OPERATING MANUAL
QUEENSLAND RAILWAYS
2470 and 2170 CLASS
LOCOMOTIVES

CLYDE

MODEL GL22C-2 & GL26C-2
DIESEL ELECTRIC
LOCOMOTIVES

CLYDE
DIESEL ELECTRIC LOCOMOTIVES

Model GL22C-2 & GL26C-2

DESIGNED and POWERED By GENERAL MOTORS

THE CLYDE ENGINEERING COMPANY PTY. LIMITED
SYDNEY, N.S.W. AUSTRALIA

CLYDE ENGINEERING (Q'LAND) PTY, LIMITED
EAGLE FARM, QUEENSLAND, AUSTRALIA. 4007

in association with
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INTRODUCTION

This manual is written basically for locomotive operating crews and is compiled for the express purpose of instructing crewmen concerning the manufacturer's requirements for the operation of the Clyde Model GL22C-2 and GL26C-2 Diesel Electric Locomotives.

To obtain maximum benefit from the manual it is recommended that the sections be read in the sequence in which they occur.

No attempt has been made to include instructions on the repair and adjustment of equipment as repair information, in the form of Maintenance Instructions, is issued to the Railways Department for distribution to Locomotive Depots.

Information contained herein is supplementary to any instructions issued by the Operating Authorities for the operation of Clyde Model GL22C-2 and GL26C-2 Diesel Electric Locomotives.

The contents are divided into six sections as follows:

1. **General Description** – Provides a general description of the operation of the locomotive.
2. **Cab Controls** – Explains the functions of cab control equipment used in operating the locomotive.
3. **Starting and Stopping Engines** – Outlines the recommended procedure for starting and stopping the diesel engine and for establishing locomotive control.
4. **Operation** – Details the recommended procedures for operation of the locomotive.
5. **Locomotive Systems** – Explains the function of the various systems in the operation of the locomotive.
6. **Trouble Shooting** – Describes causes, location and correction of possible troubles which may develop during operation.

General Data relating to the Model GL22C-2 and GL26C-2 locomotive is included at the rear to this manual together with the general arrangement and other diagrams which may be unfolded to show the location of the major component parts of the locomotive mentioned in the text.

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SECTION 1

GENERAL DESCRIPTION

THE CLYDE ENGINEERING COMPANY PTY LIMITED, AUSTRALIA

"Home of the Diesel Locomotive"

GENERAL DESCRIPTION

INTRODUCTION

The locomotive is equipped with a Rootes blown diesel engine that delivers the power developed to the main alternator for tractive purposes.

This power is then distributed to six traction motors, each of which is directly geared to a pair of driving wheels.

The basic locomotive is arranged and equipped so that the short hood or cab end is considered the front or forward part of the unit. However, the locomotive operates equally well in either direction. On some models dual controls are provided.

The locomotive may consist of one or more individual units, each of which is a completely functional power plant. When coupled together for multiple unit operation, all can be simultaneously controlled from a single set of controls located in the cab of the lead unit. This is accomplished through jumper cables connected between the units.

A general arrangement of the locomotive is attached at the back of this manual. Each of the more important equipment components is numbered and identified.

HOW THE LOCOMOTIVE OPERATES:

1. The fuel pump is driven by an electric motor which, for fuel priming, uses current from the storage battery.

   Once the engine is started and running, the fuel pump motor uses current directly from the auxiliary generator.

   The fuel pump transfers fuel from the fuel tank under the locomotive to the engine injectors.

2. The diesel engine is started by means of two starter motors whose pinions engage a ring gear attached to the engine flywheel. The storage battery supplies the electric current to rotate the starter motors and start the engine.

3. All the power for the operation of the locomotive is developed from the fuel oil burned by a General Motors Model 645E two stroke cycle diesel engine.

   The engine has solid unit, fuel injection, is blower scavenged and operates at engine speeds ranging from 255 prm at low idle to 900 rpm at full load.

4. When the engine is running, it supplies mechanical power through shafts and couplings to directly drive three electrical machines (3 alternators), the air compressor, traction motor and generator blowers, the engine mounted lube oil and cooling water pumps, and the engine governor.
5. Over 90% of the power mechanically produced by the engine is converted to electrical power.

   The conversion is performed by an AR6 main traction alternator. This alternator generates high voltage AC which is converted to high voltage DC through a power rectifier assembly and delivered to the traction motors for locomotive pulling power.

   The auxiliary alternator furnishes 3 phase current to operate the two radiator cooling fans and provides a supply voltage for control purposes.

   A small amount of the engine power is converted by a 18KW auxiliary alternator, directly driven by the diesel engine, and rectified into low voltage direct current at approximately 74 volts. This power is used for charging the locomotive storage batteries, for exciting the companion alternator and for the operation of the control, lighting and locomotive accessory circuits (hotplates and cab heaters).
6. By means of the cab controls, low voltage circuits are established to actuate the engine governor and the switchgear in the electrical cabinet. This switchgear controls alternator excitation and distribution of electrical power to the traction motors.
7. Six traction motors are located under the locomotive. Each traction motor is directly geared to an axle and pair of driving wheels. These motors are mounted in two trucks which support the locomotive weight and distribute it to the driving wheels. The motors convert the electrical power to mechanical power for propelling the locomotive.
8. The electrical power produced at the main traction alternator is then distributed to the six traction motors through circuits established by various power switchgear components located in the electrical cabinet.

   Traction motor field shunting is used so that full power may be obtained from the traction alternator over the full locomotive speed range.

9. The driver's throttle electrically controls the diesel engine speed and power output in two ways:

   Firstly, when opened to notch 1, main traction alternator excitation is established and current is transmitted to the traction motors. Secondly the subsequent running notches actuate the engine mounted governor and cause an increase in engine speed for each successive notch.

   This operation increases the pulling power of the locomotive. At locomotive start, as the throttle is advanced, main traction alternator exitation and output is increased, the throttle response module operates to provide a controlled application of power, with a specific output being available for each operating notch of the throttle.

   In the multiple unit operation these controls pass through the Jumper Coupling connecting the units enabling the engines and alternators in all units to be operated from the one driver's controller.

10. A load regulator automatically maintains power output at a level consistent with engine speed, through the entire speed range of the locomotive.

    Thus the engine is never overloaded or underloaded.

11. The locomotive is equipped with a Gardner Denver 3 cylinder, two stage water cooled compressor, directly driven by the diesel engine through a shaft, to which it is flexibly coupled.

    The air compressor supplies, to the reservoirs, air under pressure, used primarily for the air brakes which are controlled by the operator through suitable equipment in the cab.

    Compressed air is also used for operation of sanding equipment, warning horn, windscreen wipers and flange lubricators which are fitted to some locomotives.

12. Dynamic braking can be selected to retard train speed in many phases of locomotive operation.

    A fan for cooling roof mounted dynamic brake grids is driven by direct current generated by traction motors when the dynamic brake is in operation.

13. Except for manual operation of the cab controls, the locomotive operation is completely automatic. Various alarms and safety devices will alert the operator should any operating difficulties occur.

FIELD SHUNTING

Two types of traction motor electrical circuit connections are used so that full power may be obtained at all times from the main traction alternator within its voltage range.

1. PARALLEL – For starting, heavy pulling and normal running. Six motors in parallel.
2. PARALLEL with 63% SHUNTING of traction motor fields for higher speed.

SECTION 2

ENGINE STARTING AND CAB CONTROLS

THE CLYDE ENGINEERING COMPANY
PTY LIMITED, AUSTRALIA

"Home of the Diesel Locomotive"

ENGINE STARTING AND CAB CONTROLS

INTRODUCTION

A switch for fuel priming and engine cranking is located at the equipment rack in the engine room. All other basic control equipment used during locomotive operation is at three locations in the cab.

1. Distribution and switch and circuit breaker panels which are located in the electrical cabinet behind the door marked "Stop and Isolation Switch."
2. The Locomotive Control Stands.
3. The Air Brake Pedestals.

Each are illustrated in diagrams at the rear of this manual.

ENGINE STARTING CONTROLS

This switch located on the equipment rack in the engine room is a three position rotary switch used for fuel priming and engine starting. Before attempting to start the diesel engine the isolation switch in the electrical cabinet must be placed in the START position. The rotary switch must then be placed in the Fuel Prime position and held there for approximately 25 to 30 seconds to operate the fuel pump and purge the fuel system of air. With the layshaft lever manually opened to half rack or more, the rotary switch is turned to the engine start position and held (for no longer than 20 seconds) until the engine starts.

Locomotives 2181 to 2213 are fitted with an Engine Purge System which alleviates the necessity of barring the engine over after an extended shut down period. Starting on these locomotives is the same as in the previous paragraph except that cranking speed will be low for the first few seconds (approx 6) during which time the operator must pull back on the lay shaft to prevent the engine starting. If Engine Fails to crank or starting Fuse Blows during Purge cycle, REPORT FAILURE.

LAYSHAFT LEVER

This engine mounted hand operated lever operates the injector racks. It is used to open the injector racks during engine starting, thereby providing an immediate supply of fuel to the cylinders. It may also be used to shut the engine down by closing the racks manually.

LOW WATER RESET PUSH BUTTON

The low water detector will often trip during engine starting, especially when the engine is cold or when the water tank pressure cap has been removed to add water. The detector should be reset as soon as the engine starts and is idling, or else the engine will shut down after a time delay established by the governor.

NOTE: Check the low water reset push button after every engine start. The reset buttons on some detectors will not latch in when the engine is shut down. If such a condition is encountered, reset the device after engine start.

CAB CONTROLS

DISTRIBUTION PANEL

The Distribution Panel has the following equipment:

Auxiliary Alternator Field 60-ampere Fuse

The auxiliary alternator receives its excitation through a pair of slip rings connected to the low voltage DC auxiliary alternator output. To protect these windings, a 60-ampere fuse is provided in the excitation circuit. This fuse must be serviceable and in place at all times during locomotive operation.

In the event that the fuse is blown, alternator excitation and resulting power ouput will cease, giving an alternator failure light, audible alarm and reduce the engine speed to idle, when the Isolation Switch is in RUN position.

Ground Relay Cutout Switch

The purpose of the ground relay cutout switch is to eliminate the ground protective relay from the locomotive circuits during certain shop maintenance inspections. It MUST ALWAYS BE KEPT CLOSED in normal operation, otherwise the protection offered by the ground relay will be nullified and possible serious equipment damage could occur. It may be opened, however, in the event of extreme emergency upon receipt of definite instruction to that effect from a responsible officer of the department.

Fuse Test Equipment

To facilitate the testing of fuses, a pair of fuse test blocks, a test light and a test light toggle switch are installed on the fuse panel.

Fuses may be readily tested as follows. First, move the toggle switch to the ON position to make sure the fuse test light is not burned out. Extinguish the light by moving the toggle switch to the OFF position. Place a fuse across the test blocks so that the metal ends of the fuse are in firm contact with the blocks. If the fuse is good, the light will come on. If the fuse is burned out, the light will not come on and a new fuse is required.

It is always advisable to test fuses before installing them in their circuits. Always isolate the circuits in question by opening their switches before changing or replacing fuses.

Spare fuses are located on inside of panel door.

Starting 400-ampere Fuse

The starting fuse is in use only during the period that the diesel engine is actually being started. At this time, battery current flows through the fuse and starting contactors to the cranking motors.

Although this fuse should be in good condition and always left in place, it has no effect on locomotive operation other than for engine starting. A defective fuse can be detected when attempting to start the engine, since at that time (even though the starting contactor closes) the cranking circuit is open.

See special note in Trouble Shooting, Section 6.

Main Battery Knife Switch

The large double-pole single-throw knife switch at the lower portion of the fuse panel is the main battery switch. It is used to connect the battery to the locomotive low voltage system and should be kept closed at all times during operation.

This switch may be opened during certain shop maintenance procedures and in instances where the engine is shut down and the locomotive taken out of service for an extended layover. This will prevent the battery from being discharged in the event of the lights or other low voltage devices inadvertently left operating during the layover.

If this switch were left open, the fuel pump could not be operated, the lights would not function and the engine could not be started. If the switch is opened after the engine has been started, the auxiliary generator will continue to supply the low voltage needs, but the batteries will not receive charge.

CIRCUIT BREAKER PANEL

This panel is located adjacent to the distribution panel.

Lights Circuit Breaker

This circuit breaker must be ON to supply power for the individual switches provided for cab, step, engine room, class, ground and gauge lights, number lights and draft gear lights.

Headlight Circuit Breaker

This circuit breaker must be ON to supply current to headlights which are further controlled by selector switches on the control stand.

Local Control Circuit Breaker

This circuit breaker must be in the ON position before operation of the locomotive is possible. During operation it establishes "local" power from the auxiliary alternator to operate heavy duty switchgear, and various control devices.

Control Circuit Breaker

This circuit breaker must be in the ON position before locomotive operation is possible. It sets up the fuel pump and control circuits for engine starting. Once the engine is running, power is supplied through this breaker from the auxiliary alternator to maintain operating control.

Fuel Pump Circuit Breaker

The fuel pump circuit breaker must be ON for operation of the fuel pump either during starting or normal running of the engine.

Locotrol Circuit Breaker

This circuit breaker permits the locomotive to be used as a remote unit in conjunction with locotrol radio control equipment.

Brake Transfer Control Circuit Breaker

This circuit breaker supplies auxiliary generator power to drive the motor brake transfer switch motor. This motor sets up circuits for either power or dynamic braking.

Motor Reversing Control Circuit Breaker

This circuit breaker allows power from the auxiliary generator to drive the motor reversing transfer switch motor. This motor drives the transfer switches for forward or reverse operation of the traction motors.

Module Control 5-ampere Circuit Breaker

This circuit breaker must be ON to supply power to the modules.

AC Control 15-ampere Circuit Breaker

This circuit breaker must be ON before operation of the locomotive is possible. It establishes power from the auxiliary alternator to the modules and various control and protection circuits.

Auxiliary Generator Field Circuit Breaker

The field excitation circuit of the auxiliary alternator is protected by this circuit breaker. This circuit breaker must be ON during locomotive operation. Tripping of this circuit breaker will stop auxiliary alternator output to the low voltage system and stop fuel pump operation. An Auxiliary Alternator failure light and alarm will occur. The engine will return to idle speed and eventually stop from lack of fuel.

Auxiliary Generator Output Circuit Breaker

This circuit breaker connects the auxiliary generator output to the low voltage system and protects against excessive current demands. A tripped circuit breaker stops fuel pump operation and an Auxiliary Generator/Alternator failure light and alarm will occur. The engine will return to idle speed and eventually stop from lack of fuel.

Generator Field Circuit Breaker

The main alternator receives its excitation through a pair of slip rings connected to the auxiliary alternator output through a controlled rectifier. The circuit breaker is provided to protect the controlled rectifier and the alternator field windings. A tripped circuit breaker will result in a complete loss of power.

Engine Stop Pushbutton

The diesel engine will stop whenever the engine stop pushbutton is pressed. The action of the pushbutton is immediate, therefore it need not be held in until the engine stops.

OCP Reset Switch

This sealed switch will reset the detection circuit for an open circuit condition in the dynamic brake grid circuit and as such should only be operated by authorised personnel when the fault has been rectified.

Miscellaneous Circuit Breakers

Circuit Breakers are included for Cab Heaters and hot plate. The circuit breakers should be placed in the ON position to obtain the desired operation.

Isolation Switch

The isolation switch has two positions, one labelled START, the other labelled RUN. The functions of these two positions are as follows:

1. START Position

   The isolation switch is placed in this position whenever the diesel engine is to be started. The start switch is effective only when the isolation switch is in this position.

   The START position is also used to isolate the unit, and when isolated the unit will not develop power or respond to the controls. In this event the engine will run at low idle regardless of throttle position. This position will also silence the alarm bell in the event of ground relay and alternator failure. It will not, however, stop the alarm in the event of engine protector operation, low oil pressure or hot engine.

2. RUN Position

   After the engine has been started, the unit can be placed "on the line" by moving the isolation switch to the RUN position. The unit will then respond to control and will develop power in normal operation.

Emergency Switch

This three position switch is used in the event of Voltage Regulator Module (VR11), Auxiliary Generator or Auxiliary Alternator failure. Its function is explained in Section 6, Trouble Shooting, fault 11.

ACCESSORY PANEL

The accessory panel is located at the centre of the Electrical Cabinet and contains the following items:

(a) Battery Charging Meter

With the main battery knife switch closed, the battery charging ammeter is connected into the low voltage circuits to indicate the extent of current flowing to and from the storage battery. This meter does not indicate the output of the auxiliary generator. The ammeter may show a high charge immediately after starting but should reduce to zero and in normal running should read zero or show a slight charge.

A very strong discharge at time of engine shutdown, followed by blown fuses, indicates a shorted battery charging rectifier. When very strong discharge is indicated, exercise care opening the main battery switch.

(b) Auxiliary generator/alternator failure indicating light.

(c) Ground Relay indicating light.

(d) Hot Engine indicating light.

(e) Fire Alarm indicating light.

(f) Compressor and Engine Protection indicating light.

(g) Test light.

(h) Detonator Sensing Device Reset and Isolation Switch.

(i) Fire Alarm Cancel Switch.

LOCOMOTIVE CONTROL STAND

The locomotive controller contains the switches, gauges and operating levers used by the operator during operation of the locomotive. The individual components of the controller are described, together with their functions, in the following paragraphs.

AIR GAUGES

Air gauges indicating main reservoir, equalising reservoir, brake pipe, and brake cylinder pressures and a brake pipe flowmeter are prominently located along the top of the controller.

Load Current Indicating Meter

The locomotive pulling force is indicated by the centre zero current indicating meter. Readings to the right of the centre zero indicate current flowing from the main generator to the traction motors in the power condition, the maximum reading on this scale being 800.

The meter is connected so as to indicate the current flowing through the No. 3 traction motor. Since the amperage is the same in all motors, each motor will carry the amount shown on the meter. Since the traction motors receive the power from the main alternator, the meter reading may be multiplied by six to determine the approximate alternator output.

During dynamic brake operation the meter will indicate traction motor armature current (braking force) to the left of the centre zero.

The meter should seldom if ever indicate in the red band.

Operating Switches

A group of switches is located along the front face of the controller, each identified by a name plate indicating switch function. The switches are in the ON position when moved upward.

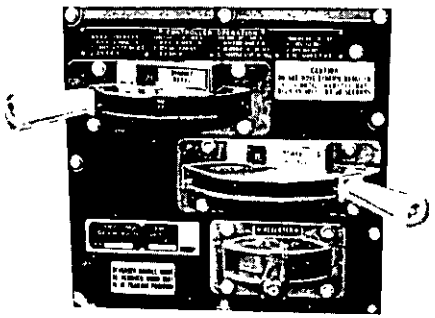
Before the engine is to be started, the control and fuel pump switch and the engine run switch must be placed ON. To obtain power from the locomotive, the generator field switch must be ON and brake pipe pressure must be in excess of 413kPa the pick up value of the PKS.

These three important switches are grouped at the right side of the controller. They must be placed in the OFF position on controllers of trailing units and the second control stand (where fitted) on lead unit.

Other switches control cab fan, cab heater, manual power control, headlights "bright" and various lights. They are placed on as required.

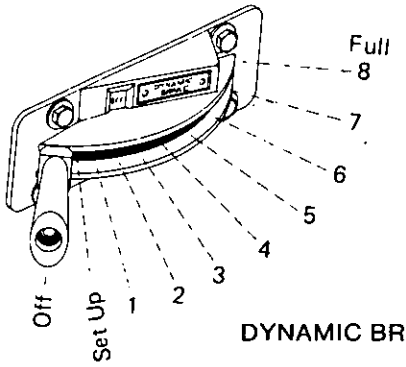
CONTROLLER

The following operating handles are located on the controller panel.



Dynamic Brake Handle

A separate handle is provided for control of dynamic brakes. It is uppermost on the controller panel and is moved from left to right to increase braking effort. The handle grip is somewhat out-of-round with the flattened surfaces vertical to distinguish it from the throttle handle, which has its flattened surfaces horizontal. The brake handle has two detent positions; OFF and SETUP, and an operating range 1 through FULL 8, through which the handle moves freely without notching. Mechanical interlocking prevents the dynamic brake handle from being moved out of the OFF position unless the throttle is in IDLE and the reverser is positioned for either forward or reverse operation.



DYNAMIC BRAKE HANDLE

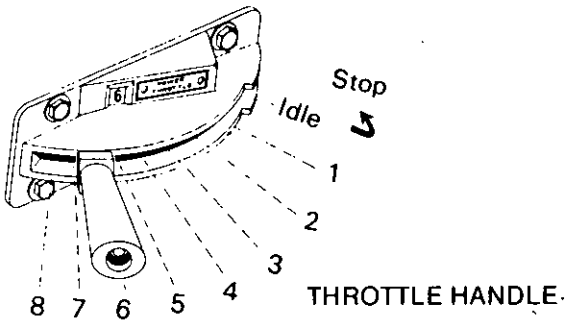
CAUTION: During transfer from power operation to dynamic braking, the throttle must be held in IDLE for 3 seconds before moving the dynamic brake handle to the SET UP position. This is to eliminate the possibility of a sudden surge of braking effort with possible train run-in or motor flashover.

Throttle Handle

The throttle handle is located just below the dynamic brake handle. It is moved from right to left to increase locomotive power. The handle grip is somewhat out-of-round, with the flattened surfaces horizontal to distinguish it from the dynamic brake handle. The throttle has nine detent positions; IDLE, and 1 through 8 plus a STOP position, which is obtained by pulling the handle outward and moving it to the right beyond IDLE to stop all engines in a

locomotive consist. Mechanical interlocking prevents the throttle handle from being moved out of IDLE into power positions when the dynamic brake handle is advanced to SET UP or beyond, but it can be moved into STOP position to stop all engines in the consist. The throttle can not be moved when the reverser handle is centred and removed from the controller.

NOTE: The STOP throttle position will not shut an engine down unless the isolation switch is in RUN.



Reverser Handle

The reverser handle is the lowest handle on the controller panel. It has three detent positions; left, centred and right. When the handle is moved to the right toward the short hood end of the unit, circuits are set up for the locomotive to move in that direction. When the handle is moved to the left toward the long hood end, the locomotive will move in that direction when power is applied. With the reverser handle centered, mechanical interlocking prevents movement of the dynamic brake handle, but the throttle handle can be moved. In such case, power will not be applied to the traction motors.

The Reverser handle is centered and removed from the panel to lock the throttle in IDLE position and the dynamic brake handle in OFF position.

MECHANICAL INTERLOCKS ON THE CONTROLLER

The handles on the controller are interlocked so that:

1. With reverser handle in neutral (centred)

a. Dynamic brake handle can not be moved out of OFF position.

b. Throttle can be moved to any position.

c. Reverser handle can be removed from controller if throttle is in IDLE position.

2. Reverser handle in forward or reverse –

a. Throttle can be moved to any position if dynamic brake handle is in OFF position.

b. Dynamic brake handle can be moved to any position if throttle is in IDLE position.

3. Reverser handle removed from controller –

a. Throttle locked in IDLE position.

b. Dynamic brake handle locked in OFF position.

4. Throttle in IDLE position –

a. Dynamic brake handle can be moved to any position if reverser is in forward or reverse position.

b. Reverser handle can be placed in neutral, forward, or reverse position if dynamic brake handle is in OFF position.

5. Throttle above IDLE position –

a. Dynamic brake handle can not be moved.

b. Reverser handle can not be moved.

6. Dynamic brake handle in OFF position –

a. Throttle can be moved to any position.

b. Reverser handle can be moved to any position if throttle is in IDLE position.

7. Dynamic brake handle moved out of OFF position –

a. Throttle can not be moved out of IDLE position into power positions, but can be moved into STOP position.

b. Reverser handle can not be moved out of forward or reverse into OFF position.

Headlight Control Switch

A four position switch is located on the controller below the fault indicator light panel. In one position it provides for dim headlights on both ends of the locomotive. In the other two positions it provides for a dim headlight at either the front or rear of the locomotive. The fourth position is Off.

For this switch to function, the headlight circuit breaker on the circuit breaker panel most be placed ON. In addition a "headlight bright" switch on the controller gives bright headlights as selected by the four position switch.

Dynamic Brake Circuit Breaker

This circuit breaker must be ON to obtain dynamic brake and can be used when operating in M.U. to isolate a locomotive with faulty dynamic brake.

Cab Heater Control Switch

A switch located on the switch panel of both control stands operates heaters in the base of each stand. Air flow through the heaters can be controlled by operating a slide type shutter located at floor level on each stand. This must be opened before turning on heater switch.

Lamp Test Switch

This switch located adjacent to dynamic brake circuit breaker is in centre position and can be moved up or down to light all failure lights on both control stands and accessory panel on electrical cabinet to ensure all lights are operational.

Manual Power Control Switch and Control Knob

The manual power control switch has the following positions on the driver's side:

1. Normal – Locomotive in normal power.
2. Lead – Only lead locomotive will respond to control knob other units in consist will produce power according to throttle notch in lead unit.
3. All – All locomotives in M.U. consist will respond to control knob.

4. Pacesetter(2 Positions)– Either position will place locomotive under "Pacesetter" control if fitted other locomotives will not obtain power if operating in M.U.

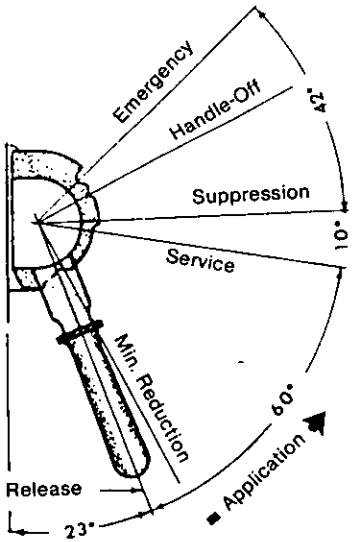
The positions on the fireman's side (where two driving stations are available) are Normal, Lead and All and these operate similarly to the drivers side control.

AIR BRAKE EQUIPMENT

The 26L air brake control equipment is located on a pedestal to the left of the controller. This equipment consists of an automatic brake, independent brake, multiple unit valve, cut-off valve, a brakepipe air pressure adjustment device and a dead engine feature as well as a non maintain feature.

Automatic Brake Valve

The automatic brake valve handle may be placed in any of six operating positions.



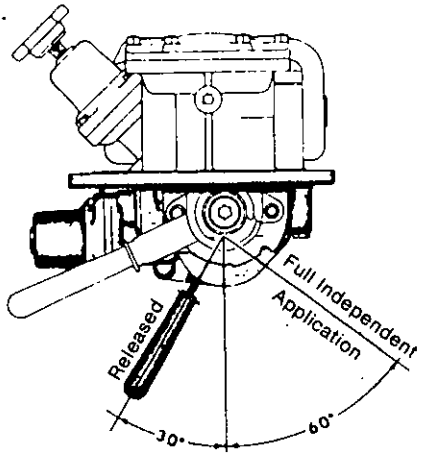
AUTOMATIC BRAKE HANDLE POSITIONS

Independent Air Brake

The independent air brake handle is located directly below the automatic brake handle. It has two positions; namely, RELEASE and FULL APPLICATION. Between these two positions is the application zone. Since this is a self-lapping brake, it automatically laps off the flow of air and maintains brake cylinder pressure corresponding to the position of the handle in the application zone.

Depression of the independent brake valve handle when the RELEASE position causes release of any automatic brake application existing on the locomotive.

The Independent Brake Valve handle is removable in the release position.



INDEPENDENT BRAKE HANDLE POSITIONS

Cut-Off Valve

The cut-off valve is located on the automatic brake valve housing directly beneath the automatic brake valve handle.

This valve has two positions:

1. OUT (pointer vertical – brake valve isolated).
2. IN (pointer horizontal).

The valve is positioned by pushing in and turning to the desired setting. Regardless of single or multiple unit operation all other cut-off valves should be placed in the OUT position.

Multiple Unit Valve

The multiple unit (MU-2A) valve is located on the lower front of the air brake pedestal. Its purpose is to cut-in or isolate the Independent Brake Valve on the locomotive.

The MU-2A valve has two positions which are:

1. LEAD or DEAD (CUT IN – pointer vertically up).
2. TRAIL 6 or 26 (ISOLATED – pointer horizontal).

The valve is positioned by pushing and turning to the desired setting.

NOTE: Refer to QGR General Instructions regarding Air Brake Equipment.

Brakepipe Pressure Adjustment

The brakepipe air pressure adjusting setscrew is located behind the automatic brake valve at the upper portion of the brake pedestal.

Alerting System Acknowledgement Button

The button is located on the control stand adjacent to the Manual Control Switch.

A description relating to Alerting System Operation is included in Section 4 – Operation.

Alarm Indicating Lights

Indicating lights are installed to provide a visual warning of operating difficulties. The functions of these lights are discussed in Section 5 – Locomotive Systems.

Ground Relay Reset Button

This button located adjacent to dynamic brake circuit breaker, will only reset ground relays in trailing locomotives in multiple unit which are not fitted with automatic ground relay reset as found on locomotives 1566 onwards.

Brakepipe Emergency Cock

This cock provides a method of venting the brakepipe directly to atmosphere in an emergency due to malfunction of the locomotive air brake valve. It is located below the cab window on the left-hand side.

Maintain – Non Maintain Switch

This switch is located adjacent to the MU2A valve. When the switch is in the "maintain" position and a brake application is made, the self lapping feature of the regulating valve automatically maintains equalising reservoir pressure, which, through the relay valve establishes a pressure in the brake pipe equal to the pressure in the equalising reservoir. This will maintain the brake application made by the driver.

When the switch is in the "non-maintain" position and a brake application is made a leak of 27kPa per minute is induced from the equalising reservoir with the resultant reduction in brake pipe pressure and an increase of the brake application made by the driver.

NOTE: The departmental instructions relating to the feature must be observed.

MISCELLANEOUS CAB EQUIPMENT

Speedometer

The speedometer, at the control stand, is located so that it is clearly visible to the driver.

Speeds are indicated up to 100km per hour.

Horn Valve

The horns are operated by pull cords on the cab ceiling

Windscreen Wipers

There are four air operated windscreen wipers. Each can be operated independently at varying speeds by graduating the opening of the control valve mounted on the cab side walls adjacent to and above the crew seats.

Windscreen Washers

Air operated windscreen washers are fitted to some locomotives. A push button switch situated below the driver's tray will cause water to be pumped from the 3.5 litre reservoir via the spray nozzles on to the windscreens of the short hood end only.

Detonate Sensing Cancel and Isolation Switch

Located on rear wall of the cab, the switch is used to cancel an alarm given after the locomotive passes over detonators. The switch is turned to the cancel position. On releasing, a spring mechanism returns the switch to normal centre position.

In case of malfunction the system can be isolated by placing the switch in the "isolate" position.

Sand Button

A foot operated sanding switch is located on the floor adjacent to the driver's control stand and is provided to operate the sanding magnet valves, to apply sand as required.

To test Operation of Sanders:

1. With –
   a. Main air reservoirs charged.
   b. Battery knife switch CLOSED.
   c. Control circuit breaker ON.
   d. Control and fuel pump switch ON.
   e. Local control circuit breaker ON.
   f. Dynamic Brake Lever OFF.
2. Place reverser handle in FORWARD.
3. Press foot sanding button.
4. Observe the discharge of sand.
5. Place reverser handle in REVERSE and repeat steps 3 and 4.

NOTE: Continuous operation of sanders occurs in the Emergency position of the Automatic Brake Valve Handle.

SECTION 3

STARTING AND STOPPING ENGINES

THE CLYDE ENGINEERING COMPANY
PTY LIMITED, AUSTRALIA

"Home of the Diesel Locomotive"

INTRODUCTION

This section of the manual covers recommended procedures concerning the starting and stopping of the diesel engine and establishing control preparatory to operation.

PREPARATIONS FOR STARTING ENGINE

In the Cab

At Locomotive Control Stand

The control stand operating levers should be positioned as follows:

1. Dynamic brake handle should be in the OFF position.
2. Make sure throttle remains in IDLE position and reverse lever is at NEUTRAL position.

Air Brakes – Type 26L

1. Insert automatic brake valve handle (if removed) and place in RELEASE position.
2. Insert independent brake valve handle (if removed) and move to FULL APPLICATION position.
3. Position cutoff valve to IN position.
4. Place MU-2A valve in LEAD position.

At Distribution and Isolation Switch Panel

1. All knife switches should be CLOSED.
2. All fuses should be installed and in good condition.
3. All circuit breakers on the Circuit Breaker Panel ON, excepting the Locotrol circuit breaker.
4. Isolation switch in START position.
5. Emergency switch in NORMAL position.

Miscellaneous

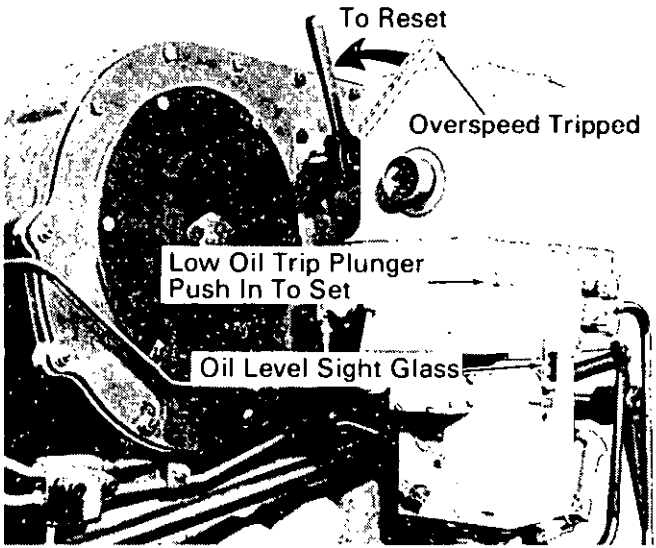
1. Hand Brake should be ON.

NOTE: After positioning the operative brake pedestal isolating valves as above, ensure that at the driving stations in all trailing cabs the cutoff valve(s) is at the OUT position and the MU-2A valve(s) is in TRAIL (ISOLATED) position.

In the Engine Room

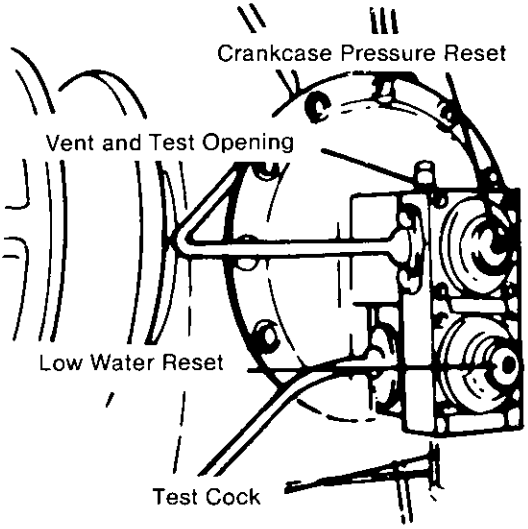
1. Check the engine lubricating oil level – As the marks on the dipstick are correct level limits with engine running, the oil level may be above the full mark on the dipstick with the engine shut down.

2. Check the governor oil level – should be at the mark on the sight glass. Too much or too little oil should be reported.



3. Check low oil shut down button on the governor. Test alarm signal by pulling out button. Audible alarm should sound and engine protector light on locomotive controllers should shine – push in to reset.

4. Check "Crankcase" and "Low Water" reset buttons on Engine Protector. If either or both buttons protrude with the red colour band showing (i.e. are in the tripped position) press in firmly to reset and hold for 5 seconds to allow the devices to latch.



5. Check the overspeed trip lever – if tripped, pull to reset.
6. Check the engine water level.

   Level should be between the STOPPED FULL mark and STOPPED LOW mark with the Engine stopped. If level is below RUNNING LOW mark do not start engine until maintenance staff have checked for internal and external water leaks.

   Shortly after starting the engine water level should be between RUNNING FULL and RUNNING LOW mark.
7. Check air compressor oil level at gauge or dipstick with locomotive on level track.
8. Test the water accumulation in engine cylinders. If the shut down period exceeds twelve hours:
   a. Remove 400 ampere starting fuse.
   b. Open engine cylinder test valves about three turns. (Maintenance staff only, not drivers unless instructed).
   c. Rotate engine at least one complete revolution using the enigne turning jack.

NOTE: Except for locomotives 2181 to 2214. The Fuel Prime/Engine Start Switch MUST NOT be used when testing for water accumulation.

d. Watch the cylinder test valve openings for discharge of liquid.

   If water is discharged from any test valve, do not attempt to start the engine until the maintenance staff has corrected the leaking condition.

   If there is no discharge –

e. Close cylinder test valves using test valve wrench, firm nip hand tight.

f. Replace 400 ampere starting fuse.

9. Locomotives 2181 and 2212, are fitted with an engine purge system and do not require a water accumulation test prior to a start. Refer Engine Starting and Cab Controls (Section 2) for details.

10. Observe that engine top deck, air box and oil pan inspection covers are in place, and are securely closed.

NOTE: The engine should be inspected after starting in addition to the preceding inspection.

STARTING AND STOPPING ENGINES

STARTING THE DIESEL ENGINE

After the preceding inspection has been completed the diesel engine may be started. Starting controls are located at the accessory end of the engine in the area of the equipment rack.

In the Cab

1. Place control and fuel pump switch in ON (up) position.

2. Place engine run switch in ON (up) position.

In the Engine Room

1. Place the fuel prime/engine start switch in the "FUEL PRIME" position and hold until the return sight glass (nearest to the engine) is full and clear. This is necessary to ensure that the fuel return sight glass nearest engine is full and clear before turning engine over.

2. Move layshaft lever to half or more rack position, turn the fuel prime/engine start switch to START position and hold till engine fires. Do not crank the engine for more than 20 seconds if the engine fails to fire. Allow two minutes to elapse between cranking attempts.

   a. On Locomotives 2181 to 2213 hold lay shaft back for approximately 6 seconds during engine purge cycle then without releasing FP/ES switch handle from the start position push lay shaft to half rack position and hold until engine fires. Do not crank engine in "start" cycle for more than 20 seconds if the engine fails to fire. Allow two minutes to elapse between cranking attempts.

3. Immediately after engine starts check that the crankcase (oil pan) pressure and low water detector reset buttons are set (pressed in). If the buttons protrude, press and hold for 5 seconds.

   The low water detector will often trip during engine starting, especially when the engine is cold or when the water tank pressure cap has been removed to add water. The detector should be reset as soon as the engine starts and is idling, or else the engine will shut down after a time delay established by the governor.

   Check the low water reset pushbutton after every engine start.

   NOTE: The reset buttons on some detectors will not latch in when the engine is shut down. If such a condition is encountered reset the device after engine starts.

4. Check that engine oil pressure engine oil level, and governor oil level are satisfactory.

   Pressure may reach approximately 482kPa when starting a cold engine, and is normally above 110kPa at idle with engine temperature at 71° C-82° C.

5. Check that the engine cooling water level does not fall below the "LOW" mark on the "Engine Running" portion of the water level gauge plate.

NOTE: It is recommended that the engine cooling water temperature be approximately 49° C before hauling a train at full throttle.

6. Observe for leakage of fuel oil, lubricating oil, water or air.

Drain air compressor intercooler and close cocks.

In the Cab

1. Immediately after starting, check the Battery Charging Ammeter. A high charge may be indicated but should reduce towards zero and in normal running conditions, should read zero or show slight charge.

   Report condition if discharge is indicated. Ammeter should be checked periodically whilst running.

   NOTE: If engine will not start see "Trouble Shooting", Section 6.

On the Ground

1. Check for flow of air from traction motor outlets to ensure that traction motor blower is operating.
2. Generally inspect the exterior of the locomotive, noting any abnormalities and ensure that there are no leakages, of fuel, lube oil or water. Check for loose parts on undergear, broken bogie springs, or damage to traction motor cables, bellows, or gear cases. Ensure air pipes and jumper cables are in good condition and correctly secured.
3. Check all brake gear for adjustment, piston travel and condition of brake blocks.
4. Check fuel supply. Be sure valves are open at top and bottom of sight glasses, so as to avoid false reading.
5. Check sand boxes and operation of sanders in forward and reverse.
6. Open dirt collector drain cocks under the underframe.
7. Open drain valves of the main air reservoirs, to drain condensate.
8. Check that all isolating cocks in air equipment piping and brake equipment are open, (handle in line with pipe).
9. Check engine airbox drain.

   A metal casting mounted on the front end plate of the engine connects drain pipes from each side of the airbox to a common drain pipe. Pressures in opposition at the casting restrict airflow to a permissible amount, yet allow elimination of airbox contaminants. The system is completely automatic and

requires no attention by the locomotive operator. The outlet is located at the rear right-hand side of the fuel tank.

NOTE: If a discharge, as distinct from an airflow, is observed at any time from the airbox drain, or if the presence of water is noted, the maintenance staff should be informed.

STARTING TRAILING UNIT DIESEL ENGINES

Engines in trailing units are started in the same manner after the engine in the lead unit has been started with the exception that control and fuel pump, engine run and generator field switches are left in the OFF position and the reversing lever and braking levers are removed from the stands.

ESTABLISHING LOCOMOTIVE CONTROL

PLACING UNITS ON THE LINE

After the diesel engines are started and inspected, units may be placed on the line as desired by placing the isolation switch on the engine control panel in the cab in the RUN position. If the consist is at a standstill, be certain that the throttle lever in all units is in the idle position before placing any unit on the line.

STOPPING ENGINE

There are five ways to stop the engine.

1. Press the engine stop button on the circuit breaker panel. This is the normal method adopted. Since the action of the stop button is instantaneous, it need not be held in.
2. Use layshaft lever. The layshaft lever at the accessory end of the engine can be operated to override the engine governor and move the injector racks to the no fuel position.
3. Open the low water detector test cock. When the low water detector trips, oil is dumped from the governor low oil shut-down device, stopping the engine.
4. Use throttle lever. 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 the STOP position.

NOTE: All isolation switches must be in "RUN" position to enable all locomotives of consists to shut down in throttle stop.

5. Pull out low oil shutdown button on the governor.

NOTE: Observe freezing weather precautions whenever an engine is shut down during cold weather.

STABLING LOCOMOTIVE

1. Place the reverse lever in neutral position and the throttle in IDLE.
2. Ensure dynamic brake lever is in the OFF position.
3. Remove reverse lever from controller.
4. Place isolation switch in START and press stop button IN.
5. Place all switches on the controller panel in the OFF position (down), after engine stops.
6. Open battery switch.
7. Apply handbrake and block wheels, if necessary.
8. Cover exhaust stack if there is danger of severe rain.
9. Protect engine if there is danger of freezing.

SAFETY PRECAUTIONS

To Kill High Voltage

Turn isolation switch to START.

To Kill Low Voltage

1. Stop the diesel engine.
2. Open battery knife switch on the Distribution Panel.

To Prevent Start of Engine

To work safely without the danger of someone accidentally starting the engine:

1. Remove the 400 ampere starting fuse on the Distribution Panel.
2. Place "DO NOT START" notice adjacent to the engine start controls.

To Prevent Movement of Locomotive While Engine Is Running

Before leaving the locomotive unattended:

1. Move throttle lever to IDLE. Dynamic Brake lever to OFF.
2. Place the independent air brake in full application position.
3. Apply hand brake.
4. Remove the reverser handle.
5. Place generator field switch in OFF position.
6. Place Isolation Switch in START position.

SECTION 4

OPERATION

THE CLYDE ENGINEERING COMPANY
PTY LIMITED, AUSTRALIA

"Home of the Diesel Locomotive"

INTRODUCTION

This section of the manual covers recommended procedures for operation of the locomotive. The procedures are briefly outlined and do not contain detailed explanation of equipment location or function.

Operation of special features such as dynamic braking are also covered herein.

PRECAUTIONS BEFORE MOVING LOCOMOTIVE

The following points should be carefully checked before attempting to move the locomotive under its own power:

1. MAKE SURE THAT MAIN RESERVOIR AIR PRESSURE IS NORMAL (approximately 827kPa.)

   The locomotive can not be powered until brakepipe pressure exceeds 413kPa. this is the pick up value of the Power Knockout Switch (PKS).

2. Check for proper application and release of air brakes.
3. Release hand brakes and remove any blocking under the wheels.
4. Check for proper functioning of Alerting System Equipment in accordance with Departmental Instructions.

   NOTE: In the trailing cab the brake pedestal cut-off (isolating) valve should be in the OUT position and the MU-2A valve should be in TRAIL (6 or 26).

HANDLING LIGHT LOCOMOTIVE

With the engine started and placed "on-the-line" and the preceding inspections and precautions completed, the locomotive is handled as follows:

1. Place the generator field switch in ON (up) position.
2. Place headlight and other lights ON as needed.
3. Insert reverser lever and move it to desired direction of travel, either forward or reverse.
4. Release air brakes.
5. Open throttle to Run 1, 2 or 3 as needed to move locomotive at desired speed.

NOTE: Locomotive response to throttle movement is almost immediate. There is no delay in power buildup.

It is recommended that the diesel engine not be operated above throttle position No. 3 until water temperature is greater than 49°C.

6. Throttle should be in IDLE before coming to a dead stop. When standing, for any significant period, centre the reverser.
7. REVERSE LEVER SHOULD BE MOVED TO CHANGE DIRECTION OF TRAVEL ONLY WHEN LOCOMOTIVE IS COMPLETELY STOPPED.
8. Proceed as indicated in steps 5 and 6 for operation in reverse direction of travel.

COUPLING LOCOMOTIVE UNITS TOGETHER

When coupling units together for multiple unit operation, the procedure below should be followed:

1. Couple and stretch units to ensure couplers are locked.
2. Install control jumper cable between units (on either side).
3. Perform ground, engineroom and engine inspections as outlined in preceding articles.
4. Position cab controls for trailing unit operation as outlined in the following article "Trailing Unit Cab Inspection".
5. Connect air brake hoses between units on locomotive headstocks and open air hose cutout cocks on both units.

   Hoses are numbered as follows:

   No. 2. Brake Pipe.

   No. 3. Control Pipe.

   No. 4. Independent Release Pipe.

   No. 5. Main Reservoir Equalising Pipe.

   A test of the brakes on the consist must be made to determine that brakes apply and release on all units when operated by both the automatic brake and the independent brake. Also check that an automatic brake service applications is released on all units by depressing the independent brake valve handle.

NOTE: On multiple consists equipped with either identical or different brake equipment the brake valve isolation cock(s) or cut-off valve(s) should be positioned in OUT (CLOSED) on all non-operative brake pedestals and brake valve handles removed.

All MU-2A valves on non-operative pedestals should be positioned in TRAIL.

If, for any reason, the No. 3 control and No. 4 independent release pipes are not coupled in a multiple consist of mixed brake equipment the following procedure shall be observed on the trailing locomotive:

1. For 26L brake equipped locomotives leading.

   Brake valve isolating cock(s) should be CLOSED and both brake valve handles placed in the respective running positions.

   This enables air pressure in No. 3 control pipe of the trailing unit to exhaust and avoids sticking brakes.

2. For 26L brake equipped locomotives trailing.

   Brake valve cut-off valves should be placed in OUT position, the MU-2A valve on **one** brake pedestal in the LEAD OR DEAD position and both brake valve handles removed.

IMPORTANT: Failure to place **one** MU-2A valve in the LEAD or DEAD position may result in failure of the brakes to release on the 26L brake equipped locomotive(s).

When the No. 3 and No. 4 Multiple unit control air hoses are not connected a test of the brakes on the consist must be made to determine that brakes apply and release on all units when operated by the automatic brake valve.

NOTE: Under the above conditions the independent brake will apply only on the leading locomotive to hold a train when stopped on a grade.

When such conditions exist Departmental instructions should be observed to secure the train on the grade.

TRAILING UNIT CAB INSPECTION

After locomotives have been coupled

Switches, circuit breakers and control equipment located in the cab of a trailing unit should be checked for proper positioning as follows:

Distribution Panel

1. All knife switches closed.
2. All fuses installed and in good condition.

Circuit Breaker Panel

1. Local control circuit breaker ON.
2. Control circuit breaker ON.
3. Fuel pump circuit breaker ON.

Switch Panel

1. Isolation switch in RUN position.
2. Motor cut out switch in NORMAL.
3. Emergency switch in NORMAL.
4. Generator field circuit breaker ON.
5. Other switches may be placed ON as needed or left off, as they do not affect locomotive operation.

LOCOMOTIVE CONTROL STAND

The control stand switches and operating levers should be positioned as follows:

1. Control and fuel pump switch, generator field switch, and engine run switch must be OFF (down).
2. Throttle in IDLE.
3. Reverse lever placed in neutral and then removed from the controller to lock the other levers.

Air Brakes – Type 26L

Observe instructions in the preceding article concerning the correct positioning of brake equipment when locomotives are to be operated in multiple.

COUPLING LOCOMOTIVE(S) TO TRAIN

Locomotive(s) should be coupled to the train using the same care taken when coupling units together. After coupling, make the following checks:

1. Test to see that couplers are locked by stretching connection.

2. Connect air brake hoses.
3. Slowly open air valves on locomotive and train to cut in brakes.
4. Pump up air if necessary, using the following procedure:

PUMPING UP AIR

After cutting in air brakes on train, note the reaction of the main reservoir air gauge. If pressure falls below brakepipe pressure, pump up air as follows:

1. Place generator field switch in OFF (down) position.
2. Move reverse lever to neutral position.
3. Open throttle as needed to speed up engine and thus increase air compressor output.

NOTE: Throttle may be advanced to RUN 4 or 5 if necessary. Increased air compressor pumping rate can be obtained only when the brake pipe pressure is sufficient to pick up the Power Knockout Switch (PKS) (P.U. 413kPa D.O. 310kPa.)

BRAKE PIPE LEAKAGE TEST PROCEDURE

Prior to operating the 26L brake equipment, a leakage test must be performed. This is accomplished in the following manner, when coupled to the train.

1. With the cutoff valve set at IN position, move the automatic brake valve handle gradually into service position until the equalising reservoir gauge indicates that a 103kPa reduction has been made.
2. Without any further movement of the automatic brake valve handle, observe the brake pipe gauge until this pressure has dropped 103kPa and exhaust has stopped blowing.
3. At this moment turn the cutoff valve to OUT position. This cuts out the maintaining function of the brake valve.
4. From the instant the cutoff valve is turned to OUT position, the brake pipe gauge should be observed and any possible drop in brake pipe pressure should be timed for one minute. Brake pipe leakage must not exceed 34kPa.

   If variation in excess of this value exists the brake examination is not to commence until the defect is rectified.

5. On completion of leakage test, if necessary, again operate the automatic brake valve handle to adjust equalising reservoir pressure to 34kPa below the brake pipe pressure.
6. Return the brake pipe cutoff valve to the IN position. The brake examination can then be commenced.

NOTE: As in this position the brake pipe pressure maintaining conditions are being employed it is very important for the cutoff valve to be set at the IN position to ensure that auxiliary reservoir leakage, with resultant brake release on any vehicle, will be detected.

STARTING A TRAIN

The method to be used in starting a train depends upon many factors such as, the type of locomotive being used; the type, weight and length of the train and amount of slack in the train; as well as the weather, grade and track conditions. Since all of these factors are variable, specific train starting instructions cannot be provided and it will therefore be up to the operator to use good judgement in properly applying the power to suit requirements. There are, however, certain general considerations that should be observed. They are discussed in the following paragraphs.

A basic characteristic of the diesel locomotive is its HIGH STARTING TRACTIVE EFFORT. This is DIRECTLY RELATED TO THROTTLE POSITION. The design of the locomotive power control system is such that tractive effort is low in low throttle position and high in high throttle position, and this effort is available immediately as the throttle is positioned. These characteristics make the use of independent locomotive brakes or the manipulation of the throttle between run 1 and idle generally unnecessary during starting.

The available tractive effort does however make it imperative that the air brakes be completely released before any attempt is made to start a train. On an average 100 car freight train having uniformly distributed leakage, it may take 10 minutes or more to completely release the brakes after a reduction has been made. It is therefore important that sufficient time be allowed after stopping, or otherwise applying brakes, to allow them to be fully released before attempting to start the train.

The locomotive possesses sufficiently high tractive effort to enable it to start most trains without taking slack. The practice of taking slack indiscriminately should thus be avoided. There will,

however be instances in which it is advisable (and sometimes necessary) to take slack in starting a train. Care should be taken in such cases to prevent excessive locomotive acceleration which will cause undue shock to draft gear and couplers, and lading.

Proper throttle handling is important when starting trains, since it has a direct bearing on the power being developed. As the throttle is advanced, a power increase occurs almost immediately, and power applied is at a value dependent upon throttle position. It is therefore advisable to advance the throttle one notch at a time when starting a train. A train should be started in as low a throttle position as possible, thus keeping the speed of the locomotive at a minimum until all slack has been removed and the train completely stretched. Sometimes it is advisable to reduce the throttle a notch or two at the moment the locomotive begins to move in order to prevent stretching slack too quickly or to avoid slipping.

A high reading on the load indicating meter is permissible when starting the train provided care is taken to avoid wheel slip.

When ready to start, the following general procedure is recommended:

1. Move reverse lever to the desired direction, either forward or reverse.
2. Place generator field switch in the ON (up) position.
3. Release both automatic and independent air brakes.
4. Open the throttle one notch at a time. In Notch 1, the engine will quickly load but loading will remain at a specific low value as will be noted on the load indicating meter.

   Notches 2, 3 or higher may be selected until the locomotive moves the train. Avoid high load meter readings with the locomotive stationary. This can result in damage to the traction motor commutators. Either increase the current to start the train moving or return the throttle to idle to check for sticking brakes on the locomotive and train.
5. After the train is stretched, advance the throttle as desired.

NOTE: When the locomotive brakes are released the Alerting System Equipment becomes operative and it will be necessary to periodically acknowledge the warning light in accordance with Departmental Instructions.

ACCELERATING A TRAIN

After the train has been started, the throttle can be advanced as rapidly as desired to accelerate the train. The speed which the throttle is advanced depends upon demands of the schedule and the type of locomotive and train involved. In general however, advancing the throttle one notch at a time is desired to prevent slipping.

The load indicating meter provides the best guide for throttle handling when accelerating a train. By observing this meter it will be noted that the pointer moves toward the right (increased amperage) as the throttle is advanced. As soon as the increased power is absorbed, the meter pointer begins moving toward the left. At that time, the throttle may again be advanced. Thus for maximum acceleration without slipping, the throttle should be advanced one notch each time the meter pointer begins moving toward the left until full power is reached in throttle position 8.

Additional train acceleration is provided by motor field shunting. This change of electrical circuits takes place automatically without any attention or action required on the part of the operator.

CLOSING THE THROTTLE

It is possible to close the throttle to IDLE in one sweep, but this should not be done in normal handling. Close the throttle one notch at a time with a pause between notches.

THE STOP FEATURE OF THE THROTTLE LEVER IS FOR EMERGENCY ONLY AND SHOULD NOT BE USED DURING NORMAL THROTTLE HANDLING OR TO SHUT THE ENGINE DOWN WHEN STABLING THE LOCOMOTIVE.

The throttle should always be closed before applying the brakes to stop the train.

OPERATING OVER RAIL CROSSINGS

When operating over rail crossings, it is advisable to reduce power and speed before reaching the crossing and not to increase power again until all locomotive units have passed over the crossing, to prevent damage to traction motors.

RUNNING THROUGH WATER

Locomotives are not permitted to travel through flooded areas unless top of rail is visible, with the exception that in low-lying

country with poor run off, the locomotives may proceed through such water of a depth not exceeding three inches above rail level at a maximum speed of 4.8km/h. Permission must be obtained from E/C Diesels.

WHEEL SLIP LIGHT INDICATIONS

Flashing of the wheel slip light indicates that wheels are slipping.

When Wheel Slip Occurs

Automatic sanding, together with reduction of locomotive power functions to correct wheel slip. After adhesion is regained, a timed application of sand for 8 to 10 seconds continues while power is smoothly restored. The system functions entirely automatically, and no action is required by the locomotive operator.

Full power is re-applied when wheel slip stops.

NOTE: Throttle reduction is recommended only when slip conditions are such that repeated wheel slip causes severe lurching that may pull a train apart.

Depending upon the seriousness of slipping, the wheel slip light may flash on and off as the wheel slip control system functions to correct the slips. Normal intermittent flashing of the light indicates that the wheel slip system is doing its job and is correcting the slips, but correction of wheel slips without the light flashing on and off is a normal condition. No action is required by the operator.

If the wheel slip light blinks on and off slowly and persistently during locomotive operation, a pair of wheels may be sliding or circuit difficulty may exist. Due to the seriousness of sliding wheels, under such indications the locomotive should be IMMEDIATELY STOPPED and an investigation made to determine the cause. The wheels may be sliding due to a locked brake, damaged traction motor bearings, or broken pinion or gear teeth.

Check by starting slowly with someone on the ground to check if all wheels are rotating. If wheels are locked, notify the locomotive depot and do not attempt to move the locomotive.

Repeat ground relay tripping, accompanied by unusual noises such as thumping or squealing, may also indicate serious traction motor trouble that should be investigated at once.

Do not allow any unit that must be isolated due to repeated wheel slip or ground relay action to remain in a locomotive consist UNLESS IT HAS BEEN ABSOLUTELY DETERMINED THAT ALL OF ITS WHEELS ROTATE FREELY.

LOCOMOTIVE SPEED LIMIT

The maximum speed at which the locomotive can be safely operated is determined by the gear ratio. This ratio is expressed as a double number such as 63 : 14. The 63 indicates the number of teeth on the axle gear while the 14 represents the number of teeth on the traction motor pinion gear.

Since the two gears are meshed together, it can be seen that for this particular ratio the motor armature turns approximately four times for a single revolution of the driving wheels. The locomotive speed limit of 99.7km/h is therefore determined by the maximum permissible rotation speed of the motor armature. Exceeding this maximum could result in serious damage to the traction motors.

DYNAMIC BRAKE OPERATION

Dynamic Brake Principle

Electrical connections are made to convert the traction motors into generators.

Power required to rotate the "generators" through the gearing on the wheels and axles, retards the locomotive.

Current generated by the traction motors is dissipated in resistance grids located in the roof above the traction motor blower. The grids are cooled by a motor-driven fan supplied with portion of the current generated by the traction motors during dynamic braking.

Dynamic brake, although similar in effect to an independent air brake application, is fully electrical and does not produce friction between brake shoes and tyres, thus avoiding heat and wear on these parts.

The load indicating meter shows the current generated by the traction motors.

Dynamic braking is valuable in retarding train speed in many phases of locomotive operation. It is particularly valuable while descending grades, thus reducing the necessity for using air brakes.

TO USE THE DYNAMIC BRAKE

1. Dynamic Brake Circuit Breaker on driver's control stand must be ON or dynamic brake will be inoperative
2. Reverser lever must be positioned in the direction of locomotive movement.
3. Throttle must be in IDLE.
4. The control and fuel pump, engine run and generator field switches must be ON (up position).
5. Independent air brake should be in RELEASE position.
6. Pause three seconds in IDLE position of throttle then move brake lever to SET UP position. This establishes the dynamic brake circuits.
7. After slack is bunched the brake lever is used to control dynamic brake strength. As it is advanced away from the SET UP position the engine speed will increase noticeably. This is to provide ample cooling air to the traction motors and main alternator during dynamic braking.

The time delay above is provided:-

a. To allow electrical circuits to stablise before changing from powering to braking and to prevent a possible heavy initial brake application.

b. To allow for slack in the train to "run in" before the brake is applied and thus reduce the effects of bunching.

To Release Dynamic Brake

Return the brake lever to the notched SET UP position, pausing briefly before returning to OFF. Allow three seconds before moving throttle from IDLE to any desired notch position for powering.

Dynamic Brake Characteristics

1. Braking effort may be increased by slowly advancing the lever to the full 8 position if desired. Maximum braking amperage (braking effort) is automatically limited to 370 amps by the Dynamic Brake Regulator Module (DR) regardless of locomotive speed or throttle position.

2. Maximum braking strength is obtained at approximately 27 km/hr. At train speeds higher than this optimum, braking effectiveness gradually declines as speed increases. For this reason when controlling heavy trains on steep gradients it is important that dynamic braking be started BEFORE train speed becomes excessive. For the dynamic brake to be most effective the speed of the train should not be allowed to "creep" up by careless handling of the brake.

   Notwithstanding this dynamic brake may be used to control high speed trains on gradual declining gradients. Braking strength is maintained below the optimum 27 km/hr as the speed falls to approximately 9.5km/hr by the extended range system of dynamic braking.

3. Backup rough regulation of dynamic brake grid current is provided by the Dynamic Brake Protection Module (DP), in the event of a Dynamic Brake Regulator Module (DR) failure. This rough regulation is achieved by interrupting traction motor exitation when dynamic brake grid current exceeds 410 amperes. When grid current falls to a safe value, exitation to the traction motor fields is re-established. This regulating action is noticed at the load meter. If the fault light on the control stand flashes on and off, move the brake handle back towards minimum until the flashes cease. Severe lurching of the train may occur unless brake handle position is reduced.

4. When necessary, automatic air brakes may be used to supplement dynamic brakes. A dynamic brake interlock (DBI) is energised when operating in dynamic brake and normally prevents air brakes from applying on the locomotive when a automatic train brake application is made.

   In the event of an emergency brake application, the dynamic brake is automatically released and air brakes apply on the locomotive when brake pipe pressure falls below 310kPa, the dropout value of the Power Knockout Switch (PKS). In an emergency brake application sand is automatically applied to the rails.

5. It is permissible for a train to be brought to a stand (such as at a station or a signal) using dynamic brake, in conjunction with the automatic air brake.

However, it is recommended that the independent air brake be applied and the dynamic brake released immediately the train is brought to rest.

When operating the dynamic brake, independent air brakes are available for emergency but must normally be kept FULLY RELEASED whenever dynamic brake is in use or the wheels may slide.

6. The wheel slip light may shine during dynamic braking if slippery rail conditions are encountered. Sand will be applied automatically to the rails.

   Braking amperage will be reduced automatically.

   Should a dynamic brake grid fail, operation of the dynamic brake will be automatically discontinued.

7. Do not place an engine "on the line", that is, turn the isolation switch to RUN while using dynamic brake in a multiple unit consist.

8. Other Clyde General Motors locomotives having different gear ratios and maximum brake current ratings can be operated in multiple with classes described in this manual.

Dynamic Brake Warning

The Brake Controlling Lever should be moved to full position. The handle should always be moved SLOWLY to prevent sudden surges of current in excess of the maximum brake current rating. Generally, if the lever is moved slowly to the full braking position, with automatic regulation of maximum braking strength the dynamic brake regulator module will limit the braking current to a maximum of 370 AMPS, and the fault light on the controller should seldom give indications of excessive brake current.

NOTE: The fault light is "trainlined" so that a warning will be given in the lead unit if any unit in the consist is generating excessive current in dynamic braking. Thus whenever the warning light comes on, it should not be allowed to remain on for any longer than two or three seconds before moving the lever to reduce braking effort. Continuous operation of indication light should be recorded on drivers log sheet.

DOUBLE HEADING (Not multiple coupled)

Prior to double heading behind another locomotive, make a full service brake pipe reduction with the automatic brake valve, and place the cut-off valve in the OUT position. Return the automatic brake valve handle to the release position and place the independent brake valve in RELEASE position. The MU valve remains in LEAD or DEAD position.

The operation of the throttle is normal, but the brakes are controlled from the lead locomotive. An emergency air brake application may be made, however, from the automatic brake valve of the second unit. Also, the brakes on this unit may be released by depressing the independent brake valve handle while it is in the release position.

OPERATION IN HELPER SERVICE (Pushing from the rear of the train)

Basically there is no difference in the instructions for operating the locomotive as a helper or with a helper. In most instances it is desirable to get over a grade in the shortest possible time. Thus, wherever possible, operation on the grades should be in the full throttle position. The throttle can be reduced, or manual power reduction used in instances where excessive wheel slips are occurring. For proper traction motor cooling, the locomotive should never be operated on grades below the 5th throttle position. Brake equipment isolating valves should be positioned as for single locomotive operation.

Regardless of whether the locomotive is coupled to the train or otherwise assisting, in such circumstances Departmental Instructions relative to this type of working must be observed.

ISOLATING A UNIT

Taking off the line (while under power)

The following instructions apply in general to multiple unit operation but are applicable to single unit opertion.

When the occasion arises where it becomes advisable to isolate a locomotive unit, observe the following:

1. When operating under power, a unit may be isolated at any time, but discretion as to timing should be used. It is recommended that the throttle be returned to IDLE before turning the isolating switch to START.

If considered necessary to stop the diesel engine without stopping the train or reducing the throttle in other units : Pull engine layshaft lever back until engine stops.

Turn isolating switch to START position.

2. When operating in dynamic braking, it is important to reduce braking current to zero before attempting to isolate the unit. This is done by reducing the braking lever to OFF. The isolation switch can then be moved to START position to eliminate the braking on that unit. If braking is resumed, other units in a multiple consist will function normally.

PLACING ON THE LINE (while under power)

A locomotive unit may be started and placed "on the line" (isolation switch turned to RUN) without stopping the train or reducing throttle (provided the engine temperature is above 48.8°C).

Do not place the engine "on the line" while using dynamic brakes.

Emergency Stopping of Engines from Cab

In the case of fire, collision or other emergency, all engines "on the line" (isolation switch in RUN) can be stopped from the cab.

1. Pull the throttle lever out away from the controller and then move the throttle beyond IDLE to STOP position.

CHANGING CONTROL STATIONS WITHIN THE CAB

Applicable Dual Station Locomotives

Driving the locomotive from the second control station.

When changing operating station within the cab, the following procedure is recommended.

On Station Being Cutout

1. Place independent brake in full application position.
2. Leave MU-2A valve in LEAD or DEAD position. (MU-2A valve is located low on the front of the air pedestal.)
3. Without depressing the Independent Brake Valve Handle move to release position and remove handle.

4. Move the automatic brake valve handle to service position and make a 140kPa reduction.
5. After brake pipe exhaust stops, place cutoff valve in OUT position by pushing dial indicator handle in and turning to the required position.
6. Position automatic brake valve handle in off position, and remove handle.
7. Place throttle lever in IDLE and dynamic brake lever in OFF position.
8. Place reverse lever in neutral position and remove to lock controller.
9. The control and fuel pump switch, engine run switch at the opposite control stand should be switched ON (up position).
10. At the vacated control stand place all switches in the "OFF" (down position).

NOTE: If the control and fuel pump switch on the first driver's control panel is placed in the "OFF" position prior to changing to the second control station, the fuel pump will stop. Once fuel remaining in the injector supply system is exhausted the engine will shut down resulting in probable damage to injectors.

On Control Station being Cut in

1. Make certain the throttle lever is in IDLE dynamic brake lever OFF.
2. Insert reverser lever and leave in neutral position.
3. Insert automatic brake valve handle and place in RELEASE position.
4. Insert independent brake valve handle to full independent application position.
5. Position cutoff valve to IN position.
6. MU-2A valve in LEAD or DEAD position.
7. Test operation of air brakes to determine that brakes apply and release when operated by both automatic and independent brake valves.

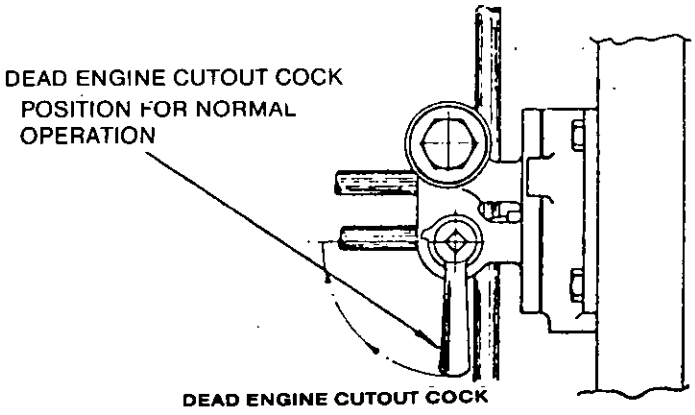
CHANGING OPERATING CABS - Multiple Unit

The procedure for changing from one cab to another in a multiple consist of locomotives is basically identical to that listed above for changing operating stations on a single locomotive, except that in the cab being vacated the MU-2A valve is placed in the trail 6 or 26 position.

TOWING LOCOMOTIVE IN TRAIN

When a locomotive is placed within a train consist to be towed, its control and air brake equipment should be set as follows:

1. Place the MU-2A valves in LEAD or DEAD position.
2. Place cutoff valves in OUT position.
3. Place independent brake valve handle in release position.
4. Place automatic brake valve handle in handle release position.
5. Cut in the dead engine device by turning the cutout cock to open position.



NOTE: The dead engine cock is only used when main reservoir pressure is not available from the towing locomotive.

The dead engine cutout cock is located in the engine room on top of the brake equipment rack adjacent to the compressor.

6. If No. 3 and No. 4 pipes have been connected, Independent and Automatic brake handles have to be removed (see 3 and 4).
7. Open Battery Switch.

ALERTING SYSTEM

The locomotive is fitted with Westinghouse electro pneumatic vigilance control equipment located in the engine room adjacent to the electrical cabinet, assessible through door on firemans side of locomotive.

During normal operation of the locomotive (brake cylinder pressure less than 172kPa it is necessary to periodically acknowledge the vigilance control when called upon to do so. Acknowledgement requires the momentary depression of one of the vigilance control acknowledgement buttons mounted on the locomotive control stands.

This action commences operation of the timing cycle.

A white alerting light on the control stand, and a warning whistle in the stand indicate when acknowledgement is required.

If the vigilance is not acknowledged after a pre-determined time delay:

a. An automatic penalty brake application will be made on the locomotive and train.
b. Engine will return to idle and power will be cut off to the traction motors (P.K.S. drops out to drop V.C.R.)

To Release

1. **Allow the train to come to a halt then secure the locomotive and train with both the independent and automatic brake.**
2. **Close the throttle.**
3. **Press acknowledgement button.**
4. **Brake pipe pressure will re-establish. Proceed with normal train operation.**

To Release Locotrol Equipped Locomotives

1. Allow the train to come to a halt then secure the locomotive and train with both the independent and automatic brake.
2. Close the throttle.
3. Allow the equalising reservoir pressure to drop to zero, minimum time 60 seconds after brake application.
4. Press and hold alerting button in. Release the automatic brake. Release the alerting button.
5. Brake pipe pressure will then re-establish. Proceed with normal train operation.

Vigilance Control Equipment Defective

In the event of a defect developing in the vigilance penalty valve unit the sealed brake pipe isolating cock, located directly behind the sealed flap marked I.C. should be closed and the equipment operated with audible warning only.

Observe Department Instructions relative to isolation of Vigilance Control Equipment.

STAND OVER FEATURE

The locomotive is provided with a stand over feature which allows an alerting system suppression with the engine running and the independent brake in the release position. This is achieved by placing the isolation switch in START and the controller handle in IDLE.

TRACTION MOTOR CUTOUT SWITCH

To cut out a pair of motors.

1. The battery switch must be closed.
2. The control and fuel pump switch must be ON.
3. The isolating switch must be at START.
4. Press in knob of switch to energise coil which releases switch lock, and then turn to cut out desired pair of motors.

Traction Motor Failure

If traction motor failure is suspected after repeated ground relay operation, proceed as follows:

1. Stop the locomotive.
2. Turn isolation switch to START and reset the ground relay.
3. Inspect traction motors for any obvious indications as to which motor is faulty (eg overheating, presence of smoke etc).
4. If no fault is apparent, isolate the traction motors by turning the MOTOR CUTOUT SWITCH to positions 1-6, 2-5, 3-4 in sequence and apply power in each position until the faulty motor is located.
5. Check that the armatures of any motors that have been cut out are free to rotate by observing from the ground that wheels do not skid when the locomotive is moved.

NOTE: Motors are isolated in pairs, ie, with motor cutout switch in 1-6 position motors 1 and 6 are isolated. With motor cutout switch in 2-5 position motors 2 and 5 are isolated. With motor cutout switch in 3-4 position motors 3 and 4 are cut out.

With a pair of motors cutout, the power control system automatically limits engine power to prevent overloading the operative motors and it may be necessary to reduce the trailing load before proceeding.

It should be noted that if motors 3 and 4 are isolated, no current will be shown on the load indicating ammeter.

NOTE: Dynamic brakes become inoperative when any pair of motors are cut out.

SECTION 5

LOCOMOTIVE SYSTEMS

THE CLYDE ENGINEERING COMPANY
PTY LIMITED, AUSTRALIA

"Home of the Diesel Locomotive"

COLOUR CODING

All piping in the locomotive car body is colour coded at connections, elbows, tee pieces, etc., so that each of the five locomotive systems may be readily identified.

Cooling System (Water)	SEA GREEN
Lubricating System (Oil)	SALMON PINK
Fuel System	LIGHT BROWN
Air System	WHITE
Electrical System	LIGHT ORANGE

COOLING SYSTEM

Path of the Water

Water is drawn from the oil cooler and header tank by the engine driven WATER PUMPS and forced through the engine to cool the cylinders.

Heat is absorbed by the water which is then discharged from the engine to the RADIATORS where this heat is given up to the atmosphere.

Cooling air flowing through the radiators is controlled by two alternating current driven COOLING FANS located in the roof. These motors rotate at a speed relative to the engine speed.

Two THERMOSTAT SWITCHES located in a manifold connected to the radiator outlet line operate at predetermined temperatures and control the operation of the cooling fans.

Cooled water returning from the radiators flows to the engine through the engine LUBRICATING OIL COOLER and in so doing extracts heat from the engine lubricating oil.

The WATER HEADER TANK serves as a reservoir for water draining from the radiators when the engine shuts down and also provides a reserve of water to make up for losses.

Cooling Water Level

When checking the engine cooling water level consideration must be given as to whether the engine is running or stopped.

With engine stopped, water level should be between the STOPPED FULL mark and STOPPED LOW. If the level is below the

RUNNING LOW mark, do not start the engine until a check for internal and external water leaks has been completed.

Normally, when the engine is running the level will be between the running full and running low marks. If the water level is at the RUNNING LOW mark or below the engine may continue to run at idle speed but may shut down when the throttle is advanced.

In the event of loss of engine cooling water the low water protection mechanism of the engine protector will function to shut the engine down, ring the alarm bells and illuminate the engine protector lights on the control stands.

The engine protector is discussed in detail under "Alarms" included at the rear of this section and in Section 6 – "Trouble Shooting".

Engine Operating Water Temperature

It is recommended, that engine water temperature be approximately 48.8°C.

Under full load operation the cooling water temperature will normally be maintained at approximately 76.6°C. Temperature will reduce slightly during extended idling periods.

Hot engine is indicated by illumination of the red hot engine alarm light and ringing of the alarm bells.

Engine should not be operated with water boiling.

Water Treatment

The water used in the Diesel locomotive cooling system is treated with a special compound to reduce mineral deposits and resist corrosion. This treatment is different from that used for steam locomotives. For this reason the system normally should be filled ONLY where this water is available.

Only in an emergency should ordinary water be used and should such an occasion arise, the maintenance staff should be informed as soon as possible.

Treated water must not be used for drinking or washing.

Filling the System

The system may be filled through the filler pipe located on the engine end of the water header tank facing the engine governor.

To fill the system proceed as follows (steps 1 to 3 are necessary only when filling a dry or nearly dry engine):

1. Stop the engine and ensure water level valves on the header tank are open.
2. Remove the header tank filler pressure cap and fill slowly until water shows STOPPED FULL in the sight glass. DO NOT OVER FILL.
3. Start the engine and run for several minutes. This will eliminate any air pockets in the system.
4. With the engine at IDLE add further water if required until water shows RUNNING FULL in the sight glass.
5. Do not neglect to replace and secure the water header tank filler pressure cap.

If the cooling system of a hot engine has been drained, do not refill immediately with COLD water. If this is done, the sudden change in temperature might crack or warp the cylinder liners and heads.

DO NOT FILL HOT ENGINES WITH COLD WATER

Draining the System

The draining procedure is as follows:

1. Remove the water header tank filler pressure cap.
2. Remove plug from engine drain line and open drain valve.

LUBRICATING SYSTEM

Path of the Oil

An engine driven scavenging pump draws lubricating oil from the engine oil pan sump through a SCAVENGE STRAINER and discharges the oil into the MICHIANA LUBRICATING OIL FILTER where the oil is filtered before passing to the engine.

The oil flowing from the Michiana filter is then delivered into the LUBRICATING OIL COOLER where heat is extracted from the oil by the engine cooling water.

The oil then returns to the strainer housing and is delivered through TWO SUCTION STRAINERS by the engine driven lubricating oil pumps.

The MAIN LUBRICATING OIL PUMP forces oil through the engine to lubricate the crankshaft and connecting rod bearings, both front and rear gear trains, camshaft bearings, both engine blowers and the auxiliary generator drive assembly.

The PISTON COOLING OIL PUMP delivers oil to the piston cooling oil manifolds from where oil is directed via a piston cooling pipe through the piston carrier to the underside of the piston crown, piston wrist pin and the ring belt, to cool and lubricate piston assemblies.

Excess oil discharged from all locations within the engine returns to the sump.

A BY-PASS is connected between the inlet to the lubricating oil filter and the discharge side of the lubricating oil cooler to permit circulation of cold oil or oil volume in excess of the filter capacity.

Engine Lubricating Oil Level

There are two oil levels to be considered depending on whether the engine is running or stopped.

Normally when the system is fully charged and the engine at IDLE speed and operating temperature, the oil level will be at the FULL mark on the dip stick. An operating level between the FULL and LOW marks is permissible. The level should not be allowed to fall beneath the LOW mark.

When sufficient time has elapsed after engine shutdown to allow oil being circulated to drain back, the oil level will normally rise to approximately 76.2mm above the FULL mark. Oil level to be checked with engine at IDLE.

Lubricating Oil Pressure

The engine lubricating oil pressure depends on the relief valve setting and is non-adjustable.

No specific value is quoted as the pressure depends on the conditions of the lubricating oil and engine and the engine speed.

The minimum oil pressure is approximately 27.5-41.3kPa at idle and 103-130kPa at full speed.

In the event of insufficient oil pressure, a shutdown feature in the engine governor will automatically shut the engine down, illuminate the engine protector lights and ring the alarm bells.

High suction will also cause engine shutdown.

Low oil pressure may indicate a low oil level.

High suction usually indicates dirty suction strainers.

Strainers MUST not be removed until the engine is shut down.

Low oil pressure failure is discussed further under "Alarms" included at the rear of this section.

Filling the System After Oil Change

1. Remove the square cover from the top of the oil strainer box at the accessory end of the engine.
2. Pour in oil until the level reaches
   a. the FULL MARK ON THE DIPSTICK (engine at IDLE)
   b. approximately 3 inches above the FULL mark (engine SHUT DOWN).

Adding Oil to System

1. Add oil through oil filler in crankcase covers adjacent to cylinders No. 4 and No. 12.

Draining the System

The following procedure should be followed when draining the engine lubricating oil:

1. Lift and turn the valve in the strainer housing to drain oil from the housing.
2. Remove the plug from the oil drain line of the lubricating oil cooler. This is located below the door of the Michiana filter.
3. Remove the plug and open the drain valve on the engine oil pan drain line located outside the locomotive.

FUEL SYSTEM

Path of the Fuel

When the CONTROL CIRCUIT BREAKER and CONTROL AND FUEL PUMP SWITCH in the cab are placed ON the circuit to the FUEL PUMP RELAY is completed.

With the LOCAL CONTROL CIRCUIT BREAKER AND FUEL PUMP CIRCUIT BREAKER switch ON and the FUEL PRIME/ ENGINE START SWITCH held IN PRIME POSITION, the fuel pump is connected to the battery and will run.

The fuel pump also runs when the fuel prime/engine start switch is turned to start position when the engine will commence to turn over.

Once the engine has started and the fuel prime/engine start switch has been released, the fuel pump continues to run from power supplied by the auxiliary generator to which it is now connected.

The FUEL TANK where the fuel for engine operation is stored, is mounted beneath the under frame.

In operation fuel from the fuel tank is drawn up by the FUEL PUMP through a STAINLESS STEEL SUCTION STRAINER which serves as protection for the fuel pump.

The fuel discharged by the pump then flows through a Michiana type WASTEX SOCK OR PAPER CARTRIDGE before it enters the engine mounted FUEL SUCTION STRAINERS where all remaining foreign matter is removed before the fuel passes to the INJECTORS.

The injectors measure, time and atomise the fuel while injecting it into the cylinders.

A SIGHT GLASS shows surplus fuel returning to the fuel tank. This provides a visual indication of fuel flow.

NOTE: When the engine is running, the glass next to the engine must be full and clear. If there is any flow through the adjacent (right-hand) glass, the maintenance staff must be notified.

To Fill the Tank

1. Remove dust cap.
2. Connect fuel nozzle to locomotive refuelling point on either side of the locomotive.
3. Push override button firmly and release.
4. Fuel will automatically shut off at the pre-set level.
5. After automatic shut-off fuel may be topped by pushing override button and holding until desired level is obtained.

NOTE: Be sure that both top and bottom valves in each sight glass are OPEN to avoid false reading.

KEEP OPEN FLAMES AWAY WHEN FILLING

AIR SYSTEM

Path of the Air

Air is drawn in through the compressor INTAKE AIR FILTERS where it is cleaned before entering the LOW PRESSURE CYLINDERS. The air in the low pressure cylinders is the compressed to about 206kPa pressure and discharged into the INTERCOOLER. Here the air is cooled before flowing to the HIGH PRESSURE CYLINDER where it is compressed to about 830kPa pressure and discharged into the MAIN RESERVOIRS.

When the main reservoir reaches its maximum pressure, a pressure switch is tripped which energises an air valve, which in turn applies air pressure to act on the unloader pistons and so hold the compressor suction valves off their seats. Thus no air is compressed as the compressor rotates.

When the main reservoir pressure is reduced the pressure switch is tripped in the reverse direction which de-energises the air valve which closes off air pressure to the unloader pistons. This causes the suction valves to seat and the compressor to start pumping.

Intercooler Pressure

Intercooler air is normally approximately 206kPa pressure when the compressor is pumping. Safety valve is set at 344kPa.

Compressor Oil Pressure

The oiling system is arranged so that oil under pressure is circulated by means of a pump to lubricate the compressor. Low oil pressure will operate a bell and light in cab.

Oil Level

The oil level in the compressor crankcase should preferably be maintained in the green zone on the compressor oil level gauge, or between minimum and maximum where dipstick is fitted.

The oil level should be checked only when the compressor is stationary.

Main Reservoir Pressure

Normally pressure should be maintained between 725kPa to 830kPa control is automatic.

Manual Control of Air Pumping

In emergencies it may be necessary to control the loading and unloading of the compressor manually.

1. **Normal Operation** – The pressure switch controls the compressor. The two way cock beside the pressure switch is to connect the main reservoir to the compressor unloader pistons via the compressor magnet valve (handle vertical).
2. **Permanently Loaded** – The isolating cock beside the pressure switch should be set to isolate and drain main reservoir pressure from the pressure switch and attendant indicating gauge (horizontal position), thus causing the switch to remain in the loaded position. This will cause pressure to rise to the safety valve limit of 862kPa.

LOCOMOTIVE ALARM SYSTEMS

Alarm Indication Lights

The driver's control stand is fitted with the following alarm indicating lights:

This group is located directly in front of the driver and provides instant indication for the driver of conditions on all locomotives in multiple consist.

1. Fault Light
2. Brake Cylinder Pressure
3. Wheel Slip Light
4. Manual Power Control
5. Alerting System

The following alarm indicating lights are grouped on the accessory panel on the electrical cabinet; and indicate faults on that particular locomotive.

1. Auxiliary Generator/Alternator Fail Light.
2. Ground Relay.
3. Hot Engine.
4. Fire Alarm.
5. Compressor and Engine Protection (compressor low oil pressure and engine protection device).

6. Test Light. An audible alarm will sound in conjunction with lights 1 to 5 inclusive. The alarm will sound in all units of the consist but the light will only indicate in the affected unit.

Wheel Slip Light

Intermittent flashing of the light when under power, indicates that the wheel slip control system is doing its job and is correcting the slips. The throttle and locomotive power need not be reduced unless severe lurching threatens to break the train.

When Wheel Slip occurs – Power to the traction motors is automatically reduced.

Wheel slip light shines.

Sand is applied automatically.

After 8 to 10 seconds sanding stops.

Full power is re-applied gradually when wheel slip stops.

If wheel slip light flashes repeatedly – and train surging occurs reduce power by reducing throttle. **If the light persists.** This may indicate a pair of sliding wheels or a circuitry fault. Check by stopping the train then start slowly with an observer on the ground to check that all wheels are rotating. If wheels are locked, notify the locomotive depot and do not attempt to move the locomotive.

Sand Button

A foot-operated sanding switch is located on the floor adjacent to the driver's control stand and is provided to operate the sanding magnet valves manually, if necessary.

Sand should be used to prevent slipping – not to stop it.

Fault Light

This light will shine if any of the alarm lights on the accessory panel are lit and will flash slowly if braking current is excessive when operating in dynamic brake.

Correction of excessive brake current generally operates automatically. In the event that the fault light comes on and does not go out quickly, braking current should be reduced immediately to prevent possible equipment damage. To reduce excessive brake current, move dynamic brake lever towards minimum.

Hot Engine Light

The hot engine alarm light operates to warn the driver that the engine cooling water has reached an excessive temperature.

When engine water temperature reaches 97.7° the alarms will ring and the lights will shine.

Isolate engine and investigate cause. Allow engine to remain running at idle speed.

Check engine water temperature gauge to confirm that the alarm is genuine. An alarm should not occur below 93.3°C. Check that the two radiator cooling fans are running.

Light goes out and alarm becomes silent when engine water temperature drops to 92.2°C.

CAUTION: Should it be necessary to remove the pressure cap from the header tank extreme care should be taken to turn the cap slowly. The cap should NOT be removed while the hot engine alarm is ringing.

NOTE: Continued operation of the locomotive while hot engine is indicated may result in engine shut down due to operation of the engine protector.

In the event of hot engine alarm indication, engine speed will be limited to notch 6.

Fire Alarm Light

Detectors are located both in the engine room and generator compartment and warn the driver of an outbreak of fire in these areas. Refer Section 6 "Trouble Shooting" for required action.

NOTE: Fault, brake cylinder, wheel slip lights and audible alarm will operate in conjunction with the fire alarm light. All indicators with the exception of fire alarm light may be isolated by the operation of the fire alarm cancel switch.

Compressor and Engine Protector Light

This light is activated by either the compressor low oil pressure switch or by a mechanism built into the engine governor. The governor mechanism may be initiated by any of three means.

a. Low engine lubricating oil pressure. This device provides protection against both crankcase pressure and low engine oil pressure.

b. Low Water Pressure. This device provides protection against low water pressure on coolant return from engine and also against cavitation at the water pump inlet.

c. High Lubricating Oil Temperature. A thermostat at the lubricating oil pump outlet senses high oil temperature and trips the governor mechanism at 123° – 126°C. This thermostat does not reset until oil temperature drops to 110°C. If the red button protruding from the side of the governor is reset manually before oil temperature drops to 110°C, engine can again be started but will shut down after approximately 40 seconds.

   When a Crankcase (Oil Pan) Pressure/Low Water/Low Oil/ High Lubricating Oil Temperature alarm occurs it is necessary to determine whether the crankcase pressure – low water detector has tripped to dump engine oil from the line leading to the governor or whether a true oil pressure or temperature failure has occurred. This can be determined by checking the crankcase pressure – low water detecting device, at the governor end of the engine for protruding reset buttons. A protruding lower button indicates excessive oil pan pressure; a protruding upper button indicates low water. Refer engine protector light this section if buttons are not protruding.

NOTE: The reset buttons on some detectors will not latch in while the engine is shut down, and on some detectors the button will trip at engine start. Always check and press the reset button immediately after starting the engine.

In a multiple consist the alarm sounds in all units. The light shines only in the affected unit.

In all instances the engine will shut down.

Brake Cylinder Pressure Light

In multiple header consists this light provides indication to the driver that an independent brake "leak on" is occurring on one or more of the trailing locomotives.

AUTOMATIC GROUND RELAY RESET

The locomotives are fitted with an automatic ground protective relay system. The Ground Relay is mounted on the electrical panel behind the driver's side door. The left counter on the face of the

relay will count up to 5 ground relays before power is locked out. The other counter will register the total number of ground relays and has a manual reset button. The reset switch is also mounted on the face of the relay and to reset, the switch is lifted up and released. The switch is spring loaded and will return to the down position. The power is limited at the 4th ground relay and when this occurs the "GEN VOLT LIMIT" light on the face of the ground relay will be lit.

The normal ground relay reset button on the Driver's Console will only reset the ground relays of trailing locomotives when operating in M.U. This ground relay reset on all other classes as well as locomotives 1566 ONWARD will not reset the ground relay on locomotives 1566 ONWARD if they are trailing in M.U. operation.

Ground Relay Light

The ground relay light indicates an electrical path to ground caused by insulation failure, presence of water, or an electrical arc.

When the Ground Relay (GR) is energised, Generator field excitation is lost, engine speed is reduced to idle and the alarm sounds in all units in a multiple consist. The GR relay light will be on, after 10 or 20 seconds power and engine speed will be restored.

This sequence will occur for the 1st, 2nd, 3rd and 4th ground relay operation within 35 minutes though on the 4th operation when the ground relay automatically resets, power will be limited and the "Gen Volt Limit" light on the ground relay will be on. If no further ground relays occur after 35 to 50 minutes of operation, normal power will be restored. If the 5th operation occurs within 35 minutes the ground relay will suspend Generation field excitation and reduce engine speed to idle.

To Reset - after 5th operation.

Return the throttle to idle and reset by lifting the switch on the ground relay and releasing.

Proceed with normal operation.

The left counter will return to "O". Do not reset the total grounds counter.

Should the ground relay again operate after manually resetting, return the throttle to idle, isolate the traction motors in pairs to try and eliminate fault, attempting to operate normally in each position. If fault cannot be eliminated open earth link, manually reset Ground Relay if 5th operation has occurred, and clear section only. Do not advance throttle above notch 7.

Alerting System

This light provides the normal indication at the end of an alert timing cycle, prior to a penalty application.

Manual Power Control

This light is not an alarm but indicates the locomotive is under manual power control. This will not light until throttle is advanced.

Auxiliary Generator/Alternator Failure Light

The Auxiliary Generator/Alternator failure light will come on and the audible alarm will sound any time the AC voltage (NVR) relay opens with the isolation switch in RUN position and the engine run switch in ON (up) position.

This will occur if the engine stops for any reason, the auxiliary generator fails for any reason, or if the auxiliary alternator failure occurs during operation – when alternator failure is experienced engine speed returns to idle.

MISCELLANEOUS DEVICES

Detonator Sensing Device

This system detects the explosion of detonators on the rail and will cause the locomotive horns to sound. A reset and isolation switch is provided on the rear wall of the cab.

Station Protection System

Permanent magnets set between the rails cause the vigilance system alarms to operate as the locomotive passes over. The acknowledgement button must be pressed to cancel the alarm.

Flange Lubricators fitted to Some Locomotives

Automatic flange lubricators will apply oil to the wheel flanges at intervals according to distance travelled. The applications may be recognised by the driver by periodical air blows.

In case of a fault in the system, air isolation may be achieved by closing the air cocks located:

a. Lead Bogie – air cock under lift (up) section of cab floor.

b. Trail Bogie – air cock adjacent to compressor dip stock.

SECTION 6

TROUBLE SHOOTING

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THE CLYDE ENGINEERING COMPANY
PTY. LIMITED, AUSTRALIA

"Home of the Diesel Locomotive"

FAULT LOCATION

Should faulty operation occur, the actions indicated in the following suggestions for fault finding should be carried out in sequence A, B, C, etc and when each action is carried out, check whether the fault has been eliminated before proceeding to the next check.

If on completion of all checks the fault still persists – request assistance.

On working through the faults, the driver will find the possible causes obvious from the actions suggested.

FAULT LOCATION IN MULTIPLE UNIT OPERATION

If the audible alarm sounds in the cab from which driving is being carried out and NO indicator light shines, the fault is in the remote unit.

In this case, the driver should proceed to the remote unit cab and endeavour to locate the fault.

FAULT 1 – Engine does not turn when fuel prime/engine start switch is placed in start position.

Indication	Action to be taken
Starting motors fail to engage when fuel prime/engine start switch is placed in "start" (usually indicated by dull thud type noise)	A. Release switch and attempt another three or four starts. B. If motors still fail to engage move starting motor pinions by using a piece of wood (Caution – do not use fingers.)
Starting motors do not move and engage pinions.	A. Check that Isolation switch is in START position. B. Check that Control Circuit Breaker on isolation switch panel is ON. C. Check that Control & Fuel Pump Switch on Driver's Control Panel is ON. D. Check that Main Battery Switch is CLOSED. E. Check 400 amp Starting Fuse. NOTE: If 400 amp starting fuse is blown, engine must be checked by maintenance staff before the fuse is replaced and another start attempted. F. Bar engine over to ensure free to turn. G. Note condition of battery from appearance of Headlights.

FAULT 2 – Engine rotates but will not fire.

Indication	Action to be taken
Engine turns normally but does not fire.	A. Check fuel flow through the sight glass with "fuel prime/engine start" switch in "PRIME" (if fuel flow is not evident see 4 below). B. If fuel is visible pull start fuse. turn FP/ES to start and press stop button. Repeat several times. Replace 400A fuse. Check C, D and E. Re-attempt start. C. Check that low oil pressure button on the governor is IN. D. Check Overspeed trip lever –Pull anti-clockwise to reset. E. Check governor oil level – oil level should be between marks on the sight glass.
Engine turns with loud blowing noise.	A. Close the compression relief valves.

FAULT 3 – Engine starts but stops soon after switch is turned to run.

Indication	Action to be taken
	A. Check that throttle is not in STOP position.

FAULT 4 – No fuel flow through sight glass closest to engine

Indication	Action to be taken
No fuel in sight glass closest to engine.	A. Check contents of fuel tank. B. Check control Circuit Breaker is ON. C. Check Fuel Pump Circuit Breaker is ON. D. Check Control and Fuel Pump Switch is ON. E. Check that Main Battery Switch is CLOSED. F. Check fuel pump motor is running with fuel prime switch at "PRIME".
Fuel Pump Motor is running but there is no fuel in the sight glass closest to engine.	A. Check contents of fuel tank. B. Check for leaks or loose connections in suction piping between tank and pump. C. Check for broken or slipping coupling between motor and pump. D. Check drain valve on Michiana Fuel Filler is closed.

FAULT 5 – Fuel flowing through by-pass (right-hand) sight glass.

Indication	Action to be taken
Fuel Pump motor is running and fuel is flowing in both sight glasses.	A. Report to E/C Diesels or the Locomotive Engineer through control, if glass is more than half full.

FAULT 6 – Engine stop.
Fault light ON. Engine protect light ON (faulty unit only).

Indication	Action to be taken
Audible alarm sounds and Comp. and Engine Protection light will shine if (B) is the fault. If (F) is the fault, engine will stop when isolation switch is turned to run position. NOTE: If engine stops, auxiliary generator/alternator failure light will be on when isolation switch is in run position.	A. Check overspeed trip lever – Pull anti-clockwise to reset. B. Check that low oil pressure button on governor is IN – Refer also Fault 13. C. Check that Control circuit breaker on Isolation Switch panel is ON. D. Check that Fuel Pump circuit breaker on isolation switch panel is ON. E. Check that Control and Fuel Pump switch on Driver's Control panel is ON. F. Check that throttle is not in STOP position. G. Check fuel flow through the sight glass with fuel prime switch at "PRIME". H. If engine will restart and again shuts down after short period, check auxiliary generator field Circuit Breaker.

FAULT 7 – Engine will not speed up when throttle is opened.

Indication	Action to be taken
	A. Check that Isolation Switch is in RUN. B. Check that Engine Run Switch is ON. C. Check that Control and Fuel Pump switch is ON. D. Check that train pipe pressure is greater than 413kPa. E. Check that Control circuit breaker is ON.

FAULT 8 – Engine speeds up but locomotive will not move when throttle is opened.

Indication	Action to be taken
Load indicating ammeter shows no current. Load indicating ammeter shows current but locomotive does not move.	A. Check that Generator Field Switch on Driver's Control Stand is ON. B. Check that Reverser Handle is in FORWARD or REVERSE. C. Check Local Control Circuit Breaker is ON. D. Check Generator Field Circuit Breaker is ON. A. Check that hand and air brakes are fully released.

FAULT 9 – Loss of Power and Engine goes to idle.

Indication	Action to be taken
Due to failure to acknowledge the alerting system, buzzer alarm sounds, alarm light is illuminated and brakes apply on locomotive and train. Load indicating ammeter shows no current.	A. Allow the train to come to a halt. Do not move the throttle handle. B. Close the throttle to IDLE. When the brake system recharges, proceed with normal locomotive operation. If the throttle has been in IDLE it will be necesary to momentarily depress an acknowledgement button.
Due to fault light ON, ground light ON (on faulty locomotive) and audible alarm sounding, lead indicating ammeter indicating no current.	A. Allow 10 to 20 seconds for Ground Relay to reset. If ground relays continue follow Departmental procedure Automatic Ground Relay Reset and cut out traction motors to isolate fault. If, after operating the motor cutout switch, the fault is still apparent, open the ground relay cutout. Check that all wheels are turning and there is no smell of burning. If everything appears normal, clear the section ONLY. (Details of automatic ground reset can be found in Section Locomotive Systems.

FAULT 9 (cont'd) – Loss of Power and engine goes to idle.

Indication	Action to be taken
No apparent cause.	A. Check control circuit breaker is ON. B. Check Local Control circuit breaker is ON. C. Check Control and Fuel Pump switch is ON. D. Check Engine Run switch is ON. E. Check Isolation Switch is in RUN position. F. Request assistance from control.

FAULT 10 – Loss of Power and engine stops.

Indication	Action to be taken
Due to overpeed trip, engine stops after working in high-throttle notches.	A. Close the throttle, turn isolation switch to START. Reset overspeed trip lever – pull anti-clockwise to reset. Restart engine in the normal manner.
Due to low oil pressure audible alarm sounds and Comp Fault light will be on. Compressor/ engine light will be on. (Faulty locomotive only).	A. Close the throttle, turn Isolation Switch to START. Reset oil pressure button on the governor by pushing it in. B. Check engine oil level. Check overspeed trip. Reset the engine in the normal manner – Refer also Fault 13.
Due to lack of fuel. Engine labours, then stops. No fuel in sight glass closest to engine. When fuel prime switch is turned prime.	A. Close throttle, turn Isolation Switch to START. B. Check Control and Fuel Pump Switch. Control Circuit Breaker and Fuel Pump Circuit Breaker are ON.
NOTE: If engine stops, Auxiliary Generator Alt fail light and Compressor and engine protection light will be on, and if Isolation Switch is in RUN position the audible alarm will sound. Turn Isolation to START before checking cause of shut-down.	C. Check that main Battery Switch is closed. D. Check contents of fuel tank. E. Restart engine in normal manner. F. Check Fuel Pump is running, if not check Auxiliary Generator Field Circuit Breaker.

FAULT 11 – Auxiliary Generator/Alternator Fail light on, faulty locomotive. Audible alarm sounds with engine running.

Indication	Action to be taken
If battery ammeter shows continuous discharge.	A. Shut engine down. B. Check Aux Gen Output Circuit Breaker. C. Check Aux Gen Field Circuit Breaker. D. Check Alternator Field Fuse. E. If fuses OK restart engine and switch emergency switch to VR FAIL position. F. Increase engine speed to Notch 8. G. If battery charge ammeter shows charge, and light and bell go off, return throttle to idle and proceed. NOTE: Under these conditions, the engine cooling fans will operate in Notch 8 only and engine water temp must be closely watched until section is cleared. H. If ammeter does not show charge, and light and bell remain on after checking A to F, return throttle to IDLE and place emergency switch in "AG/ALT. FAIL" position and clear section. Lights remain on, but bell is silenced. NOTE: Engine cooling water temp must be closely watched as the engine cooling fans will not operate with the emergency switch in this position.
If Battery Charge Ammeter shows charge.	A. Check auxiliary alternator field fuse. B. If fuse blown replace it and proceed. C. If light and audible alarm remain on, turn emergency switch to AG/ALT FAIL position and clear section, watching engine temperature as fans will not operate. NOTE: If emergency switch has been moved to either VR FAIL or AG/ALT FAIL position, Dynamic brakes and Manual Power Control will not operate.

FAULT 12 – High Water Temperature

Indication	Action to be taken
Fault light ON. Hot engine light ON (Faulty Locomotive).	A. If possible, reduce power. Stop the locomotive when convenient but leave engine running. B. Check water level in header tank. Light goes out and bell stops ringing when engine water temperature drops to 92.2°C. C. Check Emergency switches in normal position. See Section C Fault 11. D. Check for conditions existing as in Fault 11.

FAULT 13 – Engine Protection – Incorporating protection for Low Oil Pressure, High Lubrication Oil Temperature, Low Water Level and/or Pressure and Excess Crankcase Pressure. Also Compressor Oil Pressure Failure.

Indication	Action to be taken
Fault lights ON. Engine Protection light ON. Audible alarm sounds and engine does not shut down. Fault is compressor oil pressure failure.	A. Shut engine down and check compressor oil level. B. Restart engine. If alarm still operates locomotive is a failure.
Fault light ON. compressor and engine protect light ON (faulty unit). Audible alarm sounds and engine shuts down.	A. Close the throttle and stop the train. B. RESET low oil button on governor. C. Check engine oil and water levels and if all are normal then have the fireman stand by to reset "Crankcase" and/or "Low Oil" button. D. START the engine and allow it to idle with the Isolation Switch in START. If audible alarm and light remain on, shut locomotive down – locomotive now a failure.

FAULT 13 (Cont'd) – Engine Protection.

Indication	Action to be taken
	E. When the engine is idling, both reset buttons may be pushed in by the fireman. The buttons must be pushed fully home and held for several seconds to allow the device to latch. This must be done within 35 seconds of the engine being started or another shut down will occur. F. If after 40 seconds light and audible alarm come on and another shut down occurs with neither reset buttons having come out, repeat procedure and have fireman note the oil pressure. If oil pressure is normal and a third alarm occurs, request assistance as the locomotive is a failure due most likely to a high lubricating oil temperature.

NOTE: DO NOT REPEATEDLY START ENGINE IF LOW OIL PRESSURE BUTTON KEEPS SHUTTING DOWN THE ENGINE.

FAULT 14 – Fire Alarm

Indication	Action to be taken
Fault, Wheelslip, Brake Cylinder Pressure Lights ON, Fire Alarm light on (Fault locomotive), audible alarm sounds.	A. Stop the train. B. Stop the engine – this may be done by moving the throttle to "EMERGENCY STOP" position, provided brake pipe pressure exceeds 310kPa. Should brake pipe pressure be reduced below 310kPa it will be necessary to turn the isolation switch to START and stop the engine in the normal manner. C. Switch the fuel pump circuit breaker OFF. D. Ascertain that a fire outbreak has actually occurred by observing through the engine room doors. E. To extinguish a fire in the engine room, operate the large fixed BCF extinguisher until the fire is out. The small extinguisher is portable.

FAULT 14 (Cont'd) – Fire Alarm

Indication	Action to be taken
	In the event of the main or hand extinguishers being operated by accident, or in the case of fire, the matter MUST be reported as soon as possible. NOTE: If under item (4) above, it is found that no outbreak of fire has occurred, the audible alarm may be cancelled by placing the fire alarm cancel switch in the CANCEL position. The fire alarm light however, will continue to be ON. Note on the log sheet.

FAULT 15 – Heavy Power Application in Notch 1.

Indication	Action to be taken
Fault light flashes. Excitation limit light ON (faulty unit annunciator panel).	No immediate action required. Note problem on log sheet.

MISCELLANEOUS GENERAL DATA

2470

Model Designation	GL 22C-2
Locomotive Type	(C.C) 0660
Locomotive Rating	1230/1119KW
Diesel Engine	
Model	645E
Type	Normally Aspirated
Number of Cylinders	12
Cylinder Arrangement	45° "V"
Cylinder Bore and Stroke	230.13 x 254mm
Operating Principle	2 Stroke Cycle, Roots Blower Aspirated, Unit Injection, Water Cooled
Full Speed	904 RPM
Idle Speed	235/300 RPM
Main Generator Model	AR 6-G-D14 or AR 6-G-D18
Traction Alternator	AR 6-G
Number of Poles	10
Nominal Voltage (DC)	600
Frequency (at 900 RPM)	75 Hz
Companion Alternator	D14 or D18
Nominal Voltage (AC)	180
Frequency (at 900 RPM)	120 Hz
Auxiliary Generator	
Voltage (DC)	74
Rating	18KW-AC
Traction Motors	
Model	D29
Number	6
Type	DC, Series Wound, Axle Hung
Driving Wheels	
Number	6 pair
Diameter	1016mm
Gear Ratio	63 : 14
Top Speed	99.7 km/h
Speed at Continuous (as limited by adhesion	19.3 km/h approx.

Air Compressor
- Type WBO 8133 or WBO 8108 ..... Gardner Denver
- Number of Cylinders 3
- Capacity (at 900 RPM) ..... 5663 litres
- Air Compressor Cooling ..... Water Cooled
- Lube Oil Capacity ..... 12.5 litres

Storage Battery
- Number of Cells 32
- Voltage 64
- Rating (5 Hours) ..... 285 Amp Hr

Supplies
- Lubricating Oil Capacity ..... 627 litres
- Cooling Water Capacity ..... 795 litres
- Fuel Capacity ..... 6365 litres
- Sand ..... 0,87 m__

Air Brakes ..... Type 26L
Approximate Weight on Rails ..... 91.8 tonnes
Weight on Drivers 100%

Major Dimensions
- Length Over Headstocks 17043mm
- Width Over Underframe 2768mm
- Overall Height – Top of Rail to Top of Exhaust Stack 3848mm

Minimum Curve Radius ..... 80.46 Metres

MISCELLANEOUS GENERAL DATA

2170

Model Designation	GL 22C-2
Locomotive Type	(C.C) 0660
Locomotive Horsepower	1641/1492KW
Diesel Engine	
Model	645E
Type	Normally Aspirated
Number of Cylinders	16
Cylinder Arrangement	45° "V"
Cylinder Bore and Stroke	230.18 x 254mm
Operating Principle	2 Stroke Cycle, Roots Blower Aspirated, Unit Injection, Water Cooled
Full Speed	904 RPM
Idle Speed	235/300 RPM
Main Generator Model	AR 6-G-D18
Traction Alternator	AR 6-G
Number of Poles	10
Nominal Voltage (DC)	600
Frequency (at 900 RPM)	75 Hz
Companion Alternator	D18
Nominal Voltage (AC)	180
Frequency (at 900 RPM)	120 Hz
Auxiliary Generator	
Voltage (DC)	74
Rating	18KW-AC
Traction Motors	
Model	D29
Number	6
Type	DC, Series Wound, Axle Hung
Driving Wheels	
Number	6 pair
Diameter	1016mm
Gear Ratio	63 : 14
Top Speed	99.7 km/h
Speed at Continuous (as limited by adhesion	19.3 km/h approx.

900
1300

GENERAL DATA

Air Compressor
- Type WBO 8133 ..... Gardner Denver
- Number of Cylinders 3
- Capacity (at 900 RPM) ..... 7192 litres
- Air Compressor Cooling ..... Water Cooled
- Lube Oil Capacity ..... 12.5 litres

Storage Battery
- Number of Cells 32
- Voltage 64
- Rating (5 Hours) ..... 285 Amp Hr

Supplies
- Lubricating Oil Capacity ..... 918 litres
- Cooling Water Capacity ..... 795 litres
- Fuel Capacity ..... 2725/7275 litres
- Sand ..... 0,87 m

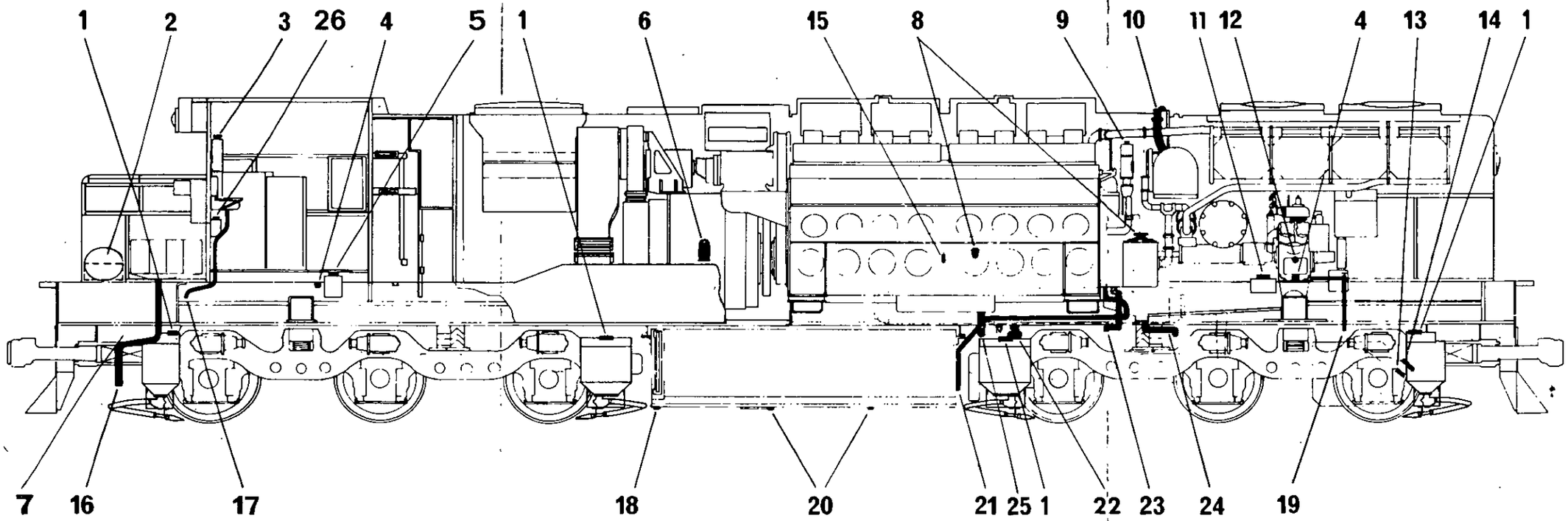
Air Brakes ..... Type 26L

Approximate Weight on Rails ..... 91.8/97.54 tonnes

Weight on Drivers 100%

Major Dimensions
- Length Over Headstocks 17043mm
- Width Over Underframe 2768mm
- Overall Height – Top of Rail to Top of Exhaust Stack 3848mm

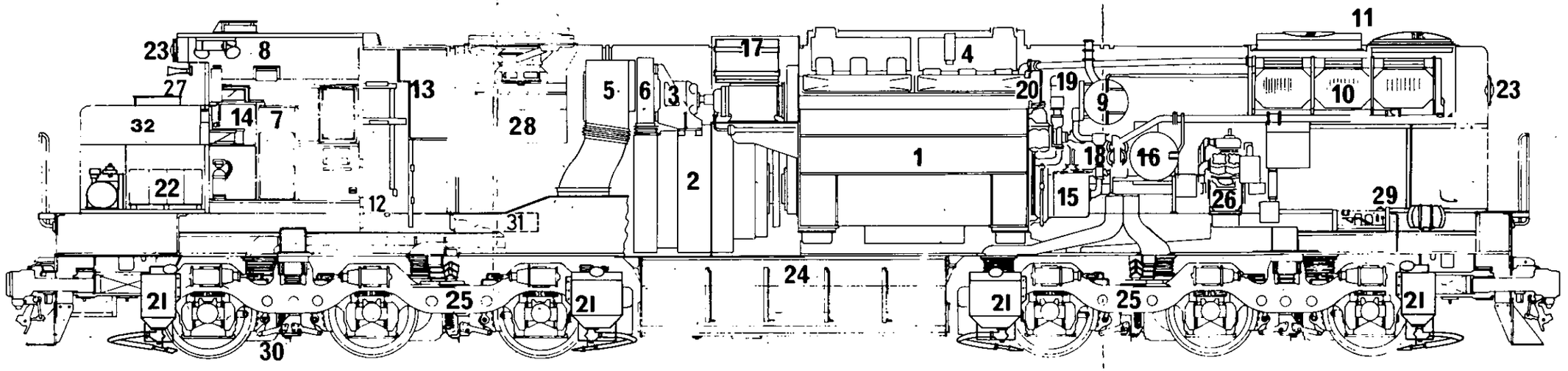
Minimum Curve Radius ..... 80.48 Metres



FILL AND DRAIN POINTS
LOCOMOTIVES 2170 CLASS

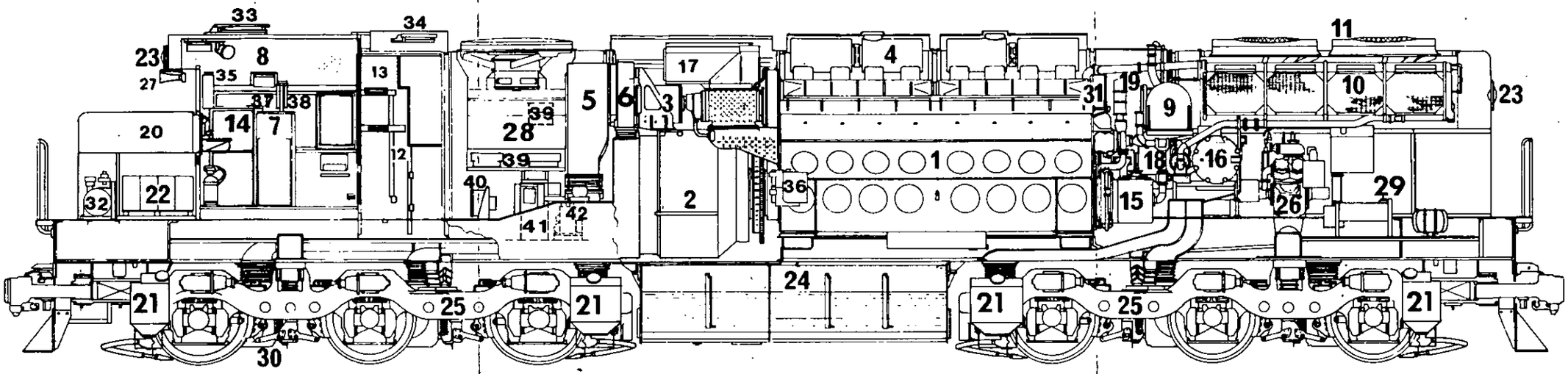
1. SAND BOX FILTER/FILLER
2. WASH BASIN WATER TANK
3. DRINKING WATER CONTAINER
4. CENTRE POINT LUBRICATOR FILTER
5. No. 1 END FLANGE LUBRICATOR RESERVOIR
6. FUEL FILTER — BOTH SIDES
7. AIR CONDITIONER DRAIN
8. ENGINE LUBRICATING OIL
9. GOVERNOR
10. RADIATOR WATER TANK
11. No. 2 END FLANGE LUBRICATOR RESERVOIR
12. COMPRESSOR LUBRICATING OIL
13. TRACTION MOTOR BERAINGS (12)
14. TRACTION MOTOR GEAR CASES (6)
15. DIP STICK
16. BATTERY BOX DRAIN
17. WASH BASIN OUTLET
18. FUEL TANK WATER DRAIN
19. COMPRESSOR OIL DRAINS
20. CLEANING HOLES AND DRAINS
21. AIR BOX DRAIN
22. AIR RESERVOIR — BOTH SIDES
23. WATER SYSTEM DRAIN
24. ENGINE COMPARTMENT DRAIN
25. ENGINE SUMP DRAIN
26. WINDSCREEN WASHER RESERVOIR

LOCOMOTIVE
MODEL GL22C-2



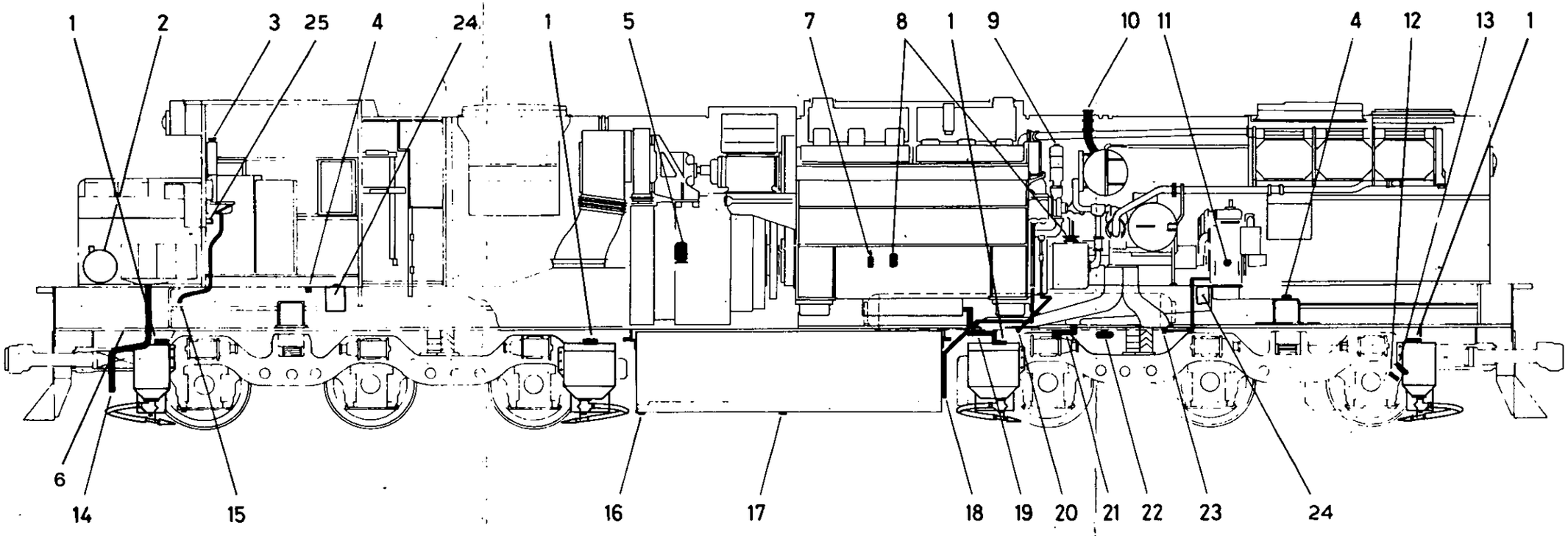
SECTIONAL ELEVATION
2470 CLASS LOCOMOTIVES

1. ENGINE
2. ALTERNATOR
3. AUXILIARY GENERATOR
4. EXHAUST MANIFOLD
5. TRACTION MOTOR BLOWERS
6. MAIN GENERATOR BLOWER
7. DRIVER'S BRAKE STAND
8. TRANSMITTER/RECEIVER EQUIPMENT
9. ENGINE WATER TANK
10. RADIATOR
11. RADIATOR FANS
12. ALERTING SYSTEM
13. ELECTRICAL CABINET
14. DRIVER'S CONTROL STAND
15. OIL STRAINER
16. OIL FILTER
17. ENGINE AIR FILTER (DYNACELL)
18. OIL COOLER
19. (a) GOVERNOR
    (b) LOW OIL PRESSURE BUTTON (GOVERNOR SIDE)
20. (a) LAY SHAFT LEVER
    (b) ENGINE DETECTOR/CRANKCASE PRESSURE
21. SAND BOXES
22. BATTERY BOX
23. HEADLIGHTS
24. FUEL TANK
25. TRUCKS
26. COMPRESSOR
27. AIR HORNS
28. DYNAMIC BRAKE UNIT
29. BRAKE EQUIPMENT RACK
30. TRACTION MOTOR
31. ELECTRICAL CABINET AIR FILTER
32. AIR CONDITIONING UNIT



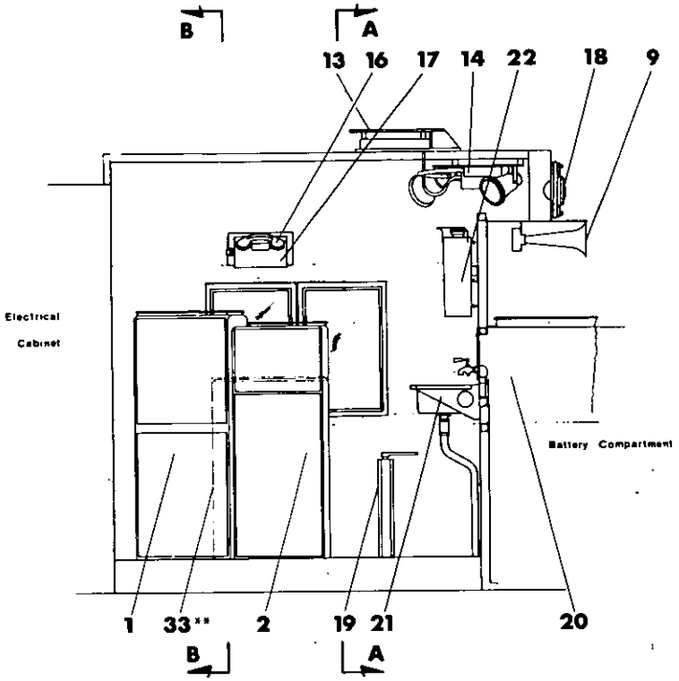
SECTION ELEVATION
2170 CLASS LOCOMOTIVES

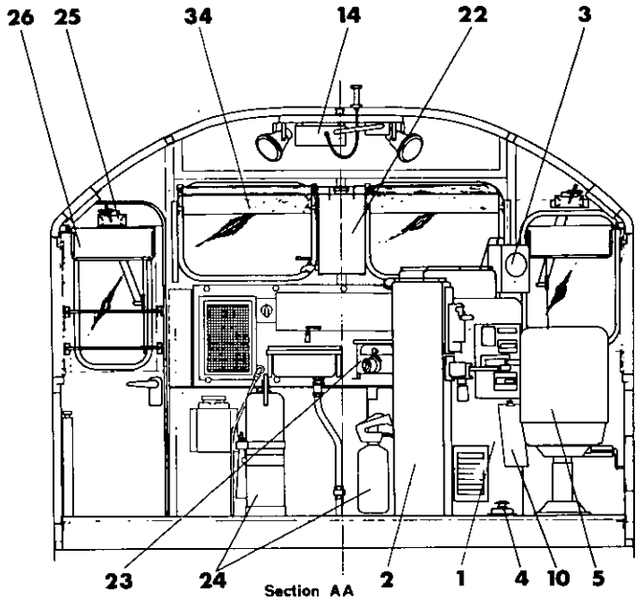
1. ENGINE
2. TRACTION ALTERNATOR AUXILIARY ALTERNATOR
3. AUXILIARY GENERATOR
4. EXHAUST MANIFOLD
5. TRACTION MOTOR BLOWERS
6. TRACTION ALTERNATOR BLOWER
7. DRIVER'S BRAKE STAND
8. VOICE RADIO EQUIPMENT
9. ENGINE WATER TANK
10. RADIATOR
11. RADIATOR FANS
12. ELECTRICAL CABINET
13. MODULE CABINET
14. DRIVER'S CONTROL STAND
15. OIL STRAINER
16. OIL FILTER
17. ENGINE AIR FILTERS (DYNACELL)
18. OIL COOLER
19. GOVERNOR
20. AIR CONDITIONING UNIT
21. SAND BOXES
22. BATTERY BOX
23. HEADLIGHTS
24. FUEL TANK
25. TRUCKS
26. COMPRESSOR
27. AIR HORNS
28. DYNAMIC BRAKE UNIT
29. BRAKE EQUIPMENT RACK
30. TRACTION MOTOR
31. LAY SHAFT LEVER
32. WATER TANK HAND BASIN
33. VOICE RADIO ANTENNA
34. DATA RADIO ANTENNA
35. DRINKING WATER RESERVOIR
36. STARTER MOTORS
37. LOCOTROL CONSOLE
38. LOCOTROL AIR BRAKE CONSOLE
39. DATA RADIO UNITS AND FILTER
40. INTERFACE CABINET
41. LOGIC CABINETS AND POWER SUPPLY
42. AIR BRAKE MANIFOLD

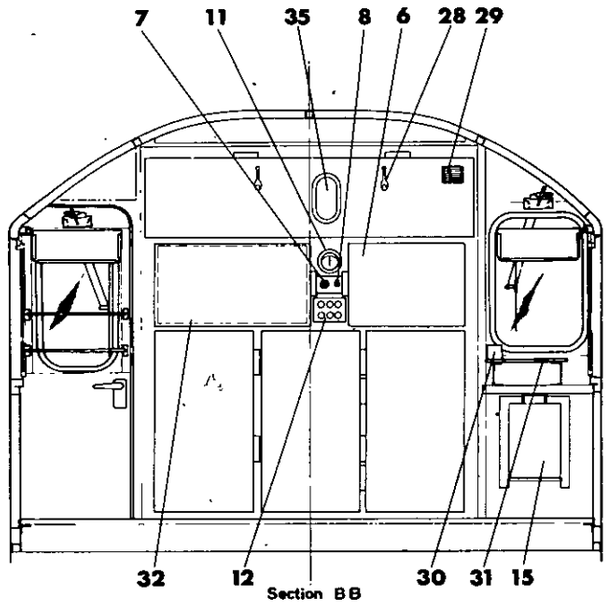


FILLING AND DRAINING POINTS
LOCOMOTIVES 2470 CLASS

1. SAND BOX FILLER/FILTER
2. WASH BASIN TANK
3. DRINK WATER CONTAINER
4. CENTRE PIVOT LUBRICATOR
5. FUEL FILLER — BOTH SIDES
6. AIR CONDITIONING DRAIN
7. DIP STICK — BOTH SIDES
8. ENGINE LUBE OIL
9. ENGINE GOVERNOR
10. RADIATOR WATER TANK
11. COMPRESSOR LUBE OIL
12. TRACTION MOTOR BEARINGS
13. TRACTION MOTOR GEAR CASES
14. BATTERY BOX DRAINS
15. WASH BASIN OUTLET
16. FUEL TANK WATER DRAIN
17. CLEANING HOLES AND DRAINS
18. AIR BOX DRAINS
19. ENGINE SUMP DRAIN
20. WATER SYSTEM DRAIN
21. ENGINE COMPARTMENT DRAIN
22. AIR RESERVOIR DRAIN — BOTH SIDES.
23. AIR COMPRESSOR LUBE OIL DRAIN
24. FLANGE LUBRICATOR RESERVOIR
25. WINDSCREEN WASHER RESERVOIR



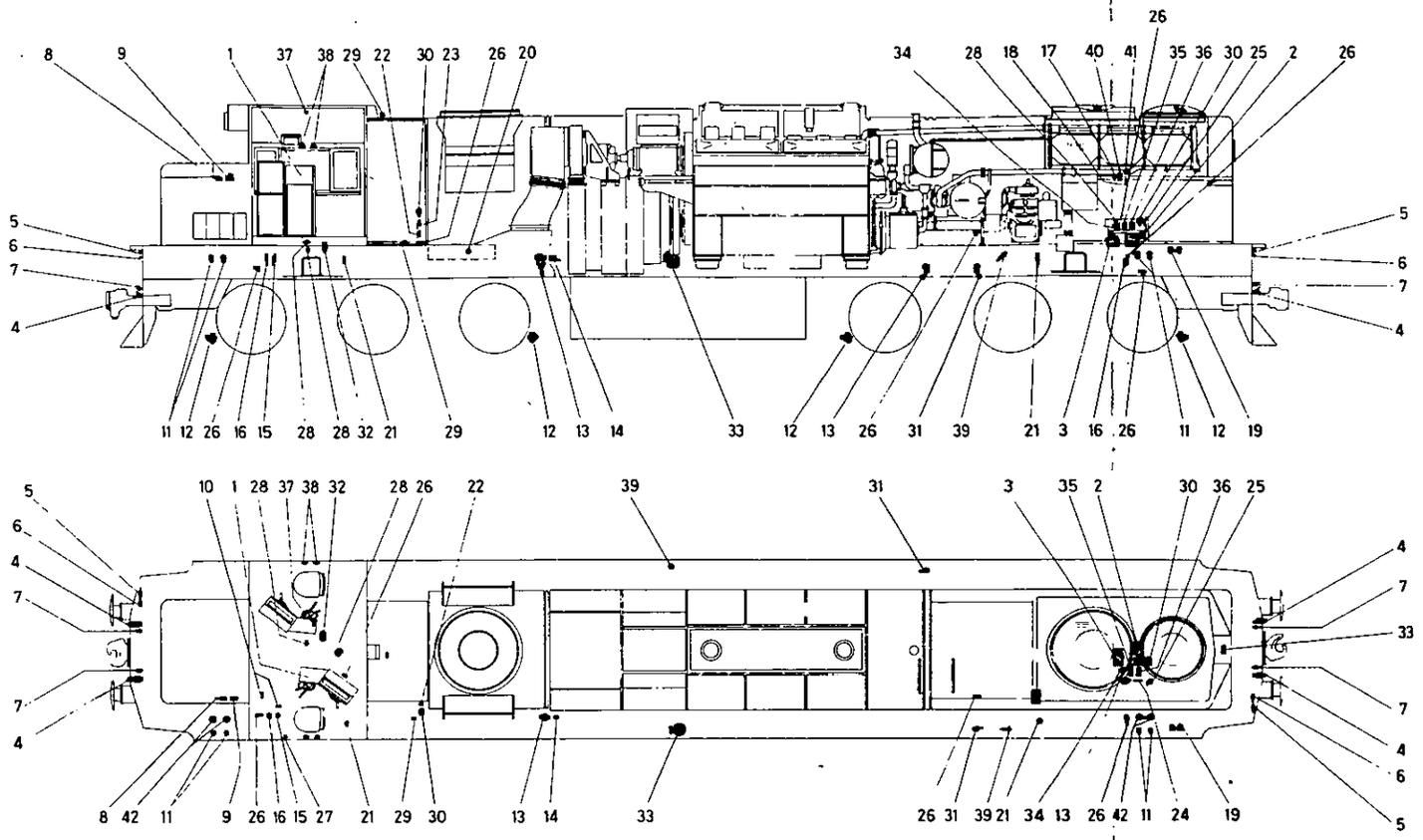




CAB LAYOUT

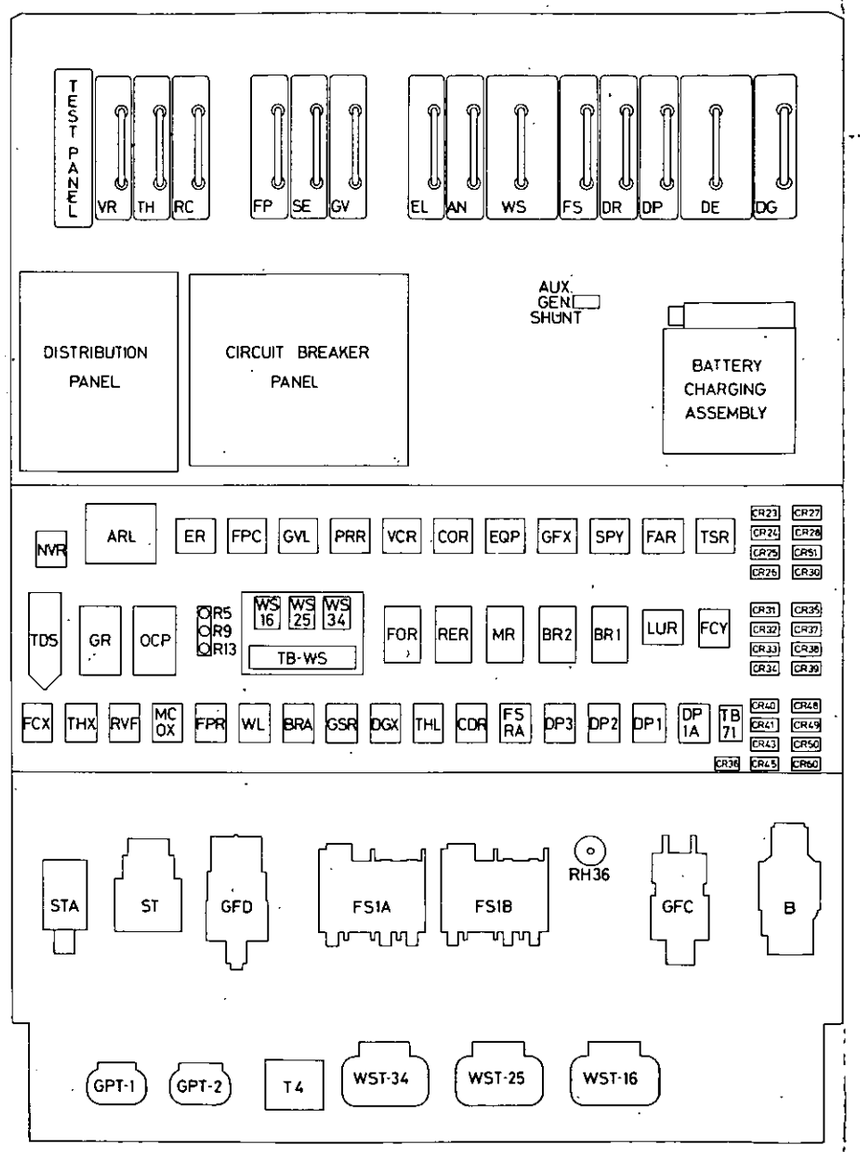
1. DRIVER'S CONTROL STAND
2. DRIVER'S BRAKE STAND
3. SPEEDOMETER/RECORDER
4. FOOT SAND BUTTON
5. DRIVER'S SEAT
6. ELECTRICAL CABINET DOORS
7. D.S.D. RESET SWITCH
8. FIRE ALARM CANCEL SWITCH
9. AIR HORN
10. DRIVER'S CLIPBOARD
11. BATTERY CHARGING AMMETER
12. FAULT INDICATION LIGHTS
    Aux Gen/Alt Fail, Ground Relay, Hot Engine, Fire Alarm, Comp. & Eng. Prot., Test.
13. RADIO ANTENNA
14. TRANSCEIVER EQUIPMENT
15. STATIC CONVERTER
16. RADIO TELEPHONE HAND SET
17. CAB LIGHT
18. HEADLIGHT
19. EMERGENCY BRAKE COCK
20. AIR CONDITIONING UNIT
21. WASH BASIN
22. DRINKING WATER CONTAINER
23. HOT PLATE
24. FIRE EXTINGUISHERS
25. WINDSCREEN WIPER
26. SUN VISOR
27. COAT HOOK
28. PIPING COLOUR CODE PLATE
29. WATCH HOLDER
30. DRIVER'S TRAY
31. ISOLATION AND DISTRIBUTION PANEL
32. **FIREMAN'S CONSOLE
33. ROLLER BLIND
34. ANNUNICATOR INSPECTION WINDOW

**Not applicable for locomotives with dual driving stations.

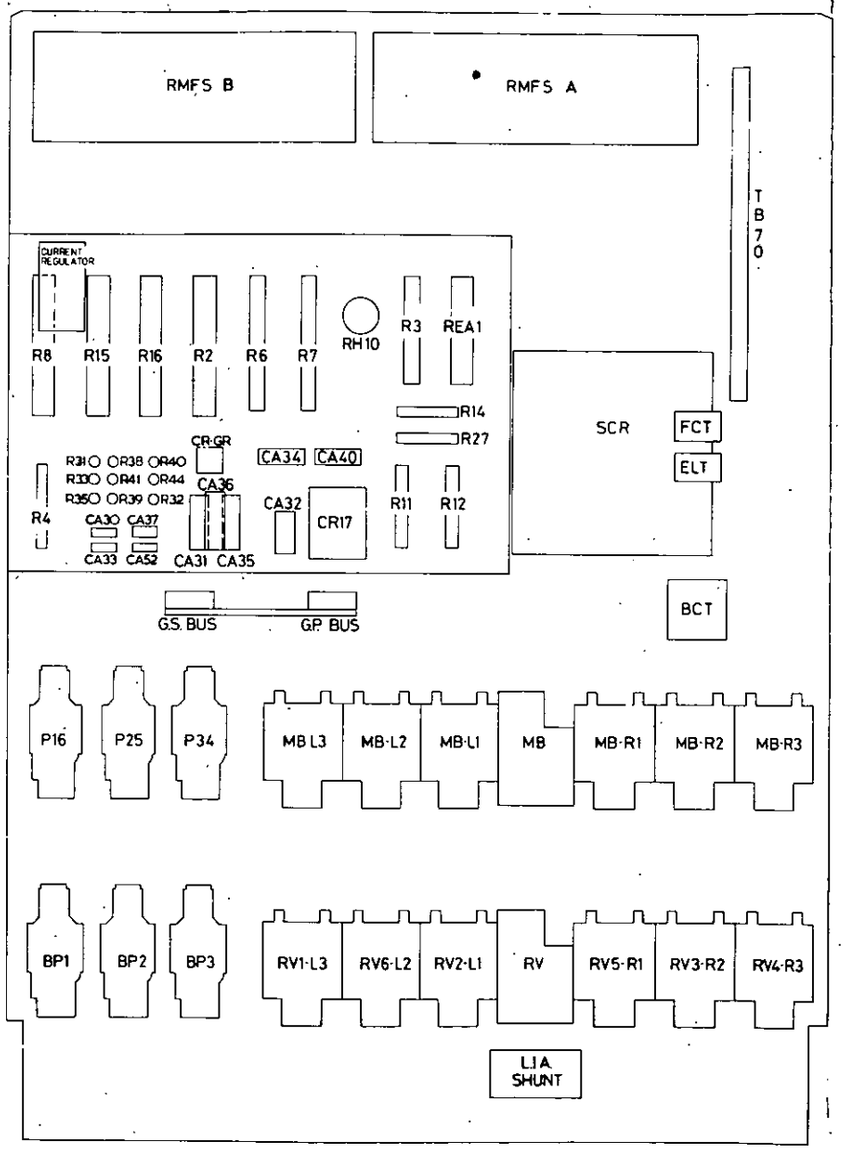


AIR EQUIPMENT

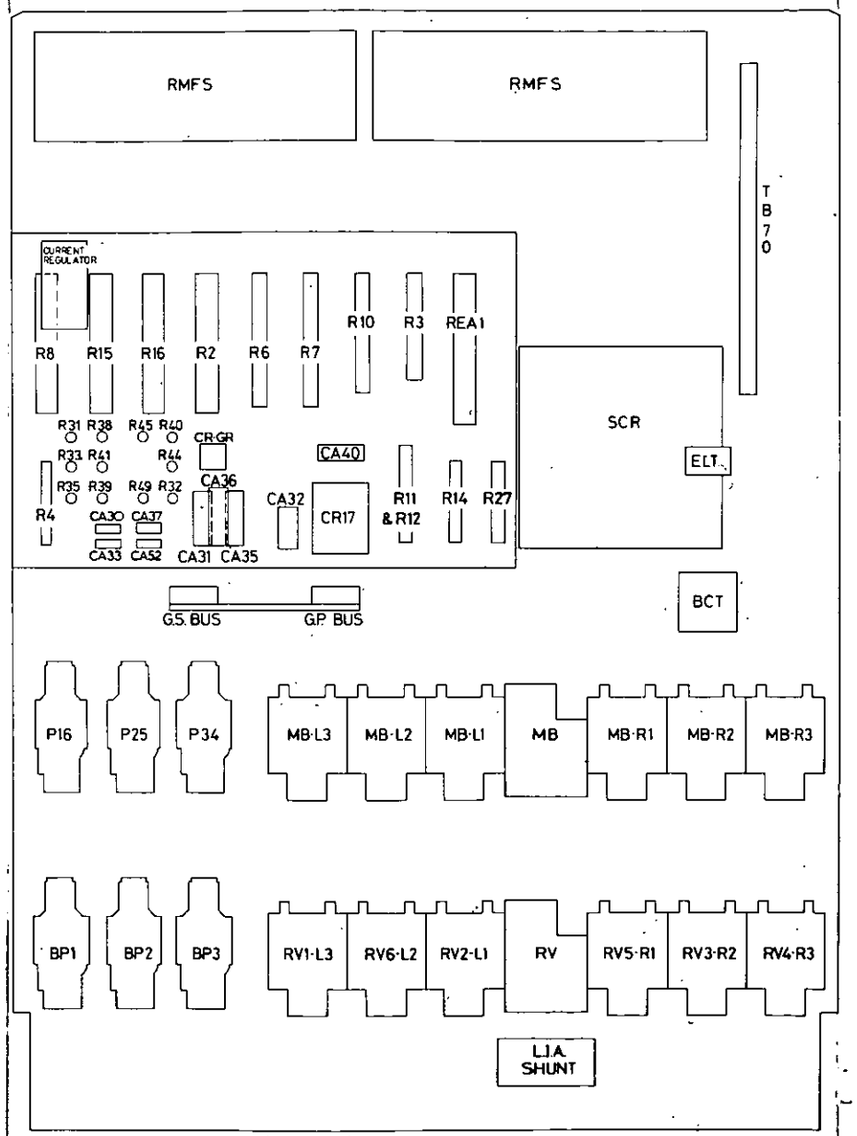
1. BRAKE VALVE STAND (INCLUDES FLOWMETER AND Mu-2A VALVE)
2. CONTROL VALVE TYPE 26D
3. RELAY VALVE TYPE J1
4. ISOLATING COCK — BRAKE PIPE
5. ISOLATING COCK — MAIN RESERVOIR EQUALIZING
6. ISOLATING COCK — CONTROL PIPE No.3
7. ISOLATING COCK — INDEPENDENT RELEASE PIPE No. 4
8. ALERTING SYSTEM — ISOLATING UNIT
9. EMERGENCY APPLICATION VALVE
10. FLOWMETER VENTURI
11. SANDING CONTROL VALVE
12. SAND TRAP
13. DIRT COLLECTOR
14. ISOLATION COCK — MAIN RESERVOIR EQUALIZING
15. SAND CLEAN OUT COCK
16. SAND ISOLATION COCK
17. COMPRESSOR UNLOADER MAGNET VALVE
18. COMPRESSOR UNLOADER ISOLATION COCK
19. DUPLEX SOLENOID VALVE (SANDING)
20. ELEC. CABINET AIR FILTER
21. BOGIE ISOLATION COCK
22. HORN & WINDSCREEN WIPERS ISOLATION COCK
23. DETONATOR SENSOR ALARM ISOLATION COCK
24. BRAKE PIPE ISOLATION COCK
25. DEAD ENGINE DEVICE
26. AIRLINE STRAINER
27. EMERGENCY BRAKE COCK
28. DOUBLE CHECK VALVE
29. CHECK VALVE
30. MAGNET VALVE
31. ROADSIDE SANDER COCK AND COUPLING HEAD
32. EMERGENCY SANDING SWITCH
33. No. 8 VENT VALVE
34. BRAKE CYLINDER PRESSURE SWITCH
35. INDEPENDENT PRESSURE SWITCH
36. DYNAMIC PNEUMATIC INTERLOCK
37. HORN VALVE
38. WINDSCREEN WIPER CONTROL VALVE
39. SAFETY VALVE
40. COMPRESSOR UNLOADER MAGNET VALVE
41. PRESSURE GUAGE
42. AIR FILTER (REAR OF 11)



ELECTRICAL CABINET - DRIVER'S CAB SIDE



ELECTRICAL CABINET - ENGINE ROOM SIDE
2150 CLASS



ELECTRICAL CABINET - ENGINE ROOM SIDE
2170 CLASS