

PROJECT
RESET



The LMS-Patriot Project

CREATING THE NEW NATIONAL MEMORIAL ENGINE



WELCOME TO THE 2021 ANNUAL GENERAL MEETING OF THE LMS-PATRIOT PROJECT

WILL THE LOCO BE FINISHED IN MY LIFETIME?

WHAT HAS HAPPENED SINCE 2019
THE CAUSES AND WHAT WE HAVE LEARNED
OUR PROGRAMME FOR COMPLETION

WHAT HAS HAPPENED SINCE THE 2019 AGM?



Work on Boiler and Tender ticking along nicely subject to availability of funds.

WE ARE WORKING BETTER TOGETHER

More frequent member communication

Improved internal liaison – regular monthly meetings with PRCLT

Improved cash flow forecasting

Learning from the A1 Trust

KEY CHANGES

Appointment of Ricardo as certification body

Risk assessment management

Understanding safety certification requirements

BUT...

CHASSIS ASSEMBLY PROGRESS AT WEST SHED
SEEMS TO HAVE GONE BACKWARDS

WE HAVE THE DRIVING WHEEL ISSUES TOO





WHY HAS PROGRESS SLOWED?

JOURNEY OF DISCOVERY SINCE AUTUMN 2019,
WELL BEYOND THE SCOPE OF OUR FIRST CONTRACT WITH PRCLT

Guided by the PRCLT detailed inspection of rolling chassis
January–September 2021

Guided by our certification body

A gradual process with limited resources in 2021
(Overhaul of No. 6233 February–October)

AN AUTUMN 2021 WATERSHED • WE KNOW WHERE WE STAND • BASELINE FOR PLANNING

MANY ISSUES TO FIX:

DRIVING WHEELS

BOGIE

MOTION

LUBRICATION SYSTEM

CHASSIS ASSEMBLY

(most components can be reused)

...and many more detailed points

BETTER TO KNOW NOW RATHER THAN MUCH LATER

WHAT WE ARE HAVING TO FIX?

ITEM	ACTION	CAUSE			
		DESIGN	MANUFACTURING QUALITY	ASSEMBLY QUALITY	UNUSABLE DONOR COMPONENTS
FRAMES/CHASSIS ASSEMBLY	Reassemble		●	●	
BOGIE	Redesign/Replace	●	●	●	●
DRIVING WHEELS	Replace/Repair		●		
LUBRICATION PIPING	Replace	●		●	
BRAKE HANGER BRACKET/CROSS SHAFT	Risk assess	○			
EXPANSION LINK BEARINGS	Replace			○	
REAR CYLINDER COVERS	Repair		○	○	
CYLINDER EXHAUST PORTS	Repair			○	
BRAKE CYLINDER TRUNNION BRACKETS	Repair			○	
HORN GUIDES	Repair		○	○	
ALL FRAME ASSEMBLY STUDS	Replace		○	○	
DRIVING WHEEL SPRINGS	Replace		○		
MOTION COMPONENTS (PART)	Repair/Replace		●	●	●
SPRING HANGERS	Replace		○		
OUTSIDE CYLINDERS	Modify	○			
REVERSER SHAFT (CENTRE)	Replace			○	
STEAM INJECTOR SYSTEM (LMS)	Redesign	○			
MECHANICAL LUBRICATORS	Redesign/Replace	○			○
BRAKING SYSTEM	Change of scope	○			
TENDER FRAMES	Reassemble/Repair			●	●
BOGIE AXLES AND WHEELS	Still to be tested				

ESTIMATED COST OF RECTIFICATION: £350,000–£400,000

CAUSES

MAJOR ASSEMBLY QUALITY ISSUES

MANUFACTURING QUALITY ISSUES

OUR DESIGN ASSUMPTIONS

OUR USE OF DONOR COMPONENTS

OUR OWN HISTORIC DOCUMENTATION AND QUALITY CONTROL SHORTCOMINGS

RECTIFICATION WORK PROGRAMME

PATRIOT PROJECT CAD PROGRESS						
Part number	Description	Quantity	Material	Faults identified	Rectification work	Material documentation to hand
Frame Arrangement						
MAIN FRAMES						
D30-11675-1	RH Main Frame	1	EN 10025-2 S355JO	Mill Scale on Frame surface	Remove parts and clean back Frame surface	
D30-11675-2	LH Main Frame	1	EN 10025-2 S355JO	Mill Scale on Frame surface	Remove parts and clean back Frame surface	
D30-11675-14	Stiffening Plate	2	S275			
Rivets		16	TBC	Specification	Check and replace if required	
D30-11675-27	Stiffening Plate	2	S275			
Rivets		14	TBC	Specification	Check and replace if required	
D30-11675-20	Cover Plate at Cylinders	1	S275			
Bolts			TBC	Specification	Check and replace if required	
D30-11675-30	Cover Plate at Cylinders	1	S275			
Bolts			TBC	Specification	Check and replace if required	
D30-11680 - LH	Life Guard - LH	1	S275			
D30-11680 - RH	Life Guard - RH	1	S275			
Bolts		8	TBC	Specification	Check and replace if required	
Buffer Assy	Buffers	2	Legacy	Refurbish		
Fixings	Bolts, Nuts	8	TBC	Specification	Check and replace if required	
BUFFER BEAMS						
D30-11675-3	Front Buffer Beam	1	EN 10025-2 S275JR	Check Frame surface.	Remove beam to check	
30-11665-6	Front Beam Vertical Angle LH Outside	1	RSA			
30-11665-6-RH	Front Beam Vertical Angle RH Outside	1	RSA			
30-11665-7	Front Beam Vertical Angle LH Inside	1	RSA			
30-11665-7-RH	Front Beam Vertical Angle RH Inside	1	RSA			
Fixings	Bolts, Nuts, Rivets		TBC	Specification	Check and replace if required	

Extract from master spreadsheet – faults identified and work required
Details by component for Frame reassembly – 50+ items

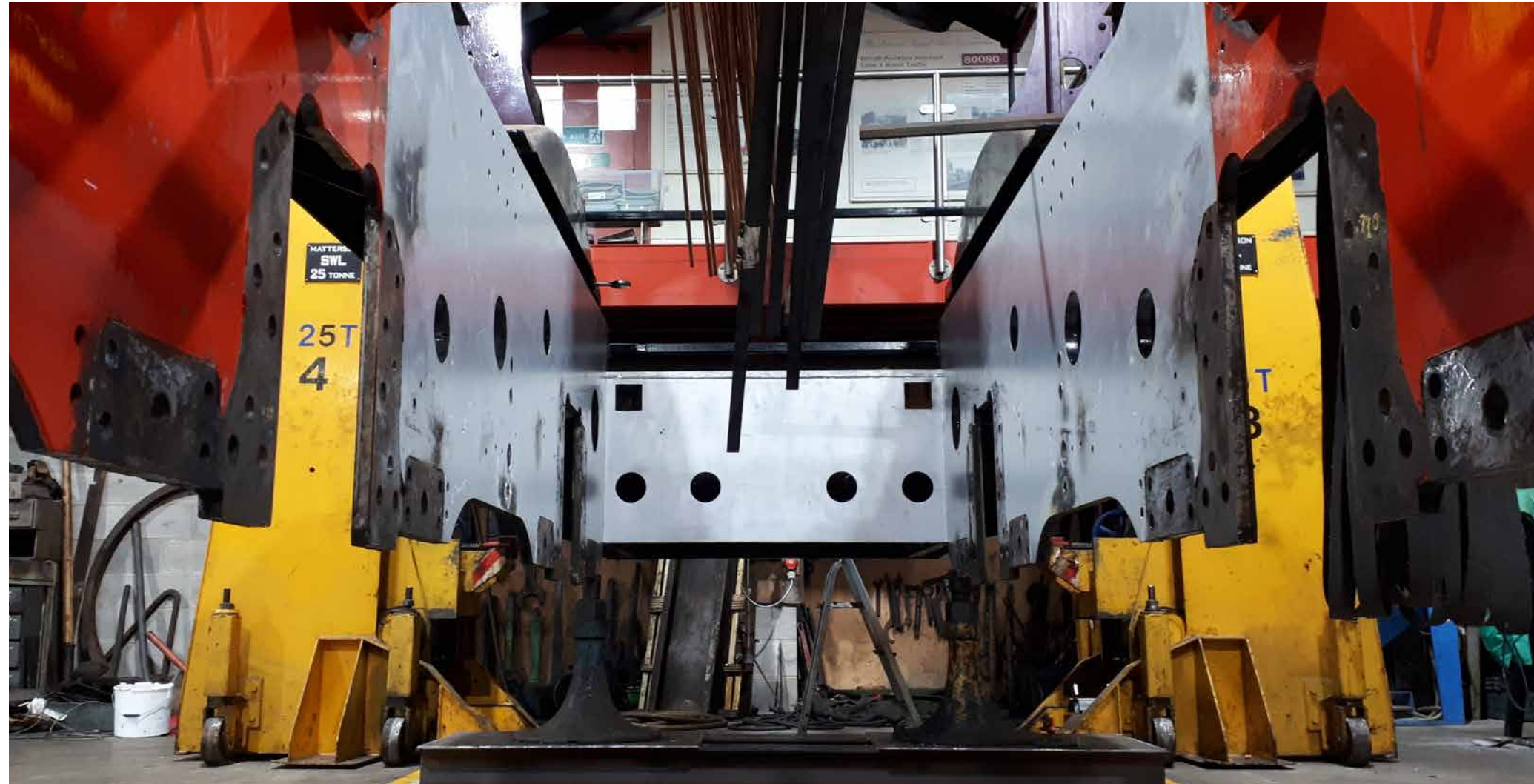
WHY ARE WE HAVING TO DO THIS?



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A large amount of parts we have had manufactured for 5551 are suitable for future use, although they may need a little detail work or some form of testing to confirm the material conforms to the required specification and provide the required documentation.

WHAT LESSONS HAVE WE LEARNT?

Engineering quality control and documentation

Rail industry certification requirements

Risk assessment

Contractor performance quality – unable to control historically

Donor components (tender, motion, 8F bogie parts, lubricator)

Forecasting realism

THE DRIVING WHEELS

Boro Foundry are cooperating with us in investigating the cause and the solution

Repairs would need to be acceptable in engineering and risk management terms

We have support from a metallurgist and our certification body in assessing what is proposed

We plan to make a decision on repair or replacement by January 2022

Project impact is included in programme

OUR PROGRAMME FOR COMPLETION – COST

Workstream	Estimated Expenditure
Total spend to date	£2,799,000
Spend to complete	£1,562,520
Locomotive Chassis	£658,760
Boiler (including estimate for tubes, backhead fittings and ashpan)	£268,000
Tender (including tank)	£80,000
Final Assembly (Boiler install, piping up, including TPWS, OTMR)	£555,760
Total Estimate	£4,361,520

Locomotive Chassis expenditure includes new driving wheelsets

An estimate has been made on all materials required to complete,
pricing is currently subject to fluctuation

Includes a budget of £170,000 for Ricardo Rail

KEY MILESTONES ASSUMING BEST CASE SCENARIO

December 2022 – Driving wheelsets complete

June 2023 – Frame rectification work complete, locomotive chassis rewheeled

December 2023 – Delivery of tender chassis to PRCLT for air brake fitting

December 2024 – Lubrication, braking systems and fitment of all motion to locomotive chassis complete

December 2024 – Boiler complete ready for installation to chassis

December 2026 – Completion



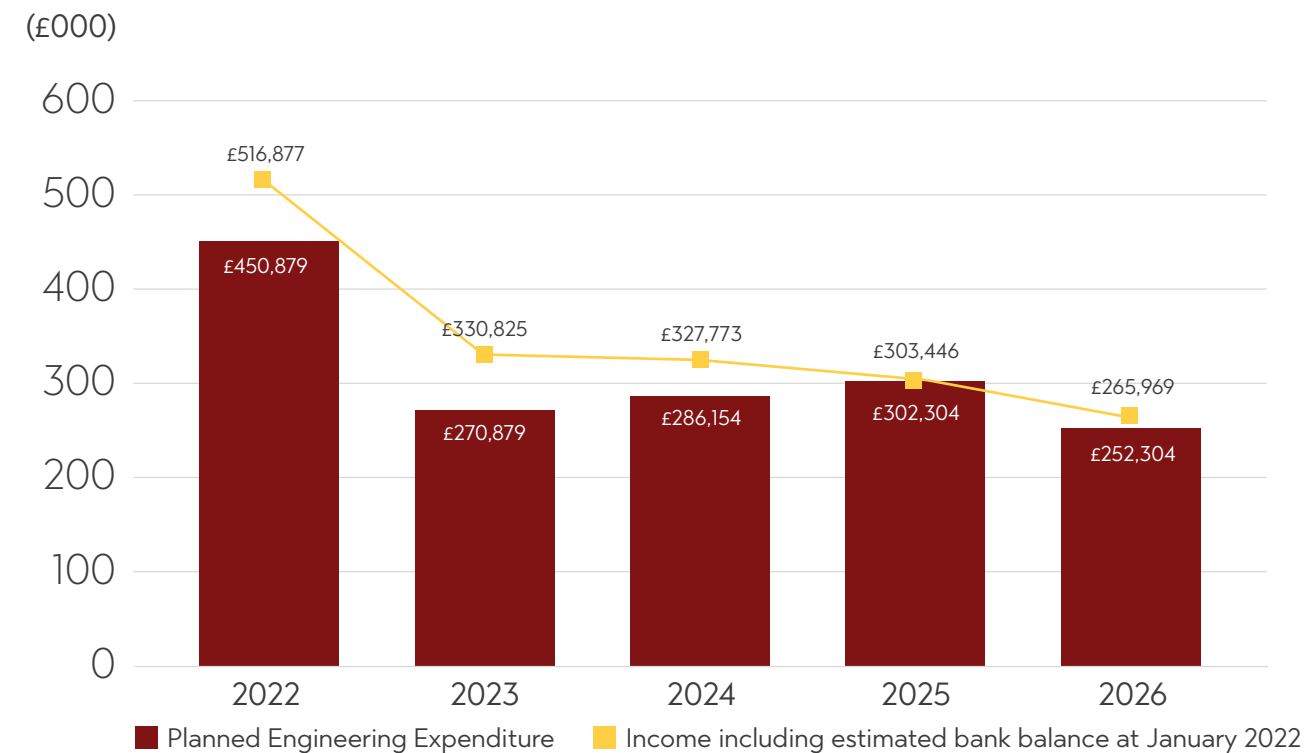
ASSEMBLY SCHEDULE 2021-2026

Item Ref.	Task Description	Start Date	Estimated Delivery/ Completion	Comments
1	Place order for Driving Wheel Repair/Replacement.	September 2021	May 2022	
2	Design and manufacture lubricators. PRCLT to machine.	September 2021	July 2022	
3	Remove inside cylinder.	October 2021	February 2022	
4	Outside Cylinder Remediation – weld guide bars in the valve chest	October 2021	December 2021	
5	Frame remediation – shot blasting, remove horn guides. Four stretcher bars. Outside motion brackets – front end and reassemble.	September 2021	May 2022	
6	Bogie wheels and 2 axles to be ultrasonically tested	January 2022	January 2022	
7	Motion: All legacy motion is to be x-rayed and inspected. Quotations are to be obtained to replace the following legacy parts: 1x left outside radius rod; and the connecting rod to ensure correct balance and even weight distribution with the existing new one. It is possible 2x outside combination levers, 1x outside union link will also be required subject to testing. All new motion components that have been cast and machined are to be stress relieved and case hardened if necessary. All substandard bushes fitted by Llangollen to be replaced.	November 2021	December 2022	
8	Order new fitted bolts (circa 300) – to be phased.	November 2021	June 2022	
9	Bogie: Offer bogie manufacture assembly out to tender (PRCLT to undertake axlebox machining).	December 2021	May 2022	
10	Place order for Driving Wheel tyres.	January 2022	May 2022	Currently 15 week lead time
11	Boiler backhead fittings: Design and order.	February 2022	February 2024	
12	Frame remediation – shot blasting, remove horn guides. Four stretcher bars. Outside motion brackets – rear end and reassemble.	February 2022	June 2022	
13	PRCLT to machine lubricators and complete lubrication pipework.	February 2022	August 2022	
14	Bogie: Evaluate tender returns and award manufacture. Delivery of bogie required before locomotive is lowered back onto its driving wheels.	March 2022	December 2022	
15	Machine wheels, fit axles, crank pins, tyres.	June 2022	September 2022	Duration to be confirmed – Riley and Sons.
16	Spring hangers and pins to be replaced.	June 2022	July 2022	
17	Manufacture replacement centre section of reverser and install. Outside sections to be retained.	June 2022	October 2022	
18	Weld, machine and fit new rear cylinder covers.	June 2022	August 2022	
19	Install main line running gear, TPWS, ERTMS.	June 2022	December 2026	
20	Install air brake system to locomotive chassis and tender chassis.	July 2022	December 2024	
21	Driving wheel axleboxes: remove existing white metal. Re white metal, bronze and machine.	July 2022	December 2022	
22	Injectors: deliver our exhaust injector to PRCLT from HBSS. Test that it is fit for purpose.	December 2022	December 2022	
23	Install driving wheels.	December 2022	December 2022	
24	Deliver tender chassis to PRCLT for air brake fitting.	December 2022	December 2022	
25	Machine and fit all motion bushes.	January 2023	June 2023	
26	Complete motion assembly and fitting to rolling chassis	January 2023	December 2023	
27	Obtain materials from Tyseley for the valves, pistons and crossheads. Machine and fit.	February 2023	December 2023	
28	Order/Fabricate ashpan.	October 2023	December 2023	

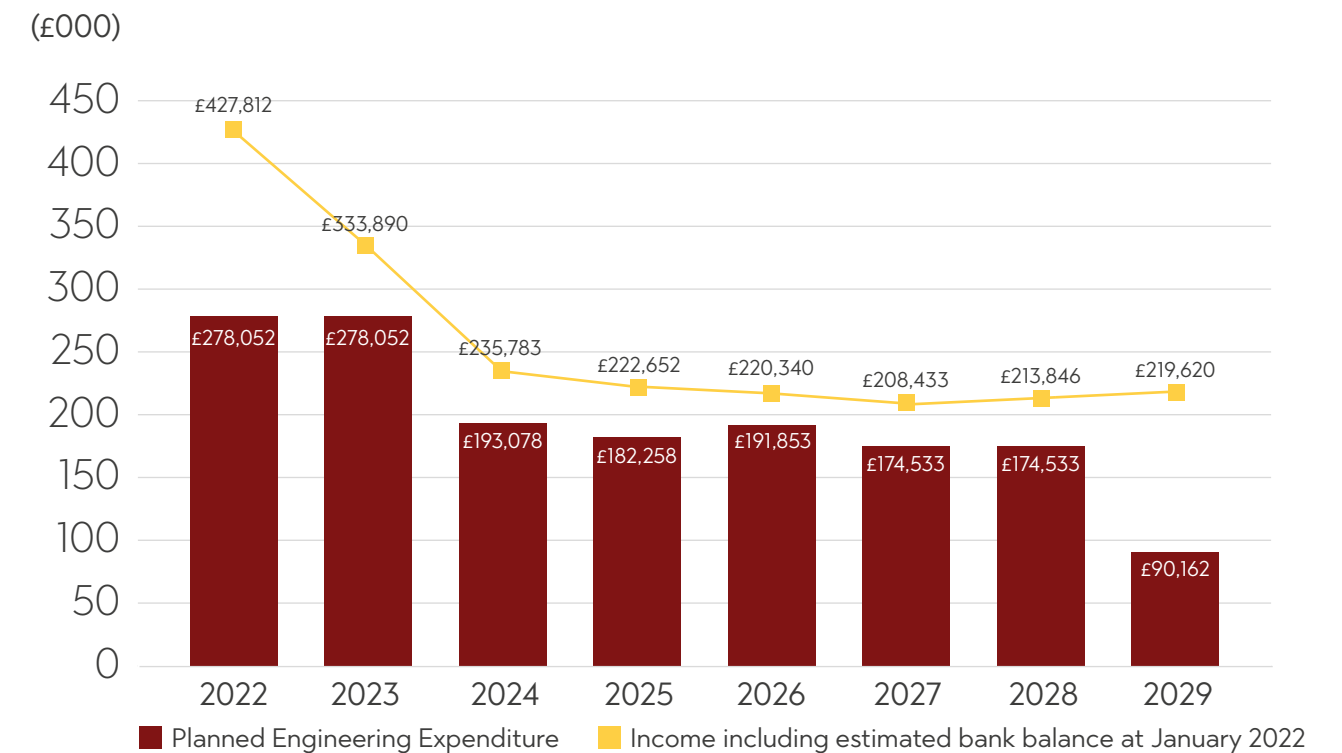
Item Ref.	Task Description	Start Date	Estimated Delivery/ Completion	Comments
29	Deliver boiler to PRCLT.	December 2023	December 2023	
30	Fit ashpan to firebox, lower complete boiler assembly into frames.	January 2024	January 2024	
31	Bolt front tubeplate to stretcher 5, bolt smokebox to chassis and fit firebox expansion slides.	February 2024	December 2026	
32	Fit inside valve crosshead lubrication tunnel.	February 2024	December 2026	
33	Fit main steam pipes from header to cylinders.	February 2024	December 2026	
34	Fit blast pipe and exhaust pipework from cylinders, fit smokebox floor plates and complete sealing of smokebox floor plus add concrete. Install petticoat pipe.	February 2024	December 2026	
35	Supply, fabricate and install spark arrestor gear.	February 2024	December 2026	
36	Fabricate copper pipework, fittings and install pipe runs to both injectors. Supply and fabricate copper pipework, fittings and install pipe run to the drains from both water gauges. Fit vacuum and steam brake combination valve, supply fabricate and install pipework from brake valve, pipework alongside boiler to vacuum ejector. Exhaust from brake valve also steam supply to brake cylinder. Supply, fabricate and install Pipework from ejector to train pipe, drain from ejector. Supply, fabricate and install pipework from cab sander valve to sanders. Install vacuum ejector, supply, fabricate and install pipework – left hand side of the boiler.	February 2024	December 2026	
37	Fit whistle operating gear in cab roof.	February 2024	December 2026	
38	Install grate, supply and install concrete arch and couple up ashpan dampers, need to establish whether grate will need re-fitting after steam test at HBSS. Firehole ring bottom protector plate also smoke deflector plates.	February 2024	December 2026	
39	Install firehole door and mechanism.	February 2024	December 2026	
40	Install snifting valves.	February 2024	December 2026	
41	Fit vacuum, steam heat, boiler pressure and air gauges in cab and pipe up same.	February 2024	December 2026	
42	Supply, fabricate and install steam heat pipework to front of chassis – route to be determined.	February 2024	December 2026	
43	Install handrails on boiler side.	February 2024	December 2026	
44	Install cab windows and deflector shields.	February 2024	December 2026	
45	Install cab seats.	February 2024	December 2026	
46	Install cab floor structure.	February 2024	December 2026	
47	Install slacking pipe cock into cab, supply, fabricate and install connecting pipework.	February 2024	December 2026	
48	Install Speedometer in Cab and drive from left hand Trailing Driver.	February 2024	December 2026	
49	Fit crinolines to boiler and firebox.	February 2024	December 2026	
50	Install boiler insulation to boiler and firebox.	February 2024	December 2026	
51	Fit free issue boiler cladding and bands, secure same to include for various cut outs to clear handhole doors and washout plugs.	February 2024	December 2026	
52	Install smoke deflectors.	February 2024	December 2026	
53	Complete fitting out of cab floor, cab furniture and generally complete cab internals.	February 2024	December 2026	
54	Weigh locomotive and set springs.	February 2024	December 2026	
55	Install Tender Tank and complete.	February 2024	December 2026	
56	STEAM!		December 2026	

INCOME/EXPENDITURE PROJECTION

INCOME AGAINST ENGINEERING EXPENDITURE SCENARIO 1



INCOME AGAINST ENGINEERING EXPENDITURE SCENARIO 2



‘BEST EFFORTS’ FORECAST

INCOME ASSUMPTIONS

PRICING ASSUMPTIONS

CONTRACTOR RESOURCING

CONSTRUCTION TIME

PROJECT NOVELTY



PROJECT CONTROL TOOL · CONTINUOUS REVIEW · PUBLISH UPDATE EVERY SIX MONTHS



RISK MANAGEMENT DOCUMENTATION

An essential workstream for certification

PATRIOT PROJECT 5551: BOGIE HAZARD TECHNICAL ASSESSMENT							
Hazard	Cause	Fault/Reason	Likelihood+Severity = ?	Principle of Comparison	Safety Requirements	Demonstration of Compliance	References (Project Doc.)
BOGIE DERAILMENT BOGIE FAILURE Leading to: Engine failure Possible injury Possible fatality Network disruption Cost implications	1. Frame structural failure (new build)	Crack/fracture of: Side plate/centre cast/rear tie bar Front stretcher fracture. Failure of attachment bolts. (New front plate to attach AWS)	1 + 2 = 3 1 + 1 = 2	Reference System Standards Reference System (LMS Royal Scot 46100) Standards Standards	Design: To Original LMS Drawing D32-12350 Manufacture: Correct materials and specification. (original BR specification has been updated). Design: Derive a new CAD drawing for front stretcher based on the LMS Royal Scot 46100 bogie. Manufacture: Correct materials & specification. Maintenance: By regular inspection.	The aim is to accurately replicate the original Patriot bogie design. LMS Drawing D32-12350 has been used to derive new 3D CAD data; 2D drawings to follow. Manufacturer will be RISAS compliant using updated material specifications. Original Patriot Class engines were fitted with a modified front stretcher to carry AWS equipment in the 1950's which performed satisfactorily but no drawing or pictures exist. LMS 46100 bogie has been inspected, measured and photographed to derive new CAD. The frame plate will be squared off for more positive fixing (prev. approved by Ricardo). Original Patriots and Royal Scot 46100: satisfactory in service record with this modification. Manufacture will be RISAS compliant with updated material specifications. Inspection programme and log to be developed.	D32-12350. CAD. Supplier/order. CoC. QA/sign off. LMS46100 information. New CAD. Stress data? Evidence data? tbd
	2. Leading Wheelset Failure (new build)	Spoke/hub fractured. Axle cracked. Tyres damaged.	1 + 5 = 6	Reference System Standards	Design: To original LMS Drawings. Manufacture: Materials to correct specification. Maintenance: By regular inspection.	Parts manufactured according to original LMS drawings. Wheelpan pattern by Premier Patterns. Wheelpan casting by Micron Castings. Axle machined by Harco Engineering. Wheel centres fitted by South Devon Railway. Tyres fitted by South Devon Railway. Tyres profiled by LM Depot Tyseley. Assembly at South Devon Railway complied with rail industry standards (RIS). Planned inspection schedule to be RIS-2766 compliant.	Drawings ref. RISAS paperwork. CoC. QA sign off. tbd
	3. Rear Wheelset Failure (ex-Barry 8F 48518 item)	Spoke/hub fractured. Axle cracked. Tyres damaged.	2 + 5 = 7	Reference System Standards Standards	Design: LMS Design/Specification Manufacture: Provide service history/provenance. Must prove still fit for purpose. Maintenance: By regular inspection	LMS legacy 3' 3½" wheelset. Obtained from pony truck on Stanier Class 8F 48518 built Doncaster 1944, but actually an earlier Midland Railway part. Mileage in service unknown. Axle tested – satisfactory (Llangollen Engineering). Castings - NDT tested. Passed. Following Ricardo inspection (2020) axle skimmed in wheel lathe to remove pitting and confirm no deeper flaws; new tyres to correct spec. fitted at same time (Riley & Son Ltd). Planned inspection schedule to be RIS-2766 compliant.	Test data rept ref. RISAS/CoC/QA sign off. tbd
	4. Axle Box overheating/seizure (new parts)	Excessive wear. Inadequate lubrication.	2 + 4 = 6	Reference System Standards	Design: New 10 inch axleboxes to LMS Patriot design. Manufacture: Correct specification and materials: axleboxes should be bronze with white metal linings. Maintenance: By regular inspection.	LMS Drawing D32-12350 doesn't show axleboxes. Original Midland Rlwy axlebox drawings no longer exist. Measurements taken from an original part and new CAD drawing created. Patterns based on the CAD have yet to be made. New parts will then be cast. Proposed modification: oil boxes + oil lines into horn guide cheeks to improve lubrication. Planned inspection/lubrication schedule and log to be developed.	New CAD ref. Pattern ref. CoC. QA. Evidence for mod. tbd
	5. Side Control Springs fail (new parts)	Crack/fracture.	1 + 1 = 2	Risk Assessment (new part/new design) Standards Standards	Design: Altered round section spring design but must confirm meets original Patriot spring specification. Manufacture: Correct steel/size/diameter/stiffness Maintenance: By regular inspection	Original rectangular spring specification as on drawing D32-12350 is no longer available. Modern bogie springs are manufactured to round section design. Tested Spring Co. provided with copy of original spring specification and tasked to supply round section spring of equivalent performance with all supporting documentation. Planned inspection programme and log to be developed.	
	6. Suspension Springs fail (new parts)	Crack/fracture.	2 + 1 = 3	Reference System Standards Standards	Design: To specification on LMS drawing Manufacture: Correct size/spec. steel leaf spring. Maintenance: By regular inspection.	New CAD drawing created derived from LMS D32-12350. Manufactured as specified to BR standards by Jones Springs (Engineering Ltd). Planned inspection programme and log to be developed.	
Original bogie specification 6ft. 3in. wheelbase 3ft 3½in diameter wheels 10 spoke pattern Side bolsters Central pivot Reused original frames			Scoring System Likelihood: 1 = Very low 2 = Low 3 = Medium 4 = High 5 = Very high Severity 1 = Insignificant 2 = Marginal 3 = Moderate 4 = Critical 5 = Catastrophic	Principle of comparison: 1) Industry 'Standard' compliance. 2) Reference equivalent LMS Original or similar 3) New part/new design (= new stat. risk analysis)	For each component: 1) Design: Original drawing or new CAD/method. 2) Manufacture: Correct materials. Accredited supplier. 3) Maintenance: Meets industry standards. RIS-2004 = Rail Industry Standard for vehicle maintenance. RIS-2766 = Rail Industry Standard for design, manufacture and maintenance of wheelsets.	General Requirements for all parts: 1. Supplier accreditation (RISAS Approval). 2. LMS or equivalent drawings/CAD. 3. Build and materials specification. 4. Finished item quality assurance. 5. Maintenance schedule, inspection, log. RIS-2004/2766 compliance. Drawings D32-12350 = General arrangement D32-12338 = Bogie frame Not available D32-12354 = Bolster (previously C.18742) Not available D32-12351 = Slide & details Not available	

CAN WE BE CONFIDENT GOING FORWARD?

Our present contractors all operate by sound engineering quality management principles

We are introducing a documented quality control process

We started tackling risk assessment in 2020

We have certification arrangements that are fit for main line running

We have a project plan and forecast for the first time (replacing targets)

Thanks to PRCLTs full assessment of the chassis we now know for the first time the work required to complete the loco to the standard required

PRCLT helped produce our plan – they back it

We are managing the wheel defects to produce the best solution for the project

YES, BUT WE NEED TO RAISE THE MONEY

CONCLUSION

UNDERSTAND US

BUY INTO OUR APPROACH

SUPPORT US

CONTINUE TO HELP WHERE YOU CAN

QUESTIONS



THANK YOU FOR ATTENDING TODAY,
IT'S GOOD TO SEE YOU HERE

YOUR MEMBERSHIP IS VITAL TO US AND
WE APPRECIATE THE FINANCIAL AND MORAL SUPPORT
YOU GIVE TO THE PROJECT