
- Possibility of fault logging
- Less black smoke from Engine
- Savings in fuel
- Ease of operation
- Retraining of Driver not required
- Additional features

DISPLAY & MONITORING OF ENGINE PARAMETERS.

- Engine RPM
- Notch position
- LOP (Kg/Sq.cm)
- BAP (Kg/Sq.cm)
- LCR position (6:30 to 5:30 clockwise)
- Fuel rack position (0 to 30 mm)

SETTING OF OPERATING PARAMETERS

- Desired RPM at various Notches
- Programmable Engine RPM response
- Checking of Mechanical OST setting
- Desired LOPS at various Notches
- Desired LOPS response
- Limitation of fuel rack based on BAP
- Limitation of fuel rack based on Notch
-

Installation of Control Unit in Driver's CAB SH side in a WDM/WDG series Locomotive.

DAY-4

1st session (01.40Hrs):

Cylinder Head Components and Camshaft rotation:

Training Objective(s):

At the end of Training, Trainees will be able to –

- a) State the major components of the cylinder head.
- b) Explain different parts of camshaft and rotation of camshaft.

DESCRIPTION:-

Cylinder Head components:

On every cylinder liner, a cylinder head is fitted. There is a provision of separate chamber, for two-inlet and two-exhaust valve, and one injector. Inlet and outlet valves are activated with the help of rocker arm assembly which is called valve lever mechanism. One inlet passage for fresh air and one exhaust outlet is provided to expel the used air from the cylinder. Since the cylinder head is coming directly in contact with hot gases, it is cooled by water coming from cylinder block through jumper pipe and after cooling it goes back to water return pipe. Valve lever mechanism is lubricated by lube oil coming from respective sub header.

Camshaft :

The camshaft on "V" type engines is located on either side of the cylinder block and extends the entire length of the engine. Both the camshafts are driven by crankshaft split gear assembly. The camshaft rotates on bearing, which are pressed into supports in the cylinder block. Lubrication is delivered to the bearing through in oil hole, which runs the length of the camshaft. This hole feeds oil to every bearing journal. Both the camshafts are divided into four sections (one for every two cylinders) and is joined at the section flanges by stud bolts and nuts. Each section of the camshaft has three integral cams for each cylinder. As the rollers for the fuel pump cross head and valve push rod lifters ride on the cams, the rotation of the camshaft actuates the fuel pumps, engine's air inlet and exhaust valves.

DAY-4

2nd session (1.20Hrs).

Explanation of Fuel oil system with its various components.

Training Objective(s):

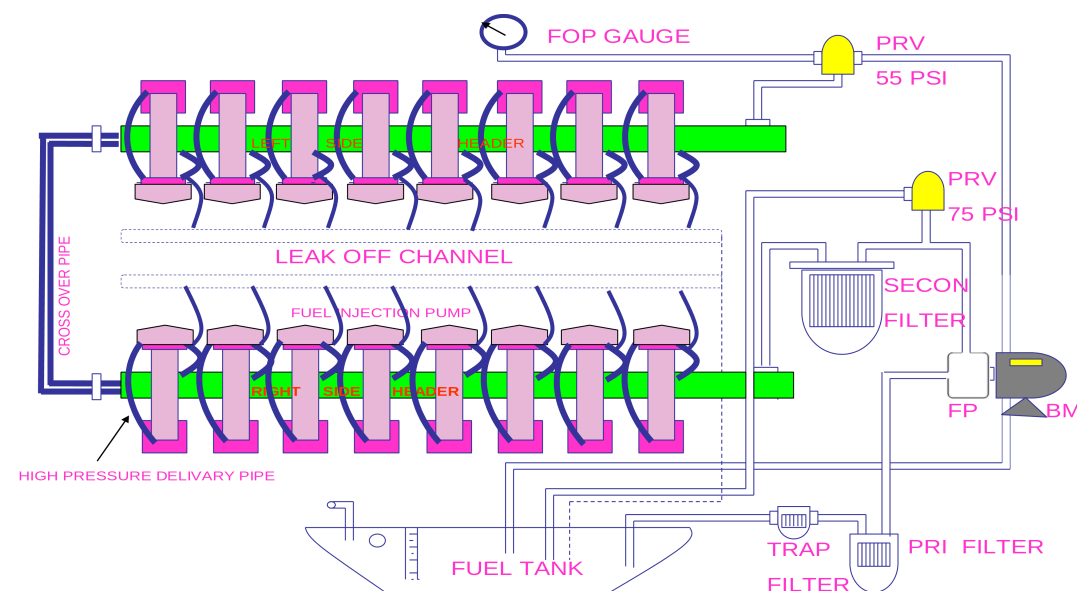
On completion of this lesson, trainees will be able to:

- a) Explain the fuel circulation system in a diesel engine.
- b) List out the major components of fuel circulation system.

DESCRIPTION:-

There is one fuel oil tank located in between the two trucks having 5000 Lts. capacities in WDM2 & 6000 Lts. in WDM3D, WDG3A etc. This tank is having two vent holes, one drain pipe at the bottom (which is kept closed by dummy plug), two glow gauges to measure the quantity of such oil and two filtering plugs with strainer provided with caps on each side for refilling. One fuel oil pump is provided on booster motor, which is located at the right side of the free end near the air compressor to supply fuel oil to the system. This booster motor has two pumps. Short hood side pump is fuel pump and the Long hood side pump is governor pump. This motor gets electric supply from batteries or auxiliary generator. When motor starts, the fuel pump also starts, which sucks oil from the tank through trap filter by suction pipe, oil goes to primary filter then to the pump. This oil in the pump is forced in to the delivery pipe with pressure, goes to pressure relief valve, which is set at 75 psi (5.2 kg/cm²) pressure will go back to the tank and saves the fuel pump from over loading damages. Further this oil goes to secondary filter. After filtering oil goes to the right side fuel oil header. From here, it is supplied to all 8 fuel injection pumps

through T-joints and afterwards through the crossover flexible pipe at power take off end it goes to left side fuel oil header. Where it again supplies fuel oil to left side 8 fuel injection pumps through T-joints and after cylinder no. L-1, it goes to pressure regulating valve, which is set at 55-60 psi (3.8 kg/cm²), excessive oil goes to the fuel oil tank. The function of regulating valve is to maintain a constant fuel oil pressure throughout the headers (both right and left). From this regulating valve one thin pipe goes to the fuel oil gauge, fitted in the driver's cab room to indicate the fuel pressure in the system. In fuel injection pump oil pressure is increased up to 3600 to 3800 psi by getting movement from camshaft and oil enters in to the high-pressure pipeline and to the injector in cylinder head and then sprayed in to the cylinder in atomized form, at the time of injection to develop power. The remaining fuel in the injector nozzle and the fuel injection pump goes back through leak off pipe to leak off gallery from where it is returned to the tank.



DAY-4

3rd & 4th session (03.20Hrs).

Fuel oil system & Related Trouble Shootings:

Training Objective(s):

On completion of this lesson, trainees will be able to:

- Explain the fuel circulation system in a diesel engine
- Shoot the troubles pertaining to fuel oil system of a diesel engine.

Trouble shooting:

Fuel oil pressure not building up or low FOP:

No fuel in fuel oil tank.	Check oil level in the fuel oil tank. The level should not be less than 1000 it, shut down the engine till further fuelling is done.
FOP gauge may be defective.	Gauge line may be dummied. Ignore it and work the train if hauling is satisfactorily.
Fuel pump motor not working.	Check battery knife switch in the nose compartment. Close it, if not already closed properly.
Circuit breaker may not be closed properly or defective circuit breaker.	Battery, Control, Fuel pump (additional FPB if provided on control compartment) or MFPB on any control stand may not be in closed position. If so, close/reset the circuit breaker and if defective short both the terminals of breakers.
Note: Battery CB (MB1) or control CB (MB2) should not be shorted.	
Fuel pump contactor (FPC) in control compartment not picking up.	FPC (Fuel pump contactor) inside control compartment is not picking up when MFPB on both control stand closed. If so, wedge the FPC with wooden plug duly switching off MFPB on control stand.
<p>Note: i. The method as wedging is shown in fig 5.</p> <p>ii. After wedging FPC or shorting abnormal battery discharge is indicated battery ammeter. Stop the operation.</p>	
Fuel pump motor not working.	<p>i. Check the wire connections in fuel pump motor junction for slack/broken, if so, attend the same.</p> <p>ii. Carbon brushes of fuel pump motor may be worn out and not coming in contact with the commutator. The same can be pressed gently.</p> <p>iii. If FPM commutator is blackened, clean it with the dry cloth.</p> <p>iv. In order to check whether bearing is seized, check for free rotation of the fuel pump shaft by rotating by hand.</p>
Caution: While attending the carbon brushes or commutator, wire connections of fuel pump motor, the MFPB should be switched off at first.	
Note: If breaker repeatedly trips, this is due to wires disconnected or touching with each other.	
fuel pump motor working but fuel pressure still not building up.	<p>a. Check the free rotation of the pump and hear the sound.</p> <p>b. Check the spider coupling and attend if possible.</p> <p>c. There may be external leakage of fuel oil in the fuel oil system. Locate the leakage and arrest it.</p> <p>d. Suction pipe blocked. Remove the pipe and clean it with wire, if suction pipe is drawing air, arrest the same.</p> <p>e. Check the primary filter socks. If it is choked or dirty, it may be taken out, work the train further informing the DPC. Make and entry in the repair book and hand over the removed socks to the shed for further investigation.</p> <p>f. Fuel oil relief or regulating valve may be stuck-up. Tap the valve gently and check the fuel oil pressure.</p>

DAY- 5

1st & 2nd session (03.20Hrs):

Explanation of super charged air system with related trouble shootings.

Training Objective(s):

On completion of this lesson, trainees will be able to

- a) Explain Super charged Air system with different components and related trouble shooting.

DESCRIPTION:

SUPER CHARGED AIR SYSTEM

On diesel loco motive the supercharged air system is provided. The TSC as a machine, is mechanically independent of the Diesel engine and gets its energy from exhaust gases of the Diesel engine. The exhaust gases which have sufficiently high internal energy, is used to drive a turbine in the TSC. In WDM₂ TSC is fitted above the after cooler housing at the free end. When the Diesel engine starts, the exhaust gases enters in to the exhaust manifold with high internal energy, which moves the turbine fitted on a rotor at one end and centrifugal blower at the other end, hence the blower also starts rotating. Due to differential pressure, fresh air enter through the cyclonic filter and due to centrifugal force, it is forced into the after cooler. In the after cooler it is cooled by water and its density increases and becomes rich in oxygen and enters in to the 'V' shaped air manifold from where it enters into the cylinders through inlet elbow at the time of suction stroke when the inlet valve

opens. From 'V' shaped manifold one pipe is taken to the gauge in driver's cabin to indicate the amount of pressure available in the 'V' shaped manifold. This pressure is also called Booster air pressure. There are five casings in Turbo Super Charger

1. Gas inlet casing
2. Turbine casing
3. Intermediate casing
4. Centrifugal blower casing
5. Air inlet casing

NOTE: (i). When the locomotive is hauling full loaded train on up gradient with 8th notch, pressure should be 1.05 to 1.26 kg/cm² in WDM₂ loco.

(ii). In some modified loco which is fitted with Napier TSC, the booster pressure should be 1.8 to 2.2 kg/cm².

(iii) Cyclonic filters are cleaned by individual dust exhaustor blower, which is driven by low voltage current from Aux/Battery.

TURBO RUN DOWN TEST

When there is a reduction of booster air pressure according to the throttle notch, at that time as required the Turbo Rundown Test to be conducted.

Procedure: -

- 1) Stop the locomotive after clearing the 'OHE'. Then send a man (ALP) on the roof of the loco with a torch, to watch the turbine rotation.
- 2) Raise the diesel engine at full speed for two or three minutes.
- 3) Without delay stop the engine by pressing the 'MU Run button'.
- 4) As soon as the alarm bell sounds, (i.e. low lube oil indication), start the stop watch.
- 5) The man on the roof of the locomotive has been instructed to indicate the stopping of the turbine rotation simultaneously stop the 'stop watch' immediately.

If the turbine stop rotating before 90 sec, it is under stood that the working of 'TSC' is defective.

If the time of rotation exceeds 90 sec. and below 180 sec. It means the 'TSC' is 'OK'.

Some locos are provided with modified turbo super charger i.e. ABB/Napier. In these types of locos the turbine random time should be 40 to 80 sec.

Note: - If there is a Napier type TSC, engine should be shut down by keeping throttle handle on 4th notch. while performing Rundown Test.

DAY- 5

3rd & 4th session (02.50 Hrs).

Explanation of Lube oil system with various components.

Training Objectives:

On completion of this lesson, trainees will be able to:

- a) Explain the lube oil system in diesel loco.
- b) Identify the different components.

DESCRIPTION:

In diesel engine moving parts are lubricated by means of forced lubrication system. In this system, lube oil is stored in crankcase having 1270 Lts. capacity. One dipstick gauge is provided at right side of no. 5 cylinder to measure the quantity.

For this system one positive displacement type of lube oil pump, which is gear driven by extension crankshaft, provided on right side of the engine at free end. When Diesel engine starts, this pump also starts, which sucks the oil from crankcase through suction pipe and delivers it to the delivery pipe. Oil goes to the pressure relief valve, which is set at 7.5 kg/cm² (8.5 kg/cm² in case of steel cap cylinder) excessive pressure oil goes back to the sump. Further, this oil goes to the lube oil filter drum through differential bypass valve. This bypass valve is set at 20 psi differential pressure and acts in two ways: When Diesel engine starts, at that time, this valve allows some oil to bypass lube oil filter, since it is going to take some time for filtering the oil, without filtering to the system to avoid dry run.

Oil after filtering in lube oil filter goes to lube oil cooler, located in the radiator compartment and gets cooled by the water and goes to lube oil strainer via pressure regulating valve set at 65 psi. Excessive oil pressure than this setting will go back to the sump. This pressure regulating valve and pressure relief valves are located close to the right side of engine in compressor room. Finally oil gets strained in lube oil strainer, which is located at the left side of the engine at the free end and enters in to main header and from here it is supplied all over for lubrication.

(1). One passage of lube oil from main header goes to the main header pipe located in the crank case on which nine jumper pipes are equipped to supply oil to the nine main bearings of main crankshaft. After lubricating the main bearings, oil from the main bearing inside drilled hole, goes to the adjacent crank pin. After lubricating crank pin journal, oil goes through connecting rod drilled hole to the piston pin. Piston pin has three holes. Oil comes out through the central hole, lubricates the little end of connecting rod and lubricate piston boss. Further through the right side hole of piston pin, oil goes to piston crown. This oil cools down the piston crown. There are five circular grooves inside the piston crown, this oil cools down the piston crown and returns to the sump via return passage. While dropping in the sump, it splashes due to rotary motion of the main crankshaft and sticks to the cylinder liner, and after lubricating cylinder liner, it drops to the sump by scrapper rings provided on the piston.

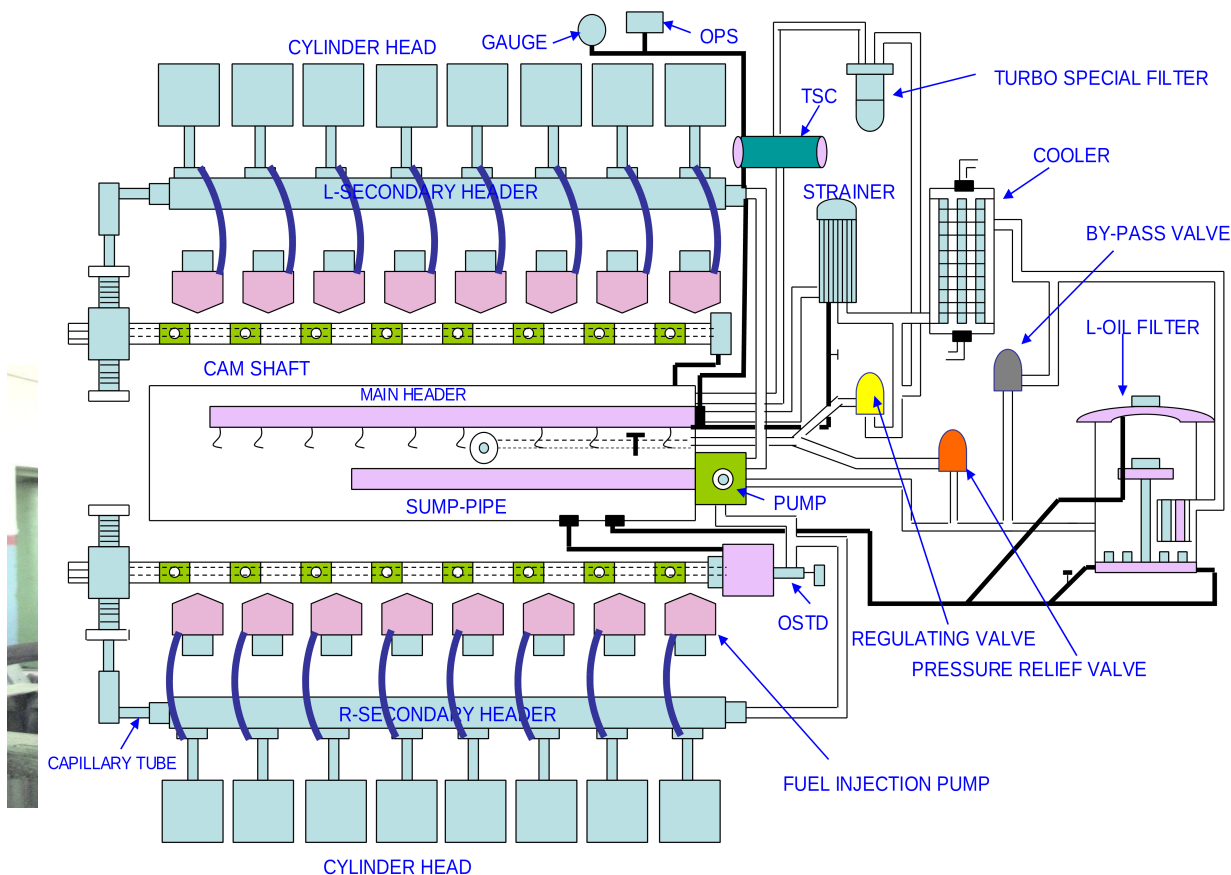
(2). The second passage from main header goes to right and left side of sub header. In between one joint is given to provide lubrication for right and left side camshaft bearing. From the sub, header one pipe goes to each cylinder head for lubrication of rocker arm assembly push rods and at the end it lubricates camshaft gear and goes back to the sump. On the other end it goes to camshaft vibration damper, over speed trip assembly and to the vibration damper back to the sump.

(3). Third connection is between pre-regulating valve and lube oil cooler goes to the TSC through special filter with flexible pipe to lubricate its bearing and back to the sump.

(4). Fourth connection from main header is going to the lube oil gauge through OPS in the driver's cabin to indicate the pressure in the system. This OPS is located in the cab room, which normally picks up at 1.6 kg/cm² and drops at 1.3 kg/cm² oil pressure. Whenever due to any fault in the lube system, if the pressure drops below 1.3 kg/cm², OPS will drop and interlocks will change to shutdown the Diesel engine and protects the Diesel engine from damages due to lack of lubrication.

NOTE: Before taking over charge of locomotive, driver must ensure that both drain cocks of lube oil filter and one drain cock of lube oil strainer is completely close and sealed. There are three kinds of lubrication: - a) Pressurizing Lubrication, b) Housing Lubrication, c) Splashing Lubrication.

LUBE OIL SYSTEM



DAY-6

1st & 2nd session (03.20 Hrs):

Understanding of CCEM, Explosion door, Low lube oil button (LLOB/WW Gov Trip Plunger), OPS & other components. Trouble shootings of lube oil system

Training Objective(s):

On completion of this lesson, trainees will be able to:

- State the CCEM, Explosion door, LLOB, OPS & other components
- Shoot the troubles related to lube oil system.

DESCRIPTION:

Crankcase Exhauster Motor:

This exhauster motor is located on the left side over the engine block at the power take off end near L-8 cylinder in WDM2. It is motor driven. This motor is a low voltage motor and the exhauster works till such time, this crank case motor is fed with low voltage current. Its function is to exhaust the hot gases and vapors from the crankcase during engine working. The accumulation of hot gases in the crankcase would cause damage to the engine bearings. To avoid such damage a safety device is also provided i.e. in case of failure of exhauster motor, the explosion door would explode due to pressure of gases. The working of the exhaust motor is indicated by amber colour light on control panel in WDM2 loco. The amber colour light remains extinguished till such time crank case exhauster motor works and will glow as soon as the exhauster motor fails to work. If there is any doubt about non working of exhauster motor stop the locomotive, and check if any gas is escaping from the exhaust pipe.

Explosion door:

These doors are located on the both side of crankcase towards power take off end on both sides, on the bottom side of the Electro hydraulic governor, towards right side and at the bottom of the crank case exhauster, towards the left side of the engine block. In case, if the crankcase exhauster motor fails to work, this causes increase in pressure inside the crankcase due to accumulation of hot gases and vapours and will result to burst the above door. Also in case there is abnormal leakage of hot gases from the cylinder due to defective gas ring i.e., scrappers ring.

Note: A few locos have been provided with modified spring-loaded explosion doors, which are located on any of the inspection cover over crankcase. These doors do not burst but whenever there is an increase in pressure inside crankcase, they keep open and come back to their respective seating as soon as the pressure is reduced.

Oil pressure switch (OPS)

This switch is provided in the cab room behind lube oil pressure gauge on right side of control panel. This switch will shut down the diesel engine with the help of Electro hydraulic governor with low lube oil indication, in case of lube oil pressure drops below 1.3 kg/cm^2 . It is a protective device against inadequate lubrication.

Note: OPS is a two contact switch ,upper & lower contact. When lube oil pressure built up to 1.6 kg/cm^2 it closes the upper position & at 1.3 kg/cm^2 it closes lower contact.

Trouble shooting in lube oil system.

16.0 Lube oil pressure not building:		
16.1	Lube oil level low.	Check these drain cocks. If open, close them.
16.2	Filter or strainer choked or drain cocks open.	Check these drain cocks. If open, close them.
16.3	External leakage.	Check for leakage of lube oil in system and attend to it, if possible.
16.4	ESD with high water temperature.	Check water temperature and working of radiator fan. Bring down the water temperature by raising engine speed by faster pumping.
Note: 1. Check the water level if the hot engine alarm frequently occurs and 2. If on easing throttle from higher notches if the lube oil pressure drops below 2.2 kg/cm^2 and the diesel engine shutdown, ease the throttle gradually and keep it on 2 nd notch for some time so that the lube oil is allowed to cool and the lube oil pressure gets settled.		

DAY- 6

3rd & 4th session (02.50Hrs):

Explaining of cooling water system

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) State the components related to Cooling Water System
- b) Explain cooling water system.

DESCRIPTION.

The diesel engine's cooling system is to maintain within the reasonable temperature of each component like liners, pistons, cylinders, headers etc. The temperature in the diesel engine is such that the materials used in their construction would be unable to withstand the temperature stresses imposed upon them for any appreciable length of time without some form of cooling.

In ALCO locos forced and closed water-cooling system is provided for cooling. For this purpose, one centrifugal water pump is provided on left side of engine at free end, which is driven by extension crankshaft gear. In this system, there is 1210 lt. of water filled through expansion tank No. 1 situated on the top of the radiator room and fills up in the whole system.

When the Diesel engine starts, water pump also starts and water from four places comes to the water pump through suction pipe viz., expansion tank, TSC outlet, left side radiator core (after lube oil cooler) and right side radiator core, from where water is forced in to four places:

- (i) Right side of the engine block
- (ii) Left side of the engine block
- (iii) Turbo super charger
- (iv) After cooler

The water going to right and left side cylinder block, cools the cylinder liner and afterwards rises through jumper pipe to each cylinder head and cools the cylinder head and rises through raiser pipe to the right side water return pipe. Water goes to the left side radiator through bubble collector and water from left

side water return pipe goes to the right side radiator through bubble collector. In the radiator core water gets cooled by working of radiator fan. After getting cooled from left side radiator water goes to the lube oil cooler, where it cools lube oil and comes out and mixes with water of right side radiator core and goes to the water pump again.

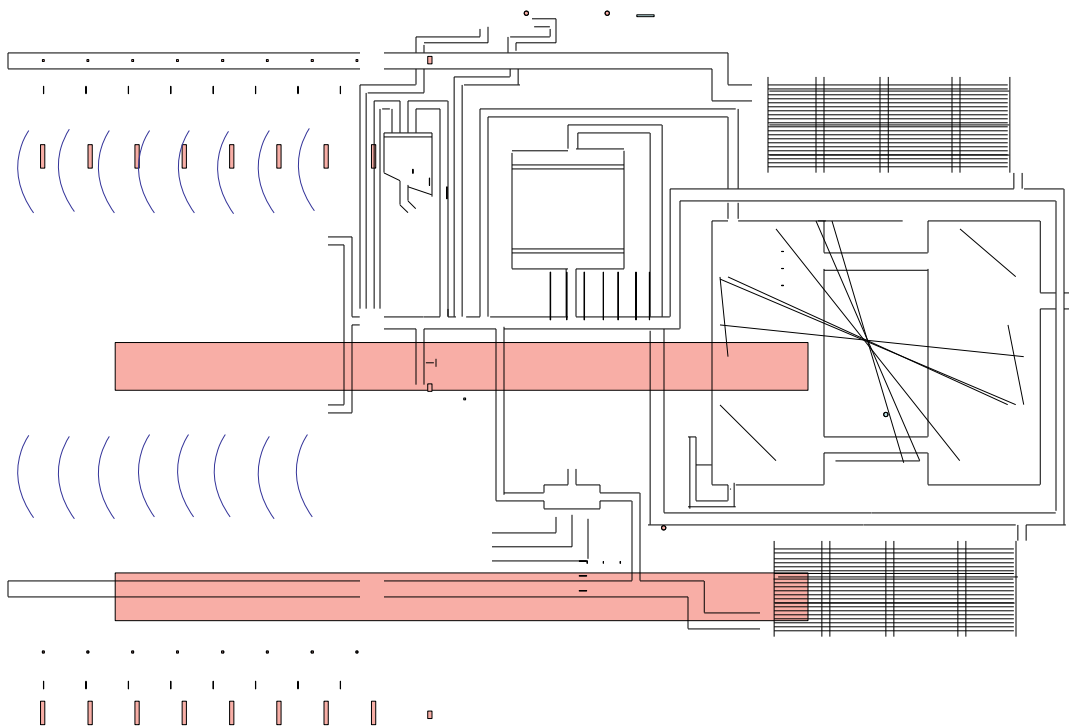
The second connection goes to TSC. This is connected to the intermediate casing of the bottom of TSC with the help of flexible pipe. After cooling the turbine casing water comes out to delivery line.

Third connection goes to after cooler by a flexible pipe. Where it cools the booster air, then goes to delivery line.

A chromium mixture compound mixed in engine water-cooling system to prevent corrosion and erosion in the water pipe line. It also leaks yellow marks to indicate water leakage on getting low water alarm.

The driver should first check the water level in the expansion tank. If the water level has dropped, then he should find the reason for loss of water and rectify the same, book the repair in the logbook. If driver is getting the hot engine alarm, he should check the water temperature and water level in the expansion tank.

WATER COOLING SYSTEM



DAY-7

1st & 2nd session (3.20 hrs)

Temperature switches & their purpose.

Related trouble shooting of cooling water system.

Training Objective(s):

On completion of this lesson, trainees will be able to:

- State the functions of temperature switches.
- Shoot troubles in water cooling system.

Thermostatic switch:

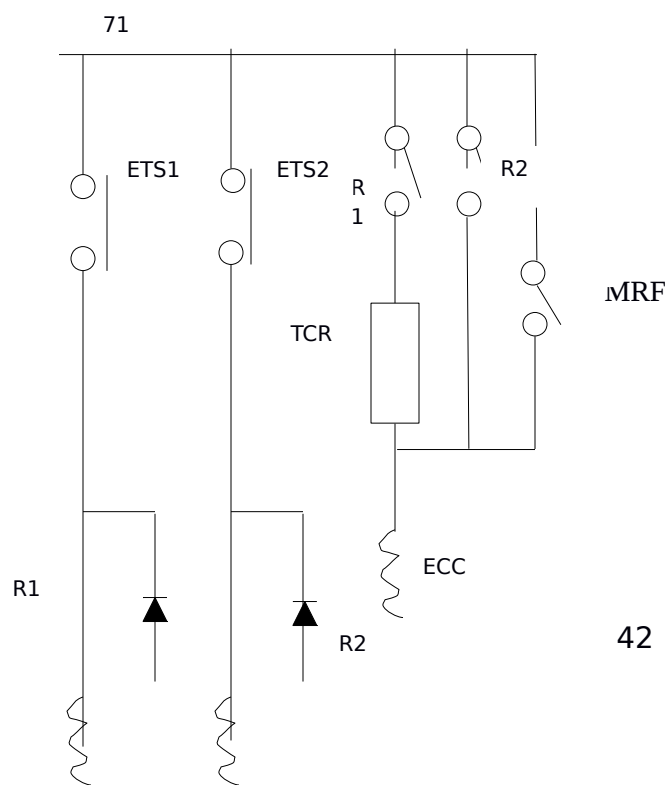
There are 3 nos. thermostatic switches fitted on water jacket in compressor room. They are ETS-1, ETS-2, ETS-3. The hot water while going back to the radiator for cooling, passes through this thermostatic switch which control the speed of radiator fan. One water temperature gauge is provided near the thermostatic switches. The thermostatic switch ETS-1 operates at the water temperature of 75°C and then radiator fan rotates at medium speed by R1 contactor & ECC. ETS-2 operates at 80°C by which the radiator fan rotates at full speed by R2 contactor. ETS-3 is operated at a water temperature of 90°C and hot engine alarm indication is experienced.

Radiator fan circuit:

This circuit is more or same on all type of locomotive. This circuit gets current from wire no. 71-4.

1. When water temperature rises to 75 degree centigrade that time ETS1 operates through thermostatic switches, R1 coil gets energized. R1 contactor picks up, hence it's open contact closes, now current from wire 71 flows through resistance TCR comes to wire 72 and completes circuit with wire 4 on ECC coil, ECC coil gets energized, in turn this coil starts revolving with outer drum as such radiator fan starts working with slow speed because of resistance TCR.

2. When water temperature raises more than 80 degree centigrade that time ETS2 operates and completes circuit with wire 4 through R2 coil. R2 contactor picks up and, it's contact 71-72 closes. Now current from 71 flows to wire 72 without any resistance to ECC, which gets energized and now radiator fan rotates with full speed.



Trouble shooting in water cooling system

26.0 Radiator fan not working:	
Defective engine temperature switch (ETS).	Gently tap on the ETS body.
Defect in radiator fan contactors R1 and R2 (as a result, fan does not state operate automatically at low and high speeds at 75° C and 80° C respectively).	Check R1 and R2 contactors in the back of control compartment. Secure them if not taking proper contact by giving suitable packing. Before doing this ensure that R1 and R2 tip surface is OK. If there is any dust or insulation tape in between, remove it.
Eddy current clutch (ECC).	<ol style="list-style-type: none"> Carbon brush of ECC to be checked for being worn out, pig tail broken or not touching the slip ring. If so, increase the length of the carbon brushes by providing sufficient packing in the cap of brush pocket stretching the spring. Wire terminal on ECC coil (inner drum) may be loose. Tighten properly. Check for loose/broken wire connection in junction box provided on the floor near ECC. Secure it properly.
Note: In case all the above steps fail, operate manual switch for fan operation provided on the control panel.	
Note: Some locos are provided with digital water temperature panels. Malfunctioning of panels due to dust and water accumulation in the sensor switch terminals (B & C) clean and attend.	
Action: Put MRF in on position and proceed. Observe temperature gauge (conventional).	
Warning: All the checking to be carried out after shutting down the diesel engine.	

DAY-7

3rd & 4th session (02.50Hrs):

Explanation of Compressed Air System with related Components

Training Objective(s):

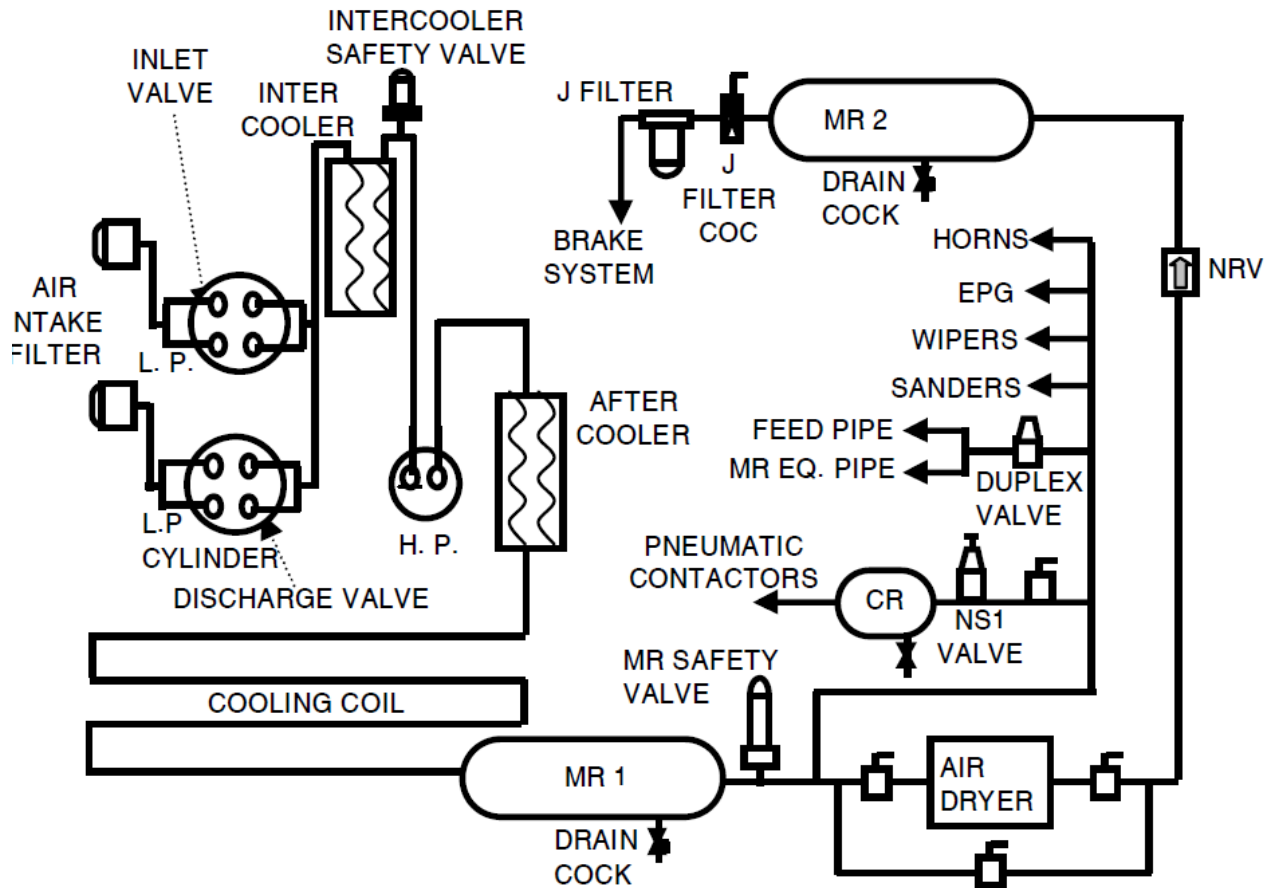
On completion of this lesson, trainees will be able to:

- a) Describe the compressed air system.
- b) State the location & operation of related components.

DESCRIPTION:

Locomotive equipped with IRAB-1 Air Brake system have compressor unit which furnishes compressed air for purposes of locomotive control and air for the train brake. Power to drive the compressor unit comes from the diesel engine through a flexible coupling. Compressor consists of three sets of cylinders and cylinder heads, two pair for first stage (Low pressure) and one pair for second stage (High pressure) fitted in a W form on a crankcase. The crankcase the crankshaft and connecting rod assembly which receives and converts circular motion into reciprocating motion. The drive is taken from the locomotive. When crank shaft start rotates compressor also start functioning. Air suck from atmosphere. Air passing through a strainer enters the compressor intake.

Since these compressors are of the compound type, each is fitted with an intercooler through which the discharge air from each low pressure cylinder passes to the intake of the high pressure cylinder. The use of an intercooler reduces the temperature of the discharge air and improves the volumetric and overall efficiency of the compressor. The intercooler is of the radiator type, employing finned copper tubing mounted between cast iron headers the intercooler is divided into two halves, one for each of the low pressure cylinders. The low pressure discharge air enters the intercooler, through a side header leading to the top or upper header where it is directed down through part of the tubes in the one-half of the intercooler and back up through the remaining tubes in that half, in this way the air from each low pressure cylinder is so directed through its half of the intercooler that, in passing to the high pressure cylinder the air has traveled approximately twice the length of an intercooler tube. After passing the tubes, the air enters a common passage leading to the intercooler safety valves and to the inlet side of the high pressure cylinder. Safety-valves are employed to protect the intercooler against excessive pressure. These valves are set to open at 60 psi.



INTERNAL OILING SYSTEM OF COMPRESSOR :

A chain driven/ gear driven oil pump circulates oil under pressure through the system.

Before the oil goes to the pump it is filtered. The filter consists of a housing incorporating a fine straining screen of large area through which the oil flows on its way to the pump body.

An oil pressure relief valve, mounted in the oil pump housing, protects the pump and associated parts against excessive pressure. Lifting of floating valve which provided on the compressor body, indicates the working of the pump.

ELECTRO PNEUMATIC GOVERNOR(EPG):

The electro pneumatic governor is working with pneumatic pressure and electric supply.

When the compressor is charging the pneumatic circuit the air pressure is building up. When the air pressure exceeds the cutout pressure, pressure switch makes contact to give electrical supply of 72 V DC to magnet valve to energize the coil, which will connect the inlet air pressure to outlet to off- load the compressor or to actuate auto drain valve etc. When using the compressed air pressure for different application, air pressure drops down. When the air pressure is sufficiently reduced below the cut-in pressure setting of the pressure switch the pressure switch will break the electrical supply to the magnet valve for de-energizing the coil resulting in connecting the outlet pressure to atmosphere for compressor to start building up the air pressure in the circuit.

DAY-8

1st session (01.40Hrs):

Description of Expresser, & checking of Expresser oil

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) Explain the Expresser.
- b) Checking of expresser oil.

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 crankpin 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.

—

Air Compressor Lube Oil (Bayonet Gauge types):

This bayonet gauge is having one full mark with six dots. Oil level should be at full mark but should not be below the 4 dots while counting from bottom.

Sight Fit Glass:

Sight glass is provided with three different marks on it. Oil should be with full glass or $\frac{3}{4}$ glass but not less than $\frac{1}{2}$ glass.

Dial gauge:

In some locos it has been modified with a dial gauge with three colour bands, red, yellow & green indicating Full, Add & Empty respectively.

Floating Valve:

On compressor unit a float valve is provided which indicates air compressor lube oil pressure. At idle speed, the floating valve spindle will lift $\frac{1}{2}$ " and $\frac{1}{2}$ " to 1" as the notches open. The oil capacity is 21.8 lt.

DAY-8

2nd & 3rd session (03.10Hrs):

Different Pressure Gauges of diesel engine and their locations & functions

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) State the location & function of pressure gauges in diesel loco.

Gauges in control stand:

1. First Gauge from Left Side: (BP & BC gauge)

It is provided with two pointers, one is white and the other is red. The white pointer indicates the brake pipe pressure, which should be 70 psi or 5 kg/cm². It is adjusted by brake pipe pressure feed valve in WDM₂. The red pointer indicates brake cylinder pressure, which should be 3.5 kg/cm² (for ghat section) & 3.0 kg/cm² for level section, when the SA-9 (independent) brake valve handle is in application position and it will show zero when the loco brakes are released. It is adjusted by brake cylinder pressure regulating valve.

2. Second Gauge from Left Side (MAR & FP):

This gauge consists of two pointers, one is white and the other is red. The white pointer indicates feed pipe pressure 6 kg/cm² and red pointer indicates MAR₂ pressure, which should be 8.4 to 10.1 kg/cm².

3. Third Gauge Indicator (Vacuum-Reservoir or Vacuum Train Pipe Pressure Gauge):

The third gauge is for the vacuum with two pointers.

White pointer indicates the vacuum in the train pipe, which should be 21" or 52½ cm. Red pointer indicates the vacuum in the reservoir, which should be 25" or 65 cm approximately.

4. Fourth Gauge from Left Side (Vacuum-Brake Pipe Control Air Pressure Gauge):

It is a double dial single pointer gauge and is called Vacuum-control air pressure gauge. It indicates vacuum brake pipe control air pressure, which should be 24 to 25 psi or 1.68 to 1.75 kg/cm². With this air pressure, it is possible to obtain 21" or 52½ cm of vacuum. This pressure is adjusted by HS-4 valve.

Note: In modified locos (IRAB) there are three gauges, i) BP, ii) BC, iii) MAR & FP. Air flow indicator also provided in both control stand.

Gauges in control pannel:

Lube Oil Pressure Gauge:

In WDM₂, it is provided in the cab room on short hood side. The lube oil pressure starts building up immediately along with the rotation of crankshaft and is indicated by the pressure gauge. The working pressure should be 1.6 to 3.5 kg/cm² in WDM₂. This pressure will be low at idle speed and high at higher notches, as the pump speed increases according to the crankshaft rotation depending on the throttle notches. If the pressure drops below 1.3 kg/cm² the diesel engine will shut down

Fuel Oil Pressure Gauge:

This gauge is located near lube oil pressure gauge as stated previously. The fuel oil pressure starts building up as soon as the booster motor starts working. The pressure should be in between 2.5 to 3.2 kg/cm² since the pump speed is constant. The fuel oil pressure will be high at idle speed and oil pressure decrease with increase in notch.

Booster Air Pressure Gauge:

This gauge is located near lube oil pressure gauge and fuel oil pressure gauge.

This gauge indicates turbo super charged air pressure inside 'V' shaped air manifold.

It should be in between 1.05 to 1.26 kg/cm² on 8th notch with full load and on up gradient.

Note: No pressure will be indicated on the gauge till fourth notch of the throttle and when loco is running on light engine.

This same pressure will be less on level section according to load and throttle notch.

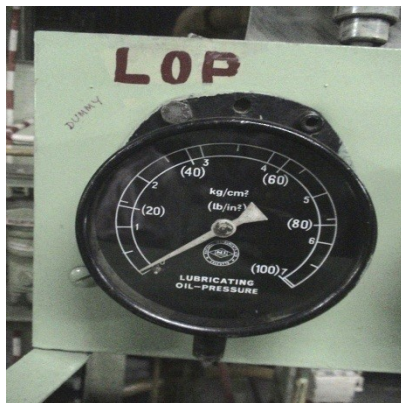
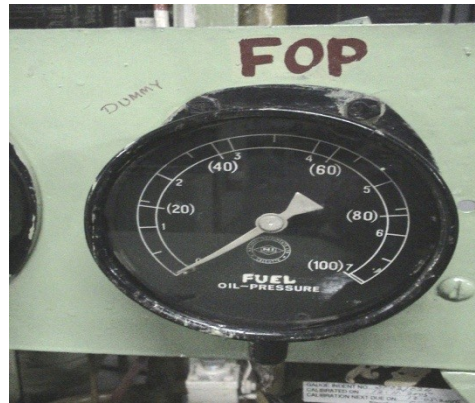
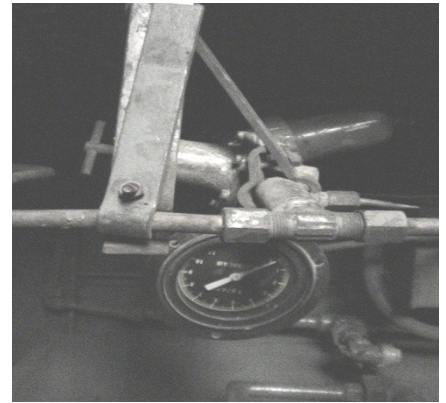
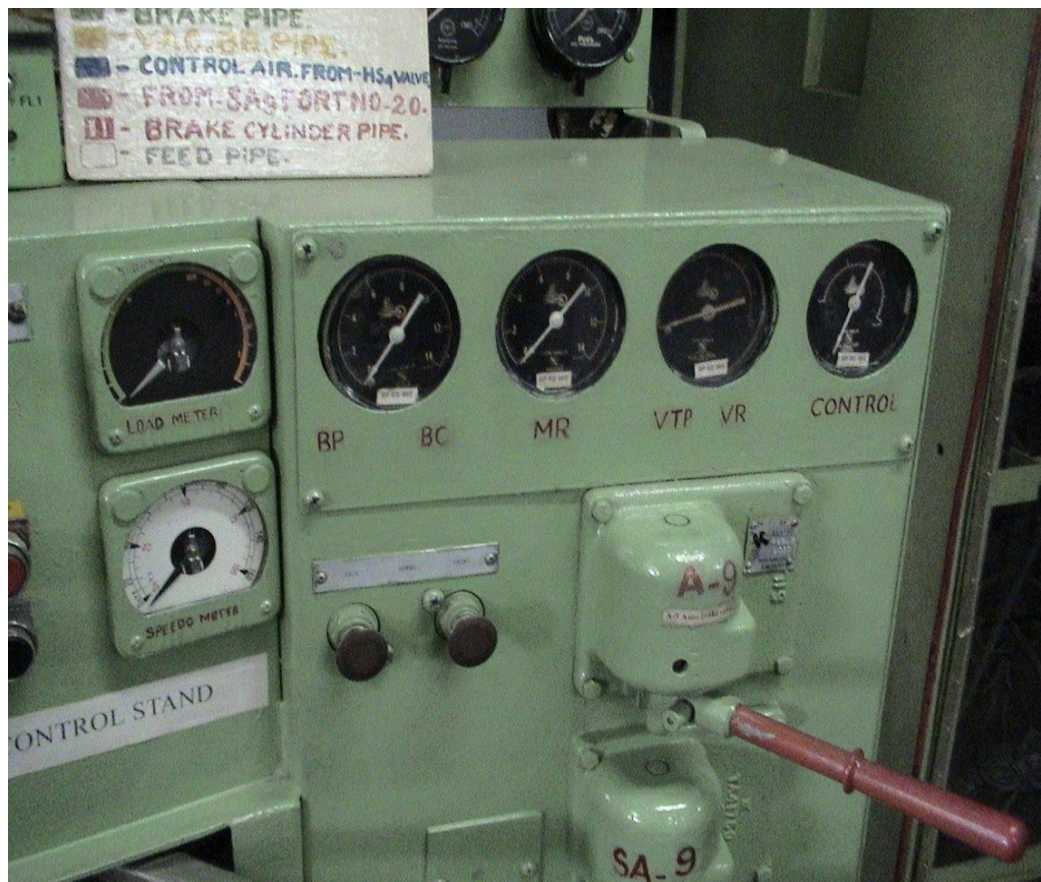
Napier model – 1.8 to 2.2 kg/cm²

ABB model – 1.6 to 1.8 kg/cm²

Control Air Pressure Gauge:

This pressure gauge is located in the short hood compartment of WDM₂. This pressure should be 5 kg/cm². The Main Air Reservoir pressure is reduced by N-1 reducing valve and is stored in the control air pressure reservoir. This air is called pneumatic control air pressure. This air is utilized to operate electro-pneumatic contactors such as power contactors, reversers, BKT etc.

(In some modified locos CP gau



DAY-8

4th session
(01.20Hrs):

Different
Handles of
diesel loco

and their position & functions

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) State the position & function of different handles

DIFFERENT OPERATING HANDLES AND THEIR POSITIONS

INDEPENDENT BRAKE VALVE (SA-9)

There are two positions of this valve handle on diesel loco

1. Application
2. Release

Application: At this position of the handle, the loco brake cylinder pressure adjusted to 3.5 kg/cm² on gradient section 3.0 kg/cm² in level.

Release: At this position of the handle the loco brake cylinder pressure comes to zero gradually and loco brakes released.

AUTOMATIC BRAKE VALVE (A-9)

In 28LAV-1/IRAB Brake System, it has five positions. They are as follows:

- a) Release
- b) Minimum reduction
- c) Full service
- d) Over reduction and
- e) Emergency

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

2. Neutral

3. Reverse

This handle is used to move the locomotive in desired direction. By alternating the position of the handle, the direction of flow of current to the traction motor can be changed. This can be removed or fixed in neutral position.

Note: Reverser position should not be changed without stopping the locomotive.

SELECTER HANDLE

This handle is located on both the control stands towards the other side of the throttle. It has three positions. i.e, Motoring, Off, Braking position

Motoring Position: At this position of the handle, BKT will be changed to motoring position and connect the traction motors with power for the movement of the loco.

There are four motoring positions i.e. 1, 2, 3 & 4. No. 1 position is the normal motoring position and transition will pick up according to the speed as per signal generated by the axle generator. If axle generator fails transition, can be done manually on some locos by putting this handle to no. 2 position for 1st transition, no. 3 for 2nd transition and no. 4 for 3rd transition.

Off Position: At this position of the handle, it disconnects traction motor power and dynamic braking circuit. Besides this, throttle handle is in lock position and cannot be moved from idle.

Braking Position: At this position of the handle, BKT changes to braking position and traction motor field coils connected to main generator and armature connects with grids. At that time traction motors work as generator and dynamic brake gets applied.

THROTTLE HANDLE

Throttle handle is used to change the speed of the Diesel engine by energizing or de-energizing the engine speed relay coils which in turn changes the fuel supply to the Diesel engine. It has total nine positions including idle position. Idle and first notch speed of the Diesel engine is same. Electric current to the traction motors and speed of the diesel engine both can be regulated by changing the position of the throttle handle.

DAY- 9(SUNDAY)

1st & 2nd session (03.50 Hrs):

Operations and functions of Various valves in Diesel Loco like MU-2B, F-1 SV, D24B Feed valve, Duplex Valve etc

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) Explain the functions of various valves in locomotives.

Various valves and cocks are provided in diesel loco.

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/cm² to 5 kg/cm² 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

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 three 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.

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.

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/cm² to charge feed pipe. **1 ¼ COC** - It is provided on air l

Duplex check v
is built up more
pipe pressure.

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

When MR pressure
ing pipe and feed

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 /cm².

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.

DAY-10

1st session (01.40 Hrs):

Loco air brake system (SA9)

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) State the procedure of loco brake application and release.

Description:

Independent Brake system (Loco Brake)

Loco brake system is provided to stop the Locomotive, whenever it runs as light engine. It is purely compressed air brake system known as independent brake system. For this separate air circuit is provided

in 28LAV-1 & IRAB-1 Brake system which is independent to other air circuit. SA9 Independent brake valve is provided in driving control stand for application & release of loco brake. Valve has two positions ie. release and application.

Purpose of this system

Independent Brake System is designed to apply and release brake on locomotive only, specially when the locomotive is moving independently.

System brake valves

System consists SA9 Independent Brake valve, Double check valve and C2-Relay valve.

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

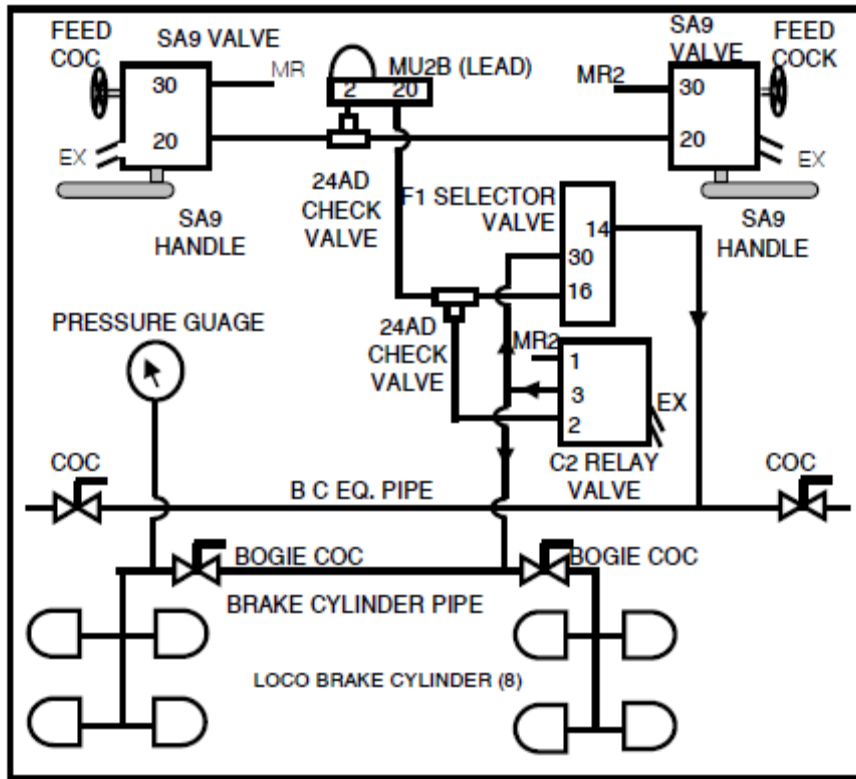
Application - In this position loco brakes are applied. Release - In this position loco brakes are released.

Loco brake application - When SA-9 valve handle is kept in application position its port no. 30 and 20 connected, adjusted pressure of 3.5kg/cm² 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 3.5 kg/cm² and goes to following places. A) Through boogie cut out cock to brake cylinder and operates loco brakes. B) 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/cm²
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 3.5 kg/cm² with the help of its feed cock.

DAY- 10

2nd session (01.40Hrs)

Related trouble shooting of Loco Brake (SA9)
And SA-9 operation in MU unit

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) Explain the trouble shooting of Loco Brake Application & Released
- b) State SA9 operation in MU(trailing loco)

Loco brakes not releasing:

- | | | |
|---|--|--|
| 1 | SA-9 handle on other control stand may be in applied position. | The same should be put in quick release position. |
| 2 | C2 relay valve may be in stuck-up position. | Tap gently. |
| 3 | MU-2B valve not making proper internal connection. | Keep MU-2B valve in 13° clock position between the 'lead' and 'trail' positions. |
| 4 | Defect in brake cylinder pressure. | Both control stand brake cylinder pressures is not equal. Adjust the pressure by the brake cylinder pressure-regulating valve. |

Loco brakes not getting applied:

- | | | |
|---|--|---|
| 1 | MU-2B valve may be in trail/dead position. | Keep in lead position. |
| 2 | Air brake cylinder COC may be closed. | Open the cocks. |
| 3 | Brake cylinders pressure less. | Adjust the pressure to 2.5 kg/cm ² through the regulating valve in the control stand. |
| 4 | C2 air relay valve may be defective. | Check the pipelines leakage and attend to it. Tap gently so that the valve will come on its proper seating. |

SA-9 operation in MU unit(Trailing loco)

In multi unit when SA-9 handle (Leading loco) is brought in application position MAR₂ air goes to brake cylinder via port no. 3 of C-2 relay valve, from this port no. 3, one connection is given to brake cylinder equalizing pipe through F1 selector valve(via port no 30-14). Both the brake cylinder equalizing pipes are connected with each other with their COC in open position. Hence, this air goes in the equalizing pipe of trailing unit. F-1 selector valve port no. 14 which is directly connected to the brake-equalizing pipe. In trail position this port 14 is connected to port no. 16 of F-1 selector valve, hence this pressure enters in port no. 14 and comes out from port no. 16 and through 24-A-Double check valve goes to C-2 relay port no. 2 and applies the locomotive brakes on trailing locomotive also.

Loco air brake (A9)& related trouble shooting

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) Explain the A9 system (charging, application & release) along with related trouble shooting.

DESCRIPTION:

AUTO BRAKE (A-9)

Compressed air from MAR₁ goes to MAR₂ through non-return valve. MAR₂ air is utilized in brake system. When master cut out cock remains open, MAR₂ compressed air charges into system after filtering in the 'J' filter. That MAR pressure goes to

1. Port no 1 of Add C-2 relay air valve through airflow measuring valve
2. Port no 63 of MU-2B valve.
3. Port no 30 of A-9 feed valve, and
4. MAR pressure gauge.

Charging

Keeping A-9 valve handle in released position, MAR pressure, which enters in to A-9 valve port no. 30 is adjusted to 5 kg/cm² by A-9 feed valve. On release position, port no. 30 gets connected to port no. 5.

When 3/8" COC of the control stand remains open, piloting pressure of 5 kg/cm² comes out from port no. 5 of A-9 valve and goes to port no. 3 of MU-2B valve. When MU-2B valve is in lead position, port no. 3 is connected with port no. 13. Pilot pressure comes out from port no. 13 and goes to add C-2 relay air valve port no. 2 also charges 110 Cubic Inch air reservoir. The pilot air pressure operates the spool valve causing the MAR pressure at port no. 1 of Additional C-2 relay air valve to find its way in same proportion as the spool valve operates i.e. at 5 kg/cm² and gets connected with port no. 3 of Additional C-2 relay air valve. This pressure of 5 kg/cm² goes to the train pipe when 3/4" COC is in the open position. From train brake pipe, the BP pressure always remains at to port no. 1 of the A-9 valve by another pipe. A thin pipe is connected to the brake pipe pressure gauge from the train pipe.

Application

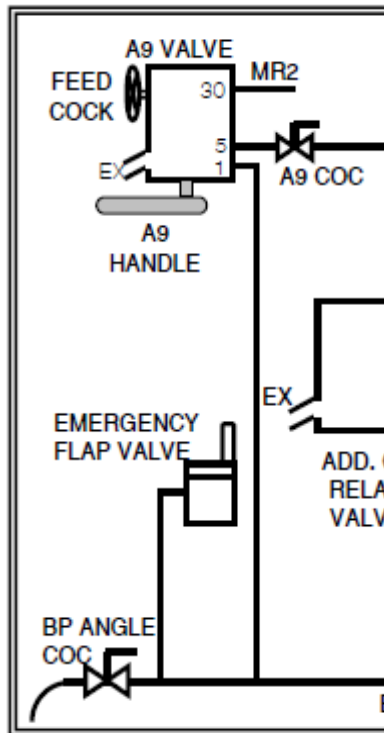
When the A-9 valve handle is kept in minimum reduction or full service at that time the port no. 30 get closed and MAR pressure stops flowing through port no. 5. Simultaneously port no. 5 connects with the exhaust port of A-9 valve. Air from port no. 2 of Add C-2 relay air valve exhausted to atmosphere by A-9 exhaust port, according to the pressure drop by A-9 handle via MU-2B valve (port No. 13 & 3). By which the spool valve of Add C-2 relay air valve also changes its position in accordance.

The pressure drops by A-9 valve will connect port no. 3 of Add C-2 relay air valve with the exhaust port, as a result the brake pipe pressure in the train pipe is exhausted to the atmosphere proportionally through the exhaust port of Add. C-2 relay air valve and the brake pipe pressure inside the train pipe also drops.

Releasing

When A-9 valve handle is kept in 'release' position, to release the brakes on train, at that time the exhaust valve of A-9 handle gets closed and port no. 30 (MAR regulating valve) gets connected with port no. 5 and via MU-2B valve it enters the ports of Add. C-2 relay air valve to maintain the pressure of 5 kg/cm². As a result the spool valve inside Add. C-2 relay air valve gets operated and comes to its normal position by which the exhaust port is closed and MAR pressure at port no. 1 enters proportionally in Add. C-2 relay air valve and comes out through port no. 3 to charges the brake pipe pressure inside the train brake pipe.

TROUBLE SHOOTING



BP pressure not builds up-

Reason	Remedy
1. Inadequate amount of MR pressure	Charge the MR up to 8-10 kg/cm ²
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

Explanation of synchronizing brake system .

Training Objective(s):

On completion of this lesson, trainees will be able to:

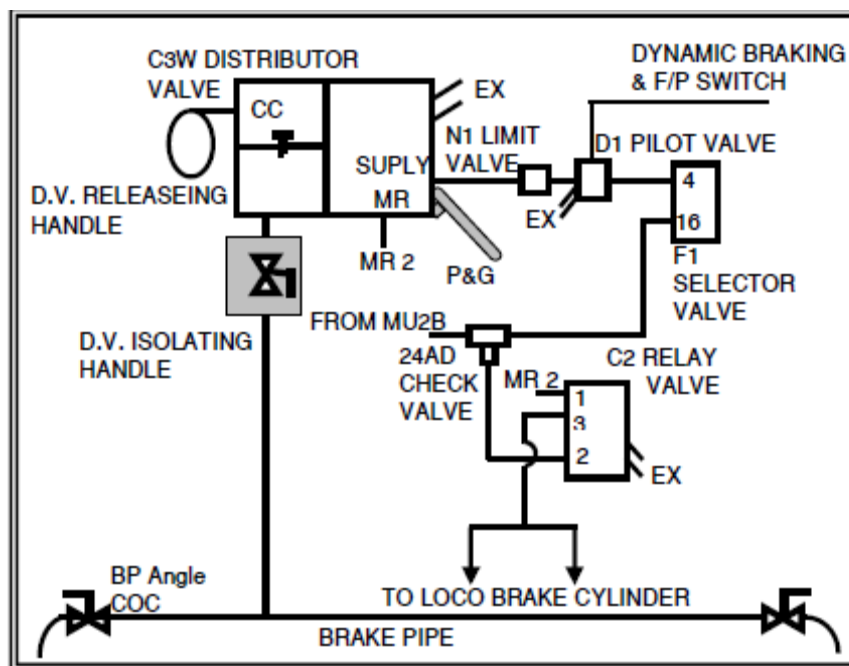
Explain the synchronizing brake system.

Synchronizing brake

The main components of synchronizing brake system are, C3W distributor valve , limiting valve, D1 pilot valve, F1 selector valve , double check valve and C2 relay valve

Application position - The C3-W distributor valve has three pipe connections viz. BP, BC, and MAR. When BP pressure is 5.0kg/cm² that time BP chamber and control chamber of C3W valve also charged with 5.0kg/cm², in this position distributor valve is in balance position and loco brake are in released position, but when train brakes applied through A9, BP chamber of C3W drop and distributor valve is operated. This valve allowed MAR pressure to N1 limit valve which is set on maximum 1.8kg/cm² pressure. Then this pr. goes to D-1 pilot valve (Rotex Magnet Valve) from here it enters the F1 selector valve at port no. 4 and comes out from port no. 16 and finally reaches the port no. 2 of C-2 relay valve through 24 AD check valve. Therefore MAR pressure waiting at port no. 1 of C-2 relay valve get a path through port no. 3 and goes to brake cylinder and loco brakes get applied.

Release position - When A9 handle kept on releases position to release train brake, again BP becomes to 5.0 kg/cm². At that time C3W distributor valve BP chamber and control chamber charged with 5.0kg/cm² 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



DAY- 11

2nd session (01.40Hrs):

Basic knowledge about Dynamic Brake.
Applications & Releasing procedure of Dynamic Brake.

Training Objective(s):

On completion of this lesson, trainees will be able to:

- a) State the Applications & Releasing procedure of Dynamic Brake.

DESCRIPTION:

It is an electrical brake applied the loco axle indirectly. It is applied to control the speed of train and to maintain constant low speed. It works efficiently at the speed of 20 to 45 km/hr.

Application:

- 1) Put TH in 'Idle'
- 2) RH in desired direction.
- 3) GF switch may be ON or OFF.
- 4) SH shift to "OFF" then to big B or D position .

Following changes takes places .

All Traction motor armature & fields will be separated , Traction motor armature will be connected across dynamic grids.

- 1) All Traction motor fields will be connected in series with Traction generator including the Traction generator series field (This is done by BKT & 5 power contactors, P₁, P₂₁, P₃₁, P₃₂, S₁)
- 2) Engine speed comes to 4th notch RPM for proper cooling effect of Traction motors armature.
- 3) Traction generator field excitation re-calibrated to reduce excitation.

Release:

- 1) While not using the air brake / vacuum brake, reduce dynamic breaking slowly, when load
- 2) meter pointer indicates at first white lines on the green scale to prevent the slack ran out. After that the handle can be moved to 'off' or 'zero' position.
- 3) When releasing dynamic brake after a service application has been made depress the independent brake handle in quick release position and move the selector handle to "off " or "o" position because of dynamic brake is released before depressing independent brake handle a rapid loco brake cylinder pressure will build up, which may result in locked axle flat wheels.

Precautions:

- 1) If speed is not reduced as desired the auto brake may also be applied, but the independent brake will not work in conjunction with auto brake, since the dynamic brake is inter locked with independent brake.
- 2) Emergency application should be avoided, because it cuts off dynamic brake.
- 3) Do not apply dynamic brake if you experience power ground on application of dynamic brake.
- 4) Bring SA-9 to quick release before applying dynamic brake.
- 5) Always observe 750 amps. Upto 94 kmph and 600 amps. Above 94 kmph.

NB: In which two BKT are provided except P2 & P22 all power contactors picks up, and where only one BKT provided except P2, P22, S21 & S31 all 5 power contactors picks up.

Benefits of Dynamic Brake Application

- 1) By the application of dynamic brake and due to bunching of all vehicle train moves smoothly and gradual reduction of speed takes place.
- 2) It implies non contact of brake block with wheel and as such reduces the wear and tear of wheels and brake block. It prevents the over heating of wheels.
- 3) It is beneficial for time saving compared to controlling of train through Auto brake application

Disadvantages

This brake becomes poor after train speed comes below 15 Kmph. So, it should be released while approaching a stop signal for the stop dead purpose when the train speed becomes below 5kmph

DAY- 11

3rd & 4th session (02.50 hrs):

Excitation system of conventional & MEP loco.

Training Objective(s):

On completion of this lesson, trainees will be able to:

Explain the Excitation system of conventional & MEP loco.

DESCRIPTION:

What is Excitation.

The voltage output of a generator depends on the speed of the armature and the amount of field excitation. The current, on the other hand, depends on the circuit connected to the generator (usually called "load"). In a diesel electric locomotive, the load is the combination of traction motors connected with their cables and switches. These motors should have the right voltage at all the times. To get the right voltage, the current in the generator field must be varied to suit the locomotive operating conditions. This is known as excitation control.

A diesel engine gives maximum fuel efficiency if it is loaded in such a way so that it develops constant HP with each throttle setting. In a diesel electric locomotive, load is the combination of traction motors, and the current through them varies with their change in speed. So to keep main generator power constant, the output voltage must be varied accordingly.

Excitation system controls the out put voltage of the main generator to (1) maintain constant horse power (2) limit the current at stand still condition of the locomotive (being the series motor, they draw excessive current at stand still. (3) Limit the voltage to avoid flash over at higher speed of the locomotive. For these jobs it must respond automatically to any movement of the throttle handle, to any change in load on the generator, or to any combination of both.

ELECTRONICS EXCITATION SYSTEM

In a locomotive, the load on the main generator at any fixed engine speed varies as locomotive track speed increases due to the counter EMF created by the rotating armatures of the traction motors. The load is also changed by shunting the traction motor fields or changing connections from series to parallel. Therefore, the excitation control must act to keep generator horsepower demand constant over a wide variation of terminal voltage to run the diesel engine with maximum fuel efficiency.

The "electronics excitation system" is a system using semiconductor components. The system controls exciter generator field current; i.e. the exciter output. The system provides the function of current limit, voltage limit on the generator and keeps the generator power constant at eight different levels as far as possible at each of the eight engine speeds available.

BASIC EXCITATION SYSTEM

Fig.3 shows a basic block diagram of the Electronics Excitation System. The exciter shunt field is fed from the locomotive battery through a network of resistors and exciter field transistor EFT1. The power transistor functions as a switch and is turned "ON" and "OFF" 800 times per second by pulses generated by the oscillator. The pulse width modulator (PWM) controls the duration of "ON" time as compared to "OFF" time during each pulse, thus regulating the average current in the exciter field. PWM responds to several "feed-back" signals as shown in the block diagram, Fig.3 and described in detail below.

Generator armature current is measured by a special reactor called armature current control reactor (ACCR). Generator voltage is measured by a reactor called voltage control Reactor (VCR).

The outputs of these reactors are fed to the reference mixer network. Only the greater of the two outputs is used at any one time. When the output of either ACCR or VCR is greater than the reference current, a current is put through the main winding of the pulse width modulator to limit generator excitation.

The function generator circuit modifies the output of ACCR in relation to generator voltage to produce the constant horsepower portion of the generator characteristic curve for notch 8. In the lower notches, the function generator also responds to engine speed to provide the proper separation of the notch curves.

SYSTEM COMPONENTS

EXCITER-GENERATOR

The exciter - generator is a shunt wound d-c machine. The generator is mounted on the traction generator gear box and gear driven from it at a speed proportional to engine speed.

EXCITATION PANEL

The excitation panel is a steel fabricated housing with component parts mounted on seven plug in type cards, which slide out of the housing for easy inspection. Three rheostats are mounted on the face of one card. One adjusts main generator characteristic and two adjust dynamic braking efforts.

OSCILLATOR

The oscillator is an a-c power supply used to supply power for various control functions. It operates from a d-c input voltage from the locomotive battery. The schematic diagram of the oscillator is shown in Fig.4.

The oscillator transformer (OST) has number of secondaries to supply a-c power to various circuits as follows:

WINDING	FUNCTIONS
1.	Excitation Transistor (EFT1)
2.	Oscillator Feed Back.
3.	Pulse Width Modulator (PWM)
4.	Spare
5.	A C C R.
6.	V C R.

The power supply consists of a saturating transformer alternately energized in opposite directions. Transistors which function as switch, causes flux reversal in the transformer core. The oscillator changes d-c input to a 400 CPS (cycles per second) square wave output.

To avoid the need for a stiff voltage divider for the oscillator supply, the fact that a series resistor having constant current in it will deliver the same voltage at its centre terminal is utilized. The principle is used in the self pulsing circuit by having a secondary winding on the oscillator transformer (shown at the top left among the various windings of the oscillator), feeding its rectified output through the resistors OVDR1 and 2 to maintain a current through these resistors proportional to oscillator secondary voltage.

If more load is placed on the secondaries, more current will flow through the resistors and the supply voltage to this oscillator will be decreased. This will decrease the voltage to the secondary supplying the constant current through its rectifier ERT3 and bring the current through OVDR1 and 2 back to normal.

The starting circuit consists of two sections utilising the resistor OR54, capacitor OC16, Shockley diode ORD3 and resistor OR55 in conjunction with the transformer winding connected across emitter of OT2 and negative and another section connected across the secondary supplying VCR. This latter section consists of ER13, ER14, EC11 and ERD5.

On initially starting the oscillator by energizing wire 50, a transient current will flow through OR54 and upward through the capacitor OC16, then down to the negative side of the battery. This will ordinarily cause the potential to increase at lower plate of the capacitor OC16. At a voltage (shockley breakdown voltage), the Shockley diode ORD3 starts conducting and the current flows from wire 38 to OR54, ORD3, OR55, transformer winding and negative.

The four windings in series are wound so that the voltages produced in them will all add together. In other words, this is like a single continuous winding with three taps. The current flowing upward through the winding across emitter of OT2 and battery negative, gives an induced emf. in all other windings with positive polarity on the lower end.

Positive polarity on the lower winding provides a small current flowing through the base to the emitter and through resistor OR3 back to the negative side of the lower winding. This turns transistor OT2 on fully. Meanwhile, the top winding has the reverse effect on transistor OT1 because it has applied a voltage across base emitter junction with positive voltage on the emitter "clamping" the transistor OT1 off so that no current can flow from its collector to its emitter. Current will flow from wire 38 through the transistor OT2 and transformer winding to wire 4 only as long as it continues to rise in the inductive circuit.

When it reaches a maximum value, the lower winding voltage will collapse and reverse the action on transistor OT2, clamping it off. This will result in a reversal of polarity on all the windings. Transistor OT1 will turn on, and current will flow upward from wire 38 through the collector of the transistor OT1 and its emitter to the transformer winding and back to the 4 wire. The action of each half cycle is the same in each half of the oscillator, with each of these halves alternating in function. Thus on the first half cycle and each succeeding odd half cycle, OT2 will conduct, and on the second half cycle and all succeeding even half cycles OT1 will conduct.

It is possible that when the system was shut off last time, the transformer might have been left saturated in such a direction that the current flow through the starting winding would be such as to try to further saturate. This could not be done. For this reason, the secondary feeding VCR during operation of the oscillator, charges capacitor EC11 on each positive half cycle through ERD5 and ER14, with some slight discharge occurring on each negative half cycle through ER13, but not enough to fully discharge EC11. When the oscillator is shut off, EC11 will discharge through ER13 and the secondaries feeding VCR in such a direction as to de-saturate it, so that the condition above, which would prevent proper starting, can not occur.

Rectifier ORD1 and capacitor OC2 permit the voltage developed by the inductive effect of the transformer windings between wire 38 and the emitter of transistor OT1 to be discharged without over-stressing transistor OT1 with voltage, when it is suddenly shut off. Thus capacitor OC2 is charged on each half cycle. To get it ready for the next charge, resistor OR1 is provided to discharge it. Rectifier ORD2 works in conjunction with OC2 in the same way on alternate half cycles.

The combination of ORD19 and capacitor OC1 protects the transistors in the oscillator circuit from voltage surges resulting from discharge of other inductive apparatus on the locomotive. These devices have nothing to do with the operation of the oscillator but simply provide protection for it.

ARMATURE CURRENT CONTROL REACTOR

The armature current control reactor is a measuring device which when powered by an a.c. source produces a signal proportional to main generator current. A reactor offers the advantage of isolating the output circuit from the main or high voltage input circuit. The a.c. input is fed to the a.c. winding from a secondary of the oscillator.

The reactor consists of a large busbar, two cores, two a.c. windings single turn d.c. winding and a 1740 turn d.c. winding. The large busbar is made to encompass the d.c. and a.c. windings. Fig. 5 shows a cross sectional view of the reactor.

The one turn d.c. winding is copper wire connected to the large busbar, and forming a parallel path for current in the busbar. The cores, with the a.c. and d.c. windings, are assembled around the one turn d.c. winding. The reactor is calibrated and the complete magnetic structure is sealed in epoxy.

The ACCR is connected in series with the main generator. The majority of the main generator current passes through the busbar with only a small fraction of the generator current passing through the single turn d.c. winding. Since the current in the single turn winding is directly proportional to the main generator current, it may be measured by the reactor to obtain a signal proportional to main generator current.

The more d.c. input in the one turn winding, the more a.c. output. If current is also passed through the 1740 turn winding, the a.c. output will increase. Further discussion of the use of 1740 turn winding is contained under the heading "Function Generator". The a.c. output of the reactor is rectified and fed to the mixer circuit.

VOLTAGE CONTROL REACTOR (VCR)

The voltage control reactor is a measuring reactor which provides a signal to the mixer circuit to limit main generator voltage. This reactor, part of the voltage control reactor card in the excitation panel, is a device about the size of a large pocket watch and enclosed in epoxy. The reactor consists of two cores around which an a.c. winding and two d.c. windings are wound.

The operation of the reactor is similar to the operation of ACCR, ie. more d.c. input the more a.c. output. One d.c. winding is connected through suitable resistors across the main generator and measures main generator voltage. Here again, a reactor is used so that the output circuit is isolated from high voltage input circuit. The circuit is adjusted so that the a.c. output of VCR will be greater than the a.c. output of ACCR when main generator voltage and current reach the upper corner point of the horse power curve.

The second d.c. winding is used on locomotives with dynamic braking. This winding is connected across the braking grids so as to measure traction motor voltage during braking. It operates to increase a.c. output in VCR the same as the other d.c. winding which measures main generator voltage.

PULSE WIDTH MODULATOR (PWM)

The pulse width modulator (PWM), mounted in the excitation panel, is a small self-saturating reactor with five d.c. control windings and two a.c. windings fed by one of the oscillator transformer secondaries. The function of the pulse width modulator is to control the time that the exciter generator shunt field is excited thus controlling the main generator output. This reactor is used in the excitation system to control rather than to measure.

The pulse width modulator contains two cores. There is an a.c. winding on each core; the five d.c. windings are wound about both cores. Refer to Fig.6 for simplified circuit.

The output of each a.c. winding is rectified and half of the input cycle is used from each coil. Since the oscillator frequency is 400 Hz, there will be 800 times ON pulses per second fed to the base emitter circuit of transistor EFT1. This causes the transistor to be fully turned on.

Referring to Fig.6 during the positive half cycle of the oscillator voltage at OST current will flow from point A through ERD13, the top PWM winding, EFT1 and resistor ER5. During the negative half cycle, current will flow from point A1 through ERD14, the bottom PWM winding and back to OST via the same path as the positive half cycle; this makes both halves of the cycle appear as positive pulses between B and C of Fig.6.

This action of the d.c. windings is such that when current flows through them, they block the a.c. output for a period of time during each half cycle and thus reduce the duration of the turn-on pulse being fed to the transistor. Therefore, the more current flow in the d.c. windings, the shorter the pulse and, in turn the less average excitation for the main generator (Fig.7). Each of the various d.c. windings are wound with a polarity such that the current flowing through the winding to the dot shown at one end of the winding will be additive to currents flowing similarly in any of the other windings. The effect of current flowing through the winding to the dot is to turn off the pulse width modulator by making it saturate later in the half cycle thus producing a shorter transistor turn on pulse.

This principle of changing the pulse width or duration, which controls the turn-on time of the exciter field transistor EFT1.

The function of each d.c. winding is as follows:

1. Exciter suicide and stabilization winding reduces exciter voltage to nearly zero when GF contactor is open and also provides exciter stabilization when GF contactor is closed.
2. Main excitation control winding fed by mixer circuit turns excitation off to maintain proper load.
3. Wheel slip power reduction winding reduces excitation during the operation of wheel slip system.
4. Dynamic braking stabilization restrains changes in excitation to avoid roughness when going from one braking level to another.
5. Dynamic braking anti-negative control prevents the excitation system from producing excessive negative generator voltage when suddenly reducing braking effort called for by the engine man.

After the PWM saturates, its impedance falls almost to zero and most of the oscillator output voltage then appears across the transistor and ER5. This causes the transistor to conduct. It changes in average current flow through EFT1 and thus the exciter field, controlling the main generator.

Excitation system in MEP loco

DAY- 12

1st & 2nd session (03.20Hrs):

Explanation of transition & advantages.

Training Objective(s):

On completion of this lesson, trainees will be able to:
Explain transition system with its advantages.

DESCRIPTION:

Transition in WDM2 loco.

It is defined as the changing of electrical connections between main generator and traction motors at pre-determined speed of locomotive. It is automatically done on locomotive according to the signal generated by the axle generator as per loco speed, so that full speed of loco can be achieved

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.

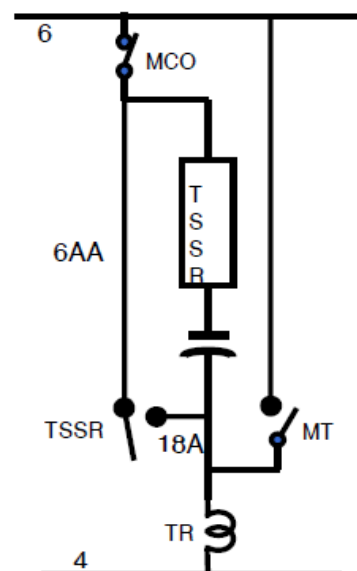
Transition chart -

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



nain

DAY- 12

3rd & 4th session (01.30Hrs):

Explanation of starting circuit .

Training Objective(s):

On completion of this lesson, trainees will be able to:

- 1) Explain starting circuit of DC/DC loco, (W.W.Governor).
- 2) start diesel engine.

STARTING CIRCUIT OF DIESEL LOCO (DC/DC) FITTED WITH W.W. GOVERNOR :

To start the diesel engine:

Close the battery knife switch; battery current goes in two directions. In one direction positive current flows through wire no. 49 to CK1 main contactor and BCB in control panel and negative current flows through wire no. 44 to CK2 main contactor and CBC in control panel.

When BCB is closed, positive current flows through battery ammeter wire no. 50 to FP contactor, MCCB1, and MFPCB1 on control stand. When CCB is closed, negative current flows through wire no. 4 to low voltage negative supply.

When MFPCB1 is closed, positive current flows, through wire no. 13C to MFPCB2 when this is closed, current flows through wire no. 13 and

energizes FPC coil and FP contactor makes contact and a sound is heard.

The positive current flows through wire no. 70 to the following :-

(i). CCE light resistance and CCEM light glows.

(ii). CCEMCB on control panel.

(iii). FPCB on control panel.

In this way, the glowing of CCE light is the first indication of engine starting.

Now close CCEMCB and CCE motor starts working and CCE light goes "OFF". After this close FPCB on control panel and fuel pump motor starts working and pressure builds up in fuel oil system. Fuel oil pressure gauge in the cab room shows reading 3.5 kg/cm^2 . In this way we get second indication of engine starting.

Now close MCCB1 and MCCB2 on control stand. Then positive current from wire no. 16A goes to

(i). DMR

(ii). On other side to both the control stands in throttle handle at idle position, selector handle at motoring position to MU run button on both control stands to wire no. 7A and wire no. 16 energises the DMR coil. DMR is pull up by PCS normally close interlock. Simultaneously it passes through OPS lower contact to

—

(i). CK2 normal close interlock, CPR7 diode to wire no. 50T. It energises D-valve solenoid.

(ii). On other side through wire no. 16M to engine starting lamp resistance and engine starting lamp glows.

(iii). On third side through wire no. 16N to ECS (on idle), energises LOR coil and LOR opens. In this way we get third indication of engine starting.

After getting the three indications, we move ECS "Idle" to "Run" position and give three warning bells.

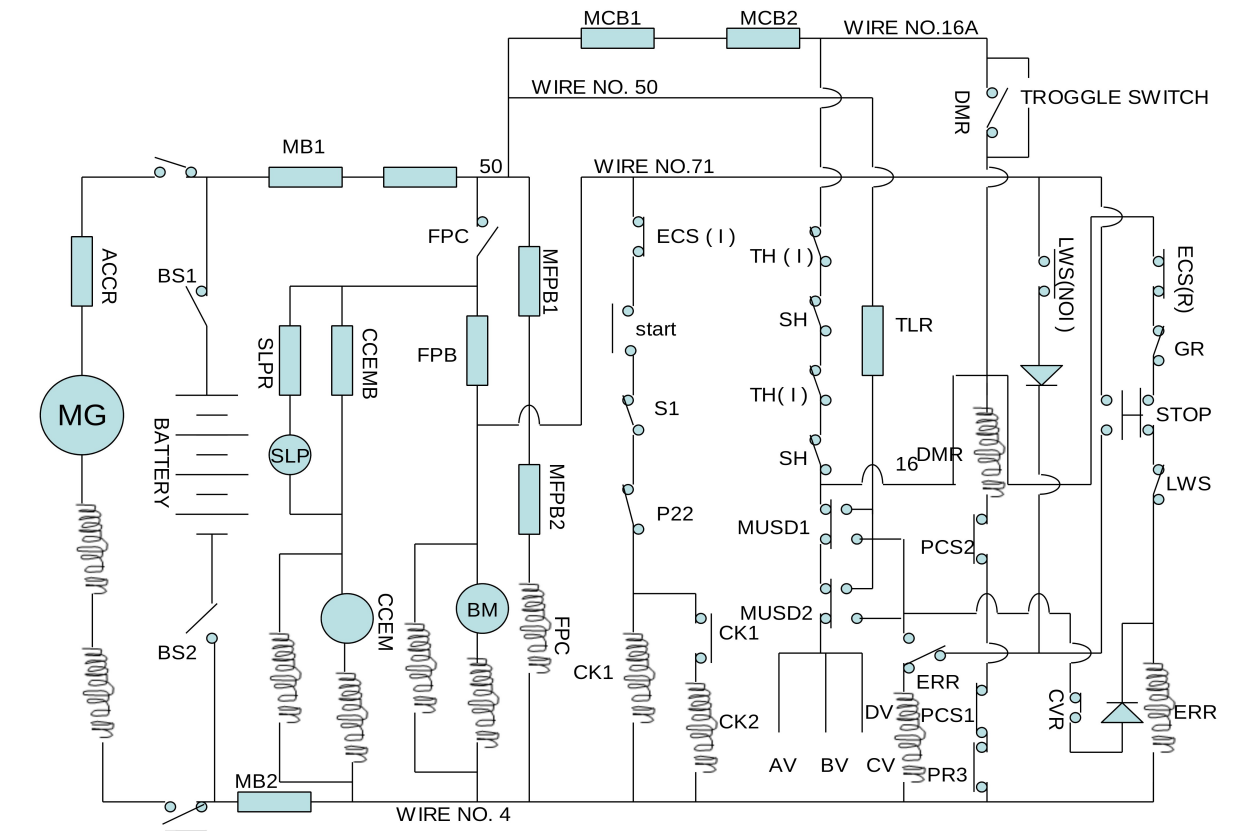
When ECS is in "Run" position LOR coil de-energises and LOR picks up, 16N-1B get connected and bell rings. When ECS is moved in "Idle" position, LOR coil energises, LOR opens and bell stop ringing.

When start button is pressed, positive current flows through wire no. 71 to ECS on Idle. The current from wire no. 50C to start button connects wire no. 43 to P22. From 43A, it goes to S1 normal close interlock and it picks up then wire no. 4 makes contact. CK1 normal open interlock close and CK2 coil energises.

When CK2 coil energises, CK2 contactor makes contact and CK2 coil normal close interlock opens, 50T wire current supply stops due to which D-valve solenoid de-energises and cranking starts. When the crankshaft revolves, the camshaft also starts revolving due to which Woodward Governor pump starts working and develops pressure.

Since lube oil pump rotates with the help of crankshaft gear, the lube oil system starts working; lube oil pressure gauge in the cab room indicates the reading of 1.6-kg/cm^2 pressure. When required lube oil pressure is acquired OPS makes upper contact and engine-starting lamp goes 'off'.

Release the start button, when we release the start button, CK1 and CK2 coils get de-energised and CK1 and CK2 stops supply to main generator. In this way the engine starts.



DAY – 13

1st & 2nd session (3.20 hrs)

Explanation of starting circuit of AC/DC loco with related trouble shootings.

Training Objective(s):

On completion of this lesson, trainees will be able to:

- 1) Explain starting circuit of AC/DC loco, (W.W.Governor).
- 2) start the diesel engine.
- 3) Shoot the troubles related to starting circuit.

Engine starting circuit (AC/DC, WW Gov.) with related trouble shootings.

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/cm². 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. 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/cm² 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.

Trouble shooting in starting circuit

5.0 Engine not cranking:	
ECS may be in RUN position.	ECS should be kept in 'Idle' position.
MUSD (MU shutdown) switch is placed at stop position.	Reset the switch position in RUN, MG-8 governor only.
Defective start button	i). Press and release the start button 4 to 5 times. The trouble may be rectified. ii). Loose/broken wire connection of start push button (attend to it by pulling out the knife switch, which should be disconnected before this).
Batteries in fully discharge condition.	This is indicated by fluttering or sluggish operation of CK1, CK2 and fuel pump contactors. In such cases, cranking may not be repeated.
ESR4 may be defective	Check operating coil condition, also check its wire connection for loose/broken, check if the interlock is taking proper contact. (If not clean the interlock tips with clean dry cloth) for MG-8 governor.
Note: ESR4 is on the top of the control compartment (on Electro-Hydraulic governor loco)	
Normally closed interlock of P22 or S1 power contactor may not be contacting properly.	i). Clean interlock and check for proper contact. ii). Check for wire connection of interlocks for slack/broken if so, attend to it.
Defect in CK1 or CK2	i). Check operating coil condition of CK1 and CK2. ii). Check wire condition of CK1 and CK2. iii). Check mechanical binding by flash guard, if so, attends to it.
Warning: CK1 and CK2, CK3 are to be attended duly opening the Battery knife switch.	
6.0 Engine cranking but not starting:	
Releasing the starting button before the starting light goes off or before LOP builds up to 1.6 kg/cm ² .	Hold the start button in the pressed condition till the starting light goes off or till the LOP builds, up to about 1.6 kg/cm ² .
No/low fuel oil pressure (FOP).	Check for no/low FOP.
Linkage of governor uncoupled or obstructed.	Check and disconnect the linkage. Remove the obstruction and connect the linkage again.
No oil in governor.	Fail the loco.
Insufficient lube oil pressure (LOP).	Check the reasons for low lube oil pressure and attend.
Over speed assembly or W/W governor plunger tripping.	Reset it.
Insufficient cranking speed.	May be due to weak batteries. In this case, loco may be started by pressing governor linkage, if possible.
LWS may have operated.	i). Water level in the expansion tank may be low. If the level has low due to leakage in the system, add clean water after arresting leakage. Make entry in the repair book. ii). LWS water COC may be not opening. Set it at correct position. iii). Ball LWS device may be punctured.
Note: If sufficient water is available in the tank and still LWS operates, treat it as false LWS alarm and if so, short wire no. 50D, 50J (in 16 series locos with WW governor these are wire no. 16K and 16E).	
WDG2	
CKR1	Check for normally open interlock for any welding, separate it. CKC main contactor for welding and stuck up.
CKC	
Stop button (Only for Wood ward Gov.)	Stop switch may be stuck up, operate manually severe times to release it.

Defective OPS (MG-8 Gov.)	Check for loose/broken wires and attend to it.
SAR interlock (MG-8 Gov.)	Check for normally open interlock for proper closing.
Am phenol plug (MG-8 Gov.)	Check for loose or uncoupling of Am phenol plug, secure it properly.
Tacho Generator	Check for loose/broken wires in Tacho Generator junction box. (When engine over speeding while cranking)
MUSD at start position (WW Gov.)	Put it in RUN position
Note: ESR4 is on the top of the control compartment (on EH Gov. loco)	
Warning: Water level should be checked in only non-electrified area whenever possible. Do not climb the loco in the electrified area under any circumstances.	
7.0 Engine shutdown (ESD) on release of start button:	
Defect in OPS	i). Check OPS lube oil line in the Nose compartment. If any, leakage attend to it. ii). Check the wire to OPS for loose/broken connections and if so, attend to it.
Defect in SAR (Safety Auxiliary Relay).	Check SAR coil and its interlock wire for loose/broken connections. Clean the interlock finger.
Note: SAR is in the right top of control compartment.	
Fuel rack binding.	Shut off the fuel pump motor; disconnect the rack from the governor linkage by taking out the pin. Now rack can be given movement 2/3 times manually. This may remove any possible obstructions.
Defect in lube oil circuit and LOP not building up above 1.6 kg/cm ²	Check for the reason for low lube oil pressure. (Given in item no. 16.0)
Defective Tacho Generator	Check broken/loose connection in Tacho Generator junction box.
Defect in LWS (Back side T-board)	Short with jumper wire 50D to 50J (MG-8 Gov.) and 16E to 16H in Woodward Governor.
8.0 Engine shutting down (ESD) during cranking with over speeding:	
Defect in Exciter Alternator (static)	i). Check wires in the alternator Exciter terminal box for being loose/broken and attend to it, if any wire is touching the box, insulate it and secure it properly. ii). Check the carbon brushes of alternator exciter for their proper fitment. These may not be coming in contact with the slip ring and if so, attend to it. iii). Check for loose/broken wire connections of carbon brush; attend to it if required;
Defect in SAR	Check for loose/broken connections of wire of SAR coil (SAR coil is in the right top of control compartment).
Broken/loose wires on engine control panel.	Attend to it if possible (ECP is in the right top of control compartment)
Fuel rack binding	Fuel rack may be in advanced position. Open linkage and operate several times to reset it.
9.0 Engine shutting down (ESD) with out any indication during working:	
Defect in battery charging circuit.	i). Output supply from VRP may be stopped. ii). Battery may be run down which will be indicated by battery showing towards discharge side (see 1.0 for reason).
Defect in circuit breaker	Check if fuel pump circuit breaker, AFPB or control panel Fuel pump circuit breaker on stand might be tripping.

Fuel pump contactor in control compartment de-energised. (not picking up).	While closing MFPB on control stand, check if FPC in control compartment is picking up or not. If FPC is not picking up, wedge the same with wooden piece. If any mechanical binding in the FPC, remove the same after switching off MFPB on control stand.
WDG₂	
Defect in TDR and CKR2 NC interlock AGFB and MB2 breakers.	Normally close interlocks may be in open condition along with MB2, reset it. Check AFGFB and MB2 breakers for tripped condition reset it.
Note: Even after wedging FPC, if still fuel pump motor is not working, see item no. 14.0	
10.0 Engine shutting down (ESD) with alarm:	
SAR defective	Check SAR interlock and coil wire for loose/broken connections. Clean the interlock finger.
MUSD switch might have taken STOP position.	Put in RUN position.
Engine shutting down with over speed trip (OST).	Reset the trip handle / plunger.
Lube oil pressure dropping below 1.3 kg/cm ² .	Check for reasons of lube oil pressure not building up a given in item no. 16.0
Low water switch operated.	Follow instructions as given at item no. 6.8
Fuel oil pressure trouble	See trouble shooting procedure at item no. 4.0
Less Governor oil	Check the reasons for leakage and fill up the oil with clean HSD oil and make a remark in the logbook. Loco can be worked onwards.
Warning: Do not fill oil from GD-80 or oil maze bath filters	
Defective Gov. linkage or uncoupling.	Check for any dropping of linkage pin and attend to it.
Gov.AMP plug (MG-8 Gov.) uncoupled.	Secure Governor Am phenol plug properly.
Defective Tacho Generator	Check for any loose/broken wires.
Defective OPS	Check for any loose/broken wires and attend it.

DAY – 13
3rd & 4th session (2.50 hrs)

Explanation GF circuit and DMR circuit with related trouble shooting.

Training Objective(s):

On completion of this lesson, trainees will be able to:

- 1) Explain the GF circuit and DMR circuit.
- 2) Shoot the troubles related to these circuit.

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

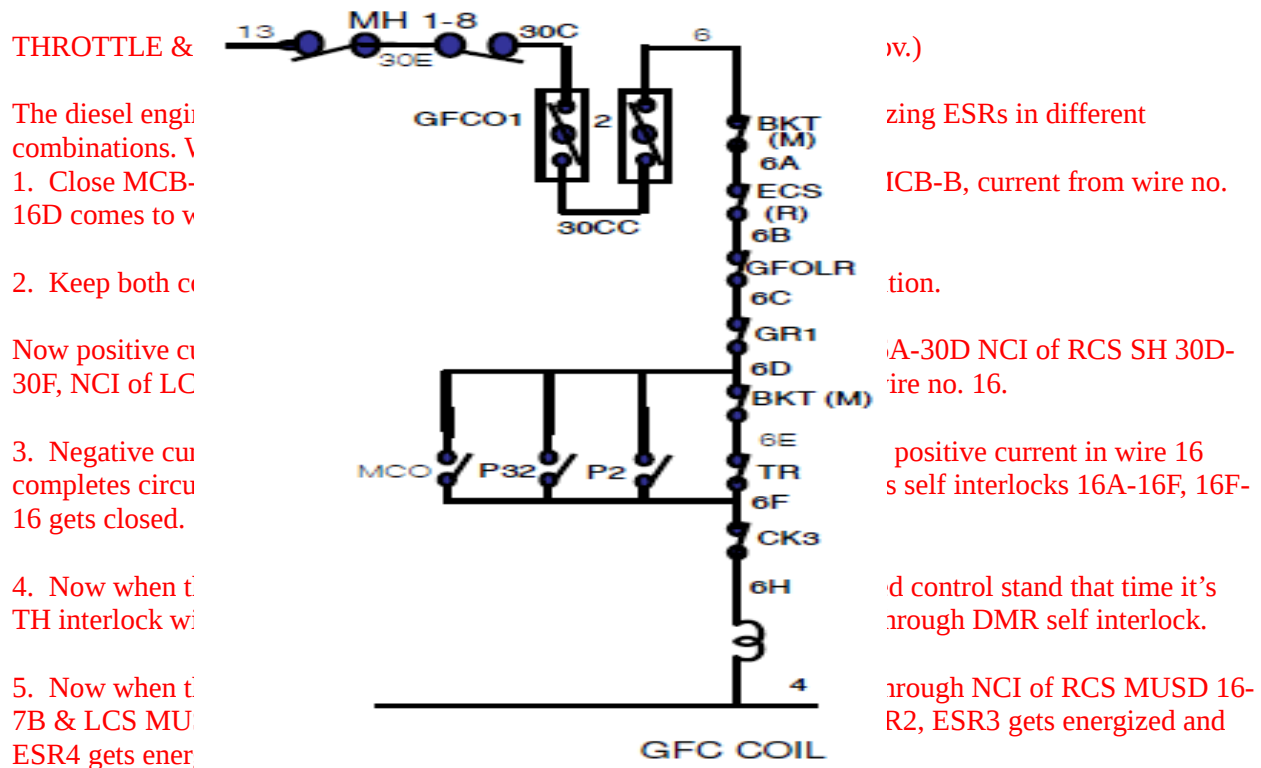
GR1 NCI 6C-6D

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.



6. In idle and TH notch no.1 no ESRs are picking up hence the D/engine speed is constant at 400 RPM.

7. On TH notch no.2 it's interlock 7A-15 will be closed and ESR1 coil will get energized and ESR1 will be picked up, which will add resistance in balance current to governor speed coil and the d/engine speed will increase.

8. On TH notch no.3, 7A-15 will get open and 7A-7 will get close and ESR3 will pick up.

9. On TH notch no.4, 7A-7 will remain close and in addition 7A-15 will get close due to which now ESR1 & ESR3 will remain closed.

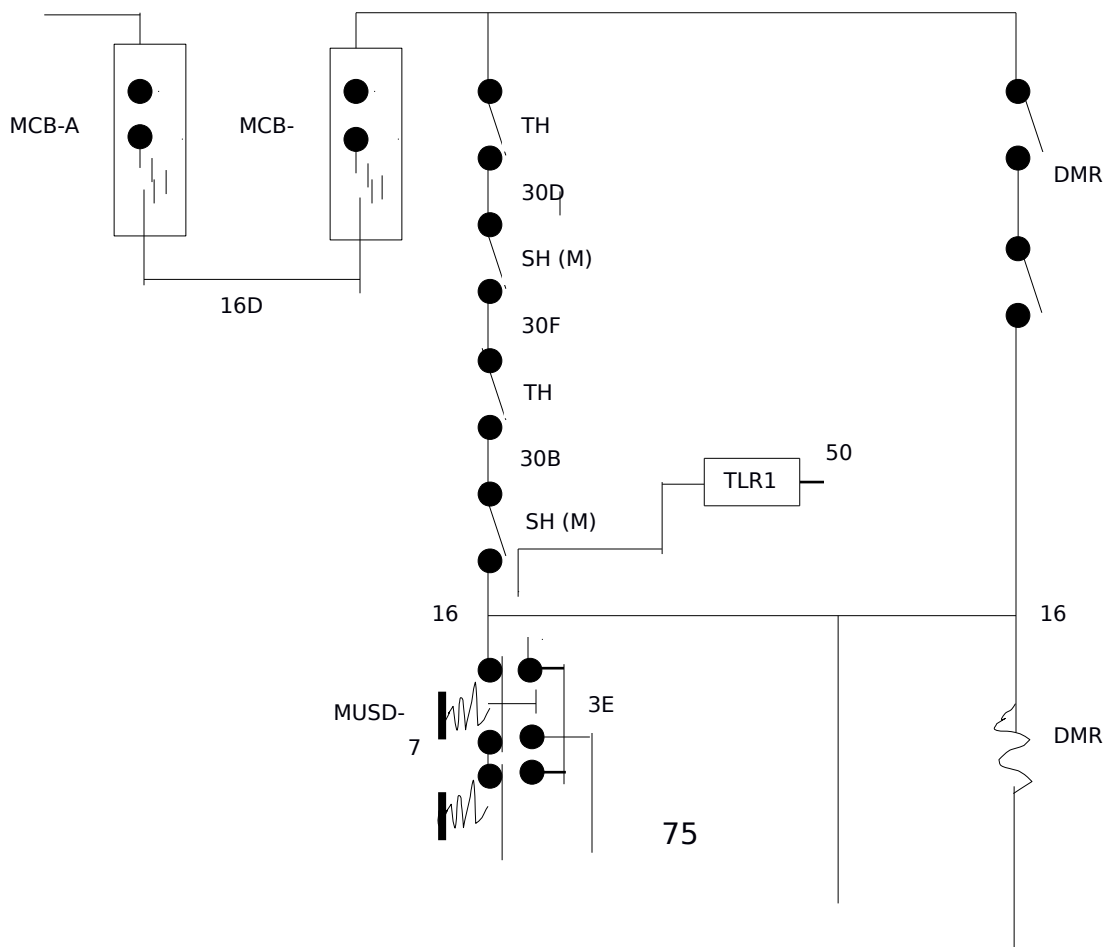
10. On TH notch no.5, 7A-15 will get open , 7A-7 will remain close and in addition 7A- 12 and 16-3 will get closed, now ESR2,ESR3,ESR4 will remain closed.

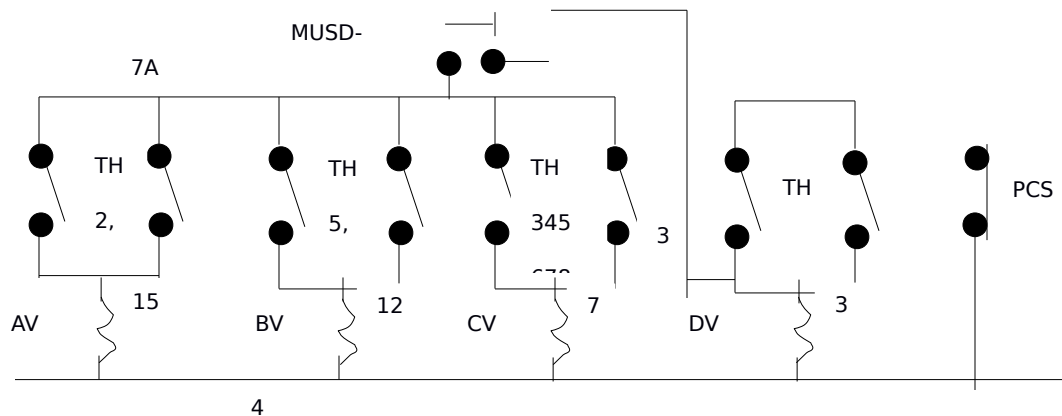
11. On TH notch no.6, in addition to ESR2,ESR3,ESR4 7A-15 will also get closed and hence ESR1 will also be picked up, it means all ESRs will remain closed.

12. On TH notch no.7, 7A-15 & 16-3 will get open due to which ESR1 & ESR4 will drop, but ESR2,ESR3 will remain picked up.

13. On TH notch no.8, in addition to ESR2,ESR3 7A-15 will get closed and ESR1 will pick up.

Note: To increase the diesel engine speed ECS should be on RUN, GR should be in de-energized condition, DMR should be in pick up position and if ETR is provided it should also be in de-energized condition.





DAY – 14
1st & 2nd session (3.20 hrs)

Explanation Battery charging circuit with related trouble shooting
Battery charging circuit

Tr

Or The batteries in Diesel loco are charged by the Auxiliary generator with constant voltage i.e. 72 ± 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.)

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.

DAY – 14
3rd & 4th session (2.50 hrs)

Different Circuit Breakers, switches, relay and contactor & their function

Training Objective(s):

On completion of this lesson, trainees will be able to:

Explain different Circuit Breakers & their function in locomotives.

DESCRIPTION:

Circuit breaker

It is a thermal switch act, as switch and fuse. It acts as a switch when circuit is opened or closed, operating this breaker normally and acts, as a fuse when excess current flows through it, will be tripped to open the circuit. It is safety device fitted in the close circuit to protect it from over current .It has three positions CLOSE, OPEN& Trip. In OPEN position toggle is downward position, in CLOSE 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 OPEN Position then after one minute take it to "CLOSE"

If again tripped, open and close after three minutes interval. It tripped for third time, repeat the same but with five minutes interval. If still tripped, no attempt should be made to close it. Its thermal plate may be melt. Inform DPC and act as per his advice.

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-energized condition, the contacts which are in open position are known as NOI

Normally Close Interlock (NCI) - When the relay in de-energized 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 demagnetized 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

1. 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

DAY – 15 (SUNDAY)
1st & 2nd session (3.50 hrs)

Generators and Motors in locomotive

Training Objective(s):

On completion of this lesson, trainees will be able to:

Explain different Generators and Motors provided in diesel locomotive.

Traction Alternator:

In AC-DC loco Traction Alternator is provided in place of Main generator. The traction alternator type TA10102CW is a salient pole, 3 phase, star connected, separately excited machine, is directly coupled with 3100 HP 16 cylinder Diesel Engine type 251 C. The series winding provided on the gear driven DC Auxiliary generator and exciter, will enable Diesel engine cranking when connected across the locomotive battery. The alternator roller bearing is splash lubricated from the auxiliary drive gear unit Gear box oil capacity 5 liters approx. Three phase output of the Alternator with varying frequency and voltage depending on rpm of diesel engine and excitation level. Maximum rpm of rotor is 400 -1050 rpm, and no load voltage is 1130 volt DC. Current produced by alternator armature (stator) is given to rectifier block; it converts AC into DC, which is mounted on the top of the alternator. The rectified output from rectifier is fed to 6 DC series Traction Motors which in turn move the locomotive. The rectifier is now force cooled from a high capacity blower unit, mounted on the power take off unit. To meet the power requirement of high capacity blower unit, a higher capacity power take off unit type PT70AZ has been specially designed and mounted on the traction alternator gear box. In the new version of Traction Alternator system, the Rectifier is mounted on the stator frame of Alternator. The electrical connections are taken from the Traction Alternator to the Rectifier through flexible copper leads. The rectifier is self cooled by Alternator fan.

Auxiliary Generator: - Auxiliary generator is a 6 pole, shunt excited, wave wound self-ventilated DC machine. A series winding is provided on the main poles to work as series motor for starting purpose. The auxiliary generator is located at the left-hand side of the Alternator at the power take-off end. It is mounted on Traction Alternator gear box, and driven by the bull gear wheel meshing with the pinion on the Auxiliary Generator shaft. Auxiliary generator/ exciter is specially designed to meet the cranking requirement of diesel engine on alternator/ rectifier system of diesel electric locomotives. Both machines put together when connected across the locomotive battery provide the necessary cranking effort and enable diesel engine cranking, in addition the normal functions as Exciter and Aux. Generator. It produces low voltage DC (75 V, 160 Amp 900 TO 2500 RPM) and after being regulated to 72 V with the help of VRP (voltage regulating Panel) it is used for charging the batteries and to supply the low voltage circuits, crankcase exhaust motor, booster motor, lights and control circuits etc.

Exciter generator: -

This generator is located at the power take-off end and is gear driven by alternator's armature shaft gear. In E-type excitation system, this Generator produces DC (75V, 250 Amp 2500 RPM) and is used to excite the alternator field.

Exciter is specially designed to meet the cranking requirement of diesel engine on alternator/ rectifier system of diesel electric locomotives.

Booster Motor:

This motor is located on right side of the diesel Engine in front of expressor on loco frame. It gets current from low voltage circuit supplied by battery or auxiliary generator, after being converted to AC by an inverter. It drives two pumps namely governor pump and fuel pump. Fuel oil pump is towards the main generator and the governor oil pump is towards the radiator room. The governor oil is fed at 130 psi and fuel oil at 3.6 Kg/cm² (PGE governor equipped loco gov. oil pump not fitted with the booster Motor).

Traction Motor:

The Traction motor (TYPE TM4907AZ) is a D.C. series wound, four pole, forced ventilated machine arranged for axle mounting on roller bearings,

The pinion which is shrunk on the armature shaft, drives the loco axle through a spur gearwheel which is pressed onto the axle.

In WDM2 and WDM2C the arrangement of T/M are LLR/LRR and in WDG2/WDG3A it is arranged in LLL and RRR form. The gear ratio of armature pinion and drive gear in WDM2 is 18:65 and in WDG3A it is 18:74.

The motor is forced ventilated. Air supplied by FTTM & RTTM blower, enters the motor through a duct system connected to an opening on the motor frame at the commutator end. The cooling air then flows in two parallel paths, one under the commutator through the armature core ducts, and the other along the outside of the armature and between the field coils, and is discharged through the openings provided at the pinion end of the frame.

In motoring condition, when the alternator current flows to the traction motor, a torque is produced by the traction motor, which in turn moves the loco (wheels).

In braking condition, the traction motor works as a generator and produces a retarding effect on the armature, resulting in decrease of loco speed.

Tacho Generator:

This is located at the power take off end below the cylinder no.- 8R.

The tacho generator is a 3 phase, 6 pole permanent, magnet a.c. machine. The tacho generator (TYPE AG 1404AZ/M) which is mounted on and is gear driven by diesel engine, supplies electrical signals proportional to the engine speed. These signals are used for maintaining engine speeds at required values, for notch separation and to control horse power limits. Gear Ratio 1:2.384

Dynamic breaking blower motor (BKBL):

Dynamic breaking blower motor (BKBL)(type DY3423/M) is a four pole series wound, self ventilated DC motor having an axial-flow fan on each of the shaft ends, located in nose compartment. The fans provide cooling air to the dynamic braking resistors. It has two blowers each mounted at either end of armature shaft. The motor is connected across a section of braking resistors.

Far speed is, therefore, dependent on the amount of braking current flowing through the resistors.

Continuous rating: 325 V, 175 A, 3500 RPM, 52.5 KW.

This machine draws current from traction motor armature, now working as generator by dynamic breaking application. As the armature current passes through breaking resistors there will be always heat due to current flow. The blower supplies sufficient air for cooling the grids upward direction and hot air will be exhausted through the louvers.

The LP should ensure that while dynamic breaking application that BKBL is working satisfactory. The louvers should lift up properly and should come back to original position while releasing the selector handle.

Axle Generator:

The Axle Generator (TYPE AG903AZ/M) is a permanent magnet single phase a.c. machine which is mounted on axle of L2 wheel and directly driven by the locomotive axle supplies speed dependent electric signals for initiating the Transitions". The output of the Axle Generator is also fed to an electrical speedometer to indicate locomotive speeds. This variable a.c. voltage is fed to a panel mounted transformer, rectifier and filter. The outcome is a d.c. signals which is used for operating motor main contractors and field weakening contractors so as to set required traction motor combination and field strength.

Crankcase Exhauster Motor:

This exhauster motor is located on the left side over the engine block at the power take off end near L-8 cylinder. It is a AC motor, fed with low voltage current supplied by battery or auxiliary generator, after

being converted to AC by a inverter. Its function is to rotate a blower which is used to exhaust the oil fumes & and vapours from the crankcase and creates vacuum of about 1.5” to 2” during engine working. The accumulation of hot gases (oil fumes) in the crankcase would cause damage to the engine bearings. To avoid such damage a safety device is also provided i.e. in case of failure of exhaustor motor; the explosion door would explode due to pressure of gases. The working of the exhaust motor is indicated by amber colour light on indication panel. The amber colour light remains extinguished till such time crank case exhaustor motor works and will glow as soon as the exhaustor motor fails to work. If there is any doubt about non working of exhaustor motor stop the locomotive, and check if any gas is escaping from the exhaust pipe.

Note: A few locos have been provided with modified spring loaded explosion doors which are located on any of the lube oil inspection covers over crank case. These explosion doors do not burst but whenever there is increased pressure inside crankcase, they keep open and come back to their respective seating as soon as the pressure is released

DAY – 16

1st & 2nd session (3.20 hrs)

Different Safety Devices fitted in Diesel Locomotives

Training Objective(s):

On completion of this lesson, trainees will be able to:

Explain the different Safety devices fitted in Diesel locomotives.

DESCRIPTION:

There are 15 safety devices fitted on diesel loco. They are as follows:-

1. Flasher Light
2. Alarms
3. Circuit Breakers
4. Load Meter
5. Speedometer
6. Battery Ammeter
7. MU Run Button
8. Oil Pressure Switch (OPS)
9. Pneumatic Control Switch (PCS)
10. Explosion Door
11. over Speed Trip Device
12. Low Water Switch
13. Safety Valves
14. Woodward Governor Trip Plunger
15. Asst. Emergency Brake Valve
16. AEB
17. VCD
18. GFOLR
19. ACD

1. FLASHER LIGHT

It is provided in the diesel loco and EMU coaches just by the side of the headlight. Amber colour light in diesel loco and red colour light in EMU coaches are provided. It is a safety device and can be used effectively with great advantage to advise the driver coming in the adjacent line immediately to stop his train in rear of flasher light. It can be used for assistance from the adjacent engine crew to give message to the ahead station regarding help, to inform driver of the adjacent line regarding obstruction, fracture in the line ahead etc.

The flasher light is connected to the battery and gets low voltage current when switch is at 'ON'. A switch box is provided on short-hood control stand to operate the same whenever required. When the train is stopped in block section, due to any reason i.e. break down or failure or the adjacent line is obstructed. It should be switched 'ON' after switching 'OFF' the headlight to warn the approaching driver to control and stop his train to enquire the reason. The driver is to be informed about the obstruction and message to be handed over to convey to the next block station regarding any assistance is required. In case of any doubt about the obstruction on the adjacent line, the driver should operate the flasher light. Subsequently action for protection according to the general rules

must be taken after switching 'OFF' the flasher light and being satisfied switch 'OFF' and continue. The flasher light should be examined while taking over the charge, and in case it is out of order it should be endorsed in logbook, DPC and SCR has to be informed.

2. ALARMS

There are five kinds of alarms in WDM₂. They are as follows: -

- a. Wheel Slip Alarm.
- b. Ground Relay Alarm.
- c. Low Lube Oil Alarm.
- d. Hot Engine Alarm.
- e. Low Water Alarm.

a. **WHEEL SLIP ALARM**

There are two kinds of wheel slip alarms: -

- i. Intermittent wheel slip alarm.
- ii. Continuous wheel slip alarm.

Intermittent Wheel Slip

This wheel slip takes place generally due to wet railhead or dews of fogs, oil or dry leaves on the railhead or brake binding on train. In such cases the white light and the buzzer both are indicated intermittently and load

meter pointer will also fluctuate. When the alarm rings, the throttle is to be closed and after the alarm stops apply sanding and then open throttle smoothly and carry operation.

Continuous Wheel Slip

This may cause due to the slipped pinion or locked axle. In such cases the white light and buzzer will sound continuously and load metre will drop to zero as long as the power is applied. Then bring the throttle to 'Idle' position or 'close' to stop the alarm. Then stop the locomotive and check the reasons for slipped pinion or locked axle.

Testing of Slipped Pinion

Bring the locomotive/train to a stand. Apply Independent Brake. One of the engine crew will get down and another opens the throttle up to 1 or 2 notches. The staff observes that which traction motor armature gives any abnormal hissing/humming sound due to free movement of gear. Note the traction motor no. and make that traction motor isolation through MCO. Clear the section, otherwise ask to controller/DPC. As per their advice done work. If slipped pinion is not found, check for locked axle.

Testing of Locked Axle

Detach the loco from train and after releasing IB, move the loco slowly. While doing so watch if, any part of wheel is sliding over rails. If sliding, stop the loco and check if brake blocks on particular wheels are binding. If not binding, fail the loco for locked axle, inform the DPC and do not move the loco further until diesel mechanic arrives and makes the wheels movable.

Note: If on satisfactory test for the above, no defect is detected and fault persists, shutdown the diesel engine, open all the circuit breakers and battery knife switch. After a while restart the engine and apply the power to the traction motors. If wheel slip warning still indicates, take it for electrical fault and inform DPC.

b. **GROUND RELAY ALARM**

There are two kinds of ground relay alarm.

1. Starting ground relay alarm
2. Power ground relay alarm.

In case of the ground relay alarm, the ground relay will operate i.e., the pointer in it will come on the red dot, then engine speed will be idle and main generator power will also be zero.

Starting Ground Relay Alarm

It is experienced at the time of starting diesel engine. In case there is earth fault in the low voltage line, the indications are ground relay white light glowing, bell, ground relay pointer comes on red 'dot' and reset bottom will be tripped. When this alarm comes release the start button and reset the ground relay

reset button. All the alarm will stop. Again restart the engine and if the alarms comes again ignore it, do not release the start button till the engine is started, then reset the ground relay reset button and book the defect in the logbook.

Power Ground Relay Alarm

This will be experienced due to earth fault or short circuit in the high voltage line. It takes place generally (a) when the Throttle on notches and (b) during Dynamic brake is on application condition. The indications are:

- a. Ground relay white light glowing
- b. Bell ringing
- c. Ground relay pointer will come on 'Red dot'.
- d. Ground relay button will trip.
- e. Heavy jerks.
- f. Load meter comes to 'zero'.
- g. Power will cut off.
- h. Sound
- i. Engine comes to Idle-speed.

In such case close the throttle, turn ECS to Idle and reset the ground relay reset button. Then all alarms will stop, turn ECS to RUN and open throttle for normal operation. In all the case of power ground, must be recorded in log book and DPC should be informed with following particulars.

- a). Loco no. b). Train no. c). Train load d). Section e). Gradient f). Kilometre no. g). Time h). Throttle notch position i). Load meter reading j). Speed k). whether experienced during transition or during dynamic braking.

Note:

- 1). Three power grounds can be reset for continuing the operation and on the forth power ground stop the train, inform DPC and ask for advice.
- 2). If the power ground occurs for a long interval, the driver should use his decision to avoid failure if possible.
- 3). If it is experienced in particular notches, the driver should operate the locomotive on lower notches only.
- 4). If it is experienced at the time of particular transition operate the locomotive at the speed below the transition.
- 5). If it has take place during dynamic braking do not use dynamic brake.

c. **LOW LUBE OIL ALARM**

When the lube oil pressure drops below 30 psi or 1.3 kg/cm², lube oil alarm will be experienced.

The indications are

- i. Green light will glow
- ii. Bell will ring.
- iii. Diesel engine will shutdown.

In such case turn ECS to Idle, the alarm bell will be stopped and check for the following causes for which the low lube oil alarm may take place.

1. MU RUN, button if tripped.
2. Fuel oil pressure, if dropped abnormally.
3. E/H governor oil may be below the level mark of the bottom sight fit glass.
4. Over speed trip reset handle, if tripped.
5. Crankcase oil level if below low mark or contaminated with water.
6. Drain cock of Lube oil filter and strainer may open.
7. External leakage in lube oil system.
8. Lube oil filter or strainer is choked.

If the above defects are not found crank the diesel engine and watch the lube oil pressure. If the pressure does not build up within reasonable time (30 sec) may be due to internal leakage or choke in the system. In such case, do not crank the diesel engine repeatedly, to avoid battery from being discharged. Inform to DPC with full particulars and ask for his advice. Attempt should be made to start the diesel engine by pulling the governor linkage manually while pressing the start button. In case of WDM₂ as a last attempt, uncouple the acceleration link control device if provided and in working order and crank the diesel engine.

d. HOT ENGINE ALARM

When the water temperature reaches 90°C then hot engine alarm is started. Red light, bell ring indicates it. When this alarm begins, close the throttle handle immediately and check the water level in the expansion tank. Besides this, check the water temperature on the gauge and radiator fan is working or not? If fan is not working in the auto position, operate the fan control switch to manual position. If every thing is uniform, raise the engine speed. By doing this the water temperature will come down and the alarm will stop. Then close the throttle, move the Reverser in the desired direction, close the GF switch and open throttle up to 8th notch, resume normal operation. If the alarm experienced on up gradient stops the locomotive and then re-start after cooling down the water temperature. If experienced over a level section or down gradient, let the train roll and in between that period, cool the water temperature.

Note: In case of low water in the expansion tank, shutdown the diesel engine, check the source of leakage and rectify the defect, if possible. If this cannot be rectified, fill up water after starting and resume normal operation. Inform DPC and ask for control for a through run and book the repair in logbook.

e. LOW WATER ALARM

This device is provided in WDM₂ only. When the water level of the expansion tank falls below 1" from the bottom level of the expansion tank, the alarm switch operates and it is indicated by automatic diesel engine that shuts down with red light and bell. If the ECS on run position then green light will glow, in such case turn ECS to Idle, then green light will be off. Then open control and fuel pump circuit breakers on control stand; all indication will disappear, then check the leakage of water and rectify the same. If possible, fill up water after starting. Inform DPC and ask for through run. Book repair in the logbook. Do not try to fill up water in electrified area, ask unwired siding by relief engine and then fill up water.

DAY – 16

3rd & 4th session (2.50)

3. CIRCUIT BREAKERS

It is a thermal switch act, as switch and fuse. It acts as a switch when circuit is opened or closed, operating this breaker normally and acts, as a fuse when excess current flows through it, will be tripped to open the circuit. It is safety device fitted in the close circuit to protect it from over current. It has three positions CLOSE, OPEN& Trip. In OPEN position toggle is downward position, in CLOSE 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 OPEN Position then after one minute take it to "CLOSE"

If again tripped, open and close after three minutes interval. It tripped for third time, repeat the same but with five minutes interval. If still tripped, no attempt should be made to close it. Its thermal plate may be melt. Inform DPC and act as per his advice.

Tripping of Circuit Breakers on Control Panel

1. If battery circuit breaker tripped, battery will not charge and discharge gradually.
2. If fuel pump circuit breaker is tripped, the diesel engine will shut down without any alarm.
3. If control circuit breaker is tripped, the diesel engine will shut down without any alarm.

4. If auxiliary generator circuit breaker is tripped, battery will start discharging, since the auxiliary generator disconnects the supply to battery and the low voltage circuit will get supply from the battery.
5. If crankcase exhaust motor circuit breaker is tripped, the crankcase exhaust motor will not get supply and stops working. The crankcase explosion doors will be exploded. In some locos pressure adjusted spring type doors are provided.

On Control Stand

1. If master fuel pump circuit breaker is tripped, fuel pump contactor will be de-energized and the engine will shut down without any alarm.
2. If master control circuit breaker is tripped, the power supply to the traction motors is limited only up to the first throttle notch current on WDM₂.
3. Additional Fuel Pump Circuit Breaker:

This circuit breaker has been provided on the control panel of few WDM₂ locos.

4. Generator Field Switch (GF):

If switch is put "off" the GF contactor in control panel will be de-energized for which the generator field will not be excited to produce current and there will be no power to traction motors.

4. LOAD METER

It is a safety device for traction motors. It is located on each control stand. It indicates the load current on the traction motors and the amount of dynamic current in amperes. It protects the traction motor by indicating the over current flowing in it. The dial of the load meter has normally two zones viz., green and yellow. The green zone indicates the operating time unrestricted in normal position and it is known as unrestricted zone, free zone or continuous rating zone. The yellow zone operating time is restricted according to the minutes marked on it and is known as restricted zone, over load zone or time noting zone. The point at which the current load changes from green to yellow indicates end of continuous rating. The band is divided in equal divisions of 100 Amp. each. Green rating zone 1000 Amp.

The locomotive can be operated continuously without any time limit if the load meter pointer is within green, but in yellow zone, it indicates that the traction motors are overloaded and should not be operated for more than to that time

If the full allowed time is likely to be consumed in any particular overload zone, the throttle handle should be closed before half a minute of the time completion on that zone so that the pointer return back to green zone and the traction motors are released from the overloading just within the allowed time.

e.g.: If the pointer after starting at 50 minutes zone for 25 minutes is deflected to 12 minutes zone. The time now allowed at 12 minutes zone should be calculated as below. Since last of the allowed time is in the first overload zone is not consumed half of the time at the new overload zone the half of 12 minutes is 6 minutes, that 6 minutes shall be the full allowed time at 12 minutes zone now.

So after 5 ½ minutes keeping half minutes for the pointer to go back to the green zone. The throttle should be closed to bring the pointer to green zone for at least 20 min to cool the traction motor and then throttle can be notched again. If the pointer defects to any minute's mark of the yellow zone, full allowed time could again be occupied.

Defective Load Meter

If the load meter becomes inoperative, while starting the locomotive, accelerate to a speed of 12 km/hr or

above within the shortest possible time (approximately 4 minutes) while on run, a maximum continuous speed of 18 km/hr on WDM₂ loco must be maintained on 8th notch.

Note: During dynamic braking the load meter indicates the amount of grid current in amperes according to dynamic position, which should be shown by the pointer. The maximum grid current is 750 amperes.

5.SPEEDOMETER

Speedometer indicates the locomotive speed in km/hr and reading of the dial is calibrated up to 160 km/hr. There are two types of speedometers used in diesel locomotive viz., mechanical and electrical speedometers.

This speedometer generally located on control stand below the load meter.

This mechanical speedometer is driven by gear from axles and electrical speedometer works with AC current produced by axle generator, which is axle driven.

6.BATTERY-AMMETER

The battery ammeter is located on the control panel near the circuit breakers and is provided to indicate discharge or charge condition of the battery. When battery is fully charged (72 volts) the ammeter needle will indicate zero on the dial, which is the middle position between charge and discharge sides. Zero is the normal charge. Right side to the zero is charge side and left side to zero is discharge side. In normal charge it may be 5 to 10 amperes on the charging side and if the pointer deflects more than 10 amperes and gradually increasing it indicates that the battery is overcharging. During such situation, check the battery, which will usually be hot or smoke and pungent smell may come out. such cases the following measures are to be taken:

1. Do not shut down the diesel engine
2. Disconnect the battery knife switch
3. Book the repair in logbook
4. Inform DPC to arrange for a through run to avoid the failure. If the ammeter pointer deflects towards discharge side i.e., left side, it indicates the discharge condition of battery. In such cases, check the following.
 - i). Auxiliary generator circuit breaker may have tripped, if so, reset it and see that the battery is being recharged.
 - ii). Check the VRP fuse on E type excitation system locos, which may be fused. If fused, change it and see that battery getting recharge.
 - iii). Check the BN and BX card for loose fitting.
 - iv). If the auxiliary generator circuit breaker is 'OK' and the fuse is also all right, take the following measures.
 - a. Do not shut down the diesel engine.
 - b. Inform DPC for through run to the destination

For testing ammeter, adopt the following process:

- i). Shut down the diesel engine.
- ii). Open all the circuit breakers.
- iii). Disconnect the battery knife switch.
- iv). Now watch the condition of the ammeter pointer. If it is on zero, it should be treated as correct. This should be done in shed or before leaving shed.

Note:

1. On some locos red light is also provided for battery discharge condition, which remains 'off' in case of no current supply to the low voltage circuit from the battery and immediately glows when battery gets supply (low voltage). It is a sort of safety indication along with ammeter, which also indicates that the battery is getting discharge.
2. The ammeter swing, the charging rate of the battery by auxiliary generator is 5 to 10 amperes.

7. MU RUN BUTTON.

Emergency engine shut down button. These buttons are provided on each control stand and it consists of two buttons in one assembly. One is 'Red' another is 'Black'. Red is for stop and black is for reset. Red button is to be operated to shut down the engine along with the other engines, working in multiple units. The diesel engine cannot be started after shutdown, unless the button is reset. Hence, the black button is to be pressed to reset the red button

On some locos, MU switch is provided in the place of MU Run button, which has got two positions viz., 'Run and Stop'.

8. OIL PRESSURE SWITCH (OPS)

This switch is provided in the cab room behind lube oil pressure gauge on right side of control panel. This switch will shut down the diesel engine with the help of Electro hydraulic governor with low lube oil indication, in case of lube oil pressure drops below 1.3 kg/cm^2 . It is a protective device against inadequate lubrication.

Note: OPS is a two contact switch, upper & lower contact. When lube oil pressure built up to 1.6 kg/cm^2 it closes the upper position & at 1.3 kg/cm^2 it closes lower contact.

DAY – 17

1st & 2nd session (3.20 hrs)

Different Safety Devices fitted in Diesel Locomotives

Training Objective(s):

On completion of this lesson, trainees will be able to:
Explain the different Safety devices fitted in Diesel locomotives.

9. PNEUMATIC CONTROL SWITCH (PCS)

It is provided in the right side control stand. In case of penalty i.e., when B.P. drops below 2.1 kg/cm^2 then PCS contact opens due to entry of MAR air which in turn de-energizes DMR, so engine RPM comes to idle, whatever may be the throttle position and Traction motor will get 1st notch current till such time T/H is brought to idle.

10. EXPLOSION DOOR

These doors are located on the crankcase, towards power take off end on both sides, on the bottom side of the Electro hydraulic governor, towards right side and at the bottom of the crank case exhaustor, towards the left side of the engine block.

This door will burst under the following cases and save main bearings of the crankshaft from being damaged.

1. In case, if the crankcase exhaustor motor fails to work, this causes increase in pressure inside the crankcase due to accumulation of hot gases and vapours and will result to burst the above door.
2. In case there is abnormal leakage of hot gases from the cylinder due to defective gas ring i.e., scrappers ring.

Note: A few locos have been provided with modified spring-loaded explosion doors, which are located on any of the inspection cover over crankcase. These doors do not burst but whenever there is an increase in pressure inside crankcase, they keep open and come back to their respective seating as soon as the pressure is reduced.

11. OVER SPEED TRIP (OST) DEVICE

It is a safety device fitted at the side of the free end of the engine block by the side of R-1 cylinder. It shut downs the diesel engine automatically in cases of over speed of the diesel engine i.e., 1110 to 1150 rpm. A spring loaded weight which is normally against the carrier moves out at once and hits the trip lever which in turn pushes back the fuel control shaft to bring the fuel rack to no fuel position and the diesel engine shuts down. This device is provided with a trip handle and reset handle. In case of emergency, pulling the trip handle, which is fitted below this assembly pointing towards the engine block, may shut down the diesel engine. The diesel engine will not start till such time this assembly is reset to its normal working position. The trip device should be reset by pulling the reset handle, which is fitted on the upper side towards the free end of this assembly.

12. LOW WATER SWITCH (LWS)

Low water switch is located at free end in compressor room. When the water level of the expansion tank falls below 1" from the bottom level of the expansion tank, this switch will operate and save the diesel engine from damage(which can be caused due to low water in the water circulating system) by shutting down the Diesel engine.

When the water level in the expansion tank, becomes 1" below from its bottom level, this switch operates through its floating valve automatically and disconnects electric supply that flows to Electro-Hydraulic governor clutch coil from OPS. So A&B arms will be separated which in turn brings the fuel rack to no fuel position & engine shuts down with red lamp & bell indication.

13. SAFETY VALVES

There are two safety valves provided in the compressed air system.

1. Safety valve for intercooler located between high-pressure cylinder and inter cooler of the air compressor exhaustor. This safety valve blows at 65 psi.

2. Other safety valve is provided on MAR₁ in WDM₂. Both are fitted on left side of the locomotive. This safety valve blows at 150 psi, whenever MAR pressure increases above 150 psi due to faulty working of compressor governor.

14. WOODWARD GOVERNOR TRIP PLUNGER :

It is a safety device directly connected to diesel engine. It is provided only in the locos having Woodward governor and it remains fitted with the Woodward governor at the main generator side.

Its main function is same as the function of OPS related to Electro-Hydraulic governor, that is to save the engine crankshaft main bearings and other frictional parts from damage due to lack of lubrication during the movement.

In case the lube oil pressure drops to 1.3 kg/cm², then this emergency shut down plunger trips out and shutdown the diesel engine automatically with no fuel condition irrespective of throttle notches with low lube oil alarm indication as it happens in the case of OPS of Electro-Hydraulic governor. When it is required to restart the diesel

engine, this emergency shutdown plunger should be made reset by pushing it manually, otherwise diesel engine will not start.

15. ASST. EMERGENCY (D-1 BRAKE VALVE)

It is a safety device in the diesel engine. It is a pipe having cap/flap on top of it. It is provided on the foot board in cab room for the use of direct and possible quicker brake application at the time of emergency like A-9 valve fails to work or becomes defective, driver unable to control the train due to his improper health condition or for any reasons. As the driver's assistant mostly uses it, it got that name.

It is of a single pipe in locos having only vacuum brake system and is connected to the vacuum train pipe.

It is of a double pipe connection in locos having both the vacuum and air brake system whose each pipe connection is made with related vacuum train and BP train pipe, provided with a D –1 pilot valve for its necessary operation, when it is used.

In the case of locos equipped with only vacuum brake system, if flap of this emergency valve is lifted manually, it gives passage to the atmosphere air to enter directly in to the vacuum train pipe to cause quickest possible application brakes on train. In the event of locos equipped with dual brake i.e., air and vacuum system. If the flap/cap of this emergency brake device is lifted up to 45° it gives passage to the atmosphere air to enter in to the vacuum pipe and thus, if it is lifted up to 90° it gives passage to discharge BP pressure from BP train pipe if air brake on train, for quick application of brake. In the locos provided with dual brake, this can be provide on each side of drivers cab room foot, behind driver's seat

DAY-17

3rd & 4th sessions (2.50 hrs)

VCD (VIGILANCE CONTROLL DEVICE)

VCD is a device to stop the train if 'LP' is incapacitated. One alerting lamp provided on each control desk near LED indication panel & one VCD reset push button is provided on the control desk near master handle.

VCD alerts the 'LP' once in every 60 seconds through a blinking LED, if none of the following activities are performed within 60 sec.

Increase / decrease notch, application / release of A9, application / release of DB, change of DB level, operation of GF switches, change of RH position, operation of horn buttons, operation of sander buttons and pressing of VCD reset button

VCD starts functioning just closing the circuit breakers MB1, MB2, MPCB, MCB1 & MCB2 and while BCP is less than 2.1Kg. / cm². Up to 60 sec if LP not done stipulated operations then LED will blink & continues for 8 seconds. After 8 seconds, a buzzer is switched ON along with blinking LED.

A message 'VCD time out Press VCD reset' is displayed on the screen. The blinking LED and buzzer continues for another 8 seconds. If LP does not respond up to 76 (60+8+8) seconds, Penalty brakes will be applied. A message displayed on the screen, 'VCD' applied Penalty Brakes'

Result of Penalty Brakes application:

VCD counter is increased by 1.

Buzzer is switched OFF

LED continues to blink for another 35sec.

BP is reduced at service rate

Loco / Formation brakes are applied

Engine speed is brought to IDLE.

GF power contactor is dropped out.

Power contactors are dropped out after Master handle brought to IDLE.

Procedure of releasing of Penalty Brakes

Bring the Throttle to IDLE.

Wait till the blinking LED is OFF.

Wait till the Loco speed is reduced to zero.

Press VCD RESET button.

While waiting for signal in the yard:

Apply loco brakes with SA9 to suppress VCD function. Ensure BCP is ≥ 2.1 kgs./Sq.cm.

REAR LOCO IN MU

Switch off MCB1 & MCB2 on both control stands in rear loco..

In the Display 'VCD in MU' is displayed in the bottom line of the screen

OTHERWISE – What happens?

REAR LOCO DOES NOT RESPOND TO LEAD LOCO SIGNALS. (rear loco become idle)

TO ISOLATE VCD

Break the 'VCD' glass on the MMF box and switch ON the VCD disable switch.

'Operator disabled VCD' message is displayed on the screen.

BP dropping continuously

Close the cut out cock side of the 'VCD' magnet valve if air is leaking from the VCD magnet valve.

Warning:

Closing of this cock does not apply Loco / Formation brakes even though VCD applied penalty brakes.

GFOLR(Generator field over load relay)

The traction Alternator field has been provided with over load relay called GFOLR. When the AC traction Alternator field current exceeds 285 Amps, the GFOLR trips and bring the engine to idle with an indication of over load and bell by de-energizing ERR & GF contactor. Whenever GFOLR trips, bring the Throttle idle , put ECS to idle, press GFOLR reset button, which is provided above the start button.

ACD (anti collision device):

ACD is 'self acting ' microprocessor based communication equipment which automatically apply brakes to trains thereby protecting the traveling public as well as road users at level crossing gates "collision " related accidents.

While approaching a station, ACD gives "Station approach" warning to the LP about 2 km rear of first stop signal of the station. In the event of LP not acknowledging this warning the ACD automatically regulates the train speed, thereby reducing the probability LP passing signal at danger. In effect the loco ACD acts in this case like an "Electronic signal sighting board".

While entering the station area, if loco ACD detects the presence of a train on the main line automatically regulates the train speed, to what is maximum permitted over turnouts. Further if loco ACD after entering in loop detects the presence of another train on the same line automatically regulate speed of their respective trains to what is permitted for shunting operation in the yard.

While traveling Mid-sections, loco ACD remain in "look out" for trains present in the radius of 3 Km loco ACD Ms to handle "collision like" situation.

In case , loco ACD detects that any other train has stopped on adjacent line, they may be due to derailment, loco failure, cattle run over ACP etc. it will automatically regulates the train speed, till such time it crosses it and will also warn the LP of the same. If the LP of the stopped train presses "Normalcy" button after ensuring that there is no danger to movement of trains on adjacent line, the speed of other train will not be regulated. However if he detects that there is an infringement to the adjacent track and presses "SOS"(Save our soul) button, the other approaching train will come to a stop, there by reducing possibility of either "rear end" or "side" collision.

In case , a train detects an another train approaching it on the same track, the loco ACDs of both the trains apply brakes to bring their respective trains to a stop, there by reducing possibility of "Head on collision".

In case, a train detects an another train moving ahead of it on the same track, and having separation distance of less than 2 Kms, its loco ACD automatically apply brakes to regulate the train speed, till such time the separation distance between the two starts "increasing", there by reducing possibility of "Rear end collision".

In case, a train while approaching a level crossing gate detects it either in opened or damaged condition, its loco ACD automatically regulates the train speed and warn the LP for taking appropriate action.

In case, a train while approaching a unmanned level crossing gate its loco ACD activates the loco whistle from an adequate distance. Simultaneously, the LC gate ACD activate its hooter with visual flashing light for alerting the road users, till such time loco crosses the LC gate.

LP of the trains thereby get "Door Dristi" of 3Kms range detection system in all weather conditions, (which a human eye is incapable) through the loco ACD to detect the presence trains in the vicinity.

DAY – 18
1st session (1.40 hrs)

Different Safety items & safety fittings in diesel locomotives.

Training Objective(s):

On completion of this lesson, trainees will be able to:

Explain the different Safety devices fitted in Diesel locomotives.

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

BASICS OF MICROPROCESSOR LOCO:

Advantages of MEP 660

- 1) Low maintenance cost :due to reduced sequential interlocks and wiring.
- 2) Precise control over HP:
- 3) Digital setting of parameters Against potentiometer setting
- 4) Optimum utilization of Power.
- 5) Smart control over wheel slip against differential Voltage sensing method.
- 6) Automatic control over short term rating of Tr. motors against driver's dependency.
- 7) Adaptability and flexibility of the system, same system can be used on many type of locomotives.
- 8) On line Fault diagnostics.
- 9) Self diagnostics.
- 10) Self test to digital inputs & outputs
- 11) Historical Locomotive Data recording
- 12) Low Cost : being Indigenously Developed
- 13) Non Contact type Current Sensors :
- 14) Better isolation between power and control.
- 15) Total + Individual TM Current Monitoring:
- 16) No Change in Operational Procedure;
- 17) Drivers can easily handle the locomotive.
- 18) Smooth operation by replacing most of potentiometers, capacitors, relays and contactors with microprocessors and its different sensors.
- 19) Isolation of T/M's in case of any defect is very useful than MCO.
- 20) Manual and automatic fault display and its rectification.
- 21) Extra protection regarding high current acts automatically without depending on the driver
- 22) A superior wheel slip control
- 23) Simplified auto flasher circuit
- 24) Provision of VCD

Circuit breakers & switches used:

The nomenclatures of all the breakers and switches are almost all same as conventional WDG3A locomotive.

Existing Breakers:

- MB1 – Main Breaker 1
- MB2 – Main Breaker 2
- AGFB - Auxiliary Generator Field Breaker
- MFPB1&2 - Master Fuel Pump Breakers
- MCB1&2 - Master Control Breakers
- FPB – Fuel Pump Breaker
- CEB – Crankcase Exhauster Breaker
- DEB (Eng) - Dust Exhauster Breaker (Eng. Side)
- DEB (Carb) - Dust Exhauster Breaker (Carb. Side)
- RBB - Rectifier Blower Breaker
- RFCB - Radiator Fan Clutch Breaker (ERF)

Lighting Circuit Breakers

LPB1, LPB2, HLPB, DLCB

Extra (New) Breakers

MPCB - Microprocessor circuit breaker
PLPB - Pre lubrication Pump Breaker

DO not switch OFF MPCB while working.
Switch OFF MCB1 & MCB2 while cranking.

DAY-18

3rd & 4th session (2.50hrs)

TOTAL SENSORS USED IN MEP-660

CURRENT SENSORS	-14
VOLTAGE SENSORS	-05
TEMPERATURE SENSORS	-03
PRESSURE SENSOR	-08
SPEED SENSORS	-08
TOTAL	-38

CURRENT SENSORS -14

1. TAAI (Traction Alternator Armature current sensor)
2. AGAI (Auxiliary generator Armature current sensor)
3. AGFI (Auxiliary generator Field current sensor)
4. EXAI (Exciter generator Armature current sensor)
5. EXFI (Exciter generator Field current sensor)
6. TMAI- 6 nos (Traction motor Armature current sensor)
7. BATI (Battery current sensor)
8. BANGI (Battery Negative to Ground leakage current sensor)
9. TANGI (Traction Alternator Negative to Ground leakage Armature current sensor)

VOLTAGE SENSORS -5

1. TAV (Traction Alternator voltage) 1
2. LCPV (load control pot.voltage) 1
3. BATV (Battery voltage sensor) 1
4. BKCPV(Braking Pot. Voltage) 1
5. AGAV (auxiliary armature voltage) 1

TEMPERATURE SENSORS- 3

1. EWT (Engine water temp.)
2. LOT (lube oil temp.)
3. AAT (Ambient air temp.)
- 4.

PRESSURE SENSORS

1. MR Pr.
2. B.P. Pr.
3. B.C. Pr.
4. Altitude Pr.
5. LOP
6. FOP
7. BAP
8. Water pr.(v-3)

SPEED SENSORS

1. TM RPM sensors - 6
2. Engine speed sensor -2

Load Meter

- The load meter indicates Tr. Motor current while in motoring.
- It indicates Grid current while in Dynamic Brake.
- The load meter has got two zones of indication. Green and Yellow zones.

Green Zone in load meter

Driver can work continuously in Green zone with out any time restriction.

Yellow Zone in load meter

- There is an yellow line at 650A.
- During Dy. brake if the loco speed is above 65KMPH, driver reduces the braking level to control the load meter reading below 650Amps.

Load meter in MEP-660-No Strain to Driver

- In MEP fitted locos, Load meter is same as normal Diesel locomotives.
- The Loco Pilot need not bother about any timings / restrictions in MEP fitted locos.
- The MEP 660 automatically reduces Tr. Motor current to 1000 Amps by reducing excitation after the specified timings.
- During dynamic brake operation, the MEP automatically regulates Tr. Motor armature current to 600 Amps while the loco speed is above 65 KMPH.