

# New South Wales Government Railways

(303)



## ALCO DIESEL ELECTRIC LOCOMOTIVE

The two diesel electric locomotives which commenced running in goods service between Enfield and Broadmeadow on 30th November, 1951, were the first of twenty supplied by the American Locomotive Company from their Canadian Works at Montreal, the electrical equipment being made by the Canadian General Electric Company at Peterborough.

Although not streamlined, the equipment of these locomotives is practically the same as that in the streamliners, the only major difference being that in the design good visibility is given in all directions which renders them suitable for shunting as well as main line service.

The electrical controls are mounted between the generator compartment and the driving cab and are accessible from both sides. The various control relays are mounted on panels, fitted with aluminium covers, with all leads being brought to plug sockets. By undoing four holding screws and withdrawing the plug it is possible to replace a complete relay panel.

The locomotive body is mounted on two three-axle bogies which are of the fully equalised type giving the locomotive riding quality comparable with that of modern passenger rollingstock. The bogie centres are only 30 feet apart enabling the locomotive to negotiate curves having a minimum radius of 150 feet.

## Power Unit

The power unit is an Alco 12 cylinder V type diesel engine model and is a four cycle engine having a 9" bore and 10½" stroke, turbo-supercharged, with two intake and two exhaust valves per cylinder, water cooled cylinder liners and head, forged steel connecting rods, 7 bearing crank shaft, welded base and cylinder block. This diesel engine has been designed specifically for traction purposes and with the use of a G.E. turbo-supercharger it has been possible to design a very reliable light weight engine. The rated horsepower of the engine is 1,750 or 1,600 horsepower at the main generator and the speed range is 350 to 1,000 r.p.m. Engine starting is effected by using the main generator as a motor. The generator is wound with a special starting winding and current is supplied by the main batteries. Gear driven centrifugal pumps circulate water through the engines, radiators and lubricating oil filters. The engine temperature is maintained at a constant value by controlling the air flow through the radiators by means of modulated shutters and a variable speed radiator fan which is driven through an eddy current clutch. Thus the operation of this cooling system is entirely automatic and is fully interlocked with the other controls.

The two stage, three cylinder, air cooled, air compressor which supplies air to the brake system is direct driven by the diesel engine. The displacement at idling speed (350 r.p.m.) is 78.7 C.F.M. and at full engine speed (1,000 r.p.m.) 225 C.F.M. Two main reservoirs below the underframe have a total capacity of 60,650 cu. inches. Air brakes are Westinghouse type 6-SL. The main generator is a G.E. type GT-581 directly connected to the diesel engine. The exciter is mounted on the end of the main generator and is an amplidyne machine designed for use with the power plant regulator. There is also an auxiliary generator gear driven from the main generator

shaft. It supplies power for the battery charging, lighting and control circuits and operates at constant voltage under control of a regulator.

The traction motors are four pole direct current machines designed for operation with full or shunted fields. The armatures are equipped with roller bearings. Silicone insulating materials have been used in the windings giving a continuous current rating of 1,085 amps. The traction motors are nose suspended, there being two motors to each bogie, and are force-ventilated by means of flexible connections between the blower air duct on the underframe and the motor frames. A traction motor blower is supplied for each bogie. The motors are geared for a maximum speed of 75 miles per hour, the gear ratio being 65:18.

The storage battery is a 32 cell, 426 ampere hour lead acid type. It is installed in two battery boxes, one on either side at the rear of the operator's cab, above the underframe, there are 16 cells in each box.

#### Control Equipment

The locomotives are designed for multiple unit operation and as many as four units can be coupled together and controlled by one crew only.

The engine control stand is at the right of the operator's seat and contains throttle, selector handle, reverser handle, air brake valves, and circuit breaker type switches for generator fields, fuel transfer pump and control circuits, headlight switches, light switches, air brake gauges, speed and transition indicator, load meter, and wheel slip indicating lamp as well as signal light for low oil pressure, high engine water temperature and ground relays.

Reversers and line contactors are electro-pneumatically operated. All other contactors are operated magnetically.

The contactor compartment which contains the electrical control equipment is, as previously mentioned, located at the rear of the driving compartment. The apparatus is accessible through doors in the wall of the operating cab and through panels in the front portion. Louvres allow for adequate ventilation. Switches and meters are contained in the panel mounted on the compartment wall at the rear of the operating cab where they are accessible to the driver in the cab.

Manual, low voltage switches, of the circuit breaker type with resetting features are used on auxiliary circuits wherever overload protection is required.

Transition is manually controlled, both forward and backwards, by a selector handle and the four traction motors can be connected as series parallel full field, series parallel shunt field, parallel full field and parallel shunt field.

#### Excitation System and Power Plant Regulating System

The power plant regulating system modulates the diesel engine loading by controlling fuel to the diesel engines and adjusting generator demand. It holds constant any pre-set engine speed by limiting engine torque and adjusting generator demand to the ability of the engine to deliver power at any moment and for any set speed. The brain of this power plant regulating system is the G.E. governor. The governor is a hydraulic electric device which controls engine speed and engine load by matching generator demand with the engine ability, and controls engine torque at all engine speeds to the fuel limit at each throttle position. The position of the throttle handle governs the stop position for the fuel rack and also sets up electrical connections for a predetermined speed of the diesel engine. The governor is connected to the individual fuel pump racks by two fuel pump control shafts and a system of control linkages.

The electrical load is controlled by means of the amplidyne exciter. The governor has a load control rheostat which reduces the current in the control field of the amplidyne whenever the generator overloads the diesel engine and slows down below the rated speed for a given throttle setting.

To prevent an excess of current passing through the traction motors a load current limit is incorporated which again controls the output of amplidyne exciter thus reducing the generator output should the load current become excessive.

Regulation is extremely sensitive and the necessary balancing is effected instantaneously. The entire system is out of the hands of the operator and is so interlocked that there is no possibility whatsoever of the diesel engine being overloaded.

#### Wheel Slip Control

Another important feature of the control system is the improved method of handling power removal and re-application for wheel slip correction.

Fundamentally the desired action required to arrest and recover from a wheel slip involves:-

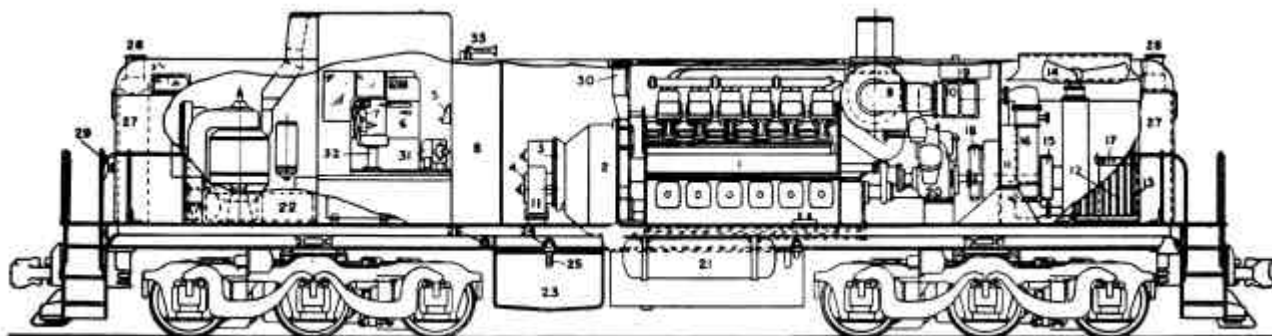
- (a) Quick-removal of power.
- (b) Smooth easy re-application of tractive effort so as not to re-establish the slip.
- (c) Execution of these actions in a minimum time.

The scheme making additional use of the current limit feature of the Alco-GE control system-accomplishes the above requirements to a highly successful degree. On a signal from the wheel slip relays the load current is instantly reduced and when the wheel slip relay drops out, the load current is allowed to restore to its former value at a smooth controlled rate. This is achieved by means of a time constant circuit. During this action neither power switching nor engine speed have been disturbed and performance is back to normal with a minimum loss of time and pulling power.

An additional benefit is realised from the action of this equipment in that it adds to the smoothness of transition.

General Characteristics of the Alco Locomotive.

Class.....	40
Gauge.....	4 ft. 8½ in.
Wheel classification.....	A1A-A1A
Builder.....	Montreal Locomotive Works
Power unit.....	One "V" type, 12 cylinder, 4 cycle, diesel
Horsepower to generator.....	1,600
Bore x stroke.....	9" X 10½"
Tractive effort:-	
Maximum.....	50,000 lbs.
Continuous.....	46,000 lbs. at 11 m.p.h.
Bogie centres.....	30 ft.
Wheel diameter.....	40 inches
Height (maximum) .....	14 ft.
Width (maximum) .....	9 ft. 10 ins.
Length over buffers.....	56 ft. 7¼ ins.
Weight.....	111½ tons
Axle loading.....	18½ tons
Maximum speed.....	75 m.p.h.
Brakes Westinghouse.....	6-SL
Supplies:-	
Fuel oil.....	1,200 imp. gallons
Lubricating oil.....	167 imp. gallons
Cooling water.....	208 imp. gallons



- 1—Engine.
- 2—Main Generator.
- 3—Exciter.
- 4—Auxiliary Generator.
- 5—Gauge Panel.
- 6—Control Stand.
- 7—Brake Valves.
- 8—Control Compartment.
- 9—Turbo Supercharger.
- 10—Turbo Supercharger  
Filters and Silencers.
- 11—Traction Motor Blowers.

- 12—Radiators.
- 13—Radiator Shutters.
- 14—Radiator Fan.
- 15—Radiator Fan Clutch.
- 16—Lubricating Oil Cooler.
- 17—Lubricating Oil Filters.
- 18—Lubricating Oil Strainer.
- 19—Engine Water Tank.
- 20—Air Compressor.
- 21—Main Air Reservoir.
- 22—Batteries.

- 23—Fuel Tank.
- 24—Fuel Tank  
Filling Connection.
- 25—Fuel Tank Gauge.
- 26—Emergency Fuel Cut Off.
- 27—Sand Boxes.
- 28—Sand Box Cover.
- 29—Hand Brake.
- 30—Generator Air Ducts.
- 31—Cab Heater.
- 32—Cab Seats.
- 33—Horn.