
L N E R
2007
PRINCE OF WALES
No 2007
BRITISH RAILWAYS
60163
LUDLOW

60163 TORNADO

New Steam for the Main Line

2007 PRINCE OF WALES

Building Britain's Most Powerful Steam Locomotive

3403 HIGHLANDER

Recreating Gresley's last design

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Welcome

Agenda

- History of the Gresley class P2s
- Design of No. 2007
- Construction & fundraising progress
- Future developments for A1SLT
- Q&A

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Where we have come from?

A1SLT launch, Railway Institute, York, 17th November 1990

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Here's one we made earlier!

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History of the Gresley class P2s

More power required

Gresley class A3 – final deliveries in 1934

Class C10/11 NB Atlantics – double heading frequent Edinburgh to Aberdeen

Gresley class P1 delivered in 1925 – 100 wagon trains

Statue of Sir Nigel Gresley at King's Cross station

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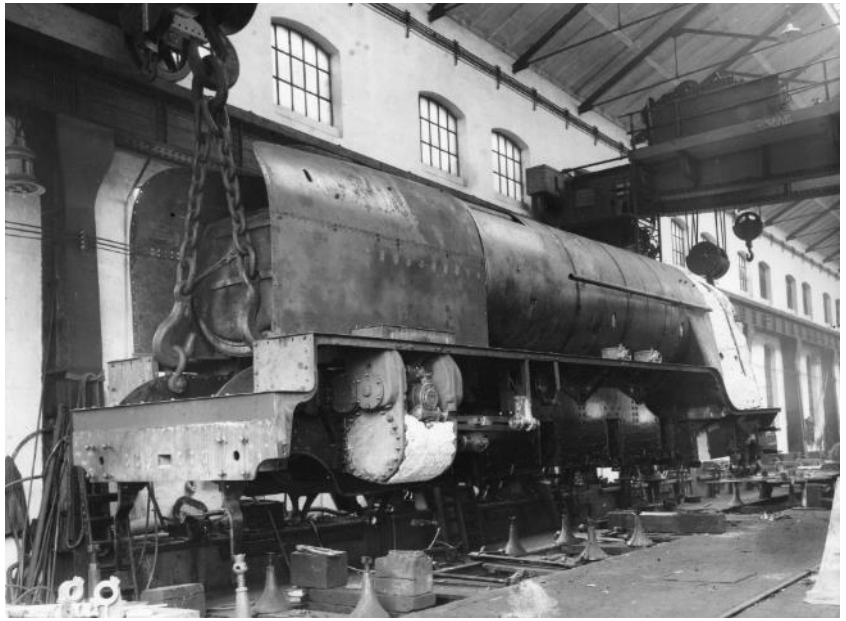
No. 2001 *Cock o' the North* under construction in 1934



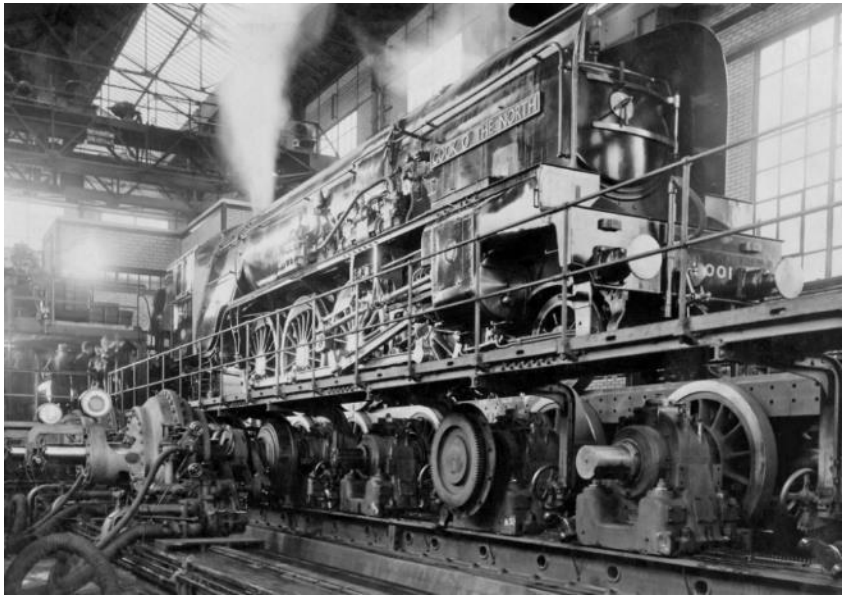
The finished article, May 1934

- 2-8-2 Mikado wheel arrangement
- 50 sq ft firebox grate
- Kylchap chimney/blastpipe arrangement
- ACFI feed water heater
- Chime whistle
- Lentz rotary cam poppet valve gear
- Semi-streamlined and a V-shaped cab front
- All-welded tender with spoked wheels
- Gill Sans nameplate

Cock o' the North unveiled to the press

No. 2001 on test

At King's Cross with indicator shelter fitted



At SNCF test plant, Vitry-sur-Seine near Paris, France

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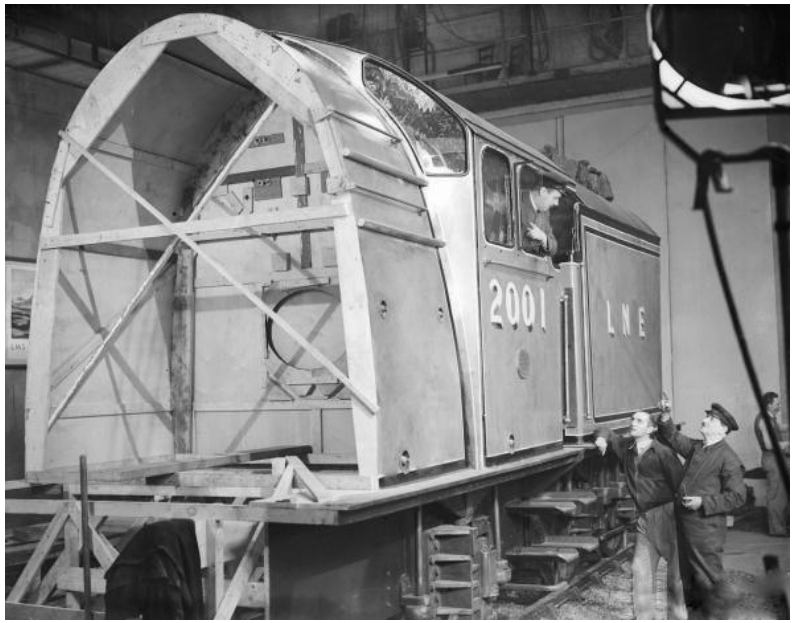
'Giant locomotive' a celebrity during the 1930s

"COCK O' THE NORTH" IN CHOCOLATE.

A chocolate model of the L.N.E.R. Company's latest super-locomotive, "Cock o' the North," has been placed in the shop window at 68 High Street, Dundee, of James Keiller & Son, Ltd.

Nearly four feet in length, the model is made exactly to scale, and reproduces faithfully the huge boiler and diminutive funnel of the engine. An engine-driver dressed as Santa Claus is peeping from the cabin, while the tender is packed with chocolates instead of coals.



Cock o' the North was the only LNER locomotive to have a Spitfire named after during WWII

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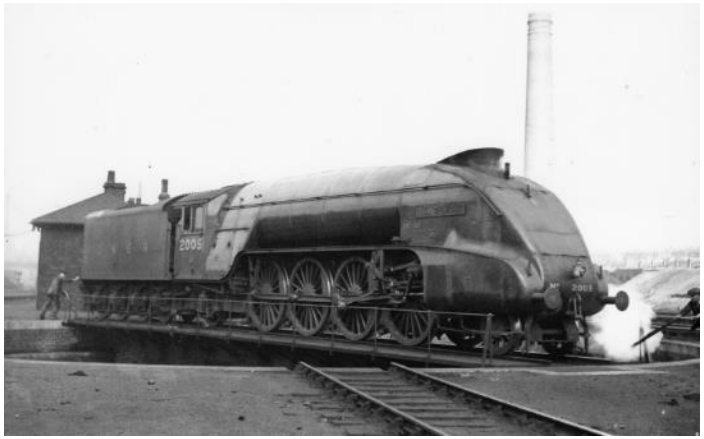
No. 2002 *Earl Marischal,* the conventional sister, completed October 1934

And then came the streamliners – June to September 1936

No. 2003 *Lord President* - first of the streamliners

No. 2004 *Mons Meg* - bypass valve to divert exhaust from the blastpipe



No. 2005 *Thane of Fife* - single chimney

No. 2006 *Wolf of Badenoch* - longer combustion chamber in firebox - prototype for *Tornado's* boiler

Nos. 2001/2 rebuilt as streamliners in 1936/7

No. 2002 entered Doncaster Works in October 1936 for its first heavy repair and also received a streamlined front end

No. 2001 was similarly treated in September 1937 with the ACFI feed water heater removed and its poppet valves replaced with Walschaerts/Gresley valve gear

Thompson's ungainly rebuild

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Why build a new P2?

- To realise the potential of the original Gresley design
- The most powerful express passenger steam locomotives to operate in the UK
- All rebuilt as Pacifics in 1943/44 and scrapped by 1961
- Fills one of the most significant gaps in preserved steam
- The “procession to the plinth” continues.

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A P2 in the 21st century

- Powerful locomotive capable of running on large part of the national network
- Increased haulage capacity
  - Perth to Inverness
  - Exeter to Plymouth
- Similar outputs to *Tornado* – 110+ miles between water stops
- 75mph but potential for slightly higher.

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Why this team?

- The team behind No. 2007 includes the key people behind the building and operation of *Tornado* as well as a number of new people
- There is significant commonality of components between No. 60163 and No. 2007
- *Tornado* is now successfully operating on the main line with her own dedicated support coach
- The Trust is now debt free, having purchased the tender from WCCP in May 2018
- We have the expertise, the track record and a plan... but we need your help to raise £6m to construct No. 2007.

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Our mission

"To develop, build and operate an improved Gresley class P2 Mikado steam locomotive for main line and preserved railway use"

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Building Britain's Most Powerful Steam Locomotive

Design

Key design principles

- Aesthetically similar to No.2001 *Cock o' the North*
- Whole locomotive to be drawn in 3D CAD
- Existing design to be used except:
  - Alterations to alleviate known problems with original design
  - Changes required to meet modern operating requirements
  - Equivalent *Tornado* design to be used where appropriate
  - Improvements to assist maintenance and life-cycle costs
  - Materials at least equal to and preferably better than original
  - Achievement of compliance with rail industry standards.

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It starts with the drawings…

Tony & Gill Lord scanning P2 drawings at the NRM

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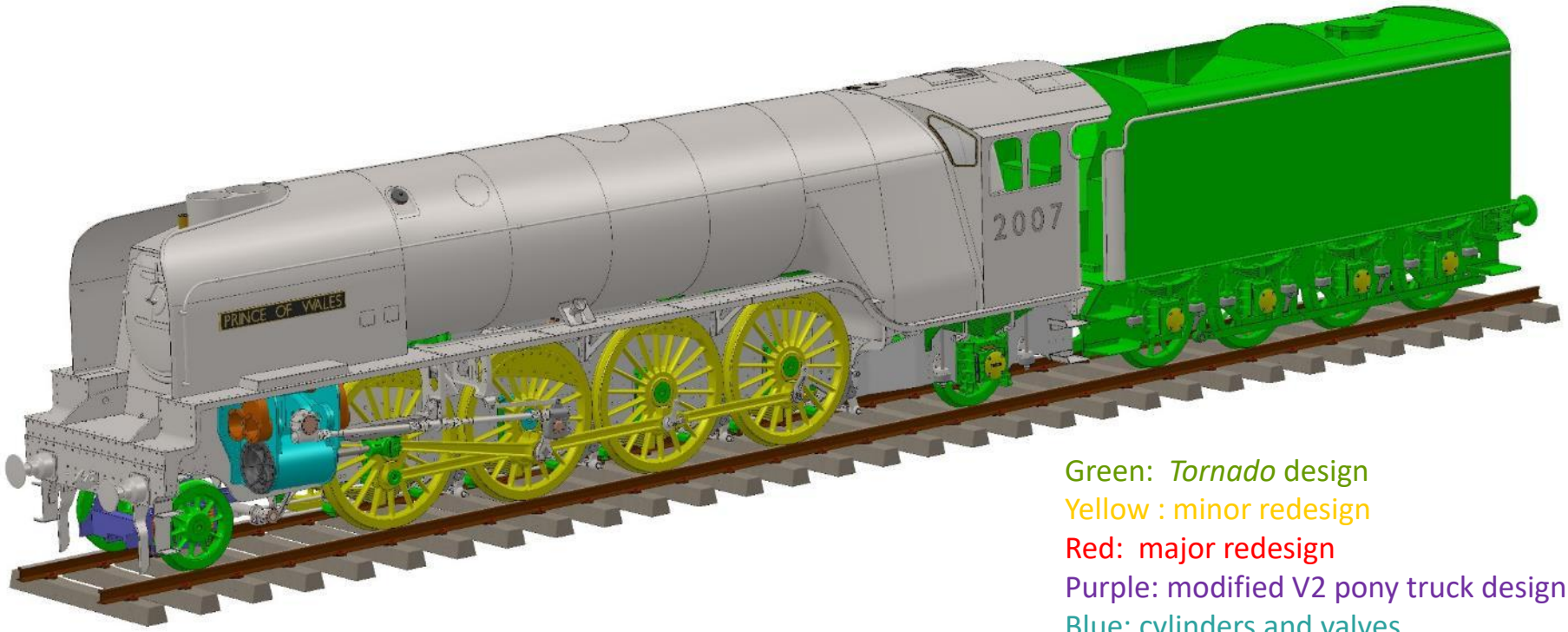
Commonality with *Tornado* and new design



Green: *Tornado* design
Yellow : minor redesign
Red: major redesign
Purple: modified V2 pony truck design
Blue: cylinders and valves

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Detailed design - Commonality with *Tornado* and new design

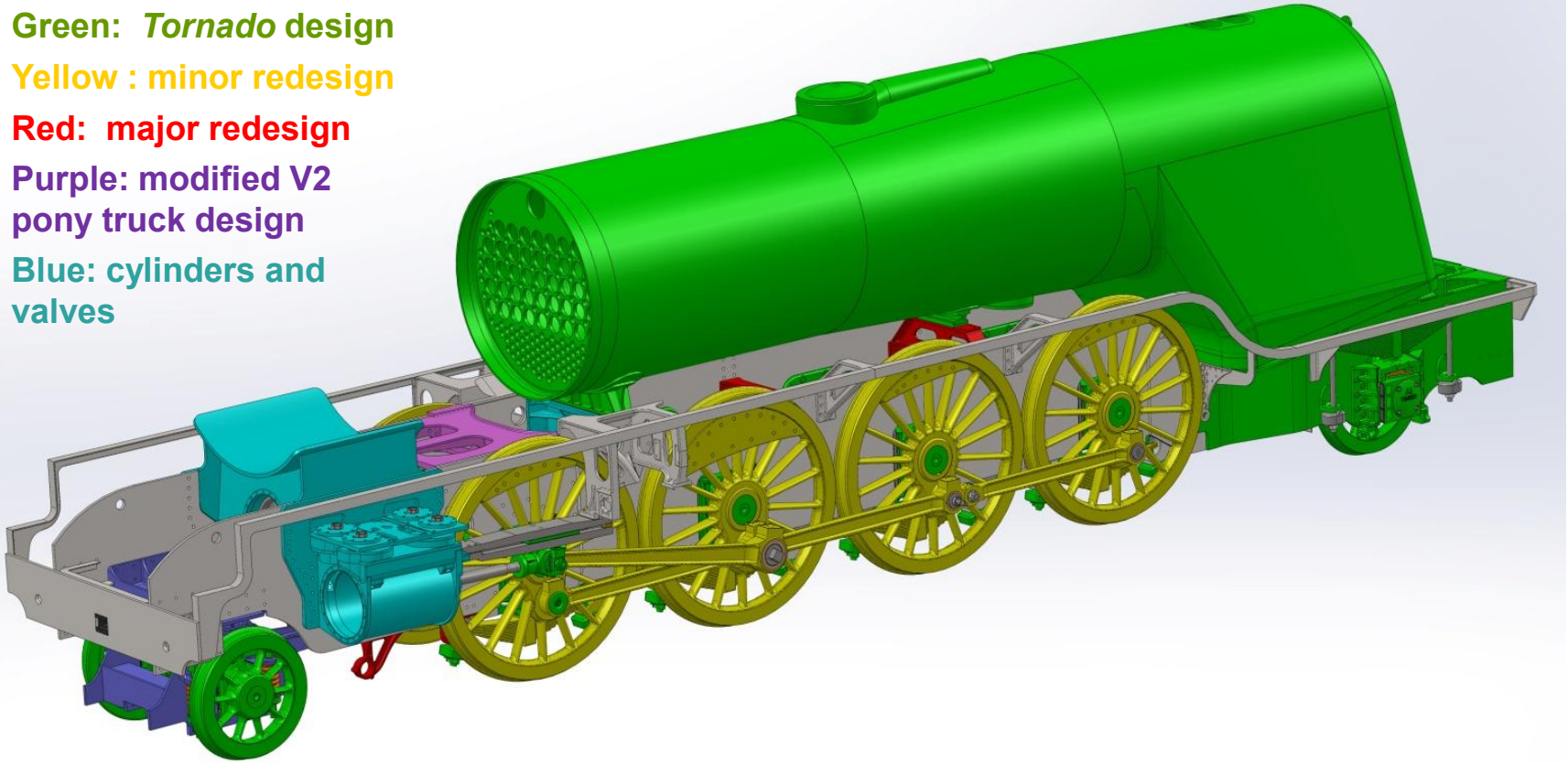
Green: *Tornado* design

Yellow : minor redesign

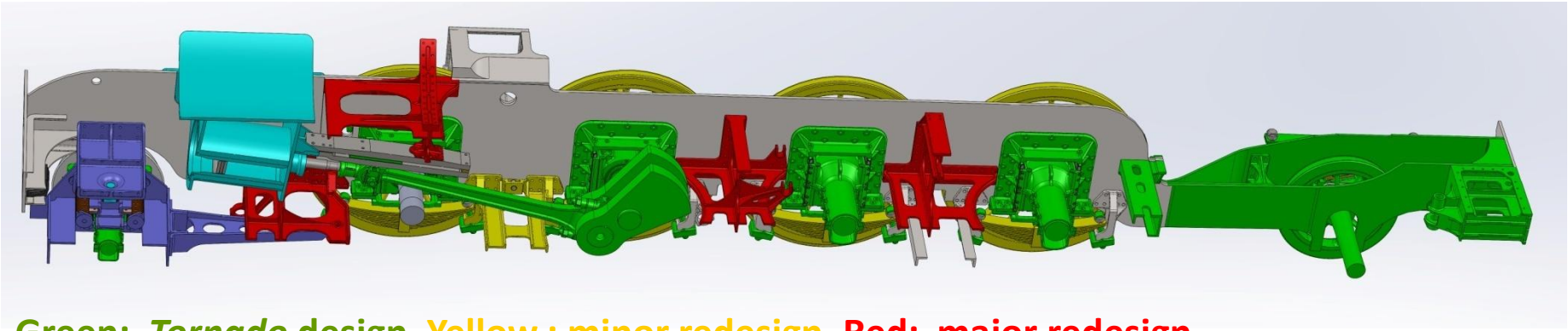
Red: major redesign

Purple: modified V2 pony truck design

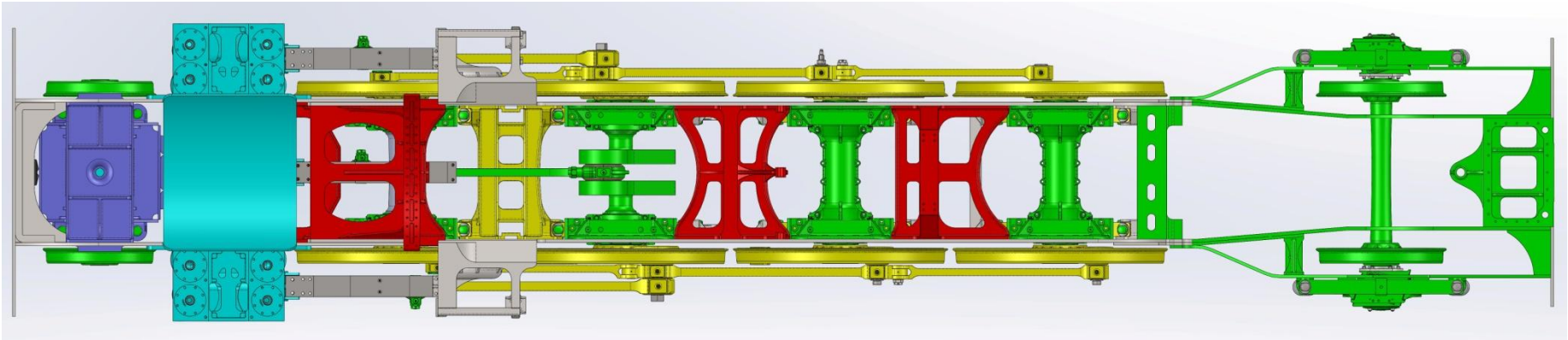
Blue: cylinders and valves



Detailed design - Some more views



Green: *Tornado* design, Yellow : minor redesign, Red: major redesign
Purple: modified V2 pony truck design, Blue: cylinders and valves



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Principle areas of redesign

- Develop improved pony truck and frame design using VAMPIRE® modelling data to confirm ride characteristics
- Investigate and confirm valve gear to be fitted choices are: improved Lentz/Franklin, Walschaerts or British Caprotti
- Investigate and reduce risk of crank axle failure apparent in original design
- Investigate and confirm design and method of construction of cylinders - cast versus fabrication.

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Other design changes

- Use of diagram 118A *Tornado* boiler
- Use of A1 type Timken roller bearings
- Substitution of fabricated frame stays for original cast design
- Modification of brake system from vacuum only to BR type dual air/vacuum installation
- Incorporation of rocking grate and hopper ashpan
- Reduce overall height to comply with modern “go anywhere” loading gauge
- Fit modern comprehensive electrical system and safety equipment.

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Building Britain's Most Powerful Steam Locomotive

Construction

Project Plan

- We maintain a project plan running into 890 lines and several feet long when printed!
- The plan presently shows that substantial completion by the end of 2027 is theoretically possible but requires access to resource levels which are presently not available
- This, coupled with the fund-raising profile suggests that completion by end of 2028 is more realistic.

The first parts appear!

James May (from *Top Gear* and *The Grand Tour*) makes the first component at Darlington Locomotive Works on 20th February 2014

The completed smokebox dart

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£6m sounds a lot of money but…

- Over £4m raised by A1SLT since 1990
  - *Tornado* construction
  - E21249 support coach overhaul and conversion
  - Ongoing maintenance and overhaul
  - £10m if include volunteer time
- Vulcan to the Sky raised over £7m to get Vulcan XH558 back into the air
- Welsh Highland Railway raised over £25m to re-open a 25 mile railway.

- The Founders Club
- Regular donations by Covenant
- Sponsoring a component by Dedicated Donation
- Commercial sponsorship
- The Boiler Club
- The Mikado Club
- The Cylinder Club + Monobloc Club
- The Motion Club
- Tender Club
- Pony Truck Club
- Turbo Gen Club
- The Injectors Club
- Valve Gear Club
- Support Coach Club
- Loan finance
- Legacies
- Grants.

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The plan in 1990 – an A1 for the price of a pint!

£1·25 = price of a pint

Slogan: "Build a brand new A1 for the price of a pint of beer a week!!!"

1000 contributors should see it built in 10 years.
less and it takes longer
More and it is a quicker build.

This will work.

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Covenanting – a P2 for the price of a pint!

- £10pm by standing order
- Price of a pint in North East now £3.50 (up from £1.65 in 1990)
- GAD makes every £10 worth £12.50
- Target of 2,000 £10 equivalents to raise £2m
- **Over 900 Covenantors already signed up worth over £100k per annum including gift aid.**

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Frames

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The Founders Club

- We estimated that the pre-launch phase would require at least £100,000
- We sought at least 100 people each donating £1,000 in up to four payments of £250 by standing order
- These funds were intended to be used to get the project to the point of cutting No. 2007's frames

Membership of The Founders Club has now closed but exceeded 360, worth over £450,000

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The frame plate material is rolled 23rd April 2014

Sir Nigel Gresley's grandsons start the profiling on 21st May 2014

Ben and Tim Godfrey start the profiler

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Frame plates

Frame plates CNC machined direct from CAD drawings by Boro' Foundry

A flat pack arrives in Darlington

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Frame assembly and bending

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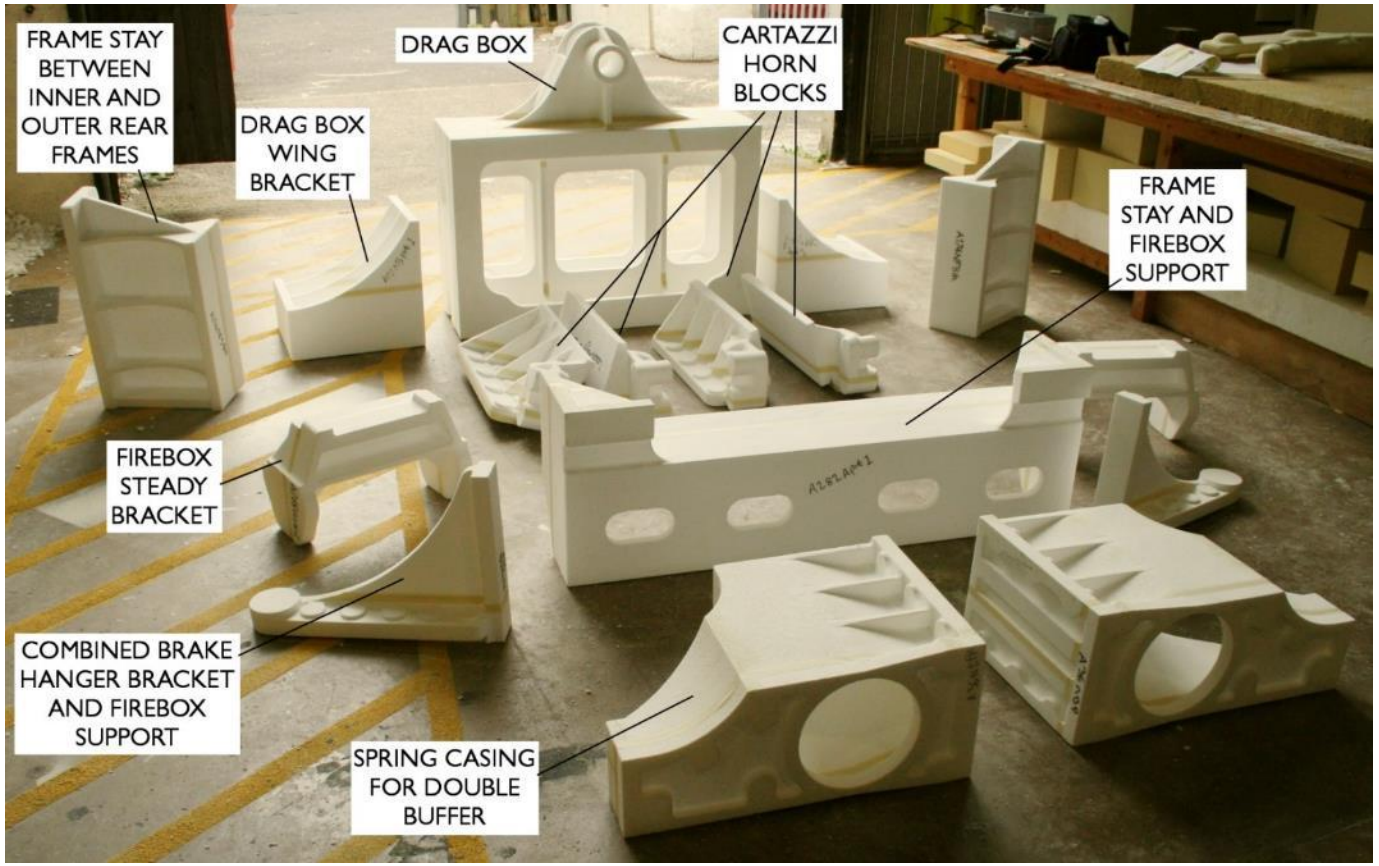
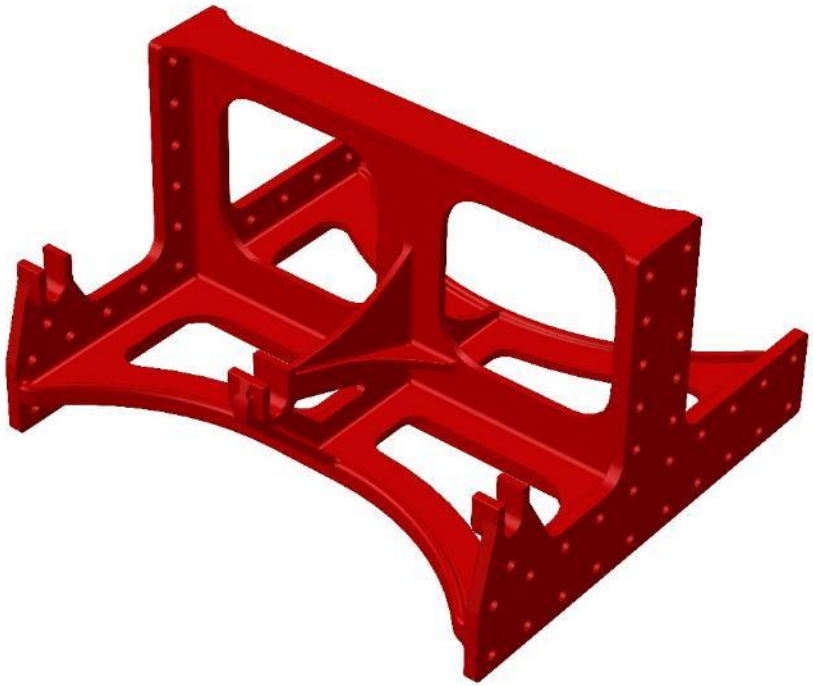
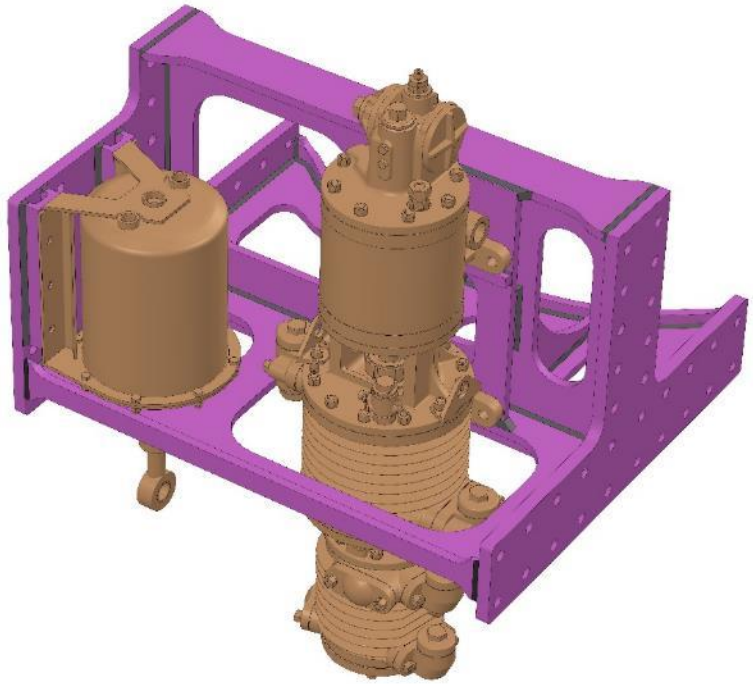
Polystyrene patterns for frame castings – castings completed



Fabricated frame stays

Original cast frame stay





Fabricated frame stay modified to carry air pump and air brake cylinder

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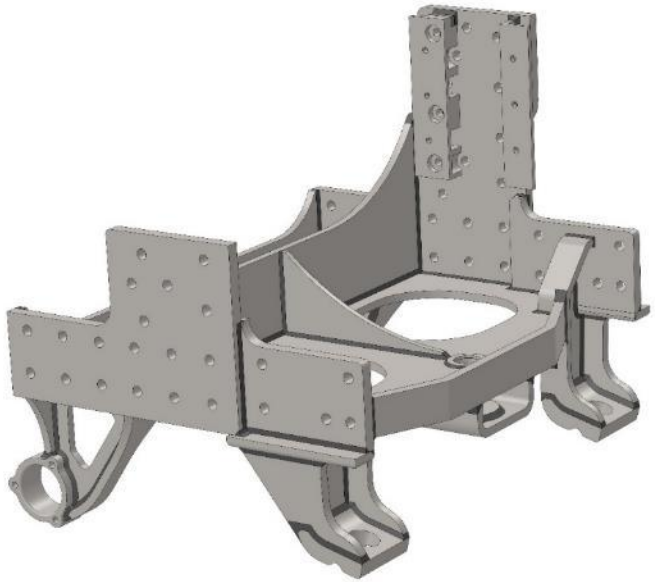
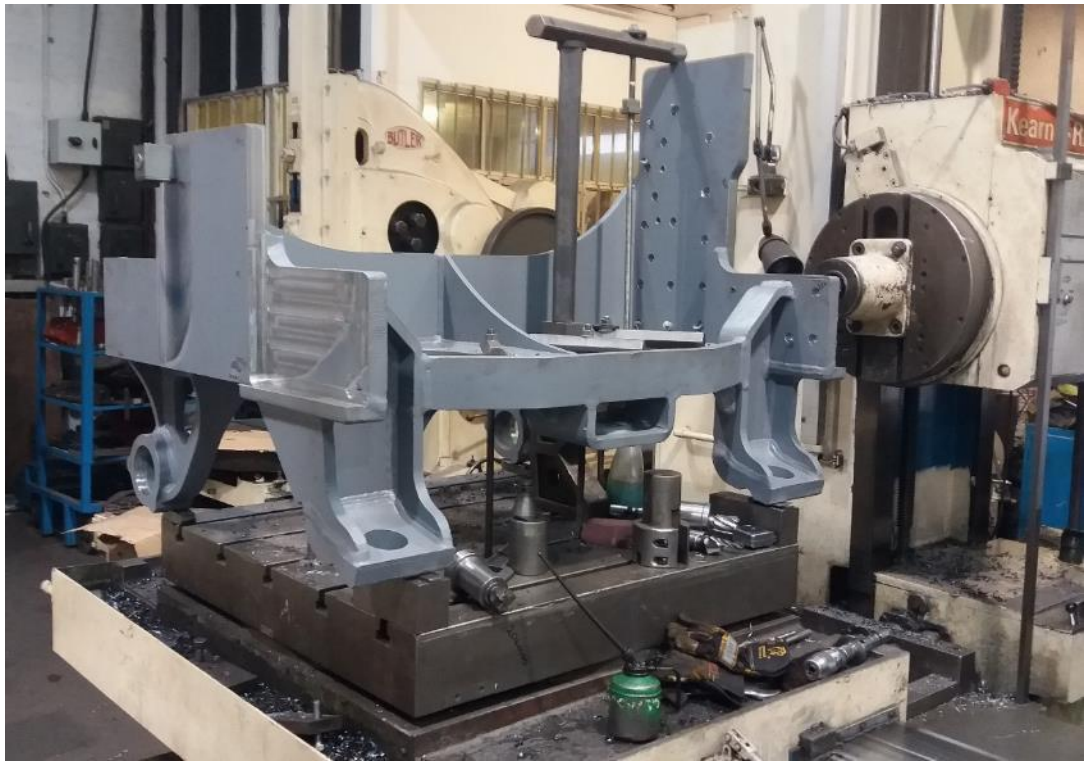
Frame progress

Last major frame stay nearing completion.





Frame progress

Engine's frames erected; all major frame stays, brackets, horn blocks, axle boxes & buffers cast and fitted using around 1,000 driven bolts.

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Cylinders

Cylinders

- P2 cylinders were 2in wider overall than A1 cylinders
- Modern track has reduced clearance between rails and platforms
- No. 2007 must be no wider than *Tornado* to retain route clearance
- 250psi boiler permits reduction in cylinder diameter to $19^{3}/_{4}$in to maintain tractive effort
- Use of fabricated steel instead of cast iron will enable No. 2007 cylinders to be no wider than those on *Tornado.*

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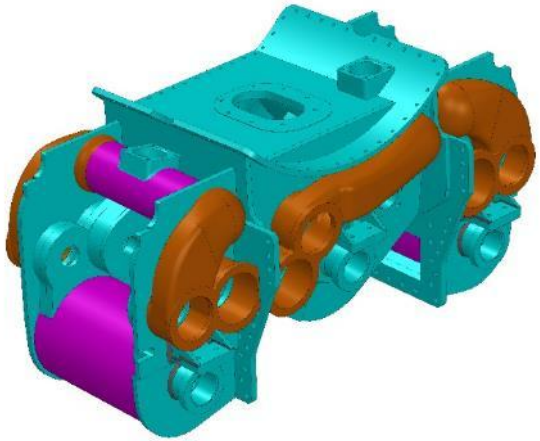
The Cylinder Club



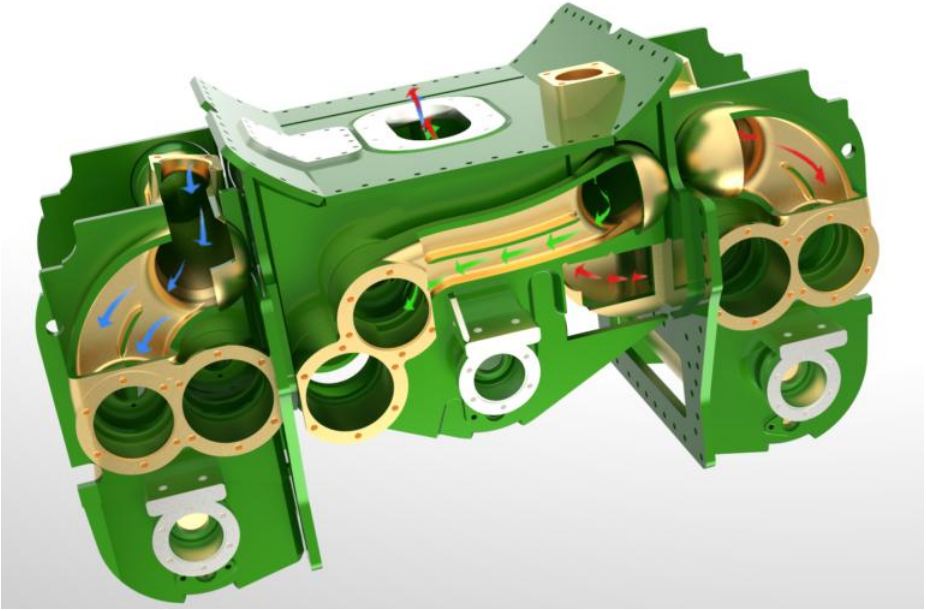
FULLY SUBSCRIBED!

- Manufacturing the cylinder block will cost around £100,000
- We are seeking at least 100 people each donating £1,000 (plus Gift Aid) in up to eight payments of £125pm by standing order
- Special benefits for members of The Cylinder Club.

100 members, with around £120,000 pledged

The Monobloc Club

The design & construction of the cylinder block is costing a lot more than originally estimated and we have therefore decided to launch The Monobloc Club to raise an initial target of £250,000 from 250 supporters each donating £1,000 plus Gift Aid (in up to eight payments of £125) to fund its construction.



91 members, with around £90,000 pledged

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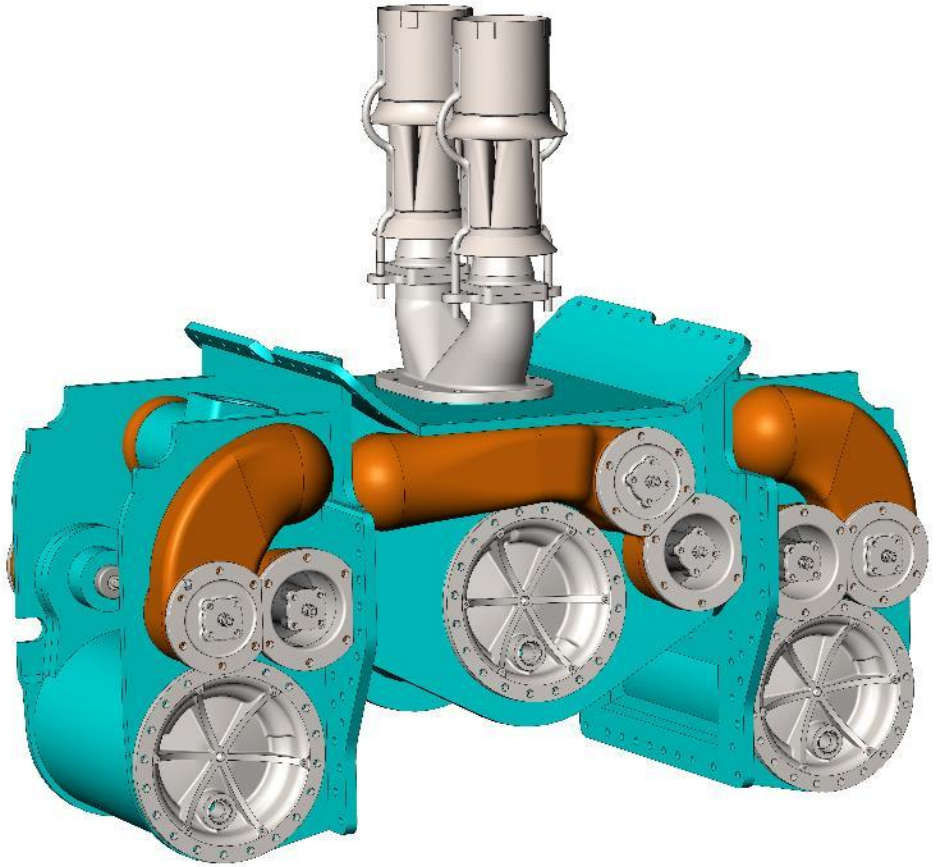
Cylinders

Redesign of the Monobloc cylinders used on No.2001 as a fabrication using steel castings, tube and plate and improved thermodynamic performance has been completed and the manufacture and testing has now been completed.



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Cylinder block

The three cylinders placed together to check alignment, clearances and to ensure preparations are complete for welding to create the Monobloc

The assembly was strapped together so the dimensions could be measured with a Faro arm.

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Cylinder block

The three cylinders were tack welded together creating the first Monobloc since the 1940s and weigh around 5 tons. Once the dimensions were checked, there followed a two week long welding process, then two weeks of being stress relieved. Proving this method was obviously vital for the P2, but the next build project - the V4 - will also require a fabricated monobloc cylinder. This method could also be applied to heritage locomotives, such as the V2.

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Cylinder block at October 2022 Convention

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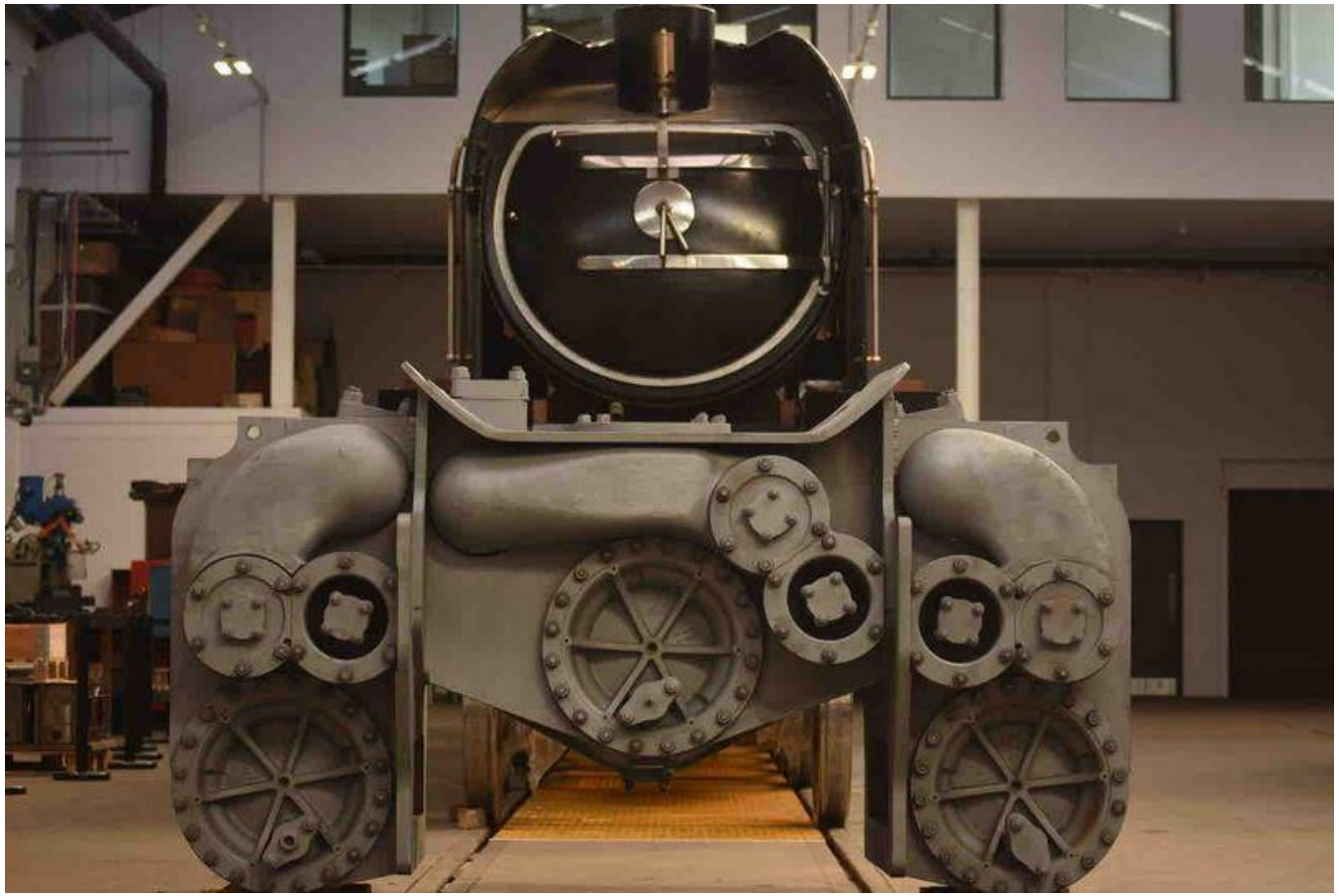
Cylinder block completed, tested, & delivered



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Valve gear

Valve gear

- No. 2001 was at first equipped with Lentz rotary cam poppet valve gear
- Originally with continuously variable cut-off
- Modified to stepped cams providing limited cut off settings following excessive wear on original cams
- Resulted in reduction in economy due to wide steps in cut-off and continued problems with high wear rate
- Investigated an improved version of Lentz/Franklin, Walschaerts or British Caprotti as developed for No. 71000 *Duke of Gloucester*
- Major design study has confirmed selection of improved Lentz/Franklin valve gear.

Franklin version of Lentz gear with infinitely variable cams

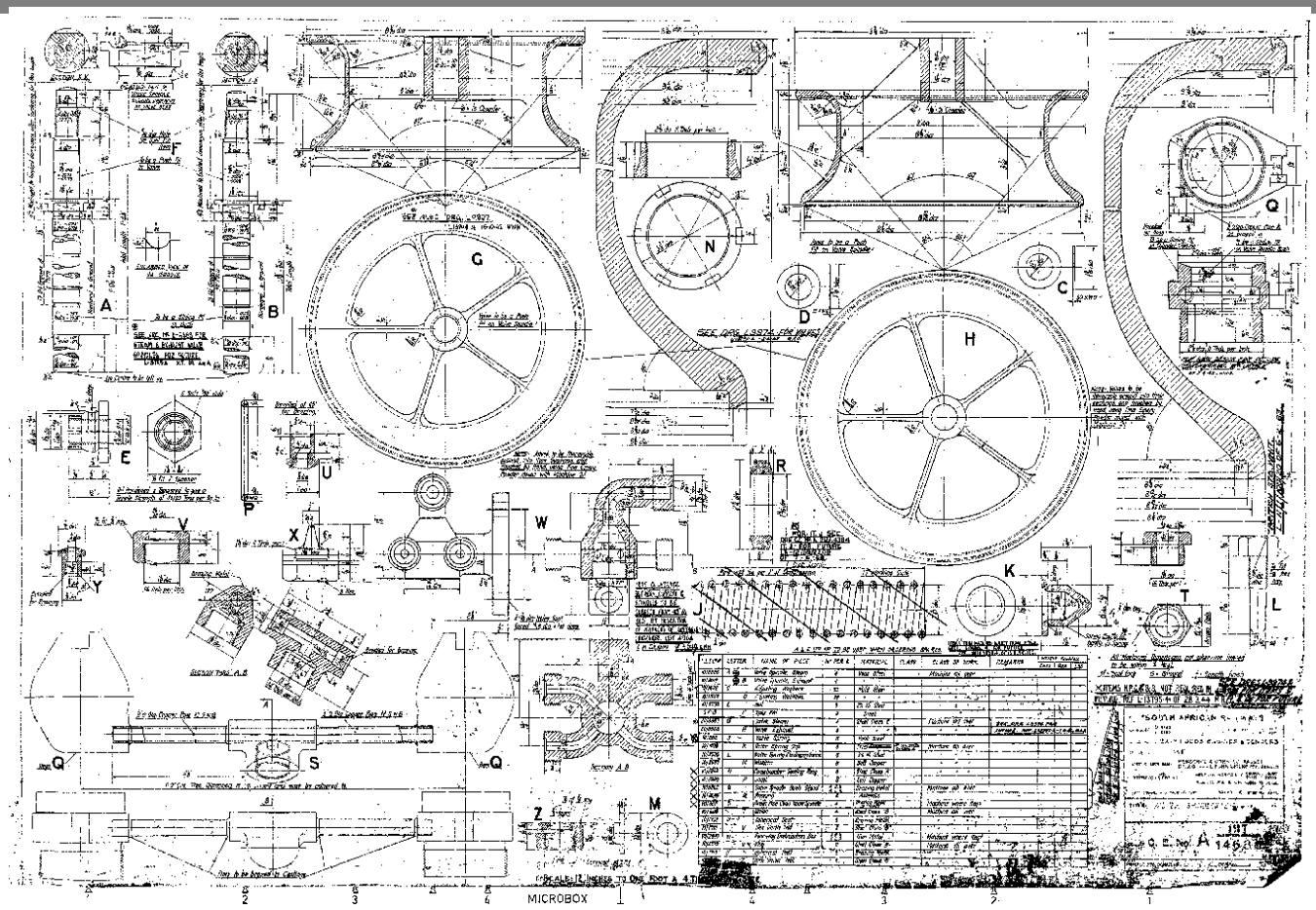
Valve gear

- There are very few detailed drawings in existence of the valve and reversing gear fitted to No. 2001
- However, at the same time as the Associated Locomotive Equipment Company (ALE) - holders of the Lentz patents - were designing the P2 valve gear, they were supplying a large order of valve gear for similar sized 15E locomotives in South Africa
- Copies of detail drawings have been sourced from SAR originals.

Shortage of original P2 Lentz valve gear drawings

South African 15E class similar in size and built in 1934/5 with Lentz valves.

Copies obtained of 15E valve gear



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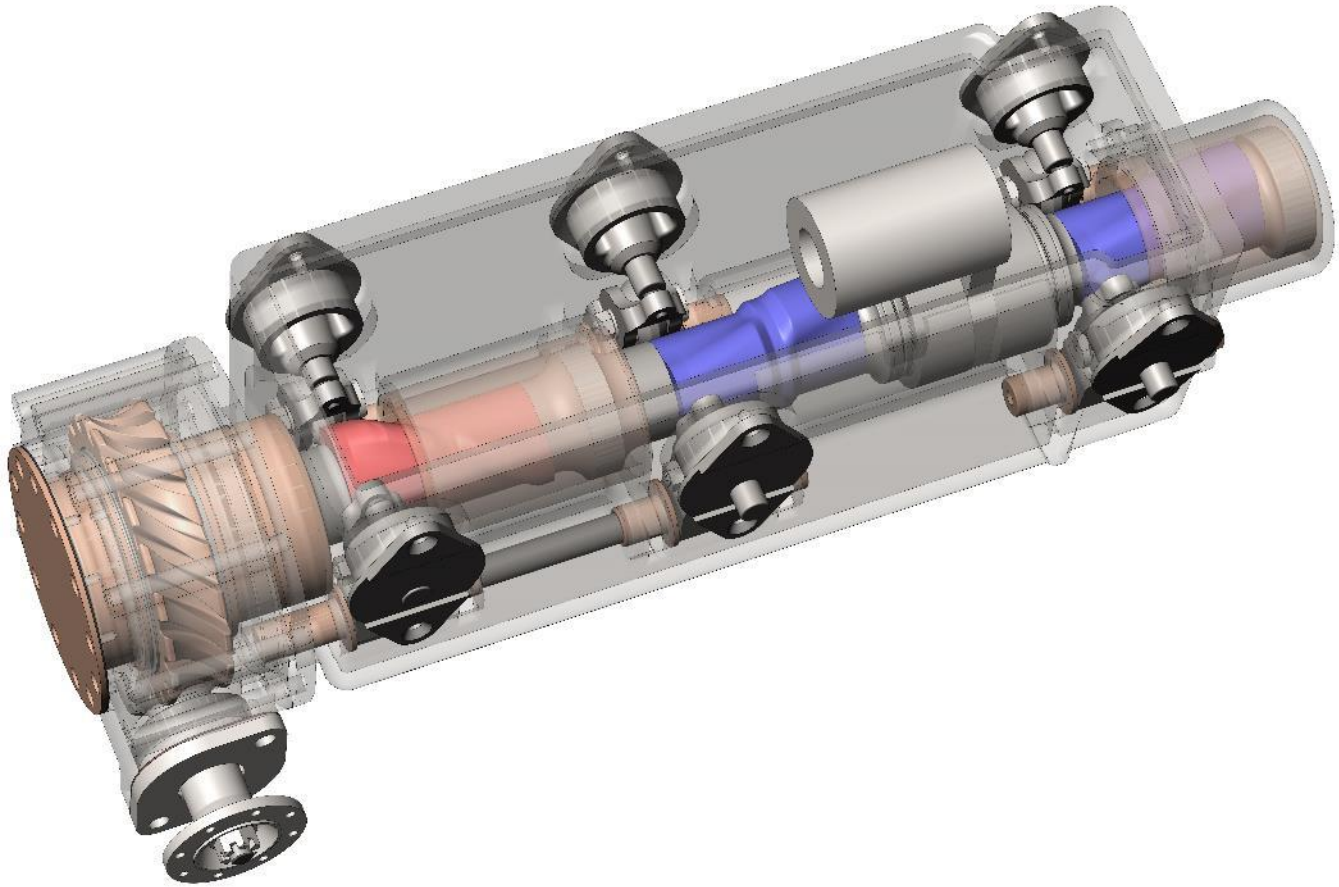
Poppet valve cam box



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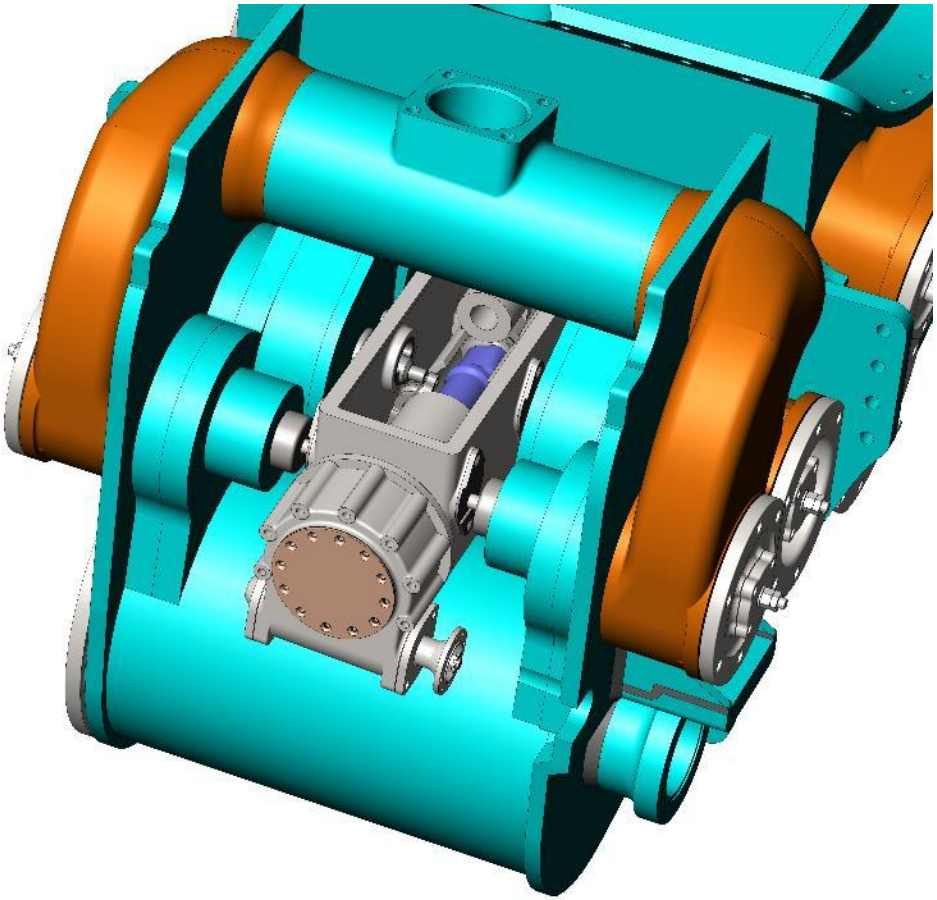
Where it fits in the cylinder block



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Poppet valve cam box - Progress

Manufacturing drawings for the cambox & its internal components largely completed, designs for lubrication of the valve spindles & oil coolers for the camboxes worked up.

The one-third scale 3D printed model of the cambox and its internals manufactured.

Meetings held with Warwick University WMG to assist in choosing the optimum materials for cams and cam followers.
Further advice has been sought on the most suitable lubricant for camboxes.

3D printed cambox and screw

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Valve Gear Club

The valve gear club was launched in April 2024 and has raised over £60,000 towards its target of £300,000 from 300 members (currently 66 members)

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Smokebox and chimney

Smokebox

Thanks to generous sponsorship from The Gresley Society Trust the smokebox was assembled, starting with a kit of parts which were profiled and rolled from CorTen steel to improve corrosion resistance.

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Smokebox

The anti-vacuum valve and superheater covers are made and fitted, door hinges and fittings mounted enabling a trial fit of the smokebox on a temporary frame stay.

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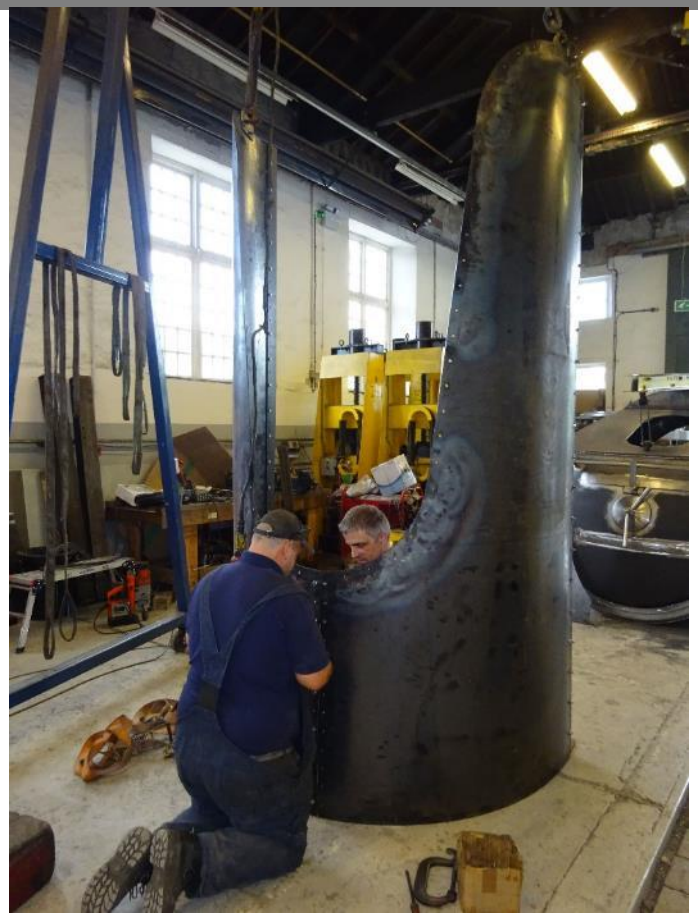
Smokebox

Beading for the smoke lifting plates is formed and the lifting plate joint strip made and fitted.



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Smokebox door pressed from CorTen steel

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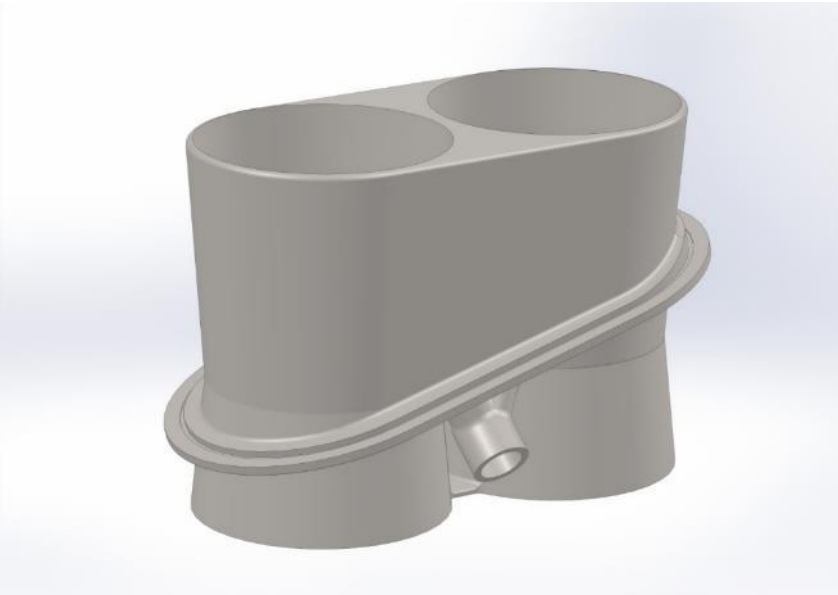
Double Kylchap chimney



3D CAD model of chimney

Chimney casting from

Spheroidal Graphite Iron

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Fittings and pipework

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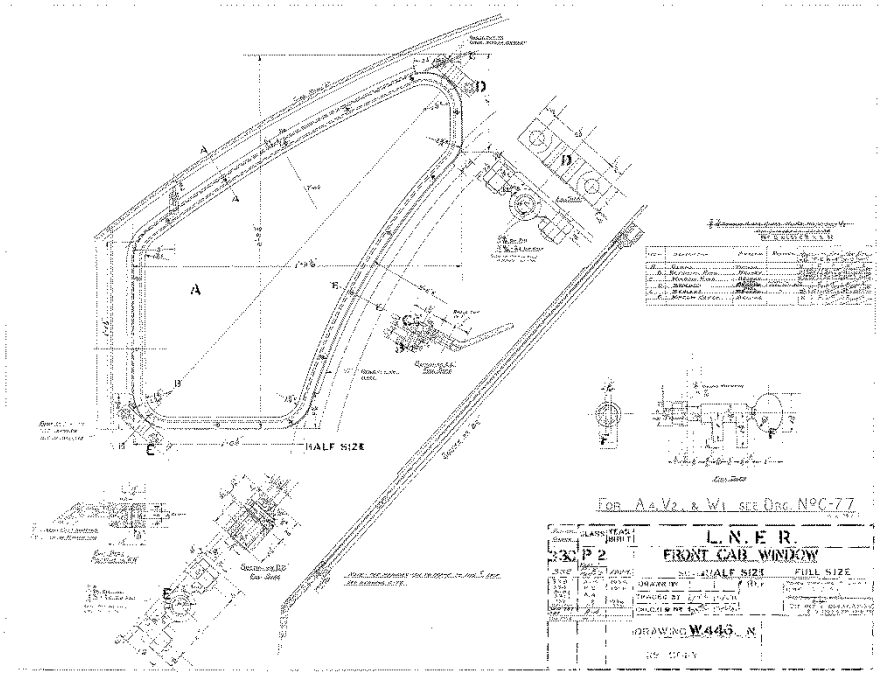
Sponsoring a component – Dedicated Donations



Over £400,000 already raised

- From as little as £25 to in excess of £50,000
- Payable either as a single donation or monthly by standing order
- Regular release of components
- Benefits to include an A4 copy of the drawing, a photograph of the component, inclusion in the Roll of Honour
- GAD also applies making every eligible donation worth 25% more
- Launched in July 2014 with a target of raising £560,000.

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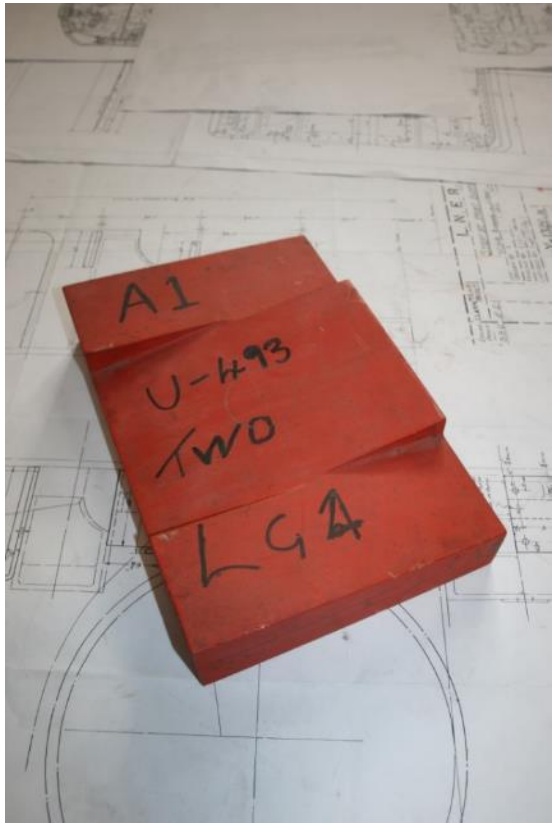
First bronze castings ordered

Injector control valves



Cartazzi bottom wedge

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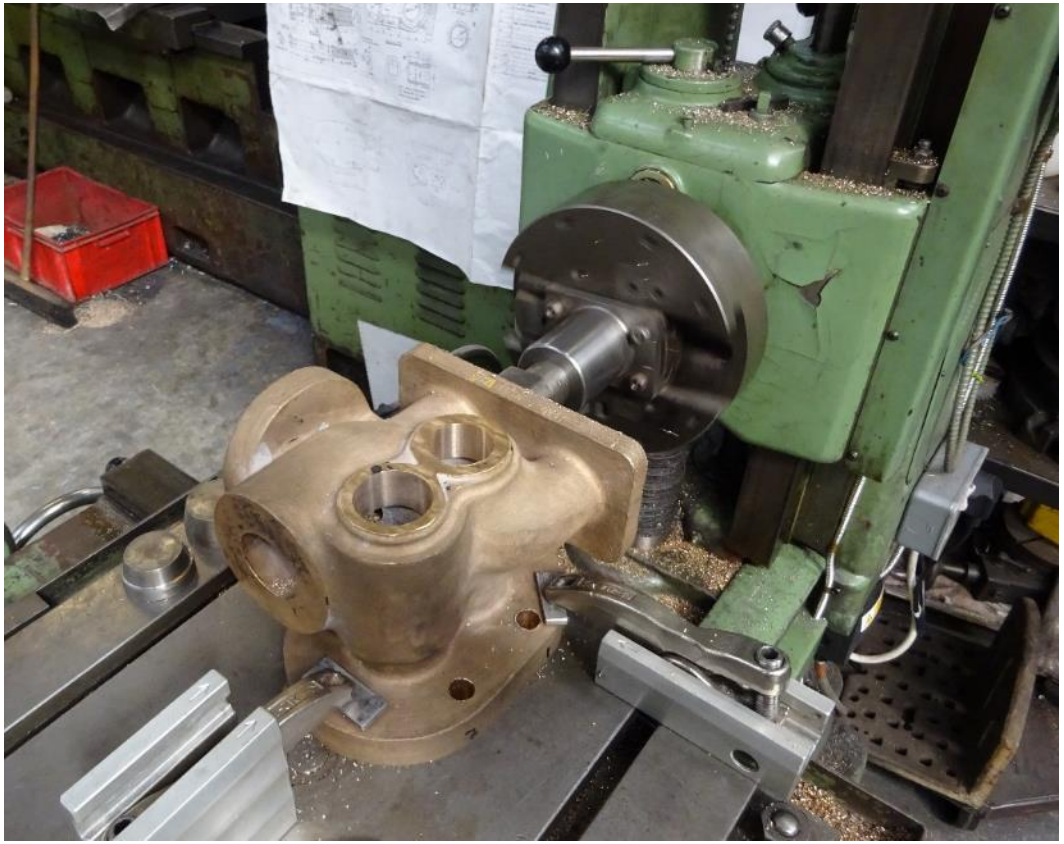
Steam fittings under way



Injector control valve machining

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Injector Club

We estimate that the live and exhaust steam injectors will cost around £50,000 to acquire, manufacture and install. It is therefore our aim is to raise at least £50,000 with The Injectors Club from 50 supporters each donating £1,000 plus Gift Aid (in up to four payments of £250). Members receive the following special benefits:

- Opportunity to buy ticket (seat already reserved) on one of the first trains hauled by No. 2007 *Prince of Wales*
- Reasonable access to No. 2007 at all times
- First choice of components to sponsor as a Dedicated Donation
- Special supporters' day with *Tornado*
- Exclusive certificate signed by the design team of David Elliott, Daniela Filová and Martin Shepherd
- A limited-edition injectors coaster
- Invitation to a steam test of the new injectors.

43 members so far, with over £40,000 already pledged

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More bronze components cast

James May and the Slacking Cock Flange

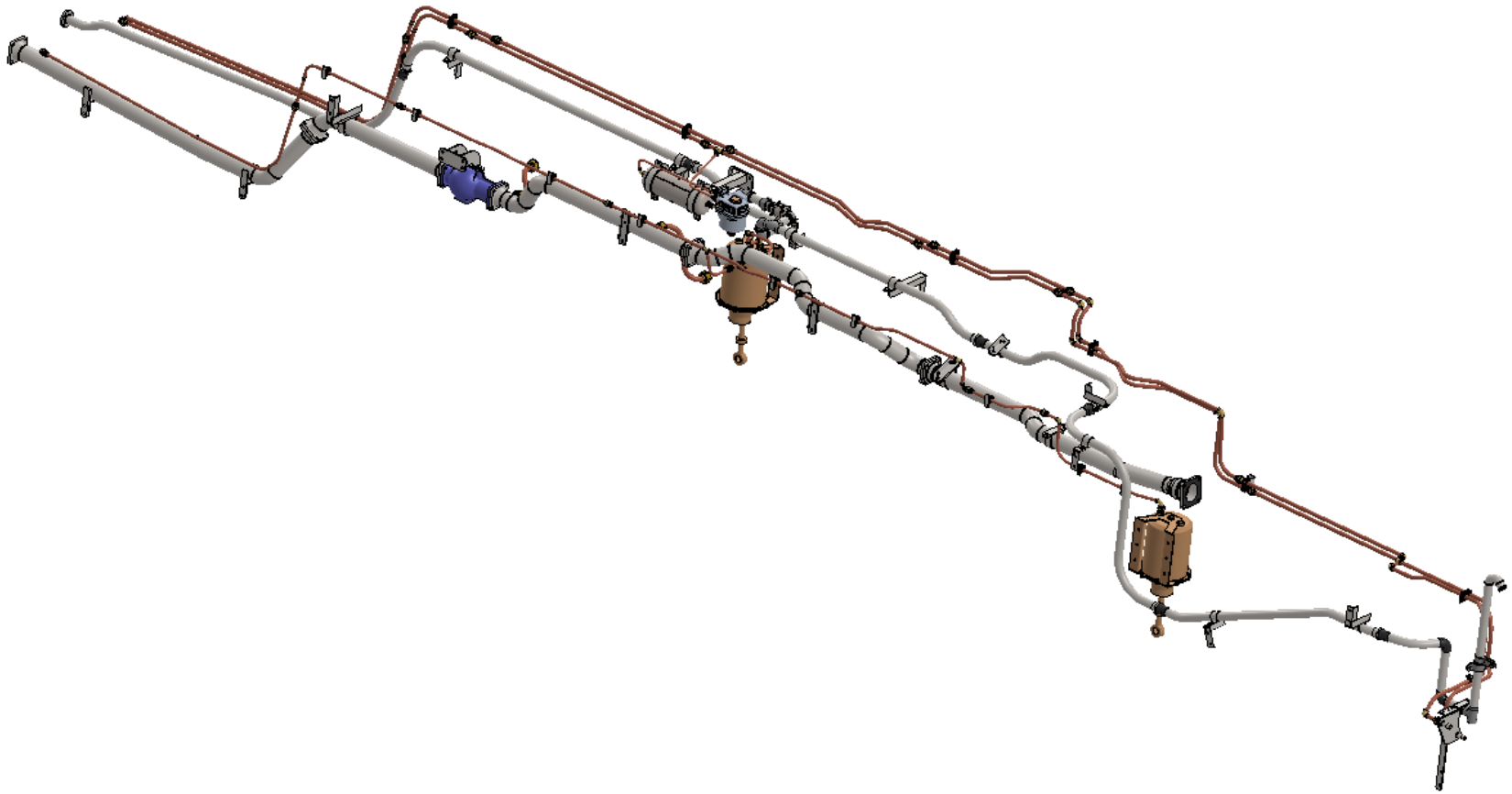
James May visited Darlington Locomotive Works to make another piece of the locomotive – the "Slacking Cock Flange"

79

James May's "Slacking cock flange"

80

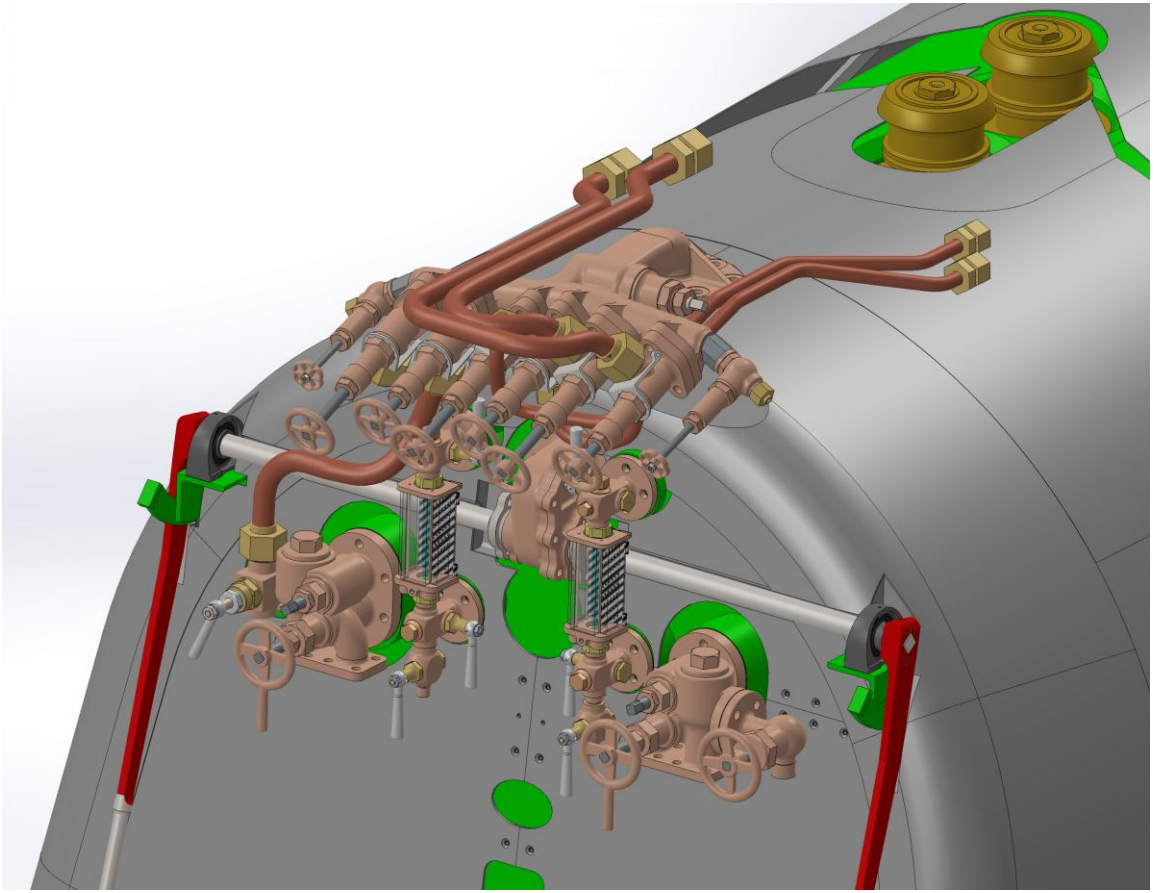
Some of the pipework



81

Backhead fittings and pipework

- Steam stand installed on boiler, valves modelled and fitted to stand.
- Water gauges, combined steam and delivery, and blower valves installed on boiler.
- Pipes to air pumps and turbogens routed



Building Britain's Most Powerful Steam Locomotive

Boiler and cladding

The Boiler Club

- Boiler and associated systems will cost around £600,000
- We are seeking at least 300 people each donating £2,000 in up to 40 payments of £50pm by standing order
- Special benefits for members of The Boiler Club:
  - Reserved seat on No. 2007's first main line train
  - Reasonable access to No. 2007 at all times
  - Opportunity to join one of the teams building No. 2007 and first choice of other components to sponsor
  - Exclusive Boiler Club badge and limited edition version of the first official painting of No. 2007 *Prince of Wales* with No. 60163 *Tornado*
  - Special Boiler Club day with *Tornado.*

Boiler finished ready to deliver

268 members so far, with over £500,000 already pledged

84

Boiler design

- Use of diagram 118A *Tornado* boiler with detailed modifications to improve overhaul life
- Interchangeable with *Tornado* boiler
- *Tornado* boiler is 16.5in shorter than P2 boiler – smoke box extended within cladding
- 250psi retained to improve economy and increase maximum power

85

Boilers Ordered!

Following a competitive tender two boilers were ordered from Dampflokwerk Meiningen (where *Tornado*'s boiler was built)

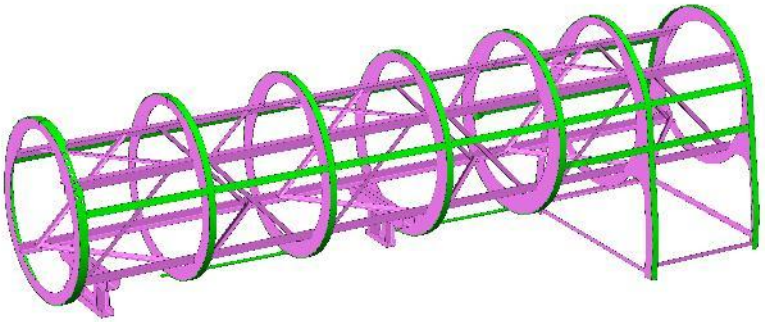
The first expected to be delivered by the Autumn of 2025.

The second boiler should be delivered in 2026.

A spare boiler will dramatically shorten the overhaul duration for both locomotives.

86

Cladding Jig

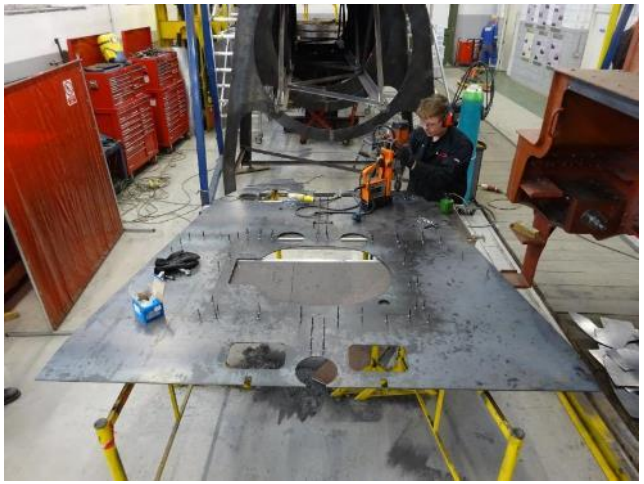


87

Making cladding parts

Cleveland Bridge apprentices assist with rolling cladding sheets

Virgin Trains apprentices bending cladding frame angles



Another Virgin Trains apprentice drilling holes to assemble backhead cladding

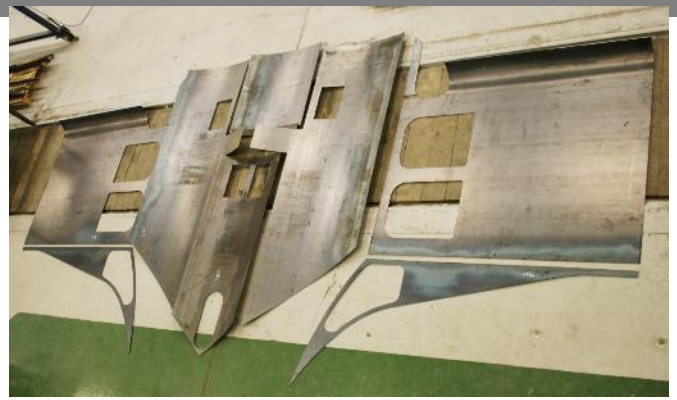
Cladding

89

Building Britain's Most Powerful Steam Locomotive

Cab

Cab

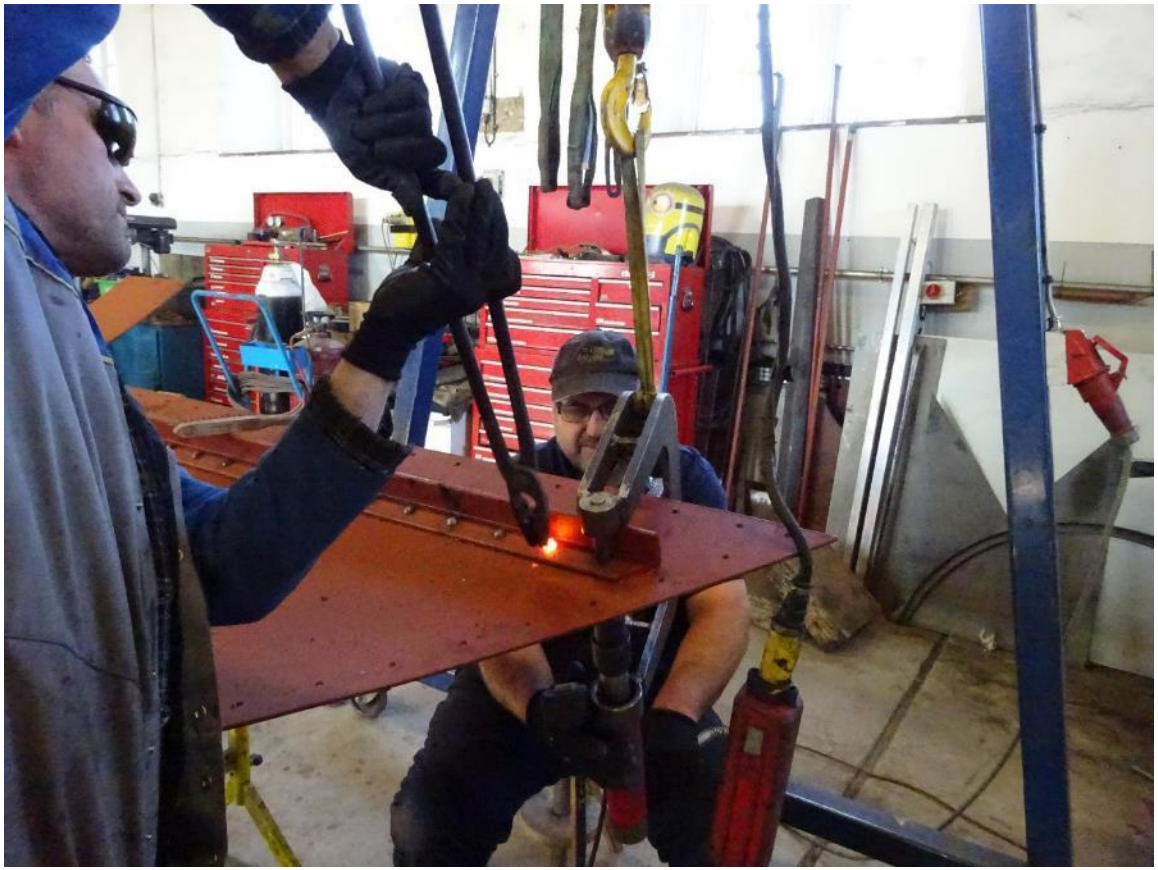


With the delay to the wheelsets, cab construction was brought forward. Cab was trial fitted to the frames

91

Cab

The cab is dismantled, all parts grit blasted and primed, and permanent riveting of the roof carried out using our specially made rivet squeezer.



92

Cab

The beading on the back edges of the cab is made from 2in x 1in rectangular bar with a 5mm thick spacer turned to round to make 2in half round beading.

93

Cab

Beading is formed by blacksmithing and a large amount of propane gas!

Beads are fitted to cab sides using recessed bolts which are welded over afterwards.

94

Cab

The cab is refitted to the frames to check that it is in gauge – it is!

The air brake equipment cubicle is fitted to the lower sides of the cab.

95

Building Britain's Most Powerful Steam Locomotive

Wheelsets

Ride Feasibility study

- The original P2s gained an adverse reputation and history records that they were rebuilt into 4-6-2s
- The reputational issue of track spread in depots is a sensitive issue in the modern railway era
- Very little technical evidence (basically none!) to research these issues
- A very different starting point compared to the A1 for gaining acceptance on today's railway.

60163 TORNADO

New Steam for the Main Line

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3403 HIGHLANDER

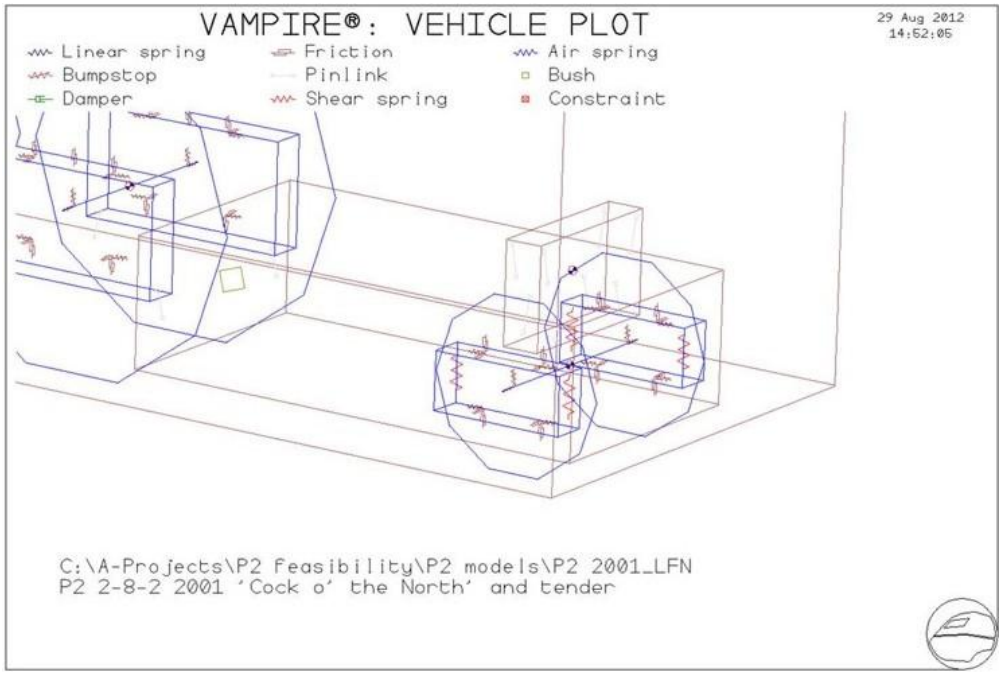
Recreating Gresley's last design

Fully instrumented – *Tornado* at 60mph on the GCR

98

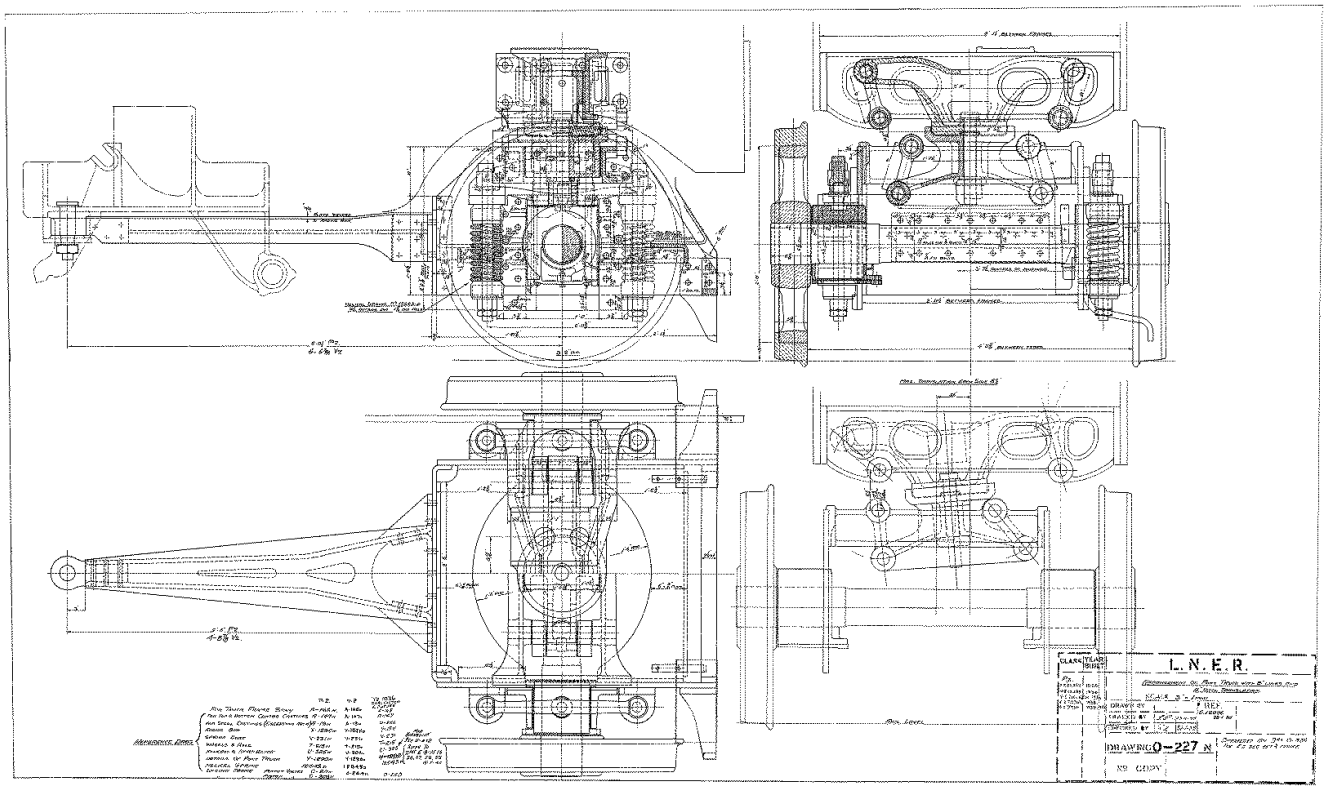
Feasibility study – apparent performance

- The ride performance of the P2 as originally built (No. 2001) is worse than *Tornado* – but not by as much as might have been expected
- The ride performance of a P2 with a spring control pony truck (No. 2007) is better than No. 2001 – and has the potential to be as good as the A1.



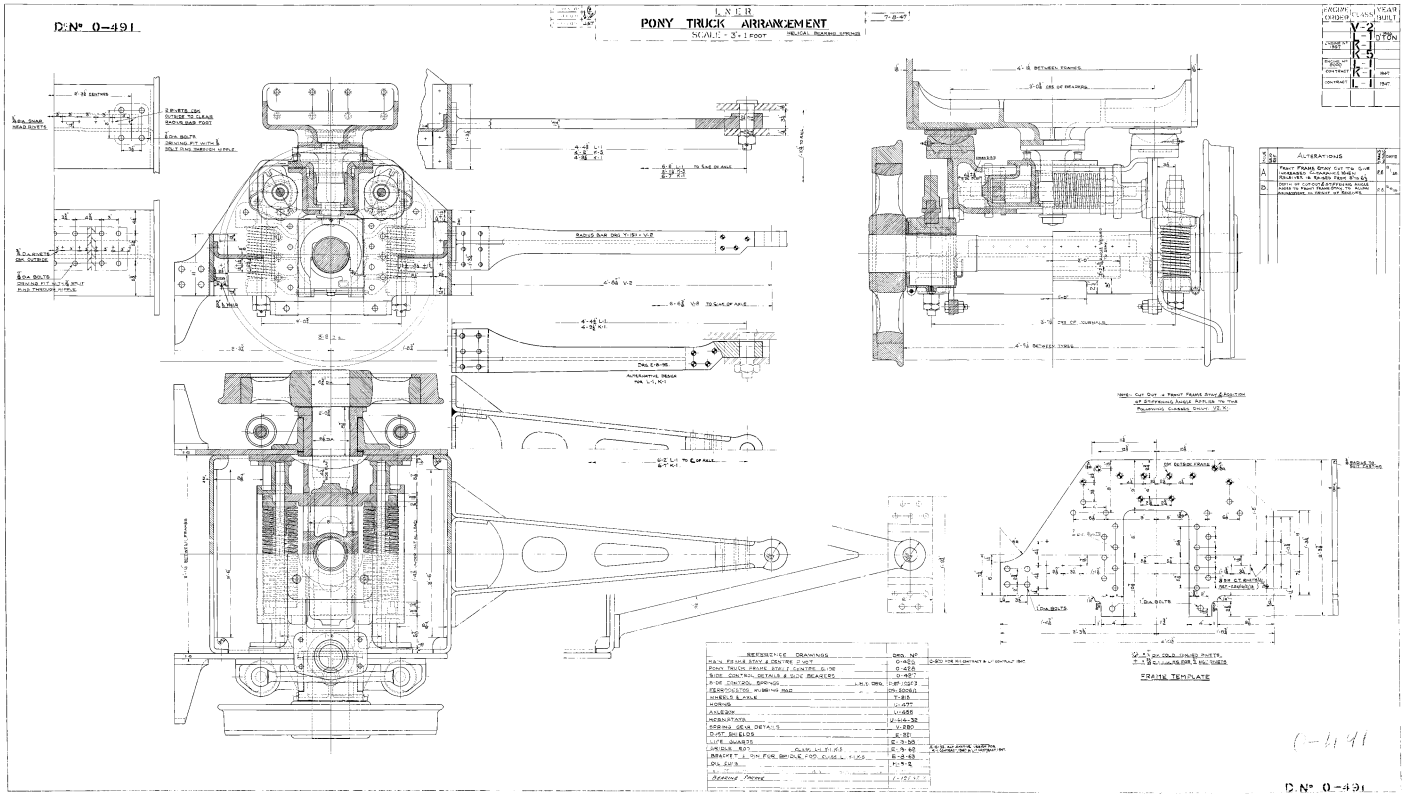
P2 pony truck as the LNER originally built it

- Research into P2 (and V2) incidents
- Technical details extracted and sent to Deltarail.



Post war V2 pony truck

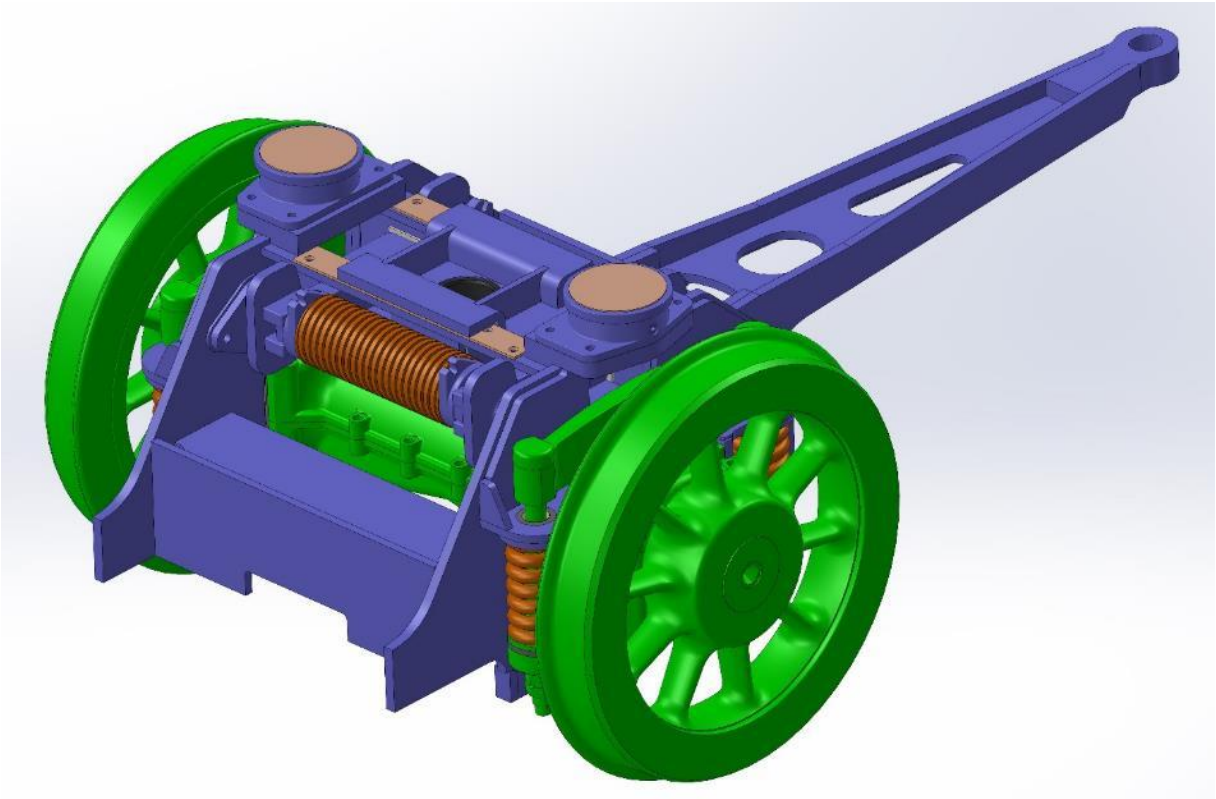
Following several derailments due to poor track condition during WW2, V2 locomotives had swing link pony trucks replaced with spring side control trucks.



101

No. 2007 pony truck solution

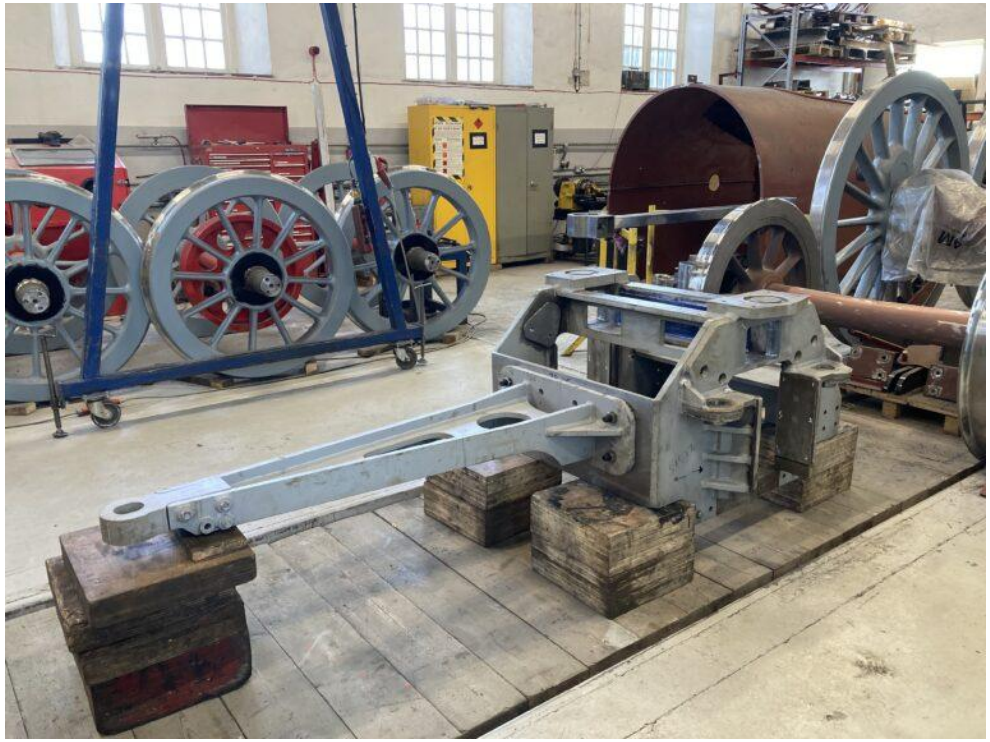
Further modification of V2 design for greater side travel and use of roller bearings



102

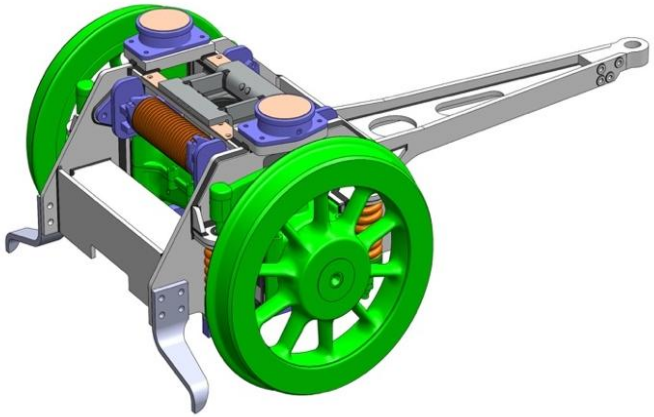
No. 2007 pony truck completed

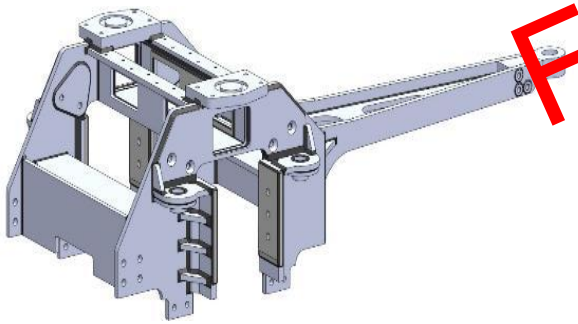
The pony truck frame has been delivered to Darlington Locomotive Works (DLW) following its fabrication by North View Engineering Solutions (NVES) in Darlington.



103

The Pony (Truck) Club – launched April 2020





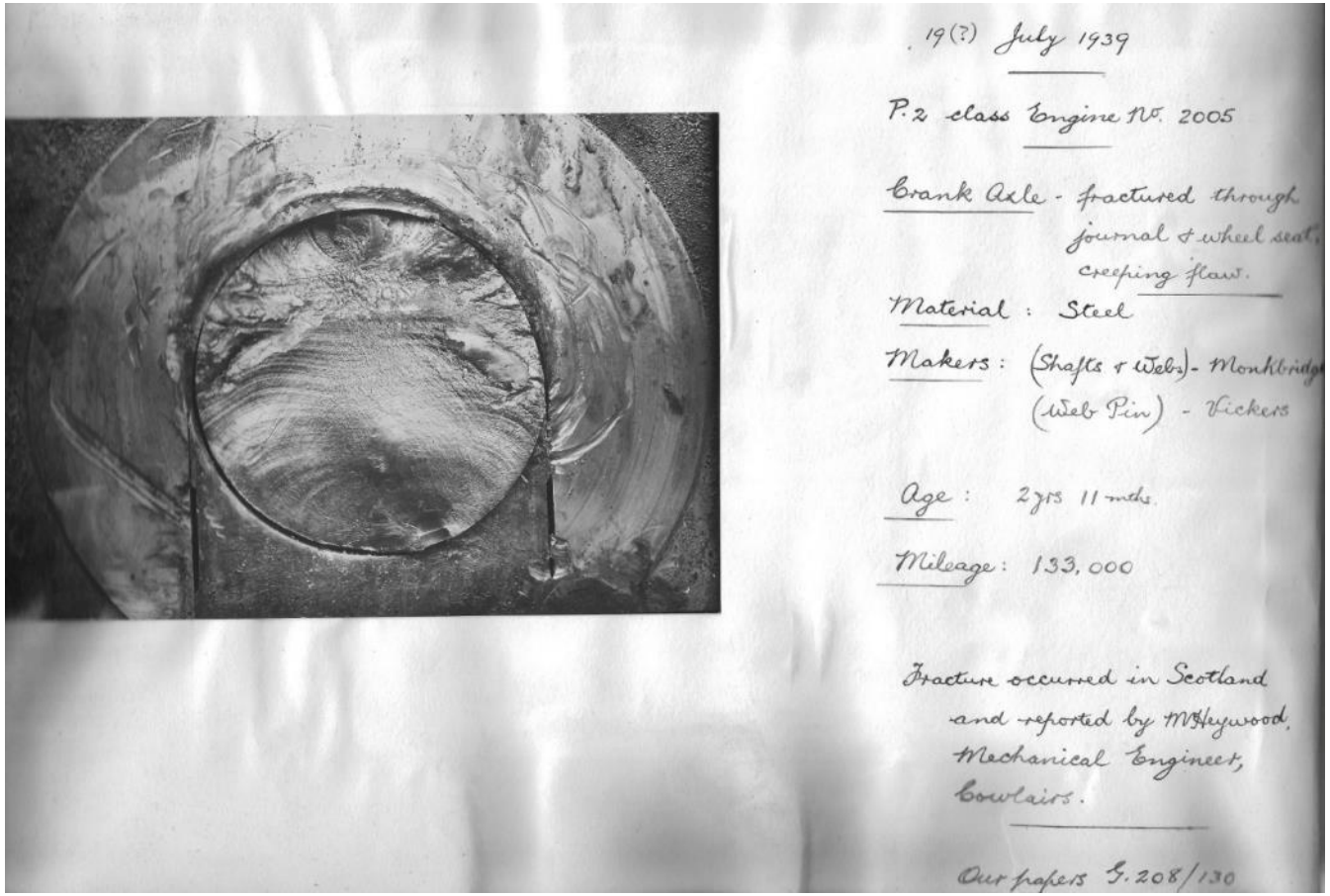
- The first of our new mini-clubs
- Assembling the pony truck will cost around £20,000
- We are seeking 20 people each donating £1,000 (plus Gift Aid) in up to four payments of £250pm by standing order
- Additional donations will be used to fund certification-related costs

FULLY SUBSCRIBED!

30 members, with around £36,000 pledged

104

A design issue – crank axle



19(?) July 1939

P.2 class Engine No. 2005

Crank Axle - fractured through journal & wheel seat, creeping flaw.

Material : Steel

Makers : (Shafts & Webs) - Monkbridge
(Web Pin) - Vickers

Age : 2 yrs 11 mths

Mileage : 133,000

Fracture occurred in Scotland and reported by W Heywood, Mechanical Engineer, Cowlairs.

Our papers S.208/130

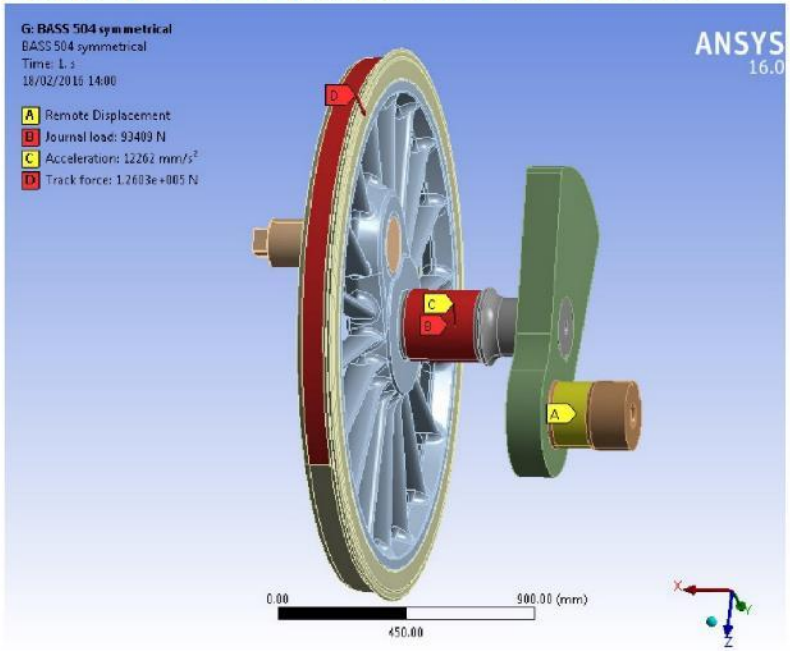
Crank axle – the problem

- Five crank axles known to have broken in a class of six locomotives in less than ten years
- Design was same as crank axles on Gresley Pacifics
- Two possible causes identified:
  - Higher piston forces with P2 class (larger cylinders)
  - Eight coupled engine less likely to slip at high starting tractive effort
- Proposed solution based on Timken axle design for A1 class modified to incorporate BR BASS 504 principles.

106

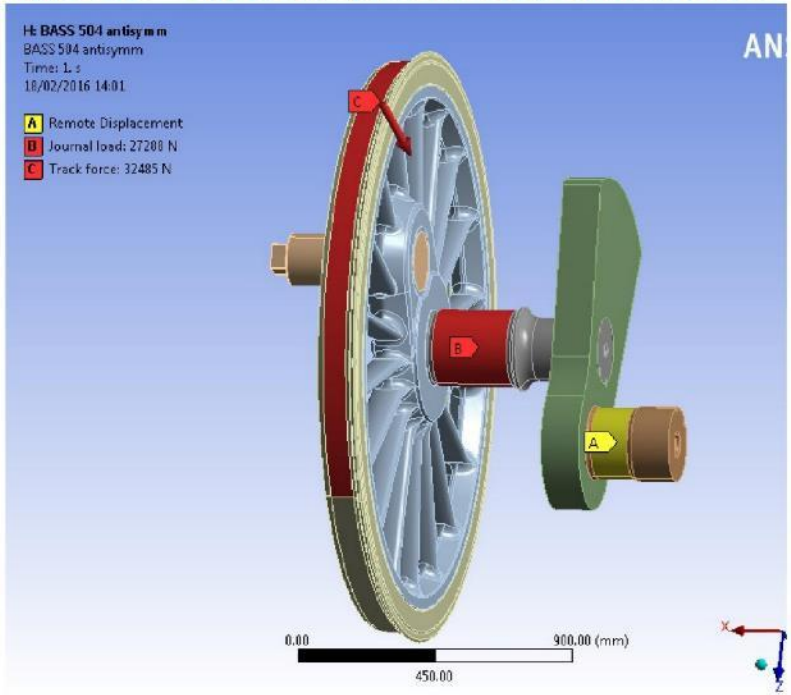
Crank axle – Mott MacDonald FEA study

Figure 2.8: BASS Symmetric loads and constraints



Source: ANSYS Workbench Full Model

Figure 2.9: BASS Anti-symmetric loads and constraints



Source: ANSYS Workbench Full Model

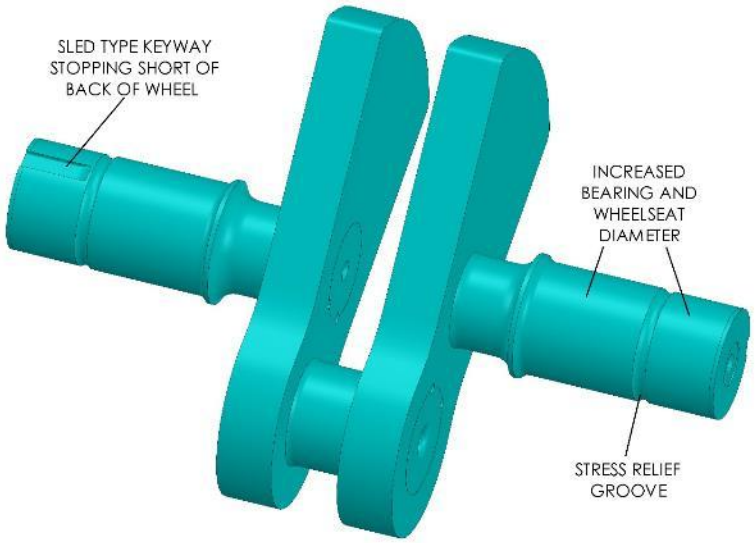
Original design

Modified Timken design

107

Crank axle – the solution

- Current practice BASS 504 design used for axle/wheel interface
- Strongest available A4T axle material used instead of standard A1T
- Wheel and bearing seats increased by 3/8in in diameter
- Crank sweep material upgraded from EN8 used on *Tornado* to EN19 (approx. 25% stronger with improved fatigue performance)
- The solution provides a crank axle with a life well in excess of the 250,000 miles at which LNER/BR renewed them.



108

The Mikado Club

- Wheeling the engine will cost around £200,000
- We are seeking at least 160 people each donating £1,000 (plus Gift Aid) in up to eight payments of £125pm by standing order
- Special benefits for members of The Mikado Club:
  - Reserved seat on No. 2007's first main line train
  - Reasonable access to No. 2007 at all times
  - Exclusive Mikado Club badge
  - Opportunity to join one of the teams building No. 2007
  - First choice of other components to sponsor
- Special limited edition version (signed/numbered) of Stephen Bainbridge's new painting of No. 2007 *Prince of Wales* at Darlington station
- Special Mikado Club day with *Tornado*

FULLY SUBSCRIBED!

Extended to 200 members to wheel tender!

200 members, with around £250,000 pledged

109

From 3D models the driving wheels are cast

110

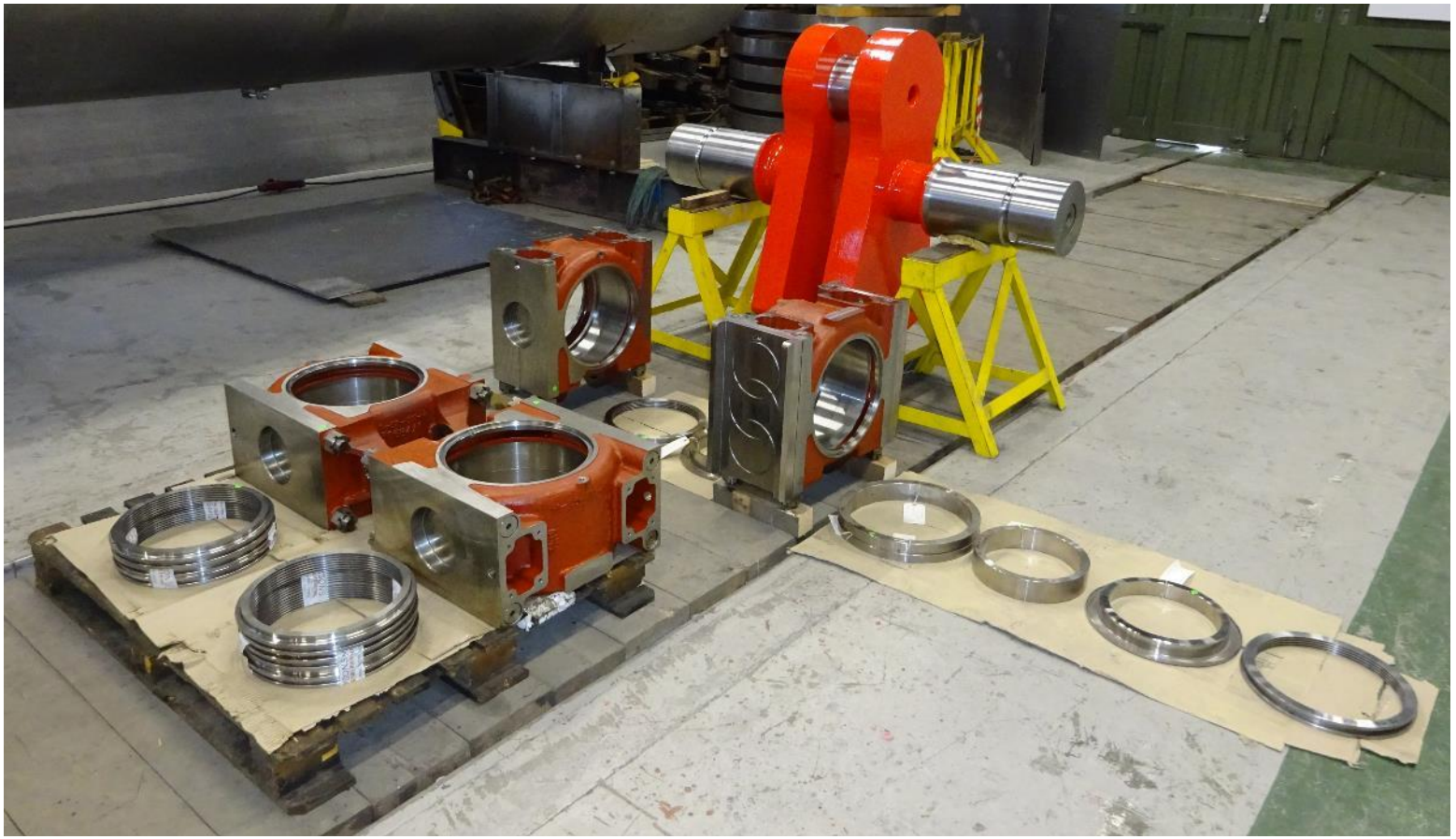
A full locomotive set of wheels

111

Crank Axle at Buckfastleigh

112

Completed crank axle and axleboxes



113

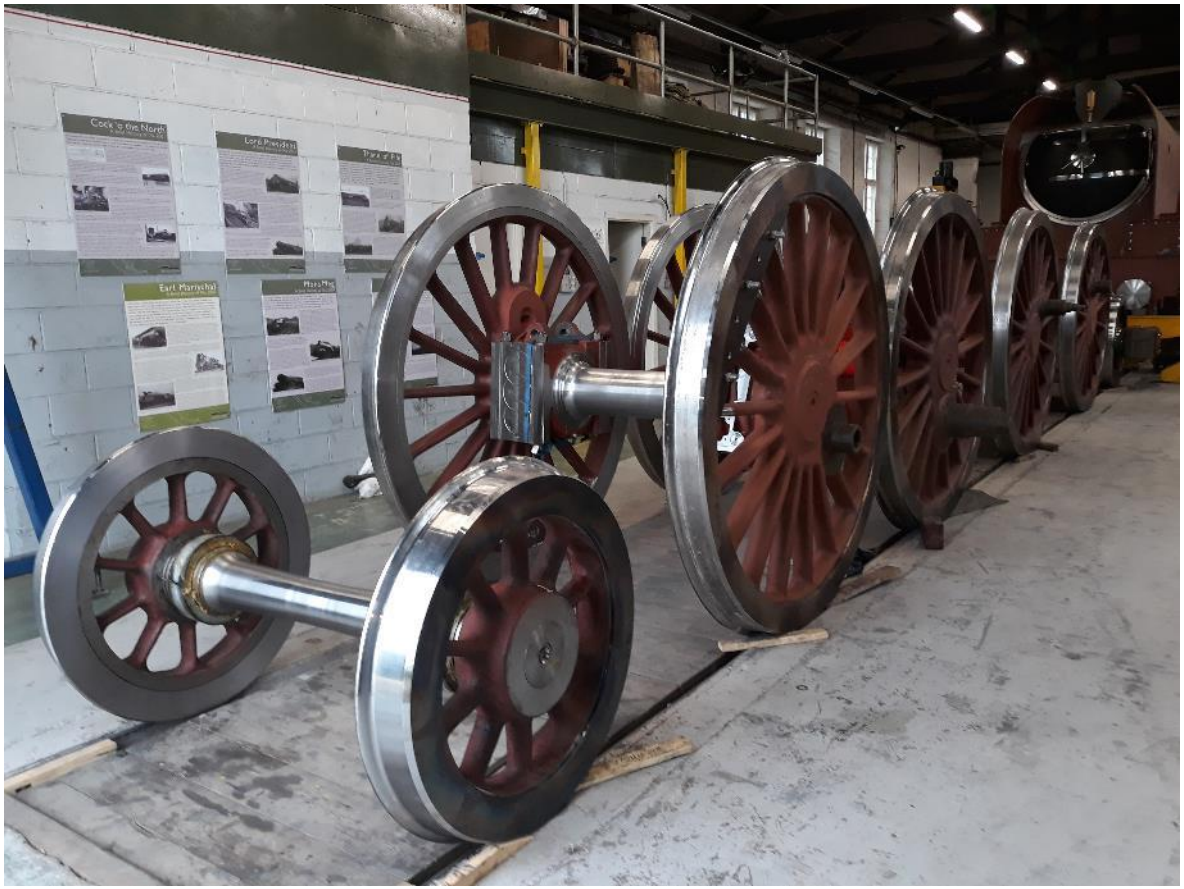
Wheel Pressing at Buckfastleigh

114

Wheelset assembly

115

A full set!



Balance weight manufacture

117

Tender wheelsets

118

Building Britain's Most Powerful Steam Locomotive

Motion

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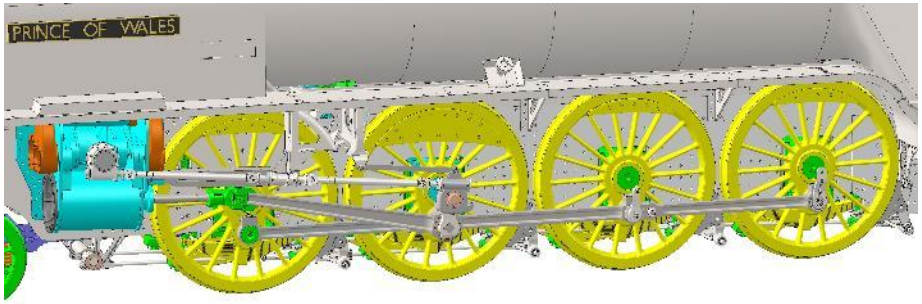
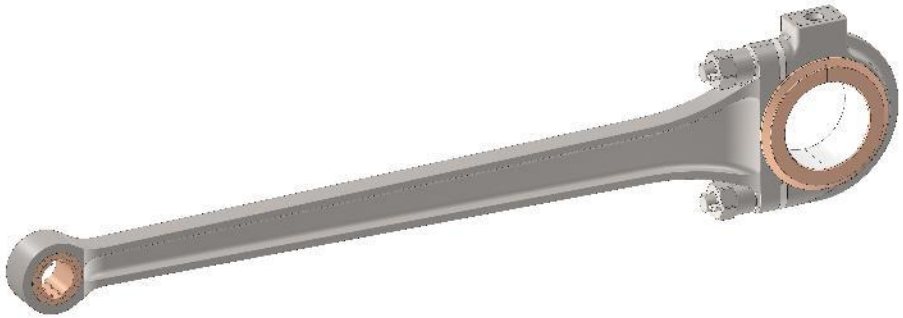
3403 HIGHLANDER

Recreating Gresley's last design

The Motion Club – Launched in April 2018





- Manufacturing the motion will cost around £210,000
- We are seeking at least 175 people each donating £1,000 (plus Gift Aid) in up to eight payments of £125pm by standing order
- Special benefits for members of The Motion Club.

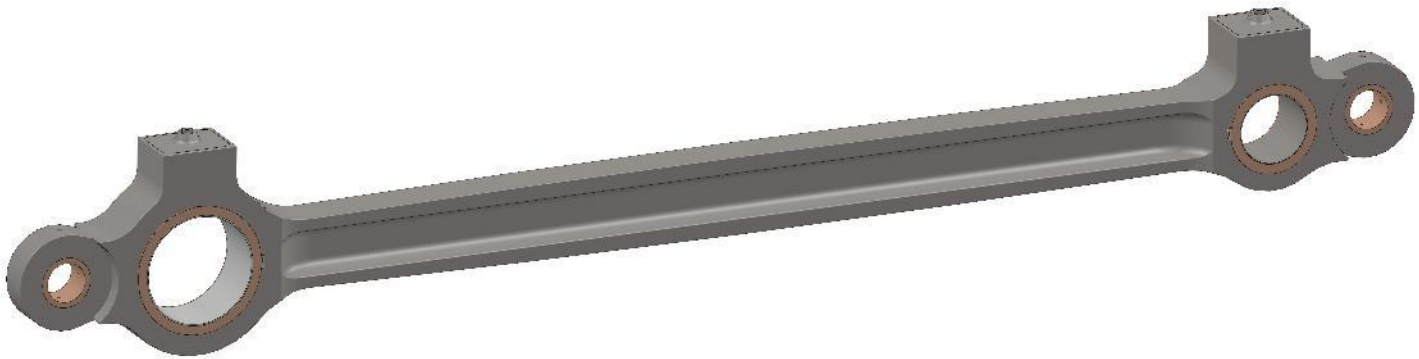
All motion now made and machined!

Initial 175 members reached, with over £200,000 pledged, now closed

120

Motion

- The coupling and connecting rods on the original P2 were of a lightweight design using high tensile nickel chrome steel. These proved to be prone to fatigue fracture
- The rods for No. 2007 are based on the post war design for the A1 class using a durable manganese steel and incorporating BR standard rod bushes.



121

Motion progress

Arthur Stephenson Engineers at Atherton have forged and machined a full set of heavy motion

122

Coupling rod forgings

Building Britain's Most Powerful Steam Locomotive

Electrical systems

Electrical Team

- Core A1 electrical team of Rob Morland and Paul Depledge are on board for the P2
- We have taken on Alan Parkin to help with electrical design

125

Electrical System Principles

- Based on the successful A1 electrical system
- Dual redundant power supplies and electronic battery management
- Steam turbine and axle-driven generators
- Structured trunking system for wiring
- Military components for maximum reliability.

126

Auxiliary Lighting System

- As with the A1, all the lighting will be LED
- The A1's instrument and frame lighting has worked well and we'll be installing similar systems on the P2
- There may be some additional innovations – you'll have to wait and see what these will be!

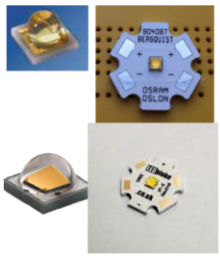
127

Head, tail and marker lamps

- The P2s had distinctive headlamps with a flared hood around the front lens
- We have made replicas of these lamps and fitted new LED luminaries inside
- The P2s didn't have Stones marker lamps, so we need a combined head, tail and marker lamp within the same housing
- On the rear of the tender we'll fit recessed marker/tail lamps and lamp brackets for headlamps if needed on preserved railways.

Head, tail and marker lamps

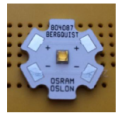
White high power leds



Oslon SSL80
80CRI 3000K warm white
Luminous flux @ 25°C / 350mA: 76-97lm
Should be 127-160lm @ 700mA
Might not really be good to 1A
Measured die size 1.25mm x 1.2mm
Beware poor quality from offset silicone lens (Roberts)
80°fwhm so good for marker for use with TIR or alone

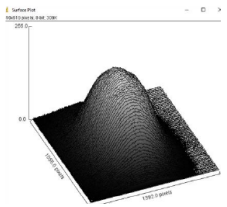
CREE XP-G2 (*XT-E star shown*)
Luminous flux >200lm @700mA
Choose variant carefully
Measured die size 1.4mm square (accurately centred to silicone lens)
120°fwhm so good for use with reflector not alone)
(ledbloke)

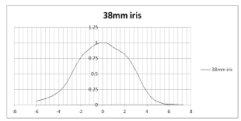
Headlamp 76lm Oslon SSL80 with 38mm Ledil Iris



80CRI 3000K
Luminous Flux @ 25°C / 350mA: 76-97lm
Can drive to 1000mA

Spot 150mm at 132cm scanned 5.95° fwhm 4.2° >70% pk
7963cd just one
So three would be 23889cd
Need 70000cd at centre
136lm measured at one optics yesterday for 1A
113lm today for 0.7A (should be 127lm according to spec)
this is very low compared to spec!?

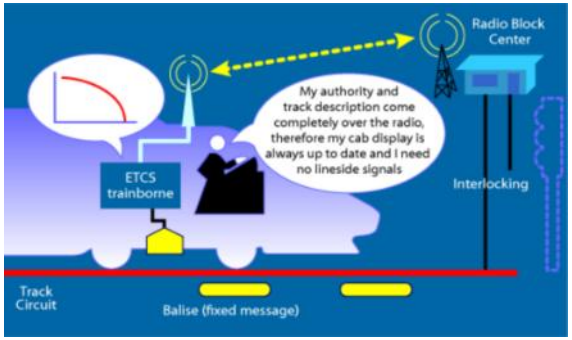


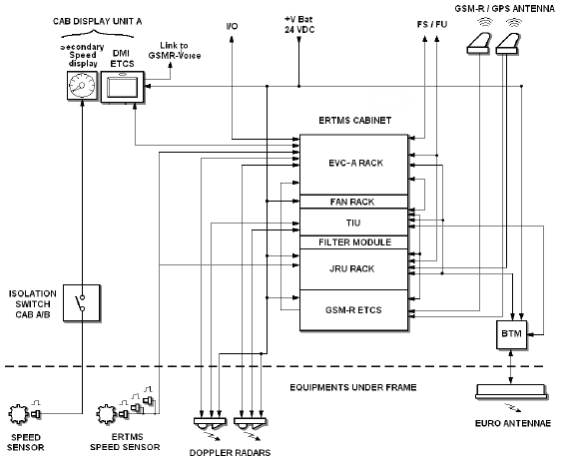


129

Control, Command and Signalling

- AWS/TPWS, OTMR and GSM-R radio as on the A1
- GPS tracker for operating statistics
- European Rail Traffic Management System (ERTMS) from new:
  - cab-based signalling system
  - common design for A1 and P2
  - will be proven first on the A1
  - can be used first on GW main line
  - and will be needed on ECML from ~2020
- Member of the Network Rail ETCS Heritage Stakeholder Group
- Feasibility study completed, no show-stoppers
- Talking to suppliers about equipment sponsorship.

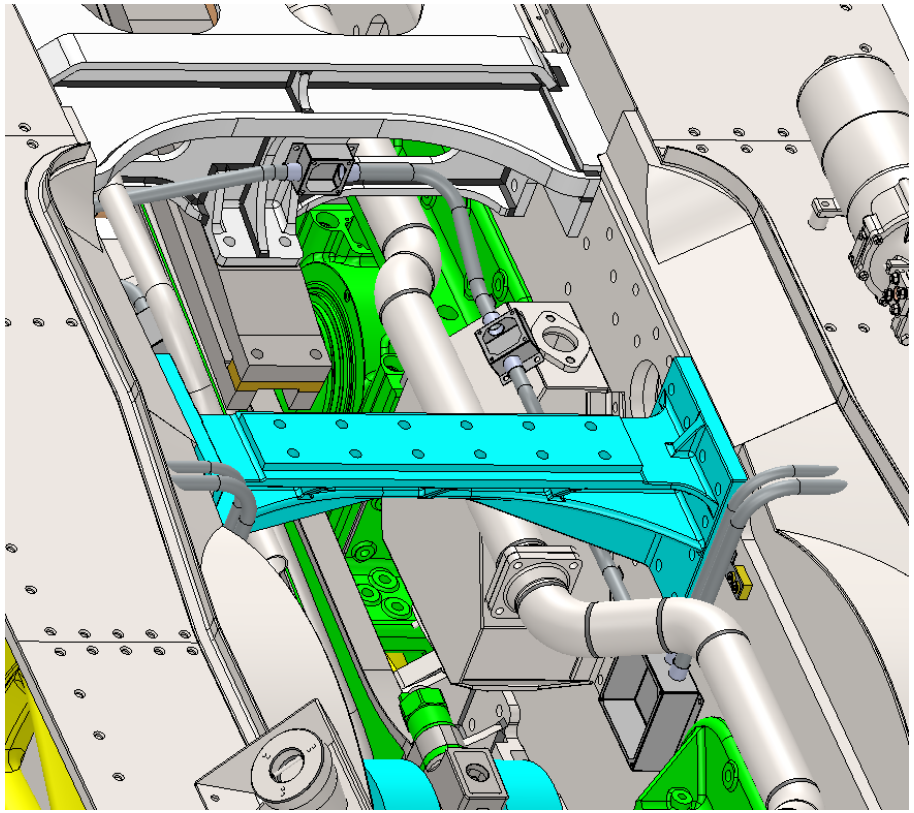




130

"Current" progress

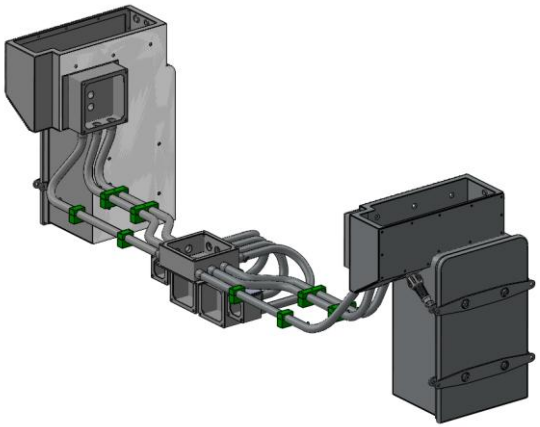
New turbine wheel

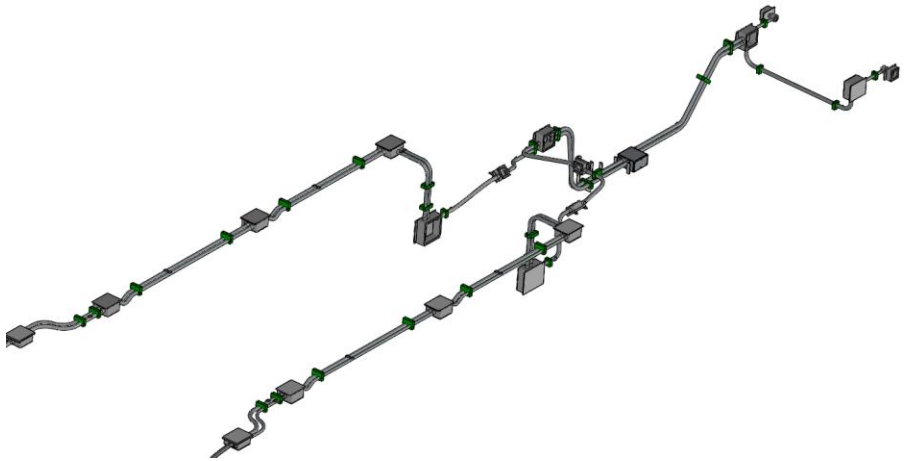


Electrical, steam and vacuum pipework

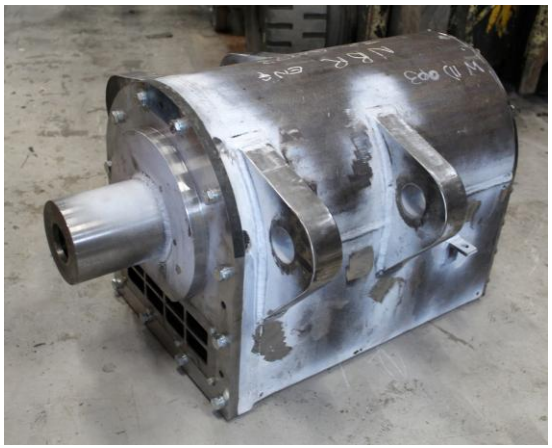
131

Structured Trunking and Alternator



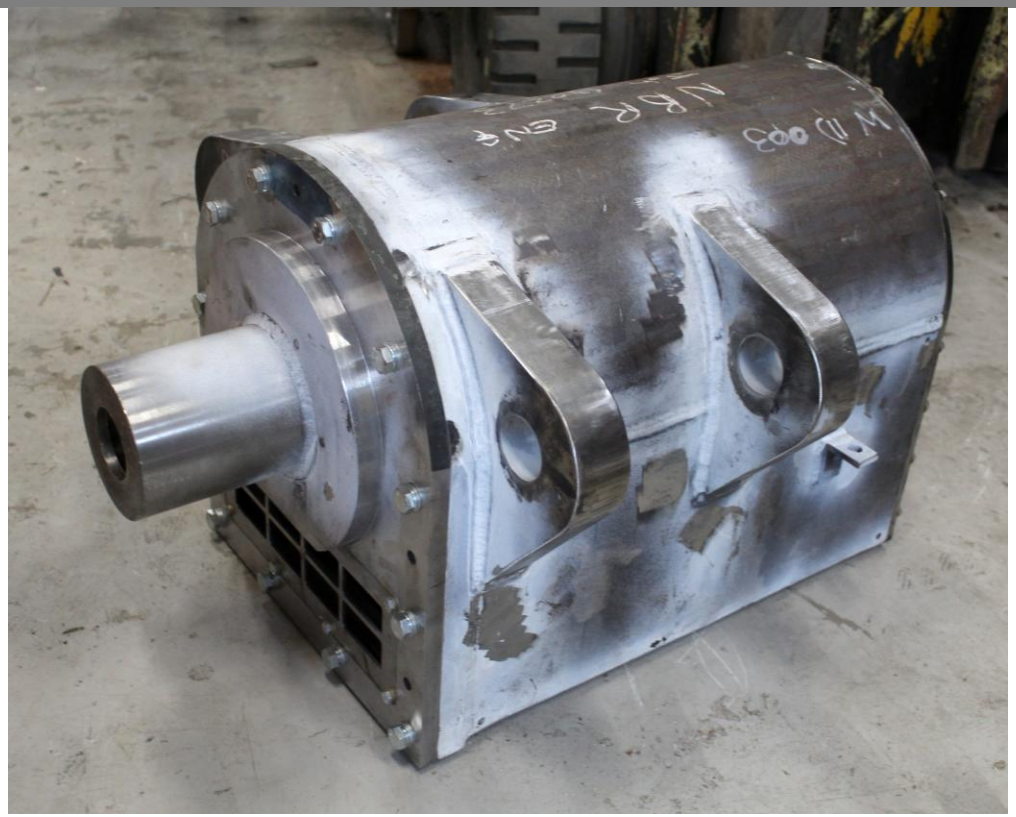


New axle driven alternator casing



- Design of trunking system broadly complete
- Trunks run from front to rear of engine
- Main junction area above battery box with cabling up to cab or to rear of engine for tender connections

"Noo Noo"



New axle driven alternator casing

133

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New Steam for the Main Line

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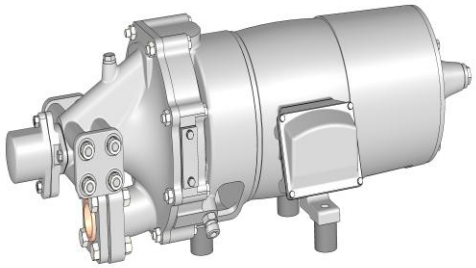
3403 HIGHLANDER

Recreating Gresley's last design

The Turbogen Club – launched June 2020



- The second of our new mini-clubs
- Overhaul of each turbo-generator will cost around £40,000
- We are seeking 40 people each donating £1,000 (plus Gift Aid) in up to four payments of £250pm by standing order
- Additional donations will be used to fund the second turbo-generator

40 members achieved, and is now closed

134

Building Britain's Most Powerful Steam Locomotive

Tender

60163 TORNADO

New Steam for the Main Line

2007 PRINCE OF WALES

Building Britain's Most Powerful Steam Locomotive

3403 HIGHLANDER

Recreating Gresley's last design

The Tender Club – Launched in April 2019

Constructing the tender will cost around £450,000

We are seeking 250 people each donating £1,500 (plus Gift Aid) in up to 15 payments of £100pm by standing order

- Special benefits for members of The Tender Club.

Tender now trial assembled

121 members so far, with around £180,000 pledged

Tender progress - frames

Frames under construction at I D Howitt, Crofton

137

Tender progress – frames completed

138

Tender frame parts

Front drag box

Spring hanger brackets

139

Tender Tank Construction – North View Engineering

140

The P2 Support Coach Appeal – launched August 2020

- Overhaul and conversion of E35457 to No. 2007's support coach will cost around £100,000
- We are seeking 100 people each donating £1,000 (plus Gift Aid) in up to eight payments of £125pm by standing order

65 members so far, with around £70,000 pledged

141

Targets for last 12 months

- Pony truck complete – now undergoing certification studies.
- First boiler delivered, P2 boiler substantially complete – first boiler expected autumn of 2025, second boiler 2026
- Tender structurally complete – tank complete, wheelsets complete, frames delivered end of 2024
- Electrical trunking approaching completion – materials delivered, most components made and formed, installation on frames started
- Brake linkage complete – almost all made/delivered, delay with 6 brake block hangers
- Pipework layout complete, installation well under way – detailed design (apart from cab) complete, materials about to be ordered
- Heavy motion fully delivered, coupling rods fitted – all completed.
- Cylinder block fabrication nearing completion – 3D design complete, detailed drawings complete and ordered. Castings by William Cook and fabrication by Howco at Irvine, Scotland now complete with liners fitted. Final machining now completed.
- Valve gear in manufacture – 3D design complete, detailed drawings to follow on from cylinder block

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Now for what we have done!

- Accommodation bogies
- Tender tank
- Tender wheelsets
- Tender frames
- Boiler and superheater
- Additional machining of cannon boxes
- Cylinder drain cock gear
- Spring gear
- Moved DLW to new works
- Fittings
- Brake gear
- Pony truck
- Motion
- Completion of engine frame structure
- Progress with electrical design
- Completion of sander design
- Progress with axle driven alternator
- Manufacture of detail components
- Completion of cylinder block 3D design
- Progress with valve gear
- Student training and experience

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Next 12 months

Pony truck complete and certified for use

First boiler delivered, second boiler complete

Tender structurally complete

Electrical trunking approaching completion

Brake linkage complete

Pipework layout complete, installation well under way

Heavy motion fully delivered, coupling rods fitted

Cylinder block installed

Valve gear in manufacture

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Other ways of raising the money

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Our Growing List of Sponsors

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York EMC Services

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Principal Sponsor

WILLIAM COOK CAST PRODUCTS

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Legacies

- Major UK charities raise around 40% of donated income from legacies – the equivalent at least £200,000pa for the P2 Project
- Legacies could go on to fund No. 2007's five-yearly overhauls
- New legacy scheme launched for *Tornado* in 2014 and planned for *Prince of Wales* in 2017
- Around 30 pledges signed for *Tornado* and Trustees leading by example
- Major legacy of £500,000 for *Tornado* from Mr Peter Haddon of Rearsby, Leicestershire in 2012/13
- All legacies 'hypothecated' to follow the donor's wishes
- 'Ashes to Ashes' ceremonies.

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Other sources of funds

- Loan finance
  - Bond issue of up to £2m over 15 years to be launched if necessary
  - Other bridging loans as necessary
- Grants
  - Development aspect of the project gives more scope than with *Tornado*
  - Grant giving bodies "missed out" on *Tornado*
  - Apprenticeship route looking increasingly attractive.

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Some help from our friends

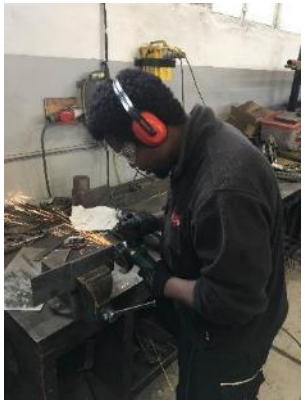
Michael Olley and
Simon Nadolny

LNER

LONDON NORTH EASTERN RAILWAY

cleveland

Michael Spence and Jack Morton



Ondre Brooks

150

Links with Royal Navy

HMS Prince of Wales crest

The other Prince of Wales!

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Future developments:

Darlington Locomotive Works

Old Home – Darlington Locomotive Works

Thanks to Darlington Borough Council for an 'Arthur' rent - Peppercorn

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The Vision

- Long standing vision of the Trust for a larger facility
- Key requirements
  - Main line connected
  - Space for building, overhauling and stabling simultaneously
  - More access for supporters and those wishing to learn
- Desirable requirements
  - All on one site
  - Ability to run over ¼ mile or more
  - Space for a turntable and carriage shed.

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Aerial view

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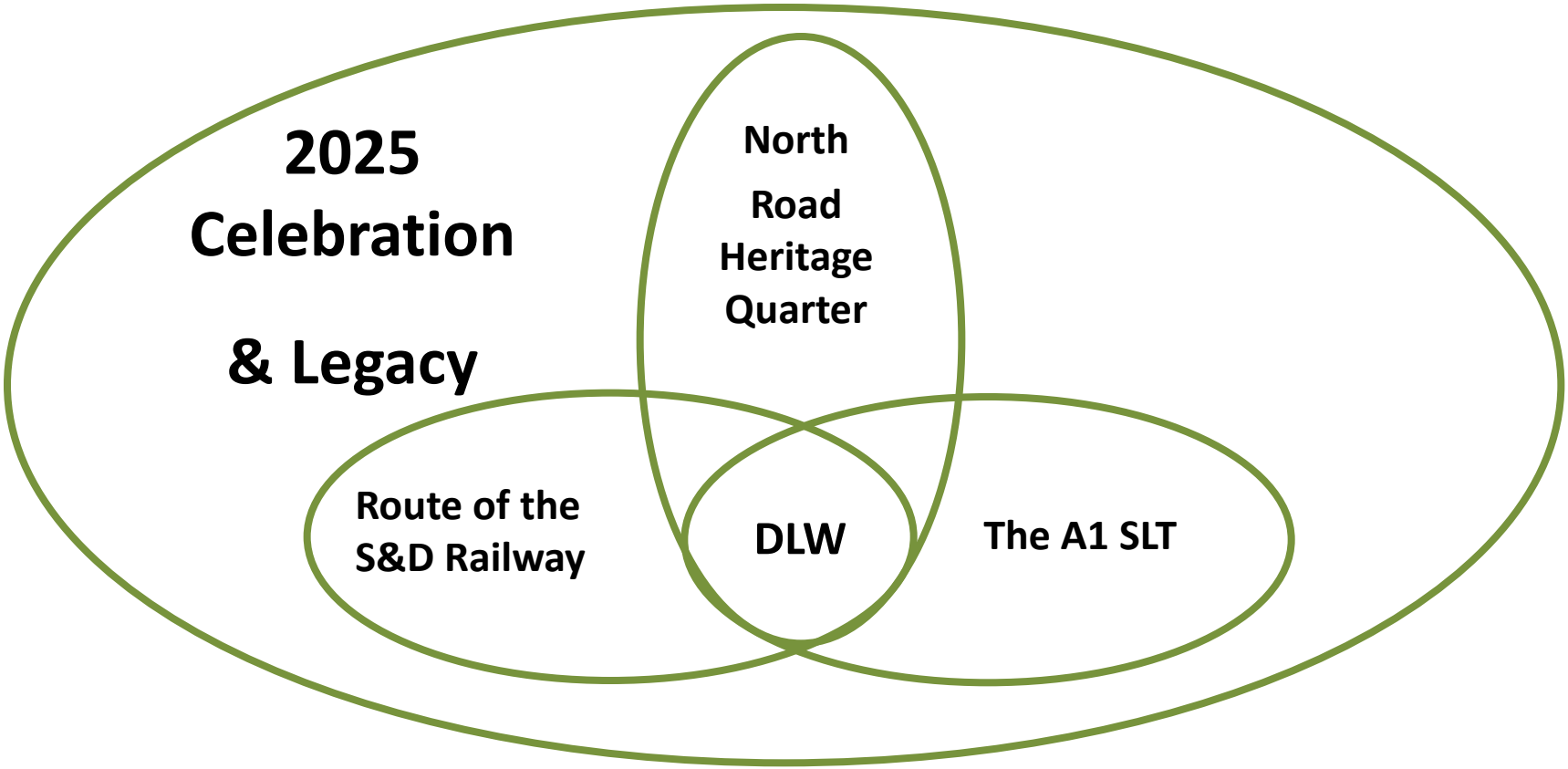
'DLW 2' – At the heart of the 2025



156

Indicative layout

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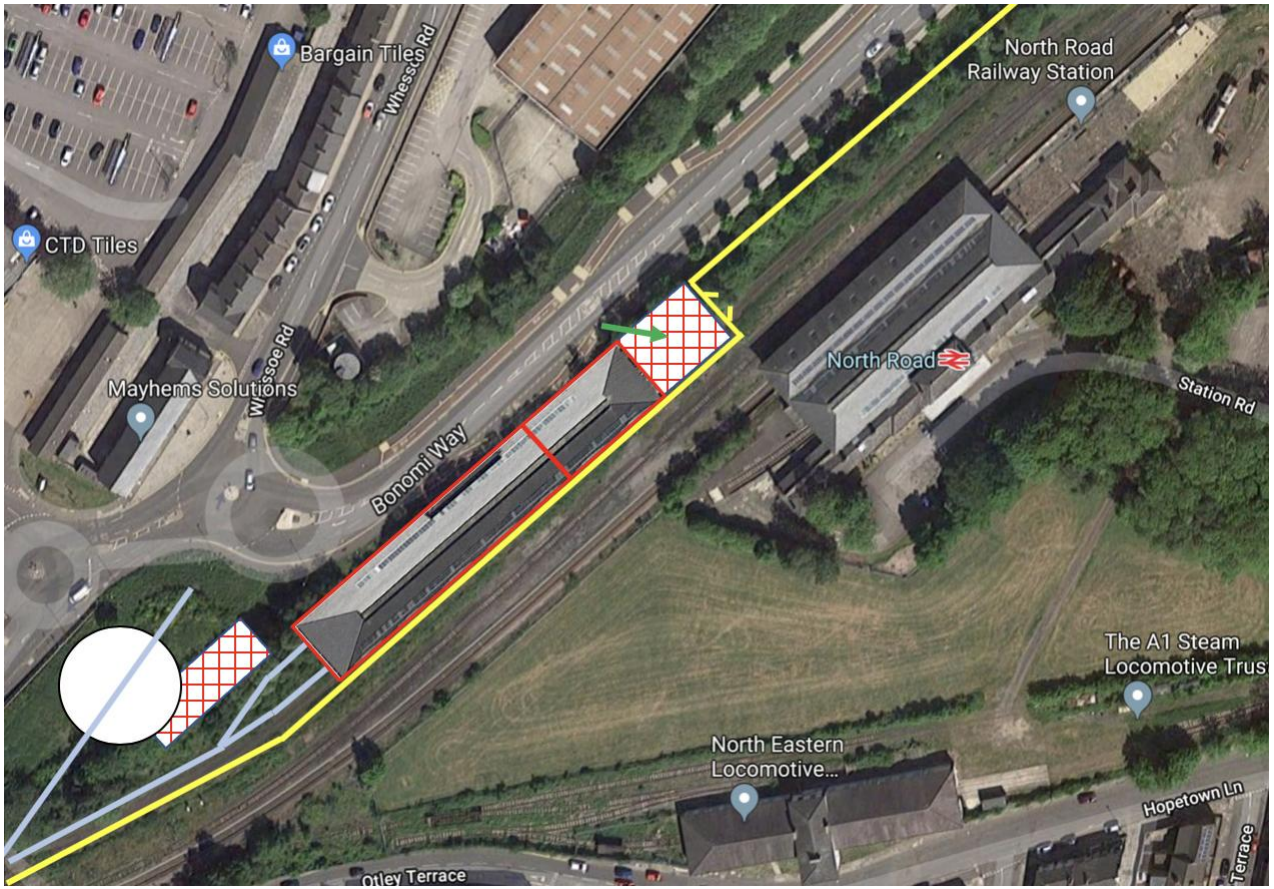
Will it actually happen?



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Ground clearance started

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Building work started

Building work progress

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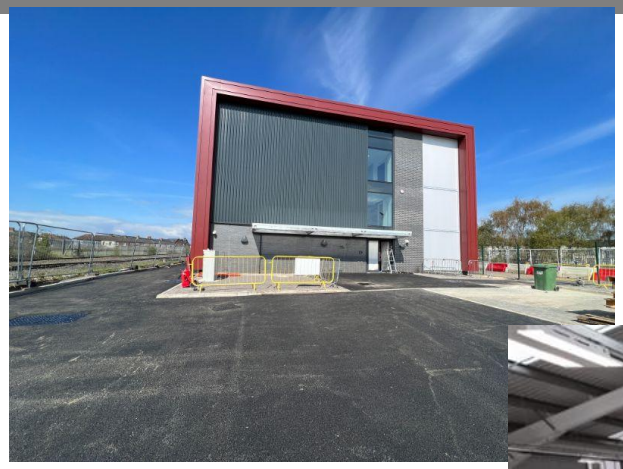
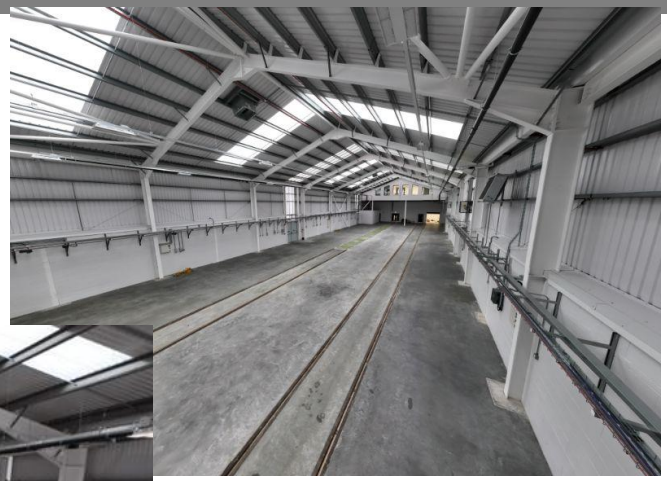
The finished Works





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Main line connection – Why?

1. A main line connection will allow both No. 60163 *Tornado* and, on completion, No. 2007 *Prince of Wales* to return to DLW for stabling and maintenance between operations on the main line, thereby reducing the requirement for road haulage. The constant movement of large steam locomotives on the back of road vehicles is not conducive to their health given the unnatural stresses placed on the frames from the loading and unloading process

2. The main line connection directly onto the Bishop Auckland branch, on the route of the original 1825 Stockton and Darlington Railway, will allow DLW to offer servicing facilities for other locomotives visiting the area. This would be a commercial activity, generating income for the Trust, and also positively impact on local tourism.

3. The Trust would be able to offer live steam experiences at the Works.

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Main line connection – Progress Ballast

To complete the task, we require a total of 6,000 tons. By the end of February 2025 we had bought 2000 tons.

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Main line connection – Progress Track

Over the last couple of years we raised over £75,000 to allow the Trust to purchase of all the rails and sleepers required around the site. The Trust also acquired a number of points, or turnouts, that are no longer required by Network Rail. Our volunteers, with help from the Army, have been laying the ballast and track over the last six months and have completed it for the S&D 200 celebrations.

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Future developments:

Gresley class V4

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Our third locomotive – in pre-launch phase

Gresley class V4 design to be created in 3D CAD.

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What are we building?

- P2-style electrical system
- Air plus vacuum brakes
- All steel, all welded boiler with no thermic syphon
- 4,200 gallon tender
- Roller bearings
- As much detailed commonality as possible with A1/P2

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V4 – we already have some components!

V4 tyres with spare set of A1 coupled wheel tyres and chimney

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3

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Building Britain's Most Powerful Steam Locomotive

Future developments:

Lot 4, Lot 5 and …

Lot 4 - Gresley class V3 2-6-2T

Lot 5 - Gresley class K3 2-6-0

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Lot 6 – Gresley class J38?

Questions & answers

A GIANT RESURRECTED

No. 2007 PRINCE OF WALES IN DARLINGTON LOCOMOTIVE WORKS

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