

# Enfield Archaeology

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Written information and data about the Enfield 8000 is very limited, and one of the few accessible records is the Electricity Board Research Report. This was intended to give a summary of the tests carried out and the conclusions deduced from the test programme, not to be an historical archive. However, once you start to dig within the lines of its contents, you start to find little facts that can be cross-reference and enable a number of details to be deduced.

## 1) Numbers and Location

Firstly, the report states EXPLICITLY, that the CEGB decreed and defined that 66 cars should be and were used on the tests. It also states that although these were originally scattered as single vehicles across the country, the maintenance required was specialist and the wide dispersal of the cars meant that the availability of the cars for use was poor, due to the limited expertise available. This led to the cars being clustered into small groups around the country, and meant that the expertise for maintenance and repair could be focused and made readily available. The site locations are not disclosed apart from 'London', and even here it is reported that the cars were dispersed across the City.

Sadly, the number of people who were involved with the tests is diminishing with time, hence it is important to recover and record their knowledge before it completely disappears. I have a friend who worked for the CEGB at one of their South Yorkshire Offices and he drove and tested a small fleet of 3 of the cars which were based there. I am still working on him to gain as much information as I can. One of his memories was that he often had to stop at the bottom of the hill up to the Office, and have 'a smoke' while he waited for the batteries to recover sufficiently to climb the hill back to the office. Another related the limited distance and careful planning required when he took his then girlfriend – now Wife – out, due to the limited range!

I am still trying to find out precisely WHERE he was stationed in South Yorks. Sadly, he perhaps doesn't realise he may be one of the last testers still alive and approachable – and therefore doesn't value the memories in his head!

## 2) Batteries

One of the primary limitations, then as now, was the capacity of the batteries. Numerous configurations and manufacturer sources of battery were tested, and this appears to have been an important aspect of the test programme. Although alternative chemistries were being developed at the time, their cost and availability was both prohibitive and poor. This meant that the only available and affordable battery chemistry was Lead Acid. Within the report it is noted both flat plate and tubular battery types were investigated, and on Page 9 of the report you will see a photograph of a car bonnet with extra tall single cell batteries in it – the bonnet lock/castle and assembly has been removed to accommodate the height of the batteries which almost fill the bonnet cavity. The registration number is legible below the bumper: - MBD 823P! The text describes that there were 3 cars used to test 'new cylindrical batteries', one used Oldham OTM6 cells at 56V. If you count the cells in the bonnet of MBD there are 14! - which means that MBD MUST be this car if the cells are a lead-acid chemistry at 2V per cell.

In mid-2017 I was given some original photographs of this car when it was sold at auction on the 2<sup>nd</sup> February 1988 at Colchester Car Auctions – the original batteries can clearly be seen in place and the bonnet of this car is still shown as being retained by 60's 'rally' style stretchable rubber external fixings, but still retaining the lower hinge mount.

The other two cars are stated as using 'new high energy density' OTH5 cells at 64V. It says the second one was being prepared with these cells. I presume that one had already been converted and that the second was in progress when the report was being written in 1978 (ish). Well, a bit more forensic info for you - I can tell you that one of these two cars may have been my own car MCL74P.

When I bought it the whole of the front bonnet lock/castle assembly was missing and had been carefully but somewhat brutally removed from the car. The bonnet had been converted to use 3 small over-centre catches to retain it (I know - I have just filled in the holes in bonnet skin prior to painting). There were no bonnet hinge parts with the car apart from the front rail 'hooks' inside the bonnet. (to enable restoration I had to borrow a castle and bonnet from which to make the necessary patterns for the replacements.) There is also another peculiar bit about my car, which now might make sense – the rear panel or parcel shelf has been 'raised' by about 1" and everything including the fuse holders moved up – I wonder if that was to cover the taller cylindrical batteries in the boot? When I get the opportunity to rummage in the loft I will photograph the parcel shelf to show the modifications made. It is of course pure co-incidence that I received the original colour prints of MDB 823P, when I purchased the remains of a very decomposed Enfield - LFT 766P!

It would appear that my car must have been one of the two OTH5 powered cars! The Contactors and the throttle pedal were completely missing from my car – I wonder if the Contactor reliability problems became too great when the Battery Voltage was increased to 64V? It would have been almost twice as bad with the higher voltage. It was already a problem with the 48V system which required regular contactor cleaning. There were indications of a conflagration around the electrics of my car but whether this was due to the electrics or vandalism remains unclear.

### 3) Performance

Throughout the CEGB report there are a number of performance figures quoted for the cars in different configurations.

The first figure is the specific energy consumption of the cars when using the standard Heavy Duty Starter (SLI) Batteries as 500 to 600 Wh/mile. The next figure quoted is for cars using light weight Traction Batteries (Trojans?). This is 493Wh/Mile. While a 3<sup>rd</sup> is 476 Wh/mile – specifically if the vehicles were used across the full range of their battery capacity, and the power losses due to charging and out-gassing carefully controlled.

The power measurements used represent the 'total input power' used to travel a given distance' and, as far as can tell, certainly every test car, was fitted with a mains import meter to measure total power input every time the vehicle was charged.

Remembering that these vehicles would need to pull 150 to 200 amps to provide the necessary traction power, the batteries were being used and deep cycled at roughly the '1C' rate where wet Lead Acid batteries are already becoming increasingly inefficient in terms of their Charge/Discharge characteristics.

A last and interesting number which comes out of the report are the specific performance capabilities taken from the first of the cars with the OTH5 cells, even after a very short running in period (it) was returning "348Wh/mile", it is said to have a top speed over 50mph, it could easily cruise and maintain a speed in excess of 40 mph, it achieved 41 ½ miles in one hour on public roads, and achieved 227miles on 75kWh, and could achieve a range of more than 70miles on a single charge. Forgive me – 50mph? 70 mile range? 40+ miles in one hour? 1975? - doesn't that make a G-Wizz look a bit stupid!

All that remains is to find out which of the other cars is the 3<sup>rd</sup> of the 3 special experimental battery cars, and also some specifications of the battery cells that were used – from the information gleaned from the report there were 16 cells in the front and back of the OTH5 equipped cars. Sadly, I suspect that these cells could have been 'Specials' which would have been typical of the period, and with the interactions between the CEGB and Oldhams.

A significant search on the internet has failed to unearth any information on Oldham OTM and OTH cells. However, these cells appear to be similar to modern heavy duty fork lift truck batteries. These batteries are still sold under the 'Hawker' brand name, and there appear to be strong links between Oldham, and Hawker and also Enersys flooded cylindrical cells. Of course there are links between Hawker and Hawker Genesys, which in turn is linked to modern Hawker Red Top domestic high

efficiency sealed lead acid gel batteries, with a power to weight ratio almost double flooded lead acid batteries.

If you do some 'fag packet' calculations from the data, 348Wh/Mile and 70 mile range comes out at about 24kWh, before you take into account the charging efficiency (poor), and the charger and electronic efficiency – (still poor), and the high current discharge efficiency – (still poor). It would look as if the OTH and OTM batteries were probably rated somewhere about 12kWh. Alternatively a genuinely deep cycle battery capable of giving out about 200 AH. However, I suspect that the re-batteried cars weighed rather more than the '970kg' quoted on our registration documents!

### **3a) Chassis Performance**

We have talked about, and often think of, batteries as being 'perfect'. In fact this is far from the case. A very large amount of energy is wasted in the process of charging and particularly discharging a Lead Acid Battery. Performance is dependent on a number of factors, construction, manufacturer, age etc., but the really determining factor is the discharge current.

When fully charged, the capacity of a lead acid battery is defined at the '0.1C' rate, i.e. the current which will discharge the battery totally in 10 hours – i.e a rate of 1/10<sup>th</sup> of its capacity.

Remembering that Enfields had a limited range and often never ran for much more than an hour before the batteries were flat, this would indicate that the batteries were typically discharged near to the '1C' rate.

At this level of discharge, the actual energy supplied by the battery was often not more than 50% of the 'rated' capacity of the battery, and this is assuming typical batteries of the modern era – not those from the 1970's. To put this into perspective, if a lead acid battery is fully charged and then discharged at '1C', it can only give back 50% of its rated capacity.

Similarly, you should also consider that the charging efficiency of these batteries lies in the range 90 to 95%. Again it means that you must supply an extra 10% or so of energy to completely re-charge a battery to its full rated capacity, when charging it at '0.1C'.

Remembering that the figures quoted in the Project Report are deduced from the Total Energy required to re-charge the battery after a run, we must also realise that the efficiency of the Charging System must also be considered. Very difficult to determine, given the physical size of the huge mains transformer used to charge the battery, but for medium sized mains transformers I have seen figures in the range of the low 80's % quoted when used in 'full wave rectifier mode'.

The real measure of the vehicle's chassis is the amount of power needed to move the car a given distance. Using the above figures would indicate that potentially up to 62% of the energy fed into the vehicle to charge the battery was wasted and that only 38% actually used to move the vehicle! (Please remember that the efficiency of an internal combustion engine lies in the range 18 to 23%, and that the efficiency of producing and transporting electrical energy is only about 33% in the first place!

To put this into perspective – the Chassis, when sorted, reportedly returned an energy consumption of 476Wh/mile. This is, in reality, only a real power into the motor of the car of 180Wh/mile! - once the discharge, Charging, and Charger losses are considered.

That is a pretty efficient chassis – it can move over 5 miles on 1 kWh of energy – so a human being would be able to push it over a mile and a half in one hour! (Pardon me while I see how far I can push my bike in 1 hour.)

Interesting (approximate) figures!

(now about that very expensive LiFePo4 battery with 95% discharge efficiency that I was saving up for!)

### **4) Controllers**

One last observation from the Project report, is the reason that Electronic Controllers were not standard on the cars. It is stated that only one Enfield was converted to use a 'Cableform MkX Pulsematic Controller'. Trawl of the Internet has again turned up little detailed information on this

device, apart from sufficient to know that it did exist - does anyone know anything about this controller or know which car was fitted with it?

I found a NASA report on it looking at efficiency and torque etc, done by a university, and can tell that Cableform is still a part of Hubbel Industrial Controls making motor controllers for big AC and DC Mining motor installations (funny link that isn't it! But I wonder if the one MkX Enfield controller actually went into a Miner?) I have since had information that a Cableform was never fitted to a Miner, so the MkX miner may still be out there somewhere!

## **5) Bonnet closings**

Following on from the need to find the last of the 'battery research' cars, I went through every photo or every Enfield available – guess what – I could only find MBD and my own car that had modified closing methods for the bonnet when they were in early form There are of course essentially NO photographs of my car recognisable on the web apart from the one on the website and that has no registration number. I found that HYC 599N has at one time had one rubber clamp in the top centre of the bonnet, but bonnet still appears to close with an internal catch as do normal Enfields I think that the clamp was not fitted due to battery changes, merely to help the main catch.

MBD retained the original lower bonnet hinges, which can be clearly seen in one of the photographs of her from 1988. I believe that MCL probably didn't (hence the 3 clips) since there was nothing that looked like the lower hinge mounts or hinges on the remains of the bonnet frame when I got her. Consider it – quite a feat for MBD to still have her special batteries in place and presumably functioning after more than 10 years – interesting batteries!

## **6) Conclusions**

This little treatise and excavation through the little factual information that remains from the Enfield Project leaves an interesting pair of questions – 1) which is the other battery test car, since we don't actually know anything about it, and it is obvious in none of the photos we have access to, - and 2) was the second conversion of a OTH5 powered car ever finished?

Perhaps you will let me take some comfort that MCL having been an abandoned project with many irreplaceable parts missing, will go back on the road to continue her long and distinguished 'experimental' role and that she never did or will remain a 'standard' Enfield for very long. The other tantalising observation is that there is no such thing as a 'standard' Enfield, they were all changed and modified, altered and used as mobile tests beds throughout their lives. In returning MCL to the road, what I am having to do to her, really and truly is in keeping with her experimental past!