



NEWSLETTER No. 26 - FEB 2025



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CHAIRMAN'S PIECE

John Hind

We are into our annual renewals window. At time of writing 85 out of the 124 members on our books have renewed. The simplest way to renew is by direct debit as then it's never forgotten. If you haven't renewed please can I ask you to do so ASAP.

One of the topics in the last committee meeting was the future of the Trust. This is dependent on people. Like all voluntary organisations, we depend on a small number of people to function and we need to make sure that there are members following in our footsteps to take over the running of the Trust, which in a couple of years' time will have a locomotive to look after.

I will be looking to stand down in 3 years' time to make way for new blood and Chris Newman would like others to start taking over some of his responsibilities NOW as a prelude to stepping down. Without new people coming forward there is a very real danger that within a few years ASTT will cease to exist. This problem is not unique to us, but we need to be aware of it and take steps to put in succession plans.

Chris takes on an enormous number of tasks – Webmaster, Treasurer and Book Publisher. We are not expecting someone to take on all of these. These are activities that can be done on-line from home and established practices are in place. Our membership is worldwide and we are open to offers of help from outside the UK.

The impact of the Book Publisher was brought home to me last year, when I was in New Zealand and visited Sam Mackwell's company <https://mackwell.co.nz/> In the company library where well used copies of our books, showing the value of what Chris does.

If you are interested in helping, please contact me on john-hind@advanced-steam.org .

MEMBERSHIP MATTERS

Chris Newman

Committee Members

ASTT's management committee :

John Hind	Chairman & Trustee	Jamie Keyte	Trustee
Hendrik Kaptein	Secretary & Trustee	Alex Powell	Trustee
Chris Newman	Treasurer & Trustee	Grant Soden	Ex-officio
Mike Stockbridge	Ex-officio		

New Members:

We welcome eight new members who have joined since our No 25 Newsletter of September 2024:

John Johnson III from Minneapolis, USA. John is a retired welding specialist who has worked on submarines, pressure vessels and power plants. He has spent many years undertaking welding and other mechanical work on preserved Milwaukee Road S3 Class 4-8-4 No. 261.

Andrew Matthews from Elizabeth Downs, South Australia. Andrew is a professional Model Engineer and runs his own business under the name Miniature Design Services.

David Sumpton from London, Ontario, Canada. David's credentials include MBA, M.Eng., P.Eng., PMP, CSSBB, CISA. He has spent 30 years in engineering project management, finance. training etc.

Maik Drechsel from Hiddenhausen, Germany. Maik runs a freelance engineering office that focuses on historical rail vehicle technology – see <https://steam-technologies.de/?lang=en>. He recently spearheaded a demonstration of wood-pellet firing on a vintage 0-6-0T locomotive on the Emsland historic railway near Haselünne, in Germany. For further information, see <https://www.youtube.com/watch?v=jT1ApY4YLhU&t=5s> and https://steam-technologies.de/wp-content/uploads/2023/09/wood_pellet_firing_info-1.pdf.

Claudio Espinosa from Argentina, now living in the UK and working at Tyseley Locomotive Works. Claudio is experienced in all aspects of locomotive (steam, diesel and electric), and rolling stock. He is probably the only member of ASTT who knew Dante Porta personally.

Fraser Birrell from Oxfordshire, UK.

John Skiba from Burleson, Texas, USA. John is studying Mechanical Engineering at the University of Texas at Arlington, from where he expects to graduate in the summer of 2025.

Harry Andrews from Ipswich, UK. He is studying for a BSc in Banking and Finance at Essex University.

Membership Numbers

We currently have 124 members on our books, of whom 85 (67%) have paid their 2025 subscription. Others are reminded that subscriptions fell due on 1st January 2025. The current breakdown of 124 members is as follows (in the hope that all resubscribe!):

Full Members:	39	UK Members:	79	Age Ranges	Age Ranges
Associate Members:	74	EU:	18	Over 60	Approx. 46%
Student Members:	11	North America:	12	30 to 60	Approx. 40%
		South America:	1	Under 30	Approx. 15%
		Australasia:	11	Av. age	Approx. 56
		Asia & Africa:	3		

PUBLICATIONS PAGE

Chris Newman

Book Sales

A total of 129 books were sold in the four months since Newsletter 25 was sent out. These included 20 copies of “Porta Papers Volume 4” that were sold to the author, Martyn Bane at-cost. In addition, 3 copies of the same book were sent to railway periodicals in the hope of getting it reviewed and one was donated to the NRM library. A total of 218 books were sold in 2024 compared to 120 in 2023.

No new publications have come on stream since “Porta Papers Volume 4” and Adrian Tester’s “Physiology of the Loco Boiler – Part 1”, but it is expected that “Porta Papers Volume 5” will be published shortly. Apart from that, there are no new titles in the pipeline unless someone amongst our members can offer something for us to publish.

Books sales since September 2024 have been as follows:

Publisher	Author	Title	Sales since N/L 25	Total Sales
ASTT	L.D. Porta	Porta’s Papers Vol 1	4	152
	L.D. Porta	Porta’s Papers Vol 2	3	143
	L.D. Porta	Porta’s Papers Vol 3	9	111
	Martyn Bane	Porta’s Papers Vol 3	78	78
ASTT (continued)	C. Newman (Editor)	Porta’s Centenary Compendium Vol 1	3	88
	C. Newman (Editor)	Porta’s Centenary Compendium Vol 2	8	47
	Ian Gaylor	Lyn Design Calculations	1	111
	David Wardale	5AT FDCs	3	223
	David Wardale	Reminiscences of a Trainspotter	3	43
	Alan Fozard	5AT Feasibility Study	2	47
Camden*	<i>David Wardale</i>	<i>The Red Devil and Other Tales from the Age of Steam</i>	0	260
	<i>Phil Girdlestone</i>	<i>Here be Dragons</i>	0	33
	<i>Jos Koopmans</i>	<i>The Fire Burns Better ...</i>	0	11
	<i>L.D. Porta</i>	<i>Advanced Steam Design</i>	0	5
Crimson Lake	Adrian Tester	Physiology of the Loco Boiler – Part 1	10	34
	Adrian Tester	A Defence of the MR/LMS 4F 0-6-0	2	44
	Adrian Tester	Introduction to Large Lap Valves	3	23
		Total sales	129	1456

* Camden is now selling these titles in digital format, so they have been withdrawn from ASTT’s website. A total of 43 books were sold to Camden Miniature Steam amounting to 33% of sales.

Book sales provide a valuable source of income to ASTT which helps to fund activities, not least our Revolution project. **Members are urged to support our endeavours by purchasing books from us.**

Note: We’d like to expand our book selection, so we welcome any suggestions for additional titles that we might be able to sell, or new texts that we might publish under ASTT’s logo.

Titles published by the Advanced Steam Traction Trust

	Year	Author	Title	Pages	RRP*
	2015	David Wardale	The 5AT Fundamental Design Calculations	556 (b&w)	£49.00
	2016	Alan Fozard and others	The 5AT Feasibility Study edited	230 (colour)	£35.00
	2018	Ian Gaylor	Steam Locomotive Design Specifications and Calculations for New Build Baldwin 2-4-2T 'LYN'	604 (colour)	£52.00
	2018	L.D. Porta transcribed and edited by Chris Newman	Selection of Papers by L.D. Porta – Vol 1 - Tribology and Lubrication	250 (b&w)	£27.00
	2019	L.D. Porta transcribed and edited by Chris Newman	Selection of Papers by L.D. Porta – Vol 2 - Adhesion, Compounding and the Tornado Proposal	256 (b&w)	£27.00
	2021	L.D. Porta transcribed and edited by Chris Newman	Selection of Papers by L.D. Porta – Vol 3 - Steam Locomotive Boilers, Fireboxes and Combustion	290 (b&w)	£27.00
	2024	L.D. Porta and others Compiled by Martyn Bane	Selection of Papers by L.D. Porta - Vol 4 - Locomotive Boiler Water – Treatment, Circulation and Preheating	513 (colour)	£40.00 (£48 hard cover)
	2022	Compiled and edited by Chris Newman	A Compendium of Articles and Papers to celebrate the Centenary of the birth of Livio Dante Porta - Volume 1	226 (colour)	£27.00
	2023	Compiled and edited by Chris Newman	A Compendium of Articles and Papers to celebrate the Centenary of the birth of Livio Dante Porta – Volume 2	331 (colour)	TBA
	2023	David Wardale	Reminiscences of a Trainspotter	67 (b&w)	£16.00

As noted before, it is planned to add another title in the near future – viz: Volume 5 of the series of papers by Livio Dante Porta.

* The RRP's (recommended retail prices) shown include UK postage. Additional postage costs may apply to some titles. Paid-up members of ASTT are entitled to a 20% discount on these prices.

All these plus three other titles by Adrian Tester can be purchased through ASTT's website at

<http://advanced-steam.org/books-for-sale/>.



The Advanced Steam Traction Trust

is pleased to offer

Porta Papers Volume 4 Locomotive Boiler Water

Compiled and Edited by Martyn Bane

Selection of Papers
by
L.D. Porta
Volume 4
- Special Edition -
Locomotive Boiler Water
covering
Water Treatment, Feedwater Heating and
Boiler Water Behaviour



including papers by
Ing. Livio Dante Porta, Martyn Bane, Nigel Day, Shaun McMahon,
Joachim Robrade, William Richardson and Friedrich Witte

Compiled and Edited by
Martyn Bane

On behalf of the Advanced Steam Traction Trust



Topics covered include
**Water Treatment,
Feedwater Heating and
Boiler Water Behaviour**

*505 numbered pages
212,312 words
152 Colour illustrations
154 black and white illustrations*

*23 separate papers
12 by Ing. L.D. Porta
9 by other authors*

*30 page glossary
28 pages of references
14 page index*

£40 soft cover or £48 hard cover

To download a 72 page sample, more information and to order visit:

www.advanced-steam.org/books-for-sale

or email ASTT at

info@advanced-steam.org

2025 EVENTS

John Hind

AGM 2025 – Saturday 1st March 2025 – 13.30 pm

The formal notice for the 2025 AGM will be going out separately to the Newsletter. As in previous years it will be a Zoom meeting.

As well as the usual formalities we will voting on an amendment to the articles.

As part of our preparation for Charity Commission registration we have identified the need to make some subtle changes to the wording of our purposes in the articles of association that we believe will help our application. The changes are to emphasise the 'public benefit' of what we do and how what we do with Revolution can help the environment.

These will need to be voted on at the AGM.

At last year's AGM, as an AOB, we voted to implement an increase in the subscriptions, however, come the end of 2024, we forgot to implement it. To make amends, there will be a vote in the main part of the agenda for an increase in subscriptions to come into effect for 2026. The proposal is that for Full members it will be £25/annum and for Associate members £15/annum.

Greatest Gathering – 1st to 3rd August – Derby, Litchurch Lane

Richard Coleby is in negotiation with the organisers of the Greatest Gathering to secure us a stand at this Railway 200 Event, at ALSTOM in Derby. If we are successful, we will be taking Revolution along for its first public airing, which will probably mean some late nights in Jamie's workshop! If anyone would like to help man the stand please let me know.

October Conference – 4th/5th October – Hopetown Darlington

Preparations are in hand for the October Conference. As it's Railway 200 year, it's appropriate we return to Hopetown, Darlington to the refurbished museum, which is adjacent to the A1 Trust's Darlington Locomotive Works, where the P2 is being built. This year we will see it in their new facilities.

The conference is recognised as a Railway 200 event and outline details can be found on the Railway 200 website <https://railway200.co.uk/search-for-activities-and-events/>

The conference theme is keeping steam locomotives operating beyond the celebration of 200 years of rail travel and into the 21st century.

There will be presentations on alternative fuels, new build steam locomotives and a series of presentations from young engineers about their contribution to steam locomotive engineering and operation.

As well as presentations, there will be a visit to the A1 Trust's Darlington Locomotive works and a conference dinner on the Saturday night.

Andrew Hartland has been confirmed as our first speaker on 'Alternative Net Zero Fuels'.

To pre-register interest – please send an e-mail to asttconference2025@advanced-steam.org

We will be ramping up publicity to attract delegates outside of ASTT.

HERITAGE RAIL - ALL PARTY PARLIAMENTARY GROUP

John Hind

In November of last year, the Heritage Railway Association (HRA) had written to Michael Shanks MP, who is Minister for Energy Security and Net Zero about unintended consequences on the Heritage Railway sector. Quoting extracts from the HRA press release:-

“The announcement, which came on November 14, said that the government would ‘restrict’ the licensing of new coal mines ‘as the government commits to bringing in legislation which will prohibit new coal mining projects.’ However, the announcement makes no reference to any users of coal beyond electricity generation.

We have grave concerns that the government’s aim to end the use of coal for electricity generation has become mixed up with other remaining uses for coal that are not linked to large-scale pollution in any way, including users like the UK’s 170-plus heritage railways.

That’s why we’ve written to the minister requesting a meeting so that he and his department fully understand that heritage railways need coal – and that the best quality and most environmentally conscious option is UK mined coal.”

Although there is no indication that imports of coal would be banned, making the heritage rail sector permanently dependent upon imported fuel is widely considered to be a worrying step. Far from reducing emissions, a ban on coal mining in the UK would permanently bake in higher emissions for those residual users of coal now forced to import the raw material from thousands of miles away. Shipping coal to the UK produces up to five times more CO2 emissions than using domestically mined coal. The Heritage Railway Association believes that the use of coal by heritage railways can be totally compatible with the net-zero agenda ... the minimal emissions caused by the sector are already offset by its social, cultural and environmental benefits.

There is an urgent need to ensure that wider net-zero policies such as this one do not have unintended consequences for heritage rail.

By ignoring the needs of those remaining coal users and conflating them with policies designed for electricity generation, the future of heritage rail is being placed in wholly unnecessary jeopardy while not delivering any benefits for the environment.

While this proposed legislation is unlikely to create an immediate cliff edge scenario for steam locomotive fuel, it is clear that in the long-term this would leave heritage rail much weaker and permanently more dependent upon lower quality, imported fuel that would do the opposite of the stated aims of this policy.”

Perhaps because of this, ASTT, along with others received an invite to attend an evening meeting of the Heritage Rail All-Party Parliamentary Group on Coal.

All-Party Parliamentary Groups (APPGs) are informal cross-party groups that have no official status within Parliament. They are run by and for Members of the Commons and Lords, though many choose to involve individuals and organisations from outside Parliament in their administration and activities.

The meeting took place on Wednesday 6th February, and Ian Gaylor, John Scott and myself attended a 1700 meeting at the House of Commons. Steve Oates of the Heritage Railway Association had suggested to the secretary of the APPG, that they invite ASTT, with the suggestion that we might be able to offer the Group some thoughts on the scope for alternative fuels and the sort of research that might be required to identify the possibilities.

As it turned out the meeting was more about how best to raise the issue with the relevant Ministers rather than the detail of the practical steps that are needed and we did not get opportunity to make our pitch, nevertheless it was an interesting experience that gave an insight into the working of parliament.

The APPG has two joint chairs – Liz Saville Roberts MP and Lord Richard Faulkner.

Liz Saville Roberts is MP for Dwyfor Meirionnydd and the leader of Plaid Cymru in the House. She has several heritage railways in her constituency including the Ffestiniog, Welsh Highland, Talyllyn, Bala, Snowdon, Llanberis

and the Llangollen. She is aware of the tourist value and employment opportunities that heritage railways bring to local communities and is worried about the impact of Net Zero policies on coal supply and heritage rail.

Lord Faulkner is President of the Heritage Railway Association, an active Labour Life peer who has published several books on railways and is known as a good friend of the Heritage Railway movement who is equally concerned about coal supply.

Lords Grocott and Snape attended plus two other MPs whose names I did not catch.

There were no clear objectives or agenda for the meeting and before the meeting I had offered to give a short talk about what we had found learnt from the testing of alternative fuels and Ian was on standby to describe how the Structured Idea Management process can help find a carbon neutral fuel.

In the event our offer was not taken up and there were three short presentations from Vic Michel of Vintage Trains, Paul Lewin from the Ffestiniog/Welsh Highland and Andrew Barnes of the Bure Valley. Steve Oates also contributed. Also, in the room there were representatives Locomotive Services Ltd, West Coast Railways and the Watercress Line. Bob Gwynne who presented at our 2024 conference was also there.

The three presentations generally confirmed that the current generation of alternative fuels do not perform as well as coal and for an alternative, development work is needed. The representative from Vintage Trains who had been talking to Academia, suggested that ammonia (to raised eyebrows) may be a suitable fuel and seemed unaware of the practical disadvantages. After the presentations there was a wide ranging random discussion, however, some points came out:

- The heritage sector needs protecting to ensure that coal can be burnt
- West Coal Railways acknowledged that they are the main supplier of coal to the Heritage Sector
- There is no shortage of coal but if the supply chain for coal breaks down then steam will stop
- Importing coal increases emissions through the need to transport it and the poor quality of it means more is burnt, increasing emissions
- Re-opening UK coal mines is a lost battle and is not going to happen
- Funding is needed for research into alternative fuels

The Parliamentarians seemed to note these points but would need further discussions amongst themselves to determine who was the best person in Government to approach to ensure that the heritage sector can still burn coal and fund research into alternatives and under what programme.

For us not a productive meeting, but good for networking and renewing old acquaintances.

REVOLUTION PROGRESS

Jamie Keyte

Since the October conference things have moved apace – largely in the design office(s). Actual production has been good in some areas, not so much in others. As usual we find ourselves at the mercy of third parties; the desire to keep costs down isn't always compatible with persuading suppliers to get on with the job in a timely manner!

CFE who have been tasked with making many of the motion components have been dragging their heels somewhat. The cylinders and liners are now complete and on their way to Metalworld Engineering to have the cladding sorted and hopefully the remainder of the valve gear components will be ready soon.

Meanwhile the tender has been proceeding nicely. A kit of flat-packed parts (Lok Vattenvagn in IKEA speak!) was delivered shortly after the October conference and has since been welded together to form the tender chassis.

In parallel with this a number of components have been machined/fabricated to form the handbrake mechanism, parts of the bogies and drawgear. Many of these parts, in addition to a number already produced for the valve gear frames and guide bars, (104 components in total) were taken to CBS Engineering in Long Eaton for Tufftriding (a chemical blacking process similar to Arcor which gives steel a black, wear- and corrosion-resistant finish).

As an experiment the tender wheels were machined from solid steel blanks on the milling machine – rather than turned on a lathe – and this has proved very successful and much cheaper than having them machined by a third party.

In sunny North Cave John Dunn has machined the four tender axles to his usual impeccable standard. These were collected on 15/01/25 enabling the tender wheelsets to be assembled – and, in turn, the bogies and eventually a trial fit to the chassis.

The tender tank drawings are nearly complete and the tank has already been sent out to Metalworld Engineering (Old Dalby) for quoting.

Whilst all this is going on Richard has been busy with producing the detail drawings for the boiler shell and the ashpan. We hope the latter will be sent out for quoting in the near future.



Milling the tender wheels



Assembled tender wheelset. Disc for the handbrake is between the wheels.



Tender Chassis under construction on a conveniently sized motorbike lift! Shown here upside down with the driver's footwell on the right.



Job lot of "Tufftrided" tender components including bolster plates, elastomer spring housings and handbrake components.



Tender bogie with elastomeric springs and bolster.



Tender Drawgear. Forks on the LHS attach to the rear driving axleboxes, pivot beam on the RHS attaches to front of tender.



Tender Handbrake mechanism



Cable operated tender hand brake calliper.



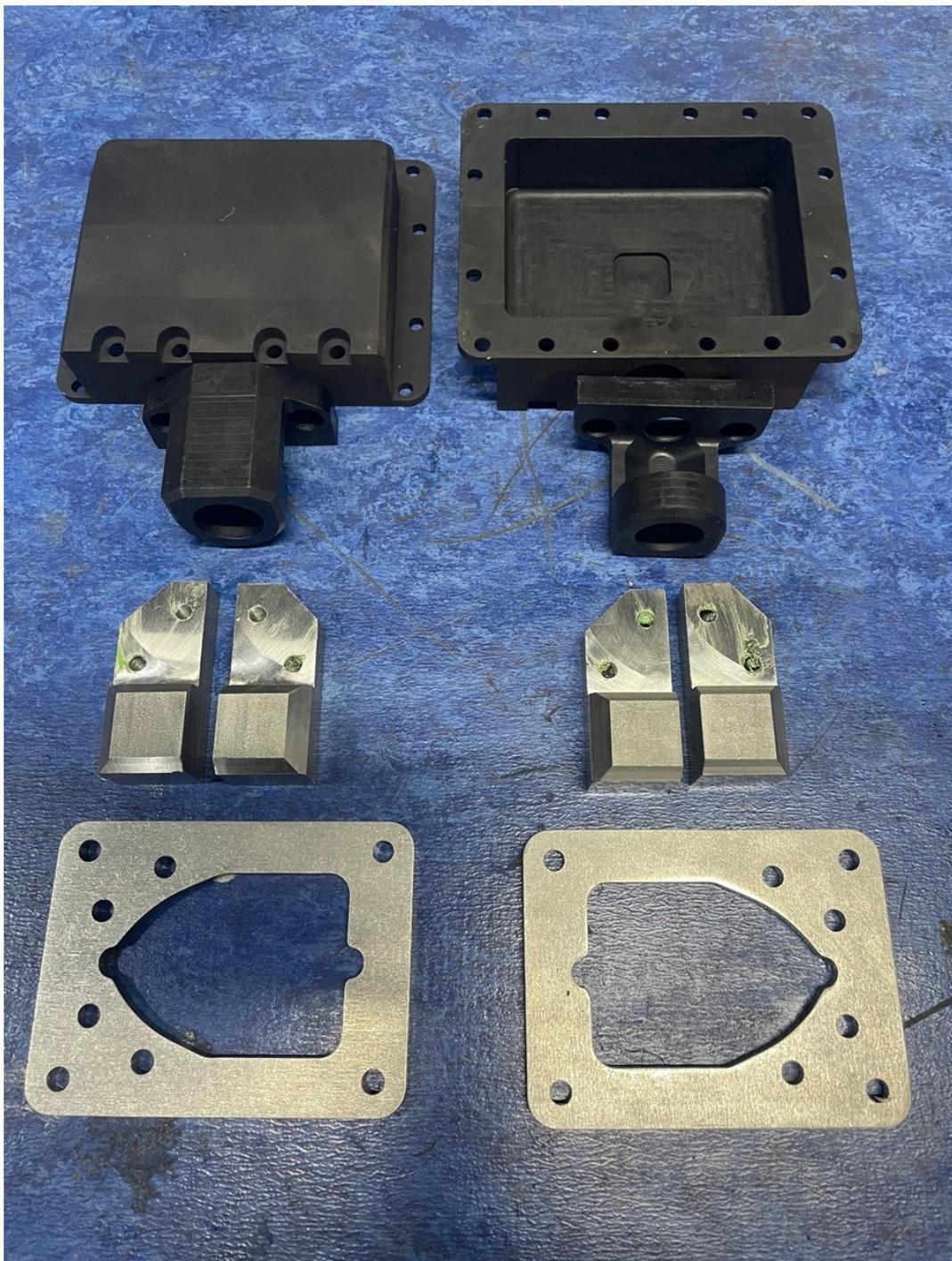
Tender Chassis on its bogies



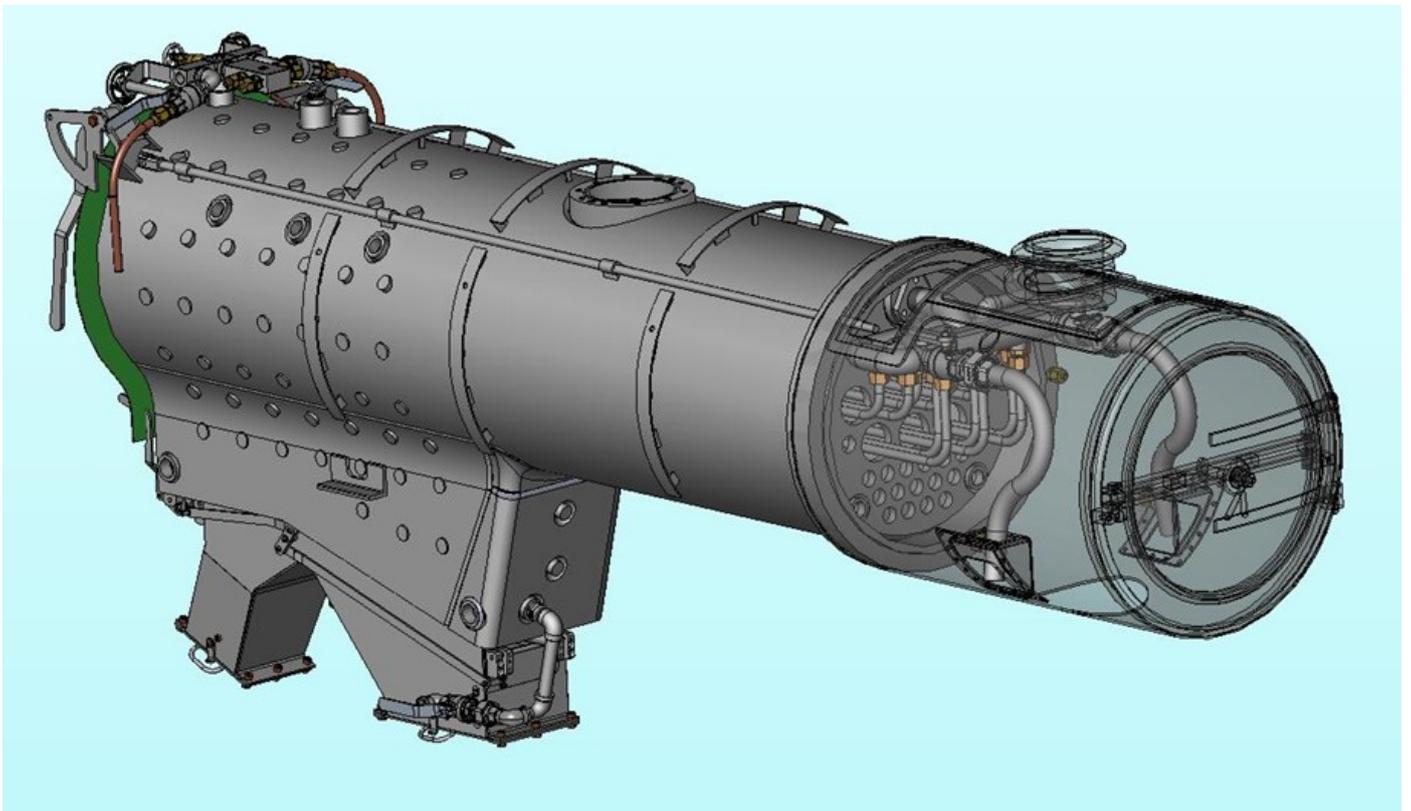
Valve gear frames, spacers and bearing housings after "Tufftriding"



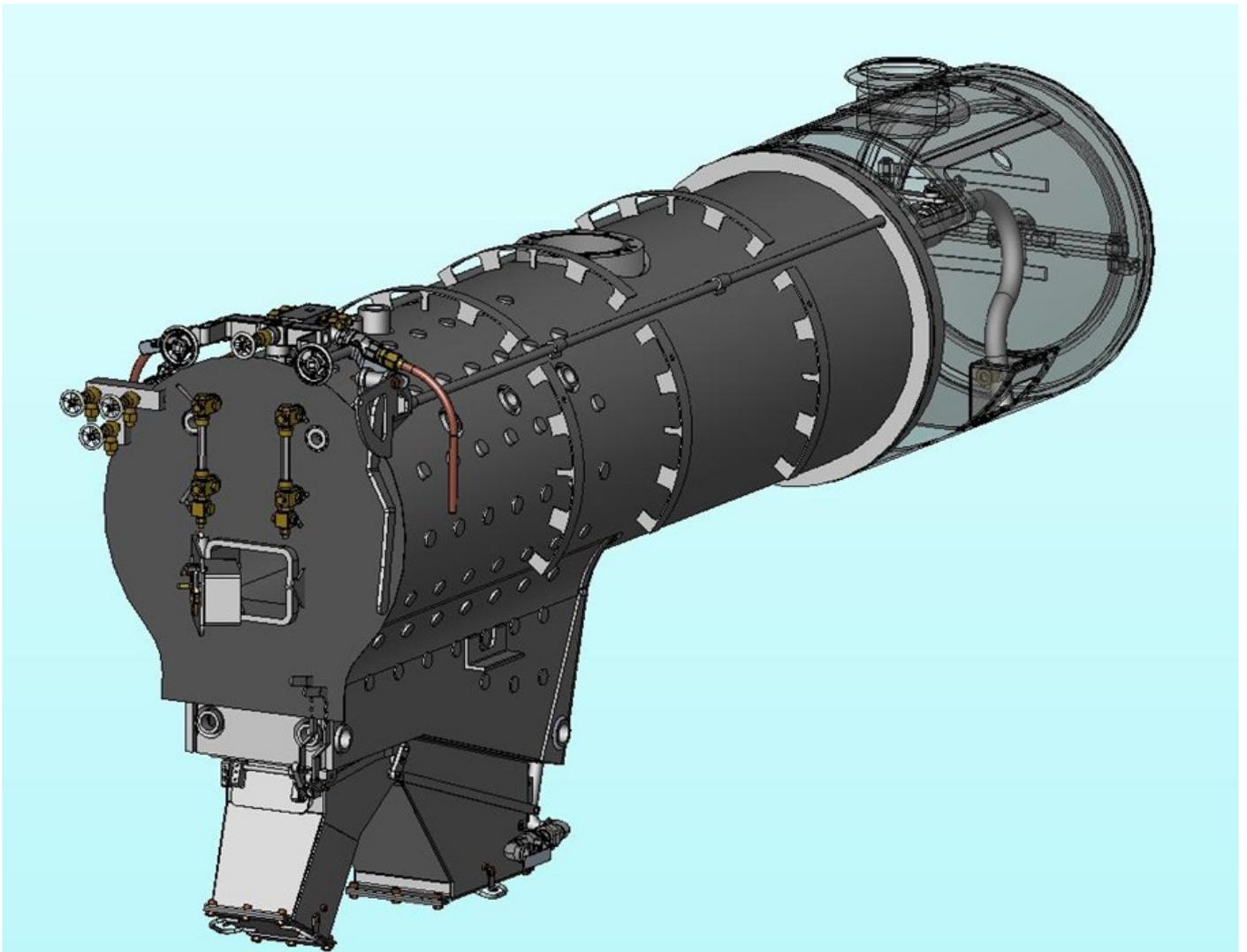
Roller Guide-bar components after "Tufftriding"



Top to bottom: Cylinder Rocker covers, bearing outriggers, rocker shaft bearing supports and mounting plates.



Finalised boiler shell complete with ashpan, smokebox, superheater and crinolines. (R Coleby)



Boiler Assembly showing firehole door, cab fittings and ashpan damper controls. (R Coleby)

RANDOMISED MACHINERY FRICTION SIMULATIONS

By Doug Landau

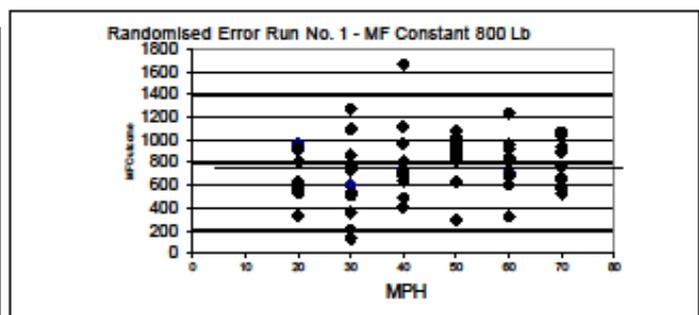
Method

A set of notional IHP values at 6 speeds were the root of this exercise, 10 values being entered for each speed, the total per set comprised 60 entries. Notionally "perfect" WRHP values were created by deducting an MF HP value equivalent to 800lb across the speed range. The ITE and WRTE values were calculated while at the same time subjected to a randomised number programme working to prescribed limits. The variation limits were set at + or - 0 to 2% for the ITE and WRTE entries. The resulting remainders providing a simulated set of experimental MF data. Carling at various times expressed a confidence level of 3% and 2% respectively or better for the Farnbro indicator and the Amsler dynamometer. The constant 800 lb MF adopted is purely notional for demonstration purposes.

In total 10 data sets or "Runs" of the 60 entries were processed. In reality it was considerably more, since the programme was such that if just one IHP entry was changed, all 60 entries were instantaneously re-scrambled, and the associated graph of derived MF values was simultaneously replotted. It was not unlike a moving picture show, and dozens, or any number you like of test plant simulations could be quickly generated. Just 10 Run sets were permanently recorded.

The scatter patterns so produced look remarkably familiar when compared to the Rugby MF experimental data. Two points are of note. Firstly, within the variable limits prescribed, the occasional impossibly low or even negative MF value can occasionally emerge - Runs 4 and 9. Secondly note how the range of scatter randomly varies for individual mph sets. Run 9a scatter at 20 mph is wide, and for Run 4 at 60 mph it is narrow. Also note how some mph sets appear biased up or down relative the assumed MF value. These patterns are similar to the scatter patterns displayed in the Rugby data. The average values of the simulations benefit in the important respect that they are typically based on a larger sample than that available from much of the Rugby data base for individual test series and speed sets. Some additional Rugby WRHP data (not linked to simultaneous IHP readings) is also available for plotting WRHP. Willans lines etc.

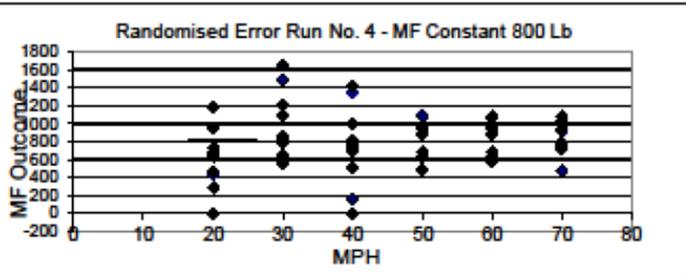
Randomised MF ± or - 2% (Actual MF 800 LB)							Average Sets 5 to 10
Run No.	20	30	40	50	60	70	
1	956	606	742	1021	716	889	725 91%
	529	1273	1115	851	958	769	
	329	1092	488	937	607	567	
	623	863	811	824	918	935	
	337	729	812	1072	850	527	
	592	521	695	912	823	1061	
	924	129	403	970	683	647	
	909	359	966	1014	699	764	
	805	209	1667	632	1235	895	
	557	781	636	300	323	670	
Averages	657	656	834	853	781	772	759
Spread	637	1144	1264	772	912	534	95%
	82%	82%	104%	107%	98%	97%	



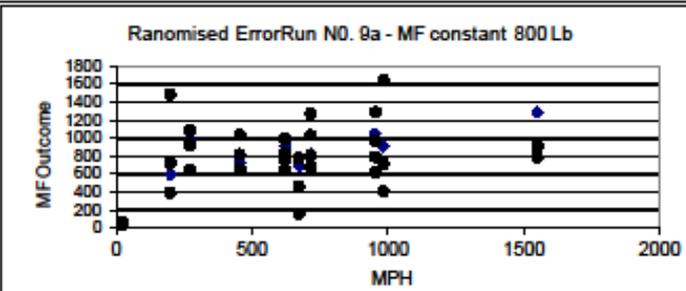
Notes

1. Averages generally sensitive to sample size. The random biases apparent are testimony to the integrity of the programme.
2. Negative results with lower MF are more frequent at the lower speeds as predicted (Run 9b) - see below. Negatives biased to low speed,
3. Note random upward bias of run no.4 at 30 mph. Such biases occur in the Rugby test plant experimental data..

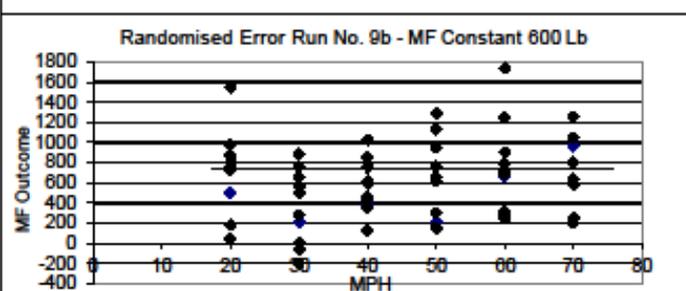
Randomised MF \pm or - 2% (Actual MF 800 LB)							Average sets
Run No.	20	30	40	50	60	70	4 to 10
4	447	797	1344	1089	632	917	786
	954	1211	818	954	954	715	98%
	667	1486	156	1082	1082	479	
	729	843	727	625	625	790	
	458	552	1002	876	876	1084	
	1177	1093	705	683	683	927	
	666	1649	757	893	893	1034	
	1	795	1422	936	936	982	
	637	649	-10	485	580	745	
	288	848	500	630	1063	925	Average All
Averages	602	992	742	825	832	860	809
Spread	1176	1097	1432	604	502	605	101%



Randomised MF \pm or - 2% (Actual MF 800 LB)							Average sets
Run No.	20	30	40	50	60	70	5 to 9
9a	1548	1293	797	931	790	901	866
	-9	752	1211	843	857	1073	108%
	197	597	1488	748	719	393	
	454	728	662	1035	820	636	
	270	980	1093	928	641	937	
	982	913	1649	706	721	409	
	953	1049	795	1289	619	968	
	621	911	641	754	837	997	
	715	822	680	806	1272	1033	
	671	691	154	781	453	465	Average All
Averages	640	874	917	882	773	781	811
Spread	1557	696	1495	541	819	680	101%

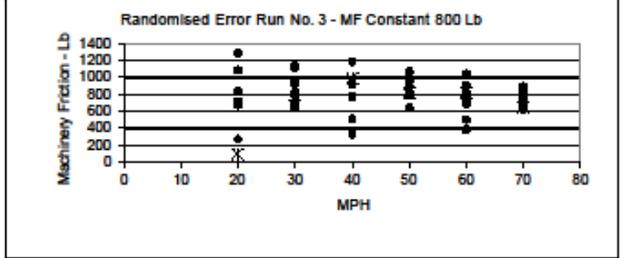
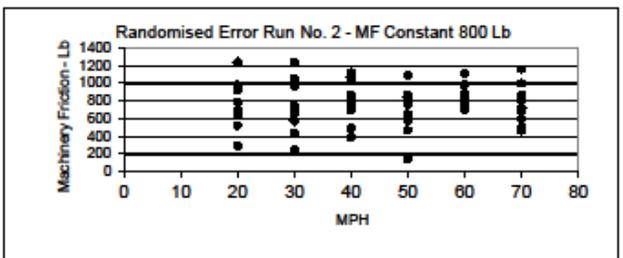
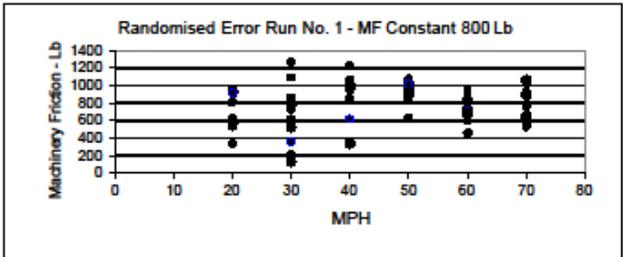


Randomised MF \pm or - 2% (Actual MF 600 LB)							Average sets
Run No.	20	30	40	50	60	70	1 to 5
9b	501	211	388	210	662	967	460
	41	278	361	157	243	203	77%
	-429	-2	456	146	317	249	
	180	663	849	1132	903	798	
	973	886	433	301	687	1045	
	732	763	614	662	718	1252	
	759	-203	592	1292	795	808	
	1550	-58	1029	618	1252	796	
	870	499	124	765	267	639	
	802	565	757	949	1739	588	Average All
Averages	598	360	560	623	758	735	606
Spread	1979	1089	905	986	1496	1049	101%

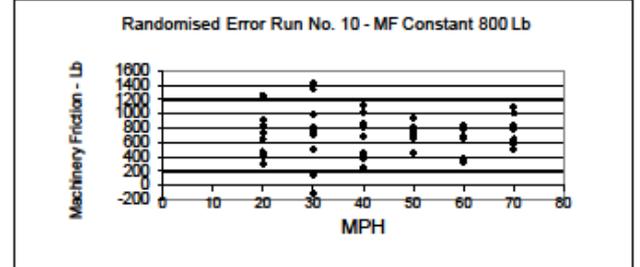
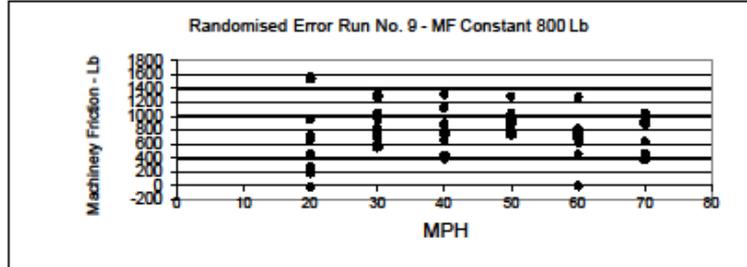
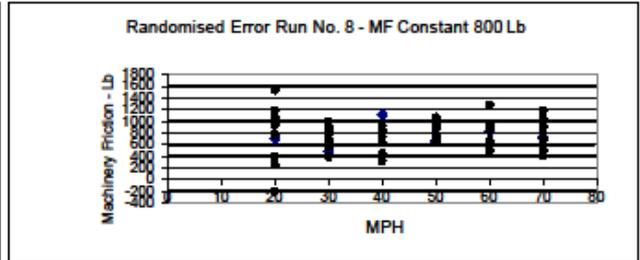
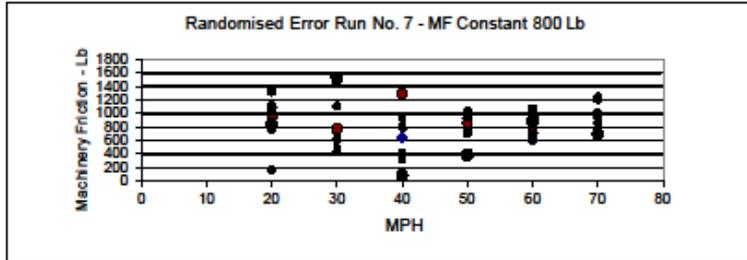
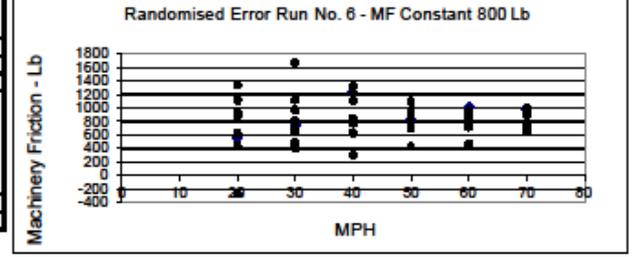
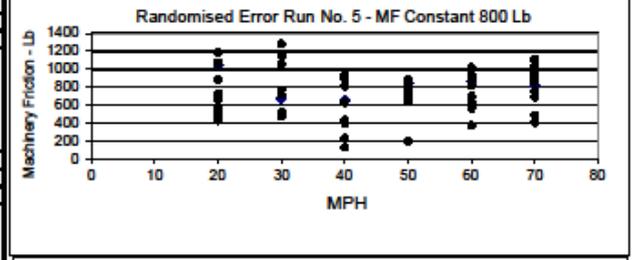
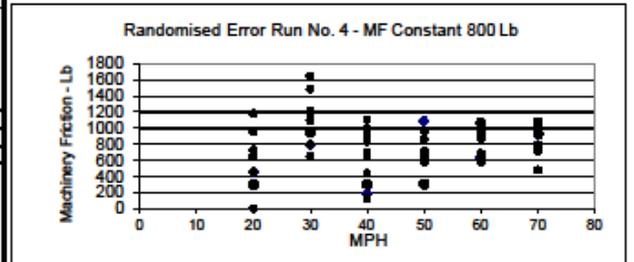


Reduced actual MF values would be more prone to negative experimental outcomes - Ref. Run 9b.

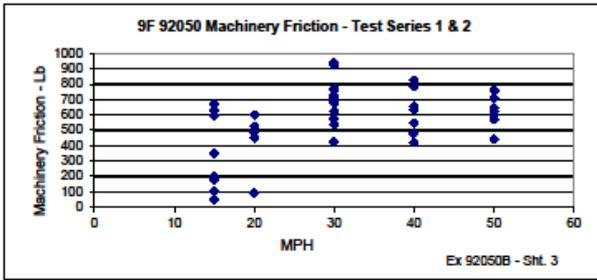
Run	MPH	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	% Ave.
1	20	931	529	329	623	337	592	924	909	805	557	82%
	30	606	1273	1092	863	729	521	129	359	209	781	82%
	40	968	823	1065	1222	972	1010	334	616	853	974	111%
	50	1021	851	937	824	1072	912	970	1014	632	922	115%
	60	716	958	607	918	650	823	683	699	683	460	93%
	70	889	769	567	935	527	1061	647	764	764	670	95%
	Average		855	867	766	898	748	820	615	727	658	727
%		107%	108%	96%	112%	93%	102%	77%	91%	82%	91%	96%
2	20	1236	787	924	523	639	644	698	923	295	977	96%
	30	578	1056	967	436	982	749	1240	652	247	723	95%
	40	1076	812	488	1054	692	873	388	1122	730	776	100%
	50	838	575	1089	780	650	767	467	645	139	870	85%
	60	977	698	727	882	887	813	1106	835	765	711	105%
	70	719	501	869	808	847	461	694	998	1161	597	96%
	Average		904	738	844	747	783	718	766	863	556	776
%		113%	92%	106%	93%	98%	90%	96%	108%	70%	97%	96%
3	20	274	1084	691	676	94	691	719	-154	1285	842	78%
	30	808	950	1121	655	669	697	792	1134	928	819	107%
	40	954	510	765	1187	988	912	332	955	919	776	104%
	50	938	641	785	885	820	820	950	956	1070	827	109%
	60	688	775	384	908	824	824	505	734	683	1045	92%
	70	772	788	893	768	653	653	714	623	822	763	93%
	Average		739	791	773	847	675	766	669	708	951	845
%		92%	99%	97%	106%	84%	96%	84%	89%	119%	106%	97%
4	20	447	954	867	729	456	1177	666	1	637	299	75%
	30	797	1211	1488	943	652	1093	1649	795	649	948	128%
	40	180	700	932	432	830	992	1105	653	128	304	80%
	50	1089	624	636	679	695	708	580	965	854	304	89%
	60	632	954	1082	625	876	683	893	982	580	1063	105%
	70	917	715	479	790	1084	927	1034	982	745	925	108%
	Average		677	860	881	700	766	930	968	730	599	641
%		85%	107%	110%	87%	96%	116%	123%	91%	75%	80%	97%
5	20	1050	667	1190	728	1077	557	883	506	427	1048	102%
	30	670	718	1053	1165	475	718	1282	770	520	1140	106%
	40	644	398	888	232	128	930	632	430	808	622	71%
	50	841	681	636	765	725	839	889	715	201	755	88%
	60	866	873	564	819	700	918	625	934	370	1024	96%
	70	825	1031	1107	864	482	944	687	754	404	911	100%
	Average		816	728	906	762	598	818	833	685	455	917
%		102%	91%	113%	95%	75%	102%	104%	86%	57%	115%	94%



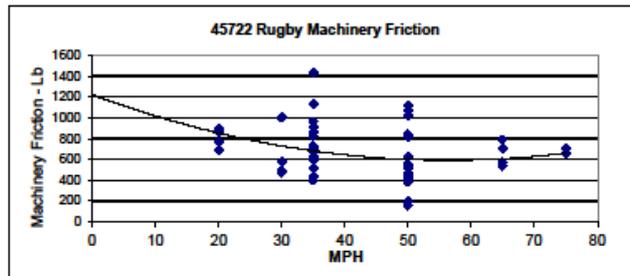
Run	MPH	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	% Ave.
6	20	550	1125	-274	1110	1334	911	625	865	931	433	95%
	30	742	1115	488	811	812	695	403	966	1667	636	104%
	40	1230	769	303	1211	848	774	628	1106	824	1320	113%
	50	817	691	716	966	1095	811	922	426	931	903	104%
	60	1007	856	959	880	727	810	469	915	726	713	101%
	70	963	717	897	898	762	927	641	753	973	991	107%
	Average	888	879	515	979	930	821	615	839	1009	833	104%
%	111%	110%	64%	122%	116%	103%	77%	105%	126%	104%	104%	
7	20	1089	165	968	1117	1320	949	1033	829	751	880	114%
	30	789	1452	1103	787	727	783	615	1532	511	432	109%
	40	642	333	944	422	811	1294	932	89	777	404	83%
	50	922	698	1036	740	835	864	962	387	978	718	102%
	60	613	1076	942	808	610	714	998	900	696	872	103%
	70	705	752	947	863	669	695	1005	700	1257	1205	108%
	Average	793	746	990	790	829	883	924	740	828	752	103%
%	99%	93%	124%	99%	104%	110%	116%	92%	104%	94%	103%	
8	20	700	248	-203	384	1186	931	770	1533	1072	988	95%
	30	484	564	389	836	992	905	671	646	701	770	87%
	40	1112	722	860	922	621	322	444	822	620	731	90%
	50	644	756	622	1003	691	775	1064	689	874	935	101%
	60	835	663	633	639	651	840	871	947	509	1273	98%
	70	723	681	513	907	1181	426	497	805	417	1047	90%
	Average	750	606	469	782	887	700	720	907	699	957	93%
%	94%	76%	59%	98%	111%	87%	90%	113%	87%	120%	93%	
9	20	1548	-9	197	454	279	982	953	631	715	671	80%
	30	1293	752	567	728	980	913	1049	911	822	691	109%
	40	762	1122	422	389	1312	854	900	780	665	880	101%
	50	931	843	748	1035	928	706	1289	754	806	781	110%
	60	790	857	719	820	641	721	619	837	1272	453	86%
	70	901	1043	393	636	937	409	966	997	1033	466	97%
	Average	1038	625	508	677	846	764	963	818	886	657	97%
%	130%	78%	63%	85%	106%	96%	120%	102%	111%	82%	97%	
10	20	472	845	439	911	738	641	401	297	1260	1247	91%
	30	1344	818	156	727	1002	705	757	1422	-108	500	92%
	40	400	690	1022	822	444	1120	390	860	248	872	86%
	50	670	741	452	933	749	758	695	943	823	759	94%
	60	831	659	693	694	670	790	805	812	323	384	83%
	70	596	585	835	639	784	499	1098	631	1006	647	92%
	Average	719	723	600	788	731	752	691	828	592	735	89%
%	90%	90%	75%	98%	91%	94%	86%	103%	74%	92%	89%	



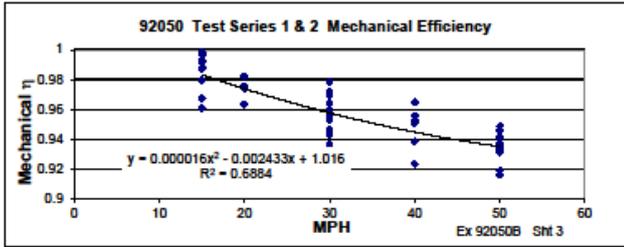
Some Characteristic Examples of Rugby Experimental MF Data



This is a not an untypical example of the confusion of scatter generated by the small remainder problem. The random tendency for the speed sets to sometimes group randomly with an upwards and downward bias is apparent here, as was sometimes evident in the random number experiments.

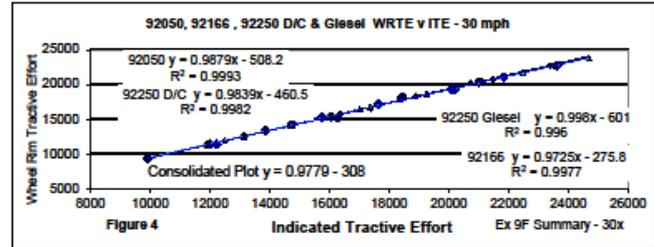


Notwithstanding the scatter, the trendline shown reflects the speed relationship roughly in line with theoretical expectations. The high traction forces at low speed fall as increasing dynamic forces kick in with rising speed. Theory notwithstanding, Some MF data sets return linear trendlines that are indistinguishable from polynomial trendlines and return the same R^2 value.



Notwithstanding the apparently biased small remainder MF scatter shifts, the trendline resolution of Mechanical η reflects the speed/ITE magnitude relationship in line with theoretical expectations. Evidently the bias apparent was the relative sensitivity to the degree of tractive effort involved at different speeds.

Mechanical Efficiency is the simple relationship $Mech. \eta = WRTE / ITE$



The confusing scatter of the Rugby machinery friction small remainders typically resolve into a simple linear trendline as seen here, return high R^2 values when WRTE is plotted against ITE. The equation is of the form $WRTE = ITEx - C$. The first term notionally represents sensitivity to effort and the negative constant represents the notional friction of the coupled wheels, motion and pistons when coasting free of any cylinder pumping effects. Both terms are sensitive to the trendline slope produced by the test plotting data scatter driving the X & C coefficients. The four trendlines bunched here closely resolve.

THE SUPER FAIRLIE - RENEWABLE FUEL STEAM LOCO, HIGH POWER- TO-WEIGHT RATIO & MODERN DESIGN TO MAXIMISE EFFICIENCY TOGETHER WITH MINIMISED FIRST COST AND MAINTENANCE

James Evans

'ROBERT FAIRLIE' 0-6-6-0T DESCRIPTION OF ALL MAJOR DETAILS

(Note: Loco specified to maximum WHR loading gauge limits)

WOOD PELLET FUEL

Why use wood pellets rather than other renewable fuels?

1/. Vegetable oil (unrefined) will increase in price due to competing demands on finite land area required to grow food, fuel, housing and solar farms; however Used Vegetable Oil could be economic and sustainable.

2/. Wood Chips produced locally would be attractive, but due to their relatively low energy density (and high water content) and non uniform nature, a very large bunker would be required (8/10 cubic metres) which would be impractical, and they would difficult for mechanical firing.

3/. Wood Pellets have a much higher energy density, are dry and produced to uniform standard dimensions, making mechanical firing possible. Manufactured from timber industry waste products, and local forestry operations (thinnings/brush). To maximise environmental benefits the locomotive would be fitted with a steam take-off to power a heavy duty wood chipper, so that all line-side tree clearance (and fallen timber) would be converted on site to feedstock for pellet manufacture after natural drying = a fully sustainably railway. (100+ HP V compound, overhung crank with a heavy flywheel and driving a standard heavy duty industrial chipper).

THE BASIC CONCEPT

1/. Maximum power within WHR loading gauge using Ffestiniog 'speciality' type of locomotive = Super Fairlie. 100% adhesion (no carrying/guiding axles, minimises weight, and cost).

2/. Maximising power to weight ratio is the most cost effective way to achieve high overall efficiency, whilst using best modern thermal and mechanical design, but avoiding excessive complexity which would increase first cost and ongoing maintenance costs.

3/. Effectively two 0-6-0T engines with a single boiler, one engine exhaust used for draughting, the other with the advantage of no exhaust back pressure has all its waste heat conserved.

1/. BOILER (combustion):-

A Sam Mackwell (New Zealand) style dry firebox 'flash' boiler with no large/heavy/expensive/dangerous pressure vessel would be ideal in this application, where low weight/low cost/high safety are all priorities, conceived for optimum wood fuel combustion. No heat is extracted in the firebox and the very high temperatures allow complete combustion and low contamination of the heat exchange surfaces.

The fuel is burnt on a large pinhole grate area (very low primary air draft/low particle carry-over), covered with broken heat storage radiator bricks (yes, 2024 road engine trials) to retain fire-bed heat, especially when standing (some cordwood can be carried for this purpose). Firebox walls made of fire brick, possibly with extra thickness at grate level to allow of erosion. Secondary air enters via side and front ducts above the grate.

Note: due to the minimal fire-bed air resistance and low primary air requirement a Lempor blast pipe would cause very low back pressure on the cylinder exhaust, only sufficient draft is required to create turbulent secondary air above the fire-bed, and this is augmented by the air blower when firing under full load conditions. The fire box to be of large volume and longer than its width, with flame path around a brick arch, with an air deflector (smoke plate) assuring good gas mixing/combustion.

Primary Air: The back damper takes warm air from a heat exchanger under the cab, heated by exhaust steam from the trailing unit, after it has passed through the feed water heater, maximum residual heat in the exhaust from the trailing unit is conserved. Air tight ash doors both sides, wood produces very little ash.

Secondary Air: Warmed air admitted via damper and ducts above grate at sides and front, below brick arch. Also through an adjustable vent at the fire door (drawn from below, preventing blow-back risk). A glass window can be opened for raking access, and hand firing cord wood. This air flow keeps the glass clean and could help cool the pellet feed deflector.

The grate, ash pan and dampers assembly is secured to the 'foundation ring' externally so that it can all be lowered and withdrawn backwards at rail level.

Two direct-loaded NON pop safety valves (see NOTES), allowing pressure to be kept near the 'red line' without wasteful explosive blowing off, or requiring unnecessary pressure reduction before closing. Steam pipes from twin regulators to two independent superheater headers (one regulator handle). The main steam pipe to the trailing unit passes along the inner bottom edge of the right tank and then down under the cab floor (drip valves at low points). Low profile manifold within firebox top lagging between windows, with integral main stop valve

Two flooded injectors of modern theoretically correct design (one larger), both mounted under the footplate on fireman's side, the smaller calculated to deliver the average boiler evaporation (both to have overflow anti-suction valves). Each injector feed pipe to have a non-return valve near the injector (plus a frost drain tap), to keep the pipes filled. Larger takes water from the top/middle of the transfer pipe (LHS, in front of the back tank transfer valve; drain cock at lowest point); small injector and feed pump supplied independently and direct from near the lowest point of right side front tank (to ensure that water in the front tanks is used first, before it becomes significantly warmed, and reducing the heaviest axle loading. Each injector service water valve precedes its in-line filter so that these can be cleaned easily. NB Injector/pump arrangements may need amendment if Mackwell type boiler is used.

Feed pump driven by the trailing power bogie feeds via a heat exchanger (contra flow), but only when there is steam chest pressure applied to that unit (normally ensuring hot feed, but this can be overridden). Pump suction has stop valve before filter (only for use when cleaning filter).

2/. GENERAL CONSTRUCTION:-

The general construction of the locomotive frame to be all welded, incorporating the front and back water tanks (all plates shot blasted, and treated internally against corrosion after welding, using the best technology available), cab floor, sides, roof and bunker. The boiler outer casing is bolted to a saddle at the smoke box, uniting the side tanks which are structural, and housing a centre-less roller which transfers some weight (small due to the overhung weight of the cylinders at the front end) to the leading power bogie, and necessary because the main pivot, with main load pads each side, is situated between axles 2 & 3. The inner plate near the bottom of the tanks is thicker than the rest of their construction, and is braced horizontally to the outside and the bottom as required. The tops

of the tanks are braced by a bolted tie plate over the top of the boiler casing, and also at the smoke box, the former (plus a curved lip along the top inner edge of the tanks alongside the firebox) prevents water going down the back of the tanks; also the long tank filler lids are hinged on their inner edges and arranged to stand just beyond vertical when open, self venting when shut. Under the boiler 'barrel' is the leading unit pivot stretcher between the tanks: the boiler does NOT rest on this, it does NOT transfer weight to the power bogie, and it is as deep as possible to accommodate traction wear. This stretcher only locates the centre of articulation and transmits traction to the boiler/tanks structure; the pivot is oil filled with a labyrinth seal at the top. On the transverse centre line there is a load bearing pad each side, grooved liners, oil filled and with covers to exclude dirt and water. At each location (3) there are sliding clamps to provide security in the event of derailment. An adjustable hydraulic damper (if required to prevent bogie hunting) could be attached between the inner end of the leading bogie and the side/tank framing. Cross brace, and transfer pipe (with drain cock) between the front tanks in front of the firebox at lowest point (with flexibility). The heavy sections near the bottom of the tanks pass alongside and close to the outer fire box.

A RH cut out as required to accommodate the main steam pipe to the trailing bogie. The boiler back-head and its cladding is entirely outside the cab front except round the fire hole, expansion bracket and for the water gauges etc to be attached. This allows the cab to be fully weatherproof, increases crew safety and stiffens the cab structurally. Immediately behind the fire box there are cross members under the cab floor which is welded to them giving diagonal stiffness to this area, and the front one extends forwards (through the cladding) and supports the back plate of the boiler via a full width expansion bracket (with bronze liner). There is a space between the firebox casing and the frame members all round filled with insulation board and the warm air ducts for the secondary air. An allowance for boiler casing expansion at the back.

At the back of the cab the main frame plates (plus additional fore and aft members between) are integrated with the back water tanks (balance pipe with drain valve between them), and with the wood pellet bunker as an all welded structure. The cab foot-plating lying outside the main frame plates is welded both to them and to the front and back tanks, and also to deep stiffening valences on their outer edges (flush with tank sides). The cab structure is all welded, and is 2" narrower than the tanks each side, and with the cab sides being curved inwards at the gangways the grab handles attached at this point are within the overall tank width. Plate edges round doorways strengthened by half-round beadings, and the roof reinforced with a double skin along its outer edges. The framing between the back tanks carries the traction and load bearing pivot for the trailing power bogie. The upper bronze circular pad is grooved and oil immersed, and fits into a steel housing on the bogie, mounted on a longitudinal pin to accommodate twist over the length of the locomotive, a lipped retaining ring/cover excludes dirt and water. Roll is limited by grease lubricated steel side bearing pads which have an adjustable running clearance (by shims), and are mounted on resilient backing. This arrangement provides some torsional flexibility and allows the individual axle-box springs to function independently. A fourth point of support is provided above the trailing cylinders as with the leading unit, and an hydraulic damper could be fitted between the inboard end of the bogie and the main structure, as on the leading unit if required. Security sliding clamps/straps.

Note: Due to the weight of the boiler being less than a conventional fire-tube boiler, there is the opportunity to add ballast weights at various places to optimise weight distribution, taking into consideration that water will be used first from the front tanks as fuel is drawn from the back bunker.

3/. POWER BOGIES, GENERAL:-

Construction of both units as welded steel boxes, the lower part 'double framed' between the cylinders and the horn guides (full depth on the pivot centre line), with horn stays etc. bolted where required for removal of the wheel sets. Also removable, any components that require regular repair/replacement. Horn guides to be part of the permanent welded structure and braced outside by the 'double frame' and ribs let-in on the centre line. Pockets in guides for manganese steel pads, set in heavy duty adhesive to prevent fretting. Guides machined at a single set-up after de-stressing the whole fabrication, and pads to be a standard thickness giving a uniform running clearance. Due to lack of depth available the top plate carrying the leading unit pivot is not load bearing, but transmits traction to the main frames. Slide bar brackets (outer web set forwards if required to allow removal of connecting rod on BDC), cylinders etc. to be bolted to machined pads, and into slightly tapered recesses for exact location rather than using drive-in fitted bolts. Power units to have a 6 foot 3 inch wheel base and use a superior brake layout where brake blocks clasp flanges. Axles 2 and 3, 4 and 5, to be leaf sprung (between double framing) and compensated (each side of main bogie pivots), and the rocking beam located on the same centre as the

adjacent brake hanger (inside frames), springs are located between the double frame plates, the outer plate relieved to allow spring replacement. Pivots etc with Vesconite bushes if suitable.....? The leading and trailing axles being at the extremity of the total wheel base are coil sprung to allow a long travel without undue change of load; they carry a lighter load than the inner compensated axles.

4/. RUNNING GEAR:-

a/. Cylinders:- The four cylinders (9 3/4" by 15 1/2") to be identical castings and symmetrical about their transverse centre lines. Castings to have sufficient thickness to allow for reborings and also ultimately for fitting liners; castings to be of Grade 17+ copper (LYD), if these are considered to have been successful ?

The valve chests to be on the inner top angle, of ample volume (inside admission) provided by increasing the diameter between the valve liners and with large inlet pipes, plus thick insulation all round. The ports to be straight and short and with their width and thickness giving an ample uniform cross section. Flat piston heads (see drg.) with bevelled edges adjacent to ports and fabricated to minimise weight, secure exact clearance dimensions and ideal clearance volume. Port clearance also cast in the top part of cylinder end covers, the lower part locating in the counter-bore: Clupet rings. Inner piston rod and valve spindle gland bushes pressure lubricated. Separate large exhaust passages (with flanges) pass inwards/downwards (for ease of de-carbonising), and fabricated steel pipes then blend 'extractor manifold' fashion, feeding into the bottom socket for the flexible pipe connecting to the blast pipe. NO exhaust through hollow piston valve (cool exhaust through superheated steam chest ?!).

Note 12/10/20. Cylinder bore to stroke ratio.

It appears that over the years the achievement of high cylinder efficiency by using a generous ratio of expansion has been sacrificed for greater tractive effort, with gradually increased bore diameters. The Great Western in the early 1900s made standard a long stroke cylinder of 30" for 18" bore, a ratio 1.66, which in combination with large diameter long lap piston valves gave superior results to all previous designs. In subsequent trials the efficient use of steam allowed G W locomotives to out-perform locomotives with larger boilers. Whilst there are theoretical disadvantages in adopting an excessively long stroke it does appear that these proportions approach the ideal; curiously the Golden Ratio (Golden Mean) is 1.618.....

b/. Valves:- 6" diameter, inside admission, long lap, 6 narrow rings per head. Ring control of events, chamfered end lands. Tubular spacer for valve heads but NOT through-ported (see Design Notes File). No sight holes for valve setting (unless arranged not to add clearance volume), but marker groove in valve spindle combined with tight tolerances for valve and liners, plus reference pointer attached to valve chest. Valve spindles supported by ample diameter/length inner gland bushes (pressure lubricated, piston rod glands ditto) and by external guide for adjuster extension. Valve assembly fully floating and attached to valve spindle between larger diameter back end and nut/lock-nut with running clearance.

c/. Wheels:- Cast steel disc style with the cast-in balance weights, supplemented as required by fly-crank weights. Particular attention to be paid to minimising reciprocating weight, and balancing to minimise bogie hunting. If required, additional hydraulic damping could be provided. Wheels braced by radial ribs inside with a view to having axleboxes with guide flanges on inside only (increasing thrust face area, and seating for cranks). Tyres to 'Porta high adhesion profile' with oil thrower lips and extended-turning treads, also possibly driving wheel tyres to be slightly larger diameter than coupled wheels as L V Porta's scheme?

d/. Axles:- Design based on FfR best practice (stepped press fits etc).

e/. Axle Boxes:- Bronze with white metal crowns, under fed and no oil grooves, fitted with inset wear pads on horn faces (hard bronze or manganese steel, grease lubricated). Possibility of one-side-only guide flanges, increasing width of pads: see GENERAL NOTES, Double Framing.....

f/. Motion:- Connecting rods:- Big ends fitted with needle roller bearings (limited ground clearance), oil lubricated with spring loaded relief valves to prevent blowing seals when pump oiling, lip seals or excavator track-roller seal design). 'King' coupling rod also needle rollers, and hardened washers/seals between big ends keep rods aligned. Little ends with standard plain spherical bearings (oil syphon lubricated) and clamping gudgeon pins (see cross head and pin drawings), this allows all rods to twist with driving axle; Leading coupled axle cranks to be fitted with spherical roller bearings (grease lubrication). Gradient pin joint spherical to allow twist between Driving and trailing coupled axles (grease); Valve gear to use roller and needle roller bearings, where loading is high and rotation

considerable, otherwise case hardened steel bushes and steel alloy pins: all grease lubricated with O ring seals and tell tail relief drillings (to prove grease delivery); expansion links and cross head slides, also valve spindle extension guide and radius rod lifting guide (unless suspension links give better geometry): oil syphon lubricated.

NOTES on crank bearings:

1/. Consider using Vesconite floating bushes in hardened rod end bushes, especially for connecting rod big ends to keep outside diameter within ground clearance limit. Note 12/12/21: WHR experience with Garratt 130 suggests this is not suitable?

2/. Not suggesting the use of roller bearings for axle boxes with hard liners and small clearances at horn faces, as there should be some resilience(?) behind facings (Manganese steel on boxes, Vesconite on guides) to allow for coupling rod centres lengthening when one axle-box lifts or falls, which could 'hammer' the bearings (ref ASTT research)? Plain bearings are more forgiving..... relatively cheap and repairable.....

g/. Valve Gear:- Compact arrangement of Walschaerts' gear (to achieve good geometry and a low profile under tanks). Box type expansion link with four feed oil box to the die blocks; sliding lift-block (oil lubricated) behind expansion link on arm pivoted at the same centre. This arm is pinned and clamped onto the weigh shaft that passes through the same centre line as the double pivot needle races for the expansion links. Provision for fitting pin/padlock to lock weigh shaft in mid gear in the event of hydraulic or other failure, after lifting die blocks with pinch bar. Valve setting indication back to cab by flexible steel cables, each unit independent (see notes).

Return crank of small throw, to give good geometry and minimise inertia in gear. Combination lever carried on a rocking lever with a ratio of 6/10 (and not on the valve spindle), which produces the required long valve travel, AND transfers the drive to the valves on the INNER top angle of the cylinders. Rocker pivot (needle roller bearings) situated between piston rod and top slide bar, levers each side of slide bar, inner one may need recess in bar (in addition to thickness of cross head) to clear leading crank pin. Connection to valve spindle extension by link, and tail guide attached to top slide bar (oil lubricated), vernier adjustment as on Lyd. Geometry tested in full size working model, but will need full computer analysis.

h/. Brake Gear:- Brake hangers and blocks as on LYD (flange claspings, and all pins Vesconite bushed), air cylinders for graduated independent brakes ('Mechanical Traction Control', possibly electronic), also linked proportionally to train vacuum system. The brakes are APPLIED by a pair of compression coil springs (each bogie) and the air pressure (two cylinders) holds them OFF (fail safe), and can only be locked off (in Works or failure in service) using special release 'nuts' stored prominently on the drivers console, the screws on which they fit also indicate degree of brake wear. Air reservoirs can be charged by external connection (in Works), by onboard battery electric compressor, and normally maintained by a mechanically driven air pump when the locomotive is running (with unloader when fully charged).

Control of air brakes proportionally by vacuum AND independently by graduated controls in PARALLEL.

5/. AUXILIARIES (Mechanically driven from trailing unit):-

A cabinet at the back of the cab (behind the twin sand box and between the back water tanks) contains a countershaft at floor level driven by a sloping shaft from a speed increasing bevel gearbox mounted in the trailing bogie, this shaft uses agricultural universal joints and splined connections for ease of dis/assembly. Each item is driven by chain or belt with ratios to give the required running speeds. Also located here is the hydraulic fluid reservoir, and all control valves for the hot water feed, braking and air systems; also twin alternators. NB All items that require to be operated whilst the loco is stationary are electrically driven, eg hydraulic pump to set valve gear, and pellet feed motors.

a/. Vacuum Pump:- Rotary vane type to maintain the train pipe vacuum under normal running. (Also large and small ejectors provided). Maintaining vacuum with an ejector uses fuel.....say 7days/4hours per day, Garratt = approx. 1/2 ton coal equivalent?

b/. Air Compressor:- To supply the main reservoirs (a secondary reservoir located between the front tanks just ahead of the firebox), and individual brake reservoirs on each bogie for the graduated brakes (non-return check valves, safety and drain valves). Also electric motor driven backup air compressor. Workshop air line connection.

c/. Boiler Feed Pump (triple ram 'CAT' type):- Circulating water constantly from the RH front tank to the transfer pipe from the back tanks (outside left frame plate) and in front of the stop valve that prevents water from the back tanks flowing forward on steep gradients, and vice versa, and also allows adhesive weight to be maintained on the trailing unit whenever possible; filter and local stop cock for use ONLY when cleaning filter. The pump only feeds the boiler (via the heat exchanger) when the bypass valve closes, which is automatic when steam chest pressure rises to a given value on the trailing unit (to insure only hot feed, and to match feed to steam consumption), but can be manually overridden (both TO feed or NOT to feed: two valves).

d/. Heat Exchanger for boiler feed (lagged):- Through which exhaust steam from the trailing unit passes before entering the combustion air pre-heater; diverter valve to a chimney vent (to prevent loco being enveloped with steam in damp conditions!). Condensate is not reused, as this would mean pumping hot, contaminated and untreated water, and the efficiency of the heat exchanger would be reduced (water is not scarce in North Wales). The cold delivery from the feed pump passes through the tube banks in contra flow arrangements to maximise heat exchange, and there are two separate stages. Frost drain taps. The main air reservoir (in two parts, each approx. 14" diameter by 48") is mounted on the RHS inside the bunker, the gap between allows for the tank filler. The feed water heat exchanger (insulated and in two parts) is mounted on the LHS inside the bunker. The trailing end sand boxes are mounted between and above the cylinders, recessed into the back of the bunker and accessible for filling from the back.

e/. Twin heavy duty 24v alternators (all systems fully fused and ammeters provided to confirm operation).

f/. Full lighting system in cab, injector overflows/foot steps, powerful head/red tail lights.

Drive for auxiliaries:-

A large split sprocket clamped (4 bolts, no keyway) onto the inner (driving) axle of the trailing unit, and drives an industrial speed increasing gearbox mounted just ahead of the bogie pivot, via a horizontal duplex self oiling roller chain to a countershaft, by means of one way clutches the rotation is always the same whichever way the loco is running; this drives the sloping shaft to the auxiliaries.

6/. GENERAL DETAILS:

a/. Draw Gear:- Similar to that on LYD (centre-less with no pivot pin), mounted on bogies.

b/. Sanding Gear:- Geared electric (possibly air) motor driven sanding by horizontal augers, and detailed to keep sand warm and dry. Leading and trailing boxes located between the cylinders, (filler tubes for trailing boxes recessed into bunker), rigid delivery pipes. Middle twin box built into the back of the cab (hinged lid forms a wooden seat) and can be used in either direction to supplement sand dropped by whichever boxes are leading. Auger: half left handed, half right handed screw, worked by 4/1 ratio chain drive from a hand wheel above (ratchet allows correct rotation only), flexible pipes attached to inner end of trailing bogie.

c/. Boiler Lagging:- The lagging could be eccentric to maximise bogie and tank clearance; 2" thick at the bottom and sides; 4" at the top where most heat would be lost. The latter is additionally enclosed by an outer steel plate which ties the top of the tanks, preventing ingress of water between the tanks and the boiler. Elsewhere 4" lagging, and 1" insulation board and air space round the lower firebox sides. Smokebox insulated and stainless steel clad.

d/. Water Tanks:- All welded construction. The heavy section, structural part of the front tanks inner plate and bottom, to be braced as required, also in the area of foot plating between the front and back tanks. Enclosed storage space on top of the L/H tank for lighting up tools flush with cab side, ie. 2" narrower than tank. Lengthened filler openings to ease 'spotting', plus additional fillers on the back tanks. All filler lids hinged on their inner edges to just over vertical only, and arranged to allow venting of those not opened during filling. Flexible joint in transfer pipe front to back tanks, with a quarter turn stop valve (and indicator: open/shut) fitted next to the back tank on the Left side to prevent surge on 1:40 gradients causing overflow at either end, this also enables water to be retained in the back tanks to maintain adhesion. Balance pipes between side tanks (front/back), and both have mechanical level gauges in the cab.

e/. Other Cab Details:- The floor non-slip timber covered, and the roof with two sliding ventilators. The side window brass frames of LYD pattern, the drivers side glass/inner frame arranged to slide back (driver seated). The front and back spectacle glasses rotatable (Lyd pattern). Folding doors provide crew safety and protection from the

elements (these fold in half and hinge back against the back tanks). A glazed shutter can be fitted during winter months, into slides above and below the fireman's side window, and slid back over the door opening to prevent rain/snow blowing through the cab.

DRIVING, right side:- The driver to have an upholstered, rotatable, 'agricultural tractor' style sprung seat (plus adjustable foot rest), and this can rotate complete with the driving 'console' around a steel column welded to the floor (cables/pipes within). The 'console' has all the pressure gauges for the braking system, steam chests, plus the independent air brake control, train vacuum brake; miniature reversing levers and hydraulic pump power switch (all spring centred) and cut-off indicators each side of them, worked by Bowden cables from weigh shafts, hydraulic pump runs forward or backwards, ie towards full forward gear or towards full back gear*; sanding gear; cylinder drain cocks. This allows the driver to sit with a clear view in either direction of travel, with a shoulder against the cab-side or doorway. The controls can also be reached by the driver standing in the cab doorway (shunting). Additional controls/gauges attached to cab side. The side window on the driver's side can slide back.

Note*:- A pressure relief valve opens at full travel of die blocks, and in-line spring loaded valves ensure setting does not 'slip'.

Note 20/01/17

Drivers seat and main console mounting:- The outer of two concentric steel tubes (with console mounted on the top) has three pairs of sealed roller bearings (spaced apart and on a vertical axis, outer tracks fit through slots so that they run on the inner tube) arranged 120 degrees apart to allow the assembly to rotate freely. Between a pair of the rollers a bracket is provided for the radius and height adjustable seat and its foot rest, also at this point a single roller bearing (axis radial) is attached to the lower edge of the outer tube and runs on a ring around the inner tube where it is welded to the cab floor; detents in the ring secure the seat in the desired positions.

Details, Rotating Console:- duplex vacuum gauge, two graduated, loco only, air parking brake/traction control gauges, and two main air reservoir pressure gauges; two steam-chest gauges; speedometer. Mounted on the cab-side between the window (lower than) and the doorway:- duplicated blower (quick action spherical valve) and ejector steam valves: these work their remote valves via linkage. Graduated air brake control (horizontal/transverse axis) brakes each unit independently: handle UP = OFF, BACK applies trailing unit, FORWARD applies leading unit (traction control); sprung toggle switch for electric sanding gear, forwards = leading unit, backwards = trailing unit, (middle boxes worked manually by fireman. Parking Brake: a transverse spindle projects horizontally from both sides of the console (reached by driver OR fireman) with a red/green double handle, retained UP or DOWN by a strong spring detent. This operates a duplex valve block such that when the parking brake handles are UP (red) both units' graduated air supply is isolated (so that the graduated controls can't override parking brake application), and the air is fully released from both units: thus fail-safe to ON due to spring application (multiple coil compression springs with air release). When the green ends of the handles are UP the parking brake is released, and the two independent graduated controls are activated. Air pressure gauges for each unit show:- 'Brakes ON/ Brakes OFF' and graduations. Whole train braking is via the vacuum system which independently applies the air brakes on the locomotive: see separate schematic plan.

Note regarding release of Parking Brake when reservoirs are discharged:-

1/. In works or in service (failure) by use of on-board 24v battery-electric air pump.

2/. In works by use of compressed air line to external feed-in connection.

3/. In works or in service (failure) by use of release nuts (see note 4/ h/. above).

The regulator lever is pendant from a transverse pivot (above side window) with a push-pull action (pull back to open), handle horizontal, locking ratchet released by a 'trigger' on the push-to-shut side (back), also a catch to prevent closing of atomiser/drift ports in normal running. The handle is located within reach if the driver is standing in the cab doorway, as also are vacuum and air brake valves (for ease of buffering-up and shunting generally). External rod passes through the cab front to an (upwards pointing) arm on the regulator shaft on the right side of the dome cover. Whistle chain across width of cab. Manifold stop valve (central). Large and small ejectors stop valves, both service valves worked by linkage from cab-side. Ejectors and valves mounted in space between R/H front tank and cab front with removable cover plates in cab (on dowels with R clips).

Additional driver's side controls and notes:- vacuum limiting valve accessible for adjustment/cleaning; release valve for 'reference only' reservoir; drain cocks (air operated, 1 per unit). Two steam chest pressure gauges, the trailing unit gauge marked with a green line showing the minimum pressure required to close the water pump bypass valve; Front tank water level, and back tank gauge on front of R/H tank; four lubricator 'WORKING' green indicator LED lights (pulsed electrical impulses).

FIRING left side:- Boiler Pressure Gauge (mounted centrally on back-head in view of driver) and isolating cock; two Water Gauges (heavy duty, reflex type), with working levels marked for 1:40 gradients UP & DOWN (running forwards); Whistle chain (duplicated). Dampers: Front damper = Secondary air via brick arch; back damper = Primary air (warm air from heat exchanger, screw control); blower, duplicated (fine control with handle not hand-wheel, and mounted centrally on boiler back-plate, driver has quick action valve. Feed pump manual by-pass; override valve to close automatic bypass (steam chest pressure controlled); pump delivery pressure gauge (confirms that pump is feeding). Parking Brake handle (red/green) at the inner end of the rotating console, see Driver's Side for details. Large and small injectors: two stop valves on manifold; quick action steam valves, and water valves (quarter turn) on cab-side; fire door with viewing glass and adjustable auxiliary air vent/deflector below. There must be an airline connector for the blower for steam raising, as the smoke is unpleasant if there is insufficient top air.

ALL THE ABOVE TO BE REVIEWED IN LIGHT OF BOILER CHANGE.

Feed hopper for observation of feed from auger to pellet 'blower', delivery via nozzle built into fire-hole door (Details see below). Footplate wash-down pipe and stop valve, fed from small injector. Diverter valve for exhaust steam (after feed water heater) direct to atmosphere. Electrics box (housing inverter and back-up for 110v AC motors) mounted on LH cab-side front corner below window (clear of floor). Battery charge/discharge ammeters (two alternators), head/tail, cab and gauge lighting switches/fuses, back up electric air pump switch. (Batteries:- Enclosure on driver's side between main frame and outer valence, towards the back, away from main steam pipe). Seat with oil bottles under. Emergency vacuum brake application valve, below L/H cab-side window and reachable from outside the cab. Middle sand box with hand wheel worked augers (chain drive with c. 4/1 ratio), two outlets fed by R/H and L/H pitched augers. Windermere Steam Kettle.

WOOD PELLET FIRING:

1/. Electric motor controls (variable speed) for drive of auger from bunker to high level hopper; A sight glass in front of bunker. Manual control valve from hopper to blower.

2/. Electric motor ON/OFF for drive of 'pellet blower', fed from hopper (details below).

3/. Deep bed, low draft combustion: anticipated depth 4"/6".....

4/. The fire door fitted with a large viewing glass, air washed via an adjustable top air vent ducted from below (blow back safety), a smaller lower port allows fire levelling. Air to glass ducted around lower port.

20/10/20

Sam Mackwell Boiler (Agloco, New Zealand) option:-

If this design was adopted there could be a considerable saving in weight, plus other advantages: near zero pressure vessel risks and easier insurance; rapid steam raising; lower first cost and repair costs. Traditional boiler 'reserve' would be replaced by a fast response water tube system. However, its outer shell would have to be sufficiently robust to perform the function of providing torsional stiffness to the locomotive structure, and protection from steam tubing failure.

Wood Pellet Firing Details:

Fuel would be wood pellets fed by auger and high velocity air blower. A small diameter auger raises pellets from the lowest point in the bunker (variable speed motor), to a high level hopper (allowed to over flow back into the bunker when full) mounted inside cab roof, glass front and fitted with a valve to control pellet flow. Pellets directed into a funnel (for observation of feed and acting as a fire-break) situated at the back of the footplate, as high as convenient, with the blower under it. Pellets drop into the air stream via a connection that creates a slight vacuum; a loosely fitting duct slopes across footplate to fire hole, with a glass access door in the top of the airtight casing,

adjustable vent below. The blower (electric drive) blasts pellets via a steel nozzle and deflector manoeuvrable by a joystick, left/right and forward/back (friction device required to hold setting). The fireman would be provided with a small rake for adjusting depth of fire-bed, and a low level seat on cab centre line for use when examining the fire. Connections in pellet feed duct are slack to allow easy disassembly and to ensure some air flow at all times to keep delivery nozzle mechanism from overheating.

f/. Mechanical Lubricators:- Mounting brackets on back end of steam chests and drive by rods from top of expansion links, via holes in slide bar brackets. Multi point feed: steam chest (with atomising steam, this is not very high superheat locomotive); valve liners and mid point at bottom of cylinders; all inner gland guide bushes. Non-return valves at each lubrication delivery point, a passing electrical contact on each lubricator drive gives a cab indication that each of the four is working.

g/. Draughting:- Low draft through the fire bed essential for burning wood pellets. The leading unit's exhaust passes to a high efficiency blast pipe and chimney liner of 'state-of-the-art' design, and with an ample free gas area only modest smokebox vacuum would be required (sufficient to create top air turbulence over fire-bed). Efficient spark arrestor required. The trailing unit's exhaust (with minimal back pressure) passes to a feed water heater (two stages and contra flow arrangement), hot feed allows the boiler to be smaller than otherwise. After passing through the water heater the steam is directed to a combustion air heat exchanger under the cab floor. The latter can be bypassed to a vent chimney on loco centre line behind cab by diverter valve (in cold damp conditions when condensed steam could affect visibility).

h/. 24v head/tail lights each end plus full cab, foot steps/injector overflows lighting system (+gauges and interior)

GENERAL NOTES:-

Double Framing, the reasons for:-

Normal plate frames need to be quite thick (with wheels inside) due to the impossibility of sufficient internal cross bracing at the bottom, and certainly require axle boxes with double flanges to share the sideways bending forces on the frames between the two sides of the locomotive. Bar frames have a similar difficulty but additionally the springs have to be either above or below and on the frame centre line: the latter not feasible with small diameter wheels. Springs above are not possible in the case of an articulated power bogie mounted under side tanks, and with a loading gauge height limit. Double framing (outside wheels) allows the horn blocks to be supported on their inner and outer edges (in this case as part of an all welded fabrication); the springs can be kept low down clear of the side tanks, between the frame plates and made accessible from outside for inspection/replacement. The double framing is also very rigid from sideways bending due to a ladder form in plan view, especially with a rib on the longitudinal centre line they provide very rigid connection between the cylinders and the horn blocks. The double framing at the sides of the pivot centres also allows the load from the boiler/tanks assembly to be uniformly distributed to the bogie framing. Due to the requirement of providing sufficient space between the double frames for the springs (also for welded construction details), and because of the loading gauge width constraint and the need for sufficient bearing width, it is necessary to have the twin plates as far apart as possible. Thus, due to the rigidity of the double framing, it would be possible to have axle boxes with inside flanges only: the wheel flange thrust being taken through the axles to the axle boxes on the opposite side (also adds width for crank seating). The axle boxes would be bronze castings (heat dissipation and ease of white metallurgy) with flanges relieved to allow for axle cant, and the horn blocks being part of the fabrication made of mild steel; both faces would have inset wear pads of dissimilar materials, manganese steel against either bronze or Vesconite. Wearing of the guide edges of the mild steel blocks/bronze boxes easily restored. The wheel hubs would be flush (more or less) with the outer tyre faces (lip on tyre), and well braced on their inner faces.

Fitting and adjusting coil springs between double framing for leading axle:-

The spring hanger, with top and bottom spring mounting plates, spring and bottom adjusting nut, is installed by partially compressing the spring using the nut, so that the assembly can be inserted at the front or back of the location. The square bottom plate fits between the double frame plates and prevents it turning, and a central boss fits snugly inside the spring. The bottom 'nut' is tubular and has a 3/4" square drive at the bottom, and accessible through a hole in the framing bottom flange for spring adjustment. Once installed the bottom nut is released so that the spring hanger can be raised and attached to the top beam connecting the springs to the axle box. When

adjusted the correct clearance can be checked between the bottom mounting plate and the frame mid-rib via the circular hole in the outer frame plate, and must be at least the maximum rebound distance between the axle box and the horn stay. The top mounting plate also has a central boss to locate inside the spring, and bridges the slot provided in the top mounting bracket to allow fitting.

GENERAL NOTES:

Note regarding the routing of live steam pipes from the manifold on the firebox top to the injectors, ejectors, etc.:- So as to increase safety, reduce copper polishing time and minimise heat loss, pipes from right angle stop valves on the back of the manifold pass down the space between the back of the tanks and the front of the cab, also feed pipes run upwards to the clacks. Vacuum ejectors mounted under removable access plates, with their service valves having extensions to the cab-side driving console. Injectors mounted on the outside of the main frame plate under the cab LHS, inside and below the outer valence. All screwed/bolted couplings in pipes to be easily accessed with spanners.

Note regarding fabrication of bogies and tank/cab unit:- All steel plates to be profile cut with locating tongues and slots to allow accurate assembly and clamping of all major components before welding in a predetermined sequence after tack welding. The side sheets of the cab, being structural and set 2" inboard of the tank sides, are welded to a thickened area of the tank tops with generous radii. Cladding covers over manifolds, clacks, etc. not to be fitted permanently until the boiler has been cycled over a period of time, so that all studs/bolts remain accessible to be fully re-tightened; all covers located on dowels with R clips for ease of access.

Note regarding presentation:- Paintwork obviously to the highest standard, Midland Red or perhaps Caledonian Blue for blue-sky thinking? A 21st century design but 19th century standard of presentation. Bright work to be nickel or satin chrome plated: side rods, motion, cab windows and whistles etc.; matt stainless steel smoke box (cladding), hand rails etc. and sheet stainless steel for highlights eg. lagging bands. Yellow brass for works plates\name plates in FfR style, ie. flat with sunken lettering (easier to clean). Any exposed cold water pipes could be left polished copper where convenient for cleaning.

Notes regarding Traction Control and superheaters:-

Independent regulator valves BUT one operating lever. (ie. if one unit slips the steam pressure does NOT fall in the other unit and independent graduated air brakes are used for control, NOT shutting regulator (driver guided by steam chest pressure gauges), plus option of using the independent control of cutoff; option of mechanical AIR BRAKE TRACTION CONTROL (see NOTE at end). With independent control of cutoff, when steaming is good the leading unit can be worked more lightly and the trailing unit harder so that its exhaust heats the feed water more, thus saving fuel, conversely if more draft is required to maintain steam pressure the leading unit can be worked harder.

Note: the centre-less rollers above the cylinders each end of the loco could have their lower tracks inclined upwards each side to provide gentle self-centering of the bogies if required (hydraulic dampers being an alternative for hunting control).

Leading sand boxes to have handles recessed in lids to allow them to be stepped on.

Brake Gear:-

Cross shaft, application springs and air cylinders to be mounted on the OUTSIDE of the inner end of each unit, arranged to clear the tanks/main framing.

Note 5/02/16:-

Cab sides and roof: these brace the main frame under the floor so the cab sides plus outer edges of the roof are of thicker plate and the roof doubled at the eaves to form a shallow box section.

Note 8/2/16:-

re. Use of Lyd patterns:

- All cab windows
- Draw Gear

- Steam valve handles
- Onion oil cups
- Axle boxes ?
- Axle box oil boxes

Note 04/12/16:-

All cylinders and steam pipes including exhaust to be well lagged, also smokebox and feed water heater.

Note 03/09/17:

The s/s smoke box should be insulated with s/s outer cladding to conserve boiler heat at night; there's no point making the effort to save 1% thermal efficiency when the loco is working, and then letting it go cold at night.....

Reasoning for exhaust from trailing unit being used to preheat feed: due to the length (heat loss) and complexity (cost/weight) of the pipework required to take the exhaust to the blast pipe, the benefit in terms of draught would not be great, and with fairly small wheels the blast from the leading unit alone would be steadier than with larger wheels (and using a Lempor ejector). It is considered that conserving the heat from the trailing unit exhaust by heating the feed (thus reducing heat input required to the boiler), and warming the combustion air would be more advantageous. Good free gas area combined with minimal depth of fire-bed, only a modest smokebox vacuum should be required. Hot feed equals smaller/lighter boiler.

Note 27/12/16

Air reservoirs must have drip valves, as any moisture in the system will cause problems especially in freezing weather conditions.

Note 19/01/17

Additional note re lubrication of motion:-

Rotating bearings generally rollers, rocking connections generally pins and bushes, except where angularity (and loading) is great and rollers can be relatively small in diameter (expansion links). Lubrication by oil where this can be retained by O rings and special seals, otherwise by grease. All sliding surfaces: cross heads/slide bars/little ends, expansion links/die blocks, tail guides, oil lubricated by syphons. Return cranks, grease lubricated sealed spherical roller bearings.

Note 22/09/20

Hydraulic drive of weigh shaft setting would save a ton of expensive mechanical engineering, and a nightmare of routing difficulties; it also gets the rattling reverser out of the cab ! If hydraulics can survive in swing shovels/ diggers surely good enough for a steam locomotive?

Reasons for independent control of cutoff on each unit:-

- 1/. With hydraulic drive it would be tricky to ensure that both units were maintained at identical settings.
- 2/. The trailing unit will have slightly lower steam temperature and pressure due to the length of delivery pipe, though it will also have lower back pressure. Adjusting the relative cutoffs between the two units would make it possible to balance the minimum draft required against the maximum feed water temperature.
- 3/. Control of slipping with a single regulator control (independent steam circuits, and air brake traction control) could be refined as weight distribution alters (water and fuel consumed) by adjusting cutoff, lengthening it on which ever unit is tending to slip.

Note: Hydraulic drive to reversing gear:-

A motor driven hydraulic pump (forward or backwards rotation) would pump fluid as directed by the two independent miniature reversing levers, and an hydraulic ram on each unit would adjust and hold the cutoff (two-way, spring centred switch to prevent power forward and back at the same time!).

Note regarding superheat:-

In specifying 'moderate' superheat this is intended to reduce the wear rate on rings and glands, thus deferring the onset of leakage and loss of thermal efficiency. The increased thermal efficiency and power which would theoretically be gained with 'high degree' superheat would be offset, in this application by any extra weight, defeating the primary object of maximising power to weight ratio, also by increasing first cost. "This application" being specifically: the narrow gauge load/envelope limits, and with only intermittent bursts of full power output where the benefit would be gained.

The lower maintenance requirements of 'moderate' superheat would be a positive advantage (longer periods between the need to replace valve/piston rings, and gland packings to minimise steam leakage), so that maximising theoretical thermal efficiency by using expensive or complex engineering is not the priority, as the potential benefit would only be modest. However, an improvement in overall locomotive efficiency can be achieved more cost effectively by maximising power to weight ratio. The 'failure' of moderate superheat on the Great Western Railway, leader in this field for many years, only became an issue as locomotives were pressed to their maximum continuous power outputs; a narrow gauge locomotive designed within tight constraints both physical and financial, and with only short spells of full power output is a different kettle of fish? See also: "Modern Railway Motive Power" (B Reed) P.5 & P.11.

POP SAFETY VALVES:-

Questions regarding pointless 'pop' safety valves:-

Unnecessary steam wastage from the violent opening of pop safety valves, where the pressure has to be brought down considerably before they close, must partly negate some of the thermal advantage resulting from small design improvements in the steam circuit?

When volunteer locomotive crews have varying levels of skill in maintaining ideal amounts of fire/water/steam, surely direct loaded safety valves must be more user friendly (for the public too) and less wasteful of fuel? What is the actual advantage of pop safety valves in narrow gauge locomotive applications?

The Story:-

It may be apocryphal and there are variations.....

An American railroad director was standing next to a locomotive that was blowing off furiously, and he noticed that the pressure gauge was reading somewhat above the 'red line'. He mentioned this perceived danger to his friend who owned a precision engineering workshop, and the latter promised to fix it. Thus was invented the Pop Safety Valve, a clever solution to a non-existent engineering problem. Boilers are of course designed with a considerable margin of safety, generally between five and seven times stronger when new than dictated by their normal working pressure, and a boiler would have to be on its last legs to explode when five or even ten percent above normal. See:- W A Tuplin, D.Sc., F.I.Mech.E. The Steam Locomotive, pages 35/36.....

Practical Considerations:-

The makers of Pop valves were excessively diligent in their marketing and made much of weight and space saving, as well as the reduced over-pressure risk of course. Interestingly Wikipedia suggests that a 'feather' of steam from the safety valves was a sign of a fireman's "virility", and that with the introduction of the Pop valve they "tried to avoid noisy blowing off, especially around stations". Neither of these statements is quite true: a 'feather' at the safety valve simply showed that the pressure was just approaching maximum (which kept any driver happy) and the loss of steam was kept minimal as no fireman wished to shovel any more coal than necessary. As far as trying to avoid noisy blowing off is concerned, crews were instructed not to allow their engines to blow off in stations because the noise, especially with pop safety valves, terrified passengers! In reality there is absolutely no disadvantage in carefully designed directly loaded safety valves in a narrow gauge application, especially where station stops are frequent and crews are of varying abilities. They are user friendly for the crew, giving gentle warning when the pressure is approaching the 'mark', customer friendly in that whilst noisy they do not suddenly explode, and fuel friendly in that corrective action can often be taken before a full-bore blow off. Also, unlike the Pop safety valve the pressure should not need to be reduced BELOW working pressure before the valve shuts (often quite a lot). The latter not only wastes fuel, but when working full-regulator the pressure drop may lead the

driver to lengthen cutoff, using more steam and requiring more fuel to redress the situation. Finally, if a boiler has been somewhat over fired, is a bit too full and working hard, a sudden discharge from a pop safety valve can be the final straw that triggers priming, possibly bringing the train to a stand on a gradient. Comments based on many years of personal experience! If direct loaded non-pop safety valves were good enough for the Great Western Railway they are good enough for me!

The above not so relevant with a monotube flash boiler.....

Further thoughts:-

Power supply from a 110v inverter power pack (duplicated), situated in the electrical enclosure under L/H cab front window. 24v DC may be more suitable for some motors.

MECHANICAL TRACTION CONTROL FOR SUPER FAIRLIE (INERTIA GOVERNOR)

Purpose:-

To regulate slipping by applying independent air brakes on each power bogie. Brakes applied by springs and held off by air pressure.

Method:-

Sensing: by means of inertia governor as once used on marine steam engines, and many others.....

Over speed sensor fitted to one crosshead, with flyweight released by rapid acceleration from front dead centre., and reset by mechanical contact near back dead centre.

When flyweight has been released a passing contact is made with a spring loaded air valve on the back stroke, allowing a pulse of air to activate a relay valve in the independent brake system.

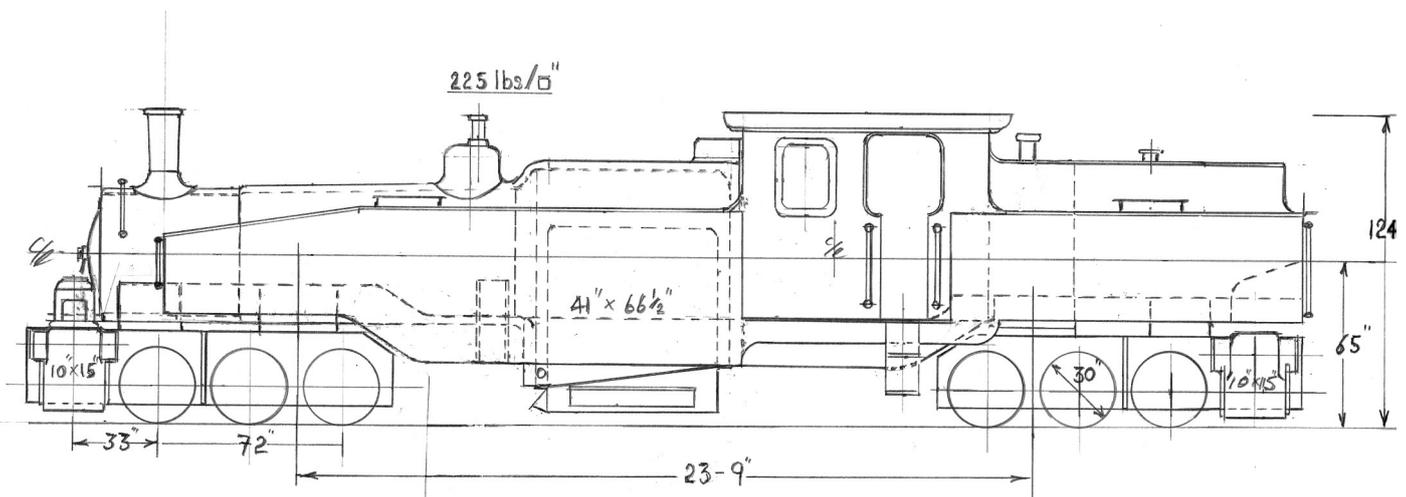
The relay valve is self-lapping and worked via an adjustable linkage by a small air cylinder, the latter having an air vessel with adjustable leak-off.

Operation:-

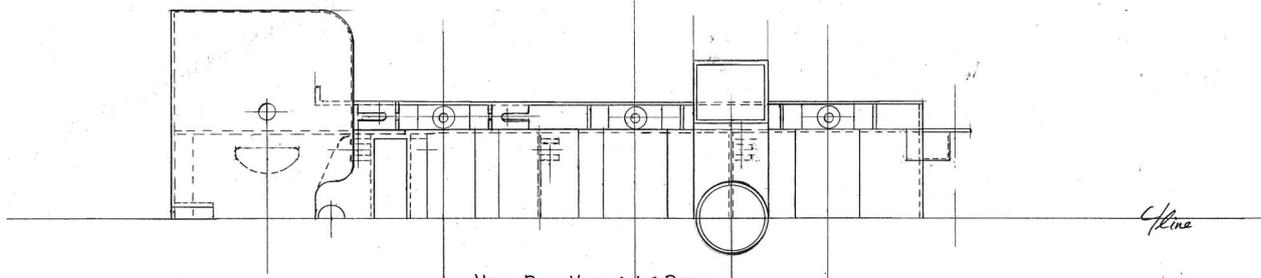
Each time the crosshead accelerates too quickly the air valve sends a pulse of high pressure air to the relay valve. The more rapid the pulses the more air pressure builds up in the air vessel and is applied to the self lapping valve. The self lapping valve reduces the pressure in the brake system allowing the spring operated brakes to be applied. When no further pulses of air are supplied the pressure leaks off from the air vessel and allows the air piston to return to normal under spring pressure/gravity, and the relay valve returns the brake pressure to "off".

Note:-

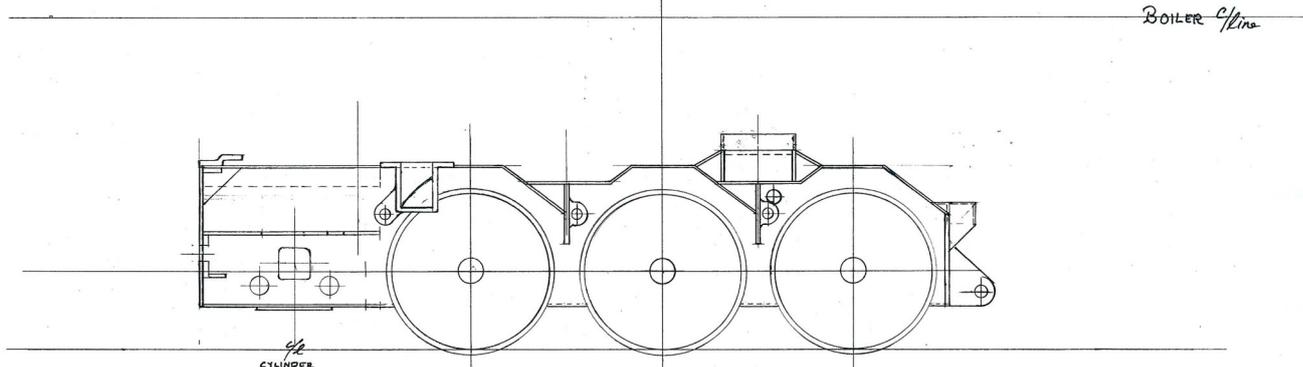
This idea came from experience controlling slipping with a BR standard loco fitted with a graduated brake valve, on a very slippery day.....



Side Elevation (Veg Oil and Lengthened WB Copy)



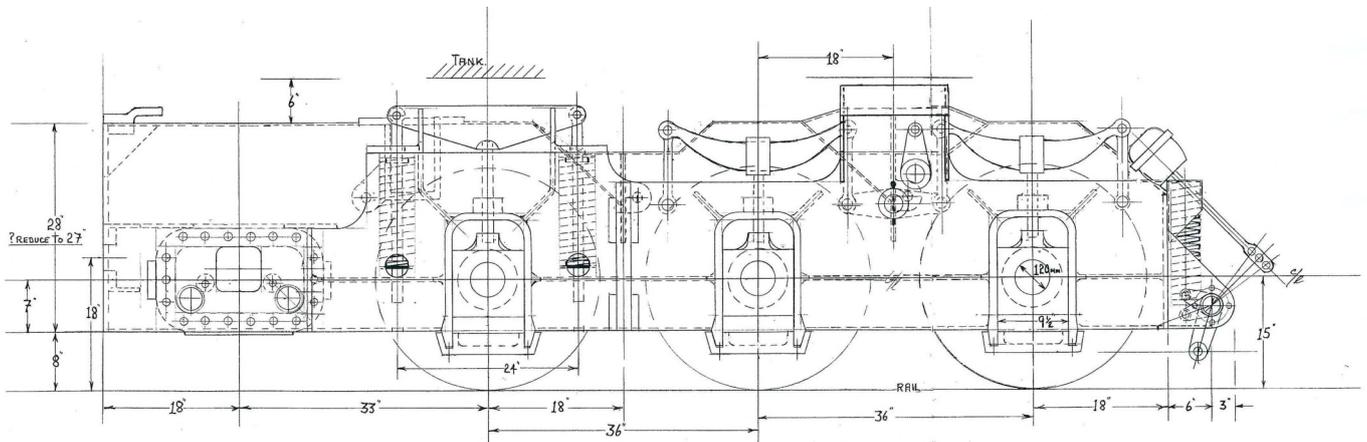
HALF PLAN VIEW: 0-6-0 BOGIE.



PROPOSED LYNTON AND BARNSTAPLE RLY SUPER FRAILIE.
LONGITUDINAL SECTION ON C.LINE: 0-6-0 BOGIE.

DRAWN BY: *[Signature]*
DATE: 09/01/2018.

Half Plan and Longitudinal Section 0-6-0 Bogie



L¹ BR SUPER FRAILIE. SIDE ELEVATION OF 0-6-0 BOGIE FRAMES. YOU MAY SCALE THIS DRAWING.
1/2" MID RIB AND FRAME SPACERS/BRACES TO BE ASSEMBLED WITH LOCATING/WARNING TONGUES.

Side Elevation 0-6-0 Bogie Frame

PACIFIC PARALLELS: THE STORIES OF HENGIST AND DUNGUN

Kayden Akisan & Austin Unruh

As a railway enthusiast in Malaysia with an interest in steam locomotives, I am constantly fascinated and impressed by ongoing projects anywhere in the world to revive a preserved steam locomotive to its former glory, or even reconstruct an entire new one from scratch. Both give paying enthusiasts and the public a taste of what riding behind these legendary machines would have been like in their heyday.

The United Kingdom has led the charge to preserve steam locomotives in operation, with examples of all shapes and sizes across the country, on both private heritage railways and the mainline. The preservation movement began with the Talylyn Railway becoming the world's first preserved railway in 1951 and Great Northern Railway No.1247, the world's first privately preserved standard gauge locomotive in 1959. The spirit of the movement continues today not only with restored locomotives but also with new-build projects such as the new-build London North Eastern Railway Peppercorn A1 60163 'Tornado', where long-scraped designs are brought back to life and even improved with modern engineering techniques.

One such project is No. 72010 Hengist, a new-build steam locomotive based on the British Railways Standard Class 6 Clan design. Hengist is being constructed to represent the second batch of Clan Class locomotives, which were planned but never built due to a shortage of steel in the 1950s. The project, which began in 2010, is steadily progressing. The completed cab and smokebox were put on display at the Great Central Railway before moving to CTL Seal in Sheffield, where assembly is ongoing. Once completed, Hengist will be the 1000th BR Standard locomotive, an incredible milestone for both the preservation and new-build movements.

The British Railways (BR) Standard Class 6, more commonly known as the Clan Class, was a series of 4-6-2 Pacific tender locomotives designed by Robert Riddles for British Railways in the early 1950s. Developed as part of the post-war standardisation plan, the Clan Class was intended to fulfil the need for a lighter Pacific locomotive with a high route availability, particularly for the challenging terrain of Scotland. This was partly inspired by the numerous 'Light Pacifics' on the Southern Region, designed by Oliver Bulleid to keep the wheels of express trains on the secondary mainlines of the region going.

When the Clan Class locomotives entered service, they quickly garnered mixed reviews. Crews that regularly operated the locomotives, especially in their intended operational area in Scotland, praised their versatility and reliability. However, outside of these regions, the Clan Class often struggled to gain widespread acceptance.

One reason for this was that the Clans were frequently assigned work intended for the larger Class 7 'Britannias', for which they were underpowered. Due to only 10 of them being built, crews were often unfamiliar with the class and failed to handle them appropriately. This resulted in performance issues, with many crews finding it difficult to maintain the tight schedules demanded of them.

A key criticism was the Clan's difficulty in maintaining steam pressure, which made it challenging for less-experienced crews to operate them efficiently. This issue, attributed to the locomotive's smaller chimney and blastpipe diameter, resulted in reduced steaming efficiency. Despite later modifications that improved these characteristics, the initial reception had already coloured public and operational opinion against the class.

In spite of their mixed reputation, the Clan Class proved capable when placed in the hands of skilled crews. The locomotives regularly worked demanding routes such as the Settle-Carlisle line and ascended the infamous Shap incline with heavy loads, even without banking assistance. In Scotland, they worked the prestigious Glasgow to Stranraer boat trains, the Carlisle to Edinburgh services, and other arduous duties. Unfortunately, plans for a further 15 were cancelled due to a combination of steel shortages and the implementation of the 1955 Modernisation Plan, which pivoted British Rail towards diesel and electric traction. All members of the Clan class would be withdrawn from 1962 to 1966, with none preserved.

Thankfully, efforts are being made to prove the true untapped potential of the Clans, to which Hengist belongs, by incorporating several design improvements, including the use of frames from the Class 7 Britannia and a new delta trailing truck for better stability and performance. The class's issues with steaming are being rectified thanks to the addition of a new Lempor exhaust, a later development that many locomotives have benefitted from, both in active

service and even the preservation scene. In addition, the operating psi is being increased from 225 to 250. These upgrades will not only help the locomotive to perform better but will also result in a lower coal and water consumption, bringing down running costs, improving ease of operation, and reducing its environmental impact.

This would not be the first time that a design mishandled by British Railways ended up finally proving itself in the hands of preservationists. 71000 'Duke of Gloucester', initially drawn up by Robert Riddles as the next step in Britain's top link express locomotive development, suffered numerous issues in service, such as a high coal consumption and poor steaming. Many crews often described the locomotive as 'enigmatic', the cost of a good run with her often being an empty tender. However, upon the locomotive's rescue from Barry Scrapyard in 1974 and a 13-year long restoration by volunteers, incorporating corrections to the build to make it faithful to the original design, the Duke would see a triumphant return to steam. Later, in 1995, it set a new record on Shap Incline, storming the treacherous grade faster than any other steam locomotive had before or since at an average speed of 51 mph.

These projects are a testament to the commitment of preservationists and railway enthusiasts to keep the spirit of steam alive. While 'Duke of Gloucester' has certainly gained both local and international fame for its performance on mainline rail tours and heritage lines, 'Hengist' is on course to follow a similar path, once again showcasing the ingenuity and power of British locomotive engineering to a new generation.

Hengist's ongoing construction coincides with the restoration process of a preserved steam locomotive in my country, Malaysia. Since her withdrawal in the 1970s, 562.04 'Dungun' has been on static display outside Bukit Mertajam Railway Station, about 200 miles north of the country's capital of Kuala Lumpur, in the guise of her scrapped classmate, 564.25 'Kuala Lumpur'. Upon my visit to the locomotive in December 2023, it was in an appalling state, with several deteriorated components due to the locomotive's exposure to the elements. However, efforts are now being made by DS Rail Mobility, a private railway contractor, to restore the locomotive to haul tourist trains between Kuala Lumpur and Butterworth, where passengers can catch a ferry to Penang Island, a popular tourist hotspot.

The Pacific was moved to DS Rail's facility in February 2024, with an estimated completion date of June 2025. The O Class Pacifics, built by the North British Locomotive Company in Glasgow for the Federated Malay States Railway, while built for service on another railway in a different country, share a similar story to the Clans on British Railways, aiding in the country's post-war recovery. During the war, the country's railways were severely damaged due to the British sabotaging many important bridges to ward off the Japanese invaders, not to mention the removal of several miles of track by the Japanese from many secondary routes and branch lines to build the Burma Death Railway. Many of the locomotives were also worn out due to a decline in maintenance standards.

The arrival of the Pacifics in 1946 certainly aided in the railway's post-war recovery and continued to serve the nation long after, hauling prestigious mainline express and mail trains. One of these runs, the Penang Mail, took them across the Taiping Pass, the steepest mainline gradient in the country, where their Caprotti Valve Gear helped make them the first locomotives capable of climbing the gradient without the need of a banker. In a way, this foreshadowed the future record set by 71000 'Duke of Gloucester', also fitted with Caprotti valve gear. Given the rather mediocre performance of the Duke in service, her rise to success with the help of her improvements and the efforts of preservationists is nothing short of amazing. It is hoped that soon, 'Dungun' will put on a similar performance in her corner of the globe as well. It will be a fitting revival of steam in a nation that has lacked it in any operational capacity for over 30 years.

The ongoing projects of both 'Hengist' and 'Dungun' are not only a testament to the dedication of their respective teams but also a reminder of the global importance of preserving our railway heritage. For me, as a Malaysian railway enthusiast, seeing 'Dungun' returning to operation will be a proud moment, not just as a piece of history revived, but as living proof that steam locomotives can still inspire awe and wonder in a country that hasn't seen steam in operation for over three decades. I hope that, like what 'Hengist' will be to Britain's preservation scene, 'Dungun' will captivate future generations, showcasing the power and beauty of these machines, reigniting interest in railway heritage.

With each restoration, we are not merely breathing life back into these wonderful machines but also preserving the stories and spirit of a bygone era. It is certainly exciting to think about what these two locomotives, on opposite sides of the world, will achieve when their wheels turn once more. I eagerly await the day when the whistle of 'Dungun' echoes across the Malaysian landscape, bringing the magic of steam back to life for everyone to enjoy. I wish the best of luck to not just the staff at Great Leisure Heritage Rail, which I hope to join the ranks of soon, but also the members of the Clan Project who are building 'Hengist', along with the Advanced Steam Traction Trust who are providing consultation services to the project. May both projects continue to carry the legacy of steam and inspire future generations!

LETTER TO THE EDITOR

From Robin Gibbons

The Suspension Systems of Steam Locomotives and the mechanisms required to adjust the suspension systems correctly

Re the above article in Newsletter No. 25, the author makes on p.17 the statement that the SECR D Class was perhaps the first example [of a/any locomotive / perhaps even locos built at Ashford? Not clear] to use coil springs. Assuming the author's claim is not limited to just locos built for the SECR/SER (and I have to say I have made no effort to check if there was anything earlier) and just looking at British locos, Webb (as an example, I suspect there were others) used coil springs from a rather earlier date. See for example the attached image of a LNWR Precedent 2-4-0 which clearly shows the coil springs on the leading coupled axle (the springs are rectangular in section). The trailing axle also has the same but not so clearly visible. Clarendon was built in 1893 but the design goes back some way before that.

I wonder if the author is going to go into spring design? There is of course a very interesting/embarrassing (for the SVR) RAIB report of the derailment of 43106 back in 2009, in which inter alia it is clear that the SVR did not exercise systematic control of the design of springs used on locos and may not even have understand how to calculate stiffness of a leaf spring (this inter alia depends on the cube of the leaf thickness so a minor difference in thickness makes a large difference in stiffness). See <https://www.gov.uk/raib-reports/derailment-on-severn-valley-railway> which contains a link to the pdf report.



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