

AUTOCAR

1903 North Eastern Railway Electric Autocar Trust

Newsletter No.24 — Autumn 2014



The North Eastern Railway 1903 Electric Autocar Trust

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- Front Cover:** *The autocoach, pictured on an evening shunt on the
3rd October 2014. (Wendy Anderson)*

October 2014

Welcome to the 24th issue of our newsletter. Much of it is about the engineering. This part of the project is the key to achieving an autocar and trailer we can be proud of, a twinset which will be mechanically reliable and easy to maintain and operate. These reports describe our recent progress and explain why we need your help to finish the project.

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New Members

A warm welcome to Mr. G Bunker of Addlestone and Mr. I Forsyth of Durham.

Notice of Annual General Meeting 2014-2015

In previous years the AGM has been held during the autumn, either in October or November. It has often been difficult to get fully audited accounts ready to present to the meeting and therefore it has been decided to hold the Annual General Meeting later in the financial year. The AGM has to be held within six months of the financial year end and it will therefore take place on Saturday 31st January 2015 starting at 14:00 in Harrogate. Stephen and Qiuying have kindly offered to allow the Trust to host the meeting at their home:

Rose Lea House, 23 Brunswick Drive, Harrogate, North Yorkshire, HG1 2QW
Sat 31st January 2015 at 14:00

A full agenda and papers will be sent out nearer the time.

(DC).

Chairman's notes

Stephen Middleton

The big story in this issue is fundraising. Now we are approaching the end of the engineering, we can clearly see how much more money we need to complete the entire project. I have covered the reasons why we have overspent later in this issue and hope very much that you can continue your greatly appreciated support.

This issue has been weighing on my mind, but lightening the load has been the progress on the autocoach. In early October it moved from the draughty carriage shed to the enclosed engineering workshop for lifting, brake work, seats, steps and headstocks. I did not witness the move but the photos taken of the move show just what our dedicated volunteer team achieved in just two years. Well done! The working underframe should be back this winter and by then I hope the autocoach will be finished and fit to run. After all, who is going to want to work on that, when there is the autocar to complete?



The engine housing, now with doors. (DJM)

The Autocoach: Peter and Ray - skills living on.

Stephen Middleton

The NER Autocoach 3453 is a vital part of the business case of the autocar, an appropriate vehicle able to help carry an economically viable passenger load. This carriage was kindly donated by the NER carriage group resident on the NYMR. It is truly gratifying to see that members Peter Brumby and Ray Sowerby are not only taking an interest in the autocoach but in the project as a whole and are offering so much. The autocar clerestory vents have been cleaned and varnished, missing hardware made and various other skilled jobs done by Ray. Peter has been responsible for cleaning up and varnishing a lot of woodwork from their former coach. He is responsible for those lovely First and Third transfers which are now so apparent in each compartment. In addition, their knowledge concerning the decor and layout of components within the coach is proving very useful.

Thank you for your help. It is much appreciated.



Engineering Progress Report – October 2014

Steve Hoather

After the frenetic activity during “Big Bang” at Adey’s described in the last Newsletter, when the underframe was delivered to Quorn, we turned our attention to the brake rigging.

Although the major (and expensive) components such as cylinders and slack adjusters had been recovered from Northern Ireland, the design of the rigging on the autocar is completely different from an NIR DEMU or BR Mark 2 coach for several reasons:

The vehicle is shorter and has a separate underframe with truss rods etc., whereas more modern vehicles are of integral construction with a clear underside.

As it is a driving vehicle, it has handbrakes in each cab, and these need slotted links in the rigging so that the handbrake linkage does not impede operation of the power brake and vice versa.

The design of the rigging layout had been done by Steve Parkes some time ago, at the early stage when we were allocating space on the underframe for all the other items such as battery box, fuel tanks and air reservoirs. In fact, some parts of the brake rigging such as the rodding to the handbrake columns were the most critical items of all since they had to have as straight a run as possible, yet clear the wheels under all conditions of track curvature and connect to the gearbox under the handbrake column, which itself had to be in a suitable location in the cab. As part of the design, Steve had calculated the brake force needed at the blocks, and hence the leverage ratios to provide this from the two cylinders (one for each bogie). If the brake force is too low the vehicle will not stop in the required distance, and if it is too high there is a risk of the wheels locking and causing flats on the wheels, which are expensive to remove.

Fig 1 opposite is a “worm’s eye” view of the central part of the rigging, as seen from below. Each of the items with an AC number had to be designed in detail and stressed by Don Carter and Peter Van Houten, based on Steve’s sketches – some are simple levers but there are two complicated brackets (AC022 and AC034) which support the levers and in which the forces are measured in tonnes when the brakes are applied. Fig 2 is a 3D CAD drawing by Peter of the AC034 assembly.

After “Big Bang” there is still a lot of welding work to do on underframe components – apart from the brake levers and brackets, there are the mounting frames for the reservoirs and other brake components. For this type of work on railway vehicles (and similar engineering fabrications) it is necessary to have welders who are periodically checked and certified by an independent body (‘coded welders’) to ensure their work is satisfactory. The welders at Adey’s came in this category, but we were looking for cheaper welders without the overheads of a large factory for the remaining work. This took some time, but by early October we had found someone in the Loughborough area whose rates were reasonable and he successfully submitted his test pieces for approval. Fig 3 below is bracket AC022 tack welded together to ensure everything fits, the two bright round bars are alignment bars to ensure the shafts will be square to the bracket.

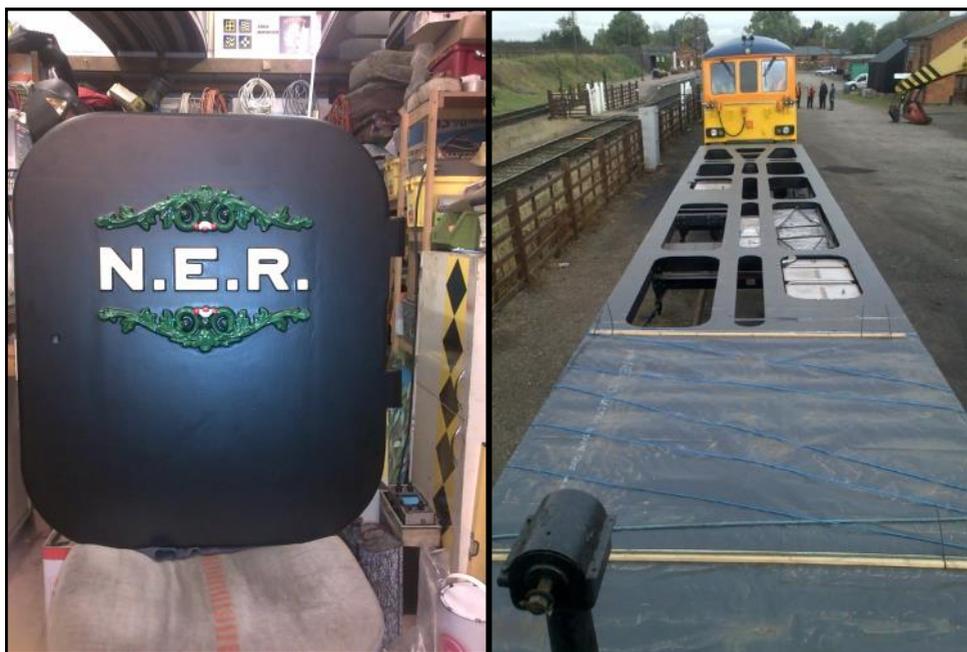
In parallel with this work, Dave Moore was applying the finishing touches to the power unit and its housing. Some of the technical aspects are described in his separate article in this issue, but the list of outstanding work included painting the doors, which Dave has now done, with the raised NER lettering highlighted in white and the decorative pattern (matching the clerestory etchings) in green – see the photo on page four and Fig 4 opposite. Cummins Engineers will be paying us another visit to see the unit running and give their final approval for warranty purposes.



Fig 3 — *Bracket tack welded.* (Peter Van Houten).

At the time of writing (late October), the underframe is still at Quorn. We had hoped to fit the power unit before moving it to Loughborough, but it now looks likely that the underframe will go to Loughborough shortly and we will fit the power unit there, as well as doing the following work:

- fit & connect brake rigging, some of which has yet to be manufactured
- fit brake valves and pipework
- connect fuel system and traction motor cables
- make and fit one cab desk, sufficient for testing
- static brake testing
- test running



Left: Fig 4 — *Power unit housing door.* (DJM)

Right: The *chassis at Quorn, with handbrake column attached.* There is *polythene sheeting over the nearer end to keep rain off the motors.* (DJM)

Autocar Cousins: There's no space in this issue for the next instalment of this serial, but issue 44 (Sept '14) of the *Railway Archive* periodical has an article on LNWR steam railmotors & LMS Sentinel railcar trials.

Fund-raising

Stephen Middleton

Here's the latest estimate to see completion of the autocar and auto-coach with vacuum and air brakes - we need an additional £55,000 and that does not take into account any contingency for unforeseen overspend. The enormity of the task and the significance of the project have given us sleepless nights and very busy days. It is gratifying to see the autocoach heading to completion and the engineering well advanced, if a little overdue. Gratifying too to have the moral, financial and volunteer support from our membership and others. Thank you.

I am asking you for financial support to ensure successful completion but think it only fair that I act as 'devil's advocate' to explain why we have overspent. Here are the questions you have every right to ask and my answers.

Q £55,000, that's a big overspend isn't it?

A *Yes, it is but that represents around 10% over expected costs for the project. A challenging sum to find but for projects such as this, quite close to budget.*

Q Couldn't you have asked for more money from the Heritage Lottery Fund at the outset?

A *We were advised that projects over £500,000 were less likely to be awarded a lottery grant. We managed to get a fixed quote for engineering that kept the project under £500,000.*

Q A fixed quote, that's great, so why the overspend?

A *Brush gave us a fixed price but, following their takeover by Wabtec, their work capacity was reduced and they declined our project. In the event the underframe proved to be in such poor condition, I am certain that additional costs would have been levied. The extent of the corrosion could not be judged until the underframe was stripped of its floor and examined closely. That alone added a hefty five figure sum to the project.*

Q So who's doing the work then, and are they any good?

A David Moore, a senior Brush engineer, was given permission by Wabtec to advise us and bring together industry professionals to do the challenging engineering. When you think about it, our project is the first UK built diesel-electric since the class 60s in the late 1980s - a standard gauge diesel electric multiple unit for £560,000! That does not sound too bad now, does it?

Q Granted, but couldn't we have made savings to keep within budget?

A We have worked very hard to make savings on non safety critical parts of the project such as the autocoach and autocar body and volunteers have done far more than expected, reducing contractors' bills. We will not be fitting floor covering or lining out the autocoach initially. These savings were passed on to engineering. A large sum was required for one off design and approvals. If we were doing more than one autocar, these costs would be minimised as they would be shared among sister autocars. Cummins sold us a new engine. It cost more than a second-hand one but we know it is right for the job, it is guaranteed and comes with parts that will see it functioning well and economically for decades. In addition Cummins engineers have given us a great deal of time when commissioning the engine to ensure all is well. Brakes in particular have to be designed and parts overhauled by professionals to make sure that they are safe, otherwise the autocar could never run. We have several independent advisors to ensure what we are doing is right, good, enthusiastic people whose input is vital. Those visitors who have seen the engineering work comment 'Wow, this certainly is not a bodge!'

Q Yes but

A OK, to be blunt, we could spend a lot less and have something that looks pretty but is dangerous, unreliable and unpopular with host railways, even if it did manage to creep past ROGS, which would be unlikely if we took shortcuts. Although our top speed is only 25mph, we are still subject to the approval process in the Railways and Other Guided Transport Systems regulations 2006 (ROGTS) where we have to satisfy ourselves and the operating Railways (and Insurers) that the train will be safe, and document the justification in a Safety File to demonstrate this.

At the outset we sought advice from and met the Head of Rail Vehicles at ORR to help us understand the requirements. There was no "Rule Book" to follow, so we had to err on the side of caution if in doubt. An example is the braking system, where we are fitting two totally independent systems, one for each bogie, as the autocar can run as a single vehicle. We thought it better to do this from the outset, rather than be forced to modify the vehicle later (as BR had to in some cases).

We have taken tough but right decisions to give us the best possible outlook for a safe, reliable popular machine. Painful now but best to spend now than suffer in the future.

Q Won't the HLF give us more money?

A The condition of the grant was that we do not ask for more money but request contingency funds. We have requested the contingency (and spent it). The HLF have been wonderfully supportive and we have to follow their rules.

Q How about we slow the project down so that we continue as funds come in?

A Again the HLF has given us a deadline to completion - March 2016. It will be a struggle but we have to do it. The HLF retains the final 10% of the grant until the job is finished and we have kept our promise. That effectively means we have to finance cash flow of £46,000 between now and March 2016.

Q What have you done so far to raise the additional money?

A We have tried crowd funding through Sponsume and raised a few hundred and a similar amount has come from donations. We have written to large companies in the industry seeking sponsorship but no luck as yet. Press releases have been sent to social electronic media and sites, specialist magazines and newspapers local to the old haunts of the auto car and we expect some response from that. What we need is help from those really enthusiastic about the project and understand its' significance. Is that you?

Q OK, you have convinced me. I'd like to help. Do you offer any benefits in return?

A Thank you! Yes, you can sponsor seats and have your name on them or framed above, free family tickets and even full train charters. Any help you can give, a loan, gift, donation, time, would be truly appreciated. If there is something else we can do in return, please discuss it with me.

Looking forward to March 2016!

Thank you all.
Stephen Middleton



Autococh doors on 29th October. (Simon Gott)

An Engineer's Perspective - Traction design: the engine

Dave Moore — Volunteer Engineering Advisor to the Trust

As described in some detail previously, the electric transmission as employed on the autocar bears a distinct resemblance to the original equipment, even though over a century separates the two. In a way we were fortunate that the state of the art 1970s style drive we have employed was the most appropriate for the project, as anything more modern would have been much more expensive and more difficult to maintain. The Engine, however, was always going to be a different matter, in that our 'new' (!) railcar would need to employ a current emissions compliant diesel engine. What is surprising to note is just how similar in principle such a new engine is, compared to its predecessor of



Engine, Alternator, Cooler Unit and the smaller items of power equipment at Cummins Wellingborough, with the Cummins staff involved in supplying the equipment. (DJM)

110 years ago. Although using Dr Diesel's compression ignition system rather than spark ignition has become the norm for larger engines, a lot of the engine's parts would be recognisable to the engineer of a century ago. A crankshaft with single acting trunk style pistons still transmits the reciprocating power into a rotary motion using the Four Stroke Cycle. Poppet style valves operated by mechanical valve gear still control the entry of combustion air and the exit of exhaust gas. So the autocar's prime mover of today is not that alien, compared to its original engine.

The 6 cylinder Cummins QSL9, made in Darlington and used mainly in commercial vehicles, buses etc., is the autocar's engine for its next life. This, its fourth engine, runs at 1800rpm and develops 340 horsepower, which is just right for powering the two car unit on preserved lines. The engine weight is 700 kg, oil capacity is 27 litres and coolant capacity 24 litres.

The size of such engines is always reducing as time progresses, consider how big the BR class 08 Shunter's engine from 1950 is, compared to our engine of the same power output. The smaller modern day engine develops its high power by running faster and burning more fuel per stroke than an old time normally aspirated engine could ever have done. Design and manufacture of compact, highly stressed mechanical components has been accompanied by improved fuel injection and pressure charging of the combustion air going into the cylinder. Our basic engine is nine litres capacity and has a High Pressure Common Rail fuel injection system, and a single Holset turbocharger.

All the control functions are electrical / electronic, so there's no throttle cable etc., and the engine has its own electronic governor built onto it. We have had to tailor this truck engine to suit the needs of a diesel electric railcar (more like a locomotive really), and this has been achieved with the assistance of Cummins at Wellingborough who handle such applications in the UK.

Cooling of such an engine requires the use of a similarly adapted Cooler Unit, that in our application is a horizontal loco style radiator mounted

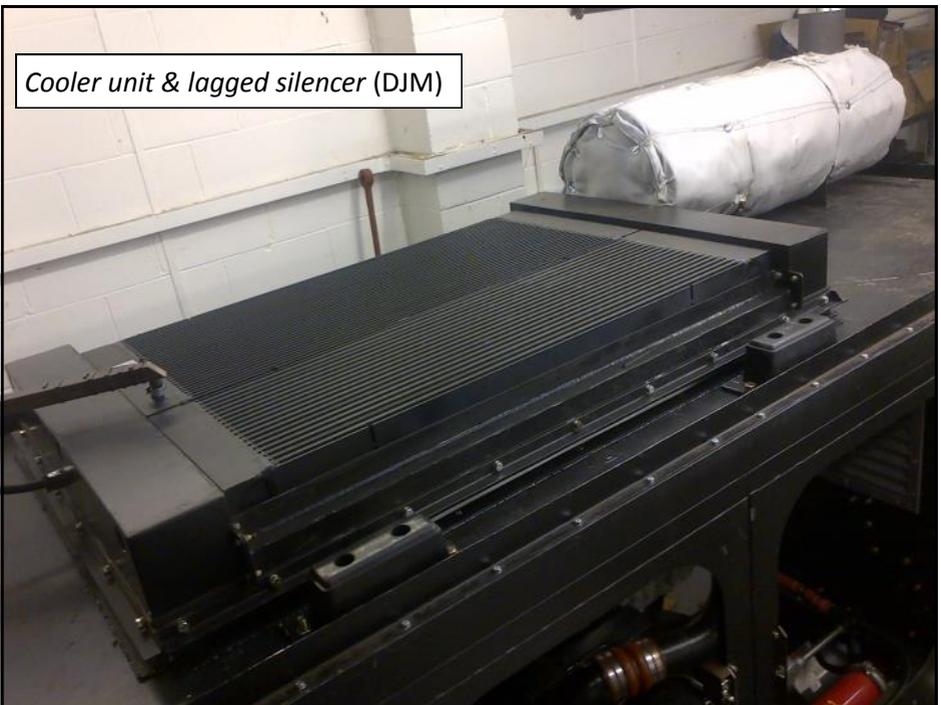
above the engine. This is actually a bespoke dual cooler assembly supplied by Cummins. It incorporates a conventional radiator for engine block cooling but it is also joined in with an air to air heat exchanger (like a dry Intercooler) essential for reducing exhaust emissions. This radiator is fan cooled with a 3 phase motor and draws cold air up through the floor and pushes it though the radiator and out into the clerestory louvre vents. The combustion air enters via a large Air Cleaner assembly next to the engine, with a much smaller version of the same filtering the Compressor's inlet air, all of which comes up through slots in the floor.

The engine has thermostats to control its temperatures in conjunction with the AKG Cooler Unit, and has a Header Tank for expansion and reserve just like most road vehicles do. Noteworthy of the autocar's bespoke Engine Housing arrangement are the large pipes going from the turbo up to the Cooler, and returning to the engine. These carry the engine's pressurised combustion air to and from the cooling matrix and are particularly unusual on rail vehicles, this all being part of the exhaust emissions control regime for modern times. So, ironically, one of the oldest railcars in the world now has a better quality exhaust than most of the thousands of railcars that came after it.

Electrically, the Cummins QSL9 is a world apart even from the classic rail engines of BR times. The basic system - Automotive / Industrial - is 24 volt, and indeed has a battery of its own. The 24 volt governing and fuel injection system has to work with the railcar's own separate 110 volt loco style control system. Starting is done conventionally with a Delco starter motor, and battery charging uses a belt driven Leece Neville alternator. For cold starting an electric preheater grid is provided in the air inlet manifold and this operates automatically when the engine is cold. An electric fuel lift pump is run before cranking the engine to draw fuel from the tank up through the filter which includes a water in fuel (WIF) sensor to prevent injection system damage through water ingress. The fuel injection itself is controlled by the Cummins CM850 Engine Management System and takes the form of timed control pulses firing the solenoid actuated Fuel Injectors in the cylinder Heads, so there are no fuel racks or mechanisms to see. All the control functions are



Radiator Fan and Motor, Air Cleaner, pipework and flexible couplings. (DJM)



Cooler unit & lagged silencer (DJM)

operated through this ECU, and even the throttle to control engine speed is sent electronically. The other loco style essentials such as Load (traction power) control is done likewise, hence the use of loco electronics (albeit somewhat vintage) to control it all. Although not that complex by modern standards, the autocar's equipment does have to blend rail with modern automotive, and spans 60 years of power equipment employed in its transmission. As such, the engine is covered with sensors reading all its temperatures and pressures, and relays much of this for simple viewing on the reader screen available to the driver on the Engine Housing Control Panel, with even greater detail being available when a laptop using Cummins' Insight engine diagnostic software is plugged in to the monitoring socket.



Engine Data Reader showing engine status, output power shown on meters.

Static testing of the engine has been conducted all this summer in the Trust's unit using an extended exhaust and temporary fuel tank, with electrical power being delivered into a load resistor to test the engine / alternator performance. The huge advantage of electric drives over mechanical types is that you do not need a dyno to spin the road wheels to absorb engine power, it can all be absorbed into a load resistor bank and dissipated as heat. And all that whilst stood still and we're able to measure it all easily.

The engine's exhaust exits from the turbo and is piped up onto the roof of the Engine Housing where it is coupled to an industrial silencer. Due to the high temperatures involved, all of this exhaust system is heavily lagged. Exiting vertically out of the clerestory roof, a blown open hinged cap prevents the silencer filling up with rain water. The engine uses highly effective modern wire rope style anti vibration mounts which give excellent isolation to prevent the windows rattling and the driver from getting double vision. The small amount of engine 'wobble' resulting requires that every rigid exhaust or boost air pipe has a flexible section to couple it up which puts a lot of complexity into the installation. Many of these are specially made or adapted 'one offs' and are particularly difficult to get right.

The engine is started using the Engine Housing Control Panel where the Driver can see the equivalent of a lorry's dashboard lamps. It cranks over quickly despite the two big alternators coupled to it, and once running the two cylinder Wabco air compressor cuts in and starts to charge the Railcar's air reservoirs. It sounds just like a bus engine does, and will be heavily muffled by the sound deadened doors.

Idle speed at its lowest is 750 rpm, and the very responsive throttle control can take the engine up to its 1800 rpm maximum in a few seconds. The fan speed follows the engine speed so maximum cooling is available when it's most needed. The engine is very responsive and can deliver full power in well under ten seconds, but for this application all our settings will be on the more sedate side!

Autocar Shop

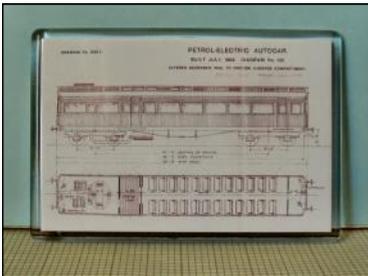
To help fund-raising we have some autocar themed items for sale.

- Fridge magnets (acrylic c90 x 60mm) showing the autocar at various places. £2 each (please say which picture(s) you would like)
- Travelling mirror (unbreakable and with case). £5
- DVD (a short film introducing the autocar). £ 10

Post and packing for up to six of these items is 80p.

- Sweat-shirt - £14.50 + P&P of £3 (sizes: large & XL)
- Fleece - £22.50 + P&P of £5 (sizes: large (44-46") & XL (48—50"))

To order: Please send written orders and a cheque (payable to NER 1903 Autocar Trust) to NER 1903 Autocar Trust, Rose Lea House, 23 Brunswick Drive, Harrogate, North Yorkshire, HG1 2QW.



E - Bay

We have registered the Trust as a charity on E-Bay. If you are selling unwanted items, please consider donating some or all the proceeds to the Trust. I list some things of mine when I have time but obviously we'll raise more money and it improves our profile if items for sale come from more than one member.

We are listed as "NER 1903 Electric Autocar Trust" and are described at:

http://www.ebay.co.uk/egw/ebay-for-charity/charity-profile/?NP_ID=68471