GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2021/Track-III/TK/12 **New Delhi, Dtd. 16.10.2025.**

Addressed to:
As per list attached.

Sub: Correction Slip No. 9 to Indian Railway Track Machine Manual (IRTMM-2019).

The Ministry of Railways (Railway Board) have decided to add new chapter 12 titled "Track Machine Engines" as indicated in the enclosed Correction Slip No. 9 to Indian Railway Track Machine Manual-2019 (IRTMM-2019).

This has the approval of Additional Member, Civil Engineering (AM/CE).

Encl.: as above

Vijay 16/10/2025

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Addendum and Corrigendum slip no 09 to Indian Railways Track Machine Manual 2019.

A new Chapter no. 12 on Track Machines Engine is to be added as under-

CHAPTER 12
TRACK MACHINE ENGINES

1201 General

Engine is the Prime mover of Track machine. An engine is a type of sub-assembly of a machine designed to convert one or more forms of energy into mechanical energy. Engines in Track machines are traditionally IC (Internal Combustion) engines with diesel fuel. An internal combustion engine converts the chemical energy of fuel into mechanical work by burning the fuel–air mixture inside a confined space, called a combustion chamber. The pressure generated during combustion drives the piston, and the crank–connecting-rod mechanism turns this reciprocating motion into usable rotary output. Engine generates mechanical and electrical energy on machine for operation of machine with self-propelled mechanism. Four stroke IC (Internal Combustion) engines with diesel fuel are used in Track machines. Indian Railways ~~are~~ is also exploring hybrid mode track machines where machine typically uses diesel for self-propelled movement on non-electrified lines or neutral sections and switches to pantograph power when under catenary.

1202 Classification of IC Engines

On the basis of variety of variable parameters and working systems, IC engines are classified into different categories:

1. **On the basis of fuel used:-**
   - (i) Petrol Engine
   - (ii) Diesel Engine (Used in Track Machines)
   - (iii) Gas Engine
2. **On the basis of no. of strokes per working cycle:-**
   - (i) Two- Stroke Engine
   - (ii) Four- Stroke Engine
3. **On the basis of Method of ignition of fuel:-**
   - (i) Spark ignition engine
   - (ii) Compression ignition engine
4. **On the basis of method of cooling:-**
   - (i) Air Cooled engine
   - (ii) Water cooled engine
5. **On the basis of no. of cylinders:-**
   - (i) Single cylinder engine
   - (ii) Multi-cylinder engine
6. **On the basis of cylinder location:-**
   - (i) In line

(ii) V shape

(iii) Flat type

(iv) Radial Engine

7. **On the basis of cycle:-**

(i) Otto Cycle (Constant volume combustion; used in petrol engines.)

(ii) Diesel cycle (Constant pressure combustion; used in diesel engines.)

(iii) Dual Cycle (Combines both Otto and Diesel cycles.)

1203 Four Stroke Engine:

A four-stroke internal combustion (IC) diesel engine uses a four-step cycle (suction, compression, power, and exhaust) where the piston completes four strokes and the crankshaft rotates twice to generate power. In this process, air is drawn into the cylinder during the suction stroke, compressed during the compression stroke, fuel being injected at the end of compression stroke and due to combustion of fuel, power generated which pushes the piston downward in power stroke and finally the burnt gases are expelled during the exhaust stroke. Movement of Piston from TDC (Top dead centre) to BDC (Bottom dead centre) or vice versa is called one stroke.

Key features of a four stroke engine are:

1. **Four Strokes per Cycle**
   Four stroke engine completes one power cycle in four stages: intake, compression, power, and exhaust. One cycle requires two complete turns (720°) of the crankshaft.
2. **Fuel Efficiency**
   Four stroke engine burns fuel more completely making them more fuel-efficient than two-stroke engines.
3. **Cleaner Emissions**
   Four stroke engine produces fewer pollutants and less smoke because of better fuel combustion.
4. **Durability**
   Four stroke engine usually last longer because they are designed to handle less stress per cycle.
5. **Less Noise**
   Compared to two-stroke engines, these engines run more smoothly and quietly.
6. **Separate Oil System**
   The lubrication system is separate from the fuel system, so oil does not mix with fuel. This keeps the engine cleaner and improves performance.
7. **Better for Long Use**
   It is Ideal for applications that require continuous or long-term running, like in cars or backup power generators.
8. **Heavier and More Complex**
   Four-stroke engines are generally heavier and have more parts, which making them a bit more expensive and complex to maintain than simpler engines.

1204 Working Principle of a four stroke engine:

a) Suction/Intake Stroke

During suction stroke, only pure air is drawn by the piston. The piston moves from TDC (Top Dead Center) to the BDC (Bottom Dead Center). TDC is the farthest position of the piston, and BDC is the nearest position of the piston to the crankshaft. As the piston moves toward the

BDC, it creates a low-pressure area in the cylinder. The intake valve remains open up to a few degrees of crankshaft rotation after BDC, and as the intake valve closes; it seals the air in the cylinder. During suction, the inlet valve remains open, the outlet valve remains closed, and the crankshaft further rotates by 180 degrees.

b) Compression Stroke

The air trapped during suction is compressed inside the cylinder during the compression stroke. The piston moves from BDC to TDC to compress the air; the piston moves forward with the help of flywheel momentum. On compressing the air, more energy is released on fuel ignition. During compression, both inlet and outlet valves remain closed, and the crankshaft rotates to 180 degrees more. Now, the total rotation of the crankshaft is 360 degrees. Fuel is injected at the end of compression stroke, which is also called heat addition at constant pressure for generating the power inside the cylinder.

c) Power Stroke

In the power stroke, the compressed air and injected diesel mix and burn. Combustion is a rapid process, and the oxidized chemical reaction (presence of oxygen in the air) releases heat energy. The hot expanding combustion gases force the piston away from the head of the cylinder. During combustion, both inlet and outlet valves remain closed, and the crankshaft rotates further by 180 degrees. Now, the total rotation of the crankshaft is 540 degrees. During the power stroke, as the piston reaches the BDC, the cylinder is filled with exhaust gases, and the combustion is completed.

d) Exhaust Stroke

During the exhaust stroke, the exhaust valve gets opened, and the inertia of the flywheel and other moving parts pushes the piston back to the TDC and allows the exhaust gases to exit through the open valve. The position of the piston is at TDC. So, at the end of the exhaust stroke, one operating cycle of the engine gets completed. During exhaust, the inlet valve remains closed, the outlet valve remains open, and the crankshaft further rotates by 180 degrees. Now, the total rotation of the crankshaft is 720 degrees.

Pressure volume Diagram of Diesel cycle is as shown in Fig 12.1 given below:

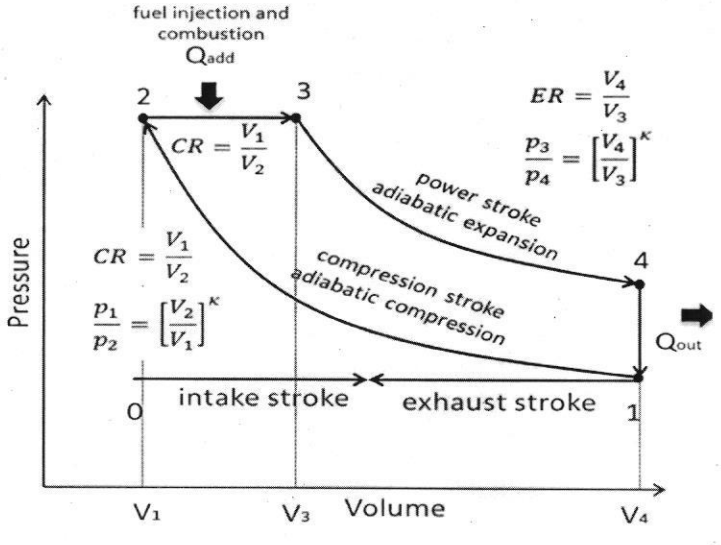

Fig 12.1 Pressure-Volume Diagram of Diesel cycle

1205 Combustion

The combustion of fuel in a Four stroke diesel engine occurs in four main stages as shown in Fig 12.2 below:

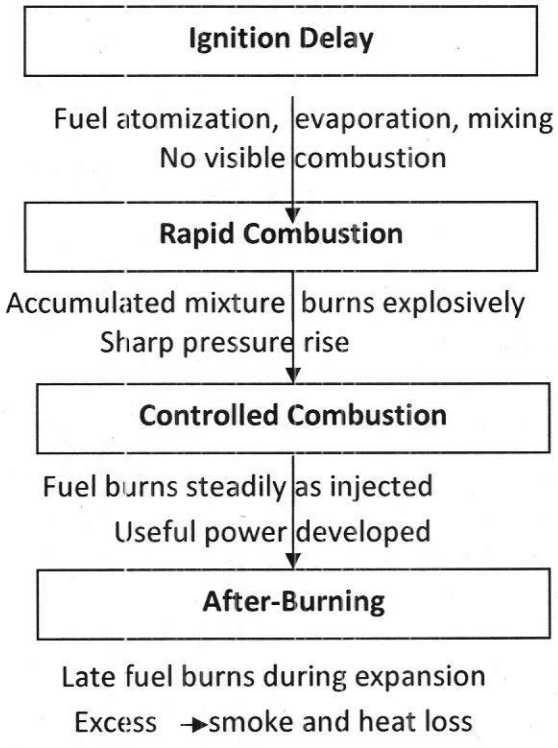

Fig 12.2 Stages of Combustion in a Four-Stroke Diesel Engine

a) Combustion Characteristics

Combustion characteristics of Diesel engine are as under:

- Compression ratio: 14:1 to 22:1
- Combustion duration: 30–40 crank angle degrees.
- Knocking tendency: More pronounced with long ignition delay.
- Efficiency: Higher than petrol engines due to lean mixture and higher compression.

b) Factors Affecting Combustion

- Fuel properties (Cetane number, viscosity).
- Injection system (pressure, timing, spray quality).
- Air motion (swirl, squish, turbulence).
- Compression ratio and temperature.
- Engine speed, load, and maintenance condition.

c) Other aspects of Diesel engine

- Fuel efficiency: Saves diesel in high-consumption machines.
- Reduced emissions: Meets CPCB/EU norms.
- Reliability: Prevents damage of piston, valve, and liner.
- Performance: Provides steady torque for railway maintenance.
- Smooth operation: Less noise and vibration, improves operator comfort.

1206 Main Systems of an I.C Engine

Following are the main systems of an I.C. engine:-

1. Air Supply System
2. Fuel Supply System
3. Lubricating System
4. Cooling System

1. **Air Supply System:** This system is about requirement of air, air cleaner, drawbacks of choking of air cleaner, Turbocharger, Aftercooler and importance of after cooling etc.The air system in a diesel engine plays a crucial role in the combustion process by supplying air to the engine cylinders. Proper air intake and management are essential for efficient combustion, power generation, and overall engine performance air supply system starts with ambient air being drawn into an air filter to remove dust. For boosted performance, this filtered air is compressed by a supercharger or turbocharger. The pressurized air then flows through after cooler to increase density before intake to the engine cylinders, providing the necessary oxygen for combustion.

Requirement of Air: For Combustion of diesel inside the engine cylinders sufficient quantity of air should be available. For complete combustion of one litre HSD 12,500 to 14,000 litre fresh air at NTP is required. Only 22 – 23% O_2 is available in atmospheric air which is used for burning of fuel. If less air is available then burning of fuel will be incomplete and instead of CO_2, CO will form. To supply air of proper quality (dry, cool, clean & fresh) in sufficient quantity inside the engine cylinders is the function of air supply system.

Main components of the Air Supply System are:

(a) Air Cleaner
(b) Hump Hose
(c) Vacuum Indicator
(d) Turbo Charger
(e) After Cooler
(f) Inlet Manifold

(a) Air Cleaner: Air contains dust and dirt. If the air is not filtered before its entrance into the engine cylinders, the dust and dirt particles will seriously damage the engine. These dust and dirt will mix with the lubricating oil and form abrasive paste, which will quickly wear the piston, rings, cylinder wall, bearings, valve guides and other relatively moving parts. This wear will cause high lubricating oil consumption, increased blow by and reduce engine components life. The purpose of air cleaner is to remove these harmful dust and dirt particles from the air. It not only cleans the air but also muffles the noise resulting from air entrance to the inlet manifold and valve ports. It also arrests the flame in case the engine backfires. There are two types of Air Cleaners:

(i) Oil bath type air cleaner
(ii) Dry (paper) type air cleaner

(i) Oil Bath Type Air Cleaner: It is a heavy duty air cleaner. It consists of a wire-mesh filter element saturated with oil. At the bottom, there is an oil pan. The operation of air cleaning is carried out in two stages. In the first stage, the air strikes on the oil surface and the dust particles

penetrate into the oil surface and get absorbed by it. In the second stage, the partially cleaned air passes through the wire-mesh filter element, in which the remaining dust particles are retained. This type of air cleaner is cleaned periodically. The wire-mesh filter is removed, cleaned with petrol and dried by air. Oil in the pan is also replaced.

(ii) Dry Type Air Cleaner: It consists of a specially pleated paper element over which a fine mesh screen is provided for strengthening. By placing the pleated element, a large filtering surface is provided and yet restriction to air flow is minimal. The element is enclosed in a silencing chamber. The element should be cleaned periodically. With a dry type air cleaner, a filter restriction indicator (Vacuum Indicator) is often found mounted into the clean air side of the system. When an air cleaner is not choked, it looks transparent and if becomes choked then it will give red indication.

Pre-cleaner: Pre-cleaner is fitted on the air cleaner to arrest the thick dust and soil particles. On the engine which work in very unsafe atmosphere (dusty atmosphere), Pre cleaners are essentially required. Pre-cleaner has screen which arrests the thick soil and straw. After filtering through the screen, the air enters in the pre-cleaner body and revolves by strips fitted on the angle. Due to revolving, thick dust and soil separates and settles down at the bottom. A glass bowl is fitted at the bottom of the pre-cleaner. The bowl is cleaned periodically after filling by dust.

(b) Turbocharger: Turbo charger is a device which is used to supply air inside the engine cylinders at more than atmospheric pressure. It is connected between air cleaner and inlet manifold. It is driven by the exhaust gases of the engine. A turbo charger consists of a turbo wheel (turbine) and a centrifugal blower impeller (compressor wheel), separately enclosed in casings but mounted and rotating on a common shaft. It is mechanically independent of the engine except that its turbine is connected with exhaust manifold and the impeller with the after cooler or inlet manifold. The turbine portion should be made of heat resistance material. The turbocharger is fitted between the air intake and exhaust system. Exhaust gases pass from the engine exhaust manifold to the turbine and rotates the wheel. The rotating motion of turbine is transferred through a common shaft to a compressor wheel. The compressor wheel then sucks air from the air cleaner and pushes it into the intake manifold under pressure. The actual pressure is measured in inches of mercury (Hg) and is dependent upon the engine, turbo design and power requirements. Turbo charger rotates by the exhaust gases at rpm of 1,25,000 to 1,40,000 approx. Bearing design and precise balancing of the whole rotating assembly are, therefore, of the greatest importance in ensuring a long useful life for the unit. Turbo-compressor performance is sensitive to the presence of dirt and other harmful deposits. Special attention should be paid to air filtration when a turbocharger is fitted. Deposits should never be allowed to build up on the compressor as they would cause unbalance, and in most designs provision is made for cleaning the compressor without dismantling the turbocharger.

Super Charging: The process of supplying air to the engine cylinder above atmospheric pressure is called super charging. In a naturally aspirated engine, the piston-cylinder draws air equal to its stroke volume. The pressure inside the cylinder is less than the atmospheric pressure during the

suction stroke. But in a supercharged engine, the air is forced into the cylinder at a pressure higher than atmospheric pressure.

Advantages of the turbocharger are:

1. By supplying more air more fuel can be injected for combustion inside the combustion chamber and therefore more power is obtained.
2. Better control over the air/fuel ratio at all engine speeds reduces the degree of smoke emission.
3. Having more air at lower speeds enables better fuel combustion and gives lower torque speeds.
4. A pressurized air manifold helps reduce combustion noise.
5. Turbocharger speed is controlled by the exhaust system and atmospheric back pressure. Engine working at high altitudes would normally suffer from lack of oxygen due to less air density. As the atmospheric pressure is less at altitude the back pressure in the exhaust system is less and the resistance to turbine shaft rotation is less. This results in the turbocharger shaft rotating at a faster speed forcing more air into the combustion chamber and thereby compensating for the lack of oxygen.

(c) After-Cooler (Intercooler): After cooler is a device, which is used to cool the air coming out from turbocharger before entering into the engine cylinders. In turbocharged engine, air coming from the turbocharger gets heated. Due to increase in temperature the density of air will decrease which is not desirable. When the air is cooled in after-cooler before it enters in to the engine cylinder, the density will increase. For limited vol. inside the engine cylinder, we can supply more air inside due to which more fuel will burn and we get more power. In this way, the output of the engine will increase. After cooler are of two types:

(i) Air cooled after cooler

(ii) Water cooled after cooler

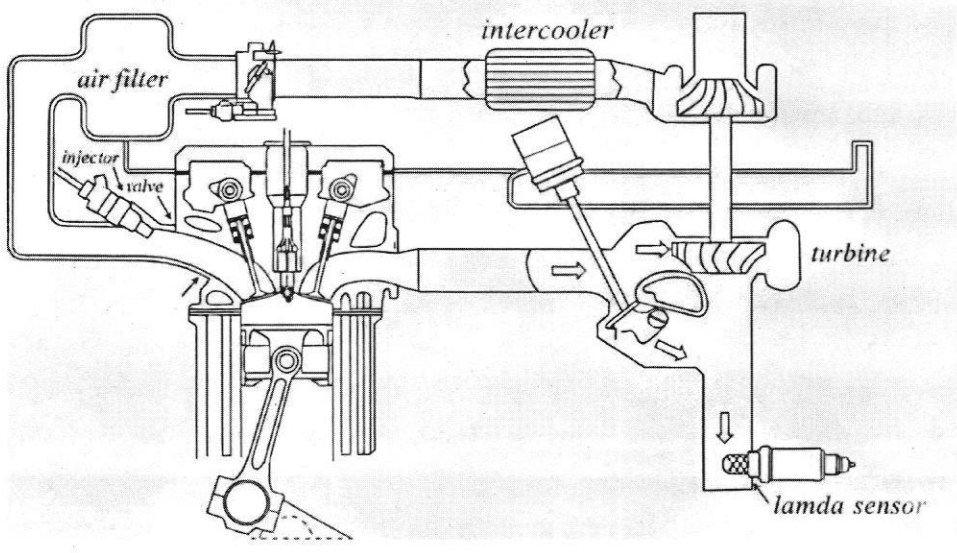

Fig 12.3 Air Intake System

2. **Fuel Supply System**: - The fuel supply system of a diesel engine can be called as the heart

of the engine, since the engine's performance directly depends upon the proper functioning of this system—which must supply, meter, inject and atomize the fuel. A diesel engine's fuel supply system delivers and injects pressurized, filtered fuel from a fuel tank to the engine's combustion chambers. This system is about fuel injectors, injection pumps, fuel filter etc. A schematic diagram of Fuel Supply System is shown in Fig. 12.4.

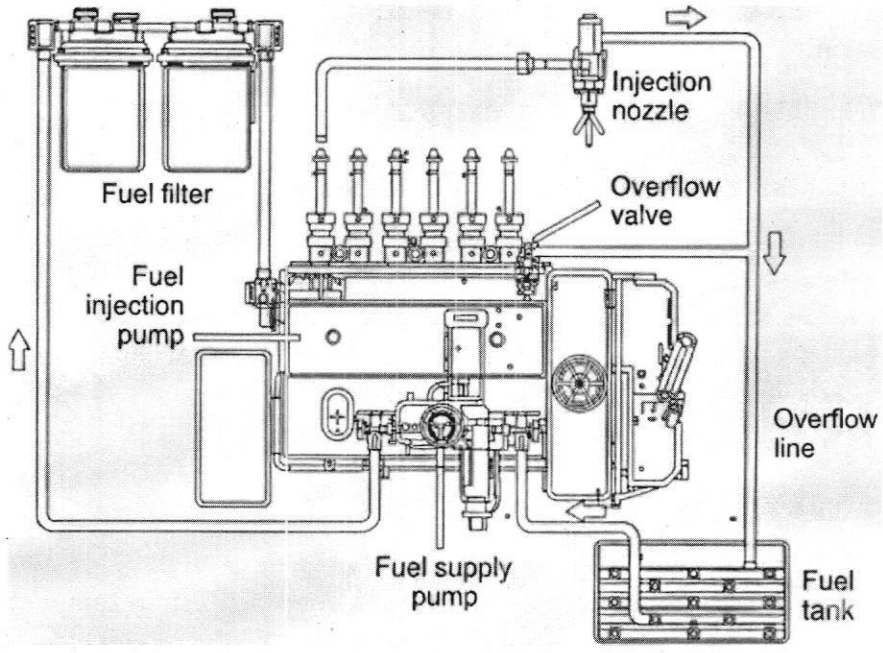

Fig 12.4 Fuel Supply System

a) **Individual Pump System:** In this system fuel is drawn from the tank by a fuel feed pump and sent to the fuel injection pump through fuel filters. The fuel injection pump (FIP) will pressurize the fuel individually for each cylinder and send to the corresponding injectors through high pressure pipes. The high pressure fuel goes to the injector at the time of injection. The injector injects fuel at approx. 180 bar to the engine cylinder in atomized and vaporized form. Extra fuel is returned by the fuel injection pump to the diesel tank. Also a leakage line from the injector goes to the diesel tank.

b) **Common rail fuel injection system:** The operation is based on the principle that amount of fuel injected depends upon pressure of fuel and time available for the filling diesel into injector cup. The PT pump is driven by cam shaft gear at crank shaft speed. The 'PT' pump draws fuel from the diesel tank through water separator and fuel fitter. The PT pump delivers fuel to the fuel manifold through shutdown valve at a pressure of 200 – 300 PSI. From fuel manifold, fuel goes to the injector and returns to the tank. The injector plunger is actuated by cam mechanism at the time of injection. Travel of plunger opens path for the diesel to the injector cup for a few degree rotation of cam shaft. Fuel pressure and the length of time the metering orifice is exposed to the fuel inlet, determines the quantity of fuel which fills in the injector cup. Then the cam mechanism pushes down the injector, resulting in injection at the pressure of approximately 180

bar.

3. **Lubricating System**: - A lubrication system in an internal combustion engine is a system that aids in lubricating and cooling the engine's moving parts. Its main purpose is to reduce friction between moving parts, which slows down the rate of wear and tear on these engine parts. Additionally, it performs other tasks like lowering noise and delivering cooling, cushioning, cleaning, and sealing effects.

4. **Cooling System: -**Internal combustion engines are cooled either by air or by a liquid coolant circulating through a heat exchanger (radiator). Water has a higher heat capacity than air so it can remove heat more quickly away from the engine. Most of the engine in Track machines is water cooled. Only some engines are air cooled due to dusty atmosphere. The Cooling System is as shown below-

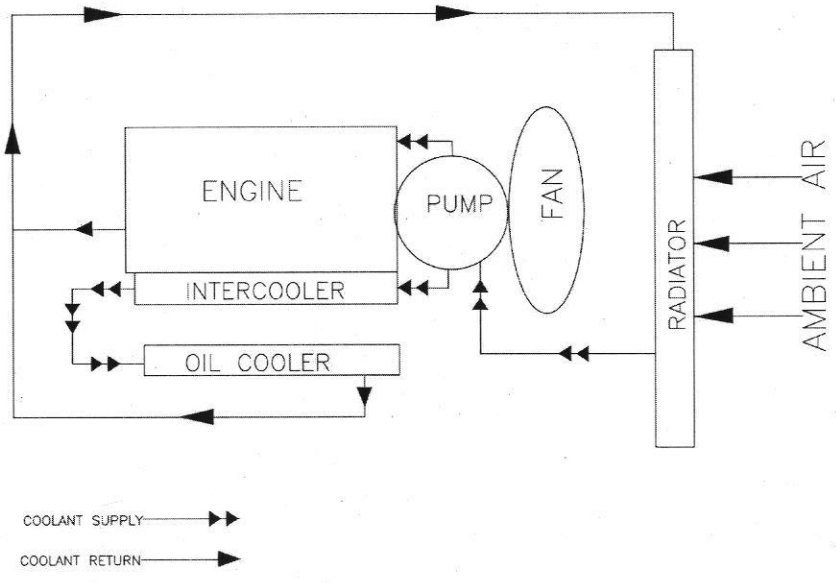

Fig 12.5 Cooling System

1207 Nomenclature of Engines Used In Track Machines

- **Cummins NTA 855 C & KTA 1150 L**

  N= 4 Valve head
  T= Turbocharged
  A= After cooled
  K= Engine Family

  855 & 1150 = Cubic Inch Displacement
  C= Construction
  L= Locomotive

- **Deutz B F 12 L 513 C**

  B= Turbocharged
  12= Twelve Cylinders
  5= Series
  C= Charge air cooler

  F= 4- Stroke
  L= Air cooled
  13= Stroke length in cm

- **MWM TBD 232 V 12**

MWM= Motoren Werke Mannhem

B= After cooled

232= Series

12= Twelve Cylinder

T= Turbocharged

D = Diesel Engine

V= V-Type

1208 Major Assemblies of I.C. Engine: Important assemblies of engine are listed below and shown in Fig 12.6-

1	Cylinder block and crankcase	7	Connecting Rod
2	Cylinder head	8	Crankshaft
3	Oil sump	9	Flywheel
4	Piston	10	Camshaft
5	Piston Rings	11	Valve and valve mechanism
6	Piston Pin or Gudgeon Pin	12	Other Accessories

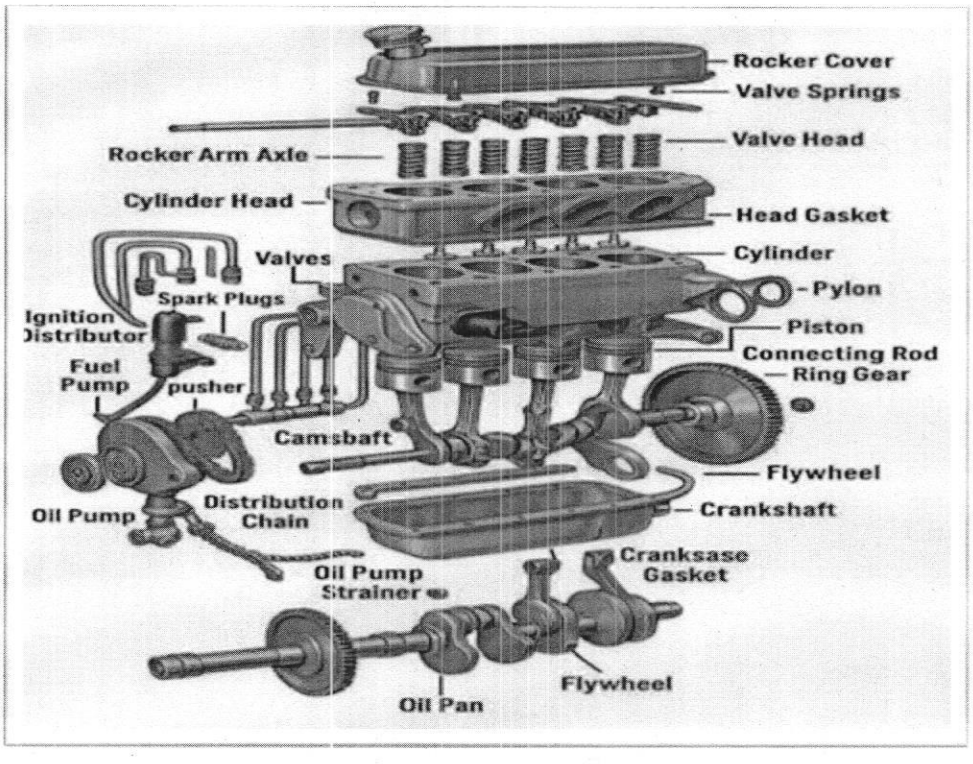

Fig 12.6 Important parts of I.C. Engine

1. Cylinder Block and Crankcase:

It forms the basic framework of the engine. Cylinder block houses the engine cylinders and crank case supports crankshaft and camshaft. Most engines have cylinder block and crankcase as a single

casting. Some big engines have separate crankcase and cylinders are fitted (bolted) separately with the crankcase. There are in-built oil galleries for circulation of lubricating oil. Water cooled engines have in-built passages for flow of cooling water. Air cooled engines have fins outside of the cylinders for cooling.

2. Cylinder Head:

The top of the cylinder block is covered by cylinder head. It has combustion chamber and holes for fitting injector and valves. There are inbuilt passages for flow of lubricating oil. In water-cooled engines, there are also passages for flow of water. Bottom holes of cylinder head for lubricating oil and water, matches with the top holes of cylinder block for the same. In air-cooled engines, there are fins outside the head for cooling. The cylinder head is bolted to the top of the cylinder block with a gasket in between them. Material used for manufacturing cylinder head is Cast Iron. The cylinder head is a crucial component of an internal combustion engine that seals the top of the cylinders to form the combustion chamber. It is bolted to the top of the engine block with gasket in between and houses essential parts of the valve train, fuel system, inlet and exhaust manifold, water jackets and oil passages.

3. Oil Sump:

It is the lowest part of the engine. It is attached to the crankcase through setscrews with a gasket in between them. It stores oil for engine lubrication system. There is a drain plug at the bottom of the oil sump. Material used for manufacturing oil sump is Steel sheet or Aluminium.

4. Piston:

Piston is a moving cylindrical part within an engine's cylinder that converts the pressure from expanding gases into mechanical energy, which drives the engine's crankshaft. It is equipped with rings. Material used for manufacturing piston is Aluminium alloy. Moving up and down in a sealed cylinder, the piston facilitates the four stroke cycle of intake, compression, combustion, and exhaust, with piston rings creating a gas-tight seal.

5. Piston Rings:

They are fitted into the grooves of the piston. There are two types of piston rings: a compression ring and an oil control ring. Piston rings are metallic, split rings mounted in grooves on a piston within an engine cylinder to create a seal between the piston and the cylinder wall. Their primary functions are sealing the combustion chamber to prevent gas loss, transferring heat from the piston to the cylinder, and controlling oil by preventing excess oil from entering the combustion chamber and scraping oil from the cylinder walls.

6. Piston Pin or Gudgeon Pin:

It connects the piston and the small end of the connecting rod. Piston pin is generally hollow. In most of the engines, piston pin floats in both the piston bosses and small end of the connecting rod. Piston pin axial movement is prevented by fitting circlips in grooves at the outer end of piston bosses. Material used for manufacturing piston pin is Steel Alloy (Case hardened).

7. Connecting Rod:

Connecting rod is a vital mechanical component that links the piston to the crankshaft. It joins the piston pin with the crank pin of the crankshaft. Small end of the connecting rod is connected to the piston pin and the big end to the crank pin. Its primary function is to convert the piston's linear, up-and-down (reciprocating) motion into the crankshaft's rotational (rotary) motion, thereby enabling the engine to produce power. Connecting rod converts the linear motion of piston into rotary motion of the crankshaft. All the connecting rods in an engine must be of equal weight. In original assembly, the connecting rods and caps are individually matched to each other and numbered to avoid interchange. The connecting rod must be strong, lightweight, and capable of withstanding high tensile and compressive forces to ensure efficient and smooth engine operation. Material used for manufacturing connecting rod is forged steel.

8. Crankshaft:

A crankshaft is the backbone of an engine that converts the reciprocating (up-and-down) motion of the pistons into rotational motion, which then turns the vehicle's wheels or powers machinery. The crankshaft also serves to transmit the engine's power to the load and help balance the engine's forces through strategically placed counterweights. A crankshaft consists of following parts:

a) Crank Pins
b) Webs
c) Balancing Weight
d) Main Journal

Crankshaft has drilled oil passages though which oil can flow from the main bearing to connecting rod (C.R) bearing. The rear end of the crankshaft carries flywheel and the front end carries a gear, vibration damper and fan belt pulley. Material used for manufacturing crankshaft is steel alloy.

9. Flywheel:

It is a heavy steel wheel attached to the rear end of crankshaft. During power stroke the engine tends to speed up and during other three strokes it tends to slow down. Flywheel stores power during power stroke and releases during other three strokes to keep the engine running at the constant speed. Flywheel is also used as a part of clutch mechanism. Flywheel also has teeth to mesh with self- starter during starting.

10. Camshaft:

It is a shaft on which cams are mounted. Cam is a device, which changes rotary motion of the camshaft into linear motion of the follower or lifter. A camshaft has a number of cams along the length. There are two cams for each cylinder, one to operate the inlet valve and the other to operate the exhaust valve. The camshaft has an eccentric to operate the fuel feed pump and a gear to drive the oil pump. Crankshaft drives the camshaft. The camshaft gear has teeth twice of crankshaft gear teeth. Thus camshaft turns at half the speed of the crankshaft.

11. Valve and Valve Operating Mechanism:

1. Valve: Valve is a device to open and close a passage. There are two valves for each cylinder– an inlet valve and another exhaust valve. Air enters to the cylinder through the inlet valve and the burnt gases escape through the exhaust valve. When closed, the valve must seal the combustion space tightly. Inlet valve is subjected to less heat and is made of nickel chromium alloy steel. Exhaust valve is subjected to severe heat and is made of silicon chromium alloy steel.

2. Valve Operating Mechanism: Cams mounted on a camshaft operate valves. The crankshaft drives the camshaft. As the cam rotates it lifts the valve tappet, which actuates the push rod. The push rod rotates the rocker arm about a shaft called rocker arm shaft. The rocker arm pushes down the valve to open the passage.

3. Valve - Tappet Clearance: A slight clearance is kept between the valve stem and rocker arm called valve tappet clearance. This clearance allows for expansion of the valve stem as the engine becomes heated. If sufficient clearance is not given, the valve will not seat properly, when the engine becomes heated, which will cause power loss. The exhaust valve has more clearance then the inlet valve due to more heating. Valve-tappet clearance is adjusted by means of an adjusting screw on the rocker arm.

4. Valve Timing: The valves of engine do not open and close exactly at Top Dead Centre (TDC) or Bottom Dead Centre (BDC) because of inertia of gases and mechanical limitations. Slight advancement and delay in valve operation improves:

- Air intake (better cylinder filling)
- Complete combustion
- Efficient exhaust removal
- Power output and fuel economy

12. Other accessories:

a) Air cleaner: It is used to allow clean air entrance into cylinders for fuel combustion.

b) Oil filter: It screens impurities from the lubricating oil so that only clean oil will circulate throughout the engine.

c) Fuel filter: It screens impurities from fuel i.e. HSD so that clean fuel will flow through fuel pump and will go for combustion inside the cylinder.

d) Oil pump: It is used to supply pressurized oil into the lubricating circuit for engine lubrication.

e) Fuel pump: It supplies pressurized fuel to the fuel circuit.

f) Injector: It is fitted into the cylinder to supply fuel in atomized and vaporized form. A fuel injector in an engine is an electro-mechanical device that precisely sprays atomized fuel into the engine's combustion chamber to create the correct air-fuel mixture for efficient combustion and power generation. Controlled electronically by the engine control unit (ECU), injector deliver fuel at the exact time and in the right quantity to improve fuel economy, boost performance, and reduce harmful emissions.

g) Vibration damper: While engine is running, winding and unwinding effect comes on crankshaft during power stroke. This winding – unwinding effect develops torsional vibration due to which crankshaft may break. It is simply a small flywheel. It is mounted at the front end of the crank shaft. It absorbs and dissipates vibrational energy, typically using a rubber or silicone damping material.

1209 Firing Order

Firing order is the specific sequence in which the power (combustion) stroke occurs in each cylinder of a multi-cylinder engine, ensuring smooth operation, balance, and efficient performance. This order is crucial for distributing the forces on the crankshaft evenly, reducing vibrations and preventing premature wear by spacing out the high-pressure events. The firing order is selected as a part of the engine design to obtain the best engine performance.

a) **Cummins Engine** - Cylinders are counted from vibration damper side. Direction of Rotation (DIR) is clockwise viewing from vibration damper side.

- **6 Cylinder Engine**

  Firing order is 1 - 5 – 3 – 6 – 2 – 4

- **12 Cylinder Engine**

  Firing order is 1L - 6R – 2L – 5R – 4L – 3R – 6L - 1R – 5L – 2R – 3L – 4R

  (L for Left Bank and R for Right Bank)

b) **Deutz Engine BF 12L 513 C (12 Cylinder Engine)**

Firing order is 1 - 8 - 5 - 10 - 3 - 7 - 6 - 11 - 2 - 9 – 4 – 12

c) **MWM (Greaves) Engine TBD 232/234 V 12 (12 Cylinder Engine)**

Firing order is A1 – B2 – A5 -- B4 – A3 – B1- A6 – B5 – A2 – B3 – A4 – B6

d) **Caterpillar Engine C-18 (6 Cylinder Engine)**

Firing order is 1 - 5 – 3 – 6 – 2 – 4

1210 Electronic Control Module (ECM) in Engines of Track Machines

Modern track machines such as tamping machines, ballast cleaners, ballast regulators, and rail grinding machines are increasingly equipped with ECM-controlled diesel engines to improve performance, efficiency, and compliance with emission norms.

a) **Introduction to ECM**

The Electronic Control Module (ECM) is essentially the brain of the engine. It is a rugged microprocessor-based control unit that continuously monitors engine parameters through sensors and regulates various functions electronically. ECM replaces traditional mechanical fuel injection systems with electronic fuel management, leading to precision, reliability, and efficiency. The introduction of ECM-controlled engines in track machines marks a shift towards smarter, efficient, and environment-friendly railway maintenance. ECM enables better performance, fuel economy, safety, and ease of troubleshooting, making it indispensable in modern railway track machines.

The following block diagram illustrates the working of an ECM system in a diesel engine:

Sensors (Oil Pressure, Coolant Temp,
RPM, Fuel Pressure, Boost)
↓
ECM Unit
↓
Actuators (Injectors, Solenoids,
Throttle, Fuel Pump Control)

b) Key Functions of ECM in Track Machine Engines

- Fuel Injection Control – Regulates timing and quantity of fuel injection precisely for efficient combustion.
- Engine Protection – Monitors oil pressure, coolant temperature, boost pressure, and fuel pressure; triggers alarms or shutdown in unsafe conditions.
- Emission Control – Adjusts fuel injection and air-fuel ratio to meet emission standards.
- Starting and Idle Control – Provides smooth engine cranking, idle stabilization, and cold start assistance.
- Data Logging & Diagnostics – Stores fault codes (DTCs) and helps in predictive maintenance.
- Communication & Integration – Interfaces with machine control systems, supports CAN-BUS / J1939 communication.

c) Components of ECM System

- ECM Unit (Microprocessor) – Central controller.
- Sensors – Oil pressure, coolant temperature, RPM, boost pressure, fuel pressure sensors, etc.
- Actuators – Electronic fuel injectors, solenoids, throttle control.
- Wiring Harness – Electrical connections between ECM, sensors, and actuators.
- Diagnostic Port – For connecting laptops/scan tools during servicing.

d) Advantages of ECM-Based Engines in Track Machines

- Improved Fuel Efficiency – Optimized combustion reduces diesel consumption.
- Higher Power & Performance – Accurate control of fuel-air ratio.
- Reduced Emissions – Meets stringent emission regulations.
- Reliability – Automatic monitoring prevents engine damage.
- Ease of Maintenance – Fault codes assist technicians in quick diagnosis.
- Integration – Real-time monitoring of engine health with machine systems.

e) Maintenance Aspects of ECM Engines

- Keep electrical connections and harnesses clean and intact.
- Use only genuine sensors and ECM-approved spare parts.
- Update ECM software/firmware as per manufacturer's recommendations.
- Regularly check for and clear Diagnostic Trouble Codes (DTCs).
- Ensure stable battery voltage (low voltage can cause ECM malfunction).
- Avoid water/dust ingress into ECM housing.

f) Examples of ECM Engines in Track Machines

- Cummins QSK19, QSB6.7, QSL9 series – Widely used in tamping and ballast cleaning machines.
- Caterpillar C18 / C27 – Used in heavy rail grinding machines.
- Deutz TCD series – Used in modern ballast regulators and utility vehicles.
- Ashok Leyland H-series with ECU – Used in smaller utility track machines.

1211 Comparison: Mechanical vs. ECM Engines

Aspect	Mechanical Engines	ECM Engines
Fuel Injection	Mechanical pump with camshaft timing	Electronically controlled injectors with precise timing
Efficiency	Lower fuel efficiency	Higher fuel efficiency due to optimized combustion
Emissions	Higher emissions, not easily controlled	Meets CPCB/EU/BS emission standards
Diagnostics	Manual inspection required	Fault codes, real-time diagnostics available
Maintenance	Frequent adjustments needed	Easier diagnosis, less frequent adjustments
Integration	No electronic interface	CAN-bus/J1939 integration with machine control systems

1212 Engines currently prevalent in Track Machines

Sr. no.	Make	Engine model no.	Power Rating	Used on M/C	No. of Engines per Machine
1	CUMMINS	NTA 855L	375 HP @2100 RPM	WST PLASSER (08-32) & WST IMPORTED(08-32C)	1
2	CUMMINS	QSNT-C500-S30	500 HP @2000 RPM	BCM GEMAC	2
3	CUMMINS	KTA-1150 & NTA-855	473 BHP @ 2100 RPM & 360 BHP @ 2100 RPM	TAMPING EXPRESS PLASSER	2
4	CUMMINS	QSM11	305HP @ 1900 RPM	WST KALUGAPUTMASH WITHOUT FLAT CAR	1
5	CUMMINS	QSM11	360HP @ 2100 RPM	WST SAN	1
6	CUMMINS	NTA 855L	400 HP @ 2100RPM	UTV PHOOLTAS	1
7	CUMMINS	NTA 855L	400 HP @ 2100RPM	UTV PHOOLTAS WITH MOBILE CRANE	1
8	CUMMINS	NTA 855L	400 HP @ 2100RPM	UTV BHEL	1
9	CUMMINS	NTA 855L	400 HP @ 2100RPM	UTV BEML	1
10	CUMMINS	NTA 855L	400 HP @ 2100RPM	UTV SAN	1
11	CUMMINS	NT 855L	335 HP @ 2100RPM	UTV OEPL	1
12	CUMMINS	NTA 855L	400 BHP @ 2100RPM	UTV TRIDENT	1
13	CUMMINS	NT-743	232HP @ 1800 RPM	BRM KERSHAW	1
14	CUMMINS	QSNT-C360-S30	361HP @ 2100RPM	BRM HUBEI SRIDA	1

15	CUMMINS	QSM11-C360	320HP @ 1800RPM	BRM METEX	1
16	CUMMINS	KTA 1150L	469 HP @ 2100 RPM	UNIMAT 4S PLASSER	1
17	CUMMINS	NT 855L	240BHP @ 2200RPM	BRM PBR 400R PLASSER	1
18	CUMMINS	KTA 1150L	469HP @ 2100 RPM	BRM USP 2000 SWS PLASSER	1
19	CUMMINS	KTA 1150L	469 HP @ 2100RPM	UNIMAT MFI PLASSER	1
20	CUMMINS	QSN-14L	405 HP @ 2100RPM	MPT-UNIMAT 275 SH MFI PLASSER	1
21	CUMMINS	NTA 855L-BC	335 BHP @2100RPM	UNIMAT COM-M PLASSER	1
22	CUMMINS	KTA 1150L	473 HP @ 2100 RPM	CSM (NEW) PLASSER	1
23	CUMMINS	KTA-1150	473 HP @ 2100 RPM	DGS PLASSER	1
24	CUMMINS	N14-L2	480 HP @ 1800 RPM	DGS METEX	1
25	CUMMINS	NTA 855L	372 HP @ 1800 RPM	DGS BHEL	1
26	CUMMINS	VTA 1710 L	737 BHP @ 2100 RPM	SBCM FRM PLASSER	1
27	CUMMINS	VT 28-P	800 HP @ 2100 RPM	SBCM,KSC-600	1
28	CUMMINS	QSX15	450 HP @ 2100 RPM	TRT HARSCO	1
29	CUMMINS	NTA-855 C	360 HP @ 2100 RPM	TRT (OLD) HARSCO	1
30	CUMMINS	QSB 6.7	189 HP @ 2300 RPM	MDU (MFS-120) (Non-retractable conveyor) PLASSER	1
31	CUMMINS	QSB 6.7	220 HP @ 2200 RPM	MDU MFS 120 PLASSER	1
32	CUMMINS	NT855 R	285 HP @ 2100 RPM	RBMV.01.B PHOOLTAS	2
33	CUMMINS	QSN 14R	400 HP @ 2100 RPM	RBMV SAN	2
34	CUMMINS	QST30-G5	1207 HP @1800 RPM	RGM-96 STONE LORAM	4
35	CUMMINS	QST30-G5	1207 HP @1800 RPM	RGM-72 STONE LORAM	3
36	CUMMINS	QST30 G5	1207 HP @1800 RPM	SRGM LORAM	1
37	DEUTZ	F12L513	359 HP @ 2300RPM	BRM GEMAC	1
38	DEUTZ	BF6M1015V6/4V	330 KW @2100 RPM	WST (PLASSER)	1
39	DEUTZ	TCD 2015 V08	643HP @ 2100 RPM	Unimat-08 4X4/4S	1
40	DEUTZ	TCD 2015V08	370KW @ 2100 RPM	PCTM CRCC	1
41	DEUTZ	BF12L513 C	453 HP @ 2300 RPM	BCM/RM-80 PLASSER	2
42	DEUTZ	BF12L513 C	396 HP	BCM RM-76 PLASSER	1
43	DEUTZ	BF6M-1015CP	335 KW @ 2100 RPM	BCM PLASSER	2
44	DEUTZ	BF12L513 C	453 HP @ 2300 RPM	RM 80-92U PLASSER	2
45	DEUTZ	D-914L06	116 HP @ 2300 RPM	TLE SIMPLEX	1
46	CATERPILLAR	C18	700 HP @ 2100 RPM	SBCM FRM PLASSER	1
47	CATERPILLAR	C18	765 KW @ 2100 RPM	SBCM CRCC	1
48	CATERPILLAR	C27	783 KW @ 1900 RPM	HOBCM PLASSER	2
49	CATERPILLAR	C18 & C9	600 HP @ 2100 RPM & 275 HP	DTE (OLD) PLASSER	2
50	CATERPILLAR	C18	700 HP @ 2100 RPM	DTE (NEW) PLASSER	1
51	CATERPILLAR	C15	480HP @ 2100 RPM	PCT GEMAC	1
52	CATERPILLAR	C32	895 KW @ 1800 RPM	RMM LINSINGER	1
53	CATERPILLAR	C13	520 HP @ 2100 RPM	RGM-10 STONE HARSCO	1
54	CATERPILLAR	C 27 V-12	1105 HP @1800 RPM	SRGM HARSCO	1

55	CATERPILLAR	C9.3B	400 HP @ 2100 RPM	RIV HARSCO	1
56	MWM GREAVES	TBD 232 V12	473HP @ 2000RPM	CSM (Old) PLASSER	1
57	MWM GREAVES	TBD-234 V-12	470 HP @2300 RPM	SBCM, FRM-80 PLASSER	1
58	KIRLOSKAR	HA -694	95 BHP @ 2000 RPM	TLE SIMPLEX	1
59	SUN	SUN/6105-73 A0	170 HP @ 2400RPM	T-28 PORTAL CRANE AMECA	1
60	VOLVO PENTA	TAD570-72VE	170 HP @ 2300 RPM	PCCM COLMAR	1
61	ASHOK LEYLAND	N6 CRS	450 HP @ 2200 RPM	RBMV.04.B PHOOLTAS	2
62	ASHOK LEYLAND	A2N46200/HA5 7L165/49	225 HP @ 2300 RPM	MDU, MODEL-WMDU-65, OEPL	1
63	ASHOK LEYLAND	ALIN6 TI/5	450 HP @ 2200 RPM	UTV (PHOOLTAS)	1

1213 Trouble Shooting Manual of Track Machine Engines

SN	Faults	Probable Causes	Remedial Actions
1.	Engine does not start.	1. Emergency stop switch is pressed.	Emergency stop switch should be in release position.
		2. No fuel in the tank.	Fill fuel in the tank. Bleed air from fuel system in the following steps: i) Loosen the bleed plug on the fuel filter and operate the priming pump until the fuel emerges free of bubbles. Tighten the bleed plug. ii) Then loosen banjo plug on injection pump and operate priming pump until fuel emerges free of bubbles. Tighten the banjo plug.
		3. Shut down mechanism stuck	Check the electrical supply at coil if it is ok, then lubricate the piston of shut down coil mechanism with lube oil and operate it manually. If still not working, then coil may be defective. Replace it with new one. Check safety related sensors switch.
		4. Air in fuel system.	Bleed air from fuel system as explained in s.no.1,item 2 above.
		5. Governor is stuck.	Call in the service engineer. Governor needs repairs.
		6. Misconnection of starting switch.	Check starting switch and if any misconnection is noticed, rectify it.
		7. Safety system	Check all safety sensors for proper function. Check engine ECM module for any warning and do needful
		8. Weak batteries.	Check electrolyte level in the batteries. Terminals should be clean and the charging system should be working. Over-aged batteries should be replaced
		9. Injectors not properly functioning.	Remove Defective injectors and get it overhauled/calibrated or alternatively replace it with new one.

		10. Valves not seating properly.	i) Check the valves spring and replace the broken spring if any. ii) Lap the valves. iii) Lap the valve seat, if required.
		11. Defective starting switch/solenoid	Bypass starting switch.
2.	Engine stops	1. No fuel.	Fill fuel in the tank and follow steps as in s. no. 1, item no.2.
		2. Air in the fuel system.	Bleed air from fuel system as explained in s. no.1, item no.2.
		3. Valve clearance is not proper.	Adjust valve clearance
		4. Governor is stuck.	Call in the service engineer. Governor needs repairs.
		5. Overheating of engine	Take remedial action as in s.no.5 below.
		6. Engine safety circuit fails.	Recheck and repair the circuit as per indication on HMI panel.
3.	Engine misfiring	1. Dirty fuel filter.	Check fuel filters and if necessary- i) Change fuel filter. ii) Clean the fuel lines.
		2. No / less fuel in tank.	Fill fuel in the tank and follow step in s. no.1, item no.2.
		3. Air in fuel system.	Bleed air from the system. Same as s. no.1, item no.2.
		4. Defective Injector.	Remove the defective injector and get it overhauled / calibrated/ replace with new one.
		5. Valve clearance is not proper.	Adjust valve clearances
		6. Fuel injection timing not proper.	Correct the timings or call the service engineer.
4.	Excessive engine smoking.	1. Engine oil level too high.	Check oil level. For this purpose, draw dipstick and clean with lint-free cloth. Return dipstick, wait a little until the oil has wetted the dipstick. Then remove dipstick again and check oil level.
		2. Defective injector	Same as s.no.1, item no.9.
		3. Valve clearance is not proper.	Same as s. no.1, item no.7.
		4. Air in fuel system.	Same as s. no.1, item no.2.
		5. Clogged air cleaner.	Clean air cleaner element and check lub oil quality.
		6. Engine overloaded.	Check and reduce the load.
		7. Defective Turbocharger	Check Turbocharger for proper functioning.
5.	Engine running too	1. Coolant level too low.	Check coolant level and top up with coolant up to the mark in the filler neck.

	hot.	2. Defective thermostat	Check thermostat as in the following steps: i) Drain cooling water and catch it for reuse. ii) Loosen hose clamps, pull back hoses and then remove thermostat. iii) Heat water in container to approx. 85° C and place thermostat in it. Maintain temperature of water by agitating. iv) By short circuiting and radiator opening, check whether the thermostat opens fully. If not, call in the Service Engineer to fit new thermostat. Or Alternatively check temperature of coolant in radiator for functioning of thermostat.
		3. Defective water pump.	Call in the service engineer to check/repair water pump.
		4. V-belt for water pump needs adjustment.	Remove V-belt guard and check V-belt tension. To adjust, release take-up pulley mount or generator and regulate tension in the belt. Then tighten the take-up pulley. If required, replace the V-belt.
		5. Oil cooler not working.	Call service engineer for repair/ replacement of Oil Cooler.
		6. Valve clearance is not proper.	Adjust valve clearance.
		7. Air filter is choked.	Clean air filter.
		8. RPM of coolant fan is too low.	Adjust RPM of the motor. Check hydraulic system and change pump and motor if necessary.
		9. Radiator choked.	Clean the radiator.
		10.Radiator cap missing or worn out	Fit new cap.
		11. Water Hose too old.	Replace water hose.
6.	Engine knocking	1. Incorrect Injector setting.	Remove the faulty injector and get it reset or replace it with new one.
		2. Mechanical damage to piston/ cylinder.	Call in the service engineer.
		3. Valve clearance is not proper.	Adjust valve clearance.
		4. Fuel injection timing not proper.	Same as s. no. 3, item 6.
		5. Fuel quality	Ensure good quality of fuel.
7.	Output of the engine too low	1. Dirty fuel filter and fuel line.	Clean fuel filter see s. no.3, item no.1.
		2. Air in fuel system.	Bleed air from system as explained in s. no.1, item no.2.
		3. Defective Injector.	Remove defective injector and get it overhauled or replace it with new one.
		5. Air filter choked.	Clean air filter element and change oil.

		6. Improper compression	Engine needs repairs in workshop.
		7. Governor is stuck.	Call in the service engineer. Governor needs repairs.
8.	Oil pressure low.	1. Dirty lube oil filter.	Replace the lube oil filter.
		2. Oil control valve not working.	Call the service engineer for repair of control valve.
		3. Dirty oil cooler	Call in the service engineer for cleaning of the oil cooler.
9.	Oil film present in crank case ventilation	1. Incorrect compression.	Engine needs repairs in workshop.
		2. Lube oil brands.	Use lube oil of proper brand and grade as recommended by the OEM.
10.	Engine speed is irregular.	1. Air in fuel system	Bleed air from the system as explained in s. no.1, item no.2.
		2. Governor is stuck.	Call in the service engineer. Governor needs repairs.
11.	Fuel consumption too high.	1. Incorrect lube oil brand.	Use proper grade and quality lube oil.
		2. Incorrect setting of Injector.	Replace or overhaul Defective injector.
		3 Incorrect engine timing.	Reset the engine timing.
		4. Clogged air filter.	Clean air filter.
		5. Poor compression	Engine needs repairs in workshop.
12.	Lube oil consumption too high.	1. Incorrect lube oil brand.	Use proper grade and quality lube oil as recommended by OEM.
		2. Poor compression	Engine needs repair in workshop.
		3. Oil filter dirty.	Replace the filter.

1214 List of Spares Count of Engines (OEM-Wise) in Policy of Procurement of Spares of Track Machines-

Sr. No.	Engine OEM	No. of engine spares in Ann-I	No. of engine spares in Ann-II	Total No. of spares of engine in PoP Annexures
1.	Cummins	695	42	737
2.	Deutz	1034	8	1042
3.	Greaves	103	0	103
4.	Kirloskar	96	0	96
5.	SUN	120	3	123
6.	Caterpillar	142	1	143
7.	Ashok Leyland	37	4	41
8.	Volvo Penta	36	2	38
	Total	**2263**	**60**	**2323**

1215 Maintenance Schedule of Engines:

Maintenance schedule of various types of engines is attached as **Annexure 12.1**.

1216 Overhauling Procedure

Diesel engine overhauling is a restorative process to fix severe wear, damage, or declining performance by completely disassembling the engine, thoroughly inspecting and cleaning every component, and then repairing or replacing worn-out parts like pistons, rings, bearings, valves, and gaskets to meet factory specifications. This comprehensive procedure extends engine life, restores lost power and efficiency, and ensures continued reliability, often costing less than replacing the entire engine. Following can be the reasons for overhauling of engine-

- Reduced Power & Performance: A heavily worn engine may lose significant power and fuel efficiency.
- Excessive Oil Consumption: Dropping oil levels and blue smoke can indicate worn parts, especially cylinder walls.
- Unusual Noises: Strange sounds from the engine can signal internal damage requiring a major repair.
- Extended Lifespan: Overhauling is a cost-effective way to restore a worn or damaged engine to like-new condition, rather than buying a new one.
- Improved Reliability: It ensures the engine operates dependably and efficiently again.

Annexure-12.1

Maintenance Schedule of Engines

I. Cummins Diesel Engine

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
Fuel System	Drain Sediments / Water from Fuel Tank
	Drain Fuel Filter / Water Separator
Cooling System	Check Coolant Level
	Check Belts Tension. Adjust if required
	Check all accessories for any loose connection (Radiator fan auxiliary shaft , V belts tensioner)
Lubrication System	Check Engine Oil Level
	Check & Correct Leaks
Other Check	Drain Air Tank
	Check and Correct all Leakages
B-Check (Every 300 hrs. or 6 Months)	
Air Induction System	Clean / Change Crank Case Breather
	Check Air Piping
Fuel System	Clean / Change Fuel Tank Breather
	Change Fuel Filter
	Clean / Check the throttle control linkages (every 100 hrs.)
	Check Aneroid / Hyd. Gov. Oil
Cooling System	Check Coolant Inhibitor. Add Coolant Concentrate, if required
	Check Heat Exchanger Zinc Plugs
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change Full-Flow & By-Pass Oil Filters
	Record Oil Pressure
C-Check (Every 1500 hrs. or 12 Months)	
Air Induction System	Check Air Cleaner Evacuator Valve. Change if required
	Adjust Injectors and Valves Adjustment
	Replace Aneroid Breather.
Fuel System	Change Aneroid / Hyd. Gov.. Oil.
	Replace Aneroid Breather
	Clean Fuel Tank from Inside
Cooling System	Clean Radiator / Charge Air Cooler Externally
	Check Fan Hub / Idler and Water Pump / Idler

D-Check (Every 6000 hrs. or 24 Months)	
Air Induction System	Check Turbocharger Bearing Clearance.
	Clean Turbo. Compressor Wheel & Diffuser, if required
	Check Air Compressor
Fuel System	Check Fuel Pump Calibration.
	Clean & Calibrate Injectors, if required
	Replace Fuel Pump Filter Screen
Cooling System	Change Coolant.
	Descale Cooling System
Lubrication System	Calibrate Lube oil pressure system
Other Maintenance	Check Vibration Damper.
	Adjust Injectors and Valves
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

II. Caterpillar Diesel Engine

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan
	Check Air Cleaner filter choking, Clean / Change Air Cleaner Element if required.
Fuel System	Drain Sediments / Water from Fuel Tank
	Drain Fuel Filter / Water Separator
	Check Fuel Level
Cooling System	Check Coolant Level
	Check Belts Tension and adjust if required
	Check all accessories for any loose connection (Radiator fan auxiliary shaft , V belts tensioner)
Lubrication System	Check Engine Oil Level and top up if required
Other Check	Drain Air Tank
	Clean engine and premises
	Check and Correct all Leakages
	Record Oil Pressure
B-Check (Every 250 hrs.)	
Air Induction System	Clean Crank Case Breather
	Clean outer air cleaner element
Fuel System	Clean Fuel Tank Breather
	Change Fuel Filter and water separator
	Change engine oil and engine oil filter (For deep sump change at 500 hrs)
Cooling System	Clean Radiator
Other Check	Check mounting bolts of engine
	Check all belts and change if required
	Inspect Starting motor, Turbocharger, water pump and alternator (Every 500 hrs.)

C-Check (Every 2000 hrs.)	
Air Induction System	Change inner air cleaner and outer air cleaner element. (Every 500 hrs. or on condition basis)
	Check Injectors and Valves Adjustment
Fuel System	Change fuel tank breather
	Clean Fuel Tank from Inside (Every 1000 hrs.)
	Adjust Injectors and Valves.
Cooling System	Clean Radiator / Change radiator hoses if required
	Check bearing and shaft of radiator fan drive and do needful
	Check aftercooler core.
	Replace Coolant temperature Regulator
Other Check	Inspect and Overhaul self-starter, alternator, turbocharger, air compressor
	Check Crankshaft Vibration Damper
	Check Speed sensor and Engine mounting.
	Check engine protective device
D-Check (Every 6000 hrs. or 8000 hrs.)	
Air Induction System	Check Turbocharger
	Check Air Compressor
Cooling System	Clean oil cooler core and aftercooler core
	Change Coolant.
	Clean /Replace Cooling coil
Lubrication System	Calibrate Lube oil pressure system
Other Maintenance	Change engine damper.
	Top overhaul of engine
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

III. Deutz Diesel Engine

BF12L 513C (Air cooled) / BF6M 1015CP (Water cooled) / TCD2015V08 (Water cooled)

A-Check (Daily Maintenance)	
Air Induction System	Clean the air cleaner housing. Check air piping.
	Check air cleaner element on dirt indication. Clean / change air cleaner element, if required.
	Check the connection of rubber hose and the hose clips between the manifold and the air cleaner before starting the engine.
	Clean the charge air cooling system, on condition basis.
Fuel System	Check fuel level and top up, if required.
	Check high pressure fuel pipes and clamps.
	Inspect &drain fuel filter / water separator.
	Clean the fuel pre filter (wire mesh), on condition basis. (BF12L 513C / BF6M 1015CP)
	Check injector pipes for any rubbing and attend, as required.

Cooling System	Check coolant level in radiator and top up if required. (BF6M 1015CP / TCD2015V08)
	Lubricate the radiator fan shaft with grease, if applicable.
	Clean the fins of engines and air charge cooler. (BF12L 513C)
	Check engine temperature safety device.
	Check all accessories for any loose connection
Lubrication System	Check engine lube oil level. Top up, if required.
	Check the engine oil pressure at idle rpm and on load after 02 hours of working.
	Check lube oil pressure safety device.
Other Check	Clean the engine.
	Check tension and condition of all belts. Adjust, if required
	Check and correct all leakages.
	Check all mounting bolts including those of self-starter, alternator, and engine etc. for tightness.
	Record the maximum engine temperature of the day's work.
	Check clutch assembly for proper working.(Clean at every 50 hrs. with pneumatic air)
	Check all engine parameter monitoring gauges after starting the engine.
B-Check (Every 300 hrs. or 6 Months)	
Air Induction System	Replace oil in the wet type air filter. Replace earlier, if required on condition basis.
	Overhaul the air compressor, if required. Replace minor repair kit.
	Replace the outer and inner engine air cleaner elements. (Every 500 hours for BF12L 513C engines and every 1000 hours for both BF6M 1015CP & TCD2015V08 engines)
Fuel System	Check crank case/fuel tank breather and clean, if required.
	Clean / Check the throttle control linkages (Every 100 hrs)
	Replace the fuel pre filters. (500 hours)
	Replace Primary fuel filters (water separator). (500 hours)
	Replace fuel filter. (500 hours)
	Replace lube oil filter & bypass element. (TCD2015V08) (500 hours)
	Replace engine lube oil. (TCD2015V08) (500 hours)
Cooling System	Clean the water radiator fins. (BF6M 1015CP / TCD2015V08)
	Check the water hoses and change, as required. (BF6M 1015CP / TCD2015V08)
	Check/add concentration of coolant /replace radiator coolant. (BF6M 1015CP / TCD2015V08)
	Clean the water radiator internally & externally, as required. (BF6M 1015CP / TCD2015V08)

Lubrication System	Replace lube oil filter & bypass element. (Every 250 hours for both BF12L 513C&BF6M 1015CP engines and every 500 hours for TCD2015V08 engines)
	Replace engine lube oil. (Every 250 hours for both BF12L 513C&BF6M 1015CP engines and every 500 hours for TCD2015V08 engines)
Other Check	Replace V-Belts on condition basis.
	Lubricate all the engine pulley bearings with grease.
	Clean the crank case breather element.
	Tighten bolts of exhaust manifold.
	Check engine mounting bolts and anti-vibration mounting pads for any defects and replace, if required.
	Clean filter bowl on hydraulic cooling air blower (BF12L 513C)
C-Check (Every 1500 hrs. or 12 Months)	
Air Induction System	Clean & check turbocharger compressor and turbine wheels. Check radial and end clearances & attend as per condition.
	Check the air compressor. Overhaul if necessary.
Fuel System	Overhaul & calibrate the fuel injection pump & fuel injectors.
	Check engine timing and attend, as required.
	Clean the diesel tank with lint free cloth.
Cooling System	Clean and de-scale cooling system/Overhaul the water radiator. (BF6M 1015CP / TCD2015V08)
	Replace radiator coolant. (BF6M 1015CP / TCD2015V08)
	Check bearing and shaft of radiator fan drive and attend, as required. (BF6M 1015CP / TCD2015V08)
	Overhaul water pump. (BF6M 1015CP / TCD2015V08)
Other Check	Overhaul the engine, if there is lack of compression on low lube oil pressure otherwise de- carbonize the engine.
	Check & replace all defective gauges & sensors.
	Replace the rocker cover gaskets. (TCD2015V08)
	Adjust the Tappet clearance.
	Check crank shaft end clearance.
	Check the engine damper for dynamic balance.
	Replace valve insert (Part no.02418444 at every 1000 hrs. for BF12L513C).
D-Check (Every 6000 hrs. or 24 Months)	
Air Induction System	Overhaul/replace the air compressor, turbocharger and blower assembly.
	Change air inlet hoses.
Fuel System	Change all the high pressure fuel pipes, pipe clamp, flexible fuel hoses and rubber hoses.
	Replace the water separator.
Cooling System	Overhaul the radiator fan drive assembly. (BF6M 1015CP / TCD2015V08)

	Replace water hoses with clamp for radiator. (BF6M 1015CP / TCD2015V08)
	Check cooling coil. Replace, if required, otherwise, clean it.
Other Check	Overhaul or replace the engine(s).
	De – carbonize the engine head (if overhauling is not done).
	Check crankshaft and camshaft end play.
	Replace silencer (Muffler).
	Replace engine lube oil & temperature sensors.
	Check the exhaust manifold for any defects and clean it.
	Change the engine mounting pads.
	Replace coolant pump, Injectors, Crank case pressure relief valve (BF6M1015CP & TCD2015V08)
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

IV. SUN Engine (Model No. 6105I73AO)

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
Fuel System	Check fuel level in tank, top-up if required.
	Drain water sediments from Fuel Tank
	Check fuel lines for any leakages.
	Drain Fuel Filter / Water Separator
	Check all connection, safety switches and clean.
Cooling System	Check and clean cooling fins.
	Check Belts Tension, Adjust if required
	Check all accessories for any loose connection (Radiator fan auxiliary shaft , V belts tensioner)
Lubrication System	Check Engine Oil Level
	Check & Correct Leaks
	Check lube oil pressure
Other Check	Check connections of Self-starter, Alternator, Battery and Shut down solenoid and safety switches.
B-Check (Every 150 hrs.)	
Air Induction System	Clean / Change Crank Case Breather
	Check Air Piping
Fuel System	Clean / Change Fuel Tank Breather
	Change Fuel Filter
	Clean / Check the throttle control linkages
	Check leakages from fuel pipes, Injectors, fuel pump.
Cooling System	Check and clean cooling fan, air fins.
	Check Heat Exchanger Zinc Plugs and lube oil cooler.
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change Full-Flow & By-Pass Oil Filters
	Record Oil Pressure

C-Check (Every 500 hrs. or 12 Months whichever occurs first)	
Air Induction System	Check Air Cleaner filter change if required.
	Check Air Cleaner Evacuator Valve. Change if required.
	Check intake connection/hoses for any defects.
Fuel System	Clean Fuel pre-filter and draining water from fuel tank.
	Check all fuel lines for wear and tear, replace if required.
Cooling System	Clean Cooling fins.
	Inspect fan, drive belts, belt tensioner and idler wheels.
D-Check (Every 1000/6000 hrs. or 24 Months)	
Air Induction System	Repair air intake manifold for any defect.
	Over haul fan drive, belt tensioner and idler wheels.
	Change rubber hoses.
Fuel System	Clean Fuel Tank from Inside, replace breather filter.
	Clean & Calibrate Fuel Pump, Injectors, if required
	Check and replace defective fuel pipes.
Lubrication System	Calibrate Lube oil pressure system
Other Maintenance	Check Vibration Damper.
	Adjust Injectors and Valves
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

V. Volvo Penta Engines (Model No.TAD570-73VE)

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
Fuel System	Drain Sediments / Water from Fuel Tank
	Drain Fuel Filter / Water Separator
	Check and Correct all Leakages.
Cooling System	Check Coolant level.
	Check Belts Tension. Adjust if required
	Check all accessories for any loose connection (Radiator fan auxiliary shaft , V belts tensioner)
Lubrication System	Check Engine Oil Level
	Check & Correct Leakages.
Other Check	Check and correct loosen bolts if any.
B-Check (Every150 Engine hrs.)	
Air Induction System	Clean Crank Case Breather.
Fuel System	Clean Fuel Tank Breather
	Change Fuel Filter
	Clean / Check the throttle control linkages

Cooling System	Check Coolant level and antifreeze mixture and top up if necessary
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change By-Pass Oil Filters
	Record Oil Pressure
C-Check (Every 500 hrs. or 12 Months whichever occurs first)	
Software	Check Software status by service Engineer.
V-Belts & idler wheels	Check Drive belts, belt tensioner and idler wheels.
Air Induction System	Check Air Cleaner filter change if required.
	Check intake connection/hoses for any defects.
	Clean Fuel pre-filter from draining water/ contamination.
Cooling System	Check coolant level and antifreeze mixture and top up if necessary.
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change By-Pass Oil Filters
	Record Oil Pressure
D-Check (Every 1000 hrs. or 12 Months whichever occurs first)	
Air Induction System	Change Air Cleaner filter.
Fuel System	Replace Fuel Pre Filter and fuel line filter
Valve clearance	Adjust valve clearance by service engineer.
E-Check (Every 1500 hrs. or 12 Months whichever occurs first)	
Crankcase	Replace crankcase ventilation filter.
F-Check (Every 2000 hrs. or 24 Months whichever occurs first)	
Valve clearance	Adjust valve clearance by service engineer.
Air Induction System	Replace Air filter
	Replace AdBlue®DEF tank breather.
	Replace AdBlue®/ DEF filter
	Replace pump Unit.
V-Belts	Replace all drive V- belts.
Belt Tensioner	Inspect the belt tensioner, pulley and idler pully bearings, replaced if required.
Selective Catalytic Reduction (SCR) systems	Replace NOx Sensor of Pre/post SCR
EGR COOLER	Clean EGR Cooler
Cooling System	Replace Coolant
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

VI. Kirloskar Engine (Model No. HA 694, Air Cooled)

A-Check (Daily Maintenance)	
Air Induction System	Clean dust collector pan.
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
Fuel System	Check fuel level in tank, top-up if required.
	Drain water sediments from Fuel Tank
	Check fuel lines for any leakages.
	Visual Check & ensure that all V-belts are tight and in good condition.
	Visual Check for any leakage from fuel pump, injectors, filters, and fuel supply and return pipes and do needful.
Cooling System	Check and clean cooling fins.
	Belts Tension, Adjust if required
	Check the engine temperature gauge pointer. It should always be in green zone
	Check all accessories for any loose connection (Radiator fan auxiliary shaft , V belts tensioner)
Lubrication System	Check level of lube oil and top up if required.
	Check &correct leakages.
	Check lub. oil pressure.
Others	Check connections of Self-starter, Alternator, Battery, Shut down, starting, and safety switches.
	Clean the engine and premises.
	Check all engine parameter monitoring gauges after starting the
	Check condition of smoke.
B-Check (Every 100 hrs.)	
Air Induction System	Clean / Change air cleaner.
	Check air piping/hose.
	Check air intake manifold for any defect.
Fuel System	Clean Fuel Tank Breather.
	Clean / Check the throttle control linkages
	Change Fuel Filter.
	Clean fuel strainer (button filter at Feed pump inlet).
	Check leakages from fuel pipes, Injectors, fuel pump.
Cooling System	Check and clean cooling fan, air fins.
	Check Heat Exchanger Zinc Plugs and lub. oil cooler.
	Record temperature.
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change oil Filters.
	Record oil Pressure
C-Check (Every 200 hrs. or 12 Months whichever occurs first.)	
Air Induction System	Clean the air cleaner element.
	Check intake connection/hoses for any defects.
Fuel System	Clean Diesel Tank.
	Check all fuel lines for wear and tear, replace if required.

Cooling System	Clean Cooling fins.
	Inspect fan, drive belts, belt tensioner and idler wheels.
Lubrication System	Lubricate all the engine pulley bearings with grease.
D-Check (Every 1000 hrs. or 24 Months)	
Air Induction System	Repair air intake manifold for any defect.
	Over haul fan drive, belt tensioner and idler wheels.
	Change rubber hoses.
Fuel System	Clean Fuel Tank from Inside, replace breather filter.
	Clean & Calibrate Fuel Pump, Injectors, if required
	Check & replace defective fuel pipes.
Lubrication System	Calibrate Lube oil pressure system
Other Maintenance	Check Vibration Damper.
	Adjust Injectors and Valves
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

VII. Ashok Leyland Diesel Engine

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
	Check the air cleaner chocking indicator
Fuel System	Check fuel level and top up if required
	Drain Sediments / Water from Fuel Tank
	Drain Fuel Filter / Water Separator
	Visual Check the leakage from fuel pump, injectors, fuel supply and return pipes and do needful.
Cooling System	Check Coolant Level and top up if required
	Check the leakage from hoses, water pump seal etc. and do the needful.
	Check Belts Tension. Adjust if required
	Check all accessories for any loose connection (Radiator fan auxiliary shaft , V belts tensioner)
Lubrication System	Check Engine Oil Level
	Check & Correct Leaks
Other Check	Drain Air Tank
	Check and Correct all Leakages
	Clean the engine and premises
B-Check (Every 200 hrs.)	
Air Induction System	Clean / Change air cleaner element
	Check Air Piping
Fuel System	Clean / Check the throttle control linkages
	Change Fuel Filter
	Check Hyd. Governor oil.
	Check coupling disc of injection pump
	Check coupling disc of injection pump

Cooling System	Check Coolant Inhibitor.
	Check/add Coolant additive concentrate if required
	Check the condition and tightness of V-belt for radiator fan.
	Check Heat Exchanger Zinc Plugs
	Check and change radiator hoses, if required
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change lube oil filter & bypass element.
	Record Oil Pressure
C-Check (Every 1000 hrs.)	
Air Induction System	Check Air Cleaner Evacuator Valve. Change if required
	Adjust Injectors and Valves Adjustment
	Replace Aneroid Breather.
Fuel System	Change Aneroid / Hyd. Gov.. Oil.
	Replace Aneroid Breather
	Clean Fuel Tank from Inside
Cooling System	Clean Radiator Air Cooler Externally
	Check Fan Hub / Idler and Water Pump / Idler
	Change worn out water hoses
	Check coolant for PH value
D-Check (Every 2000 hrs.)	
Air Induction System	Check Turbocharger Bearing Clearance.
	Check turbocharger compressor and turbine wheels. Check radial and end clearances &Do needful.
	Check Air Compressor
Fuel System	Clean & Calibrate Injectors, pump, if required
	Replace Fuel Pump Filter Screen
Cooling System	Change Coolant of radiator
	Descale Cooling System
	Overhaul water pump
Lubrication System	Calibrate Lube oil pressure system
Other Maintenance	Check Vibration Damper.
	Adjust Injectors and Valves
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

VIII. Caterpillar Diesel Engine

CATERPILLAR C32 T2, 895 KW @ 1800 RPM, C13 T3, 388 KW @ 2100 RPM, C 9 400hp KW @ 2100 RPM & C 271105 HP @ 1800 RPM

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan.
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
	Check all hoses for any defect.
Fuel System	Check fuel level in tank, top-up if required.
	Drain water sediments from Fuel Tank.
	Check fuel lines for any leakages and rubbing.
	Drain water from water separator & fuel filter.
	Check and clean all connection, safety switches.

Cooling System	Check coolant level and top up if required.
	Check and clean cooling fins.
	Check Belts Tension, Adjust if required.
Lubrication System	Check Engine oil level and top up if necessary.
	Check & Correct Leakages.
	Check lubrication oil pressure.
Others	Check connections of Self-starter, Alternator, Battery, Shut down solenoid and safety switches.
	Clean engine and premises.
	Check and Correct all Leakages.
B-Check (Every 250 hrs)	
Air Induction System	Clean / Change Crank Case Breather.
	Check air inlet piping.
	Clean air filter and change if necessary.
Fuel System	Clean / Change Fuel Tank Breather.
	Change Fuel Filter and drain water separator.
	Check leakages from fuel pipes, Injectors, fuel pump.
Cooling System	Change Coolant Filter.
	Check and clean radiator cooling fins.
	Check coolant inhibitor. Add coolant concentrate, if required.
	Check and replace hoses for any defect.
Lubrication System	Change Engine Oil. Use Recommended Oil Only
	Change Full-Flow & By-Pass Oil Filters
	Record Oil Pressure.
Others	Check bearing of fan wheel.
	Check mounting bolts of engine.
	Check all belts and change if required
	Inspect Starting motor, Turbocharger, water pump and alternator.
C-Check (Every 1000 hrs.)	
Air Induction System	Check Air Cleaner filter change if required.
	Check Air Cleaner Evacuator Valve. Change if required.
	Check intake connection/hoses for any defects.
	Check all fuel lines for wear and tear, replace if required.
	Clean fuel tank inside.
Cooling System	Clean Cooling system.
	Descale Cooling System.
	Overhaul water pump.
	Check Fan Hub / Idler and Water Pump / Idler.
D-Check (3000, hrs.)	
Fuel System	Change intake rubber hoses.
	Clean Fuel Tank from Inside, replace breather filter.
	Clean & Calibrate Fuel Pump, Injectors, if required.
	Check and replace defective fuel pipes.
Cooling System	Change coolant.

	Replace coolant temp. gauge.
	Check coolant for PH value
	Over haul fan drive, belt tensioner and idler wheels.
Lubrication System	Calibrate Lube oil pressure system.
	Clean radiator.
	Check Crankshaft Vibration Damper
	Check Speed sensor and Engine mounting.
Others	Check the RPM of Engine radiator fan, if found less than the rated RPM, take corrective measures.
	Inspect and Overhaul self-starter, alternator, turbocharger, air compressor
	Check engine protective device
E-Check (6000, hrs.)	
Air Induction System	Check Turbocharger.
	Check Air Compressor.
Fuel System	Calibrate fuel supply system.
	Adjust Injectors and Valves.
Cooling System	Clean oil cooler core and after cooler core.
	Clean /Replace Cooling coil.
	Clean Radiator.
	Change Coolant.
Lubrication System	Calibrate Lube oil pressure system.
Other Maintenance	Check all accessories, engine mounting pads and tight as per requirement.
	Top overhaul of engine.
	Change engine damper.
Note- Any OEM suggestion should also be adopted in the maintenance practices.	

IX. Cummins Diesel Engine
QST30 G5 NR2 900KW @ 1800 RPM

A-Check (Daily Maintenance)	
Air Induction System	Clean Pre-Cleaner Dust Pan.
	Check Air Cleaner Restriction. Clean / Change Air Cleaner Element if required.
Fuel System	Drain water sediments from Fuel Tank.
	Drain water from water separator & fuel filter.
	Check fuel level in tank, top-up if required.
	Check fuel lines for any leakages.
	Check all connection, safety switches and clean.
Cooling System	Check Belts Tension, Adjust if required.
	Check coolant level and top up if required.
	Check and clean cooling fins if required.
Lubrication System	Check Engine oil level and top up if necessary.
	Check & Correct Leaks.
	Check lub. oil pressure.

Others	Drain Air Tank.
	Check and Correct all Leakages.
	Check connections of Self-starter, Alternator, Battery, Shut down solenoid and safety switches.
	Inspect the air intake piping from the filters to the engine for any damaged or loose connections.
	Blow out all radiators from fan side, non fan side & oil coolers.
	Clean engine and premises.
B-Check (Every 250 hrs)	
Air Induction System	Clean / Change Crank Case Breather.
	Check air inlet piping.
	Clean air filter and change if necessary.
	Clean outer air cleaner element.
Fuel System	Clean / Change Fuel Tank Breather.
	Change Fuel Filter and water separator Filter.
	Check leakages from fuel pipes, Injectors, fuel pump.
Cooling System	Check coolant inhibitor. Add coolant concentrate, if required.
	Check heat Exchanger Zinc Plug.
	Check radiator fan shaft bolt.
	Check and clean cooling fan, air fins.
	Inspect engine belts.
	Clean Radiator.
	Change Coolant Filter.
Lubrication System	Change Engine Oil. Use Recommended Oil Only.
	Change Full-Flow & By-Pass Oil Filters.
	Record Oil Pressure.
	Replace lube oil filter.
Others	Check bearing of fan wheel.
	Check mounting bolts of engine.
	Inspect Starting motor, Turbocharger, water pump and alternator.
C-Check (Every 1000 hrs.)	
Air Induction System	Check Air Cleaner filter change if required.
	Adjust Injectors and Valves Adjustment. (every 1500 hrs.)
	Overhaul/ replace the fuel injectors if required. (every 1500 hrs.)
	Replace Aneroid Breather.
	Check Air Cleaner Evacuator Valve. Change if required.
	Check intake connection/hoses for any defects.
Fuel System	Change Aneroid / Hyd. Gov. Oil.
	Replace Aneroid Breather
	Check all fuel lines for wear and tear, replace if required.
	Clean fuel tank inside.
Cooling System	Clean Cooling system.
	Descale Cooling System.
	Overhaul water pump.
	Check Fan Hub /Idler pulley.
	Clean Cooling fins.

	Check v- belt tension of the fan (every 06 months).
Lubrication System	Drain and replace actuator oil (every 1500 hrs.).
Others	To calibrate the encoder.
D-Check (3000, hrs.)	
Air Induction System	Repair air intake manifold for any defect.
	Over haul fan drive, belt tensioner and idler wheels.
	Change rubber hoses.
	To remove and replace the generator air filter assembly.
Fuel System	Clean Fuel Tank from Inside, replace breather filter.
	Clean & Calibrate Fuel Pump, Injectors, if required.
	Check and replace defective fuel pipes.
Lubrication System	Calibrate Lube oil pressure system.
	Clean radiator.
	Change coolant.
	Replace coolant temp. Regulator.
	Inspect and Overhaul self-starter, alternator, turbocharger, air compressor
Others	Check the RPM of Engine radiator fan, if found less than the rated RPM, take corrective measures.
	Check Crankshaft Vibration Damper
	Inspect Engine mounting pad.
	Check engine protective device
E-Check (6000, hrs.)	
Air Induction System	Check Turbocharger Bearing Clearance.
	Clean Turbo. Compressor Wheel & Diffuser, if required.
	Overhaul the air compressor. if required.
	Replace the outer and inner engine air cleaner element.
Fuel System	Check Fuel Pump Calibration.
	Clean & Calibrate Injectors, if required.
	Replace Fuel Pump Filter Screen.
	Overhaul the injectors. (If required).
Cooling System	Change Coolant.
	Descale Cooling System.
	Clean oil cooler core and after cooler core .
	Clean /Replace Cooling coil.
Lubrication System	Calibrate Lube oil pressure system.
Other Maintenance	Check Vibration Damper.
	Adjust Injectors and Valves.
	Clean the engine radiator externally & internally.
	Change engine damper.
F-Check (15000 hrs. or 60 months whichever is earlier)	
Air Induction System	Change engine air cleaner elements.
	Overhaul air compressor.
Fuel System	Overhaul the fuel injection pump.
	Overhaul the injectors.
Cooling System	Overhaul cooling system.
	Checks for coolant leaks.
	Test function of thermostat.

Lubrication System	Change all engine filters along with lube oil.
Other Maintenance	Overhaul or replace the engine.
	Change engine mounting pads.
	Inspect turbo charger function.
	Change water hoses.
	Check the RPM of Engine radiator fan, if found less than the rated RPM, take corrective measures.
Note- Any OEM suggestion should also be adopted in the maintenance practices.	