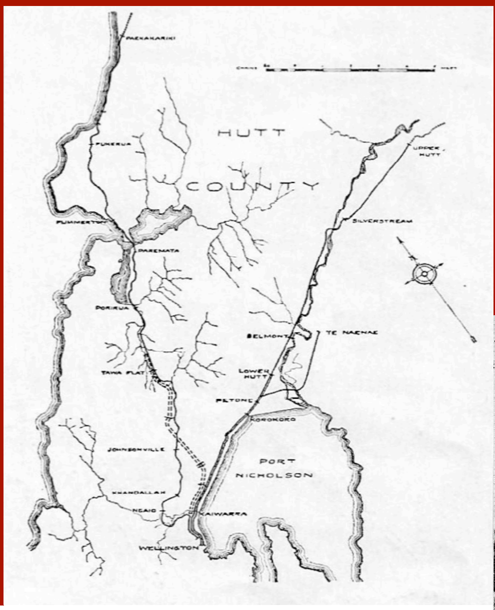
Wellington to Paekakariki

With English Electric



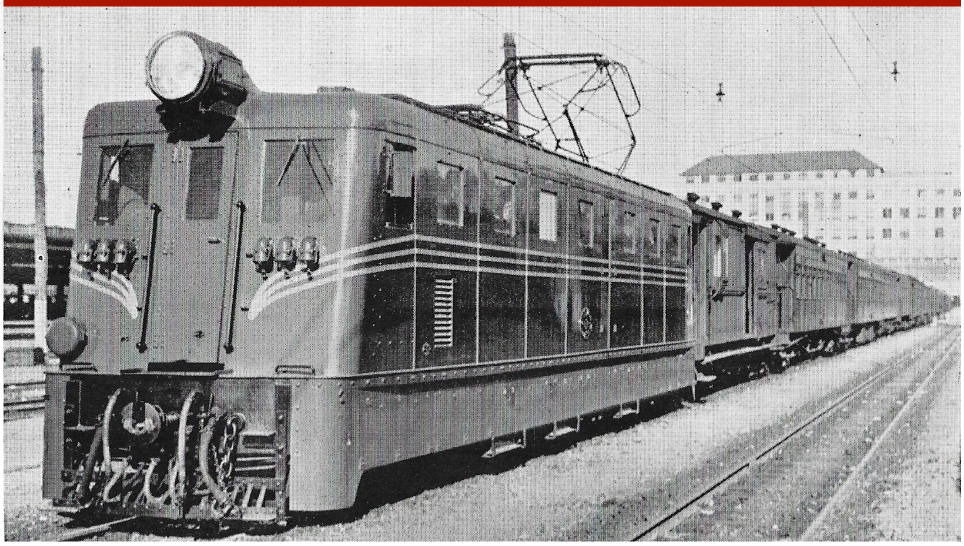
English Electric's sketch map of the route, for their brochure, showing the Tawa Flat deviation line.

English Electric Orders

NEW ZEALAND. The New Zealand Government Railways ordered complete equipment for the electrification of the Otira-Arthur's Pass Section of their lines in South Island, New Zealand; the contract comprised the power station, locomotives and overhead line. Included in this section of the railway was the longest tunnel in the British Empire, the Otira tunnel, 5 miles 25 chains in length.

NEW ZEALAND. In 1936 additional orders were received from the New Zealand Government for main-line express locomotives and suburban motor-coach stock for the newly electrified lines around Wellington.

Source: *"The English Electric Company and its Activities in Rail and Road Transport": Pub: EE Co., c. 1950s*



Wellington Suburban Electrification

Well, not strictly suburban, but the second major electrification on New Zealand's railway lines that involved English Electric; this time on the main line linking the capital, Wellington, with Auckland, 400 miles away to the north. This was the first stage in electrifying the North Island Main Trunk (NIMT), across some of the world's most spectacular, and challenging terrai

In between the two orders mentioned opposite, in 1929, English Electric had received another order for work on an electrification project on the South Island, but on that occasion it was the link between Christchurch, with the port of Lyttelton.

By: Rodger Bradley

This is the English Electric image of the first of the ED Class, and seen here on the test track at the company's Preston works.

Photo: RPB Collection

The Tawa Flat Deviation

The Lyttelton Line has the distinction of being part of the first public railway in New Zealand, and became the second electrification scheme in the country, following the publication of a report in 1925 by consulting engineers Merz & McLellan. Lyttelton was the closest seaport to the province's capital of Christchurch, and as traffic increased, electrifying the short 7 miles long link to Christchurch became inevitable.

Merz & McLellan's report outlined various schemes for the country's main population centres of Auckland, Christchurch, and the capital at Wellington. The work undertaken on the South Island lines was successful, and paved the way for implementing the other recommendations from the Merz & McLellan report.

It is perhaps no surprise, that, considering English Electric's involvement and experience with electric traction in New Zealand, an order was placed with the Preston company for locomotives and rolling stock for Wellington's newly electrified suburban lines. But mention should be made of a significant change in the main line layout north of the city, known as the Tawa Flat deviation.

Leaving Wellington, the northbound main line was created under the original Wellington and Manawatu Railway (WMR), with limited capacity on the then single-track section of the line that climbed on a 2½ % gradient from Wellington to Johnsonville. With equally challenging gradients down to Tawa Flat, before continuing the northbound run, this was impacting operations as trainloads and frequency increased.

The solution was to build a deviation, just over 8 miles long, with a 1% ruling gradient and two tunnels of ¾ mile and 2 ½ miles, thus short-circuiting the route north from Wellington to Tawa Flat, and removing that 2 ½ % gradient at the start of the journey. The deviation was opened to goods traffic in 1935, and passenger traffic in 1937.

The Tawa Flat Deviation was the first stage of the electrification from Wellington to Paekakariki, some 25 miles to the north. There still remained a 2 ½ mile stretch of one in fifty-seven further north and electrification was the only solution for the combined tunnel, gradients and single-track conditions.

Following on from the South Island success the North Island main line would be electrified at 1,500V d.c., and in 1937, English Electric received two order from New Zealand Railways, for locomotives for the line to Paekakariki, and motor coaches for Wellington to Johnsonville suburban services.

The 1937 order did not include either components for, nor the overhead contact system and cables for the latest stage in New Zealand's electrification, and only included one locomotive – but with the components for another 9, to be shipped out from Preston and Newcastle to Wellington. At the same time, English Electric were asked to provide six 2-car motor coach sets, for the services on the new route from the capital out to Johnsonville. The motor coaches carried 4 x 165hp traction motors, and these, along with the trailer coaches were constructed at English Electric's Preston Works – often still referred to as the 'Dick Kerr Works'. The order was almost repeated after the end of the Second World War, when the company received an order for 3 complete motor coaches, and two trailer coaches in 1945 – also for use on the Tawa Flat Deviation line to Johnsonville.

In 1937, the locomotives were an interesting, if plain looking, design, and which have often been described as box-cab style. The new locomotives were similar in appearance to many of the early to mid 1930s designs, and the continued development of electric and diesel traction continued to make a lot of progress – even in the depression years. In its 16th July 1937 edition, "The Engineer" published a reference to a visit to the English Electric works, mentioning it being very busy, and with a "… greater variety of jobs in hand." One of these was of course the new 1-Do-2, or 2-8-4 locomotives for the new electrified route to Paekakariki, and it got a mention in the journal, along with this locomotive's "patented quill cup drive".

The article included this observation:

> A 3ft. 6in. gauge, 1500 D.C. locomotive weighing 84 tons is being supplied to the New Zealand Government Railways (Wellington-Tawa Flats) and nine other complete electrical locomotive equipments are being built for these railways, which are constructing the mechanical parts themselves. Four 310 H.P., 700-volt motors are controlled by electro-magnetic control gear arranged for multiple unit operation of two locomotives from any one driving position. The engine is fitted with the maker's quill spring cup drive and all the motor weight is spring-borne. Special features are forced ventilated motors with

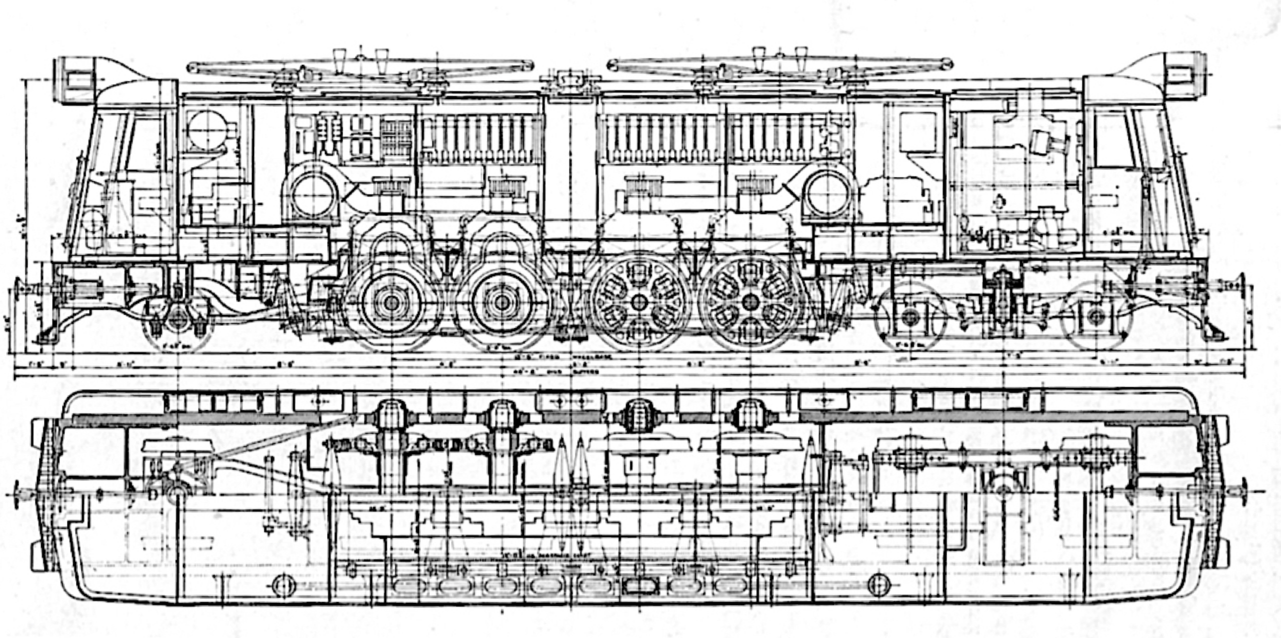
General Design & Construction

Having removed the severe gradients of the original route up to Tawa Flat (now just Tawa), the locomotive's design needed to provide sufficient traction to haul 200 and 400 tons trailing load, in passenger and up to 500 tons freight. At the same time a maximum 16-ton axle load was required, and the 2-wheeled pony truck and 4-wheeled bogie were essential for stability and ride quality, since despite the deviation line, the ruling gradient was still 1 in 57.

The starting point for the construction was a pair of 41ft 10ins long rolled steel sections, attached at either end to 'massive cast iron drag castings', within which the headstocks and drawgear were rivetted. The mechanical construction paid a lot of attention to building a steam locomotive, with hornblocks for the 4 central driving axles and axleboxes, and stretchers and frame stays positioned in true steam loco style.

The frame stays also provided support for the traction motors, which were part of the locomotive's body mass, so reducing the unsprung weight on the axles and, potentially, less harmful to the track when running.

As can be seen from the diagram below, the main body of the locomotive is essentially a welded up box, from 'Tee' section steel framing. That said, it is fascinating to read English Electric's description of the styling, in which they suggest it was "impossible to produce a streamline design", due to the limitations of the loading gauge and general dimensions. They then go on to say it has a "pleasing appearance" and is "in line with modern ideas for the construction of vehicles for public transport". Obviously the one design feature it is impossible to ignore are the two huge headlights surmounting the cab roofs at each end.



General arrangement, plan and section of the ED Class locomotives for New Zealand Railways

Current collection was by means of the two roof mounted pantographs, each of which was installed in a low recess, with the 1500v d.c. supply connected to the main resistance banks in the body of the locomotive through the main isolating switch. The pantographs were isolated from each other by means of roof mounted isolating links.

As was standard practice, the control of the traction motors was for series-parallel connection, with 'notching up' by switching the banks of resistances out, or in, as needed to raise or lower the locomotive speed. English Electric implemented their standard electro-pneumatic control system, back to the driver's cab at each end of the loco., with each of two banks of resistors controlling a pair of traction motors. These were the conventional, force ventilated, series wound d.c. motors each having a 1hour rating of 310hp, drawing 345A and 750V.

The interior of the locomotive body was sealed from the environment below in the HT compartment, where the tops of the traction motors projected through into the body, with the obvious need to keep it as dust free an area as possible. In fact, the HT compartment was made as air-tight as possible, with some of the filtered air for the traction motors diverted into the compartment, to keep it at a positive pressure in relation to the outside world.

The HT compartment occupied the lion's share of the above floor level, and was set slightly to one side, to allow a corridor to connect the two driving compartments, with access to the compartment controlled through interlocked access doors. Towards the No. 2 end of the loco, the motor-generator set for the auxiliary power supply was installed, and next to that a separate 'compartment' to house the frame mounted contactors and relays.

Interior of loco showing walkway between cabs and the access doors open on the banks of contactors

"…. noteworthy features …"

The auxiliary electrical systems provided 120V supply from a motor generator set for the electro-pneumatic control system, power for the traction motor blowers, and the steam heating boiler. This was supplied by the Sentinel Wagon Works Ltd, and was automatic, and oil-fired from a 50-gallon oil tank, with a water tank capable of holding 400 gallons.

The boiler was located next to the cab at No. 1 end of the locomotive in a separate compartment, and according to English Electric, this would provide enough water to steam for 4 hours without refilling – enough time to run from Wellington to Paekakariki and back in winter months? However, only the first 8 (*Ed101-Ed108*) had them fitted, and the boiler was said to be unreliable, and in 1950, they were isolated altogether, and although the CME wanted to restore and refurbish them for the 1955 winter season. But, apparently, as the boilers were by this time obsolete – they were 17 years old, and parts were unavailable - "refurbishing did not proceed"

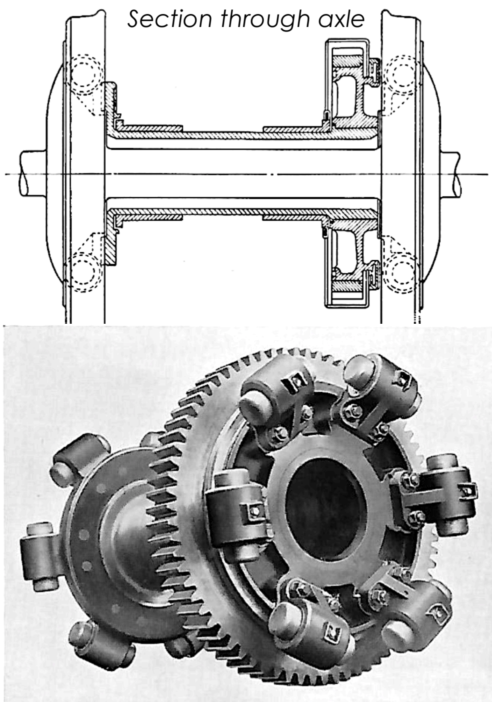
At the time these locos were being designed, the makers also introduced what they described as a "noteworthy feature" in the design of the HT side of the power circuits – a high-speed current limiter. The purpose of this switch was to guard against very high current faults in the power circuit, by opening rapidly and inserting a resistance into the circuit, the circuit with this additional resistance would then be 'ruptured' by the normal action of the line breakers. It was in effect a kind of 'belt and braces' approach to handling potential overloads in the power circuit, without relying entirely on the normal line breakers.

But that was not the only 'noteworthy featured' advertised. These new electric locomotives also had an early form of wheel slip/slide control. Each of the traction motors was fitted with a wheel slip indicating relay permanently connected in series across the motor armatures, so that it would activate when the voltage was 'out of balance' – indicating a wheel was slipping. In turn, this caused a signal lamp to light on the 'dashboard' in the driving cab, and the driver could then take the appropriate action.

Running Gear & Final Drive

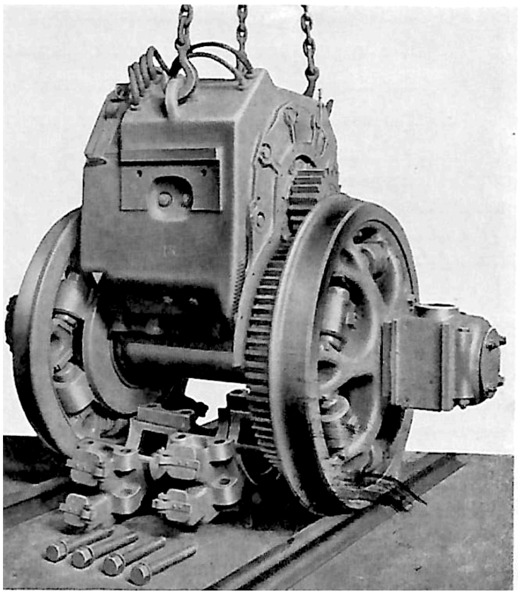
The pony trunk, and swing link bogie were deemed necessary to enable the electrical equipment to be housed in the body of the locomotive, all springing across the locomotive was fully compensated with the bogie axles independently sprung. Considering that the four traction motors were housed in the locomotive body, the next challenge was to connect to the 3ft 9ins diameter driving wheels.

The 1930s was a time of transition in electric traction, and a number of 'steam age' methods were still adopted, or adapted for the final drive from the electric motors, to the running wheels – whether locomotives or railcars. Mechanical drives, using coupling rods and jackshafts, from frame mounted gearboxes could be found on some very large locomotives, including a number built by British makers for Hungary and India. However, for New Zealand, a different approach was adopted.



The English Electric quill drive

The solution was an English Electric patented form of Quill drive. The quill drive allowed for relative vertical movement of the gear wheels on the traction motor and locomotive wheels. In this case, the quill is attached beneath the motor armature casting, with the axles of each wheel pair passing through the hollow quill. At each end, six spring cups housing compression springs were attached to the outer face, and made contact with hardened steel pads welded to the spokes of the wheels to apply the force to turn the wheels.



Traction motor and quill drive

Of course these were not the only 1930s non-steam types that used the quill drive technology – the famous Pennsylvania Railroad "GG1" electrics were another, and they were very much bigger. Other unconventional final drives adopted in the 1920s and 1930s, included the seemingly even more complex "Buchli" system, used on some locomotives in Switzerland.

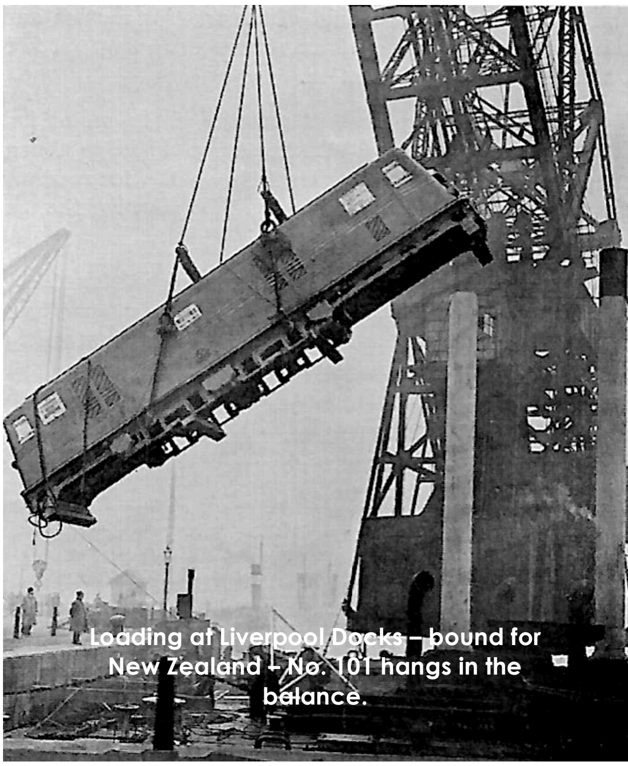
Looking at this diagram though, it is also interesting to see how perhaps, GEC Traction later developed its "Tubular Axle Induction Motor" (TAIM).

The remaining running gear, from the 6-spoked driving wheels to the centre couple buffing and drawgear was more of less conventional for the 3ft 6ins gauge. The brake gear was the Westinghouse A7EL style, with direct air brake for the locomotive, and proportional valves for the train – a more or less conventional arrangement, at least in the 1930s era for "modern electric locomotives".

Leading Dimensions:

Running Numbers	101-110
Introduced	1938
Withdrawal	1969 (8); 1981 (2)*
Gauge	3 ft. 6 in.
Weight	88 tons.
Wheel arrangement	2- 8- 4
Length over buffers	46 ft. z in.
Total wheel base	34 ft. 6 in.
Fixed wheel base	13 ft. 6 in.
Driving wheel diameter	45 in.
H.P. (one hour)	1,240
Tractive effort (one hour)	18,000 lbs.
Tractive effort (maximum)	34,000lbs.
Maximum service speed	55 m.p.h.
Line voltage	1500 d.c.
Control voltage	120 d.c.
Number of motors	4
Motor voltage	750 d.c.
Control system	Electro-pneumatic.
Brakes	Westinghouse air-brake, type A7EL.
Train-heating boiler	Sentinel, 1,250 lbs. of steam per hour.
Service	Passenger, mixed and goods trains up to 500 tons.

** Two of the class were rescued for preservation by the "Silver Stream Railway" (Ed 101), and the "Canterbury Railway Society" (Ed 103).*



Loading at Liverpool Docks – bound for New Zealand – No. 101 hangs in the balance.

Operations and Service Life

This is an image of the first of the class built in New Zealand – No. 102 is seen here in 1938 ex-works, without the skirt applied to the very first of the class, built in Preston.
Photo Courtesy: Ref: APG-0320-1/2-G. Alexander Turnbull Library, Wellington, New Zealand. /records/22545501

Whilst the order was placed with English Electric, with its main works at Preston, the electrical equipment was built at the company's Bradford site, and brought over to Preston, for installing in the first locomotive. The mechanical parts – superstructure, underframes, and the mechanical portions – were subcontracted to R & W Hawthorn Leslie in Newcastle, and they too were brought to Preston for the first of the class, and final assembly and testing was done on the company's test track. The New Zealand Government's consulting engineer, R.J.Harvey, completed the final inspection and acceptance.

Hawthorn-Leslie were merged into Robert Stephenson & Hawthorns Limited by the time this order was being delivered, and later still it became part of the whole English Electric family.

So, the first loco was dispatched complete from England to New Zealand, and followed by a further 9 sets of parts, for assembly in the New Zealand Railways' workshops. Seven of the class were assembled at the Hutt Workshops, and the other two by Addington Workshops, which were first set to work on the Arthur's Pass route after completion – although they were later sent back to the North Island.

They entered service in 1938, and classified "Ed", to differentiate from the class "Eo" locomotives for the Otira Tunnel electrification, also supplied by English Electric in 1923, and carried original running numbers 101-10.

At the same time as the Ed's appeared English Electric were supplying the six 2-car electric multiple units, for suburban services out to Johnsonville, which later classified as "DM", and these survived until the early 1980s.

One of the "DM" series of multiple units, supplied by English Electric, here seen at Khandallah Station, on the opening day of the service – 4th July 1938.
Photo Courtesy: Ref: APG-1483-1/4-G. Alexander Turnbull Library, Wellington, New Zealand. /records/23252719

Further orders for multiple units from English Electric followed, but the "Ed" Class continued to operate, until after 1949, when the EMUs were starting to work all the way out to Paekakariki. It was around this time that the proposal for the electrification of the North Island Main Trunk (NIMT) from Wellington to Auckland surfaced, but this would have been at a substantial cost. So, the cheaper option of greater numbers of diesel electric haulage was pursued – until the fuel crisis of the mid to late 1970s at least – when in the early 1980s, New Zealand went on to adopt the 25kV a.c. standard for this major piece of work.

In June 1969, the first eight of the "Ed" Class locomotives were taken out of service, with the remaining two withdrawn in March 1981. Two years earlier, NZ Railways had introduced its computerised "Traffic Monitoring System" (TMS), and so they ended their days carrying new numbers 15 and 21. The reasons for their withdrawal included work that had been completed on deepening the trackbed and tunnels on the Wellington to Tawa line, enabling diesel hauled trains to reach Wellington from the north, without a traction changeover.

Preservation

ED101 was the only one of the class to have been fully assembled in Preston, England, and on its withdrawal from service in May 1984 retired to the "Silver Stream Railway" in Hutt Valley, exactly 46 years after starting operations in May 1938. It was given the nickname "The Sergeant" owing to the appearance of the three horizontal stripes on the bodysides, and is now only a static exhibit.

The first of the class, and still in existence – but now without its original skirts, at the "Silver Stream Railway", and sadly perhaps, only as a static exhibit.

The only other member of the class to be saved was No. Ed 103, which was acquired by the Canterbury Railway Society/Ferrymead Railway in 1983, and is stored in the Ferrymead Heritage Park, in Christchurch. It is perhaps appropriate too, since Christchurch is home to New Zealand's National Railway Museum, and was the starting point for a number of orders for English Electric in Preston, England in the 1920s, 1930s, 1940s, and 1950s. Even as late as the 1980s, EE Co.'s successor – GEC Traction – was still supplying electric traction equipment to New Zealand.

-oOo-

The second member of the class built in New Zealand is preserved at the Ferrymead Heritage Park near Christchurch.