Rail Operating Code

Code Supplement CS 4.2

Operating Instructions for DC & DBR Locomotives

Issue Number	Prepared (P) Reviewed (R) Amended (A)	Approved by	Approval date
Original		R Mail	23 March 1998
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On receipt of new issue destroy all replaced pages

DC Locomotive

DBR Locomotive

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Operating Instructions for DC & DBR Locomotives

1.0 TRAINING AND CERTIFICATION

DC and / or DBR Locomotives:

1. The training for existing Locomotive Engineers shall consist of a four-hour conversion course.

2. The course will be conducted by an approved trainer.

   The course will consist of:

   a. The Locomotive Engineer being instructed by the approved trainer on all equipment in the interior and on the exterior of the locomotive plus the operation of all equipment in the cab.

   b. Safety checks.

   c. Starting up and shutting down process.

   d. Fault location and correction.

   e. Taking fuel, oil and water.

   f. The operation of the brake equipment including the location and purpose of cut out cocks and how brake rigging is adjusted.

   g. How to set up the locomotive for multiple unit operation.

3. Locomotive Engineers will be supplied with a copy of this Code Supplement during training, after training the Code Supplements are available from your depot library, and are in all DC and DBR locomotive storage bins.

4. The approved trainer will practically demonstrate to the Locomotive Engineer the correct operation of the locomotive controls and familiarise the Locomotive Engineer with them by operation of the locomotive on a main line training run.

5. Following successful completion of the conversion course, a STF23 will be issued by the approved trainer and the Locomotive Engineer will then be certified to drive DC and / or DBR class locomotives.

6. If they have not already done so, the Locomotive Engineer must also meet the other certification criteria as detailed in Section 1 of the Rail Operating Code.

7. Once a Locomotive Engineer has received a certification for one of these classes of locomotives, they will, if required to operate the other class, need a separate certification for that class of locomotive. In this instance, the criteria of No.4 will not apply.

2.0 ABBREVIATIONS

ABV	Automatic Brake Valve
BKS	Battery Knife Switch
CCB	Control Circuit Breaker
COP	Crank Case Over Pressure Switch Button on Engine Protector
ER	Engine Run Switch
FPCB	Fuel Pump Circuit Breaker
FP / ES	Fuel Pump / Engine Start
GF	Generator Field Switch
GOV	Engine Governor
GR	Ground Relay
GRCO	Ground Relay Cut Out Knife Switch
LCCB	Local Control Circuit Breaker
LOP	Low Oil Pressure Button on Engine Governor
LWP	Low Water Pressure Button on Engine Governor
MR	Main Reservoir
MU	Multiple Unit
PC	Pneumatic Control (Brake Pipe Pressure)
VD	Vigilance Device

3.0 GENERAL

The DC and DBR locomotives are similar enough to be both covered in a single Code Supplement.

All DC locomotives are rebuilds of former DA locomotives. Eighty were built in Australia by Clyde Engineering and five at Hutt Workshops. The Hutt rebuilds (4916, 4927, 4939, 4945 and 4951) have no D14 alternator and therefore have different radiator fan control system to other DC's. The Hutt rebuilds and DBR's have a speed increaser gearbox in the long-hood compartment to drive the radiator cooling fan and rear traction motor blower. They are also provided with a divertor valve to keep water circulating through the engine until a running temperature is reached when the water is circulated through the radiator for cooling. This arrangement is necessary as the radiator cooling fan is mechanically driven off the engine (via the speed increaser gearbox) unlike the Australian rebuilds which have a thermostatically controlled, electrically driven fan powered from the D14 alternator.

All DBR locomotives are rebuilds of former DB locomotives. All ten were built in Australia by Clyde Engineering.

3.1 Locomotives

	DC Locomotives	**DBR Locomotives**
Road Numbers	4006 – 4951	1199 - 1295
Wheel Arrangement	A1A – A1A	A1A – A1A
Transmission	Diesel Electric	Diesel Electric
Engine	GM 12 – 64E	GM 8 – 645C
Output Power	1230 kW	709 kW
R.P.M	900	900
Traction Motors	4	4
Gear Ratio	63 / 14	63 / 14
Continuous Tractive Effort	140 kN	117 kN
Length over Couplers	14097 mm	14097 mm
Maximum Height	3756 mm	3756 mm
Weight	82 tonne	68 tonne
Adhesive Weight	60 tonne	45.6 tonne
Fuel Tank	3737 litres	2273 litres

3.2 DC Micro Control System

3.2.1 Overview

The locomotive control system in a DC micro locomotive has been replaced by a solid state control system.

This is to provide better wheelslip control and to remove a lot of older control circuitry.

Some of the equipment that has either been removed or is now no longer functional is the IDAC, Wheelslip Relays, Dynamic Brake Regulator, Load Regulator, Field Transmission Relay and Voltage Limit Panel. The function of this equipment is now taken over by the DC Micro Control Box.

3.2.2 Difference in Driving

Drivers should find little difference in driving characteristics between the DC Micro and a standard DC locomotive and should operate the locomotive as they normally would.

The features that are seen to be different are:

3.2.2.1 Auto Ground Relay Reset

If the ground relays trips the Micro automatically resets the ground relay.

It will do this four times over a period of 12 minutes, on the fifth attempt the Micro will lock out a set of traction motors, either 1 and 2 or 3 and 4 dependant on the information that the Micro has on which traction motor set is causing the problem.

Following this, if the ground fault is still tripping the relay, the Micro will reinstate the locked out pair of traction motors and lock out the other set of traction motors. If this action fails to clear the fault then the Micro will lock out both sets of traction motors.

If a traction motor is locked out by the Micro a green indicating light, located on the CB panel next to the battery charging ammeter, will illuminate.

3.2.2.2 Traction Motor Cut Out Switch

There is a traction motor cut out switch on the side of the Micro box which is mounted on the inside of the top electrical cabinet door on the second person's side.

This can be used in the normal fashion (isolation switch needs to be in Start) to lock out a pair of traction motors. The green traction motor lockout indicating light mentioned above will illuminate when this is done.

3.2.2.3 Traction Motor Thermal Protection

To allow the maximum permissible current to be delivered to the traction motors without danger of overheating them the Micro provides motor thermal protection based on the specification for short term over current rating.

If any traction motor is running at a current higher than the continuous rating of the traction motors (450 amps) the Micro takes account of how the condition is held, if the short term rating of the traction motor is exceeded, i.e. 600 amps for 3 minutes, then the Micro will limit the current in the traction motors to 450 amps for a time sufficient to cool the traction motors.

If traction motor thermal protection is instigated by the Micro then an indicating light on the CB panel next to the battery charging ammeter will illuminate.

3.2.2.4 Field Shunt

Traction motor current drops back prior to the field shunt contactor picking up or dropping out, this is more noticeable when speed is dropping and the field shunt contactor drops out, however full control will be reinstated quickly after transition.

This is to protect the field shunt contactors from opening and closing under load.

3.2.2.5 Dynamic Brake

If a grid becomes open circuit the Micro can detect this and lets the driver know by illuminating the brake warning light and latching it in.

The brake warning light can be reset with the ground relay reset button.

NOTE: Dynamic brake should not be operated if a grid is open circuit.

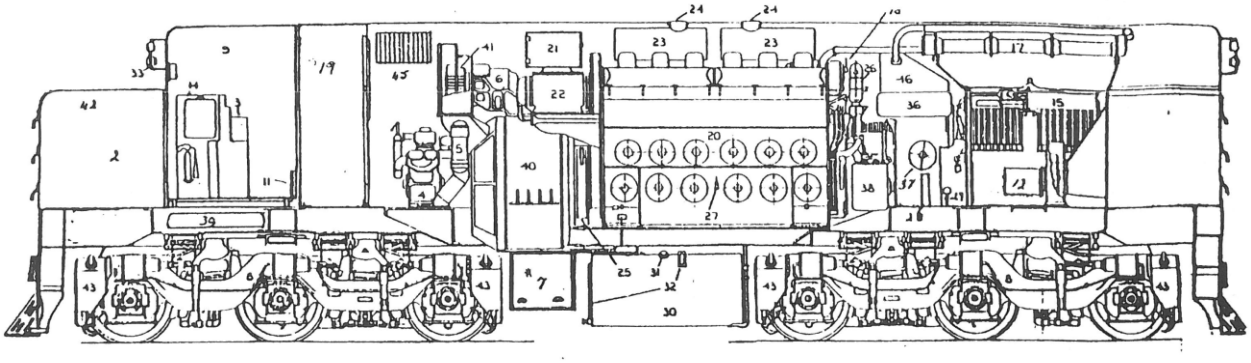
3.2.2.6 Modem

The modem on the ceiling by the front window is there to allow depot maintenance staff to assess any problems with locomotives while in operation and to allow Engineers to observe and make adjustments from a remote location.

Do not turn the modems off or pull the cables out.

4.0 GENERAL DIAGRAMS

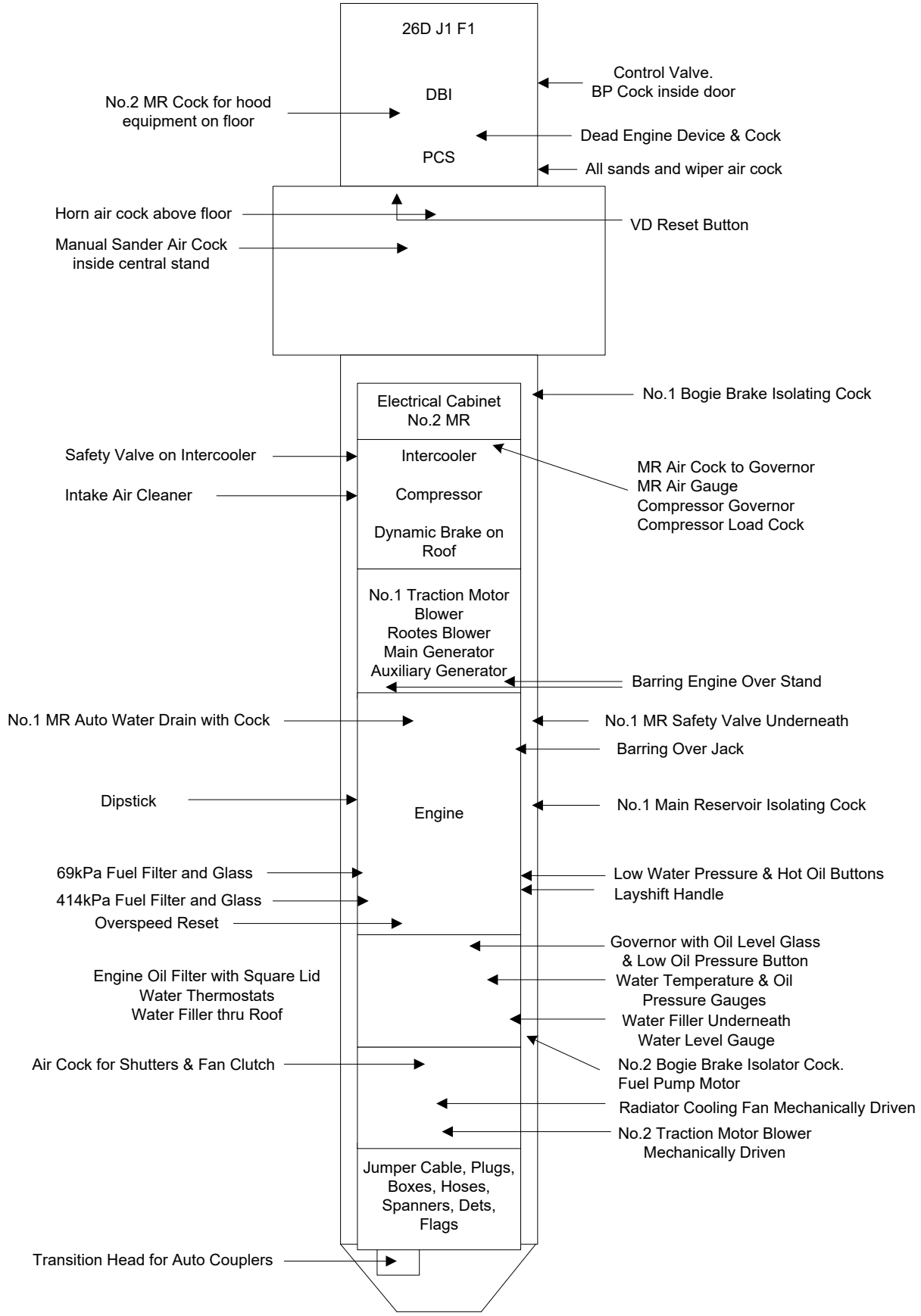
4.1 Arrangement of DC Locomotive (Australian Rebuild)



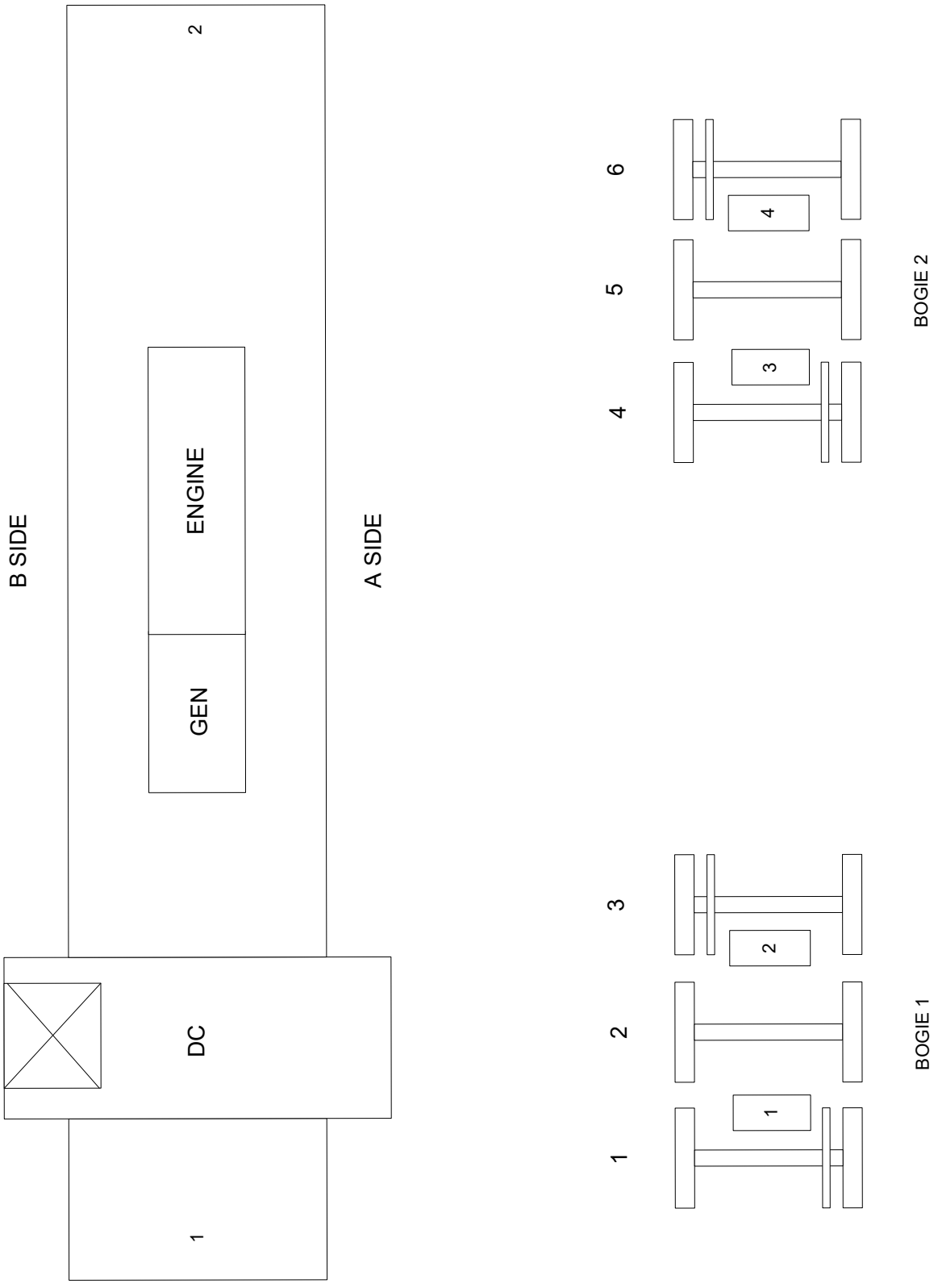
1. Air box drain
2. Airbrake equipment (short hood)
   - 26D Control Valve
   - F1 Selector Valve
   - J1 Relay Valve
   - Dynamic Brake Interlock
   - Volume Reservoir – 1.5 litres
   - Equalising Reservoir – 3.65 litres
   - Control Reservoir – 13.1 litres
   - Auxiliary Reservoir – 16.4 litres
3. Air brake pedestal
4. Air Compressor
5. Air Compressor Filter
6. Auxiliary Generator
7. Battery Box
8. Bogie Frame
9. Cab
10. Overspeed Device
11. Cab Heater
12. TM Blower Motor
14. Control Stand
15. Cooling Fan
17. Cooling Water Radiator
19. Electrical Cabinet
20. Engine
21. Engine Air Filters
22. Engine Blowers
23. Engine Exhaust Filters
24. Engine Exhaust Stacks
25. Engine Flywheel
26. Engine Governor
27. Engine Lube Oil Dip Stick
28. Fuel Filters
29. Fuel Pump
30. Fuel Tank
31. Fuel Tank Filter
32. Fuel Tank Sight Glass
33. Headlight
36. Lubricating Oil Cooler
37. Lubricating Filter
38. Lubricating Oil Strainer
39. Main Air Reservoir No.2
40. Main Generator & D14 Alternator
41. Main Generator & TM Blower
42. Hose Compartment
43. Sand Boxes
45. DB Resistance Grids
46. Water Tank

* No.1 Main Reservoir behind Battery Box

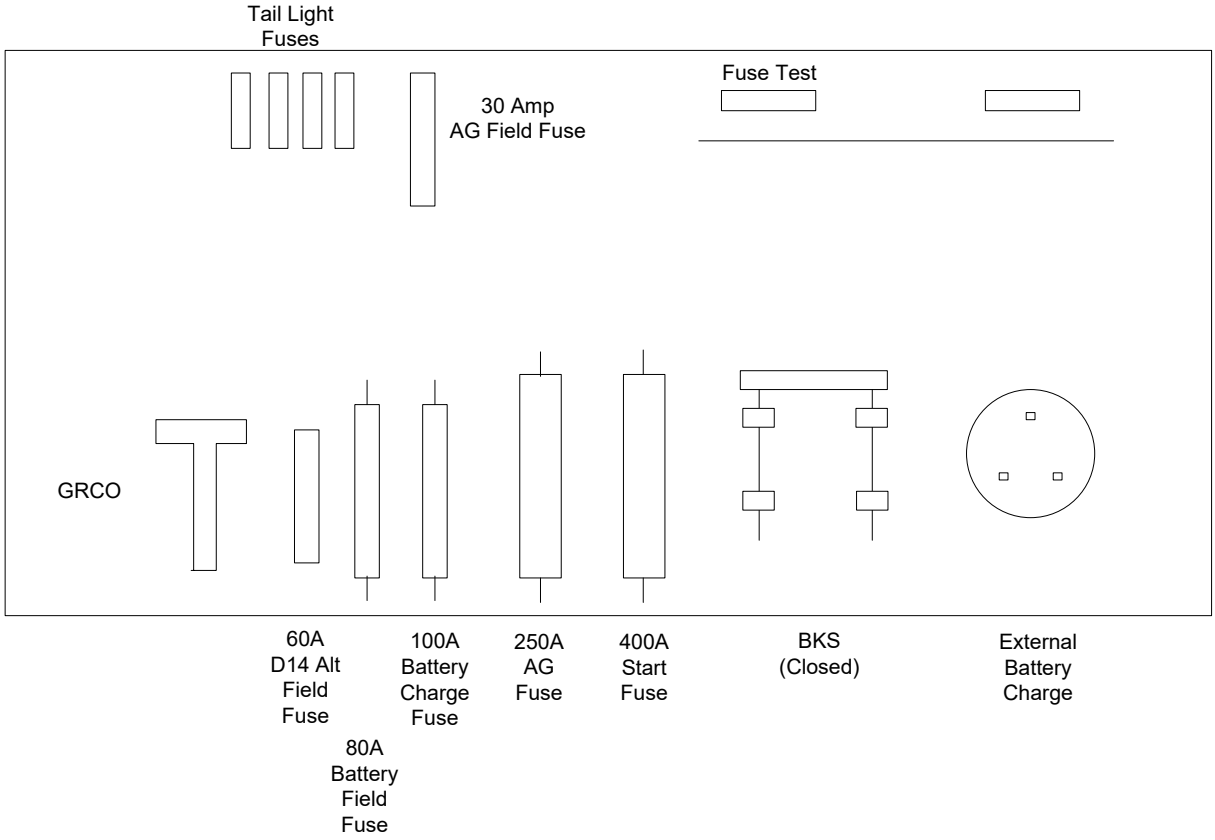
4.2 DBR Location Diagram



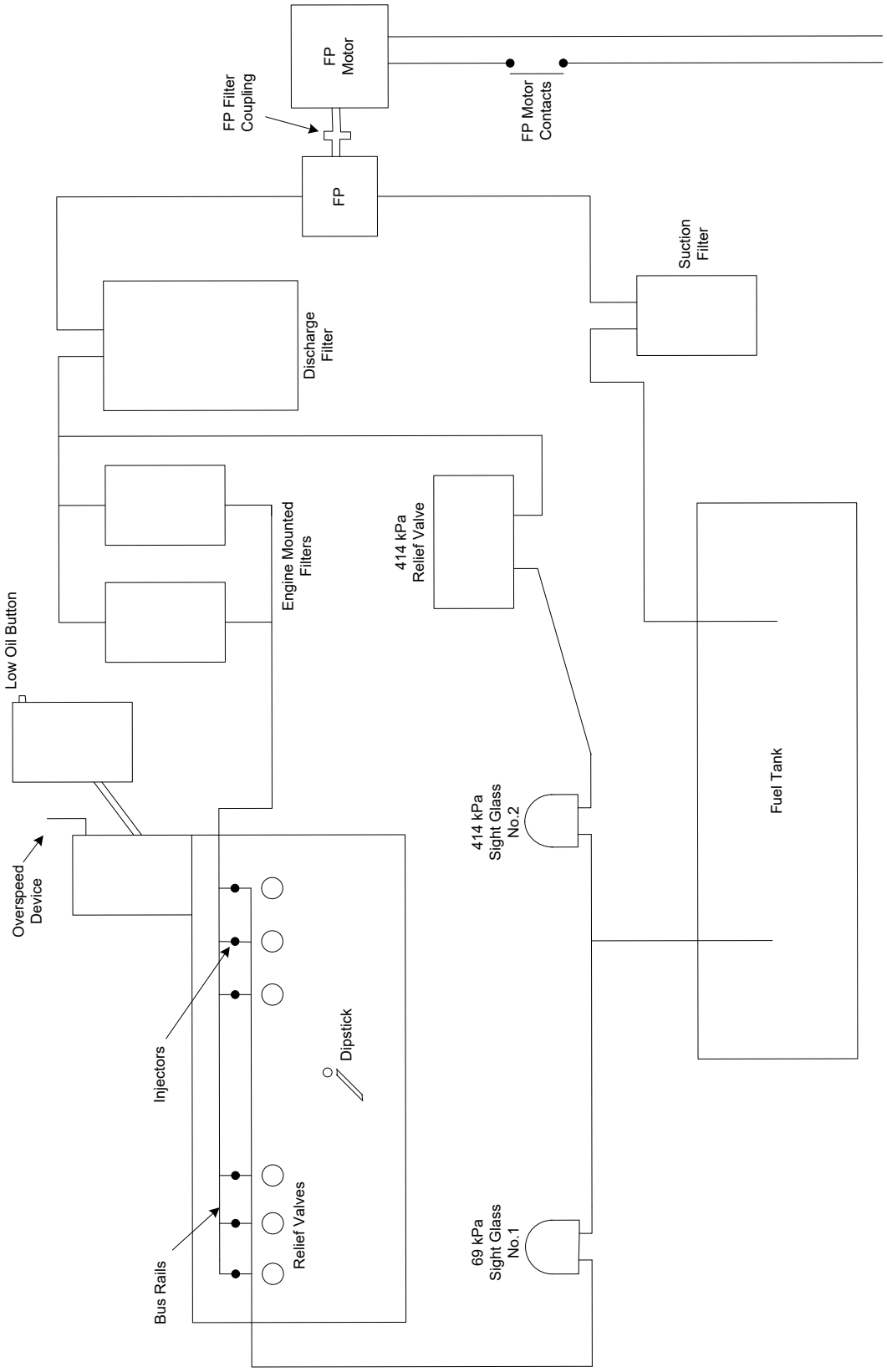
4.3 Bogie Arrangement



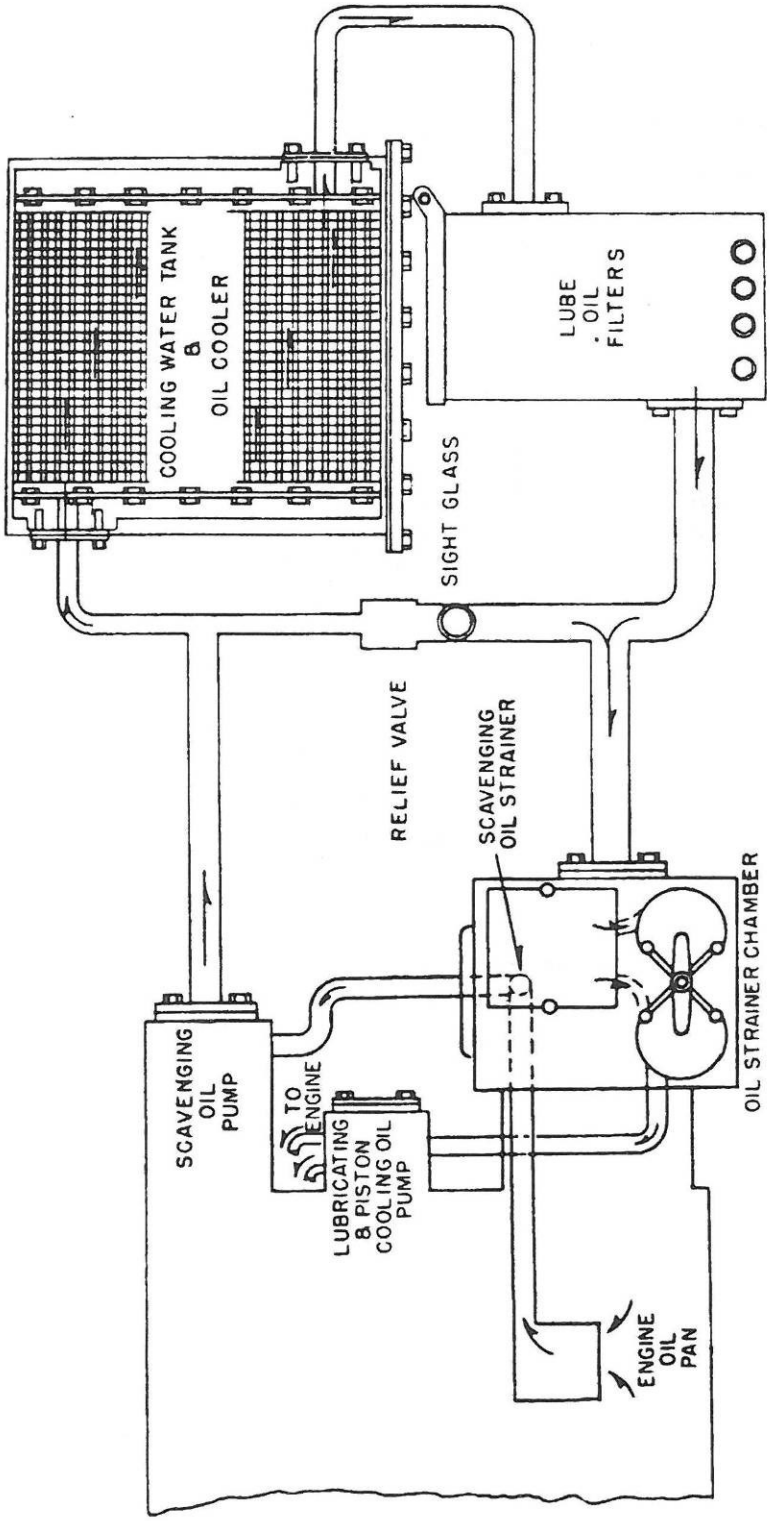
4.4 Location of Fuses

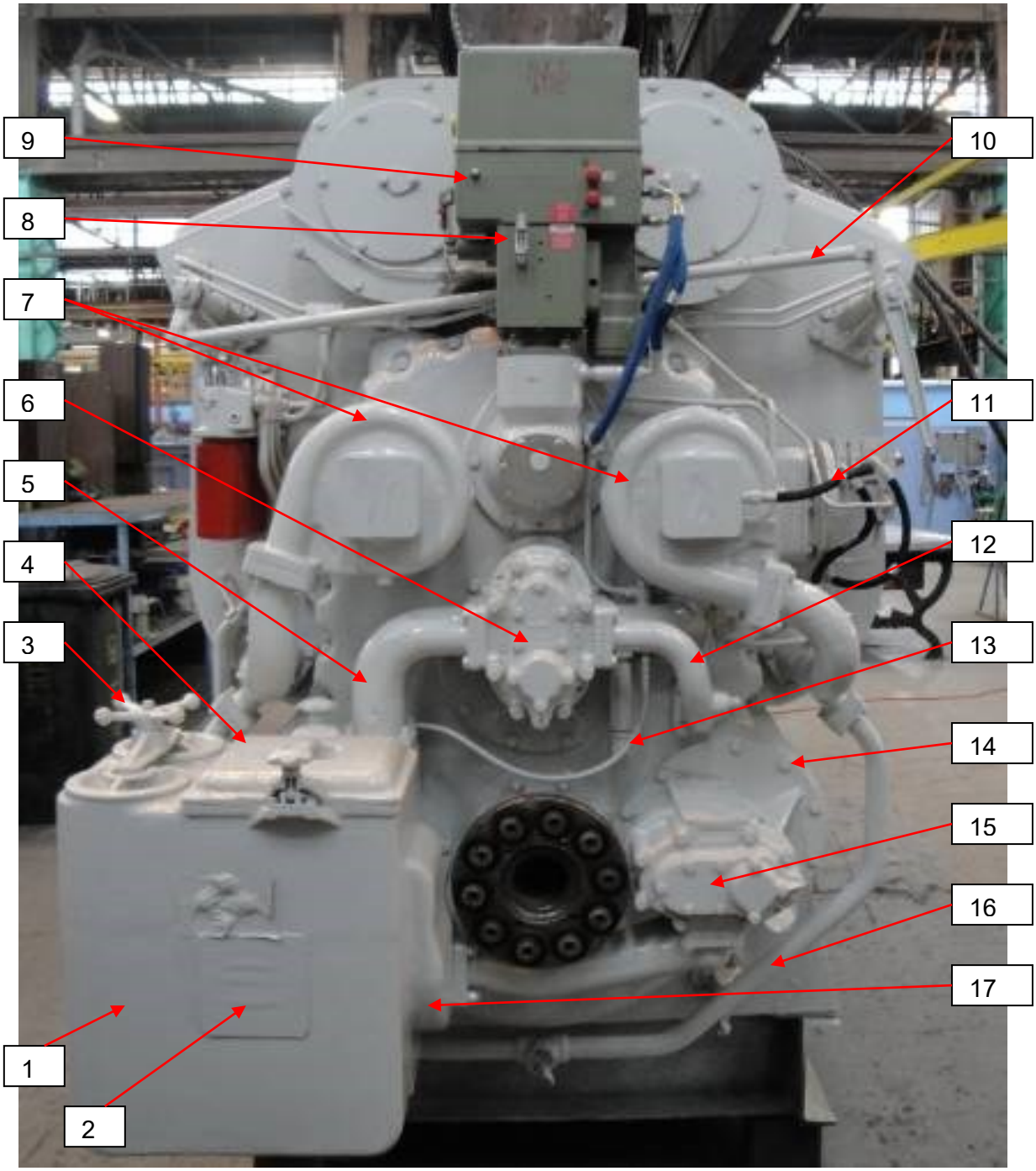


4.5 Fuel Oil System



4.6 Lube Oil System



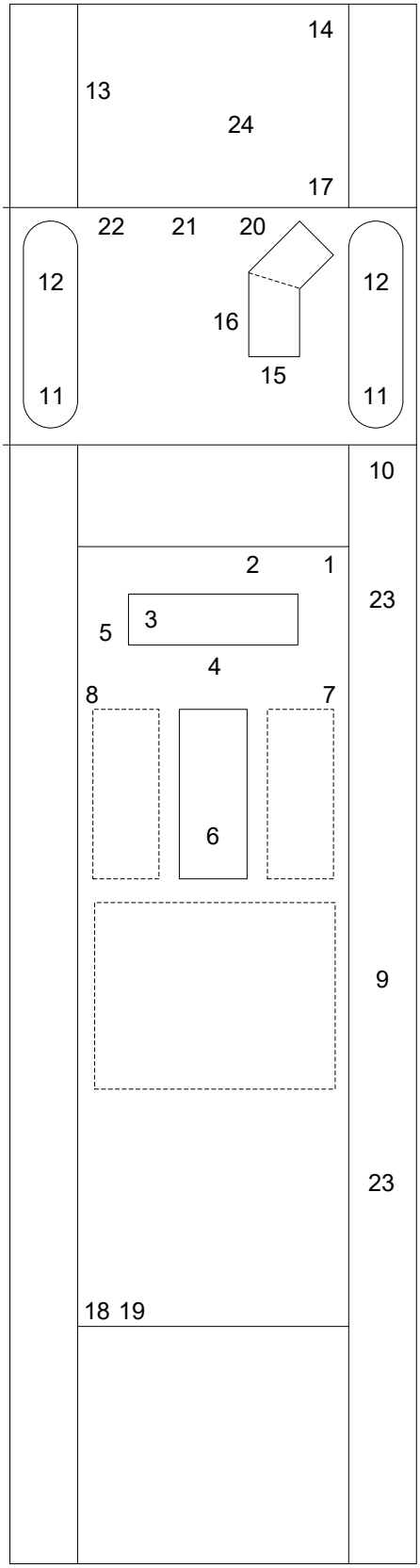


Lubricating System Components

1. Strainer Housing
2. Cooler Oil Inlet to Housing
3. Lube Strainer Hold Down Crab
4. Filler Opening Cover
5. Lube Oil Suction to Lube & Piston Cooling Pumps
6. Lube & Piston Cooling Pumps
7. Water Pumps
8. Governor Sight Glass
9. Low Oil Pressure Button
10. Layshaft Lever
11. Oil Manifold Relief Valve Cover
12. Piston Cooling Discharge
13. Strainer Seal Oil Supply Line
14. Scavenging Pump Outlet
15. Scavenging Oil Pump
16. Water Pump Balance Pipe
17. Scavenging Suction Strainer Oil Outlet Channel

4.7 Location of Air Isolating Cocks

1. Compressor load / unload cock
2. Compressor governor isolating cock
3. Compressor
4. Compressor intercooler safety valve
5. Compressor oil gauge
6. No.1 MR
7. No.1 MR safety vlave
8. No.1 MR drain
9. Auxiliary air isolating cock
10. No.2 MR non-return valve
11. No.2 MR
12. No.2 MR drain
13. No.2 MR isolating cock
14. Control valve isolating cock
15. Brake pipe pressure adjustment
16. Sand actuator isolating cock
17. Sands (both) isolating cock
18. Shutter isolating cock
19. Shutters (both) and fan isolating cock (Hutt Rebuilds)
20. Horn isolating cock
21. Vigilance control isolating cock
22. Vigilance control reset
23. Bogie isolating cock
24. Dead engine device cock



5.0 CAB CONTROLS / LAYOUT

The operating control equipment consists of three levers: the selector **(1)**, throttle **(2)**, and reverser **(3)** levers. All control levers are mechanically interlocked to prevent inadvertent faulty operation except the possibility of reversing while the locomotive is still moving.

5.1 Throttle

The position of the throttle is shown in an illuminated indicator with the lever having ten positions, ‘Stop’, ‘Idle’ and operating notches 1 to 8.

‘Stop’ can be obtained by pulling the lever out away from the controller and then moving it into the ‘Stop’ position, which is one step beyond ‘Idle’ position. This stops all engines in the locomotive consist.

5.2 Reverser

The reverser has three positions 'Forward', 'Neutral' and 'Reverse'. The direction of the locomotive is selected with this lever to the 'Forward' or 'Reverse' position. With the reverser in the 'Neutral' position no power will develop if the throttle is opened, even though the engine speed will increase. The reverser must only be moved when the locomotive is standing still.

The reverser can be removed from the controller only when the lever is in 'Neutral', the throttle is in 'Idle' and the selector lever is in 'Off'. The reverser must be removed in all non-operating cabs and placed in the electrical cabinet.

5.3 Selector Lever

The position of the selector determines whether the locomotive will operate to deliver power or dynamic brake.

The selector lever has 3 positions; 'B' (Dynamic brake), 'Off' and '1'.

The 'Off' position is used when locking the controller.

The 'B' position partially establishes the braking circuit with movement of the throttle completing the braking circuit as the throttle is moved away from 'Off' towards notch 8 thereby strengthening the braking power.

The '1' position is used to allow the locomotive to develop power.

The selector lever can only be moved one notch at a time and the lever position is shown in an illuminated indicator just above the lever.

5.4 Drivers Control Panel

The driver's control panel contains the following:-

5.4.1 Driving and Brake Ammeter

This ammeter shows the amount of current flowing to one traction motor when in power and also the output of the traction motor when operating in dynamic brake. This ammeter should be carefully watched to ensure that when operating in power the following rating is not exceeded:

When starting a train	600 amps
Quarter hour rating	545 amps
Half hour rating	510 amps
One hour rating	485 amps
Continuous rating	450 amps

When operating in dynamic brake the ammeter reading must not be allowed to exceed 375 amps.

5.4.2 Air Brake Gauges

There are standard gauges mounted on the driver's control panel. Each gauge is clearly labelled as to its function.

5.4.3 Operating Switches

The panel contains all the switches necessary for the operation of the locomotive. A nameplate below each switch identifies the function of the switch. To start the diesel engine and control its speed from the throttle, the 'Control and Fuel Pump' switch and the 'Engine Run' switch must be 'On'. To move the locomotive the 'Generator Field' switch must be 'On'.

5.5 Indicator Lights

There are seven warning lights fitted to this panel as follows:-

5.5.1 Wheel Slip

Flashing of this light during power operation indicates that wheels are slipping. Automatic sand will operate. This light also operates when working in dynamic brake.

5.5.2 Ground Relay

When is light is illuminated it indicates a tripped ground relay. With the ground relay light on, an alarm bell will ring on all locomotives but the light will only show on the locomotives that has then ground relay tripped. When the ground relay is tripped all power will be lost to the traction motors and engine speed will return to idle, but if the throttle lever is in notch 5 or 6 the engine will stop.

5.5.3 Hot Engine

The hot engine light, when showing, indicates that engine cooling water temperature is above 90 C. The hot engine light will show on the locomotive affected but an alarm bell will ring on all locomotives. Engine speed or load is not affected.

5.5.4 PC Switch Open

The PC or pneumatic control switch is often called the power cut off switch and is located in the short hood. This is a normally open electric switch which is closed by brake pipe pressure. During an emergency automatic brake application this switch opens and automatically reduces power output of the locomotive to notch 1. When opened this switch with the GF switch on will immediately reduce all engines in the consist to idle but if the throttle lever is left in notch 5 or 6 the engines will stop. The white "PC Switch Open" indicating light will show when the switch is open.

The throttle must be placed in IDLE and brake pipe pressure restored to above 350 kPa to extinguish the light.

5.5.5 Manual Power Relay

When this light is illuminated it indicates that the manual power switch on the driver's control stand is on and that the locomotive is set up for manual power control. This feature provides infinitely variable control of the main generator output for any pre-selected controller notch position.

NOTE: This feature is only available on DBR and Non micro control system DC locomotives.

5.5.6 Dynamic Brake

The brake warning light is used to indicate an excessive braking current. Generally the over-current is only temporary and the dynamic brake regulator will automatically reduce the braking current to the maximum permissible value. Under no circumstances should the light be allowed to stay on.

A 10 second delay has been fitted to the dynamic brake circuit on DC locomotives to improve reliability. If the brake warning light illuminates due to grid over-current while in dynamic brake an alarm bell will ring and braking current will automatically be reduced to a safe level on these modified locomotives.

Traction motor cut out is fitted to the micro DC locomotives to enable the locomotive to remain mobile on two traction motors after some wheelslip or ground relay faults. When running with a pair of motors cut out notch 6 will provide maximum power available with the load schedule being reduced in half. Modified DC's are identified by a Traction Motor Cut Out switch in the cab.

Traction motors can only be cut out with the throttle in 'Idle', the reverser in 'Neutral' and the isolation switch in 'Isolate'.

5.5.7 Engine Filter

This warning light is operated by a pressure switch being placed between the paper filters and the Rootes blower and if the paper filters become clogged and restrict the air supply to the blowers then the FVS (Filter Vacuum Switch) will close and bring up the engine filter light.

On a DC locomotive this warning light also serves as an alternator failure light should the 60 amp alt field fuse, the 30A aux gen field fuse or the 350A aux gen fuse become defective the alt failure engine filter light will illuminate and the engine will return to idle speed, but if the throttle is left in notch 5 or 6 the engine will shut down.

5.6 Switches

5.6.1 Ground Relay

This switch placed on the driver's panel is provided to reset the ground relay if it should trip but before operating the switch the throttle lever must be in 'Idle' and the isolating switch in 'Start'.

5.6.2 Head Light

Two headlight configurations are fitted to DBR and DC Locomotives

1. Original Configuration:

   There are three headlight switches, two for allowing a dim headlight to be used and one for allowing a bright headlight on either end of the locomotive.

   A gauge light dimming rheostat control and a cab heater control are also placed on the driver's control stand.

   The ditchlights are slaved to the headlights, so provided the ditchlight selector switch on the top of the control stand is "ON" the ditchlights will work with the selected headlights at the selected illumination level.

2. New Configuration:

   There are two headlight control switches. The main switch on the right side of the gauge panel allows the driver to select the desired headlight and ditchlight combinations. The second switch on the left of the control stand allows the driver to set "Off", "Dim" and "Full" for the selected headlight / ditchlight combination.

5.6.3 Isolating

This switch has two positions, 'start' (handle vertical) and 'run' (handle horizontal). In the start position the power plant is isolated from the control circuits and the engine speed is reduced to idle. The engine will remain at idle speed and will not respond to throttle control. The main generator will not supply power to the traction motors even with the throttle lever in an operating position.

The Fuel Prime / Engine Start Switch in the start position is only effective with the isolating switch in the 'start' position.

The isolation switch must be in 'run' for the unit to develop power and for engines revolutions to be increased.

The isolation switch should be moved only with the engine at idle or stopped.

NOTE: If operating in multiple, the isolation switch must not be moved from one position to another while in power or dynamic brake, otherwise serious damage could result.

5.6.4 Fuel Prime and Engine Start

The FP / ES switch is only effective when the isolating switch is in 'start'. This switch, when placed in 'prime' allows the fuel pump to be supplied with power from the battery and will run to charge the fuel system. When the switch is placed in 'start' the fuel pump will stop but the circuit will be made to enable the engine to rotate and start. The switch is spring loaded and will return to its centre position when released.

The FP / ES switch must not be held in the 'start' position for longer than 15 seconds. If the engine does not start within this time, check fuel faults before operating the button or switch again.

5.6.5 Engine Stop

This button is effective with the isolation switch in 'start' or 'run'. The isolation switch should always be placed in 'start' when the diesel engine is to be stopped except in an emergency. Pressing the stop button shuts down the engine by putting the fuel rack to 'no' fuel'.

5.7 Gauge

5.7.1 Battery Charge Ammeter

This ammeter shows the rate of charge or discharge of the batteries.

5.8 Electrical Cabinet

This cabinet is placed between the cab and compressor compartment and contains the various contactors, relays, CB's, fuses and knife switches necessary for the electrical controls of the units. The cabinet is assessable from both inside the cab and long hood side doors. This cabinet differs on the DC and DBR type locomotives as far as equipment is concerned. All equipment is named and its purpose is as follows:

5.8.1 Knife Switches

The BKS and ground relay bypass switch are placed in the electrical cabinet. The ground relay cut out switch must not under any circumstances be opened by the driver.

5.8.2 Circuit Breakers

These CB's are placed on the engine control panel on the back wall of the cab.

Lights	Headlights
Control	Local Control
Fuel Pump	Hot Point

5.8.3 Fuses

Main Start Fuse	400 amps
Auxiliary Generator (Battery charging fuse)	250 amps
Battery Circuit protection fuse	100 amps
Auxiliary Generator field fuse	30 amps
Battery field fuse	80 amps
External Battery charge fuse	60 amps
Tail Light fuses (4)	
D14 Alternator field fuse (DC loco only)	60 amps

5.8.4 Ground Relay

This relay is provided to protect the high voltage circuits when a ground relay fault occurs. When it trips it also opens the ER relay.

6.0 PRE START PROCEDURES

6.1 Cab Inspection

Ensure that the handbrake is applied.
Check the Loco 54 repair book that all repairs have been carried out.
Ensure that all brake equipment is correctly set up in all cabs.
Check that the vigilance glass is intact.

6.2 Ground Inspection

Check:

- Drawgear, Westinghouse hoses, springs, cowcatchers.
- That jumper socket covers are closed and dummies are on hoses.
- That all operating cocks are correctly positioned and that couplings are properly made between coupled locomotives.
- Cooling air flexible ducts to traction motors.
- Sand boxes are full.
- Ensure all air reservoir drain cocks are closed.
- Fuel oil level in tank.
- There are no loose or dragging parts.

6.3 Underneath Inspection

Check:

- Brake rigging and blocks.
- Adjust brakes if necessary.
- There are no loose or dragging parts
- Inspect electric cables to traction motors.

6.4 Long Hood End Inspection

Check:

- Oil levels in the engine, compressor and governor.
- Water level in supply tank and overflow valve closed.

- All cocks and buttons are correctly positioned.
- Jumper cable is on the engine.
- All breakdown and spare equipment including fire extinguishers intact.

While doing the checks watch for fuel oil, water and oil leaks and remove any material from the engine room that may be a fire hazard.

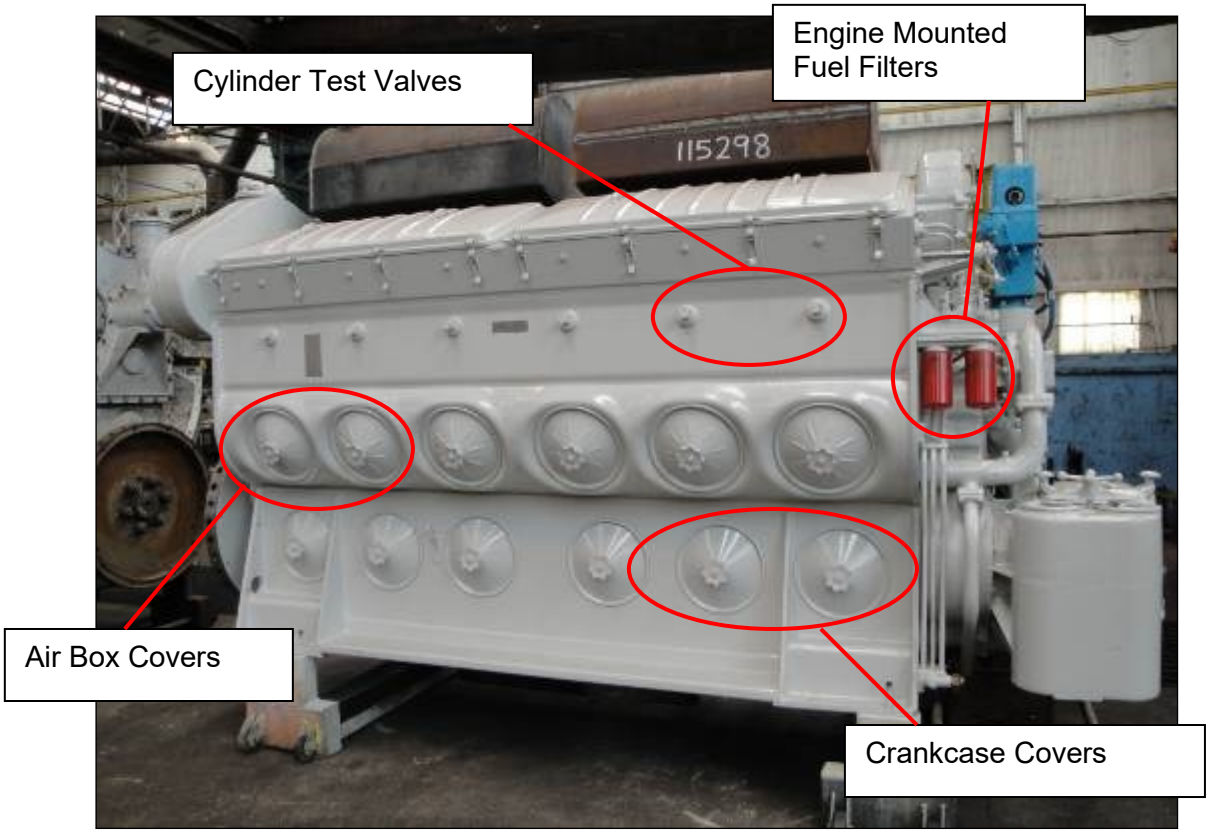
7.0 START UP PROCEDURES

7.1 Cylinder Test Valves

Each cylinder is equipped with a test valve for the purpose of testing for liquid accumulation in the cylinders prior to starting an engine that has been shut down for 72 hours or more.

To make the test, proceed as follows:

- Remove the 400-amp starting fuse so that the engine cannot be started.
- Open all cylinder test valves approximately three full turns.
- Use the engine barring over jack to rotate the engine one complete revolution.
- Check the cylinder test valves for any discharge.



- If liquid is discharged from the test valve report the fact to the Operations Controller.
- If no discharge, close all test valves firmly.
- Replace the 400 amp fuse and start the engine.
- Check all test valves to see if any are leaking.
- If any are leaking, stop engine at once and tighten valve or valves.

7.2 Engine Shut Down Less Than 72 Hours

When starting engines that have been shut down for less then 72 hours it is not necessary to bar engine over.

7.3 Before Starting

- Ensure that the GR cut out knife switch is closed.
- Close BKS.
- All CB's are in the 'on' position.
- Place isolation switch to 'start'.
- Turn on 'control' and 'fuel pump' switch on driver's control panel. Hold the 'prime' switch in prime position for a short period.

7.4 To Start

Operate the 'Engine Start' switch.
Do not hold for more than 15 seconds.
When engine starts, release switch.

7.5 After Starting

Check:-

- Battery ammeter shows a charge.
- Cylinder test valves for leakage.
- Running level of oil in engine, compressor and governor.
- For fuel, oil and water levels.
- Listen to the beat of the engine for unusual sounds.
- Flow of air from the traction motor vents.

7.6 Before Moving Locomotive

Check:-

- Oil and water temperatures are normal.
- Air pressures are correct and unloader operates at the correct pressure.

7.7 Moving Locomotive – Single Unit Operation

- Switch headlights on for the direction of travel.
- Release handbrake and all airbrakes.
- Generator Field Switch 'on'.
- Reverser to the direction of travel.
- Throttle to notch 1 and if locomotive does not move then advance throttle until it does then notch back.

7.8 Coupling Up for Multiple Unit Working

When making and breaking electrical couplers, the couplers must be handled carefully so as to avoid damage to them. Before uncoupling or coupling electrical jumpers both isolation switches must be in 'Start'.

The procedure for coupling up is:-

- Each locomotive must be started separately.
- Bring the locomotives together and make the mechanical coupling, a coupling link must be used. And all the hoses in one side coupled up and the air cocks opened.
- Ensure that both isolation switches are in 'Start'.
- Set up brake equipment on all locomotives as per the Rail Operating Code, Section 4.
- In all non operating cabs place all switches on the driver's control stand in the 'off' position. Place the reverser in the electrical cabinet.
- Check pins in coupler boxes and ensure that the jumper heads are clean.
- Insert the coupler and ensure it is completely home and held tight by the coupler box catchers.
- If the locomotives are coupled up in service the vigilance control must be tested, both brake valves in all positions, sand in both directions, horn and headlight.
- Before moving, place the isolation switch in the "run" position on the rear locomotives, check air gauges and release handbrakes.

7.9 Starting Engines, Multiple Units

When starting the engines of locomotives coupled in multiple, proceed as follows:-

- Units in multiple which have been shut down for any reason must have the jumper cables disconnected prior to starting.
- Ensure all switches on the driver's control stand on the lead locomotive are in the "off' position.
- Proceed to trail unit and close the BKS, see that all fuses are in place, check that the GR knife switch is closed.
- Check all CB's are in the "on" position and isolation switch is in "start".
- Hold the FP / ES switch in "Prime" until the fuel system is primed then operate the start switch and release when engine starts.
- When engine settles down place the isolation switch in "run".
- Turn the control and fuel pump switch "off" and ensure all fuses are in place. (Check that the GR knife switch is closed).
- Check all CB's are "on" and the isolation switch is in start.
- Turn control and fuel pump switch "on".
- Hold the FP / ES switch in prime until the fuel system is primed then operate the start switch and release when engine starts.

7.10 Multiple Unit Jumper Test

After coupling up in multiple, test the jumper connection, as follows:-

- After all the controls on both locomotives have been set up correctly.
- On the lead locomotive turn the isolation switch to “start”.
- Turn the GF switch to the “off’ position.
- Advance the throttle lever to notch 4 or 5 and check that the trailing engine responds to the throttle advance.
- Place the throttle lever in “idle” and turn the GF switch on.
- Release all brakes and place reverser in the direction of travel.
- Advance the throttle until the trail unit pushes the lead unit.
- Place the throttle lever to “idle” and turn the isolation switch to “run”.
- Advance the throttle lever and check with the ammeter that the lead unit operates.

NOTE: This test can also be carried out on the road when it is suspected that the trailing unit is not operating correctly.

7.11 Remote Headlight Switch

This switch permits the headlights of the rear unit to be controlled from the lead unit.

7.11.1 On Lead Units

If only a single unit is being used, place the switch in the “Single Unit” position. In multiple unit service if trailing units are coupled to the No.2 or long hood end of the lead unit, then place the switch in the Controlling – coupled at No.2 or long hood end. In multiple unit service if coupled units are coupled to No.1 or short hood end of the lead unit, place switch in Controlling – coupled to No.1 end or short hood end position.

7.11.2 On Intermediate Unit

On units operating in between other units in a multiple consist place the switch in the “Single Unit” position.

7.11.3 On Trailing Units

The last unit in a multiple consist should have the headlight control switch place in the “Controlled from another unit” position.

8.0 OPERATING

8.1 Throttle

This lever when placed in notch one sets up the circuit for the excitation of the main generator.

Each running notch after notch one increases the speed of the engine in increments of 80 rpm. That is from approximately 275 rpm in idle and notch one to approximately 835 rpm in notch 8. The throttle may be closed completely in one motion in an emergency but should be closed one notch at a time in normal operation.

DC locomotives which have the "E" type engine block have a low idle speed of 255 rpm, normal idle speed of 318 rpm with an increase of 80 rpm for each throttle notch to give 904 rpm in notch 8.

8.2 Changing Driving Cabs

- When the locomotives have being brought to a stand with throttle lever in "idle", place reverser in "Neutral", place selector lever in "Off".
- Remove reverser and place in electrical cabinet.
- When changing cabs it is very important to set up the trail cab for lead before doing anything else.
- Make an automatic brake application, and then cut out the brake valve cut off valve.
- Set up brakes as per Rail Operating Code, Section 4.
- Switch off all switches on the driver's control stand.
- Proceed to cab which is to become the operating cab and turn on control and fuel pump switch.
- Obtain reverser from electrical cabinet and insert in controller.
- Place selector lever in 1 position.
- Set up brakes as per Rail Operating Code, Section 4.
- Switch on ER switch and test engine revs.
- Test vigilance device, brake valves in all positions, sand in both directions, horn and headlights.
- Turn on generator field switch and ensure the locomotive moves when throttle lever operated.

NOTE: When changing cabs remember the fuel pumps are stopped from the time the control and fuel pump switch is opened at one end until the switch is closed at the other end.

8.3 Isolating a Unit When Working in Multiple

When working in multiple and it becomes necessary to isolate a unit the action will depend on whether it is a lead or trail unit. When it is a trail unit treat the locomotive as a dead locomotive and isolate it as if it were being prepared for dead (leaving brakes set up for trail of multiple and all 3 pipes on headstock joined). If it is a lead unit then the trail unit will still need to be controlled from the leading cab so isolate the lead unit as follows:-

- Place the isolation switch in “start” and stop the engine.
- Leave all knife switches closed.
- Leave the control, fuel, ER and GF switches on the driver’s control stand on.
- Operate the controls as for normal operation to control the trail units.

8.4 Manual Power Control

This feature is fitted to DBR and Non micro DC locomotives. It provides infinitely variable control of the main generator for any pre-selected controller notch position, i.e. it fine tunes amperage available for each power notch. It is an aid in minimising wheelslip under adverse conditions as well as definite advantage for starting a train on a wet rail.

A manual power circuit switch is placed on the control stand in line with other switches.

A manual power indicator light which illuminates when the switch is placed to “Manual Power” is placed in line with other indicator lights on the control stand.

A rheostat is mounted to the left of the controller.

To operate:-

- Place the rheostat in the minimum position.
- Place the throttle in “idle”.
- Turn manual power switch “on”.
- Reverser in the direction of travel.
- Open the throttle to give the selected notch position, and then adjust the manual power rheostat accordingly.

Manual power may be used in any notch position but is interlocked in the power circuit to prevent traction motor field shunting. It is therefore important that the manual power switch must only be operated with the throttle lever in “idle”.

The manual power device is also trainlined to operate on trailing units fitted with manual power control.

8.5 Dynamic Brake

To operate the dynamic brake:-

- The reverser must be positioned in the direction of travel.
- The throttle must be in “idle”.
- Move the selector lever from “run” to “off” and pause for 10 seconds.
- Move the selector to ‘B’. This partially establishes the braking circuit and depending on the speed of the train may bunch up the slack.
- After the slack is bunched, the throttle lever may be advanced to strengthen the braking effort to that required and at the same time the rpm of the engine will increase from 275 to 435 as the throttle is moved beyond the minimum position.
- The braking amps are automatically limited by the dynamic brake regulator regardless of the throttle position or locomotive speed.
- If maximum braking is required, the throttle should be moved slowly to the maximum position to prevent a sudden surge of current to the grid. Generally, if the throttle is moved slowly, the brake regulator will limit the current without a brake warning light. If the brake light does indicate then the throttle is not to be advanced further until the light goes out. If the light continually comes on, then the throttle must be backed off to a point where the light stays extinguished.
- If necessary the train brakes may be used in conjunction with dynamic braking however independent brake is not available with dynamic brake.

8.5.1 Wheel Slip in Dynamic Brake

Automatic sanding will occur if wheel slip is detected whether the locomotive is fitted with the Micro system or not. If sanding does not occur then the throttle must be backed off until the wheel slip is corrected and the wheel slip light extinguished.

9.0 SHUT DOWN PROCEDURE

9.1 Stopping Engine

There are five ways to stop the engine:-

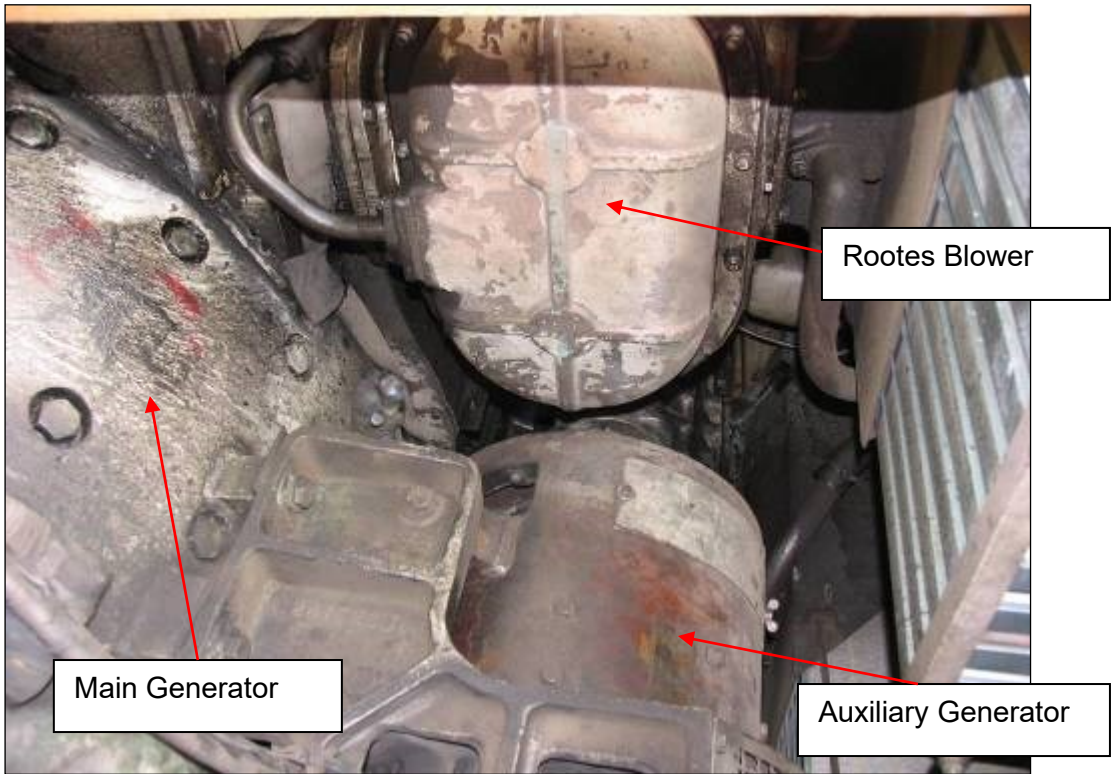
1. Press engine stop button on control panel and hold until engine stops.
2. Use the layshaft lever (injector control lever). This is at the accessory end of the engine and can be operated to override the governor and move the fuel racks to the no fuel position, this is done by pulling the layshaft lever out towards the outside of the locomotive.
3. Close the low water detector test cock. When the low water detector trips, oil is dumped from the governor low oil shutdown device, stopping the engine.
4. Use throttle handle. To stop all engines “on the line” in a consist simultaneously from the cab of the lead unit, move the throttle to the “idle” position, pull the lever out and away from the controller, and move it beyond “idle” to “stop” position. This position should only be used in an emergency.
5. Pull out the low oil shutdown plunger on the side of the governor.

9.2 Shutting Engine Down (Normally)

- Apply air and hand brake (if stabling).
- On control stand, throttle in “idle”, reverser centred, selector in “off”.
- Turn isolation switch to “start” position.
- Push ‘engine stop’ button in until engine stops (on control panel)
- Turn off all switches on driver’s control stand.
- Turn off all CB’s
- Open BKS.

10.0 DIESEL ENGINE

The diesel engine drives a main generator which produces direct current at a nominal 600 volts, an auxiliary generator which produces direct current which is held constant at 74 volts, a three cylinder two stage air compressor, a radiator fan, two traction motor blowers and two Rootes blowers



The engine is started by making the direct coupled main generator operate as a motor. Current from a 68 volt battery system rotates the main generator to start the engine.

The main generator changes the mechanical power into high voltage electrical power to move the locomotive when in power and to excite the traction motor field when in dynamic brake.

The electrical power is supplied to four traction motors, two of which are located in each bogie. The traction motors are geared to separate axles.

The load regulator ensures that the engine sends no more or less power to the main generator than should be produced for each separate throttle position.

The engine governor controls the engine speed as directed by the throttle lever and also controls the load regulator.

Two water pumps circulate water through the engine cooling system. The water temperature is automatically controlled. Only one water pump is fitted to the DBR locomotive.

Lubricating oil is circulated through the engine, oil cooler, filter and strainer by two oil pumps mounted on the engine.

Fuel oil, drawn from the fuel tank by an electric motor driven pump, passes through three filters before reaching the engine.

DC Locomotives

These locomotives have a 12 cylinder V type two cycle 1190 kW diesel engine supercharged by two Rootes blowers mechanically driven from the engine gearbox.

Air from the airboxes is supplied to the cylinder liners via ports formed in the liner walls. The liners are cast with a water jacket and water is circulated by two engine driven water pumps.

The engine is pressure lubricated by two engine driven oil pumps and the oil cooled in a heat exchanger in the engine water cooling system.

The engine is fitted with a overspeed device with the governor controlling the engine at eight different speeds.

DBR Locomotives

These locomotives are fitted with an 8 cylinder V type 746 kW diesel engine and have the same equipment fitted as the 12 cylinder engine, with the exception that the engine cooling water is circulated by only one engine driven water pump and is supercharged by only one Rootes blower.

10.1 Engine Lubricating System

The engine lubricating oil system is a combination of three separate systems:

- The engine lubricating oil system which supplies oil for lubrication of the various moving parts of the engine.
- The piston cooling oil system which supplies oil for the cooling of the pistons and lubricating of the piston pin bearing surface.
- The scavenging oil system which supplies the other two systems with cooled and filtered oil by taking the oil drained into the oil pan or sump and forcing it through the filter and cooler from where it flows to the suction strainer housing from which the lubricating and piston cooling oil pumps draw there supply.

The piston cooling and lubricating pump is a combination pump, i.e. two pumps are contained in one housing with separate oil inlets and discharge openings.

The oil strainer housing is mounted on the front right-hand side of the engine. It contains independent strainers from the main oil supply and scavenging oil pump.

Relief valves are placed in three locations in the lubricating oil system:

1. A 420 kPa relief valve is connected into the discharge side of the scavenging oil pumps. When opened this valve relieves pressure on the oil cooler core and bypasses oil around the oil cooler and filter to the oil strainer box. A sight glass is located in the bypass line to provide a visual indication of the opening of this valve. This valve will often open when the engine is first started and the oil is cold but as soon as the oil heats up the valve will close. If when operating with oil at its normal operating temperature it is noticed that oil is passing through the sight glass it indicates that the oil filter is blocked and this should be booked in the Loco 54 repair book. The locomotive may be worked home but a check should be kept on the engine for overheating.

2. A relief valve is built into the filter to allow the passage of oil to the strainer box in excess of the capacity of the oil filter elements.

3. A relief valve is mounted in the discharge side of the lubricating pump. This valve limits the maximum pressure of the lube oil entering the lubricating oil system at approximately 420 kPa.

A pressure gauge placed on the front of the water cooling tank indicates engine lubricating oil pressure. At 835 rpm the oil pressure is normally 280 – 350 kPa but should not drop below 140 kPa. At idle speed 275 rpm, the lubricating oil pressure should be at least 42 kPa.

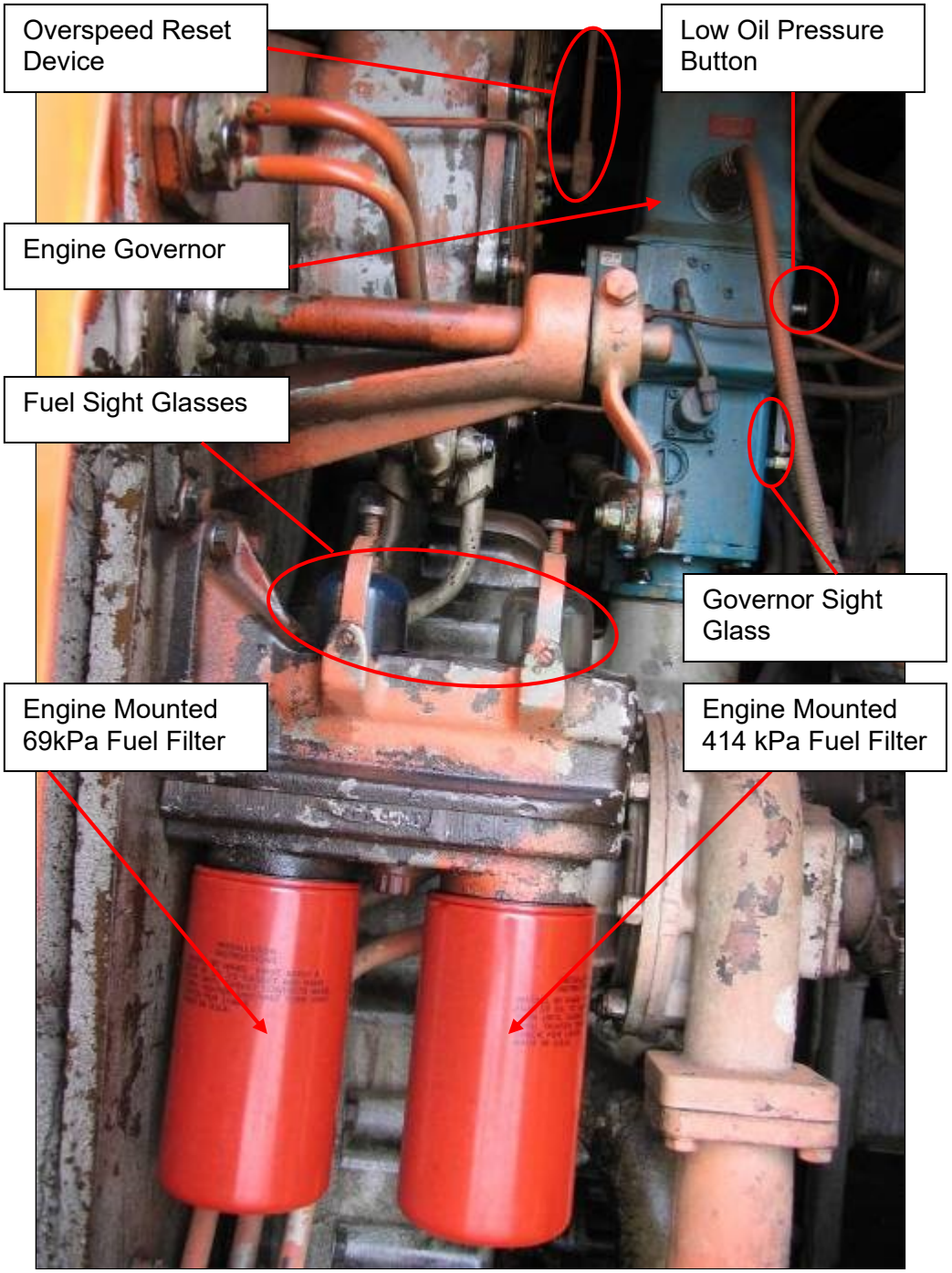
The low oil pressure device located in the engine governor will automatically stop the engine in case of a dangerously low oil pressure condition.

Oil may be added and the level checked with the engine running or stopped but when the engine is running the level of oil on the dipstick should show on the full mark and when the engine is stopped the reading on the dipstick should show over full. The engine lube oil dipstick is located on the right-hand side of the engine about half way along the side.

An oil separator is mounted between the two Rootes blowers on top of the auxiliary drive housing. Blower suction draws the hot oily vapor from the oil pan through the gear train housing into the oil separator element, drains to a trough at the separator bottom and flows into the gear train returning to the oil pan.

10.1.1 Engine Governor

This governor is electric – hydraulic in operation i.e. uses oil as a pressure medium and electrically controlled solenoid operated plunges which act to vary the engine speed.



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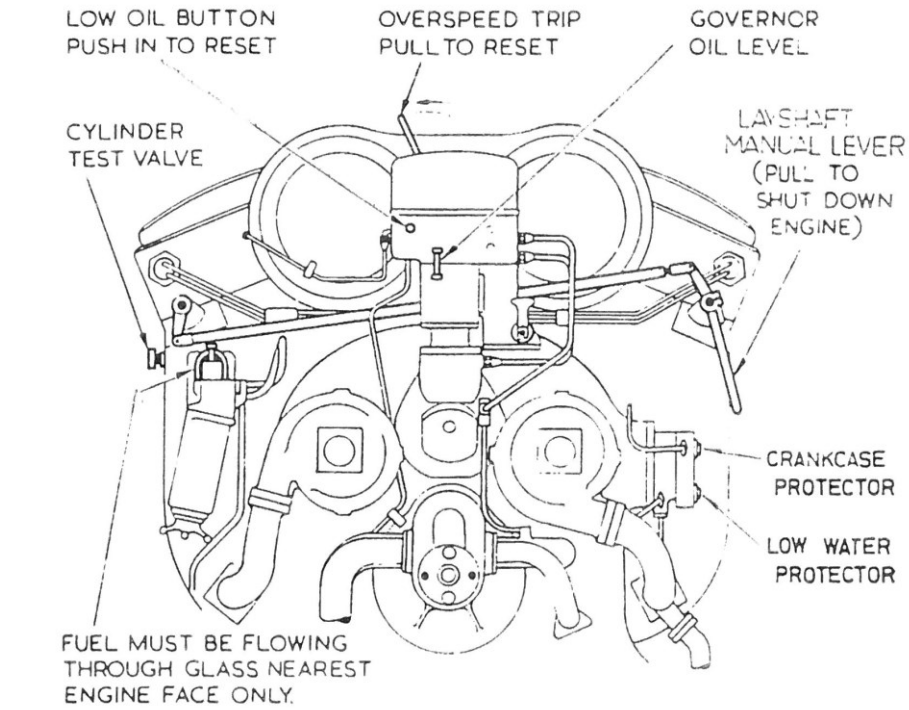


10.2 Fuel System

Fuel oil drawn through a suction filter by an electrical fuel pump and then forced through a discharge filter to an engine mounted filter. After having passed through the double element engine mounted filter the fuel flows to the injectors. The excess fuel that is not used by the injectors is returned through the return sight glass fitted on top of the engine mounted filter housing. By restricting the flow of the fuel into the glass causes a slight back pressure of fuel on the injectors and by maintaining this back pressure a positive supply of fuel for the injectors is assured as long as the fuel pump is operating.

Normally the fuel pump delivers more fuel to the engine than is burned in the cylinders. The excess fuel which is circulated through the injectors provides cooling and lubrication for the working parts of the injector pumps. The engine should never be allowed to operate without adequate fuel flow showing in the return sight glass.

10.2.1 Fuel Flow Sight Glass

Two sight glasses are mounted on the engine mounted filter housing to provide visual indications of the condition of the fuel system. For proper engine operation a good flow of fuel, clear and free of bubbles should be indicated in the sight glass nearest the engine and named the 69 kPa fuel return sight glass. The other sight glass called the 414 kPa sight glass is normally empty. When more than a trickle of fuel through the 414 kPa sight glass is seen it indicates that a 414 kPa relief valve is open. This fuel when it passes through the 414 kPa sight glass and relief valve bypasses the engine and returns to the fuel tank. It indicates that the engine mounted filter is becoming clogged and the engine will be starved for fuel and will in time shut down. When fuel is noticed in the 414 kPa glass it must be entered in the Loco 54 repair book and reported to the maintenance staff.

10.2.2 Fuel Tank

The fuel tank is placed under the locomotive frame between the two bogies and may be filled from either side. A short sight level gauge is located next to each filling aperture and must be observed when refueling to prevent overflow. This gauge indicates the fuel level from the top to about 112 mm below the top of the tank.

10.2.3 Fuel Pump

The fuel pump is driven by an electric motor through a flexible coupling. The motor is supplied with power from the battery when priming the fuel system and from the auxiliary generator when the engine is running.

10.2.4 Fuel Pump Control Gear

The governor controls the fuel pump control shafts through a linkage system which incorporates a manual lay shaft lever. Under normal operating conditions the lay shaft lever moves with the fuel control shafts but by pulling on this lever the fuel racks can be moved to the “no fuel” position and the engine will stop. By pushing this lever in towards the engine the fuel can also be increased to increase engine speed. The lay shaft lever can be used to override the governor.

10.3 Engine Overspeed Trip

This is fitted to the top front end of the engine and will trip to stop the engine if the engine speed exceeds allowable limits. Once this overspeed device is tripped, it must be reset manually by pulling the lever counter-clockwise until it latches before the engine can be restarted.

11.0 AIR SYSTEM

11.1 Air System

Compressed air is used for operating the air brakes, sanders, radiator shutters, horn and windscreen wipers. Each locomotive is equipped with a water cooled three cylinder air compressor which consists of two low pressure heads and one high pressure.

DC and DBR locomotives are fitted with 26L brake equipment.

11.2 Compressor

11.2.1 Manual Control of Compressor

A manual unloader valve is fitted in the pipeline from the governor to the compressor unloader valves. If it is desired to keep an air compressor unloaded, irrespective of the compressor control system, this valve should be moved to the unload position. This allows main reservoir air to bypass the governor and pass straight to the unloader valves which now hold open the intake valves and the compressor works to the atmosphere. Another valve placed in the pipe from the main reservoir to the governor which, if altered from its normal position, will cut off the air to the governor and the compressors will remain on load. The excess pressure which will be pumped into the main reservoirs will be relieved through the safety valves. These valves must be checked to ensure that they are in their correct position when the locomotive is being prepared.

12.0 ELECTRICAL

12.1 Main Generator

The main generator is mounted on the rear end of the diesel engine and is driven directly from the main engine crankshaft. This generator is nominally 600 V and supplies the traction motor fields and armatures when in power and the traction motor fields when in dynamic brake. The output of the generator is controlled by the load regulator and engine speed.

12.1.1 Auxiliary Generator

The auxiliary generator is mechanically driven from the rear gear train of the diesel engine and supplies power at 74 volts for battery charging, lighting, control circuits, running the fuel pump and for exciting the battery field of the main generator.

12.2 Traction Motors

The traction motors are hung on the axle on one side by suspension bearings and resiliently suspended from the bogie frame on the other.

The motors are all permanently connected in parallel. The fields of the traction motors in both types of locomotives are arranged for one stage of field diversion which takes place when loading permits.

12.2.1 Traction Motor Blowers

The traction motor blowers are mechanically driven from the diesel engine and supply cooling air to the traction motors, the main generator and a cooling grid to cool main reservoir air. One is driven from the rear gear train of the engine. The other is in the long hood end and is driven through a speed increaser gearbox which also drives the radiator fan. On a DC locomotive the rear traction motor blower is driven by an electric motor controlled by the D14 alternator.

12.3 Dynamic Brake Grid Power

This is driven by an electric motor supplied with power from the traction motors when they are operating as generators in dynamic brake. This blower is placed in the roof at the cab end of the locomotive and supplies cooling air to keep the dynamic brake resistor grid cool.

12.4 Load Regulator

The load regulator controls the electrical loading of the main generator. The load regulator itself is controlled by the engine governor: together they work to ensure the correct engine speed / fuel ratio is maintained and the main generator is not over or under loaded. On micro control system DC locomotives, the load regulator is replaced by two pressure switches and a solid state Battery Field Supply.

13.0 BRAKES

Reserved for future use

14.0 CUT OUT COCKS

Reserved for future use

15.0 EMERGENCY EQUIPMENT / OPERATION

15.1 Emergency Egress Windows

In DC locomotives where forward opening loco cab doors are not available, provision have being made for emergency egress through the front wall and side windows. The width of the window is wider than the doorway.

Description
DC locomotive cab side wall sliding windows are either:

- **Gilbert - two pane sliding window or,**
- **OEM - fixed pane and single sliding window**

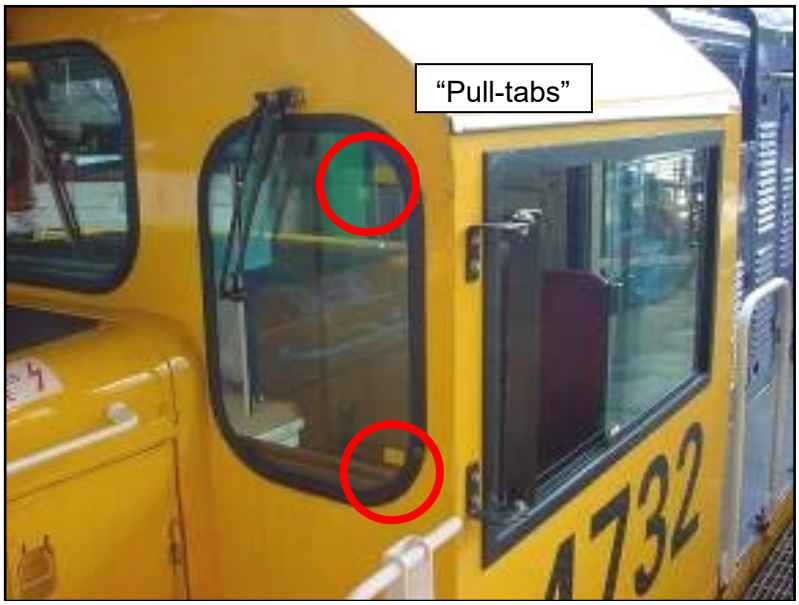
Front wall side windows have been fitted with pull-tabs on the rubber key-strips to allow removal of the key-strip; the window glass can then be pushed or knocked out.

The Train Operator's side provides more space for a person to exit through window.
The Locomotive Engineer's front wall side window is more restricted due to the control stand and drivers dash.

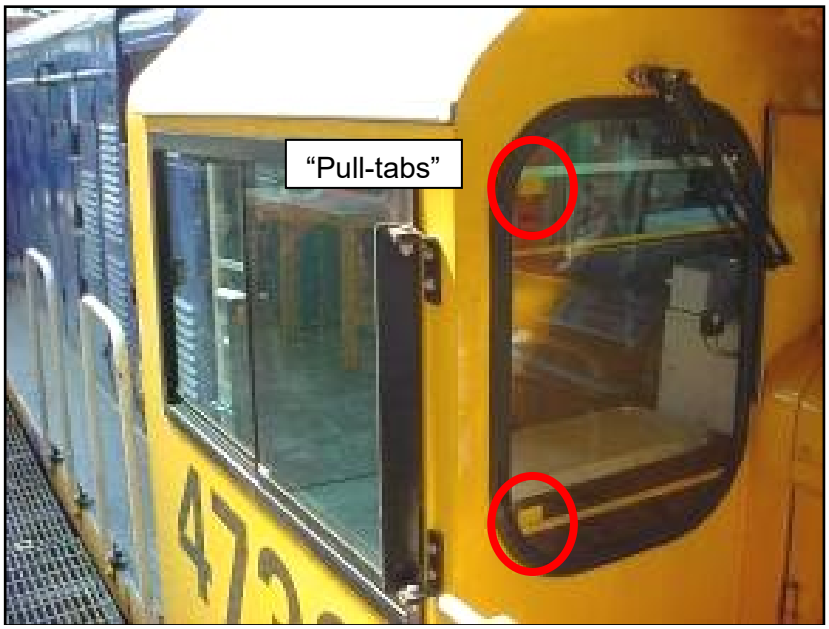
A handrail has been installed on the short hood for use in conjunction with the walkway handrail to assist in exiting through the window.

15.1.1 DC locomotive cab fitted with Gilbert sliding window

The front wall side window rubber key-strips have been fitted with top and bottom pull-tabs, with a label affixed to the inside of the window glass indicating the pull tab position.



Rail Operator's side



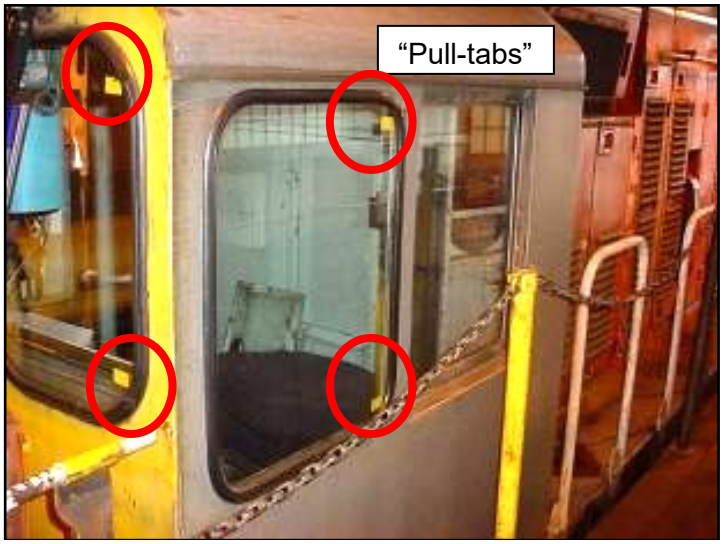
Locomotive Engineer's side

Process:

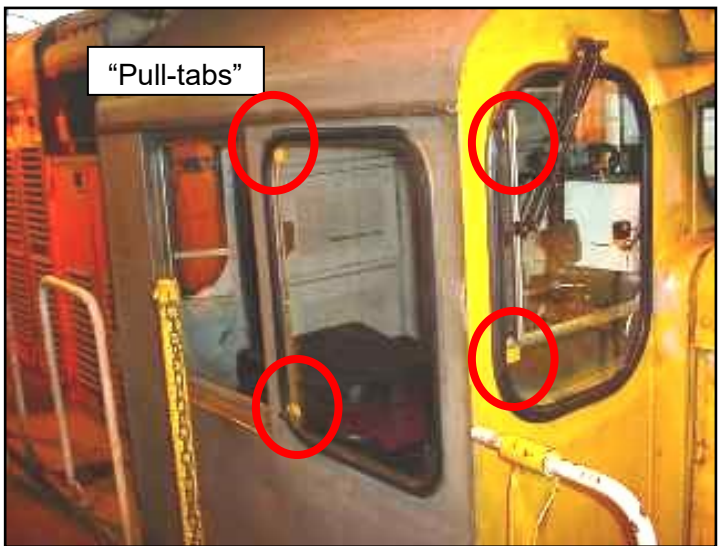
- Open the sliding window
- Reach around front pillar, grab pull-tab and pull out key-strip from window rubber.
- Removing the key-strip allows the window glass to be knocked or kicked out.
- Bend wipers arms clear of window opening.
- Seat covers can be used to cover edge of window openings.
- Use locomotive handrails to assist in exiting through the window.
- Handrails have been fitted to the short hood to assist in egress from window.

15.1.2 DC locomotive cab with OEM fixed pane and one sliding window

Both the fixed pane of the side-wall sliding windows and the front-wall side window are fitted with rubber locking key-strips. Rubber key-strips are fitted with top and bottom pull-tabs.



Rail Operator's side



Locomotive Engineer's side

Process:

- Pull-tab position labels on the inside of the window glass indicate the pull-tab positions.
- Remove the key-strip from side window allowing the window glass to be knocked or kicked out.
- After removing the side window glass, reach around to the front window and grab the pull-tab to pull out the key-strip. Knock or kick out the front window.
- Bend wipers arms clear of window opening.
- Seat covers can be used to cover the bottom edge of the window opening
- Use locomotive handrails to assist in exiting through the window.
- Handrails have been fitted to the short hood to assist in egress from window.

15.2 Fire Suppression System

15.2.1 Description

A fire suppression system is being fitted to DC locomotives. The system consists of 8 STAT-X aerosol generators and a linear heat detection wire that are located in the engine bay and 1 standalone temperature activated generator located in the electrical cabinet. A control module located in the electrical cabinet continually monitors the state of the linear heat detection wire and in the event of a fire the detection circuit is activated. The control module immediately shuts down the engine, the train line bell is sounded, the red alarm and shut-down LEDs are illuminated on the cab display panel, and the alarm buzzer sounds. There is a delay to allow the engine to come to a stop before the 8 STAT-X aerosol generators are discharged.
These will flood the engine bay with an ultra-fine potassium-based aerosol.

In the event of an electric cabinet fire, when the temperature reaches a set value, the STAT-X aerosol generator will discharge. The engine is not shut down and no warning is sounded.

The electrical cabinet or engine bay doors are not to be opened for at least 15 minutes, and when doing so a portable fire extinguisher must be on hand.

WARNING: Do not enter the engine bay until 15 minutes after all the aerosols have dispersed with the doors open.

15.2.1 Cab Equipment:

Manual Activation Switch: This is used to manually activate the STAT-X fire suppression system in the engine bay at any time. The engine will be shut down, the buzzer will sound, and the alarm and shutdown LEDs illuminated. To operate, remove pin and push in the RED knob.	
Audible Alarm: This is used to sound a fire alarm once every second, and fault conditions once every 10 seconds.	

Cab Display Panel:
Warning Indicators and Buzzer

1. POWER:
   Green – Normal condition
   Amber – Fault condition (alarm will sound every 10 seconds).
2. ALARM:
   Red – Fire condition (alarm will sound every second).
3. DISCHARGED:
   Red – Not used.
4. SHUTDOWN:
   Red – Engine shutdown initiated.
5. FAULT:
   Amber – System circuit fault (alarm will sound every 10 seconds).
6. ISOLATED:
   Amber – Panel has been isolated for maintenance purposes.

Dim Button: – Toggle operation for adjustment of display LED's intensity to suit daylight conditions.

Delay Button: – Not used.

Test Button: – Provides manual test of all visual indicators and audible alarms.

Delay / Test Button: – If a fault occurs enroute, these can be acknowledged by pressing the DELAY and TEST buttons at the same time. This will silence the audible alarm for 45 minutes but does not clear the fault.

NOTES:
Locomotives may only enter service when the POWER (Green) LED is illuminated, and all other LEDs are extinguished.

If a Fire Condition occurs enroute, the alarm will sound until the system is reset (by maintenance personnel), and the locomotive will need to be towed dead to a depot for repairs.

16.0 EVENT RECORDER / VIGILANCE

Reserved for future use

17.0 PROTECTIVE DEVICES

Reserved for future use

18.0 SAFETY INSTRUCTIONS

Reserved for future use

19.0 MISCELLANEOUS

Reserved for future use

20.0 DOOR OPERATION

Reserved for future use

21.0 RADIO / PUBLIC ADDRESS SYSTEM

Reserved for future use

22.0 TRAIN ATTENDANTS

Reserved for future use

23.0 TOWING

If it is necessary to tow the locomotive with the engine running and the BKS closed, the local CCB must be tripped before the locomotive is moved.

If the engine is shut down the BKS must be opened before towing is commenced.

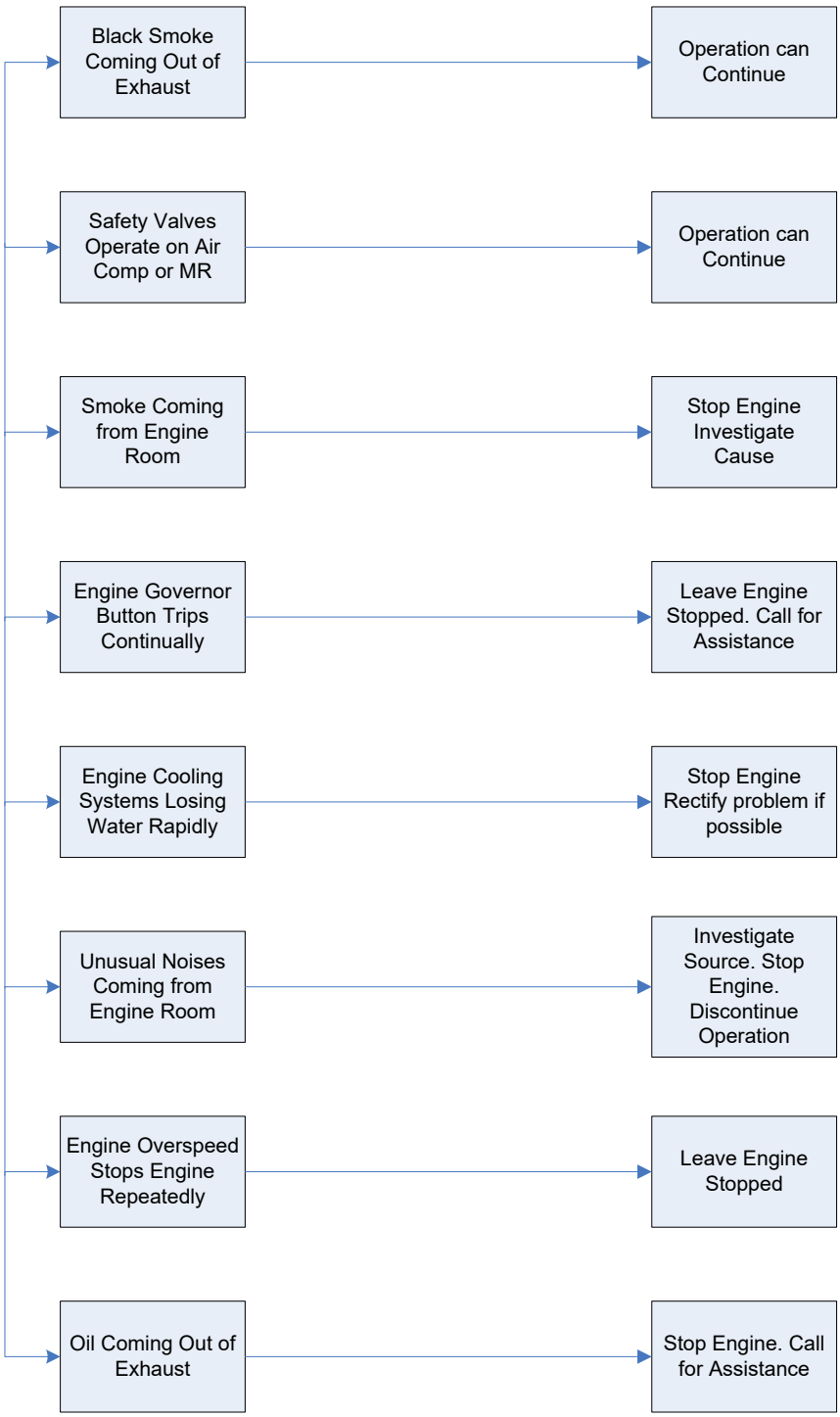
This instruction applies to those cases where it is necessary to move a locomotive into the depot as well as out on the main line. If this instruction is not observed serious flats on the tyres and possible motor damage could occur to the towed locomotive.

23.1 Towing Dead

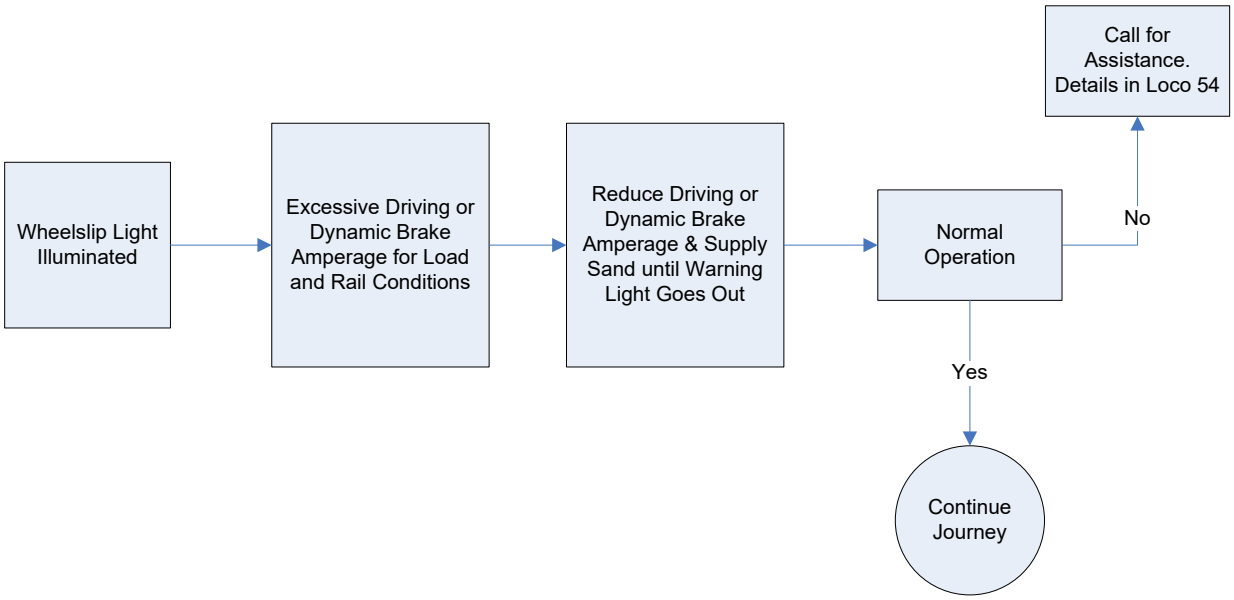
1. Set brake as per 26L brake instruction. (See Rail Operating Code, Section 4 for dead locomotive 3 pipe or BP only).
2. Stop engine.
3. Remove reverser.
4. Turn off all lights and heaters.
5. Turn off all switches and CB's.
6. Book locomotive 'prepared for towing' in Loco 54 repair book.

24.0 FAULTS

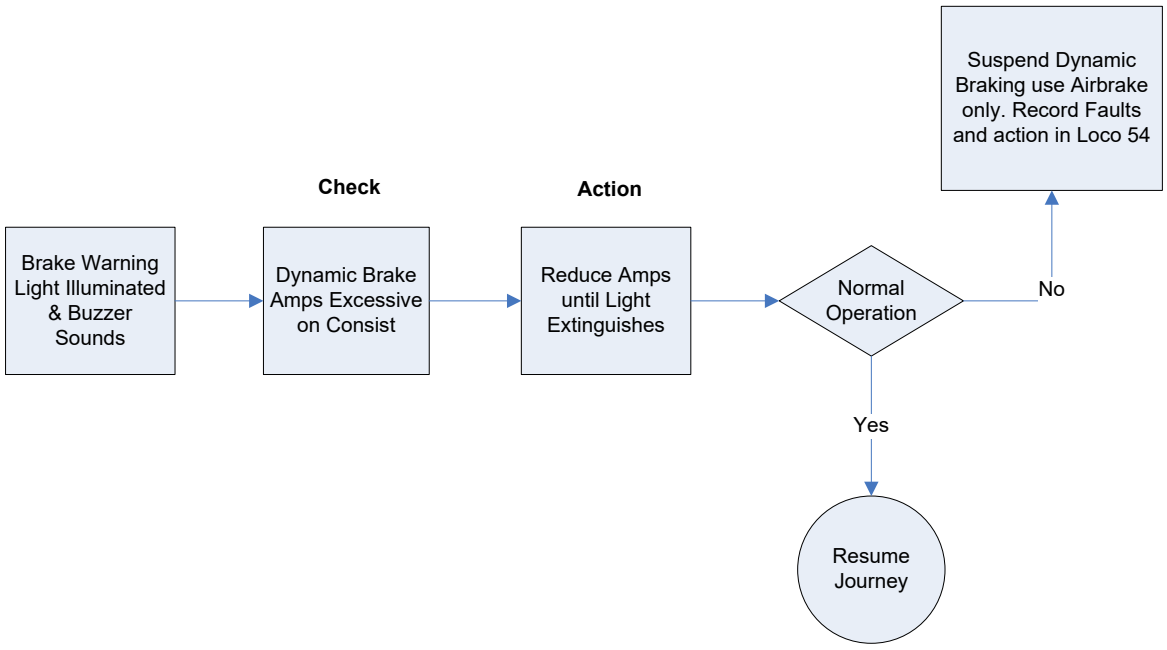
Unusual Operating Problems



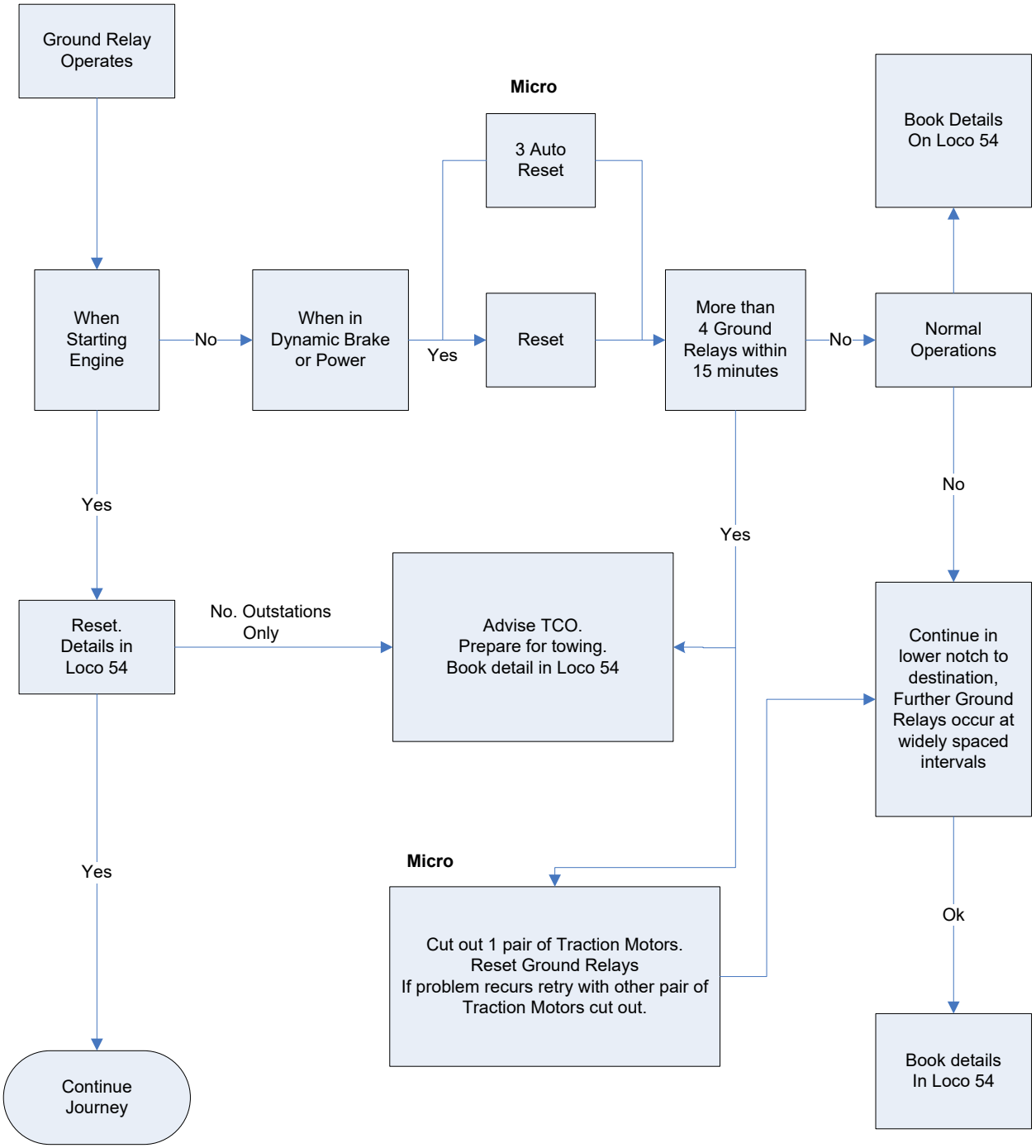
Wheelslip Light Illuminated



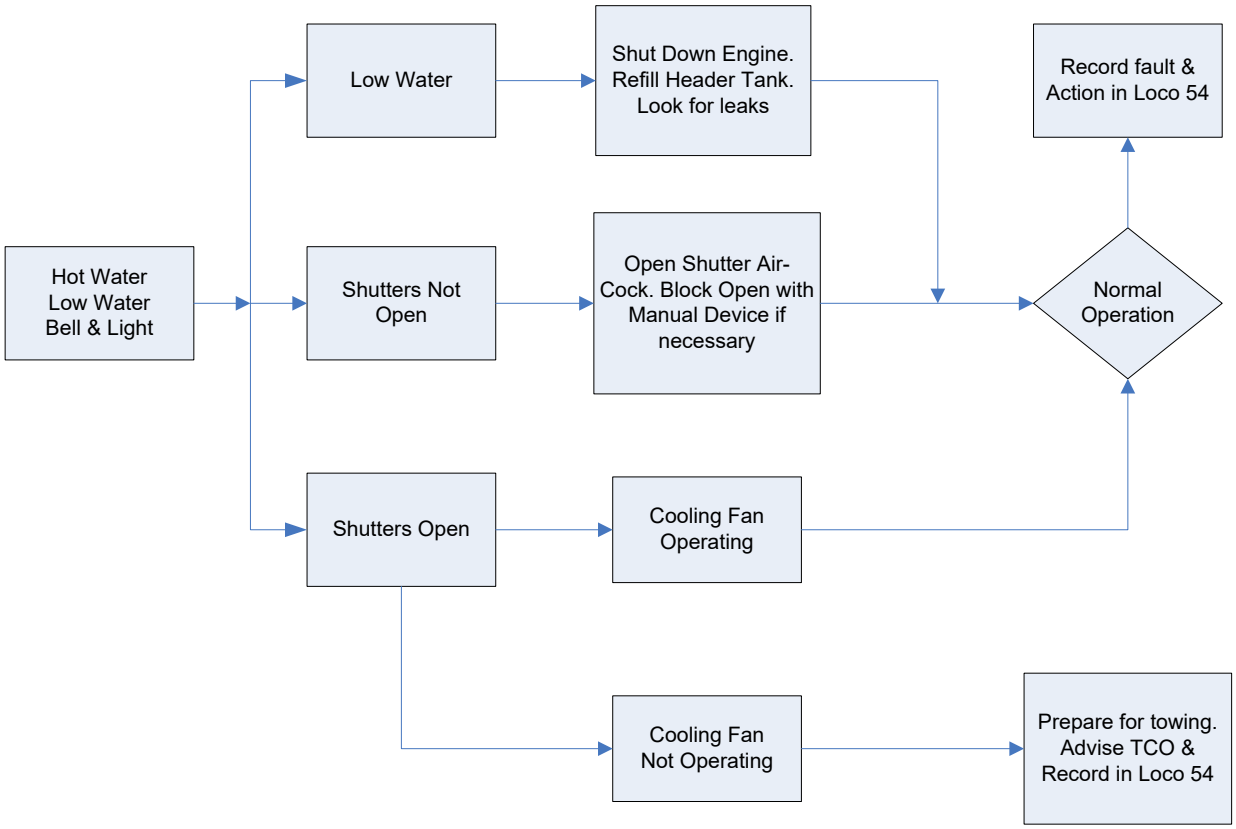
Brake Warning Light Illuminated



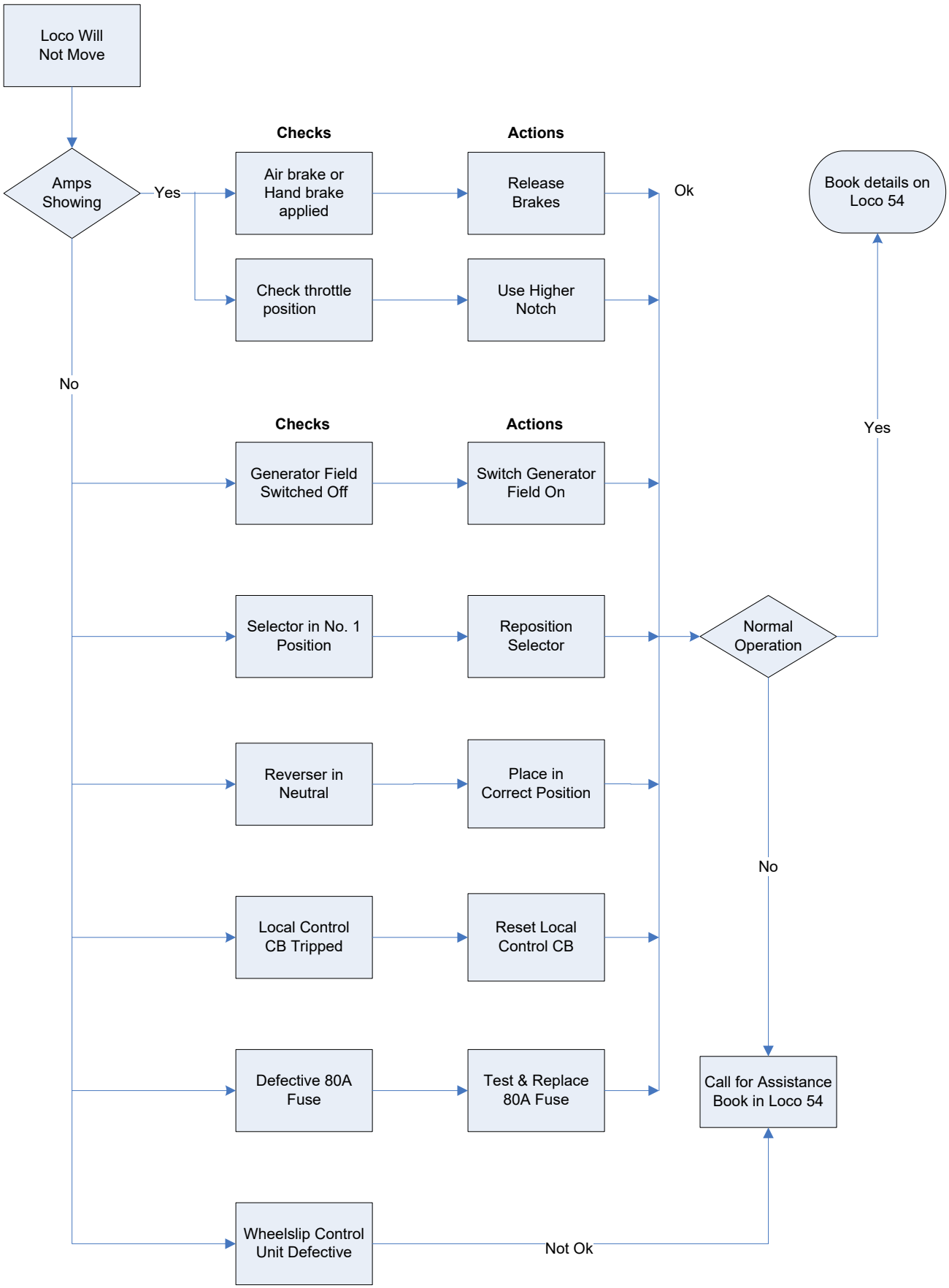
Ground Relay Operates



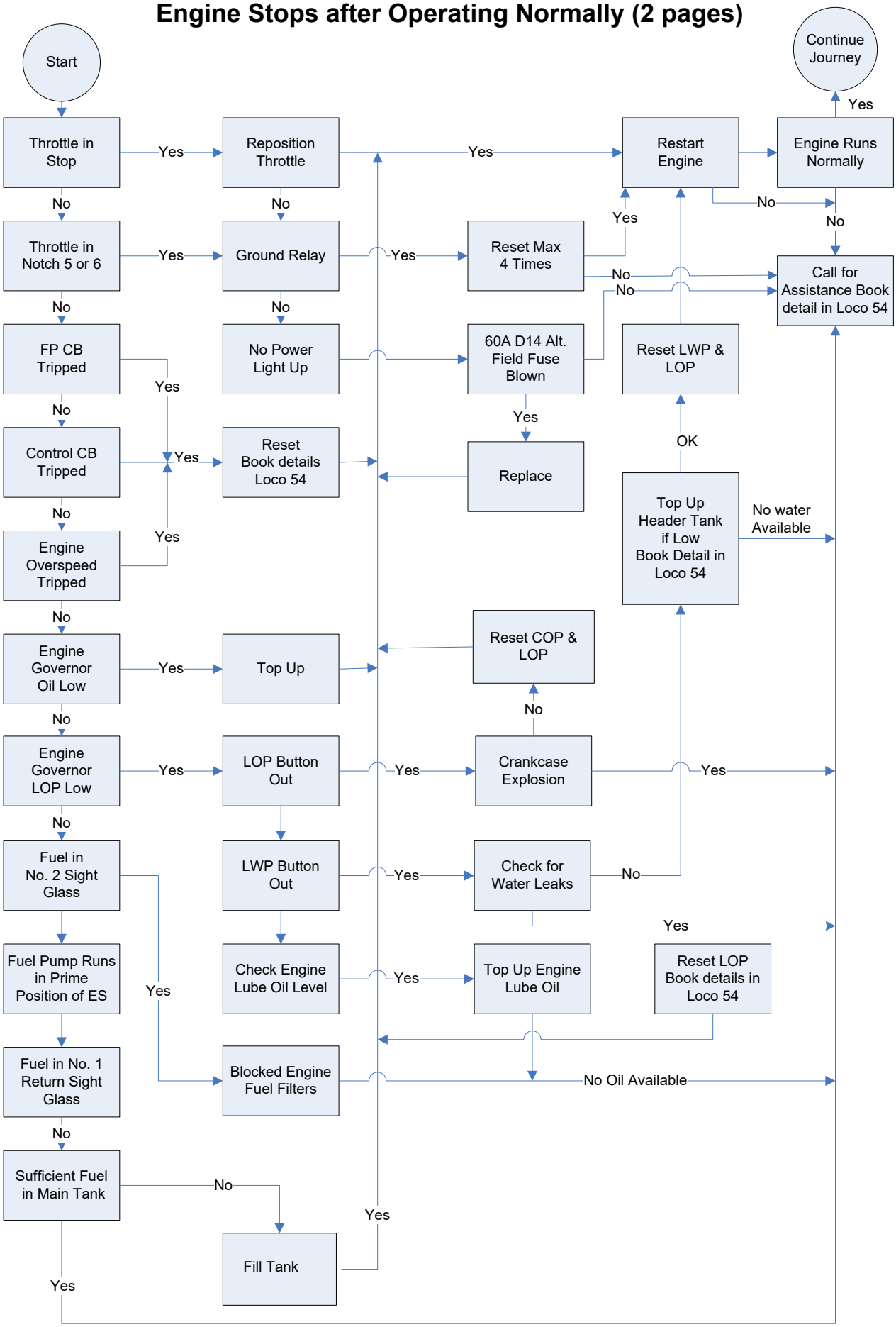
Hot Engine / Low Water Level



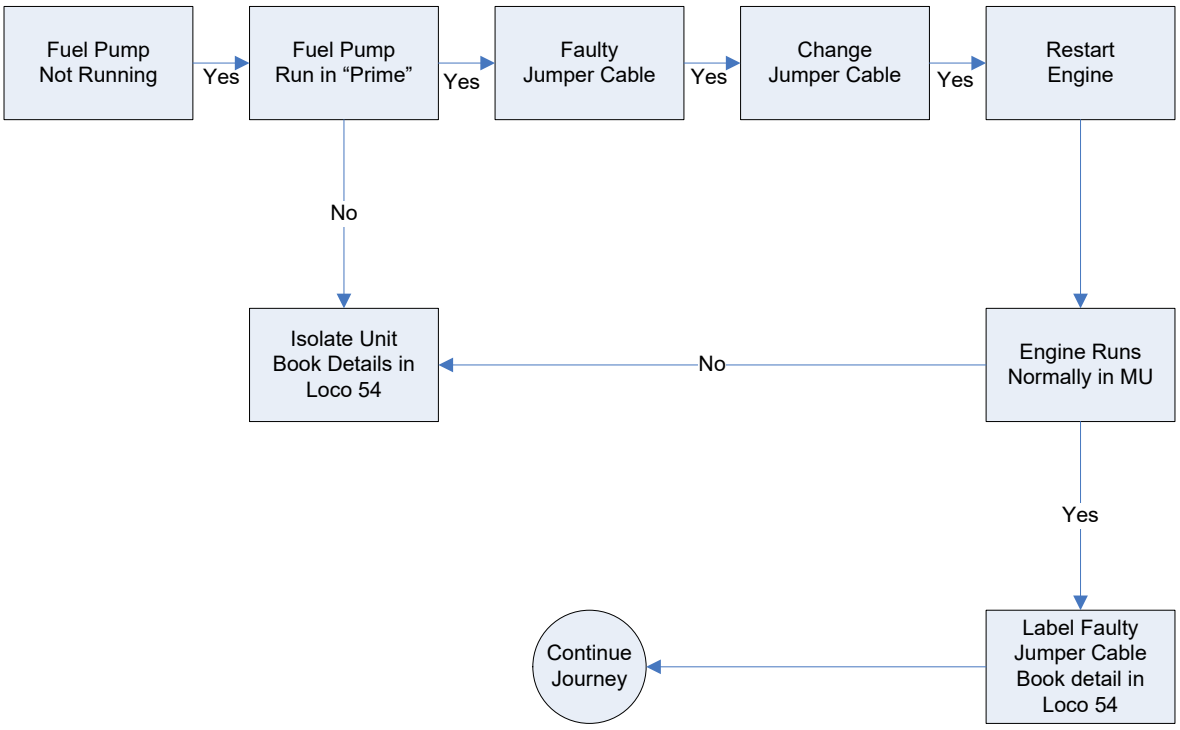
Engine Speeds Up.
Loco Fails to Move When Throttle Opened



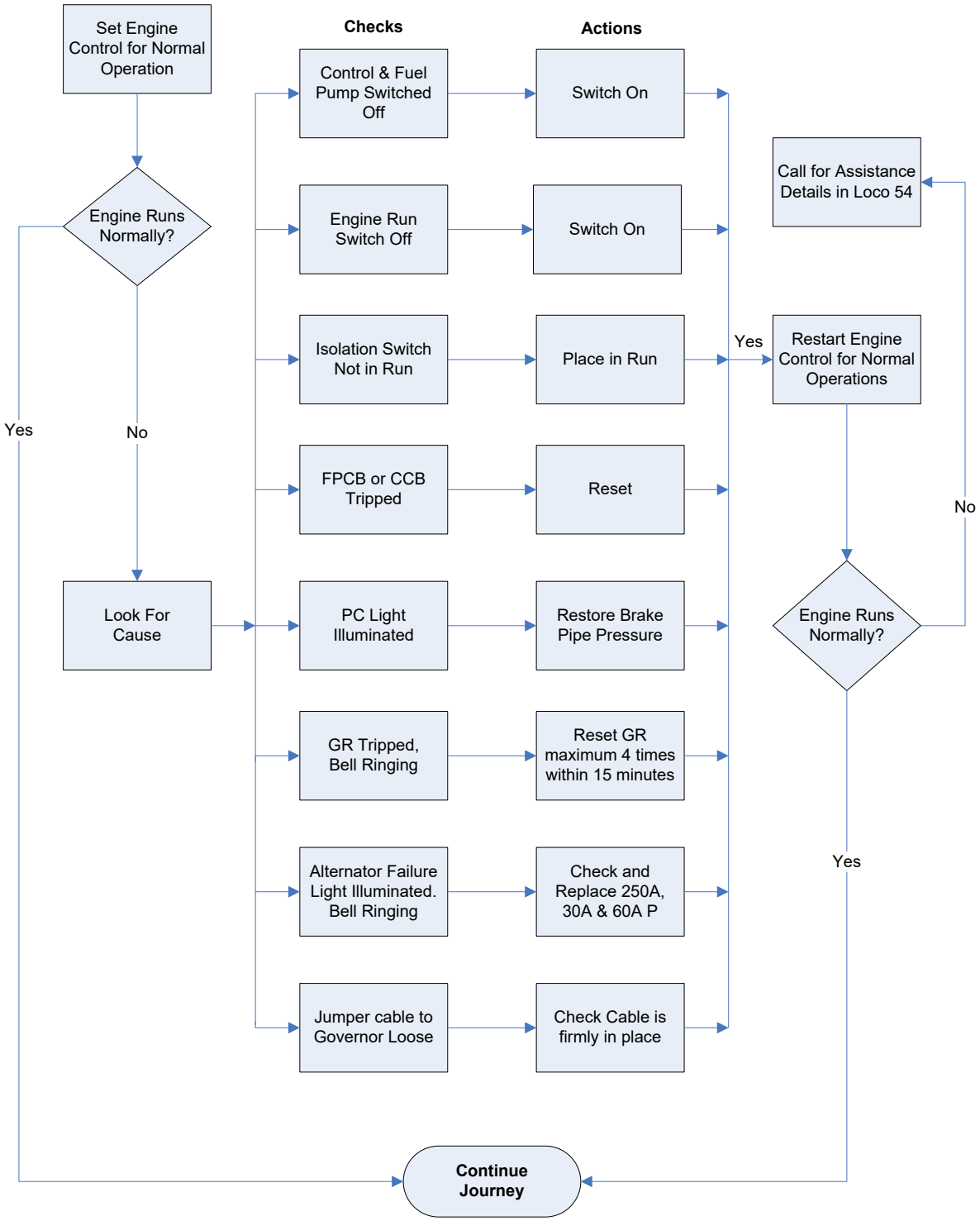
Engine Stops after Operating Normally (2 pages)



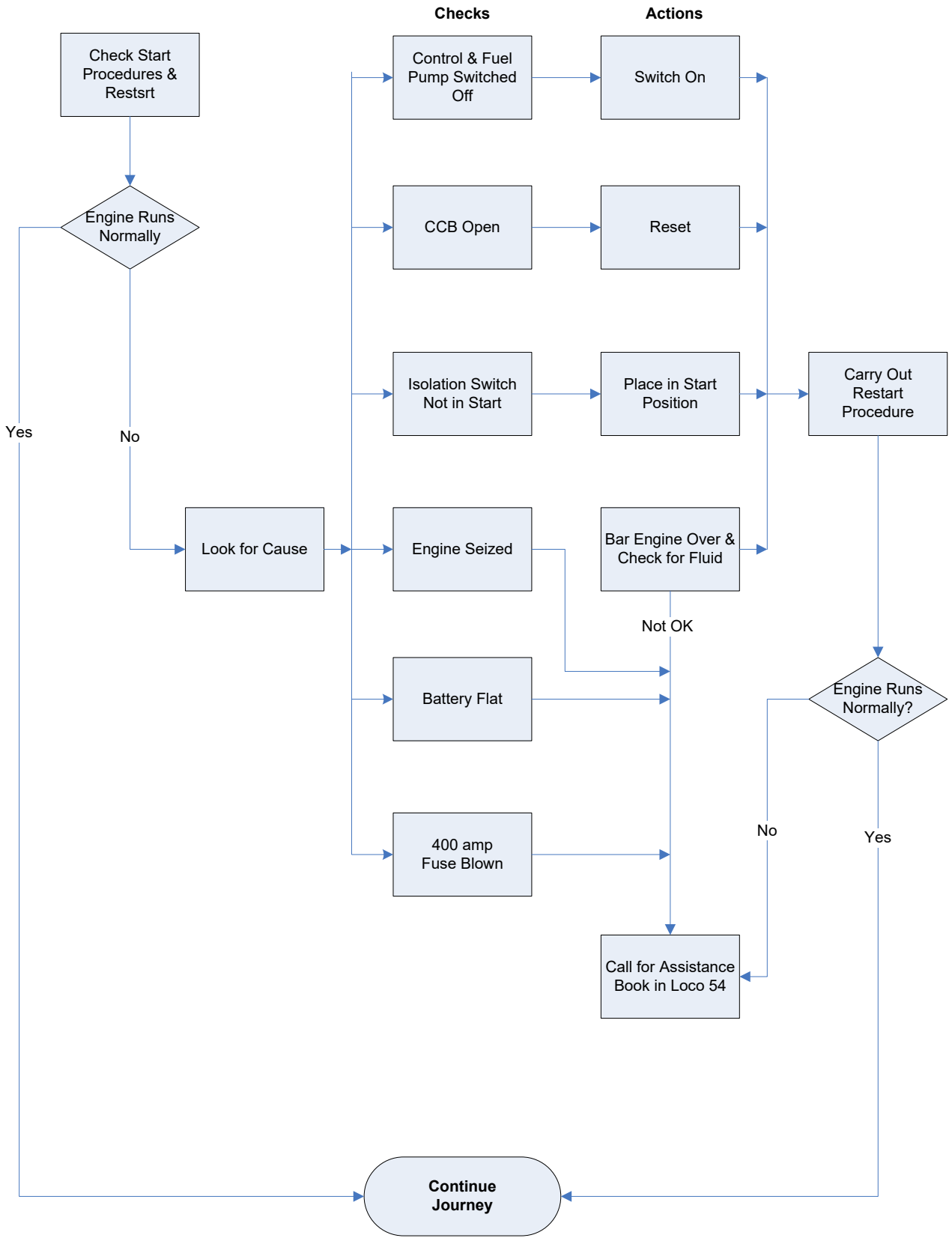
Engine Stops after Operating Normally (additional for GM loco in MU consist)



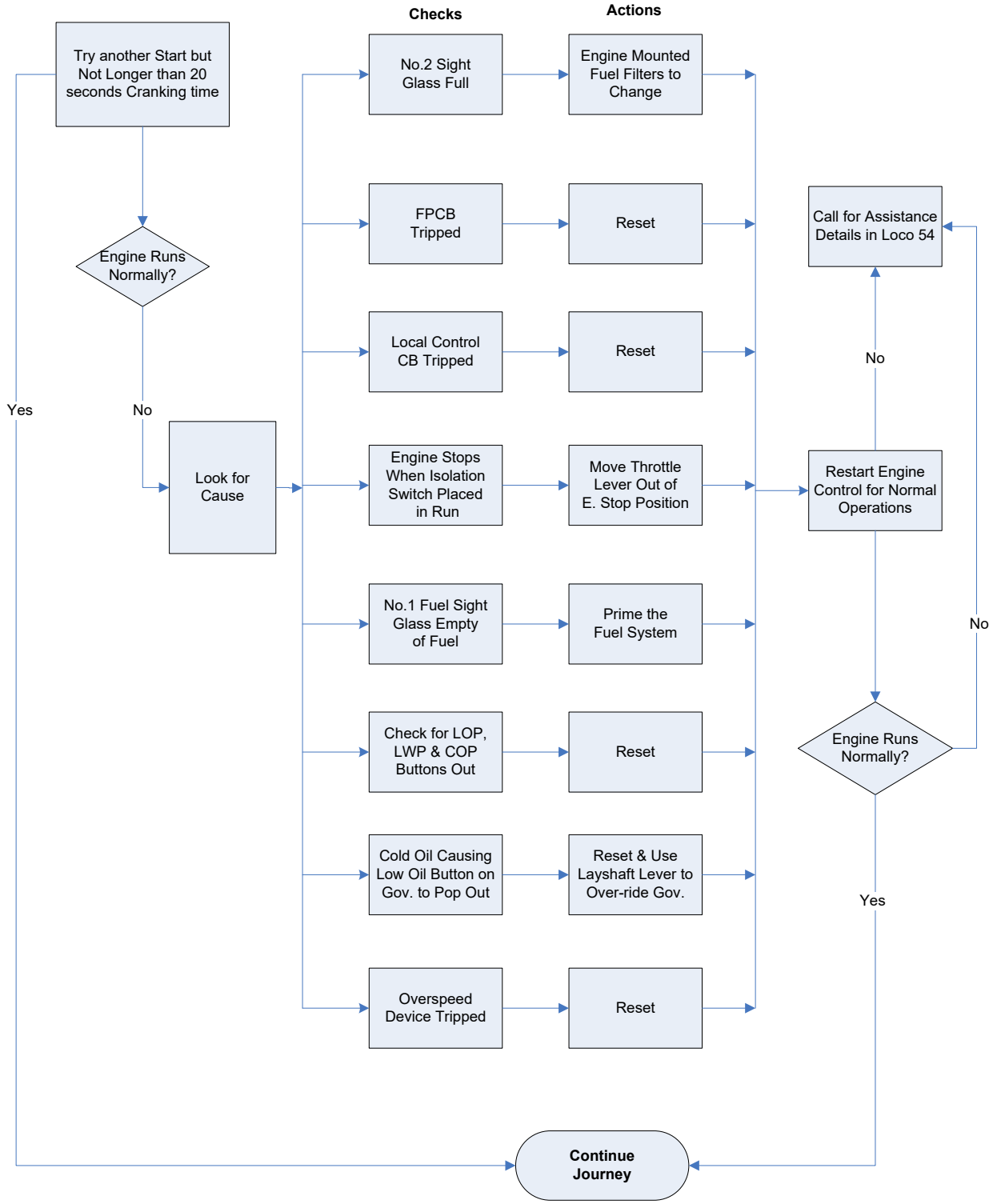
Engine Goes to Idle or Engine Fails to Speed Up When Throttle Opened



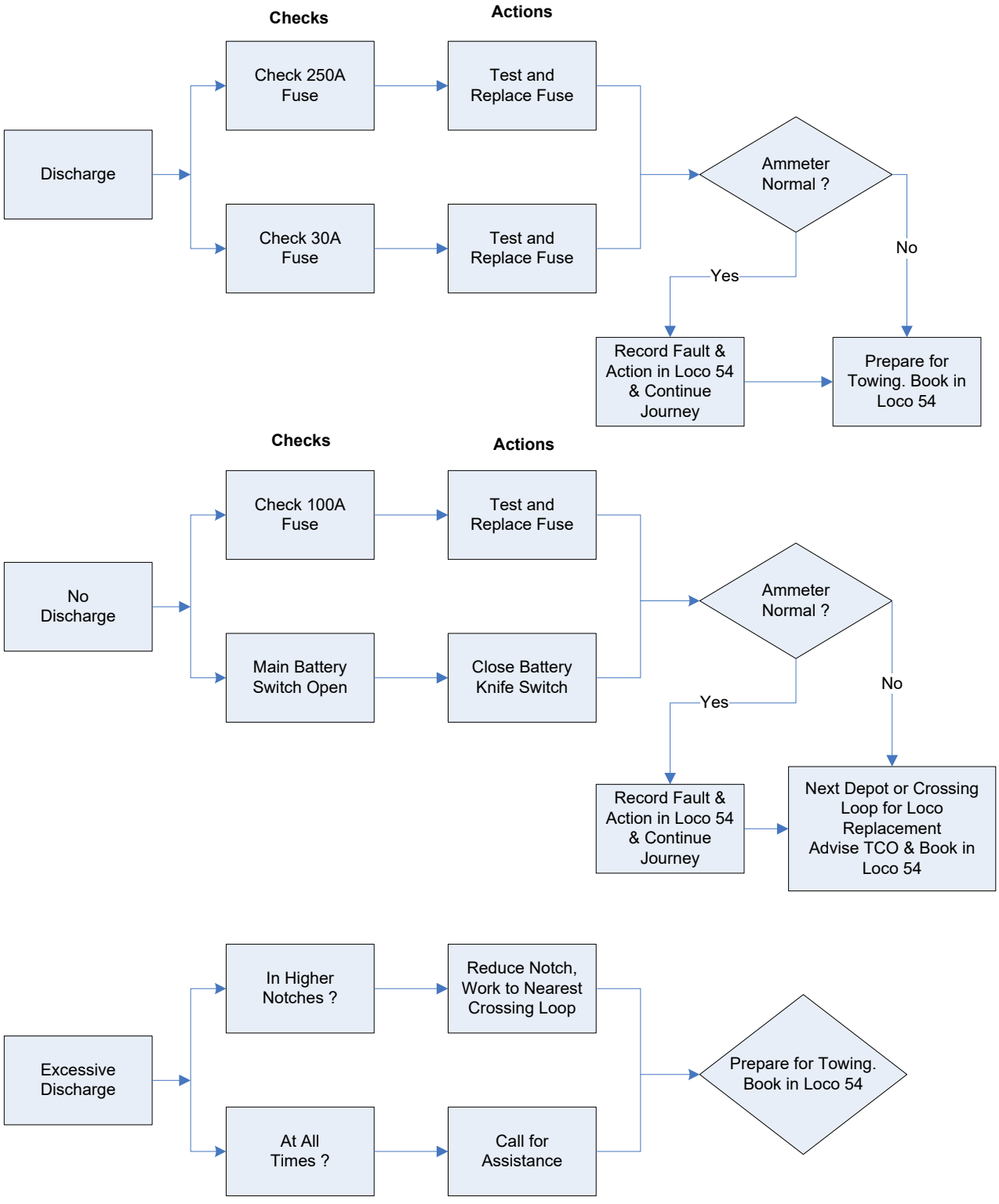
Engine Fails to Rotate



Engine Rotates But Fails to Fire
Engine Fires But Fails to Keep Running



Battery Ammeter Shows



Locomotive Road Overspeed