

The 'Royal George' Locomotive; a replica?

A study responding to the brief prepared by Caroline Hardie of the Friends of the Stockton and Darlington Railway dated 15th February 2020.

01. Which 'version' of the 'Royal George' to rebuild?

01.1 Background.

'Royal George' was built in 1827 by, and at the instigation of, Timothy Hackworth. Just as at Wylam where he had undoubtedly supervised the building of the 'Puffing Billy' series, Hackworth did not start with a clean sheet or ample funding. At Wylam he appears to have used parts of Waters' 'Black Billy' locomotive, crucially including the Trevithick type *horizontal* immersion cylinder, and a second using the same patterns. As a highly gifted foreman smith, and with another, Forster, his winning feat there was the creation of a large Trevithick type return flue combined with twin cylinders. Hackworth knew early that ample steam was everything. This is not to say that others, such as George Stephenson did not, but that he simply does not appear to have had the skilled workers to hand to create the return flues in such boilers. Wylam seems to have been famously tight fisted, certainly the locomotives there were kept, once built, grinding on well for long lives. Once Hackworth had delivered the goods he appears to have been 'constructively dismissed'. Those who later claimed all the credit, or had it claimed for them did little more to advance the design. Rather embarrassingly Hedley, much later, at Crowtrees colliery started to build another 'Billy type series with no improvements before realising that he was rather behind the times and ordering something a little more up to date from Hawthorns.

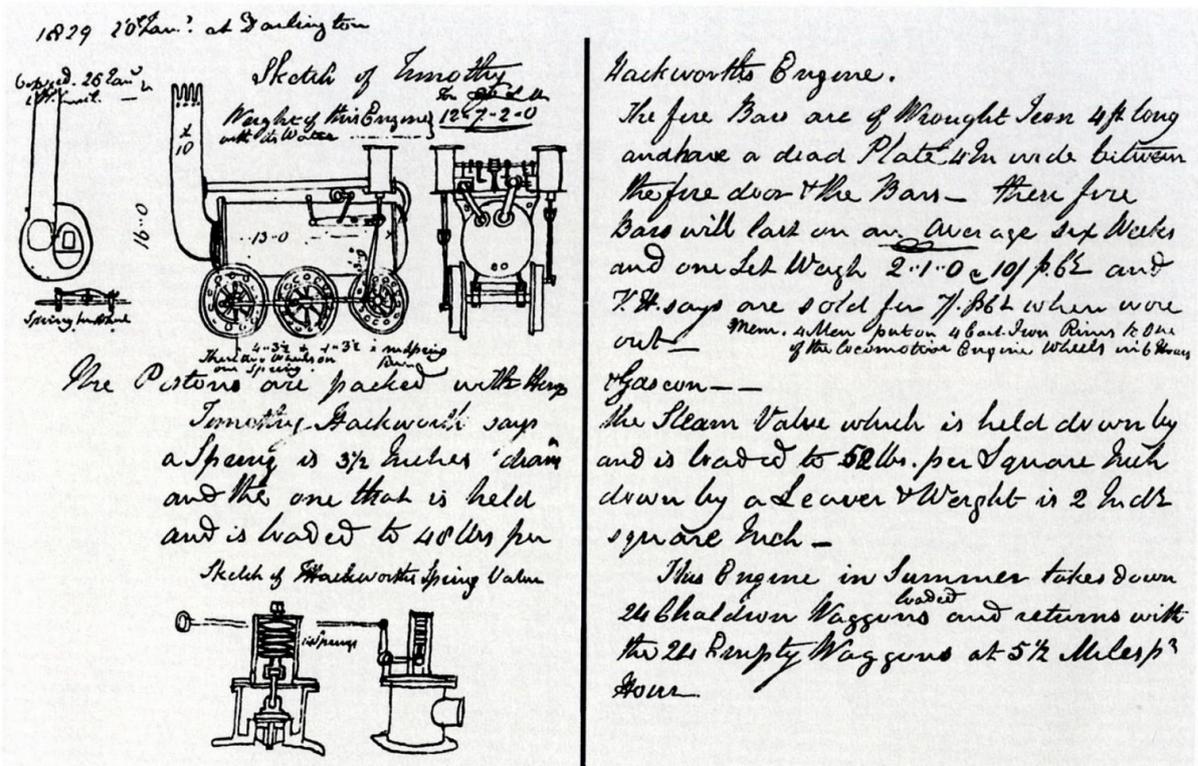
During Robert Stephenson's three year absence from RS & Co in South America, and George's absence with commitments to proposed railway schemes such as the Liverpool and Manchester and Canterbury and Whitstable, there is no doubt that the Forth Banks works were in a bad way. Even though the basic Killingworth locomotive design was sound and well proven, that did not mean that what was built in Newcastle was built to a good standard. Hackworth's brief tenure there was too short to have a real impact before George 'head hunted' him on behalf of the S&DR where his skill was desperately needed to keep the locomotives there in service and to salvage their reputation on George's behalf as he championed their use elsewhere.

The first non-Stephenson locomotive on the S&DR was by Robert Wilson (no known connection to the Leeds locomotive builders), whose works were based near Stephenson's. The locomotive he offered was brought to the railway for testing prior to a possible purchase. Little is known about Wilson or his products, but some details of the locomotive survive. It was a four wheeled engine with four vertical cylinders, two each of which drove each of the rear wheels. The perceived advantage of this idea is really not clear, unless the cylinders were of a standard type for something

else he made – stationary engines perhaps? A contemporary but pretty appalling sketch and a few notes were made by the French engineer, Marc Seguin. This sketch reappeared only in the 1920's when it did much to thin out the speculations and guesses of previous writers on the subject. What it did confirm was that the famous two part 'Hackworth' wheel, should really be called the 'Wilson' wheel, although Hackworth undoubtedly improved and developed it. Like 'Locomotion' it had coupling rods, the boiler seems to have been a return flue, very Wylam like. It was rapidly nicknamed 'Chittaprat', no doubt due to the noise of its multiple exhaust beat. 'Chittaprat' was not a success, criticisms included it being both too heavy (for four wheels) and not powerful enough, the railways declined to purchase it at the price offered. Then, apparently at Hackworth's instigation, it was agreed that the engine would be purchased but only in order to reuse the best of its parts. The board were persuaded by Hackworth to allow him to use these to form the basis of a new locomotive which he would then build. The model of 'Royal George' currently at the NRM made either by Hackworth or partly or entirely for him by the clockmaker Joseph Robson (the elder) was apparently made to successfully convince the railway's board to agree to his proposals to build a new locomotive. The best contemporary record of the resulting locomotive are the sketches made by John Urpeth Raistrick in 1829 with useful dimensions, particularly of the innovatory safety valve. It also confirms that the 'plug' wheels are in an early state of evolution, with much more open and apparent spokes to the centre section.

01.2

So Hackworth set to, as at Wylam, to design an engine incorporating his key ideas, but economically using much that was at hand. This he did so to great success; the boiler was lengthened (to 13') (it may have already had a flue tube end failure in service during testing at the S&DR) and an extra pair of wheels added, either from Wilson or presumably by borrowing his patterns. The two new vertical cylinders of 11" x 20" had their and other patterns made by the railway under Hackworth's supervision.



From J. U. Raistrick (above from his notebook) and others it is pretty clear that 'Royal George', as built was of the following dimensions.

Boiler. 13' long x 4'4" diameter

(Pearce gives working pressure of 52psi; 50 - 55psi was the 'normal' for the period)

Firetube. 12'6" x 2'1"

Return tube. 12'6" x 1'6"

Chimney. 1'6" as return flue, height 16' above railhead.

Cylinders. 11" bore x 20" stroke

Wheels. 0 6 0; 4' 3 1/2" diameter

Valve gear. Gab from overboiler eccentrics

Coupling. Outside rod

Weight. 12 tons 7 cwt excluding tenders

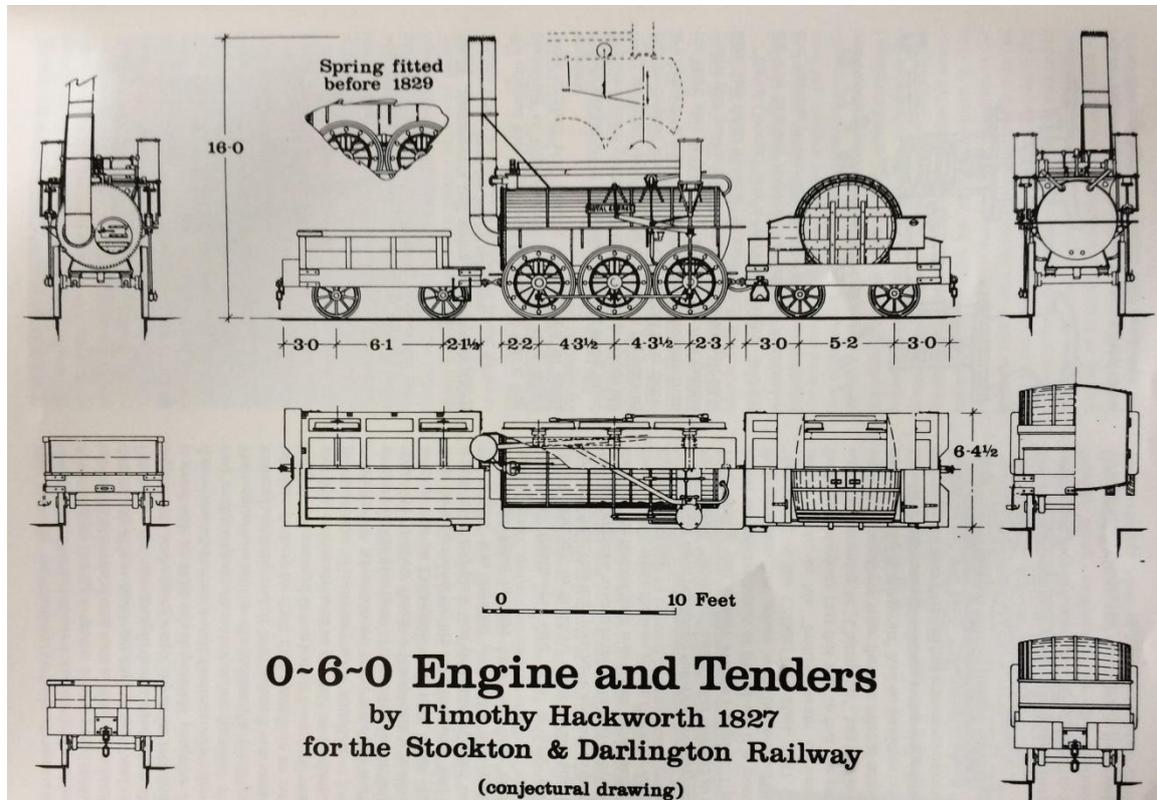
Springing. By 1829 leaf to the front (chimney end) two wheelset only

The locomotive, especially as it was effectively a prototype, was changed and modified over its successful working life at the S&DR prior to its sale to Wingate Colliery in 1840.

Thus the question of the form a replica should take? The locomotive clearly worked well and made its fame from its first use, not only following changes and revisions, therefore it is in this 'pure' form that any replica should be made. The only exception to this might be the use of plate springs to two wheelsets as added originally pre-1829 (see under 03 below)

There needs to be a clear perception here between changes made by Hackworth and the railway over the years, and changes which will have to be made anyway for a modern replica to achieve full regulatory compliance. There is no suggestion here that recreating historic changes will in any way assist in a replicas regulatory conformity.

Further there is no suggestion from the locomotive's history that it would not work perfectly adequately for the uses of the proposed replica if built in its original form. Therefore this form is recommended. The Raistrick information was excellently interpreted and drawn, if only in general arrangement by Alan Prior in his 1983 book '19th Century Railway Drawings in 4mm scale'; these were further used and reproduced by Tom Pearce in his 1994 book 'The Locomotives of the Stockton and Darlington Railway'.



Conjectural drawing by Alan Prior, likely to be extremely accurate.

01.3

It is outside the scope of this report to make more than the most cursory remarks on the actual historical importance of 'Royal George'. There is no doubt that it was a huge help to Hackworth as superintendent of the S&DR in terms of actually doing the job, it took some of the heat off the Stephenson supplied engines which were undoubtedly of very variable build quality, it helped Hackworth to become seen not just a competent manager, but eventually a major contractor and locomotive builder in his own right. It pointed the way for the railway's success with its chosen haulage system and, by inference vindicated Stephenson. However there is no doubt that these lumbering, fuel heavy coal haulers did not point the way to the 'modern' steam locomotive, 'Rocket' did that. Hackworth's engines, and 'Royal George' in particular were simply the right thing at the right time when they were very badly needed. In this sense, they may have 'saved' the locomotive as the future of rail haulage, but they did not contain their technical DNA.

02 What compromises to accurate reproduction should be made to ensure safety (how these are managed could be left to the engineering firm commissioned to come up with proposals)?

The answer to this question itself depends massively on the answer to question 03 regarding possible main line certification; assuming the answer to question 03 being a resounding 'no' then the following list is a reasonably comprehensive although not exhaustive list. It does **not** therefore cover the requirements which would be further required by a Vehicle Acceptance Body for main line use.

- 02.1 A preliminary note on materials. Although on the 'Steam Elephant' replica we did use real recycled wrought iron on some none safety critical components, it is assumed that all likely contractors will wish to use the various modern grades of steel in its place due to familiarity with working techniques and surety of supply. Personally on replicas I have always preferred to use bronze rather than modern brass as the colour looks much more authentic.
- 02.2 The use of castings and hot forgings, or fabrications. It is suggested that pragmatism rather than a ridged approach guides the design here; the most visible components should certainly be forged where possible, for example a real riveted chimney of wrought plates will look magnificent. Press braked plates with dummy rivets would look awful. Equally there is no reason to use any archaic techniques when making the modern, hidden, braking systems.
- 02.3 The Boiler. This must be fully compliant with Pressure Systems Regulations using certified plate and materials and with the design being approved by a Notified Body. Pragmatism and economy would suggest a boiler which is part welded and part riveted. Contrary to popular misconception new riveted boilers are perfectly legal and acceptable. There is a problem with the basic design of return flue boilers in terms of its 'inspectability'; the flue of the 1980 replica of 'Sans Pareil' has a welded return flue, with the actual return made of multiple short tube lengths ; should the replica be recertified for use the boiler may need to be dismantled in order to carry out the necessary ultrasonic testing of these numerous welds. When working on the redesign of 'Puffing Billy' I decided to get round this problem by taking the 'return' out of the boiler entirely; the furnace tube was truncated (as in the Killingworth modification shown in the 1838 version of Wood's treatise and now fitted to both the 'Locomotion' and 'Steam Elephant' replicas – in these cases to avoid excessive stress to the flue end plates, (itself the cause of many historic explosions) the flue gasses then turn *outside* the boiler and return through a second tube nest to the chimney root. This, in the case of 'Puffing Billy' allowed a very authentic blacksmith made and riveted rounded 'petal' end to cover this internal feature, it also allowed the 'return box' to be insulated between it and the outer plate and thus avoiding exposing the driver's legs to excessive risk of burns against an uninsulated boiler surface. The riveted end was simply bolted in place to allow easy removal for inspection, cleaning and retubing.

The conversion to tubes naturally can result in an increase in heat surface area and therefore an inauthentically high steam raising ability. This usefully permits the internal tubeplate referred to above to be set into the main barrel thus reducing the advantage again. The 1979 'Rocket' replica was built with 80 small tubes because, as Mike Satow said, he "Wanted it to work"! When that replica was rebuilt more recently and reboilered we decided to make sure

that we incorporated as much as possible new information about the original locomotive from the Bailey and Glithero study, thus it now has an actual copper firebox and only the correct 32 large tubes: apparently it works better. Small tubes are to be avoided anyway in low pressure engines, even with the advantage of a famous Hackworth blast, as this may not be sufficient to keep the tubes clear over the course of a day, a point especially to be remembered in view of the imminent prospects of the UK only having access in future to lower quality imported coal.

I would therefore suggest a rolled and butt welded main barrel, as the lagging strips will cover the upper boiler, and the wheels obscure the lower. The fireman's end should be given a riveted seam and riveted rolled outer ring and rolled and riveted furnace and chimney rings. The furnace tube-plate should be properly flanged, but could be welded rather than riveted for economy. As the majority of the unseen parts of the boiler will be welded, this is just one of many accessible seams which will require periodic testing. The key here point is that welding can provide economies of the cost of boiler construction, but that the construction itself should be to a high standard of quality for safety and longevity.

In view of Hackworth's involvement with both locomotives, it is perhaps unsurprising that the boilers of both 'Puffing Billy' and 'Royal George' are so similar, and therefore that the modern answer to replicating them so similar. It would seem sensible therefore, with Beamish's permission, to engage the same boiler designer, Graham Morris, to revisit his 'Puffing Billy' drawings and recalculate and redraw them for the 'Royal George'.

- 02.4 Safety Valves. The spring safety valve was a key contribution of Hackworth's to boiler safety and this should be properly celebrated with a fully working example. Happily examples exist at Shildon to copy in detail. This may be set a few psi light to ensure its use, but for insurance purposes a modern 'nabic' type valve capable of clearing all steam made should also be fitted, towards the front of the boiler.
- 02.5 Pressure and water gauges. These are a practical and legal necessity and will be mounted at the 'fireman's end on the flat plate there. The 'second' water gauge may be the authentic try cocks of the original.
- 02.6 Injector. The required second form of feeding water to the boiler can be supplied by an unobtrusively placed injector. These are now available in types which will continue to feed down to about 20 or 25 psi and are entirely satisfactory.
- 02.7 Cylinders and pressured castings external to the boiler, including the pump. These should be pressure grade cast steel, not cast iron. The exhaust pipes of the original were likely cast and if it is decided to repeat this, rather than fabricate, they should also be in this material. The cylinders should certainly not be fabricated.
- 02.8 Wheels. These should be entirely authentic two part Wilson/ Hackworth wheels. Research is required to confirm exactly the form which these wheels should take; as the Hackworth 'school' of locomotive building went on, the type got heavier and heavier. The earliest

illustrations suggest that the inner ring had more defined spokes. It is therefore likely that on calculation, these will also need to be cast steel.

The tender wheels can also be made entirely authentically, with steel rather than wrought iron spokes, cast into a cast steel hub and rim (there is no need for a separate modern shrunk on tyre) This technique was successfully experimentally revived for 'Puffing Billy' possibly the first time since its use on the replica 'Locomotion's' tender in the 1970's when apparently a man came out of retirement to do it.

02.9 Braking. Like most early locomotives it may be taken that the original 'Royal George' had no brakes at all, simply relying on the brakes of the connected waggons. It is just about possible to use the gab gear to impede progress, but it takes great skill and concentration. This cannot be relied upon. Therefore the replica needs proper brakes. The 'Locomotion' replica when first built had no brakes; a handbrake was soon added and when rebuilt for passenger use full train air brakes were added. As the brakes will be entirely anachronistic there is no need for them to conform to any perceived traditional railway practice, rather than being robust, effective and maintainable. It is important that the system is considered at an early stage in order that it is both integral to the design and unobtrusive. If the locomotive was intended for display only with replica freight stock, then handbrakes to both tenders would be likely to be adequate. As it must be intended that the replica can haul passengers then continuous power brakes are a legal necessity.

It is not recommended that shoe brakes are fitted to the locomotive itself, as these would be both unsightly and anachronistic; rather disc brakes are suggested, as on the 'Locomotion' and other replicas, where the Wilson / Hackworth wheels are particularly successful in hiding the feature. The number of axles to be braked will depend of course on the engineering calculations.

It is not recommended that the boiler pressure be raised in order to use an ejector in order in turn to operate with vacuum fitted stock (as on the Manchester 'Planet' replica), rather the twin pipe air line system, similar to that used on narrow gauge railways of the same approximate train weight/speed should be used; this has been used now for twenty years at Beamish and adopted for the rebuilt 'Rocket' and stock at the NRM. Interoperability with stock at these places may well be useful in the future.

Handbrakes should be fitted to both tenders, this is because in the event of brake failure or human incapacity, both crew members have access to a means of arresting the locomotives' progress. These can be of block application as the framing arrangements would largely obscure them.

The suggestion has been made that there could be an economy by only fitting the air brakes to the tenders as this would be easier to hide than that on the locomotive and as above could use block application. I am wary of this suggestion as when lightly loaded, i.e. low on coal or water and on a wet rail or gradient, their weight might be such that in an emergency brake application the two would simply skid or 'pick up' and the braking disastrously negated. This is naturally an attractive option but should not be adopted without rigorous braking calculations.

02.10 Couplings; locomotive to tenders, tenders to train and inter-stock. The coupling bars should be of high quality and /or laminated to guard against failure and certified safety chains should also be fitted at all coupling points.

02.11 Springs. It appears that as built the locomotive had no springs, but that leaf springs were fitted at an early date between the first two wheels at the fireman's end. The wheelset below the cylinders could obviously have no such degree of variance. An alternative to consider is the use of shock absorbing rubber pads, of calculated shore, beneath the cylinder wheelset and possibly under the other two as an alternative to the springs.

02.12 Fall plates. As the tender forms the 'footplate' on most early locomotives and their replicas, there can be a potentially very dangerous gap between that point and the boiler backhead down which crew could fall with almost certainly fatal results. Therefore consideration should be given to fall plates at the design stage.

02.13 Driver steps and handrail. On the original locomotive the driver's platform is approximately half way up the boiler; this gives the correct access to the gab gear and a good view of the line ahead and the train behind. Hackworth repeated this again on 'Sans Pareil'. Consideration of this latter locomotive and its replica is salutary in realising how precarious a perch this is. In fairness to Hackworth it was perhaps safer than the boiler side running board driving position of the Stephenson engines.

When rebuilt for passenger service in the 1990's a handrail was added to the 'Locomotion' replica to stop the driver falling off the engine (one had done in the 1970's but luckily only broke his arm) On the 'Steam Elephant' we copied the rear handrail on the original 'Puffing Billy' to stop the driver from stepping back and falling under the train.

For 'Royal George' a set of stage coach type steps and handrails / handholds will need to be added (if they were not actually already on the original) as well as a rear rail to the driver's platform. If well designed and blacksmith made these need not be unsightly.

02.14 Chimney. Although not a safety or regulatory issue it is recommended that the chimney and stays are made to be inconspicuously removable at cylinder top height or below if more appropriate in order that the locomotive can be transported by road on a conventional low loader with its chimney removed, rather than on the rare and expensive 'wafer bed'.

02.15 Lubrication. There is no need on such a wet low pressure engine to fit anachronistic mechanical lubrication, the original tallow cup types will be entirely adequate.

The above issues should not be left for the contractor to resolve, but should be specified at an early date and detailed by the Design Engineer, see **14 g**, below. This does not preclude the input of an experienced contractor in suggesting alternatives during the pricing process.

0.3 Should it be built to run only on heritage lines or be fully compliant with modern rail use?

I would strongly advise against any attempt to achieve main line certification for this locomotive. There are many reasons for this, many are financial and administrative, some would further erode the authenticity of the build.

Financial.

- 03.1 The cost of appointing a Vehicle Acceptance Body and the necessity of frequent inspections during all parts of the build, additional boiler inspections and then continuing certification in use would be many thousands of pounds a year, even assuming that a VAB could be found to approve the plans.
- 03.2 The locomotive would be so comparatively slow on the network that trying to book a path for it on all but the quietest routes would be extremely difficult.
- 03.3 The haulage capacity would be so low that the cost of tickets to passengers would have to be astronomical in order to cover the cost of securing the route and the train operating company's costs. There are simply not enough gold plated passengers around, and certainly not enough to make more than one journey rather than many over the nine or so years of certification. After struggling and succeeding at York to get the 'City of Truro' of 1904 certified in time for the anniversary of its 100mph run, the bookings dried up almost instantly, the Train Operating Companies were simply not interested in booking a locomotive which could haul such (relatively) small number of carriages. It was withdrawn from certification. Few even noticed. So main line use of RG will not make any money.
- 03.4 The cost of fitting a speedometer (we put a digital one on 'Truro!'), Train Protection and Warning System (TPWS) and On Train Monitoring and Recording (OTMR) would be expensive and an issue to hide.
- 03.5 Moving a locomotive by rail, especially a small one like this, is *never* a saving over road haulage. It is done with larger modern steam locomotives as otherwise they need re-weighing and the springs all re-set after taking it on and off a lorry. A cost in itself and of time.

Issues of Practicality and Authenticity

- 03.6 In addition to the matters raised above such as the fitting of TPWS and OTMR, there would be no possibility of using authentic wooden frames for the tenders. These would have to be steel framed with mock timber coverings.

03.7 The above is also true of the carriages, again they would need to be all steel framed and VAB certified, in the absence of telescoping tests, additional unoccupied vehicles would need to be added as crush zones to further protect the passengers. As in 03.1, above, this would both increase the cost of building the working train and further reduce the revenue potential.

The Cavalcade

03.8 As yet I am unaware of any regulatory arrangement where a Cavalcade of the sort which we saw in 1975 could be undertaken in 2025 on Network Rail metals where the vast majority of locomotives taking part will not have any main line certification. It may be some small comfort that if the 'Royal George' is built, it will be in good company in having this problem. My own guess, and it is no more than that, is that a temporary derogation will be permitted dependent on things like axle testing and the non-carrying of passengers during the cavalcade.

0.4 What design of passenger carriages should be built and who could build them?

04.1 Chaldrons. As 'Royal George' was built as a simple coal hauler and as far as is known, never hauled passengers, it is tempting to wish to equip it with train of chaldrons. This would be attractive but produces several problems; as the floor of a chaldron is entirely within the gauge of the wheels, the stepping distance from a platform edge would be unacceptably dangerous. Adding a side door to a chaldron waggon, as was done in the 1970's at Beamish unpleasantly opened and weakened the structure of the waggon; whilst this could be overcome by steel reinforcement, it still means that the hinge line of the door is at an extreme angle and the door can then slam very hard under its own weight posing considerable danger to hands and fingers. Variable stepping distances at different venues can be expected as railway platform widths and overhang are still by no means standardised. This can be overcome by risk assessment and the use of temporary stepping boards, but not to the extent produced by the above problem. At Beamish we decided to use chaldrons, one at either end of the train, not for passenger use, but as guards compartments and equipped with handbrakes, they also usefully serve as a place to put air reservoirs. This inevitably adds to the cost of the train.

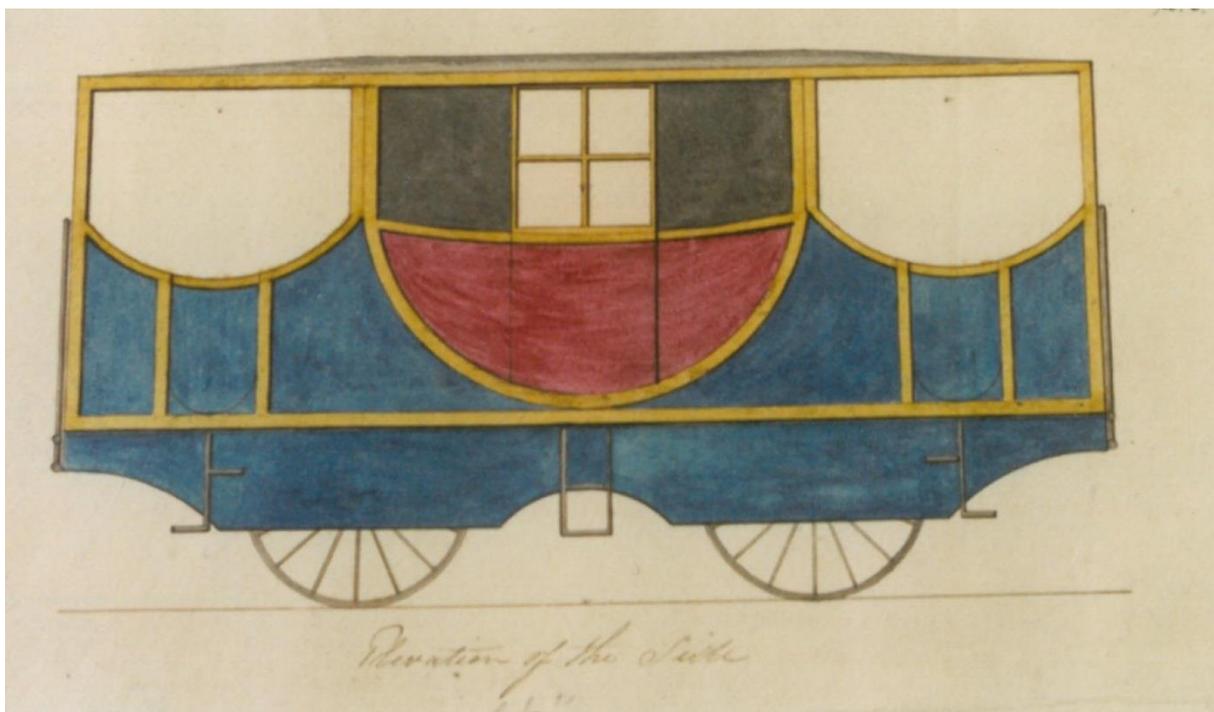
04.2 'The Experiment' and other early S&D coaches. The written descriptions of the early coach 'The Experiment' and early illustrations of it are contradictory and defy reality; although the entire body is shown *within* wheel gauge, the historic description gives lengthways seats and a table down the middle. This does not work! My attempt to recreate this in the 1990's was unhappy to say the least, especially as being within wheel gauge, as with the chaldron 'footprint', the stepping distance was just as bad. I solved this by adding platforms at each end, wider than the body of the coach – a distorted 'H' in plan. It looked pretty awful and has been replaced during the last couple of years.

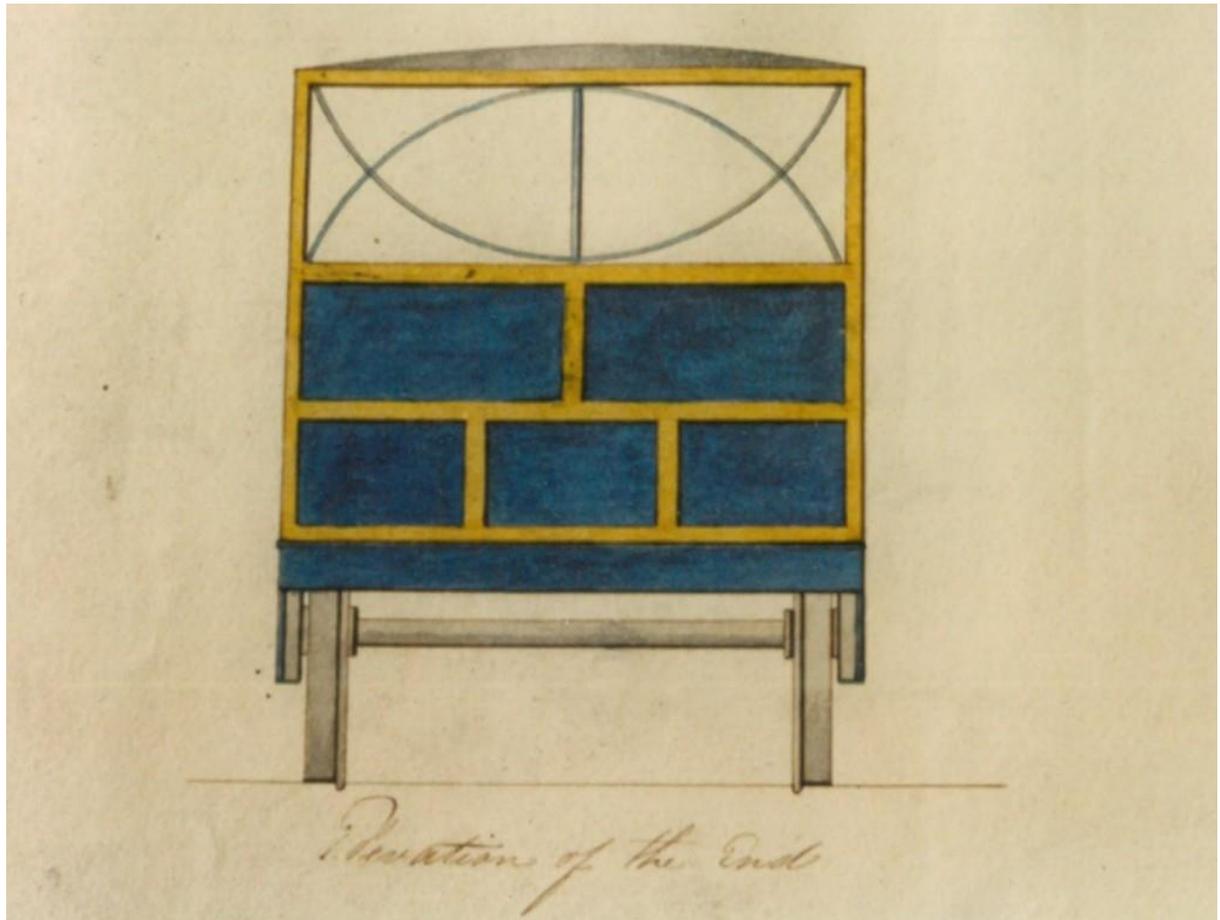
The double ended stagecoach type; beloved of illustrators is not a solution either as the platform stepping distance problem repeated, as above. No one would be allowed to travel on the roof. The capacity is also tiny.

04.2 Kitching Coaches. Replication of these Darlington built coaches is the answer; dating back to at least 1831, there are a number of accurate coloured drawings in Durham CC record office. They show attractive open and closed carriages which were used on the S&D. In the 1990's we built an approximation of an open one at Beamish, it has recently been entirely rebuilt with an authentic 'roof on poles' shown in some designs. People seem to like travelling in open coaches and this is good compromise. Care is required when redesigning open or closed unglazed carriages to adequately risk assess children standing on seats and falling out. Their common use today is on narrow gauge railways where one is much nearer the ground than on standard gauge stock such as this.

There are a variety of types illustrated, an example is shown below. Two obvious advantages of the illustrated example, if the train is formatted in the absence of 'guards chaldrons', is that an end section can be reserved for the guard and a handbrake fitted along with the train line air brake. The second is that the shrouding of the wheels allows conventional block application brakes to be used whilst remaining hidden. This feature also allows for some licence in the type of wheelsets used.

Other also four wheeled carriages within the Kitching archive show smaller and shorter open and closed carriages of the same date and general appearance. On a couple of the Beamish waggons and coaches I used some very old NER wheelsets with the outside bearings removed and new inside bearings turned. In view of the suggestion which I made in 03.3 above regarding axle testing for the cavalcade, this may not be a good idea as wrought iron is hard to test satisfactorily





04.3 Interoperability. It is strongly suggested that any stock built is designed to operate with the 'Rocket' stock at York and the Waggonway at Beamish. There is no other stock suitable in the country at present. The stock run with 'Planet' was built on heavy old freight chassis (see under braking, above) and is vacuum fitted. Of the three Liverpool & Manchester type coaches built lightly and economically for the 1979 event, I broke up one or two for the wheelsets, I think one is that at York and one was paired with the now unused 'Sans Pareil' replica. I am not aware of the latter's current whereabouts or condition. It is unlikely to offer a cheap possibility if only the wheelsets are reusable, as above these NER types may cause future testing issues.

04.4 Who would build them? The answer to this question partly depends on the design; if the brakeshoes move apart between the wheelsets it may be necessary to add a steel subframe to resist the forces. If so it might be that a rolling chassis could be produced by the engine builder and the wooden frames and body built on them by a subcontractor.

As to who could build these carriages it seems likely that it will be most straightforward for the wheelsets, couplings and metalwork to be supplied by the builder of the locomotive. If the redesign results, as suggested above, in a steel subframe to carry all the braking gear and to contain the stresses and maintain exact dimensions, then the entire rolling chassis could be delivered to the carriage builder. This in turn would widen the number of contractors who

could then take on the build for the carriage bodies. One of the finest builders and restorers is Tony Volans who ran the Appleby training centre which restored standard gauge carriages, including for the NRM. In the past I was taken aback by his speed, low costs, and high quality. He went to work at Beamish and it was he who recently entirely rebuilt the Kitching type coach for the waggonway there. I understand that he has just retired, or taken early retirement. I do not know if he could be tempted to undertake the work but he would be an ideal person to do so.

04.5 Disabled access. There are no difficulties in providing full wheelchair access to an appropriate percentage of the suggested type of replica carriage. Indeed as long as the need is incorporated from the outset it is very easy to enlarge the access doors by combining them with the surrounding panelling and providing wheelchair anchor points. It is by no means visually obvious that the Kitching type coach at Beamish has a wheelchair friendly compartment until the doors are opened. The additional cost is negligible.

05 Where will 'Royal George' (and any coaches or waggons) be curated?

To which might be added, and who by?

The question of location is limited by the available possibilities, history and, perhaps, the source of the funding to build the locomotive and train. The curation and long term management of the locomotive could not be passed on like a relay baton between operating locations, there would have to be a 'home base' at least on paper with clearly identified staff or contractors responsible for maintenance, inspections and to vet the risk assessments and suggested uses on lines further afield from the north east; for anniversary events for example.

Other than the NRM (and 'Rocket' is a bit different) and Beamish (but 'Locomotion' has been out of service for two or three years and staff do turn over) there are no other staff trained and familiar with driving engines with this type of gab gear. The operators would need to be trained and tested; if the Independent Competent Person appointed to the project was Martyn Ashworth as has suggested (a choice I concur with) then someone could be hired in to train crew for him to independently pass out as competent. The point here being that if the locomotive and train move about it will need to be the same crew or crews which go with it.

05.1 The Locomotion Museum at Shildon. NRM/ Science Museum Group. This is one of the most obvious locations, both historically and regionally, it has a short but perfectly adequate running line and the attraction of nearby real S&D history and Hackworth's house. The greatest drawback would be likely to arise from the necessity for covered and secure accommodation for locomotive and train, the NRM perennially struggles to accommodate its collections. It is however understood that there are plans to further increase covered exhibition space there. If agreement were to be reached it would also offer the attractive prospect of the locomotive and stock being on view to visitors even whilst not in use. The issue of possible hire fees versus accommodation would need careful consideration.

05.2 Darlington North Road Station Museum. DBC. This again is a very obvious location, if accommodation can be found within the existing buildings. The fine S&D goods sheds have been used for many years by the Darlington Railway Preservation Society and the A1 Trust /North Eastern Locomotive Preservation Group have in recent years used the Hopetown Carriage Works. For many years the Society ran occasional trains on the short operating line there and may still do so following overhaul of their operating locomotive. I understand that the A1 Trust may be moving to a new location, but from the discussion noted below with Ian Thompson and Mike Crawshaw, it appears that this would not entail the A1 Trust entirely vacating their section of the carriage shed. Even if this were to become vacant, there is a considerable difference in levels from this to the operating line of the DRPS, achieved through multiple reverses; this may not prove to be an insurmountable problem but would need early consideration, consideration of at least partial relaying, and strict and careful operating procedures in marshalling and disposing of the train. The attractive and closer goods shed is fully occupied by the DRPS and is not connected to a running line, it is understood that this attractive listed building is in need of considerable restoration work. Without significant partnership, investment and work to the buildings and the laying of new track, there is therefore no apparent immediate suitable accommodation here.

If however DBC were to consider investment on this site, beyond its immediate conservation needs, particularly of the goods shed, then a suggested perfect solution would be to recreate part of the Kitching works on its original footprint in the museum owned field to the south west of the main station block. The ground there is heavily contaminated from its period as a locomotive scrapyards, but if this surface layer were to be safely removed then exploration of the Kitching building could potentially be a good community excavation project before reconstruction. This would give a wonderful base for display, education, ticketing and operation of the replica, whilst avoiding the need for separate toilets, catering and security etc. as would be required on any new stand alone site.

05.3 Beamish. This venue is out of the immediate area of geographical and historic relevance for the S&D and any likely Teeside/ Darlington funders to provide any permanent housing, but it remains one of the only places in the country where the locomotive and stock could be displayed in use in a fully immersive period environment. The early establishment of cordial relations with the museum could be extremely advantageous to the project in view of the amount of relevant drawings and foundry patterns which could be used for both 'Royal George' and train to both save time and money.

The above brief summaries would suggest that whilst in the short term Shildon may appear be the most practical solution if this is politically acceptable to supporters and funders, if the NRM / Science Museum Group were to be amenable to this. Longer term building restoration, building replication or new build at North Road could change these prospects dramatically, making North Road a potentially preferable location which would substantially increase the quality of offer there to the mutual benefit of both the venue and the RG project.

However as we are four to five years away from the likely physical delivery of the 'Royal George' project, there seems to be an increasing likelihood that both venues will be in a better position by then to both house and manage the locomotive, and wish to do so.

Until the project is confirmed to be going ahead and with a clear timetable, it may be premature to enter into advanced negotiations with either venue; the railway preservation world is full of bright ideas and restoration proposals, many of which inevitably do not see light of day. No one is likely to reserve accommodation or operating time until firm proposals are on offer.

05.1 On 1st October 2020 I sent the following e-mail to both Darlington (Ian Thompson and Mike Crawshaw) and Shildon (Sarah Price) on behalf of the Friends in order to sound out their receptiveness to housing and managing the locomotive and its train;

*Dear *****,*

At the request of the Friends of the Stockton and Darlington Railway, I am undertaking for them a feasibility study (funded by Darlington Borough Council) into the possibility of building a full size working replica of the 'Royal George' locomotive built by Timothy Hackworth in 1827.

One of the key questions for the Friends is where the locomotive should be housed, curated and operated? The locomotive will be accompanied by two replica coaches of the type built in Darlington by Kitching and one or two replica chaldron waggons which will effectively operate as 'guards vans', whilst also representing the haulage function and history of the S&D line.

It is hoped and anticipated that if the project does receive the funding to go ahead, the train will be ready in time to play a key role in the forthcoming bi-centenary celebrations in 2025, as well as being able to travel further afield; locally, nationally or even internationally to publicise the history and region of the S&DR.

The locomotive and train will total nearly 100' long. Ideally, even when not in operation, the whole will be available for viewing by the public as part of the exhibitions at a suitable local location, hopefully one with considerable railway significance.

It is anticipated that the host venue will be willing and able to provide not only a good standard of covered accommodation and security, but also the ability to manage, maintain, insure and operate the locomotive and train, taking responsibility for key and safety critical skills. It is hoped that members of the Friends could offer their time voluntarily to help with this process.

Would it be possible for us to speak on the telephone and discuss these ideas and possibilities? If so perhaps you could let me know of a time convenient to you to do so?

Sincerely,

Jim Rees

Following this, on the 9th October I had a most useful telephone conversation with Ian Thompson and Mike Crawshaw of Darlington Borough Council, representing North Road. It was clear that they

are very supportive of the project and its possibilities. Following wider discussion as to the feasibility of the project in general and the desire to produce not only a lasting legacy post the 2025 celebrations, we also discussed the need to do so with a high quality recreation; DBC are naturally concerned as to the possible level of ongoing care and maintenance costs and it was useful to discuss these as well as the potential for the creation of revenue streams with which to meet ongoing costs. Both Ian and Mike thought that it would be to everyone's benefit if the locomotive and train could regularly spend time at both the Darlington and Shildon venues.

Despite sending a follow up on the 11th October, no response was received from Shildon.

06 Use on other heritage railways throughout the UK

It is highly likely that any novel and attractive locomotive and train will be in demand on Britain's heritage railways and indeed for occasional film work. This demand will result from the publicity of the 2025 events themselves and also from the inevitable sequence of 200th anniversaries in the railway world around the country which follows it.

When at Beamish we rebuilt the 'Locomotion' replica for passenger use and built the train of two chaldrons and two carriages these were finished and passed out by the then Railway Inspectorate in 1996, well before the completion of the Waggonway buildings and running line. This gave the opportunity to take the train to other railways to test and trial it, and to learn how the public took to it and wanted to use it. This provided many useful lessons.

- 06.1 Just as on the national network, even on the sub 25mph heritage railways, this train will block the way for the revenue earning service trains. The result may be that the train works a short shuttle train on a suitable stretch of line or siding, only making longer trips as part of a focussed celebration or private evening events. This I did at diverse locations such as Nene Valley, Dart Valley, West Somerset and Quainton Road. This in turn makes it difficult for the host venue to put a commercial value on its hire compared to bringing in a conventional locomotive which is compatible with its own stock, capacity and timetable.
- 06.2 The motivation for the hire may be a particular anniversary for the host railway, in which the cost of the hire and transport may be subsumed. The temptation then will be for the host to try and recoup hire and transport fees with improvised short services as above.
- 06.3 The train was popular with the public, who often want a short experience, rather than an exhaustive journey.
- 06.4 Railway enthusiasts in general are often not terribly interested in the early railway period.
- 06.5 Good relations were established with other venues, especially the NVR which had rather cornered the market for film work, leading to repeat visits.

- 06.6 It was extremely hard work and often was one person, plus a helpful and experienced haulier and with other less experienced crew supplied by the host. This understaffing will be unacceptable today.
- 06.7 The venue should be visited prior to any arrangement to inspect arrangements and proposed use. Track condition and gradient profiles should be considered.
- 06.8 These visits did slowly make money to be used as seed corn funding for future ventures or maintenance. They should not be viewed a major source of income, they are patchy, stressful, and very hard work.

07 Who pays for it to be used and moved off site?

- 07.1 It is normal practice for the hirer of the locomotive or stock to pay the haulage costs. Hire fees themselves are a complex issue as many locomotive owning groups are desperate to generate income which of course has the lowering effect of a competitive market. In the case of 'Royal George' and train one would be offering a unique product so could hold out for higher fees. An obvious problem here is that one would not be transporting the locomotive alone, but also the train. It should be possible to fit the locomotive and one tender on one low loader, and two items of stock on each successive low loader, perhaps giving a minimum of three loads. However this is entirely subject to the hauliers' interpretation of a 'divisible load'; some may see each item of stock as an individual load. Others are happy to see it as a 'train'. More vehicles means more expense obviously, however it should be born in mind that *distance* in itself is not the arbiter of cost, nor is fuel, it is the time spent at either end loading and unloading and how awkward the venue is to access tracks for loading and delivery. Naturally experienced and able staff who are entirely familiar with the locomotive and stock are expected to assist the contractor.
- 07.2 The small businesses which provide much of the haulage for Britain's minor railways are often run by enthusiasts but seem to be currently undergoing a period of retirements and business closures. The need will not go away, but the provision may become more expensive. It is common to end up with a 'normal haulier' who understands the foibles of both stock and venues. My favourite used to unload and marshal the train and even light the fire. This is rare.
- 07.3 As an example, at present it should be possible to cost a single low loader vehicle move between, say Darlington and Shildon at around £800.

08 Who will the locomotive belong to?

This is a very difficult question to answer and must surely depend on who commissions it – the Friends of the S&DR? Or the body which pays for it, if not the same? An entirely separate group may need to be formed contracted to actually run and look after it.

Only for the last five or six years has the ‘Locomotion’ replica been owned outright by Beamish, for the forty or so years prior to that it was in the ownership of the Locomotion Trust, a charitable body. During this time the museum provided most day to day care and arranged boiler inspections and insurances, but the Trust was free to earn and accrue funds, for instance by the locomotive’s visits to Japan and America, as well as the smaller hires within the UK referred to above. This meant that the Trust could hold funds on behalf of the locomotive, hire staff as needed and donate and support projects relevant to the display and use of the locomotive. This might be a pattern to follow, either within the Friends or as a separate group?

09 What will the long term costs be for its curation, maintenance, certification and insurance?

As with the question above, this is a complex question which cannot be answered simply. There are too many variables.

- 09.1 The cost of long term maintenance cannot be separated from the issue of the standards of build quality and the standards of ongoing care particularly in the cleaning of all combustion areas and the use of water treatments will significantly affect the length of boiler life in particular. The standards of winter storage locations and their humidity can make a great difference. It is normal practice in Sweden to rig up dehumidifiers to vented boilers over the winter period, a practice we would do well to emulate here.
- Maintaining the correct concentration of boiler treatment chemicals and regular washouts, or at least regular blowing down can greatly extend boiler life. With a boiler design like this the areas where sludge can accumulate are not against furnace or firebox plates, so a longer working life can be anticipated with careful use.
- 09.2 If the engine is built to the original mechanical standards where the design was for a heavy coal hauler, expected to work a Victorian working day, every day, yet is only used intermittently hauling relatively light stock, then it might be expected to have a typical working life expectation of c. 40 years. The boiler will need partial stripping and inspection annually, every ten years a full boiler strip down, retubing and hydraulic test. The ‘Steam Elephant’ at Beamish has been very heavily used – during its first year it worked *every day* from April to September; at age 19 it is now nearing the need for a thorough over haul, mainly mechanical. This might be a similar case with RG. Boiler work or partial replacement is likely to be needed, at least to the furnace area at the twenty year overhaul, the main barrel and endplates might last up to twice that.
- 09.2 The longevity of the mechanical parts of the tenders, carriages or waggon stock might be similar to the above but again depend hugely on the quality of the build, the timber used and

regular painting as well as covered accommodation for the vital winter months. It is likely however that some timber components will need replacement more frequently; coal, with water running through it, reacts badly with acidic oak.

09.3 As to the costs for these continuing works it is very hard to predict until the design drawings are fully produced. As with anything else the quality of the initial build will affect the cost and frequency of required maintenance or component replacement for the whole of the working life of the engine and train.

10. **Legacies.**

The educational potential for the project is largely outside the scope of the present report but some consideration of the build phase of the project may be considered.

10.1 Depending on the type and quality of replicas which it may be decided to commission there will be a greater or lesser alignment with modern industrial skills. For example if many components are fabricated and welded there will be more likelihood that they will have relevance to local training and apprenticeship schemes. Should a more traditional approach be taken with more foundry work and hot metal forging then it may be more suitable to look at the project as having much more relevance to the encouragement and retention of disappearing traditional skills.

10.2 When building the 'Elephant' and 'Billy' replicas, despite the natural desire to place contracts locally, such were the rarity of the necessary skills that often the work and components were being sourced from all over the country. My mantra at the time being that 'you could still (just) get anything done that you ever could historically, but not necessarily in the local area anymore; there may be only one person of company left.' This dispersed supply may mean that immediate educational tie ups are difficult to achieve in practice.

10.3 When the 'Locomotion' replica was being built in 1973-5 many components even of an extreme safety critical nature were produced locally by apprentices such as those at Whessoe. This would not be acceptable today.

10.4 Whether a single main contractor is appointed, or essentially a main assembler, it is unlikely that the involvement of local colleges and apprenticeships could provide a commercial advantage, training takes time and skilled supervision. I am far from suggesting that this does not take place it is, of course, highly desirable and may have significant sway over a funders' involvement. Rather I am saying that it is a cost to factor in due to potential delays and the provision of an enhanced Health and Safety environment.

10.5 Consideration may be given to the production by local colleges of the potentially large numbers of similar or identical fittings required for the construction of the carriages and train or strapping and corner brackets, seating etc.

11. Options for obtaining funding for the build (and maintenance)

Since 1951 railway enthusiasts and societies have been racking their brains to find new sources of funding, each for their favourite project. There are few paths which are not very well worn. It can be embarrassing to sit in a meeting to hear the suggestions of approaching Sir William MacAlpine or Pete Waterman, yet again, as hopeful and new ideas.

11.1 The HLF have said since their inception that they will not fund replicas of anything. However, in practice this does seem to occur if that is part of a wider heritage interpretation scheme and may be still worth careful consideration, subject to the inevitable delays as an HLF project may not start prior to funding approval.

11.2 The Beamish replicas all received considerable funding from the European Regional Development Fund, a source now sadly closed to us.

11.3 The biggest single cash donation which I achieved for a similar project was for £150,000 for 'Puffing Billy' from a Charitable Foundation, the origins of which lay with the family of the an early locomotive builder. They normally gave much smaller grants to other purposes such as disabled access. I am certainly not suggesting this foundation as a possibility here, but would make the point that local or even national trusts and foundations *who may not normally be thought of* in connection with steam engines or preserved railways may be far easier to enthuse.

11.4 There is no doubt that hire fees will be a most welcome source of money for continued care and maintenance but unlike 'Tornado' or similar, it should not be imagined on this scale that those fees would be in any way capable of repaying any form of capital loan.

11.5 Although there are a few sincere and enthusiastic supporters of early railways, and a very few who have come forward in the past to donate, particularly seed corn funding to previous projects. Theses have often been for particular components of useful things such as commissioning artists impressions to enable further fundraising. The 'mass market' of railway enthusiasts show no great interest in early railways or locomotives, indeed regular articles in enthusiast magazines on the subject of 'new build' locomotive rarely cover built or proposed early locomotives at all. The general public happily appear to have no such reservations.

11.6 Covenanted been popular and successful fundraising method for the A1 and other projects, and can be useful in establishing a support base bringing a small if regular income, as well as encouraging supporters to feel a real sense of involvement with the project. However the A1 locomotive took nineteen years to build and is still seeking covenanters today. The 'Royal George' project simply has not got the same time scale available and cannot be achieved on time with major significant grant aid. Managing a covenanters scheme requires attentive care of the supporters, newsletters and similar interaction. The Friends would need to provide this.

- 11.6 Crowd funding and the use of social media appear to be underused in the railway preservation world, partly perhaps due to the demographic of the key target market. They should certainly be considered for this project.
- 11.7 It is possible that the fund for the Preservation of Industrial and Scientific Material (administered via the Science Museum) might be worth approaching (maximum grant £20,000)
- 11.8 Future revenue from 'driver experience' offers. These have become popular at some venues, from the brief 'driver for a fiver' offers to full days where the customer is involved in preparing, learning to fire and drive and then disposing of the engine. Some venues offer this as an evening event where the locomotive is already in steam. None of these offered experiences can possibly be on passenger trains and ideally are on lines entirely isolated from any public presence for obvious safety reasons. There may be some wider benefit at some locations where the operation of the locomotive effectively provides a display for other visitors to the site where a non-passenger operating display might have been planned anyway and would thus be subsidised. At some railways this offer may be staffed by volunteers who are fully trained and qualified as drivers. At some venues, it can only make financial sense if the paid staff responsible for delivering the offer are on very low wages. There is inevitably an amount of administrative work and cost also involved which in this case could not be 'lost' to a larger organisation, unless a dedicated volunteer came forward.

12. If a full-size replica is not feasible, are there desirable Plan B options for a smaller scale replica?

My first reaction to this is that it actually sounds quite fun, and rather Emmett-like, but on reflection I really do think that it is not a good idea at all. A scale model, running on the suggested two foot gauge would actually still be quite an expensive thing to create as *every process required to build a full sized replica would still need to be carried out.*

Although Beamish and the NRM York both have available 2' gauge lines, neither North Road nor Shildon do. As a miniature rather than full size 2' gauge locomotive it would be of very limited attraction to actual narrow gauge railways as a guest as it could not interoperate with their stock, and its own stock, as *scale* vehicles, might only carry four or five people. In this case one could actually have a long line of one or two person chaldrons, again great fun, but bear in mind that this size and train weight would still be covered by full sized, rather than miniature, regulations.

A 2' gauge 'Royal George' would surely have very limited educational worth, as well as presenting much less appeal to potential funders.

At Beamish a single incredibly skilled and dedicated retired engineer built, voluntarily, and almost single handedly a full size 2' gauge replica locomotive for a total cost of perhaps under £30,000. One could imagine a sub group of the Friends, if sufficiently skilled and motivated, taking ten years or so on such a project. The result might be a charming addition to a Darlington park, perhaps

making a little money for the Friends, but could only be a curious side show at the 2025 celebrations.

13. Is there scope to give the membership of the Friends an active role in either building this (R.G.) or in maintaining it and/or the waggons?

As a volunteer myself from aged 14, and having managed volunteers in several capacities over many years I have had a good deal of experience with this question. Without detailed knowledge of the skill base or time availability of the Friends there is no simple answer to this question. *There is a common cultural assumption that any railway based project will attract large numbers of skilled and manageable or self-managing volunteers*; this is sometimes true. Volunteers need managing, often more managing than when the relationship between employer and employee is absent. Health and safety is rightly a very big issue once dealing with full sized railways and engineering. This can lead to conflict, especially from men of a certain age who may have retired but still may have much to offer, yet see H&S to be an issue which they left behind when they left work.

Volunteers at the forefront of this project would need careful vetting and an interview process as well as clear onward management. The best volunteers can be better than the best employees; in my experience these rarities tend to come to the fore naturally.

There are likely to be many levels at which volunteer input will come into its own, painting, oiling, cleaning, winterising the train, stewarding at events, all come to mind where a variety of skill levels can be given useful jobs.

In view of the time scale of production to 2025 it would be wise not to factor in voluntary work as a firm delivery stream. I am conscious that voluntary work can be valued and costed as match funding for lottery bids.

14. Recommendations and Summary.

14.1 Technical feasibility. There are no technical reasons to prevent the creation of a fully working 'Royal George' locomotive and train. All the key features of the locomotive have already been reproduced on different examples of the replica early locomotives which have been constructed since 1975. This should bring considerable reassurance to both those who commission or fund the project, that there are no significant technical novelties or experimental aspects of the recreation.

14.2 A train to accompany the locomotive. For a successful long term legacy and continued future beyond the 2025 celebrations, particularly in developing a revenue stream for future maintenance and display, the locomotive will need to be accompanied by dedicated replica stock. This report suggests that a minimum of two coaches, to the early 1830's designs of

Kitching of Darlington, held in the DCC record office, are also replicated. These should accommodate at least fifty people. In addition to these should be two replica S&D type chaldron waggons, the purpose of which would be threefold; they would reflect the true history of the line and this locomotive in being primarily for the purpose of hauling coal, but also have the modern use of acting as 'guards' vans' for the train and allowing handbrakes to be readily applied when the train is being run round or marshalled for use at hire and display venues. An economy would be to only produce one waggon, but this would curtail passenger numbers and revenue income by the need to convert one of the end, open, compartments to be the second dedicated guard's space. The third function of one or both waggons will be to contain the main reservoir for the air braking system as well as the compressor required to supply it.

14.3 Historical accuracy. Some of the early locomotives which do not survive could not be recreated without an unacceptable level of speculation which could in turn affect their perception and historic status and importance; this is not the case with 'Royal George' as sufficient dimensions of the original are recorded and details may be taken from other recorded Hackworth or coeval locomotives and survivals. The process of achieving good results for the recent operating replicas of 'Steam Elephant' and 'Puffing Billy' both broadly took the same path as outlined in 16) below, although obviously the latter locomotive still existed in its final form (uncertainty and lack of credible detailed information about its important original eight wheeled design forced the decision to build a replica in 'end of working life' condition) For the former a great deal of research needed to be undertaken to prove the existence, form and likely or certain details of a locomotive which was scrapped by about 1840. This extended to very close liaison between historian and engineer in producing acceptable period answers to a multitude of questions as they arose. This relationship is of prime importance and should be carefully considered with regard to the 'Royal George' project to achieve the very best result.

14.4 Quality. A major issue and one closely related to procurement and, inevitably, cost. There are a small number of UK contractors who could produce a safe working replica; there are an even smaller number of those who could produce a high quality replica. By high quality I mean one built to the highest standards which will take little or no commissioning, and a reduced burden of future maintenance. High quality should also provide the most satisfying appearance of hand wrought work, unobtrusive modern requirements and details even down to such things as the use of square headed nuts and bolts.

An example of this would be to compare the 1979 replica of Hackworth's 'Sans Pareil', now exhibited alongside the original locomotive at Shildon, the smooth deep pressing of the modern boiler back compares sadly with the multi-plate riveted petal end of the original. The whole is largely devoid of period charm and detail. This is by no means to criticise the team lead by the late Mike Satow, a brilliant engineer who managed to build it on time to a remarkably low price. Contrasted with this might be the replica and original versions of 'Puffing Billy' at Beamish and the Science Museum respectively.

This difference in approach is one that can be managed and achieved through careful specification and the choice of contactors who understand the point and the very concept of replicating late Georgian engineering.

To achieve a result which the Friends and funders can be both proud of and confident in its performance, it is crucial that, following historical research, a clear specification brief is produced before design engineers are approached.

- 15 Timescale.** The timescale to produce the locomotive and necessary train is tight but by no means unachievable, if early confirmation of funding can be achieved and specifications to be agreed for engineering drawings to be produced as a matter of urgency, from which to then call for accurate quotations for the works.

It is unlikely that the engine and train could be completed in time to achieve more than testing, running in and staff training before 2025. The suggestion of touring the train before the celebrations to publicise the anniversary further afield is a good one, but I do not think this will be achievable in the time available.

- 16 The next steps and their likely costs.** I would expect, subject to specification, the locomotive and tenders to cost at least between £650,000 and £850,000 and the three or four vehicle train to cost in the region of £200,000 to £250,000. This must remain speculative before approved drawings can be circulated. These figures are *suggested* in order that the process of fundraising can begin at an earlier stage. These figures **exclude** the work listed below which are necessary parts of the project. They have been broken down into sections for clarity and explanation and, where possible, some likely figures are given for these works, *these are not firm quotations, but are no more than considered estimates where I have been able to make or obtain them.*

Of course it may be possible that contractors may be chosen who can offer many or all of these roles in house (with the obvious exception of the IPC), however the Brief and Specification must come from the clients.

- i) Historical research.** This must cover all reasonable sources of information about the original locomotive, including the sources of information which may be gleaned from coeval locomotive details and engineering practice in order to inform the many missing details of the locomotive. The wrong thing and the right thing are likely to cost about the same, so in anticipation of the replica having a long working life this work is essential. It would be regrettable if future research proved any key aspect of the replica to be 'wrong' as happened to an extent with the 1979 'Rocket' replica. This research would likely include some UK travel and archive expenses, at a cost of perhaps £4-5,000.
- ii) Brief and specification.** This should not only explain the vision and philosophy of the build and explain how the above information should be interpreted into it, but would include such information as in section 02 above concerning the approach to be taken in incorporating modern safety features into the build. The vision for the build should confirm questions over the use of riveting or welding? Forgings or welding and fabrications? The use of castings or

fabrications? The answer will almost certainly be a mixture of all of these, so it should explain what to do where? The quality and type of the timber; the incorporation of modern features and the philosophy behind the whole approach. This work should also include the acquisition of copies of drawings and information wherever available from the other replica locomotives, carriages and waggons built since 1975. There may be copyright fees here as well as reproduction costs. This latter information should be hugely informative to the Design Engineer, and in some cases may even allow direct copying of many features saving considerable design time. At this point also the existence of any suitable foundry patterns should be established, an excellent potential saving to the project of time and money.

- iii) **Appoint ICP.** The appointment of an Independent Competent Person is a legal requirement which fulfils the role of scrutiny previously undertaken by the Railway Inspectorate. I am aware that a cost for the locomotive and tenders alone has been estimated at £16,000 to £20,000 spread over the duration of the project. As the carriages and waggons will need the same level of scrutiny. I would suggest therefore that at least £30,000 be allowed for this work.
- iv) **Appoint a Project Manager.** I find it hard to imagine the project being progressed successfully without such a role. At the very simplest this should be someone who has overview of the project and who can communicate between client and contractors, answering queries and suggesting suitable solutions to problems as they are encountered. They may also be able to guide contractors to suitable specialist suppliers if necessary. This role may be held in the form of a retainer or an agreed daily rate. However, it is not yet possible to assess the cost of this role until the procurement route has been clarified and the level of experience and in-house work which will be undertaken by any main contractor. In short, how much managing they will need.
- v) **Engineering design drawings / appoint a Design Engineer.** There is no point in the production of drawings by anyone other than a skilled engineer or they will all need to be redrawn and calculated by someone else. The time for non-engineering drawings is at stage i) The Design Engineer will produce drawings which are approved as they are produced by the project manager on behalf of the client. Time economy and cost certainty can be built up during this time if the drawings components or groups of components are sent out to suitable contractors to price for. This may be undertaken directly by the Design Engineer as part of their brief – they are ideally suited to explain to potential suppliers exactly what is being asked for. Or this may be undertaken by the chosen main contractor. This process also serves to flush out any components which may be hard to find a manufacturer for. For example the pump for ‘Elephant’ was declared to be uncastable until Cooke’s at Tow Law produced a perfect one. £50 – 75,000?
- vi) **Appoint Boiler Designer.** I have spoken about the project to one of the most respected boiler designers. His business is currently extremely busy, but he would have time to design the basic boiler to submission within the proposed project timescale. This work would be on the understanding that he would not need to undertake historical research, but that this information would be supplied to him. It would not include the design work for ancillaries

such as regulator, steam pipes, lagging, chimney, or the dummy dished end forged platework. It would include the Hackworth safety valve and the dome feature which Raistrick shows it mounted on. As soon as it is possible the work of the design engineer and boiler engineer must come together in order that the latter's work can be finalised with regard to the boiler mounting points and slides and, crucially, all the necessary mounting points for the cylinders and motion and the above boiler eccentric shaft. It is extremely helpful if the Boiler Designer and Design Engineer know and respect each other.

It was interesting to note an initial reluctance of this engineer to get involved with a new replica locomotive project as he considered that many of them are being built to such a low quality that he would not wish to be associated with them. Estimated cost c. £15,000.

- v) **Train drawings.** There should be scope here for the re-use of existing drawings as suggested in ii) above. If it is decided to adopt the suggestion of replicating Kitching type coaches, then a major consideration will be the wheel type. Research is needed here as the otherwise charming and useful original drawings give no more than a token suggestion of the wheels themselves.
- vi) **Costs of building the locomotive and tenders.** In response to the drawings and specifications produced above.
- vii) **Costs of building the train.** As above
- viii) **Appointment of Main Contractor.** This may be a firm happy to undertake all the work including the design work above, or one which will act as a co-ordinator, part manufacturer, part builder and assembler. The latter is more likely in view of the diversity of necessary trades, but this leaves the key client / contractor relationship unchanged. By this point it should be clear whether the main contractor has the capacity to undertake the build of the train vehicles. It should also be clear whether it will be straightforward for the main or an alternative contractor to produce the rolling chassis for the train vehicles and to let contracts for the wooden body building elsewhere.
By this point it should be clear whether the main contractor has the capacity to undertake the build of the train vehicles. It should also be clear whether it will be straightforward for the main or an alternative contractor to produce the rolling chassis for the train vehicles and to then let contracts for the wooden body building elsewhere. It would be preferable for the main contractor to produce the engineering components of the train to guarantee uniformity of brake and coupling interaction, as well body gauge considerations.
- ix) **Transport and commissioning.** It is assumed that the main contract should include testing and commissioning. However thought should be given as to whether the long term host venue for the locomotive and train is ready to receive it or whether an alternative heritage railway would need to be hired (or provide freely for the publicity) to provide a venue. A longer line can be very useful for running in and setting up the braking systems. Note that this process could therefore double the delivery costs. Following testing, snagging and

commissioning, this would perhaps be the time to train the staff who will be the future operators as part of the running in process.

Some or all of the above roles may be contained or supplied within the same company but it is helpful to understand the distinction of the roles and their relationships one to another.

17 Conclusion

It is hoped that the forgoing report will help the Friends in deciding how best to progress the 'Royal George' project. The multiplicity of works required to achieve a successful outcome on time and their own logical sequence means that it is necessary to rapidly agree how the Friends will approach the project in terms of how it is managed, specified and contracted out and how the Friends or other commissioning body vet or approve the proposals and responses made by contractors. The clarity of these decisions should help in engendering trust and support from funders and sponsors.

I remain very cautious of a design and build approach – this is not a utilitarian building or similar, it must produce a result to be proud of. That is not at all to say that the builder could not undertake the design work, *but that this work should be done first to an agreed specification* in order that the resulting designs can then be used to provide a firm cost for an agreed product. This process is outlined in **16)** above and will remove unnecessary stress, uncertainty and financial variation for both client and contractor.

Recreation of this wonderful locomotive would be a wonderful sight and sound and will surely help focus long term attention on the history and importance of the Stockton and Darlington Railway, the region it grew out of and of its importance in history.