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MISCELLANEOUS INSTRUCTIONS

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THE 4-STROKE CYCLE DIESEL ENGINE.

The four-stroke engine is so named because it has one power stroke to every four strokes of the piston.

The sequence of operation is as follows :—

1st. — Suction Stroke, which is a downward stroke during which a charge of air is drawn into the cylinder through the air filter and the open inlet valve.

2nd. — Compression Stroke. Just after the piston begins its upward travel, the inlet valve closes and compression of the charge of air commences. Due to the air being compressed, its pressure rises, accompanied by a rise in temperature, which may reach approximately 950°F.

A charge of fuel is sprayed into the cylinder by means of the fuel injector and fuel pump just prior to the piston reaching top dead centre. This charge ignites spontaneously in the compressed air which is sufficiently hot to ignite the fuel.

3rd. — Power Stroke. The burning fuel further heats the air and in its rapid expansion forces the piston down on its power stroke. Expansion of the gases continues until just before the piston reaches bottom dead centre when the exhaust valve opens and the expanded gases are then exhausted to atmosphere through the exhaust system.

4th. — The Exhaust Stroke. The scavenging of the spent gases is completed during the piston's upward stroke.

THE 2-STROKE CYCLE DIESEL ENGINE.

The operation of this type of engine differs from the 4-stroke type in that each downward stroke of the piston is a power stroke. There are two common types of 2-stroke engine.

On one, valves are dispensed with and their function carried out by the piston, which on its downward stroke, uncovers exhaust gas ports in one side of the cylinder and air inlet ports in the other side. The exhaust gases escape at high velocity through the exhaust ports and scavenging air blown through the air inlet ports into the cylinder under pressure from the air pump or blower blows out any remaining gases and at the same time fills the cylinder with clean air. The upward stroke of the piston closes both the exhaust and air inlet ports before the air is compressed in the cylinder. This 2-stroke system is called loop scavenge.

On other 2-stroke engines the air enters the cylinder through ports in the cylinder wall as on the former type, but the exhaust gas escapes via poppet exhaust valves ; this type is termed uni-flow scavenge.

Cooling Diesel Engines.

The engine cooling water is drawn from a vertical radiator and forced through the engine water jacket spaces by an engine-driven pump and returned to the radiator. On the majority of diesel locomotives and trains a radiator header tank is also fitted, to increase the capacity of water carried for cooling the engine. Cooling the water in the radiator is assisted by a radiator fan which may either be belt or electric motor-driven.

The normal water temperature should be between 155°F. and 180°F. when a diesel engine has been warmed up, and various methods of controlling the temperature are employed, e.g., where electrical drive to the fan is provided the speed of the fan motor can be reduced by a thermostatic electrical control. On other locomotives fitted with belt or gear driven fans the flow of warm water to the radiator can be controlled by a thermostatic valve, which at low temperatures diverts the flow back to the water pump and from there direct to the engine water jackets.

Where radiator shutters are fitted, when starting from cold these may be closed to assist warming up, but they MUST BE opened when the locomotive is running.

A separate section of the radiator is provided for cooling the engine lubricating oil. The lubricating oil is cooled by being pumped through this section of the radiator on its way to the engine bearings from the engine sump.

Radiator Water Level.

If there is a noticeable loss of water from the radiator and no cause is apparent, the matter must be investigated before any attempt is made to start the engine.

Frost Precautions.

If the locomotive is in traffic but not required for an appreciable period, the radiator shutters (when fitted) must be kept closed and the engine run periodically as necessary to eliminate freezing.

Warming Up the Engine.

Warm up the engine by running it at idling speed.

When starting up from cold the diesel engine may be warmed up by running the engine light up to three-quarters its full rated speed.

Diesel Engine Oil Sump Level.

If, when checking the lubricating oil level in a diesel engine sump, the level is below the MINIMUM mark on the dipstick, the driver must report the fact to the Motive Power Depot.

If the level is found to have risen considerably above the MAXIMUM mark, which would occur if an excessive amount of water or fuel oil had leaked into the sump, the driver must NOT start the engine, but should report the matter immediately to the Motive Power Depot.

Pressure Charging.

Air, at slightly more than atmospheric pressure is supplied via the air inlet valves of the engines fitted, with turbo-blowers or pressure chargers which are driven by the exhaust gases of the diesel engine, or may be mechanically-driven.

The weight of air thus introduced into the cylinders at each suction stroke is greater than if it were only sucked in by the downward stroke of the piston. The greater volume of air allows more fuel to be burnt in the cylinders, which in turn means a greater power output per cylinder than would otherwise be possible.

Pressure Charger Failure.

If a turbo-blower or pressure charger fails, the engine should be run at reduced speed and the locomotive taken out of service as soon as possible.

Starting the Engine.

Under no circumstances must the master switch or starting button be kept in the "Starting" position if the diesel engine fails to turn over.

The generator or starter motors must not be given long and repeated motoring if the engine fails to start.

If an engine fails to start easily the fact must be reported immediately.

Failure to comply with the above may cause damage to the electrical starting equipment and drain the battery.

Overspeed Device.

Some engines are fitted with an overspeed device so that should the engine overspeed for any reason, the device will operate and cut off fuel from the fuel injectors and stop the engine.

Before the engine can be restarted the device must be reset and an endeavour must be made to find the cause of the overspeeding.

If, on restarting the engine, overspeeding still persists the matter must be reported immediately.

If overspeeding occurs on engines NOT fitted with the overspeed device and it is not possible to reduce the engine speed or stop the engine by normal means, immediate steps should be taken to cut off the fuel supply to the engine from the fuel tanks, by closing the stop valve nearest to the engine, or by operating the emergency stop control where fitted.

"Dead Man's" Device.

The "dead man's" pedal on locomotives so fitted must be kept depressed by the driver's foot whenever the reverser and the controller are in running positions. (ANY OTHER MEANS OF DEPRESSING THE "DEAD MAN'S" PEDAL IS STRICTLY FORBIDDEN).

If the "dead man's" pedal is released with the reverser handle at "Forward" or "Reverse" and the controller is "Off", the brakes are applied, but the engine continues to run. The "dead man's" pedal becomes inoperative when the reverser is placed in the "Neutral" or "Off" positions.

On diesel electric locomotives if the "dead man's" pedal is released when the controller is in a power position, the control circuit governor opens contacts after a short time delay, the power is cut off from the traction motors, and the brakes are automatically applied. The diesel engine continues to run. The object of this time delay is to enable the Driver to cross over to the controls on the other side of the cab, where these are fitted, or to change feet on the pedal without losing control of the locomotive.

The "dead man's" devices fitted to diesel mechanical and diesel hydraulic locomotives are similar in operation.

On diesel trains the "dead man's" device is located on the throttle control handle and must be kept depressed to prevent the device from operating when the reverser is either in the "Forward" or "Reverse" positions. Where the "pull" type control handle is fitted this must be held in the "Idling" position to prevent the device from operating.

Batteries.

The chief function of a battery on diesel locomotives and trains is to provide a means of turning the diesel engine to start it. On diesel electric locomotives the battery is connected to the main generator, causing the latter to run as a motor and rotate the engine until firing commences on the starting lever being placed in the "start" position. On diesel mechanical locomotives and trains the battery supplies a current to the starter motors. The batteries are kept charged by either an auxiliary generator or dynamo, dependent upon the size of the engine unit, in conjunction with voltage regulators. The latter automatically regulate the charge rate according to the state of the battery.

Main Generator and Drive.

On diesel electric locomotives the diesel engine drives a direct current generator. This is a single bearing machine, one end of the armature shaft being coupled direct to the engine fly wheel and the other supported in a bearing housed in the generator end plate. This machine supplies current to the traction motor or motors.

Auxiliary Generator and Exciter.

On diesel electric locomotives an auxiliary generator driven from the engine is provided to supply current for the auxiliary machine control equipment, battery charging and the excitation of the fields of the main generator. On some locomotives, in addition to an auxiliary generator, an exciter is fitted. This machine supplies current for the main and auxiliary generator fields.

Traction Motor Blowers.

These are provided in order that the traction motors may be cooled by forced ventilation, and are motor-driven. On diesel electric locomotives, should these blowers fail, the instructions under "Running" must be strictly adhered to.

Air Compressors.

Air compressors provide the compressed air for operating the electro-pneumatic control equipment, sand ejectors, warning devices, window wipers, air brakes and compressed air starting.

It is also used as a power medium for refuelling fuel tanks. The air compressors are controlled by governor, which is normally set to maintain the air pressure between 65 and 105 lbs. per square inch, dependent upon the type of locomotive or train to which they are fitted.

Vacuum Exhausters.

Vacuum exhausters, either electrically or belt-driven, are fitted to main line diesel locomotives and diesel trains, also to a number of diesel shunting locomotives in order that vacuum fitted stock may be worked.

These exhausters are so arranged that 21" of vacuum can be maintained against a $\frac{3}{16}$" leak disc with the brake valve in the "Running" position. (25" in the Western Motive Power Area).

Assistance by a Steam Locomotive.

There is no objection to a steam locomotive being used in conjunction with a diesel locomotive providing that under no circumstances the maximum permissible speed of the diesel locomotive is exceeded.

NOTE: Care should be exercised to avoid excessive use of the cylinder cocks, etc., when a steam locomotive is coupled to a diesel locomotive head on.

Towing a Diesel Electric Shunting Locomotive.

If it is required to tow a diesel electric shunting locomotive the master switch, controller and reverser must be in the "OFF" positions. The locomotive air brake system cannot be operated from the towing locomotive.

A diesel electric shunting locomotive must NOT be towed at a speed in excess of 10 m.p.h., nor for a distance exceeding 25 miles, unless the traction motor gears have first been de-meshed. With the gears de-meshed the towing speed must not exceed 25 m.p.h. See separate instructions for other types of locomotives and also the General Appendix Instructions.

Derailments.

Diesel locomotives should in all cases be re-railed by jacks or crane. These locomotives must on no account be pulled on to the rails.

Unusual Smell or Knock.

If at any time an unusual smell or knock should develop, stop the locomotive and engine as soon as possible and investigate. If nothing can be found, send for a fitter from the Motive Power Depot. No attempt must be made to remove the engine crankcase doors by any member of the staff until the engine has been shut down for 20 minutes.

If an engine should emit smoky exhaust gas, this may be due to one of the following causes :—

1. Faulty fuel injectors.
2. Air filters dirty.
3. Engine compression low.

Should the driver observe that the amount or colour of the exhaust gas is unusual this should be reported to the Motive Power Depot.

Fuel Oil Economy.

It is essential that drivers economise in the use of fuel oil by stopping the engine when the locomotive is not required for traffic purposes for periods over five minutes. Special attention should, however, be paid to instructions under the heading "Frost Precautions".

Use of Open Flame Lamps.

Lighted torch lamps and lamps with an open flame must not be used on or near diesel locomotives or diesel trains. A flexible lead socket connection for an electric hand-lamp is provided on each unit and should be used when required.

Cleaning Cans and Containers for Lubricating Oils, etc.

Sponge cloths or cotton waste MUST NOT be used under any circumstances for cleaning cans or containers for lubricating oil, or for wiping down any internal parts of the crankcase, fuel pumps or injectors, as this practice may result in considerable quantities of fluff getting into the working parts, with the possibility of causing failures.

Clean rags only should be used for this purpose.

Under no circumstances must cloths or waste of any description be left in the engine or generator compartments as these can be a contributory cause of fire.

Fire Extinguishers.

All types of diesel locomotives and diesel trains are fitted with portable fire-fighting equipment. In case of fire, follow the instructions on the fire extinguishers.

FAULTS AND THEIR POSSIBLE CAUSES.

Fault	Possible Cause
Lubricating Oil Pressure Low	(1) Too small a volume of oil in the engine sump.
	(2) Partly choked filter.
	(3) Leaking connections.
	(4) Lubricating oil diluted with fuel.
High Oil Temperature (Maximum permissible 165°F)	(1) Too small a volume of oil in the engine sump.
	(2) Radiator shutters closed, or cooling elements choked with dust or dirt.
	(3) Slipping fan drive or driving belts displaced.

Fault	Possible Cause
High Water Temperature (Maximum permissible 190° F.)	(1) Radiator not full. (2) Slipping fan drive or driving belts displaced. (3) Radiator shutters closed. (4) Cooling elements choked with dust or dirt. (5) Water pump not running or defective. (6) Defective thermostatic valve.
Main Ammeter reading high	(1) Brakes not fully released. (2) Controller movement too rapid. (3) Excessive trailing load.
Generator will not motor from Battery	(1) Battery discharged. (2) Generator starting contactor defective. (3) Control fuse blown. (4) Water in cylinders. (5) Engine seized.
Engine will turn on Battery but will not fire	(1) Fuel cock not open. (2) Fuel filter choked. (3) Fuel injectors faulty. (4) Poor compression.
Engine starts, but stops after short time	(1) Fuel cock not open. (2) Fuel filter partly choked. (3) Air locks in fuel system. (4) Dirty lubricating oil filter.
Locomotive will not move	(1) Faulty control governor. (2) Bad contacts on generator starting contactor interlocks.

Fault	Possible Cause
	(3) Fault in "Dead Man's" device.
	(4) Overload or earth fault relay tripped.
High or Low Air Pressure	(1) Compressor defective.
	(2) Compressor fuse defective.
	(3) Faulty compressor governor.
	(4) Control circuit volts low.
	(5) Excessive air leaks.
Battery Volts Low or High	(1) Auxiliary generator belts slipping or displaced.
	(2) Voltage regulator faulty.
	(3) Defective auxiliary generator.

NOTE.

Before being passed to drive diesel locomotives and diesel trains, men will be required to pass an oral and practical examination by an Inspector in the following subjects :—

1. System of controls.
2. Working of diesel engine, including method of starting.
3. "Dead Man's" device.
4. Transmission and method of gear changing.
5. Purpose, and reading, of gauges and instruments, and the procedure to be followed in the event of any of the permissible limits being exceeded.
6. Care and manipulation of the diesel locomotives and diesel trains, including brake system.

7. Function and importance of the radiator.

8. Filters, their function and necessity for keeping clean.

9. Air locks in fuel system and how to avoid them.

10. Lubrication and the use of various oils.

11. Significance of state of exhaust gases.

12. Examination of diesel locomotives and trains and the reporting of defects and leakages of oil, water, or air.

13. System of visible and audible warning arrangements ; function and meaning.

14. Use and care of fire-fighting appliances.

15. Instructions contained in the General Appendix and supplements thereto governing the Working of Diesel Locomotives and Diesel Trains.

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