

THE LONDON ELECTRIC TRAIN

8 – CAPACITY CRISIS

by Piers Connor

CRISIS

The First World War of 1914-18 had led to huge increases in traffic on the Underground. By 1919, passenger journeys had increased by almost 70% over those in 1914 but stock totals had only risen by about 5% and maintenance had been reduced to minimum levels because of shortages of materials and manpower. Things were desperate and an emergency meeting of managers, led by Sir Albert Stanley, the chairman, took place on 12 August 1919 to discuss the issues. At the meeting, it was noted that 90% of tube stock was required for peak hour schedules and that “at certain times there was considerable deficiency”. It was said that this was due to “a shortage of skilled armature winders”. They were obviously having trouble keeping motor cars in service.

The shortage of armatures was worst on the District Railway. In order to overcome the problem, the Underground group management agreed with the London & North Western Railway company that the armatures ordered for the Watford Joint Stock (WJS) would be diverted to the District, while the District’s armatures were sent to the British Thomson-Houston (BTH) factory at Rugby for rewinding and subsequent inclusion into the motors being built there for the WJS.

There was also a general shortage of trailer cars, largely because they had opened the 1914-15 extensions to the Bakerloo using trailers ‘borrowed’ from the Piccadilly Line. This led to their restricting train lengths on both the Piccadilly and Bakerloo lines to a maximum of five cars. At the time, the service could cope with this but, as the war progressed and traffic levels soared, the 5-car peak formation was no longer sufficient. To overcome this, early in 1919, it was decided to order more trailer cars, which were to be added to the Piccadilly Line’s fleet.

TRANSFERS

The stock situation gradually started to be eased from early in 1920 when the Watford Joint Stock (originally ordered in 1914, as I mentioned last month) actually began to arrive. The delivery was spread over the nine months between January and October 1920 but entry into service was slow, the last of the 72 cars being recorded as entering service in May 1921. The 22 Central London motor cars that had been working the Bakerloo’s Watford service (together with Piccadilly trailers) over the previous three years were gradually moved back to the Central London’s depot at Wood Lane for conversion back to the 3-rail traction system, the last pair of cars recorded as going back in March 1921. They were needed for the Ealing service, which had started on 3 August 1920. This was before all the new WJS cars had entered service but it was just about possible because, with a carefully managed cascade, new trains had replaced the existing trains one by one. Although there were 12 WJS trains to be delivered, only nine were required for the peak hour service and they had eight in service by the time the Ealing extension opened in August 1920. The Bakerloo kept two trains powered by Central London motor cars until early in 1921 and, I suspect some ex-Piccadilly motor cars were also used on the service from time to time to cover maintenance.

Beginning in October 1920 and continuing over the next six years, there was a gradual drift of much of the loaned Piccadilly gate stock running on the Bakerloo back to the Piccadilly or over to the Hampstead. However, not all the borrowed cars went back. All the motor cars were returned to the Piccadilly eventually (some working on the Hampstead line for a time) but almost half the trailers and control trailers stayed on the Bakerloo. This was because the increasing traffic had forced the introduction of some six-car trains during rush hours on the Queen’s Park – Elephant & Castle ‘local’ service. During this period also, the Piccadilly Line was expecting to get the new stock, so it didn’t need all its old trailers back.

THE CAMMELL LAIRD STOCK

From very early on after the opening of the Bakerloo and Piccadilly lines, a 5-car train formation was adopted as the usual maximum on all lines, although both lines had their original fleets configured to provide 6-car trains. Only the Hampstead line had a 5-car formation as delivered.



Figure 1: 1920 Cammell Laird Stock trailer car No. 801 as photographed in Lillie Bridge depot in February 1925, over four years after it was delivered. The curved bodyside shape was an attempt to make room for the “air engines”, as the door operating equipment was called, without reducing the seat and standing spaces too much. The central double door opening was strengthened by a substantial vertical pillar some 7 inches wide. The car end shows the sockets for the auxiliary and control jumpers on either side at roof level and, over the centre doorway, the socket for the emergency lighting jumper. These cars were not provided with heaters. Photo: LT Museum.

The effect of the 5-car formation was to throw up a surplus of trailers and control trailers on the Bakerloo and Piccadilly lines and, as we have seen in previous articles in this series, 25 of the Piccadilly control trailers were stored. The Bakerloo never actually put any of their spare cars into store – they just rotated them in service as part of the general stock. The additional trains needed for the Queen’s Park extension absorbed some of these spare cars but the bulk of the extra trains were made up by taking trailers and control trailers from the Piccadilly, coupled with the acquisition of 19 new motor cars (10 from Brush, 2 from Leeds Forge and 7 converted from Piccadilly control trailers at Golders Green – see Article 4 in this series, *Underground News* No.649, January 2016). These figures show that an increase in the LER’s motor car stock of 19 vehicles hadn’t been matched by the acquisition of new trailers so, now that it had become necessary to bring train lengths back to the originally intended 6-car formation, new trailers had to be purchased. Forty was a sensible number, providing the equivalent of 10 new trains when formed with the excess number of existing motor cars. Numbers were never exact in those days, partly because train formations were always variable and partly because the number of spare trailers needed for maintenance was set at 10% while the number of spare motor cars was 15%, since they had more equipment to maintain but the plan was to form 10 x 6-car trains with existing motor cars and new trailers.

Plans for the new cars were prepared early in 1919. According to the ‘General Specification for Steel Trailer Cars for the London Electric Railway’ issued in that year, the cars were to have open end platforms, hinged steel gates on the entrance platforms and swinging side doors for passengers’ use, with electrically controlled locks. This design was very similar to the two Leeds Forge trailers built in 1914 for the Bakerloo Line. However, the specification was edited and re-dated September 1919 and the references to gates and swinging doors crossed out. Instead, there were to be “... sliding doors for passengers’ use...” and “...Side sliding doors will be operated by Air-engine and consequently the Door-Runner should be of a sound and strong Construction. Handles and Locks will not be required for these Doors” (sic).

The change had come about after an instruction had been passed down from the Chairman’s meeting of 12 August “that departments again confer on plans for proposed new stocks”. It is recorded¹ that a number of proposals had been put forward in the summer of 1919, including one with two separate

¹ UERL Meeting minutes (various).

single doors and another with a single door per car side. Arguments seemed to have raged too over the seating layouts, but the end result was to reduce seating to the bare minimum and have all longitudinal seats so creating lots of standing room. Invitations to tender had been issued to manufacturers in July 1919 with a single centre door and end doors and all-longitudinal seats but, following the personal intervention of Stanley, the door layout was redesigned to include a double central doorway. The tender documents were so altered in September 1919.

The 40 new cars were eventually ordered from Cammell Laird & Company of Nottingham and were all delivered by rail to Lillie Bridge depot, the trailers first (numbered 800-819) in five batches of four from 19 November 1920 to 30 April 1921, followed by the control trailers (numbered 700-719) in identical quantities from 1 June 1921 to 17 August 1921.

LONG TIME COMING

The plan to operate sliding doors with “air engines” was a bold step but it was to prove a difficult project and, in the end, the trains were a long time coming. To begin with, there was the history of the District’s disastrous flirtation with powered doors on its wooden-bodied B Stock of 1905. There had been many breakdowns and injuries to passengers with this system and it was removed in 1908. This debacle had only ended 11 years before the Cammell Laird stock was proposed and, as a result, there were still serious fears about the risk of passenger injury due to people getting caught in closing doors and, because of this, some elaborate precautions were taken to prevent it, as we shall see.

Then there was a desire to reduce staff. There were shortages of gatemen from time to time, particularly during World War I, even though women were employed in the role, and some trains operated with gangways out of use as a result, with a consequent serious loss in dwell time performance while passengers struggled to get on and off at the few remaining entrances. And, of course, remembering the District again, the Underground management was under no illusions that the door systems would be expensive to buy and maintain and it would only make good business sense if staff could be reduced to generate the necessary savings. On a 6-car gate stock train, there was a crew of 6 – driver, front guard, three gatemen and rear guard. With an air-door train, the crew was to be cut by 50%, the three gatemen being eliminated. The plan was for the front guard to operate the doors on the front three cars, while the rear guard did the rear three.

In order to make this work, the whole train had to be air-door equipped and door controls provided on the end cars. This was to be achieved by converting 20 Piccadilly gate stock motor cars to match the new trailers. The open end platforms were to be enclosed and fitted with sliding doors and the door controls. The middle of the car was to be fitted with double doors to match those proposed for the trailers. By now, the new trains were becoming a very expensive exercise. The original plan to buy new trailers matching the 1914 centre hinged door and open gated platform design and run them with existing, unmodified motor cars, had now morphed into a grand plan with remotely operated sliding doors on the new cars and the conversion of the 20 motor cars to match. It probably doubled the costs.

Apparently as a trial, in May 1920 two 1906, French-built motor cars were sent to Cammell Laird for conversion, just as construction work was starting on the first trailer cars. They came back to Lillie Bridge Depot six months later in November 1920 together with the first four trailer cars so that they could make up a full 6-car train but it was to be more than another year before the train officially went into service. There proved to be considerable difficulties to overcome. Some of these related to safety and the systems adopted but many of the problems seem to have been related to the conversion of the motor cars.

DOOR SAFETY

With the abandonment of the “man-on-every-car” principle, the door system had to be made safe. This involved a number of issues:

- Doors should only be opened by a positive action from the guard. A door controller was provided, which had a ‘door open’ lever that activated a switch to energise a ‘door open’ train wire. Door controllers were provided on the non-driving ends of motor cars and control trailers.
- Doors needed to be kept closed while the train was moving. The solution was to design the operating arm so that, in the closed position, it was held horizontally against the door. This effectively locked it closed.

- The crew must have an indication that doors were closed so a circuit was provided that lit a lamp at each guard's position if all the doors were closed. A mechanical interlock connected to each door provided a contact in the circuit.
- Passengers must be prevented from interfering with any of the equipment. Since the guard was located in a position which could also be used by passengers when he wasn't there, each control position required a key to set it up. Later this became known as the 'position switch key', since it activated the guard's position.
- In case anything went wrong, doors should be able to be released and opened from outside the train. On the first Piccadilly train, there was an external plunger on the central doorway pillar of each car which allowed someone on the platform to either open or close the doors on the car. It was soon realised that the door open feature was potentially very dangerous and was soon removed. It was replaced by a more unobtrusive 'outside door cock', which allowed the doors to be opened manually if the electrically controlled valve failed. It later became known as the 'butterfly cock'.
- Injury to passengers must be prevented (as far as reasonably practicable²). This was first tried with a recycling system (of which more in the next article) but that was soon abandoned and replaced by rubber edges and a sprung arm.

The existing procedure, where the front guard started the train, was retained but he would only do this once he had seen the doors closed indicator lamp light up. The starting bell signal for the driver still had the mechanical pull-wire in a tube arrangement used on earlier stocks.

There was no interlocking between the bell signal and the indication light, otherwise known as the 'pilot light'. Operating wise, there always had to be a guard on the leading car of a 3-car (M-T-CT) train, since the pull wire only extended over a car's length. This was also part of the agreement that they to have a man on the front car in case the driver needed help or he collapsed and someone had to drive the train. Thus, the front guard was trained as an emergency driver. This also would mean that a 3-car train had the driver and guard on the front car and it meant that the rear car guard's position was vacant and could be used by passengers.

Using the guards' doors for passenger access added complication to the control system for the guard's doors. Whilst used by passengers, the door had to open and close with other doors but it had to work independently under the guard's control when he was there. The solution was to operate the door by a straight air valve when the guard was there but by an electrically operated valve when he wasn't. He used a removable key to work the straight air valve and took it with him when he left the position. Independent operation of guards' doors was considered essential in order to, amongst other things, allow the rear guard to observe the platform while the train departed to watch for passengers caught and dragged by clothing etc.

Unlike current safety requirements, it was not thought necessary to ensure the guard's door was closed before allowing the train to depart. No one imagined that a trained employee would be stupid enough to put themselves at risk while the train was leaving the station but they were to be proved wrong, as there were a number of incidents over the years of gatemen and guards being injured or even killed as a result of contact with tunnel walls.

CAR BODY

The new cars were designed with arched roof bodies, fully enclosed and equipped with a single door at each end and double doors in the centre of the cars, separated by a vertical pillar roughly 7 inches thick (Figure 1). The single doors had a 2-foot opening, while each leaf of the double doors allowed a 2ft 9in opening.

A new philosophy of window design was another change introduced for this stock. Before, it had been the custom to provide 4ft wide windows in LER tube car sides wherever possible. Although this provided a good view – as if one was really necessary in a vehicle running almost entirely underground – it proved noisy. It was discovered that the flexing of the glass and its frame while the car was in motion caused a considerable amount of rattle, which added to the already noisy conditions emanating

² ALARP isn't new, they just didn't know what to call it then.

from the wheel-rail interface. The problem was solved by using smaller windows, which didn't flex as much, and it gave the added bonus of a stiffer bodyside structure.

The Cammell Laird car interiors were built with all-longitudinal seating for 44 persons. The idea was to maximise the standing space and thus increase train capacity. The cars were delivered with vertical hand rails in front of the seating benches but these were removed after a short time in service.



Figure 2: Interior of 1920 Cammell Laird stock car as built with plain leather longitudinal seating, vertical grab poles, horizontal handrails, plain cement flooring and twin, shaded lamps down the centre of the ceiling. The design was similar to the District Railway's F Stock of the same era. Both were later re-modelled with moquette seating and rearranged lighting.

Photo: LT Museum.

The whole interior was plain to the point of spartan and was designed simply to "pack 'em in". The seating was leather covered to make it easy to keep clean but leather can feel cold in winter and sticky in summer. The British public didn't like it and said so frequently, so much so that, in 1925, the Underground rebuilt the interior of at least one vehicle with moquette upholstered seating, a brighter paint scheme and some transverse seat pairs between the doorways. Money to do the whole batch was authorised in 1926 but it wasn't done until 1931, as we will see in a future article.

DELIVERY

Delivery of the new cars showed an unusual pattern. Following the arrival of the first train in November 1920, there was a 12-week period when nothing happened, followed by four batches of four trailers arriving at roughly 4-weekly intervals. All the trailers were delivered by the end of April 1921. On 1 June 1921, the control trailers began to arrive, again in batches of four but the periods between them were reduced to an average of three weeks so that, by 17 August 1921, they were all delivered. However, none of the 18 motor cars planned for conversion had been sent away, so the new cars languished around the yard at Lillie Bridge until it was decided to send half of them away to the Aldwych branch for storage.

The gap between the arrival of the first train and the delivery of more new cars may have been planned to prove the concept of the air door system and to see how the conversion of the motor cars went. If so, as we will see, it was a wise decision but the arrival of the Cammell Laird stock marked the first major improvement in tube car body design since the pioneer vehicles built for the opening of the City & South London Railway in 1890. The provision of remotely controlled sliding doors within the confines of the tube car profile represented a significant step in the development of the Underground and introduced a design that has remained, little changed, to this day. A unique feature of the design is the curved top of the door where it follows the roof line in order to provide sufficient height for the average passenger to board and alight comfortably. The suspension and sliding guidance system required for the doors was quite tricky to get right but, once done, it was very successful. The original design was arranged so that the door was guided at the base by double-flanged wheels running along a steel guide rail, while at the top, horizontal rollers were provided to counter the weight of the door against the roof guide.

As we've seen, the doors were operated by pneumatically powered door engines, of which more in next month's article but, suffice to say for the time being, that this was the first production installation of powered doors on the tube lines and that there were a number of technical and operational problems which led to several modifications during the first few years after their introduction. The Piccadilly's new trains were to make the Watford Joint Stock the last tube stock to be built for a-man-on-every-car operation. All subsequent designs had powered sliding doors.

DRAWING

I have prepared a drawing of the Cammell Laird control trailer (Figure 3, overleaf). For the first time in this series, I have added dimensions through scaling off the measurements generated by the computer. I know well the rule "never scale off the drawing" but, in this case, there are so few dimensions on the original that I felt it might be useful to at least offer some of the more interesting dimensions through computer generated lines. In my drawing, these are shown in italics to make the difference quite clear. The plan drawing is also arranged so that the re-arranged seating after the 1925 and 1931 alterations is shown on one half of the plan against the original arrangement on the other half.

To be continued