THE UNDERGROUND ELECTRIC TRAIN
by Piers Connor
21. OPO DEVELOPMENTS

PEA

The Piccadilly Line was the first tube line (excluding the ATO-equipped Victoria Line) to go over to One Person Operation (OPO), the new method starting on 31 August 1987. It was called OPO(T) – OPO (Tubes) – because of the difference between it and the OPO on sub-surface lines. The Piccadilly Line trains, 1973 Tube Stock, had been designed with OPO in mind, so the changeover was not too difficult technically. All that had to be done was to modify the passenger emergency stop switches inside the cars to an alarm (called PEA), fit the radio equipment for "leap frogging" (described last month), fit door control buttons to the driver's cab desk[1] and add a calling-on light to the rear cab. This last modification was necessary because, although calling-on lights had been fitted to the stock as built, they had been removed and replaced by a ventilator air intake some years earlier in an attempt to improve the cab ventilation. Work on converting the first unit for OPO(T) was started at Northfields early in 1986. After conversion, trains still ran with guards working from the rear cab until the full line changeover, when a big switchover weekend preceded the start date.

The PEA mod was a requirement for OPO(T). It was the fulfilment of LU's long-held desire to get rid of emergency brake operation by the passenger alarm system. As we have seen[2], it had been attempted on the first D Stock in 1979 but was brought down by the inbred conservatism of the unions. For OPO(T), it was finally agreed with the regulatory authorities and the unions that it was not desirable to have a single-manned train stopped in a tube tunnel where help was difficult to get and that it would be better to give the driver an audible alarm instead. This was relatively simple to do on the 1973 Stock, since the emergency brake was controlled electrically and it was just a new wiring connection to a bleeping box in the cab. As we shall see, it proved more difficult on older stocks because they had Westinghouse air braking.

The adoption of PEA was not without problems. There was considerable angst during the early discussions over the role of the driver in responding to a passenger alarm. If an alarm sounded while the train was standing in a station, the solution was simple – don't start the train until the problem has been sorted out. But, if the train is moving, what should the driver do? If he carries on to the next station and someone is being dragged by the train, would the driver be considered liable for any injuries because he did not stop? How could he make a reasonable decision about whether to stop or not? What information did he require and how should he respond to it?

As you can imagine, lots of hands shot up in the corporate classroom with cries of "Sir! Sir!" and there were more suggestions than there were people suggesting them. Eventually though, it was agreed that separate zones for stopping or for carrying on would be fixed so that drivers had sensible and unambiguous rules to follow. So, if

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1 As noted in last month's article, this wasn't the original intention as the door controls were on the back cab wall but experience on the C Stock showed that it took too long if the driver had to stop the train, get up from his seat, turn round, open the cab door and then open the passenger doors, so door controls were added to the driving desk.

2 See Article No.18, *Underground News* No.540, December 2006.

an alarm sounded while the train was within station limits[3], the driver would stop, otherwise he would carry on to the next station and then investigate. To this end, a reflective marker was fixed about a train's length beyond each platform end. The sign was an exclamation mark (!) in black on a white plate. It is recorded that, on the Piccadilly Line at least, they were not all fitted in time for the start of OPO but it went ahead anyway. So that drivers could advise a passenger who had operated the alarm that something would be done, even though the train was carrying on, they were instructed to use the public address system to acknowledge an alarm. Talkback capability for the passenger alarm system was not provided then.

JUBILEE OPO

The next line to be converted to OPO(T) was the Jubilee. The changeover from guard operation was on Monday 28 March 1988 and, whilst successful, it was somewhat complicated by the fact that the Jubilee was in the middle of a rolling stock cascade. At the time of the conversion, there were both 1972 (MkII) and 1983 Tube Stocks in service on the line. The 1983 Stock had been ordered in two batches and the second batch was being delivered. As each 1983 train arrived, a 1972 Tube Stock went to the Bakerloo.

Since the 1983 Stock was designed for OPO(T), switching it from 2PO[4] to OPO(T) was simple, even simpler than the 1973 Stock because of the knowledge that a changeover was imminent. In fact, the later deliveries entered service in OPO(T) mode. For the 1972 Stock, it was a little more complicated. Not only were the trains fitted with Westinghouse emergency brakes but when they were transferred to the Bakerloo they had to be converted back because the Bakerloo was still 2PO. It wasn't possible for the Bakerloo to go over to OPO(T) until the line had central control[5]. The resignalling which went with this was not finished. In reality, the programme was running rather behind schedule.

The cascade meant that the 1972 Stock which were converted for OPO(T) on the Jubilee had to be converted back to 2PO when they went to the Bakerloo. The initial OPO(T) conversion work was started on the 1972 Tube Stock in the spring of 1987 and the first train was completed on 11 June. The MkIIs had been built with door control panels at the traditional position in the passenger saloon at the end of driving cars for the use of guards and with duplicate panels on rear cab walls for eventual OPO conversion. When the conversion came, the guard's equipment in the passenger saloon was removed and, pending the conversion date, guards were moved to the rear cabs as they had been on the Met. To allow them to see the whole train along curved platforms, some stations were provided with CCTV monitors at the new guard's positions.

The 1972s were fitted with the by now usual offside window wiper, a new illuminated train number display, push button tripcock reset and a new passenger alarm system. This last mentioned was somewhat complicated because the stock was fitted with the Westinghouse brake and it had the traditional passenger emergency valves connected to the train line. Doubtless you will remember[6] that opening a valve on

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3 "Station Limits" is the length of the platform and the area either side of it where occupied by a train which can still be accessed from it. In practice, it equates to just under a train's length either side of the platform.

4 Two person operation.

5 An HMRI requirement – so that the controller could see where trains were and co-ordinate emergencies like "leap-frogging".

6 From Article No. 6, *Underground News* No.528, December 2005, page 599.

this type of train exhausted the air in the train line and caused an emergency brake application. The complication arose because of the need to modify it for OPO(T) on the Jubilee but to retain the emergency brake option for when the train was transferred to the Bakerloo and went back to 2PO.

An innovative solution was devised. The passenger emergency valves were blanked off and the pipes capped. The valves were replaced by passenger emergency push buttons, which activated the audible alarm in the operative cab through a round-the-train circuit. Indicator lights were provided on each car over the end doorway to indicate activation on that vehicle[7]. In order to retain the emergency braking facility for 2PO, the circuit was wired into the deadman valve. This was already electrically operated[8], so it was simple to wire in a connection to the passenger alarm circuit. While the train operated in OPO(T) on the Jubilee, the circuit was linked to the audible alarm. When the train was transferred to the Bakerloo, the link was switched over to the deadman valve. The Bakerloo carried on with 2PO into another year, the 1972 Stock finally going OPO(T) permanently on the line on 20 November 1989.

PEA AFTER KX

Just over three months after OPO(T) was introduced on the Piccadilly Line, there was a catastrophic fire at King's Cross station on 18 November 1987 in which 31 people died. Even before publication of the report on the fire by Desmond Fennell QC, the Underground went into a corporate panic and eventually, with the weight of the report behind them, persuaded the government to do the same. The government response was to give them lots of additional money for safety modifications to both trains and stations. Some of the money was wisely spent and some not. One of the sillier projects was the removal of the sundela board and hardboard interior panels on the 1959/62 Tube Stock fleets. These were regarded as a fire risk and were replaced with aluminium panels. Since the original side panels were protected by flame-retardant melamine and the ceiling panels were permanently damp from being regularly soaked by washing machine water and rain leaking through the car roofs above them, the risk of fire was very low. On top of this, the Central Line stock was already planned for replacement within five years and the Northern Line after that. This was not money well spent.

At the same time, it was decided to remove the passenger alarm emergency brake application from all stocks which still had it and adopt the OPO(T) PEA system. This was carried out system-wide, regardless of the age of the stock, its OPO or 2PO status or the difficulty of conversion. For the pre-1973 stocks, a new circuit for an audible alarm was fitted to the trains and push-button switches were installed for passenger use, just as had been done for the 1972 (MkII) OPO(T) conversion. The old passenger emergency valves were blanked off and emergency brakes could no longer be applied by passengers. If an alarm was operated, the same rules applied as for OPO(T) – the driver would stop the train if he had not passed the marker beyond each station. Otherwise, he carried on.

For the 1959/62 Tube Stock fleets, the fitting of new electrical circuits for PEA and public address required the fitting of new inter-car jumpers. Only middle cabs had

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[7] This indicator light system was first adopted on the 1973 Stock and eventually became standard across the system.

[8] In Article No.17, *Underground News* No.539, November 2006, page 651, I mentioned that the deadman facility was tied in with the Combined Traction/Brake Controller. It operated an electro-pneumatic deadman valve through a switch in the controller handle.

jumpers between them, which effectively converted the trains into “block units” where the middle cabs could not be used at the ends of trains.

PEA AFTER HOLBORN

During the early 1990s, as traffic levels continued to increase and train services struggled to keep up, there were a number of cases of passengers being injured, some fatally, as a result of platform/train interface problems, as these incidents became known. They were widely publicised by the London evening press, who delighted in taking any opportunity possible to show the system in a bad light and to over-dramatise what were, in many cases, quite minor problems. Some however, were more serious. There was a death at Hounslow East in 1993, when an elderly woman was dragged by her coat after it had been caught in the doors of a departing train and another at Ealing Common in September 1994, when a 73-year old man caught his stick in the doors and was dragged as the train left the station. In one incident, on 21 October 1997, an 11-year old boy was killed at Holborn (Piccadilly Line) when a toggle on his anorak was trapped in the doors and he was dragged into the tunnel. This last incident finally reactivated the attrition mode[9] and there was another review of the passenger alarm system and how it operated.

Although it is difficult to say whether or not an emergency stop would prevent injury or death, particularly at a tunnel station, there was now a clamour for it from some quarters, both inside and outside LU. In spite of the desire to keep operation of train brakes away from passengers, largely because most of them were quite unaware of the consequences of alarm button operation, there were still doubts within some areas of LU management about the way passenger alarm operations were responded to.

There were “hawks” and “doves”. The hawks regarded all passenger alarm systems as a nuisance. They held that most alarm operations caused unnecessary delays to the train service and were either malicious or, more often, stupid – the “I left my friend behind” or “I was *ashleep* and I *misshed* my station” sort of incident. They had fought long and hard to get the emergency brake operation removed and, having been successful, wanted to leave the system as it now was. They regarded any change as another constraint on an increasingly overloaded system and they thought it would just make things worse for the majority of passengers.

Then there were the “doves”, who were somewhat traumatised by the Holborn incident and who wanted safety at almost any price. Their view was that the problems which would be created by returning to an already discredited system were not sufficient to justify retention of the existing system. They wanted trains to stop, regardless. Doubtless some were afraid that otherwise, they would be regarded as responsible for an injury and would, at best, get sued or, at worst, be vilified by the press.

In the end, some sense was brought into the debate by people looking again at the role of the driver. Was it fair, they asked, to expect the driver to make a decision about whether to stop or not? Was it fair that there was, at that time, no easy way of proving where the train was when an alarm operated and whether the driver had responded appropriately? In other words, did the driver get an alarm before or after he reached the marker and did he stop when he should have?

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[9] The process of attrition which I referred to in Article No.18, *Underground News* No.540, December 2006.

It was an interesting but difficult debate. The driver decision-making process was regarded as vulnerable and not entirely fair to the driver. Ways of reducing this responsibility were looked at until the idea of causing an automatic brake application, but only within the station marker zone, was proposed. It was a good, old-fashioned compromise but it has merit. It gets the driver off the hook. It always stops the train if it is within range of the platform and it allows the train to keep moving if that is the more sensible option. When workable engineering options were eventually found for each stock, it was agreed that the new system should be adopted.

The principle was developed so that, when a passenger alarm was operated, the train brakes would be applied automatically but the driver should override them if the train was outside the marker limit. A rule was introduced which said that, provided part of the train was still in the platform, the driver was to "assist the train to stop". If it was not (i.e. the front of the train had passed the marker post), he could release the brake application, by means of a specially fitted foot pedal, to enable the train to be driven on to the next station, where help would be more easily rendered. The new system was known as PEAB (Passenger Emergency Alarm Brake) and the foot pedal release as PEAB Override.

Providing an emergency brake that is easily overridden is simple on stocks with ECEB (Electrical Control of Emergency Braking) like the 1973 and later stocks, because the control side is entirely electrical but on traditional Westinghouse air braked stocks it is more difficult. The loss of air pressure in emergency brake mode means that it is much more difficult to get a release. The air would not restore quickly. Indeed, the train would probably come to a stand before any attempt to reset could take effect. At the very least, there would be a sudden and jerky brake application followed by an erratic release as the air pressure restored along the train. This would not help passenger confidence, particularly if it was already shaken by the original emergency.

The solution was to apply a full service electro-pneumatic brake rather than an emergency air brake and to control it by modifying the circuits used for SCAT (Speed Control After Tripping)[10]. In a further refinement, a new marking system began to appear from March 1999. White on blue number plates, corresponding to the number of cars in a train, were placed along the track side, visible as trains left stations to indicate the limit of required stopping if a passenger alarm was operated. They were positioned closer together at the outer end to reflect the greater train speed at this point. They were called countdown markers, even though, as everyone invariably points out, they actually count up.

Curiously, the 1996 Tube Stock has no foot pedal override. The train stops and the driver has to liaise with control over the radio before proceeding. There is a sealed switch in the cab which has to be operated to allow the train to proceed. It appears to have been done this way because of the prospect of early conversion to ATO. The 1995 Stock is also different, in that there is an 8 second time slot during which an alarm operation will stop the train. Beyond that time, the train can continue. Both these stocks have in-cab CCTV, which allows the driver to see what is going on as he leaves the station.

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[10] Described in Article No.17, *Underground News* No.539, November 2006, pages 656-657. In this article, I should have made clear that a SCAT overspeed operates the emergency brakes on ECEB stocks and full service e.p. on pre-1973 stocks.

PEAB WITH ATO

Providing PEAB on ATO trains (1967 and 1992 Tube Stocks), proved something of a challenge, particularly on the 1967 Stock. If an alarm was operated, it was possible to induce a full service brake but getting the train to release it on command of the driver and still respond to the ATO commands as well, was quite complex. The solution was to use inputs to the automatic system to fool the train into thinking the brakes hadn't been applied but only when the driver operated the release switch. The driver has a foot switch on the left hand side and a button, illuminated in the dark, on the right hand side of the cab.

On the 1992 Stock, with a different ATO system, another solution had to be adopted. There is no override button on 1992 Stock. Instead a scheme has been introduced to make the changeover from 'Alarm & Brake' to 'Alarm only' automatic using a timer. A study into the time it takes trains to depart stations under both ATO and Coded Manual driving concluded that the average is 16 seconds. So, if a PEA handle is operated within 16 seconds of a train starting to leave a platform the train will stop – if it's after 16 seconds, the train will continue to the next station. The timer is reset at the next station as the saloon doors are opened[11]. I have not discovered why the 1995 Tube Stock uses 8 seconds while the 1992 Stock has 16 seconds but train length could be a factor[12].

CSDE

The spread of OPO across the Underground brought with it a number of new problems which were not foreseen when the first lines were converted in the mid-1980s. One was an increase in the number of reported wrong-side door openings. In these cases, the driver would stop the train in the platform and then open the doors on the wrong side of the train, usually followed by a rapid closure and then opening on the correct side. It didn't happen often compared with the number of door operations which took place every day but a rising number of incidents were reported by both staff and passengers. I don't recall any incident where anyone fell out onto the adjacent track or tried to step off a train into a tunnel wall but the potential for a serious accident was there. Something had to be done about it. The response was CSDE (Correct Side Door Enable)[13]. This is a detection system designed to ensure that the driver opens the train doors on the same side of the train as the platform and only when the train is berthed in the correct position.

The reasons for the increase in wrong side openings were obvious. The whole pattern of working had changed for the driver and he was now on his own for most of the working day. There was also a serious increase in his workload. Under 2PO, the driver stopped the train at the station and then did no more until he heard the bell. He then started the train again. This was the pattern all day. Often, you could go up and down a line all day, hardly knowing where you were. One evening, when I was doing Circles on a CO/CP Stock, a passenger knocked on the cab door while we were running between stations. I opened it and asked what he wanted. "What's

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[11] My thanks to Ted Robinson for filling in many details on the PEA modifications.

[12] There are a number of other inconsistencies between lines and how they deal with rolling stock. Emergency escape systems come to mind as does the wide variation in documentation for each stock and the level of information provided. This is a far cry from the time when you could move from line to line and find identical standards and systems in place, even for different stocks. Now, staff moving to a new line need considerably more training than of old to cope with the changes.

[13] It was first called "Right Side Door Opening" but this title was soon ditched because it could have been the left side!

the next station?" He asked. I didn't have a clue. "Hang on a minute" I said. I waited until I passed a signal whose number I recognised. "Tower Hill" I replied, when I saw one. When he closed the door I reflected that I hadn't noticed any stations since South Kensington. I had stopped at all of them, waited for the guard to open and close the doors, waited for the bell and, when I heard it, released the brakes and started the train without being conscious of any of it.

With OPO, as we have seen, the driver had to stop and then do all the station work. The most vulnerable moment was the door open operation, since you have to remember which station you are at. This is not always obvious and it's very difficult to stop your mind drifting when you are doing a repetitive job, hour after hour, day after day. If your memory selects the wrong station, it is easy to open the doors on the wrong side. As I said, it didn't happen often but often enough to cause CSDE to be installed from 1991 onwards across the system, except on the Victoria Line.

CSDE uses a radiating loop or transponder (there are different types around the system) at the end of each platform to tell a train mounted receiver that the cab is in the correct place (± a few feet) and, if it is OK, a lamp lights in the cab and the door open circuit is released. There is also the inevitable cut-out switch in the cab, in case it doesn't work. CSDE is not provided on the Victoria Line because the driver doesn't normally have any driving to do and he has time to cross the cab to the platform side (if necessary) before the train stops. The door controls are fitted on each side of the cab, so he has to be on the same side for the doors to open on that side. This was originally the system on the C Stock when this was converted to OPO but, as I mentioned last month, the door controls were added to the driver's desk to reduce the dwell times. Remember, the driver can't leave the driving position until he has come to a halt on a manually driven train. On the Central Line, CSDE was already built into the ATO system but, before ATO was operational, there were some incidents of wrong side opening. There was even one a few months ago, years after ATO, with CSDE, was introduced.

It was an interesting example of how the human response can still be automatic, even in an unusual situation. A train stopped at Bank westbound and the driver opened the doors on the wrong side. This was even though the CSDE equipment was functioning correctly. The driver appears to have pressed the open buttons for the wrong side and the doors had (correctly) failed to open. Thinking the CSDE had failed, he switched out the CSDE circuit but then still pressed the wrong buttons. Obviously he had "panicked" and had not thought through clearly what he should do. Drivers are taught that they should only operate the doors from the rear panel (not the driving desk) when they have isolated the CSDE because of a suspected failure and only after they have opened the cab door and placed one foot on the platform.

RESTROKING

Another example of the attrition process arose following an incident at King's Cross (Piccadilly Line) on 2 December 1993. Here, an eastbound 1973 Tube Stock train departed leaving its driver on the platform. It carried on, with 150 passengers on board according to the Daily Telegraph, and only stopped when it was 'tripped' at the Holloway Road home signal. There was an initial panic when someone suggested that the train had been hijacked but this quickly resolved itself when the empty cab was inspected. It was discovered that the driver had left the traction/brake controller with a motoring position selected and a bag hung on the deadman's handle. Although this may seem bizarre, it arose because of the link between door closure,

the pilot light circuit, traction control and its misuse by the driver. It is also a good example of the old saying that, “the devil makes work for idle hands”.

The pilot light, you may remember from last month, is the indication provided to show the train crew that all the passenger doors are closed. It is lit from a round-the-train circuit which passes through an interlock on each door leaf. The interlock is closed and the circuit “made” when the door is closed to within ½ inch (12mm). The pilot light was provided on all guard’s control panels on 2PO trains and on driver’s desks for OPO. In 2PO days, it was linked to the bell signal so that the driver would not hear the bell unless all doors were closed. When trains were converted to OPO, the bell signal became obsolete and the pilot light circuit was modified to prevent the traction control being initiated – the train could not be started unless all the doors were closed.

The link to traction control gave rise to a new possibility. The driver could press the “doors close” button and then place the traction/brake controller (TBC) in a starting position while he waited for the doors to close and the pilot light circuit to be completed. As soon as it was, the train would start. He could even select power before selecting doors close. Aware of this, the driver of our King’s Cross runaway appears to have got into the habit of doing this and of using his bag to hold the controller in a motoring position. On the fateful day in question, the train didn't start as expected and the driver saw he hadn't got the pilot light, so he got out of the cab to investigate what he suspected was a stuck door. While he was on the platform, the stuck door unstuck and closed and the train, now with pilot light circuit complete and motoring being called for by the TBC, took off. It caused a lot of red faces and cost the driver his job.

To prevent this happening again, restroking was introduced. Restroking was simply a way of ensuring that the driver had to wait for the pilot light before he could start the train. A relay was added to the traction control circuit, which de-energised if the pilot light circuit was open. It could only be reset if the traction/brake controller was in a “power off” position and the pilot light restored.

The driver of the King’s Cross train was later prosecuted at Snaresbrook Crown Court for “wilfully endangering the safety of passengers” and was found guilty. I have not been able to find out what his sentence was but the details for the story I tell here came from past issues of “From the Papers” in *Underground News*.

Restroking was called restroking because it was necessary to shut off and re-apply power if the pilot light was lost between stations. The most common causes were a sudden brake application, a jerky accelerating sequence (which you sometimes get when going over gaps) or passengers leaning on or even messing about with the doors while the train is on the move. Any of these could cause a momentary break in the interlock contact and thus in the pilot light circuit and the traction control. However, these momentary breaks in the circuit were usually so short and the loss in power so small that the driver might well not notice. Restoration of power used to be automatic as soon as the pilot light was restored and these sort of occasions rarely arose from anything unsafe but now, it is necessary for the driver to “restroke” the TBC if the pilot light is lost while the train is under power. It has the added advantage that the driver is immediately aware of a pilot light loss.

RUN-BACK

Another issue which popped up in unusual circumstances was “run back” detection. This is a situation where a train, having stopped at a station or signal, rolls backwards. Under most conditions, this is because the driver has left the brakes released upon stopping and the train, being on an uphill gradient, starts to roll backwards. Very rarely, it might be due to a loss of electrical supply to the e.p. brake system. With a train rolling backwards, there is no tripcock protection to prevent collisions. On a 2PO train, the guard was supposed to watch for such incidents and apply the emergency brake if things seemed to be getting out of hand. When ATO was being designed for the Victoria Line, the lack of a guard to act as a check against such occasions led to an automatic run back detector system being provided.

The detector system consists of an attachment added to the mechanical speed governor provided on a trailing axle of the 1967 Stock to monitor the 25mph speed limit required under certain signalling conditions. The attachment opens the circuit to the code trip valve[14] if the train rolls back more than a few feet. The system was not thought to be necessary on OPO trains since either an emergency brake or a holding brake is automatically applied when the TBC handle is let go by the driver. This was until an incident on the Northern Line on 8 July 2000.

A late-night train approaching Belsize Park was brought to a stand normally by the driver at the home signal, which happened to be at danger. A few moments later, the train began to roll backwards and carried on doing so for over a kilometre, in the wrong direction, back through Chalk Farm station until it was tripped, completely by chance, at the home signal. It transpired that the driver had fallen asleep with his hand on the master controller handle in the “Off & Release” position and with the deadman twist-grip active and he managed to keep it in that position despite being asleep. Medical advice later suggested that people could do this sort of thing for up to two minutes. Behind the usual outburst of media hysteria, London Underground implemented a simple (but not inexpensive) solution by adding run-back detectors to each train to prevent a recurrence. A modification programme was started in 2001 and has since been implemented fleet-wide on all lines. It is now referred to as RPS – Run-back Protection System and, as usual, it has a sealed isolator switch in the cab in case it goes wrong.

ARMCHAIRS

The Belsize Park incident raises another interesting issue. The 199x series of tube stocks has a considerably improved cab seat design compared with the traditional type. It is a nice armchair with the traction/brake controller in the right hand armrest. After Belsize Park, one might be tempted to ask if these armchairs are too comfortable. They certainly seem to look and feel luxurious when compared with the previous versions and the crews certainly appear very relaxed on the Central Line where, with ATO, they have little to do. It’s a different story from the Victoria Line, where drivers are always on the alert arriving at stations so they can make sure the train stops in the right place. It very often has to be forced to, with a quick emergency stop activated by the driver, as the existing ATO doesn’t do it very well – another subject for a future article.

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[14] This is the Victoria Line ATO device which takes the place of the tripcock on a conventional train. See Article No.17, *Underground News* No.539, November 2006, page 654.

The design of cab seats will only ever be a compromise. You have to try to give the driver a reasonable seat for the sake of his comfort and health but you shouldn't make it so comfortable that he will fall asleep. The seat has to be adjustable to take account of the wide range of people who will use it – including females. It also has to be very robust – the adjustment mechanisms of seats are notoriously difficult to keep in good condition. Sometimes, too, you will want to drive standing up – no longer easy on modern stocks. Even with these all catered for, there will always be someone who can't quite get comfortable.

Armchair cab seats are not new. They were first tried on the streamlined 1935 Tube Stock. They were a giant step forward from the small, round, bottom-aching, thinly padded perches provided on the Standard Stock. But, guess what. Problems with drivers nodding off soon led to the idea being dropped for the 1938 Tube Stock and a simple, padded, tip up seat with a crude backrest was offered as the solution. This did not change until the D Stock, which got a vertically adjustable seat on an independent pillar set into the cab floor, instead of being attached to the rear cab wall. It was based on a BR locomotive driver's seat.

The old armchairs were removed from the 1935 Stock when the cars were converted to trailers in 1950 to run with 1938 Stock and they were put to good use in Acton Works. They became the customer's chairs in an unofficial barber's shop, which existed in the works for many years, run by certain enterprising members of staff.

The chairs, plus the barber's shop and most of the works, are now long gone. The problem of drivers falling asleep in them obviously isn't.

To be continued …….