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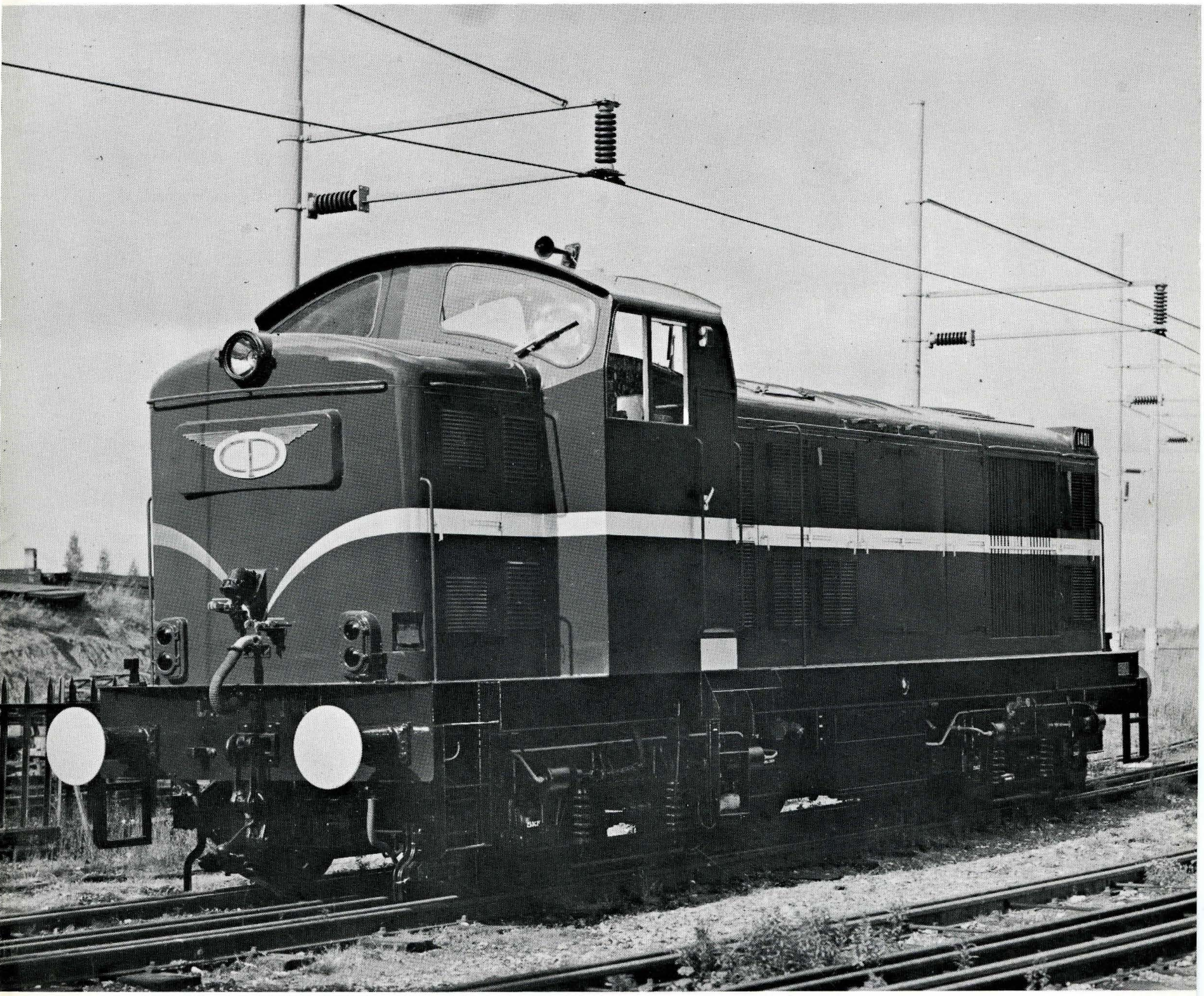
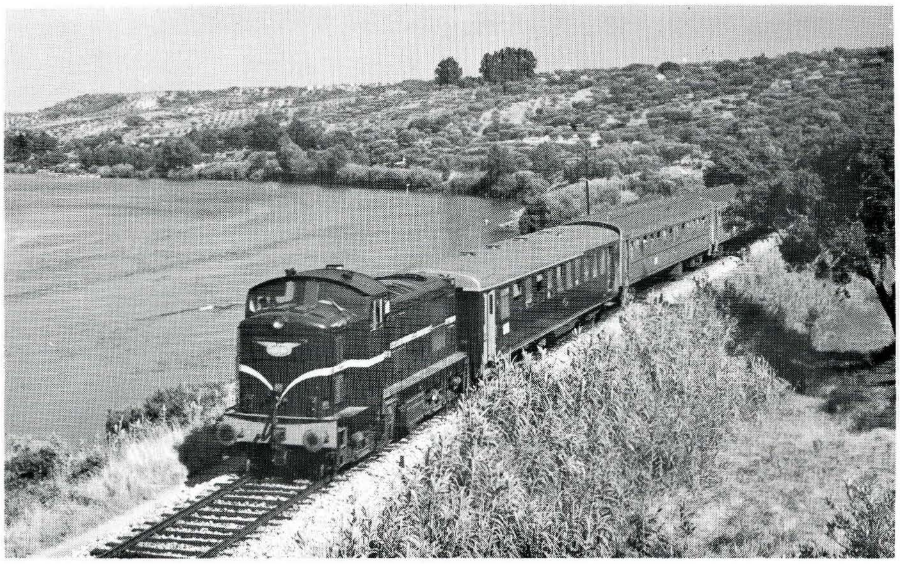


1350 hp DIESEL ELECTRIC LOCOMOTIVES FOR PORTUGAL

GEC Traction Limited

ENGLISH ELECTRIC | AEI



MIXED TRAFFIC DIESEL-ELECTRIC LOCOMOTIVES FOR PORTUGAL

These 1,350 hp locomotives now in service were Britain's first main line diesel export order for a European country

THE ORDER placed at the end of 1965 by Portuguese Railways with English Electric for 50 diesel-electric locomotives of 1,350 hp was Britain's first main line diesel export order for the European continent. Ten of these locomotives were to be built in Britain complete, and the other 40 locomotives were to be assembled in Portugal at the Sorefame Works near Lisbon using engines, equipment and materials provided from Britain. The first ten locomotives have now entered service in Portugal.

The Portuguese Railways has a considerable requirement for mixed traffic diesel locomotives for use on secondary lines, to supplement main line a.c. electrified services. In drawing up a specification stress was placed on the need for well tried components such as the engine, transmission and control gear, easy accessibility for maintenance, good visibility from a single cab to enable one man to operate the locomotive, and an axleload of not more than 16 tonnes because of bridge loading.

The design chosen was based on a steeple cab with bonnet superstructure, and the 8-cylinder English Electric diesel engine was used. Standard metre gauge traction motors, adequately rated for the performance requirements but fitted in a broad gauge bogie, give good accessibility.

The power to weight ratio (20·5 hp/tonne) is the highest achieved with any diesel-electric locomotive exported from Britain, but this light weight was not achieved by the use of expensive alloys, which make the repair of normal damage difficult, or by skimping underframe and bogies; it was brought about by judicious paring of non-essentials and simplification of layout.

Although this locomotive was specially designed to suit Portuguese conditions, it is nevertheless based upon other highly successful designs such as the B.R. Type 1 locomotive, of which 228 are already in service or on order.

Site conditions

The locomotives are for use on mixed traffic duties covering routes from Lisbon to Figueira da Foz (the coastal route north from Lisbon), and also in the regions of Beira Baja and Beira Alta (the eastern border of Portugal with Spain). The ruling gradient is 1·8 per cent, with minimum curves of 300 m radius (90 m in sidings). Maximum temperatures encountered are about 40 degC at sea level in the south of Portugal, and maximum altitude is about 900 m in the north of the country.

The speed-tractive effort curve is shown in Fig. 1. The maximum service speed of the locomotives is 105 km/h, and the maximum tractive effort of which the equipment is capable is 19,800 kg (representing 31 per cent nominal adhesion) at the wheel tread. The continuous rated tractive effort is 14,100 kg at 19 km/h.

For commissioning, each locomotive was required to haul a 400 tonne passenger trailing load on a gradient of 1·4 per cent, balancing at 36 km/h. The corresponding freight performance was 350 tonnes on a 1·8 per cent gradient at 30 km/h. In addition, each locomotive is capable of hauling a 1,100-tonne freight train up a 1 per cent incline at continuous rated speed and of hauling a 365-tonne passenger train at 105 km/h on the level.

Intensive tests

The commissioning runs of the first locomotive were successfully completed last February after an intensive programme lasting over a fortnight. High speed and accelerating runs drawing passenger stock were carried out on the main line between Lisbon and Oporto, and the maximum speed of 105 km/h on level track with 200 tonnes trailing was reached comfortably within the 4½ minutes specified. In the second test a balancing speed of 36 km/h was reached with 400 tonnes on a 1·4 per cent gradient.

The final and most arduous run was over the Beira Baixa route (Lisbon to Guarda) which lies in the deep ravine formed by the River Tagus. The section has a ruling gradient of 1·8 per cent, curves of 300 m, and speed restrictions over the numerous light girder bridges.

This test called for 350 tonnes to be hauled for 11 km between Rodam and Sarnadas up the 1·8 per cent gradient in 21 min 35 sec. It was completed in 18 min 29 sec, which so impressed the Railway staff that they decided to add a further 50 tonnes to the trailing load, making 400 total, which was then hauled in the time originally specified.

In addition to achieving performance results which were better than called for in the specification, the adhesion characteristic of the Bo-Bo locomotive was very good; 400 tonnes were started on wet rail without sand on a 1·8 per cent gradient with part of the train on a 300 m curve. The riding of the locomotive was excellent, particularly at high speed, with

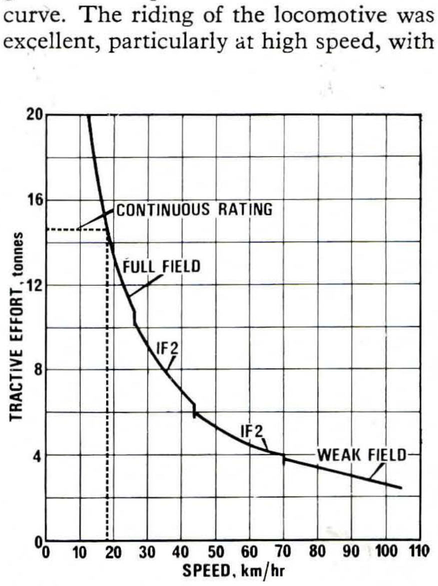
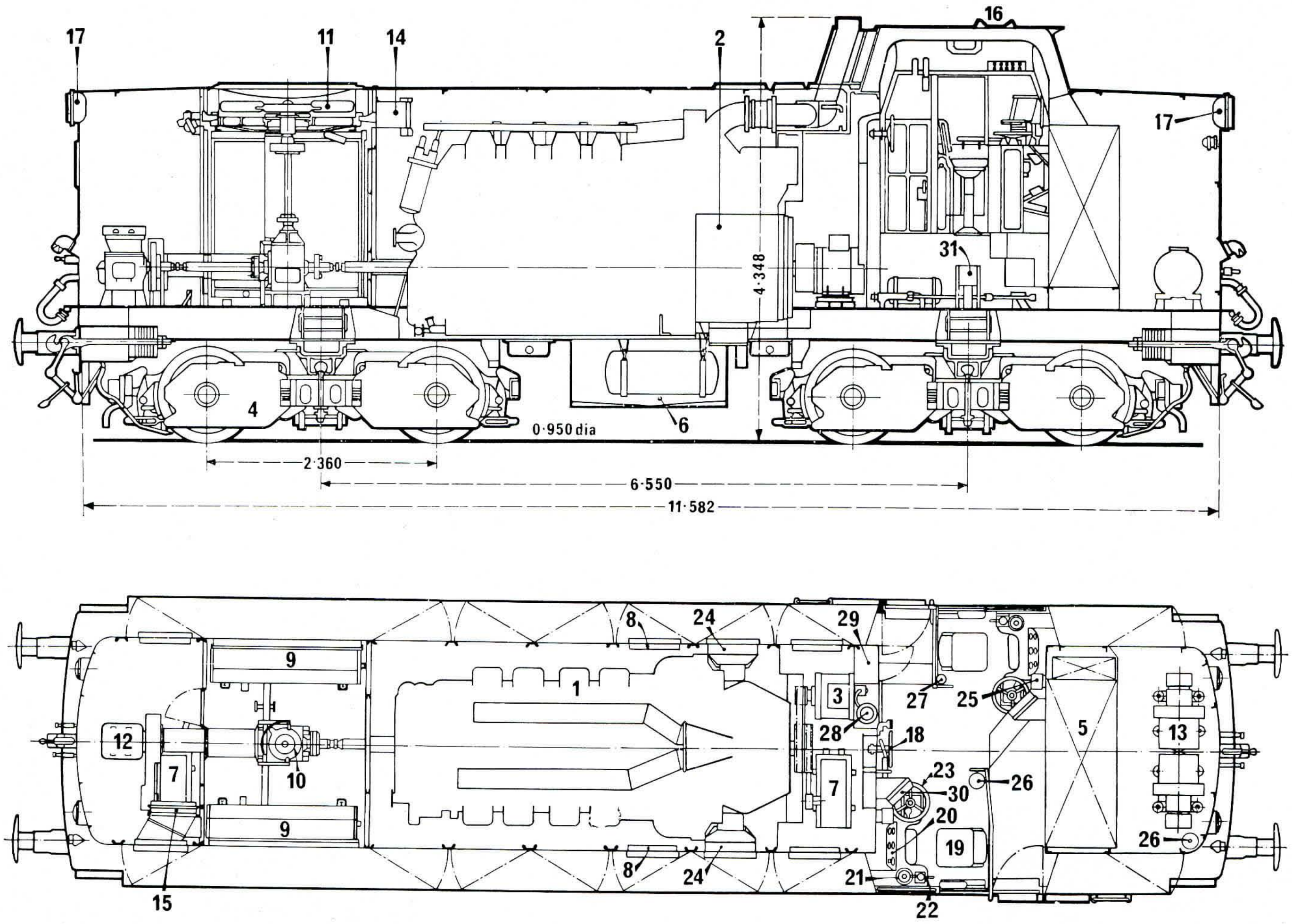


Fig. 1. Tractive effort characteristic



1. Engine (8CSVT)
2. Main generator (EE 819/9H)
3. Auxiliary generator (EE 736/7K)
4. Traction motor (EE 548/3A)
5. Control cubicle
6. Batteries (Nife 72-Cell Type DL 12)
7. Traction motor blower (KB 15)
8. Air filters
9. Radiator panels
10. Radiator fan drive
11. Radiator fan
12. Air compressor (2EC 72C)
13. Exhauster (Northey 125RE FM MK 10)
14. Water header tank
15. Horn
16. Headlamp
17. Handbrake
18. Driver's seat
19. Instrument panel
20. Brake valve (Vacuum)
21. Brake valve (Air)
22. Master controller
23. Engine air filter
24. Speed indicator & recorder
25. Fire extinguisher (15 lb)
26. Fire extinguisher (5 lb)
27. Hotplate
28. Wardrobe
29. Illuminated timetable
30. Heater for demisting
31. Intercooler (Air Compressor)

Fig. 2. Layout of equipment in the 1,350 hp locomotives for Portuguese Railways

a complete absence of nosing or vibration even when running over branch lines where track conditions were not of the best.

Principal details of the locomotive are given in the table. It has a bonnet with a single steeple cab about two-thirds of the way along the length, thus providing excellent visibility in both directions and permitting control by a single operator. The short nose end houses the main equipment frame and twin motor-driven rotary exhausters. The cab has two diagonally placed side driving positions, arranged for left hand drive. Steps allow access to the main equipment frame for maintenance.

The long nose end of the bonnet is divided into compartments separated by bulkheads. That nearest the cab is the power unit compartment containing the engine-generator set with belt driven auxiliary generator and one traction motor blower, both driven from the generator end by multiple-vee belts. Entry for main generator and engine air is through side louvres with oil-wetted panel filters, and the combustion air for the diesel engine is double filtered.

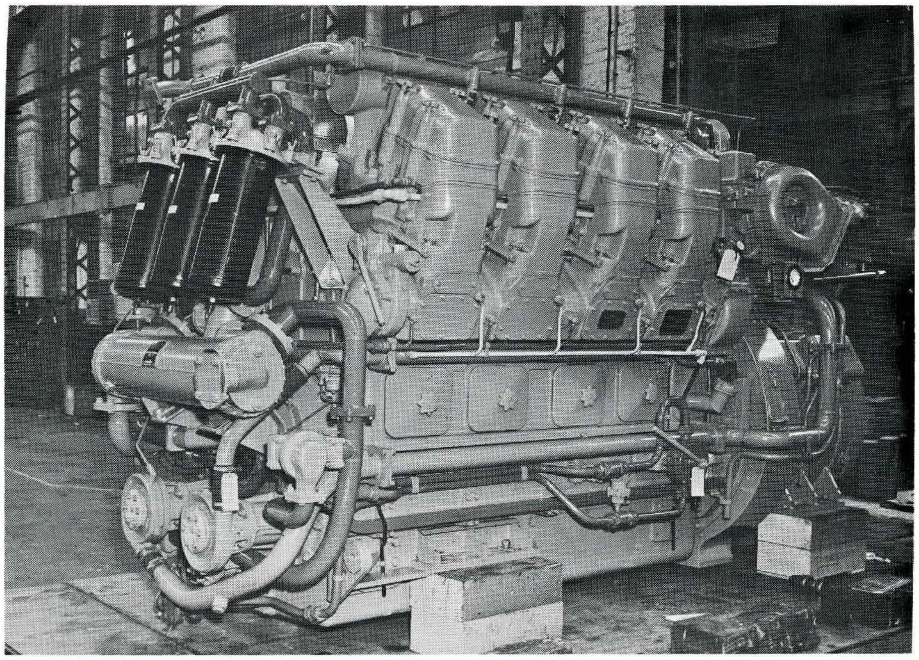
Next is the radiator compartment containing a right-angle gearbox driven from the free end of the diesel engine. This drives through a vertical shaft the 54 in diameter radiator fan, and through a horizontal shaft the reciprocating compressor and the second traction motor blower.

Principal details of mixed traffic locomotives

Gauge	1,668 mm
Wheel arrangement	Bo-Bo
Service weight	64 tonnes
Axleload	16 tonnes
Length over buffer beams	11,580 mm
Height to top of cab	4,355 mm
Width over platforms	3,000 mm
Bogie wheelbase	2,360 mm
Wheel diameter (new)	950 mm
Tractive effort (maximum)	19,800 kg continuous 14,100 kg at 19 km/h
Maximum speed	105 km/h
Fuel capacity	2,250 litres

Two radiator sections are used, one for engine jacket cooling water, the other for charge cooler water. The superstructure has steel lift-off doors on the long nose end for easy access, but the cab doors are of alloy. Removable roof sections also aid maintenance. The general arrangement (Fig. 2) shows the compartment layout.

The underframe is of box construction and has integral main fuel tanks, an arrangement which has been used by English Electric for nearly 20 years. The top deck is sealed to prevent oil seepage to the traction motors and running gear. Bogies are of welded, stress relieved box frame construction based on the B.R.



Type 1 design. Side frames, transoms and headstocks are riveted together through large gusset plates.

Primary springing is through four groups of coil springs mounted on the two forged steel compensating beams, and secondary springing is through two groups of laminated elliptical springs which support the bolster on the spring plank. Clasp brakes with cast iron blocks are fitted to all wheels, and in addition Lubrovia flange lubricators and automatic sanders are fitted to each wheel. Simultaneous operation of the Westinghouse locomotive air brakes and of the train vacuum brakes is achieved through the driver's vacuum brake valve. The wheels are of solid rolled steel with spherical roller bearings.

The colour scheme is basically blue with a silver strip and the bogies are finished in black.

Power is provided by an English Electric 8CSVT diesel engine, the latest of the range of English Electric RK/V diesel engines first introduced in 1934. Engines in this range are now fitted to over 2,500 locomotives throughout the world. This version is charge-cooled and turbo-blown, with matched blowers, and it develops 1,350 hp (NTP) at 850 rev/min from its eight 10 in bore × 12 in stroke cylinders. Brake mean effective pressure is 168 lb/in^2 and mean piston speed is 1,700 ft/min.

Protection is provided against high water temperature, low water level, loss of lubricating oil pressure and overspeed; in addition boost bias combustion control is provided by the Woodward governor.

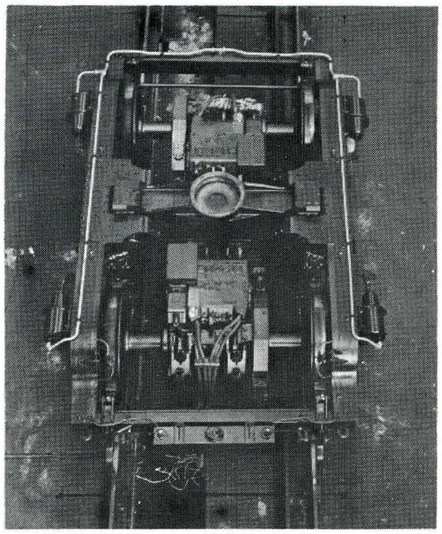
The diesel engine has two cooling circuits, one for engine jacket water and the other for engine after-coolers and lubricating oil cooler. Both circuits are fitted with thermostatic valves which can by-pass the radiator or the lubricating oil cooler respectively, to prevent excessive cooling. Combustion air is double filtered.

The main generator is flange-mounted to the bedplate and crankcase to form a rigid and integral power unit. A power take-off from the free end of the engine drives the radiator fan through a right-angle gearbox.

The main generator is a standard English Electric machine rated at 840 kW at 850 rev/min. It is a self-ventilated single bearing machine, having six main poles and six interpoles. From the free end of the generator, belts drive the auxiliary generator and one traction motor blower. The auxiliary generator provides a continuous 110 V supply for two motor-driven exhausters, battery charging, lights, control, and heaters.

Drive is through four nose-suspended axle-hung d.c. traction motors. The axle suspension is by plain bearings, but the motor bearings at each end of the armature are roller bearings. Each motor has a continuous rating of 210 kW, with four main and four interpoles.

Traction motors are connected across the main generator in two parallel strings of two motors in series, and main generator field excitation control is by an oil vane driven load regulator. Full engine power is obtained over a wide locomotive speed range by using three stages of traction motor field weakening. Power is controlled by an electro-pneumatic system of which the engine governor is an integral part.



Standard traction motors are suitable also for narrow gauge lines

Sifa-Oerlikon vigilance equipment which has the usual two step operation, functioning after distances of 100 m and 2,000 m have been traversed.

The locomotive control system also operates automatic sanding on all wheels, through electro-pneumatic valves. When wheelslip occurs sanding automatically takes place and a whistle warns the driver. In addition there is a manual sanding button.

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