VARIOUS TESTS TAKEN IN DIESEL LOCOMOTIVE

The following tests are being conducted in the diesel locomotive to check whether the different major operative parameters are working properly or not

Orifice test:

Orifice test is conducted to ascertain the efficiency to be at proper optimized position of the fuel feed system by simulating the full load condition. The procedure of testing is as under

i) An orifice plate of $1/8^{th}$ " is fitted in the system before regulating valve

ii) A container to be placed under the orifice to collect the oil that would leak through it during the test

iii) The fuel booster pump to be switched ON for 60 seconds

iv) The rate of leakage should be about 9 liters/min through the orifice (with the engine in stopped condition) the system should be able to maintain 3.7 to 3.8 kg/cm^2 pressure with this rate of leakage, which simulates approximately the full load consumption by the engine.

In the event of drop in pressure, the rate of leakage would also be less indicating some defect in the system reducing its efficiency to meet the full requirement of fuel during peak load.

This test is easy, reliable and saves time as well as fuel.

Nozzle testing

1. Spray pattern: spray of fuel should be properly atomized and uniform through all the 9 holes of the nozzle. This can be judged with an impression taken on a blotting paper. The impression of the spray pattern if symmetrical, then the nozzles are in proper working condition.

2. Opening pressure: A very minimum portion of the oil inside the nozzle passes through the clearance between the pump, the tester handle slowly and record the opening pressure of the nozzle valve. The opening pressure for new nozzle and holder should be 3900-4050 psi and rework nozzle and holder should be 3700-3800 psi. If the pressure is down to 3600 psi the nozzle needs replacement. Shims are being used to increase/decrease the spray pressure.

3. Nozzle chatter: the chattering sound sort of cracking noise created due to free movement of nozzle valve inside the valve body. It should be proper.

4. Dribbling or tightness of valve seat: there should be no loss drop of fuel coming out of the nozzle before or after the injection. The dribbling can be checked by having injectors

manually done couple of times quickly and check whether the nozzle dip is dry or leaky. Raising the pressure and holding it for 10 second may also give clear idea of the nozzle dribbling. The dribbling may occur due to improper pressure setting or direct stick up between the valve and valve seat or improper contact between valve and valve seat area or valve sticking inside the valve body.

5. Nozzle leak rate: A very minimum portion of the oil inside the nozzle passes through the clearance between the valve and valve body for circulation, for lubrication purpose. Excess clearance may cause excess leak off thus reducing the amount of fuel actually injected. Operate the test handle to attain 3500 psi and allow the pressure to drop up to 1000 psi, the time taken is known as leak off rate and is 19 seconds per nozzle (new) and 6 seconds for used or reconditioned nozzle.

DRY RUN TEST

This test conduced to check all rack position without moving the engine. The procedure is as follows:-

(1) Battery Knife switch is put on.

(2) Close fuel pump, battery, Control breakers on Control panel.

(3) Close MFPB on both control stands.

(4) E.C.S. put in Run position (CK-1 & CK-2 also dislocated by paper or wooden piece).

(5) Test to be done on MCBG (Microprocessor controlled based Governor) by selecting Dry run Test mode.

(6) Rack displacement is checked on display without fuel and with fuel with the help of fuel booster pump STOP & START.

(7) As per demand reset of racks are done by adjustment.

HYDRAULIC TESTING

Hydraulic test is being conducted to check leakage in the cylinder head. Followings are the procedure of hydraulic testing-

- The cylinder heads are to be loaded at hydraulic test stand and make connection for water inlet and outlet and check the water temperature, it should be in between 70-80º C.
- Open the inlet and outlet valve and start the water pump, check the water pressure which should be 5 Kg/cm^2.

- The heated water to be circulated through cylinder head for minimum 15 minutes for preheating the cylinder head before testing the cylinder head for leakages.

- Check the cylinder head for nozzle sleeve crack and body crack, leakage from dummies and any internal cracks.

If any leakages, through the dummies are found, then removal of the cylinder head from the test stand to be done to attend the dummy or nozzle sleeves

Pneumatic Test

Pneumatic testing is conducted to check leakage or crack developed in the cylinder head. The following procedure is being followed for pneumatic testing-

1. The cylinder head to be connected to pneumatic arrangement to supply compressed air into the system for supplying air into the system.

2. The inlet and outlet of the cylinder head to be properly flanged with gasket and then it is immersed into the water tank.

3. The water in the tank to be heated upto a temperature of 70^0 C to 80^0 C. Let the cylinder to have a preheating time.

4. Air pressure to be incorporated into the system and the air pressure to be 5 kg/cm^2.

i) If there is any crack in the cylinder head then air will come out of the system in form of air bubble and in water it is very easy to trace the point of cracking.

ii) If any crack found in the cylinder head, then it is taken out of the water tank; the pressurized air to be released from the system and rectification to be done as per the need.

Blow by test (cylinder head)

On bench blow by test is conducted to ensure the sealing effect of cylinder head. Blow by test is used to find out any leakage between valve seat insert and valves. Blow by test is also conducted for engine power assembly and cylinder head separately.

A. **Blow-by Test (Engine Power Assembly):**

Blow-by test is conducted to check the sealing efficiency of the engine power assembly or combustion chamber on engine as per the following-

1. Locomotive should be in running condition for a certain period of time.

2. Temperature should be in the range of 55^0 C to 65^0 C.

3. After shutting down the engine, bring the piston of the corresponding cylinder at TDC in the compression stroke manually by barring.

4. Fit blow-by gadget which consists of compressed air line with provision of pressure gauge and stop cock and a reducing valve.

5. Blow-by test of all 16 cylinder to be conducted as per the firing order.

6. Open the decompression plug and then the equipment or pipe with pressure gauge and cock to be connected with the decompression plug hole. The compressed air source should be having pressure of 6 kg/cm^2 and above.

7. Now by opening test set-up cock, charge the combustion chamber with compressed air of 5 kg/cm^2 pressure.

8. The stop cock to be closed to stop the supply of air to stabilize the air pressure at 5 kg/cm^2 and check the time taken for pressure reduction from 5 kg/cm^2 to 0 kg/cm^2. This time taken is known as blow-by time. It should be 6 seconds or more. It means sealing effect is good.

9. If leakage rate is high,i.e., the reduction of pressure from 5 kg/cm^2 to 0 kg/cm^2 is below 6 seconds, then major problem persist and this is not desirable.

10. The reason for this may be leakage at head side or piston side. In cylinder head, generally problem occurs at exhaust side due to high load or temperature (around 550^0 C).

11. For piston side problem, open lower crank case and hear the sound of leakage. This may happen due to liner size fault or piston ring wear.

Blow-by Test of Cylinder Head in Bench:

Blow-by test is conducted to cylinder heads that are ready for dispatch.

1. Cylinder head placed on the dummy plate with gasket arrangements.

2. Air through decompression plug to be sent to already sealed cylinder head to check for any leakage.

3. When the air pressure reaches in the pressure gauge at 5 $kg/cm^{2,}$ then the supply of pressurized air to be stopped via stop cock and check the time taken for the pressure to be reduced from 5 kg/cm^2 to 0 kg/cm^2.

4. In this case the desired time is 60 seconds. If the recorded time is less than 60 seconds, then the leakage rate is high and it may happen due to leakage in valve and valve seat insert. The desirable blow-by time for cylinder head of new Alco locomotive is 95 seconds.

HOT ENGINE TEST

At diesel locomotive shed, hot engine test is done to check the followings-

1. The operational efficiency of ETS 1, ETS 2 and ETS 3. The respective temperature of ETS 1, ETS 2 and ETS 3 are 68^0 C, 74^0 C and 92^0 C.

2. Dummy of R1 and R2 is being provided to stop radiating. Thus the temperature increases from 65^0 C to 92^0 C. The time taken for the same is known as the heating time. Generally the time period is of 25-26 minutes. There after the dummy to be removed to reduce the temperature from 92^0 C to 65^0 C. This time duration is known as cooling time and it is generally of 6 to 7 minutes.

3. Hot engine test during monthly record the water pump pressure in idle/8thnotch it should not be less than 0.5kg/cm^2 in idle, 2kg/cm^2 in 8thnotch.

The lube oil pressure in the idle and is not less than 1.8 kg/cm^2 and beyond 4 kg/cm^2 on 8th notch at 85^0 C.

TURBO RUN DOWN TEST

This test is conducted to judge the efficiency of the rotor assembly of Turbo Super Charger. To conduct this test the engine is started and allowed to run at full speed for some time (3 to 4 minutes). When the water temperature reaches to 55º C to 65^0 C, then the engine is brought to idle an idle stop button is pressed.

The crankshaft may rotate. As soon as the engine crank shaft comes to stop, the stop watch is started. (The alarm bell will be sounding almost at the time). One man should be at the Chimney where from he may observe the rotation of the turbine. As soon as the turbine comes to dead stop the man should give signal and immediately the stop watch should be stopped. The time recorded by the stop watch is termed as turbo run down time which should be between 90 to 180 in case of 720 model Turbo Super Charger.

It denotes the free movement of the rotor assembly and checks the bearing blade assembly are properly balanced or not. If this run down time is found less than 90 seconds that indicates about some defects in the turbo super charger. In case of low turbo run down time the turbo should be removed from the locomotive and the defect should be rectified before allowing the loco to work further.

TURBO RUN DOWN TIME

Sl No	TSC Make/ Model	Time	BAP (Max)
1	720 Alco Model	90 to 180 seconds	1.6 kg/cm^2
2	ABB 1. Water cooled 2. Air cooled	60 to 120 seconds	1.8 kg/cm^2 2.2 kg/cm^2
3	Napier	20 to 60 seconds	2.0 kg/cm^2
4	GE, Hispano Suiza(double discharge)	Not required to check	2.5 to 2.8 kg/cm^2

LOAD BOX TESTING METHODLOGICAL AND PARAMETERS CHECKED

INTRODUCTION:

The Load Box is a process to check the capability and performance of the engine by simulating the actual working conditions of the Locomotive at rated output in static condition.

During Load Box test, the output of the engine is measured in terms of electrical parameters (Volt and Ampere). In this the output of the generator is connected across a set of resistance instead of connecting it with the traction motors. The output of the engine is dissipated in terms of heat across the resistance during Load Box test.

REASON TO CONDUCT LOAD BOX.

- To see whether the engine gives designed output or not.
- Whether all systems are functioning properly or not.
- Whether any problem is connected to any system or component.

THE LOAD BOX IS USUALLY CARRIED OUT UNDER FOLLOWING CIRCUMSTANCES.

- After a major schedule like POH, IOH, Yearly or Half Yearly schedule.
- After changing of major components like Turbo, Generator, Governor, Excitation system etc.
- Whenever there is a booking of fuel pressure dropping, poor hauling power and repeated hot engine.
- Whenever a fault booked by the driver is not detected under no load condition during schedule.

PRECAUTION TO BE TAKEN PRIOR TO THE LOCOMOTIVE BEING PUT UNDER LOAD BOX TEST:

- ✓ Fill water in the engine to check the internal and external leakages in the system.
- ✓ Fill the fuel tank to 50% of its capacity and check fuel feed system with orfice test and rectify defects, if any.
- ✓ Check all the supplies and top up.
- ✓ Do pre-lubrication and observe that from all points the oil is coming properly and there is no leakage.

TESTS TOBE DONE BEFORE THE LOAD BOX TEST.

The following tests to be concluded before the locomotive is put under the load box test under the following two major conditions

ENGINE IN DEAD CONDITION.

- ✓ **Insulation Test: -** The insulation resistance should be measured for power to earth control to earth and power to control circuit and it should not be less than **1** Mega Ohm.
- ✓ Do dry run test and adjust the racks if necessary.
- ✓ Visual inspection of Commutators, Carbon brush holders of all electrical rotating equipments.
- ✓ Inspect the crankcase for water leakage, fallen split pins, any foreign material etc.
- ✓ Check tappet and fuel injection pump timing on the engine.
- ✓ Ensure tightness of foundation bolts of all components.

ENGINE IN RUNNING CONDITION.

- ✓ Checking for unusual sound and smoke coming out from engine during run to be carried out and rectification to be done accordingly if needed.
- ✓ Turbo Run down time to be recorded to check the condition of the Turbo Super Charger.
- ✓ Rack testing to be done to check that all the power assemblies are responding properly.
- ✓ Notch wise r.p.m, No load voltage, Auxiliary Generator voltage, AC voltage, Dynamic braking voltage etc to be measured.
- ✓ Check functioning of safety devices like OST, Hot engine alarm, Low Lube oil pressure alarm, Low water switch, Oil pressure switch, Crank case explosion door.
- ✓ Check safety devices for transmission functioning of ground relay and wheel slip relay.
- ✓ Other safety devices like power cut off switch, Head light, Flasher light, Air flow indicator etc to be checked.
- ✓ Before Load Box, Engine is to be stopped and all decompression plug of cylinder heads to be removed and then adopters with valves to be connected for measuring compression and firing pressure at idle & 8^{th} notch (Full Load) with the help of keney indicator.
- ✓ Remove the exhaust plugs from cylinder heads and connect thermocouple at each of the cylinder heads for measuring exhaust gas temperature and connect the leads to these thermocouples with a junction box.
- ✓ Connect one thermocouple in the Turbo couple in the turbo connector and one thermocouple to the Turbo chimney in the exhaust gas passage.
- ✓ Connect a water manometer to the engine crankcase.

- ✓ A pressure gauge each at the water outlet of the water pump in the 3 way elbow and one each in each of the cooling water headers. Connect a pressure gauge before and after lube oil filter tank in lube oil line.
- ✓ Ambient temperature should be taken near the car-body or cyclonic filter.

Water temperature should be ideally 65ºC – 80ºC during load box.

READING TO BE RECORDED:

1. Rack position to be recorded at each and every notch during Load box.
2. Fuel oil pressure to be recorded at every notch.
3. Lube oil pressure to be recorded at every notch. Also, Lube oil pressure to be recorded during Hot engine test, from 65ºc to HE temperature i.e. 92ºC (in an interval of 5ºC).
4. Turbo run down time to be recorded with cooling water temperature at that time.
5. OST assay Tripping rpm to be recorded.
6. Crank case vacuum to be measured.
7. Compression pressure should e between 950-1100 PSI, at 8^{th} notch. The difference between the highest and the lowest pressure of any cylinder should not be more than 75 PSI.
8. Firing pressure at 8^{th} notch should be 1400-1850 PSI subjected to 75 PSI difference between maximum and minimum.
9. Exhaust gas temperature at cylinder head should be between 475^0 C to 550^0 C. Subjected to difference between highest and lowest not exceeding 35^0 C.
10. Exhaust gas temperature before Turbo, should be in the range of 900-1100º F.

OBSERVATION AND CONCLUSION:-

- ❖ If compression pressure is alright and the firing pressure is less – Fuel injection equipment is faulty.
- ❖ If both compression pressure and firing pressure are bad with higher exhaust gas temperature – Air starvation or Air/Fuel ratio not proper.
- ❖ If compression pressure of one cylinder is less – Poor blow by.

THE COMPARATIVE MERITS AND DEMERITS OF WATER RESISTANCE LOAD BOX AND

GRID RESISTANCE LOAD BOX

Sl. No.	WATER RESISTANCE LOAD BOX	GRID RESISTANCE LOAD BOX
1.	Load resistance can be varied at infinite stages, hence a continuous HP curve can be plotted through this	Load resistance can be changed only at limited stages (3 to 8). Hence a complete graph cannot be plotted to understand the complete behaviour of the output.
2.	Load resistance can be changed during Loaded condition.	To change the load resistance in the grid type , the loco is required to be stepped down to lower notches as such load gets interrupted.
3.	Water load box can be conducted for a longer duration because of better heat dissipation facilities.	Grid resistance load box cannot be conducted for longer duration as it gets heated up quickly causing hazardous environment and gives erratic reading.
4.	Requires permanent establishment to set up water load box, hence cannot be shifted easily.	Comparatively handy and can be shifted with lesser efforts.
5.	Used for comprehensive readings like after Yearly schedule and above.	It is normally used for detecting a specific defect or doing HP adjustment.

Load Box HP Calculation:

Output of the main generator = V X I watt

Efficiency of the Main Generator = 93.6%

We know, Efficiency = Output / Input

So, The Input of the Main Generator = (V X I) / 93.6% watt

= (V X I) / (0.936 X 746) HP

Since Input of the Main Generator = Output of the diesel engine

Therefore, Horsepower of the diesel engine = (V X I) / (0.936 X 746) HP

= (880 X 2300)/ (0.936 X 746) HP

Let V= 880 volts and I=2300 Amp

This power is called the observed Horsepower of the diesel engine. But the Horsepower of the diesel engine may vary due to various factors. The HP calculated, keeping these factors in mind is called the Corrected HP.

Corrected HP = Observed HP / abcd

Where a = Air intake temperature at 60^0 F

b = Altitude

c = Fuel density at 60^0 F

d = Fuel oil temperature at 60^0 F

The corrected HP = (880 X 2300)/ (0.936 X 746 X abcd) HP

= (880 X 2300)/ (0.936 X 746 X abcd) HP

≈ (880 X 2300)/ (700 X abcd)

≈ 2891.42 / abcd HP

Remarks:

- Manual calculation is not required on both ALCO locomotives with MCBG & MEP and HHP locomotives. On display result (GHP) is displayed after considering the correction factor.
- In the above mentioned Locomotives self Load Box feature is available.