GEC
Transportation Projects

Class 91

25kV BoBo locomotives for British Rail

240 km/h

4530 kW

Class 91 locomotives

The Class 91 locomotives have been designed to provide high speed services on the East Coast Main Line (Kings Cross to Edinburgh) and the West Coast Main Line (Euston to Glasgow). The equipment has been conservatively designed in order to provide high availability and high reliability together with long life.

Simplified maps of the East Coast & West Coast Main Lines.

It is anticipated that 80% of the locomotives annual mileage will be spent handling daytime passenger trains comprising up to 11 Mark IV passenger coaches plus a driving trailer. The remaining 20% of the annual distance will be handling sleeping car trains consisting of 15 Mark III vehicles plus a driving trailer.

Daytime services on the East Coast Main Line (ECML) will involve operating for long distances at up to 225 km/h but on the West Coast Main Line (WCML) it is unlikely that operating speeds will exceed 200 km/h because of the more curved nature of the route. Sleeping car services on both routes will be limited to 160 km/h operation.

The proposed service patterns on both ECML & WCML envisage some trains running virtually non-stop but with others stopping at principal stations en-route. These latter services are known as 'semi-fast' although in fact they will require service speeds of 225 km/h between stops.

The locomotives have two cabs, one of which is streamlined and the other is not streamlined. In daytime express and semi-fast duties it is expected that the streamlined cab will always be at the end of the train — pulling in one direction and pushing in the other. When in the latter (propelling) mode the train will be controlled from a remote Driving Trailer car from which signals to the locomotive will be sent by train wires using a TDM (time division multiplier) equipment. For sleeper services and other lower speed duties (such as express parcels trains) operation will be permitted with the non-streamlined cab leading.

The locomotives

The locomotives have a continuous rating of 4530 kW and a peak rating at rail of 4700 kW (determined by the sleeping car duties on the WCML over Shap and Beattock summits).

To meet the haulage requirements on both the ECML and the WCML requires locomotives with a high installed power coupled with an advanced design of transmission which limits the loads imposed upon the track. The GEC design meets these requirements and embodies the latest in proven technology although certain detail applications within the mechanical transmission are new.

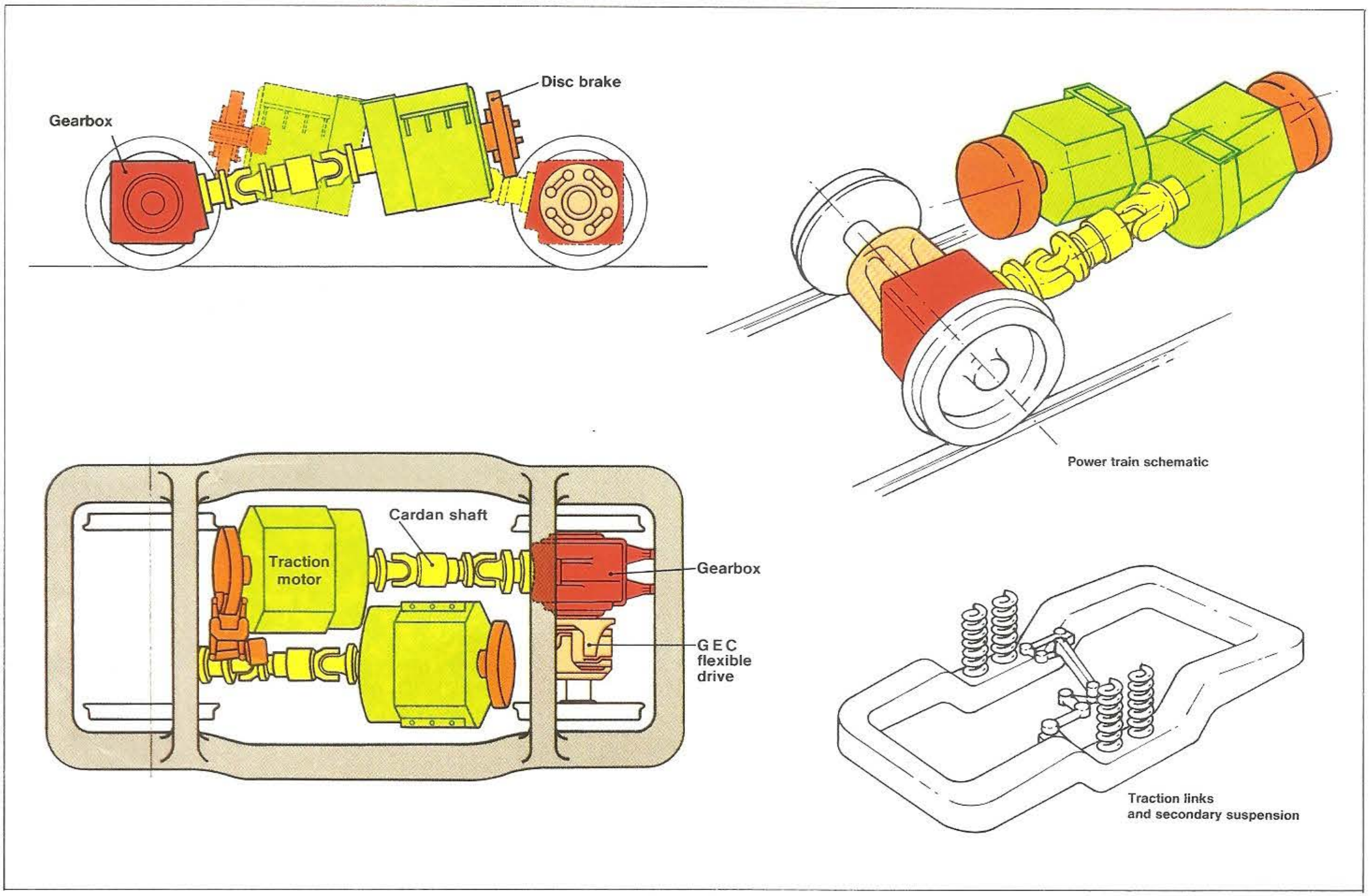
The traction motors are body mounted but hung below the body in the space where they would normally be found if they were bogie mounted. This has permitted a conventional layout of equipment to be achieved within the body, having a central gangway with consequent advantages as regards access and maintenance. As a direct consequence the locomotive length is less than would have been if the motors had been located within the body structure and this has made it much easier to meet the total weight limit whilst maintaining structural strength. The combined effect of mounting the motors within the bogie space envelope and locating the main transformer below the body has been to achieve a low centre of gravity which in turn minimises body roll and pantograph movement relative to the overhead line.

Unsprung mass has been minimised by mounting the traction motors on the body structure and a GEC patented link-type coupling permits the axles to move relative to the hollow drive-shaft of the right-angle bevel-gear type gearbox.

Electrical equipment

Separately excited (sep-ex) traction motors are employed. This form of excitation has inherently good anti-slip characteristics and enables full advantage to be taken of available adhesion. Furthermore the power and control circuits incorporate microprocessor/thyristor control, one function of which is to provide individual speed control of the motors at low creep values with high tractive effort.

The thyristor converter is oiled-cooled resulting in a lower internal body temperature and a reduction in size of the power pack. The converter is of the assymetric multiple bridge type having single thyristors and diodes in each bridge arm.



Simplified diagram showing the body mounted motors located in the bogie space. The disc brakes are also effectively body mounted thus minimising unsprung weight.

Microprocessor control

The Class 91 locomotive and the Class 87/2 locomotives (also being equipped by GEC) have identical microprocessor control modules with obvious advantages for spares and test equipment.

The armature and field converters are under the direct digital control of a microprocessor based control system using a single Intel 8086 16 bit micro-processor. The programme itself is stored in EPROM (erasable programmable read only memory), and the data in RAM (random access memory). This provides flexible and adaptable control (being software based) whilst using standardised hardware and software. The package provides high accuracy with minimum drift and high immunity to interference. The self diagnostic (ie fault logging) facility will be particularly helpful in maintenance.

The use of microprocessors simplifies the locomotive design by reducing the number of mechanical interlocks and also permits other features to be used which were not practical before the introduction of microprocessors. Some of the features associated with the Class 91 micro processor package are as follows:—

★ good load sharing between individual traction motors and bogie groups

★ closed-loop control of armature and field circuits

★ compensation for bogie weight-transfer

★ wheel slip and slide detection and correction by measurement of acceleration (deceleration) speed difference, voltage difference and current balance

★ wheel creep control in conjunction with track speed measurement by doppler radar

★ tractive effort control in both motoring and braking within limiting performance envelopes

★ automatic speed limitation

★ protection against over-voltage, under-voltage and over-load as well as limitation of motor voltage when the line voltage exceeds 25 kV

★ interfacing with the TDM (remote control) system as well as with the air brake system, the various safety systems and the train tilt control system.

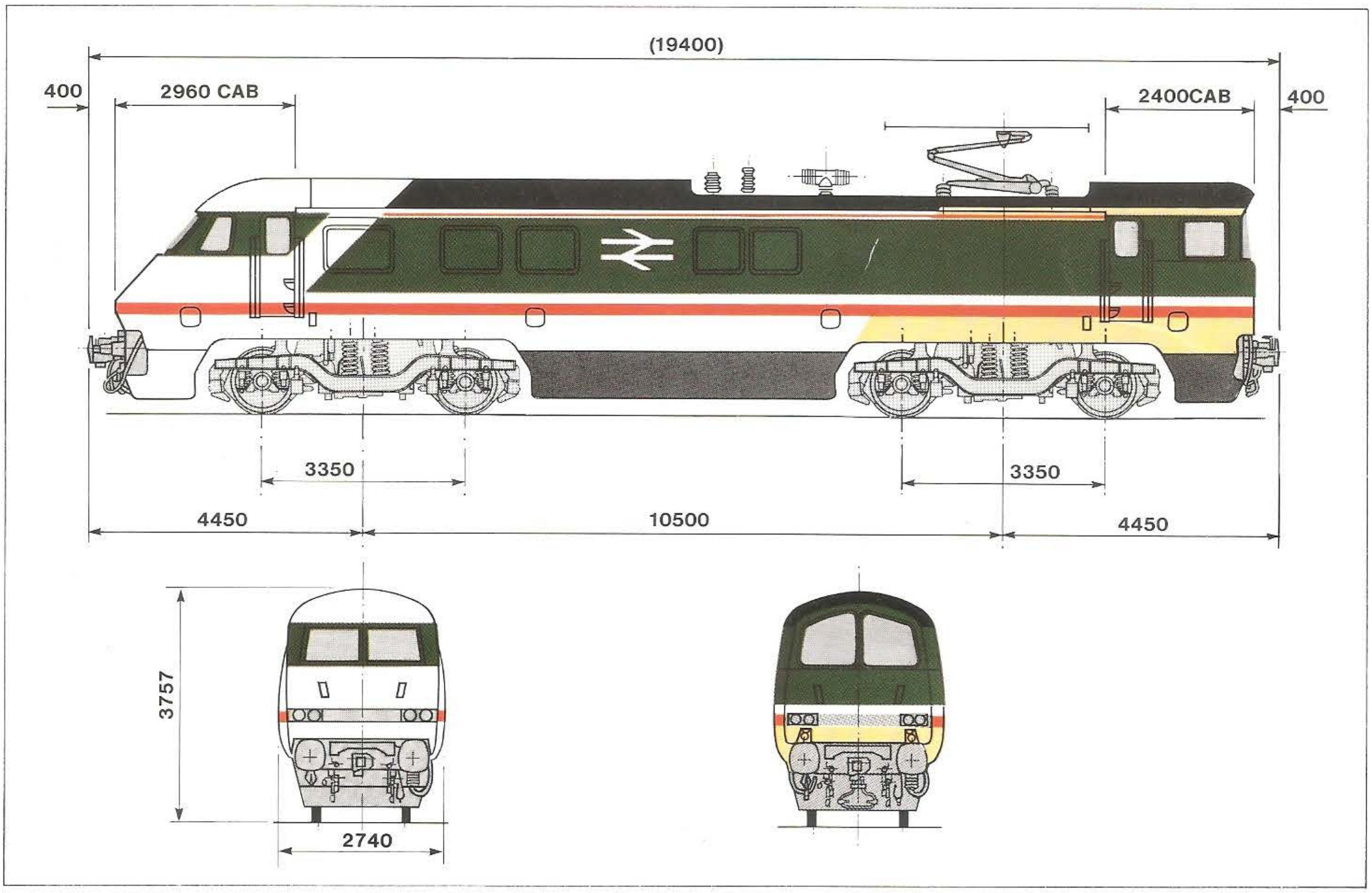
35 year life

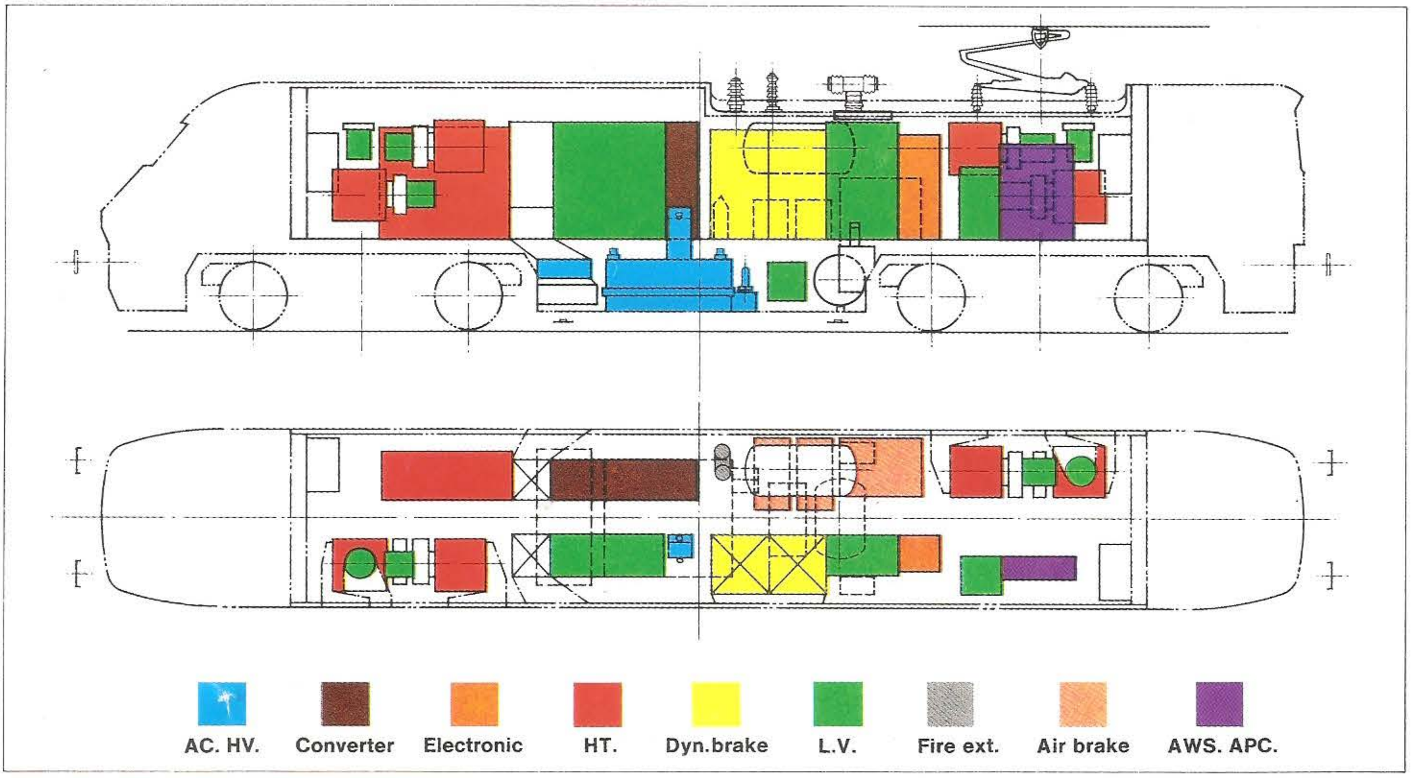
The locomotives and their equipments have been designed for a 35 year life when averaging some 420,000 km each year. It is intended that all novel features will be tested in a controlled manner and it is expected that the Company's combined testing facility will play an important part in this work.

Not all components will have a service life of 35 years, of course, but the lives of individual components have been carefully assessed and the cost of maintenance/replacement taken into account when calculating the life cycle cost of the locomotive.

Data

Maximum power at rail	4700 kW
Continuous power	4530 kW
Maximum speed	240 km/h
Total mass	80 tonnes
Unsprung mass per axle	1.7 tonne
Electric braking range	225 — 45 km/h
Daytime loading (11 Mk IV coaches + DVT)	600 tonnes
Night time loading (15 Mk III sleeping cars + DUT)	830 tonnes





Equipment layout.

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