Newsletter No. 6 May 2018

Editor: David A Nicholson

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EDITORIAL

I would like to thank Cedric C. Lodge for his good wishes as I take over as Editor of the ASTT Newsletter. I am sure that we will all wish to thank him for all the work he has put in to producing the Newsletter. Cedric is still making a significant contribution to running the ASTT as he is continuing as Secretary. I would also like to thank all the members who have contributed to my first issue and I hope that more of you will do so in the future. I am aware that the the Newsletter carries learned articles on the technical aspects of advanced steam technology and I hope that it will continue to do so in the future but I would like to include some photographs and more light hearted material. I would like to have feedback from the members, both likes and dislikes, and ideas for future content so that the Newsletter can be can be truly representative of the ASTT and its members.

The severe weather conditions at the beginning of March forced the committee to postpone the AGM scheduled for Saturday 3rd. March. Several members, including myself had already made the decision not to travel as the country was forecast to remain snowbound over the weekend. The possibility of wasting members time and money by failing to reach a quorum at the meeting was recognised. Due to the vagaries of the British weather a small group of members, who live close to Bury, were able to attend the East Lancashire Spring Steam Gala on the Saturday. A new date was set for the AGM and it was held two weeks later in Bury on 17th. March. Our hosts were very accommodating in allowing us to change date at very short notice and I would like to record our thanks to Sarah at the Museum for organising this. Twelve members and one guest attended. A committee meeting was held in the morning followed by the AGM of the Trust and Services Company. A copy of the Minutes and Appendixes will be circulated to members before being posted on the website. Following the formal proceedings and an enjoyable lunch members were treated to three presentations. On this occasion four members had originally risen to The Chairman's Challenge in which each contributor was allocated a thirty minute slot and a bottle of wine to be awarded to the contributor judged to have given the best presentation.Unfortunately due to unforeseen circumstances only three speakers gave talks. Chris Corney, Jamie Keyte and John Hind all gave informative and and entertaining presentations. These should be available for members to watch via the website and I do not want to spoil the surprise of one presentation by detailing them here. The meeting concluded just before 5pm and we left the museum in blizzard conditions.

Chairman's Notes:

General Data Protection Regulations – this may be the last Chairman's Notes you read!!! Unless you complete, sign and return the form that Chris Newman sent out on 11/4/2018 about the General Data Protection Regulations.

Like a lot of large and small organisations we have had to introduce a process to comply with the regulations. One of these, is the form that Chris sent you. To date 18 of us have signed the form, 32 to go!!. To save Chris work in chasing up on this please return the form.

Tornado - as I write these notes news is coming in that Tornado is being taken off the Ebor Flyer (the 90mph excursion to York) after a problem. Over the coming days more news will come out and a root cause established. This time last year we held our seminar on the future of mainline steam. This was just after Tornado's 100 mph run and from a traction point of view the future was looking optimistic. Main line steam has recovered from problems in the past and I hope that this incident becomes one of these.

AGM – apologies to everyone who was planning to come along to our AGM on 3/3/2018. In the days leading up to it we had been monitoring the weather, on balance it was the right decision to postpone. Although the weather round Bury was 'relatively' benign, it was not in the rest of the country.

And thanks to everyone who came along to the rescheduled AGM on the 17th., My challenge to members brought forward 3 talks – Chris Corney, Jamie Keyte and my-self. As ever Jamie surprised and delighted us with his amusing and off tangent talk – the Reverend Awrdy would have approved.

Locomotive Testing – for this newsletter, I had hoped to be able to give a positive update on testing one of the Churnet Valley's S160's. The tests were planned for Monday 12/3/18, but the 'Beast from the East' was visiting over the weekend and froze the water cranes, so trains that weekend were cancelled and with it our plans for testing 6046.

The engine is now on the West Somerset for the summer season, however, 5197 which is currently on the Paignton and Dartmouth Railway is due to return in mid-summer, so we hope to test that. Once we have done this we will be able to compare results from the KWVR's Lempor fitted S160 and a standard S160.

By now we had hoped to firm our plans for a One Day workshop on locomotive testing at the Kirklees Light Railway. This is a chance to see what is involved in instrumenting an engine, collecting the data and analysing it. The aim of the day is to give members the chance to get more involved in this side of our activities – whether that is the practical side of working with the engine or analysing the data. We had hoped to have something organised by Easter, but the railway was busy preparing for the operating season and did not have capacity. Once we have more information we will let you know.

As ever, we are dependant on the operational circumstances' and goodwill, so progress can be frustratingly slow.

Help to run the ASTT - I – David Nicholson has taken on Editorship of the newsletter, with a plan to have 4 newsletters a year. This depends on there being sufficient articles and already some have offered articles but more offers are welcome. Please support David by offering articles – the newsletter will only be as good as ***WE*** make it!

Help to run the ASTT – II – one of new members **Grant Soden**, has offered to help Chris Newman run the website. Welcome Grant and thanks for the offer.

Discussion Forum – to stimulate interest in using the discussion forum on the ASTT website, I have posted a link to a YouTube video that shows the basic mechanism of how an exhaust system works. It uses a flow visualisation technique not available to Giesel, Chapelon, Porta etc.

Click here for the link to the topic.

You will have to login to the members forum to see it.

Annual Conference: This year's conference is on the 29th/30th September at Bury. Please save the date!

John Hind
Chairman ASTT

1. Website Updates

Help found: New member Grant Soden (see below) has kindly volunteered to help ASTT with website upkeep. This will be of great importance to the long-term future of the group - and to its short-term future too if/when the webmaster is away or indisposed.

The main changes to the website have been as follows:

- The **Sales page** has been updated with an introductory paragraph that includes mention of members' discounts on books.
- A new (Members-only) page has been added about the **Bevil's Lunch Club** which ASTT members are encouraged to join. It meets every Thursday in London. However, whilst being informal both in its constitution and its meetings, admittance is by invitation only through one of its existing members. ASTT can arrange invitations to any of its members who wish to attend one of their meetings.
- A news item has been added about the **General Data Protection Regulations (GDPR)** that comes into force on 25th May as notified to members in a recent circular. Membership Application forms have been modified to include a Contact Permission form to comply with the GDPR.
- A **Student Membership Application Form** has been designed and uploaded to the website with a download link added to "How to Join" page.
- **Three technical papers by Doug Landau** have been posted to the Reference Material section of the website (under the General Interest subheading).
- A link to the **Reference Material section** of the website has been added to the Members' Library sub-menu.
- The site's **WordPress platform** has been updated to the latest version.
- **Website Back-up**: An order has been placed with Godaddy Inc. which hosts AST's website to provide a backed-up service which is hoped will ensure that the website is not "lost" in the manner that the old 5AT site which disappeared last year when Godaddy transferred its files to a new server.

Planned Website Updates include:

- A report on **ASTTs AGM** and follow-up presentations session held on 17th March.
- A page listing **ASTS's current projects and activities** in the hope of encouraging others to participate.
- A new title will shortly be added to the **Book Sales page**, offering Ian Gaylor's "Steam Locomotive Design Specifications and Calculations for New Build

Baldwin 2-4-2T 'LYN'" for sale. See also the "Book Sales" section of this newsletter.

- **Replacement of pages lost** when the 5AT website was corrupted by Godaddy. Most of the lost pages were recovered from cached (temporary) files retained by Google and Yahoo search engines. By luck, most that were lost were out-dated and of little value, however there were a small number that were not. It may be possible to reconstruct some of these by making use of pages retained from the original (2002) 5AT website.

The Forum section continues to be neglected by members. Feedback and suggestions for improving the forum are welcomed.

Members' feedback on the website, both constructive and critical, is always welcome. Members are also welcome to offer content for the site and/or to offer suggestions for new pages. The website is not just a shop-front for ASTT, but a communication channel for its membership.

2. Membership

Chris Newman

Student Membership: At its AGM in March, ASTT approved the introduction of a Student Membership grade which is currently being drafted into its constitution. Student Membership will be available to full-time students and apprentices who will be exempt from membership fees until they complete their studies. The intention is two-fold: (1) to boost our enrolment of younger members who we hope will take over the lead roles in the organization with the passage of time; and (2) to comply with one of the obligations that ASTT is expected to meet as a registered charity.

So far, we have six student members, four of whom have joined this year, two in the last month (see below).

New Members: ASTT membership numbers continue to grow. Three past members decided not to renew their membership at the end of last year and two have not responded to renewal requests. Their places have been taken by eight new members as listed below:

New members who have joined since January 2018 are:

1. **Martin Johnson**: (in his own words) mechanical engineer from Inverness-shire, specializing in liquid flow and pump performance. Past member of the L.R.P.S. and Quainton Railway Society; worked on Whipsnade & Umfolozi Railway on engineering and footplate duties from 1971 to 1975. Currently building a Fowler steam lorry model in 7" to 1' scale, and using own software to analyse boiler design and optimise performance; also utilising other advanced steam technology in the build. Hoping to expand the boiler software to include engine

and draughting performance prediction. Has no sense of humour and is almost house trained.

2. **Doug Landau**: retired engineer from St Albans. Doug's career began as a drawing office apprentice at British Thompson Houston, a leading manufacturer of high voltage switchgear, from whence he specialized in engineering design and project management, mainly in heavy power systems. Whilst his involvement with the rail industry was limited to the design of hopper wagons and the operating system for a cable railway in China during the 1980s, Doug is well known within the steam fraternity, being a long-standing member of the Bevil's Lunch Club (see above) and contributing articles to the Stephenson Locomotive Journal, two of which can be found on AST's website.
3. **Tom Kay**: Student Member from Yorkshire who presented a paper at last year's AST conference on his final year project at Huddersfield University "Austerity 90733 - Locomotive Horn guide and Frame Re-design". Tom has been a volunteer on the KWVR for many years and regularly works with Ian Riley's support crew on the West Highland line.
4. **Nigel Barnes**: fitter and turner by trade, Nigel worked as an aircraft fitter before spending 10 years in designing aircraft structures. He has volunteered on several heritage railways and was part of the three-man team who brought ELR's "Crab" back into service, resplendent in its LMS Red livery. He is currently employed on the Churnet Valley Railway and has 15 years of footplate experience.
5. **Grant Soden**: rolling stock technician from Surrey and Deputy Chief Mechanical engineer with the Great Cockrow (7¼" gauge) covering overhauls and building locomotives. He has also worked on loco designs for the Little Hampton Miniature Railway (12¼" gauge). In addition to CAD skills, Grant has experience with websites and has offered to help ASTT manage its website.
6. **Jonas Nilender**: our first overseas Student Member, Jonas is a first year mechanical engineering student at North Carolina State University. He hopes to graduate with a doctorate specializing in thermodynamics and entrepreneurship. He has already involved himself in ASTT's activities by transcribing one of Porta's manuscripts for future publication and has offered to do more.
7. **Liang Chen Yuan**: our second overseas Student Member and first member from Asia, Chen Yuan is in his first year at Traffic Engineering (Urban Rail Transit) at Beijing City University. He's also one of a small but growing band of steam enthusiasts in China.
8. **Chali Chaligha**: Chali is in his first year of study for a Mechanical Engineering degree at De Montfort University in Leicester. He's also an aspiring steam engineer. He has been a volunteer on the Bristol Harbour Railway since he was 14 through which he has gained practical experience on steam locomotive operation and maintenance. He also has a sound theoretical understanding as

evidenced by his welcome attendance at our AGM in March where he impressed everyone with his knowledgeable contributions to discussions.

The current membership base is distributed as follows:

- Full Members: 13
- Associate Members: 34
- Student Members: 6

- **Total Membership: 53**

- UK: 45 members
- EU: 5 Spain, Germany and the Netherlands
- USA: 2 members
- China: 1 member

3. General Data Protection Legislation (GDPR) Chris Newman

Members should by now have received a message from the Membership Secretary concerning the introduction on 25th May 2018 of new UK legislation relating to Data Protection. GDPR is aimed at the protection of "user data", or in the case of ASTT, the protection of members' data that is held by the Trust.

As explained in the circular letter, members must sign and return the Contact Permission form by 25th May if they wish ASTT to maintain normal communications with them. Members are asked to sign the form and to email back a scanned copy of it in PDF, JPG or similar format or post a paper copy to the Membership Secretary.

4. 2018 Autumn Conference Chris Newman

ASTT's 2018 Autumn Conference will be held once again at the Bury Transport Museum over the weekend of September 29/30th. A call for papers, and for registering interest in attending, has been circulated to members in advance of this newsletter, and will be sent out to the wider steam community after members have had time to reserve their seats. Tentative offers have already been received from a number of speakers so we expect to offer a full and interesting programme.

In addition to presentations, there will be a conference dinner on the Saturday night similar to last year, but instead of a workshop visit on the Sunday morning, conference delegates will be invited to take a ride over the ELR's tracks in a "conference carriage" where they can enjoy their morning coffee.

Due to the meeting room's space limitations, it is expected that seating will be limited to no more than 40 delegates, so members are advised (and requested) to book early. Admission prices will be set to cover costs and are expected to be in the order of £45 for two days' attendance and £30 for a single day. Non-members will be charged more.

5. Book Sales

Chris Newman

Book sales have been very slow over the first quarter of the year, however they continue to provide useful income to the Trust.

Sales since 1st Jan have been as follows:

- **Defence of the MR/LMS Class 4 0-6-0** by Adrian Tester (pub. Crimson Lake): 1 sold (total sales 13);
- **Introduction to Large-Lap Valves** by Adrian Tester (pub. Crimson Lake): 2 sold (total sales 5);
- **5AT FDCs** (pub. ASTT): 3 sold (total sales 184);
- **5AT Feasibility Study** (pub. ASTT): 4 sold (total sales 38);
- **The Red Devil** by Dave Wardale (pub. Camden): 2 sold (total sales 16 + 233 sold by 5AT Group);
- **Advanced Steam Locomotive Development** by L.D. Porta (pub. Camden): 2 sold (total sales 3);
- **Here be Dragons** by Phil Girdlestone (pub. Camden): 0 sales (total sales 20);
- **The Fire burns much better …** by J.J. Koopmans (pub. Camden): 0 sales (total sales 2);

It is hoped that ASTT will soon be able to offer three new titles:

- **Design Calculations for "Lyn"** by Ian Gaylor (pub. ASTT): Ian has completed his book and delivered the files to Chris Newman who has uploaded them to Lightning Source's server. Once Ian and Chris have finished checking the "eProof" a proof copy will be printed for final checks before releasing the book onto the market. The book is 604 pages long (50 more than the FDCs) and is expected to retail for around £50.
- **The Physiology of Locomotive Boilers** by Adrian Tester (pub. Crimson Lake): Adrian expects that the first volume of his new book will be ready for publication later in the year. The task of proof reading is taking longer than he expected due to Adrian's day-job commitments.
- **Porta Papers**: We're still waiting for Shaun McMahon to finish proof-reading the drafts. Chris Newman will travel to Wales at the end of April to meet Shaun during a short visit he will be making back to the UK.

Token exchange: Cedric C Lodge.

Newsletter No. 5 was my last as Editor. Editing is not a skill which came naturally, so it was with some trepidation that I accepted the challenge when we decided to issue a Newsletter on a regular basis. The learning curve was steep but somehow, I managed to produce four issues without much trouble. My IT skills are rudimentary, as much as anything because I spend so little time computerising. But the world moves on, and by No. 5, I realised I had reached my limit. Some articles I received I could have filed into a library, but had to admit that I could not manipulate them into a Newsletter. I did not want to find myself in a position where production of a Newsletter would have been impossible, so, discretion being the better part of valour, I had to admit defeat.
Fortunately, David Nicholson was in the wings and able to step into the breach, and it is with relief and gratitude that I hand over the reins to him. I am sure he will do a good job.

Articles of Association: ASTT: Cedric C. Lodge

During our last two AGMs, it became apparent that our Articles required some revision. As originally drafted, they require the Membership to elect the Officers-annually, as well as members of the General Committee. In practice, this means running the election process in two stages: first: General Committee members; second: Officers. Your Committee considered the position at our meeting on 17 Mar., and authorised me to go through the Articles and come up with recommendations. This I have now done, and circulated my proposals to the Committee for their comment/approval. The most significant change concerns succession, not only of Officers but also members of the General Committee. My proposals are for the Members to elect the members of the General Committee, but for the General Committee to elect its own Officers from amongst themselves. This simplifies the process for Members, ensures continuity via the Officers, enables the General Committee to respond quickly to any enforced changes of personnel amongst the Officers, and also enables the General Committee to create or revoke additional Officers posts. Inevitably the process of reviewing the Articles involves a 'knock on' effect: change one Article, and you have to go through the whole document to see what the effect may be on other Articles, even though it may only be re-numbering. Great bedtime reading!
When the General Committee has completed its perusal of my recommendations, they will be summarised, and submitted to the Membership for approval at our AGM next year, as a Special Resolution. It is a tedious business working through amendments to Articles, and not the most riveting way to spend a sunny afternoon, so we will probably make use of the technology at our disposal, and issue the Draft by e mail.

Proposed ASTT Outreach Function

16th April 2018

D. A. Gibson

1. Background

7th January 2016 was a day which neither Owen Jordan nor I will forget in a hurry, as it was the day when the K6 Rotary Engine (aka the 'York') was conceived in the dead of night in deepest, darkest Wales. It took many weeks (indeed months) to get a handle on what Owen's brain had churned out in response to Network Rail's 2.6 T unsprung axle limits for 100mph+ running; a process which was greatly assisted by three key members of the ASTT (Paul Hibberd, Richard Coleby and Jamie Keyte) who kindly reached out to us, supplying much-needed advice and guidance.

At around the same time that members of the ASTT were reaching out to us we were, in turn, reaching out to two different departments within University of Birmingham; namely the Birmingham Centre for Railway Research and Education (BCRRE) and the School of Mechanical Engineering. Thankfully, Prof. Felix Schmid (BCRRE) and Prof. Miroslaw Wyszynski (Mech. Eng.) were both willing to listen and, thanks to their help, we have so far had four students examine and develop various aspects of the York Rotary Engine (with one student undertaking two separate projects).

At this point we should explain that there are two strands to rotary development; Compression Ignition (CI) and steam. Given that CI development has in our view the greatest commercial potential, it has been the primary focus with four of the five student projects looking at this strand. Given that there is significant commonality between the steam variant of the York and the CI version (with the rotor for both types being essentially the same), progress towards a working prototype of the CI variant also moves us forward on the steam front. Delivery timescales for working prototypes are currently estimated at 18 months – 2 years under current plans; again this would not be possible without the invaluable help of ASTT Committee Member Richard Coleby in a private capacity.

The steam-related student project remains ongoing, with results due later this year. Designing and testing steam engines allows students to wrestle with the fundamentals of thermodynamics, in a form other than the steam turbine (the only type of steam engine which is still in use commercially).

2. Mutually Beneficial Relationships

What I have just described are mutually beneficial relationships between multiple individuals and organisations, with the York Rotary Engine as their focus. None of these relationships would have been formed without a decision to reach out; an action which carries no guarantee of success but which could potentially add value to many areas of ASTT activity.

The suggested term for this kind of reaching out is 'outreach'. Although, if adopted, the formal title for such an activity would be down to the ASTT Committee to decide on. Whilst the word may be accurate, it is a term used by many for job roles which are not necessarily true to the meaning. However, for the purposes of this article we will stick with outreach.

3. Proposed Outreach Function

The proposed outreach function would examine the ASTT's projects and aspirations, seeking to identify areas of activity with a potential for partnership. In looking at such potential, we must attempt to see through the eyes of others. Going back to the York Rotary Engine, we can list some of the benefits to each party:

Innovators:

- Technical analysis using sophisticated software tools on an educational licence, which would otherwise have been prohibitively expensive to acquire commercially.
- Confidence to continue developing and investing in the project.
- Contact with students, who might potentially become employees of any future business at a later date.
- Access to a low cost, but very valuable resource (cost depends on whether a contribution is needed towards student fees etc.).

Students:

- Interesting and challenging work as the project element of a BSc., MSc. or PhD.
- Chance to uncover design and performance aspects which have never been seen before.
- Chance to learn and make use of industry standard software for problems which it was not necessarily designed for, requiring some thought and improvisation.
- Possibility of future employment.

Academics:

- Opportunity to examine something new and different.
- Ability to offer a wider range of potential projects to students.
- Access to new projects reduces the risk of students plagiarising results from their peers.
- Possibility of consultancy fees at a later date, if or when funding is secured.
- Good publicity for the faculty, if the project proves successful.

ASTT:

- Potential new project for the ASTT and/or individual members to become involved in.
- Potential new members (Associates and Students).
- Opportunity to raise awareness of the work of the ASTT within academia (holding an ASTT workshop at University of Birmingham in May 2017 certainly helped to do this).

4. Outreach vs. Membership

Whilst the outreach function is not the same as membership, it can make sense for the two to co-ordinate. For both Owen and me, membership of the ASTT was a natural response to the high quality support which had very kindly been given to us.

5. Different Types of Partnership

Note that 'partnership' can be between the ASTT and individuals, as well as between the ASTT and other organisations. One of the keys to successful partnering is recognising how others may need to examine and process information differently, in order to understand how working together could be of mutual benefit. For example, within the ASTT it makes a lot of sense to categorise and report activity by project (e.g. 5AT, George V, Clan Line) and the website has quite naturally been constructed on this basis. However, if you are someone with an interest in steam who has not previously heard of the ASTT, then you will want to know just how and where your skills could be made use of; accountants, software engineers, chemical engineers, business plan writers, data analysts (and so on) want to know just how and where they might fit in. In other words the information needs to be structured around roles as well as projects, if it is to have maximum impact.

If someone expresses an interest in the work of the ASTT, then it could be the role of outreach to identify not just where that person's skills would be of most value but also what would give that person the most satisfaction; greater satisfaction being likely to lead to greater participation.

6. Outreach vs. Marketing

The outreach function might also be called the marketing function, but it goes beyond just marketing:

- Marketing is about tailoring the message to specific markets, so more people buy your product.
- Outreach is about real person-to-person contact, where you work to explore how you might work together in ways which are mutually beneficial.

Depending on available resources and the agreed scope of outreach, an argument could be made for having a marketing function which works alongside it. In other words, marketing creates materials which outreach then makes use of.

Looking at how the ASTT might use outreach to engage with students, it is important to consider the following:

- Students want projects which are interesting, stimulating and engaging.
- They do not like to be treated as 'cheap labour', or to feel like they are.
- The skills they will use in pursuing the project need to have some relevance to future employment.
- The projects need to be clearly defined, in order to be manageable as BSc., MSc. or PhD. projects (each has a different duration).
- Academic supervisors need to be convinced of the value of the work and to be willing to support it.

7. Dealing with Academia

Dealing with academia can feel at little frustrating at times, given that it ramps up and down in response to term times and has to gear itself to the priorities which exist at various times of the year (e.g. exam marking). If you can accept the way that academia works, then you stand to gain significantly from quality research which can be undertaken at very low cost. In the case of the York Rotary Engine Project, we find that regular email contact along with face-to-face meetings held every 6-8 weeks or so works well. So far, it has not been necessary to contribute to any student costs.

8. Rail Supply Chain & Apprentices

Another area where an outreach function could seek to create partnerships is within the rail supply chain, as many of the larger companies train apprentices. As with the aforementioned students, there is a need to give apprentices interesting work which will challenge them.

An effective way to reach out to could be through a networking organisation such as the Rail Alliance (www.railalliance.co.uk).

9. Economic Value

The value of steam operations to UK tourism is believed to be in excess of £250m per year.

Heritage rail has wide appeal and forms focal points - especially in England - in areas where there may be a variety of attractions, but nothing with as wide an appeal to all ages. The heritage rail industry needs the steam locomotive and the UK leisure and tourist industry needs rail heritage lines. They act as nodes, offering half or full day experiences that have something for many tastes, be it a meal on a train or the smell of hot oil. Those nodes are basic centres of attraction in areas that might otherwise have nothing particular to sell the rest of their assets and are widely distributed, not just in tourist hotspots. In fact, tourist hotspots are usually places where you will not find heritage rail; Pickering has benefitted greatly the North York Moors southern terminus. Minehead has been given new life, whilst Blaenau Ffestiniog was an abandoned slate quarry. Many in Welshpool regret their getting shot of its town section of the Llanfair railway. Weardale, Wensleydale, Matlock - places where economic activity has ebbed, and where the return of steam locomotive could provide a shot in the arm.

If you want a case study in the value of heritage rail to the local economy, then look no further than the damage done to the Severn Valley Railway by the floods of 2007. Wikipedia states that *'These events damaged the summer tourist custom to the railway, the towns served, and the area as a whole'*, as evidenced by the fact that some £3.7m was raised from a number of sources for the necessary repairs, in very short order.

10. ASTT Aims & Objectives

The ASTT's stated purpose is to *'promote the ongoing development of steam traction with the aim of prolonging steam operation of both main line and heritage line workings for the benefit of present and future generations.'*

The ASTT aims to do this by making steam locomotives which are:

- more efficient;
- less polluting;
- less costly to run; and above all
- more reliable.

This could be construed as simply the promotion of new build, but does of course include the testing of existing heritage locomotives with a view to solving running issues and maximising their efficiency.

In terms of attracting new members with an interest in steam this is absolutely fine, but in my view the case for either academic or industry involvement could be stronger, both through greater reference to the aforementioned economic benefits and to the transferability of skills.

John Hind's excellent presentation in Bury on 17th March was a great example of the type of instrumentation work which I believe students and/or apprentices would be very interested in, as data collecting and analysis skills can equally be applied to the National Railway as they can to heritage steam.

Another aspect is that steam locomotive design requires finding a balance between numerous factors, which academically could provide a challenge which is something of a 'model' for many other engineering situations.

Note that academic studies need not be technical, for example they could focus on issues such the current and projected costs associated with heritage fleet operations and the potential for 21st Century steam to contain these costs. Also, the extent to which 21st Century steam would be seen as an acceptable alternative by heritage railway customers.

11. Other Ways to Reach Out

As well as reaching out to academia through departments, it is possible to do so through contact with various types of student societies, such as the Cambridge University Railway Club or the Mechanical Engineering Society at University of Birmingham.

In addition to academia and Industry there are other groups with whom partnerships could prove valuable, such as:

- Local & National Government.
- Heritage railway owners and operators.
- Tourist Boards.

12. The skills and attributes needed for outreach are quite varied, such as:

- Good communication skills.
- Good technical skills (enough to understand the basics of the ASTT projects being undertaken, if not the engineering detail).
- An ability to identify which ASTT projects have potential to benefit from student and/or apprentice involvement and which are likely to prove interesting to them.
- An understanding of the way academia works and how BSc., MSc. and PhD projects can be structured.
- An understanding of how to approach and communicate with the rail supply chain, with a view to engaging apprentices in a similar way to students.
- An ability to best match the available skills of new and existing members with ASTT projects.
- An ability to engage with other stakeholders, such as the heritage rail industry.
- A high level of commitment.

At this point we need to be realistic, given how unlikely it is that a single person will be in a position to undertake all of the above!

Possible ways to make the role more manageable include:

- Limiting the numbers and types of stakeholder to engage with (e.g. choosing to engage with a just a limited number of academic institutions with a strong reputation in areas of interest).
- Have separate individuals be responsible for academia, rail supply chain, new and existing members and other stakeholders, potentially supported by marketing.

13. Possible Starting Point

Before deciding what form any outreach will take, the suggestion is to construct a sort of 'map' which links a list of steam activities with relevant applications in other areas. For example:

- Steam exhaust systems with general diffusion theory.
- Steam rotary with IC rotary engine design.
- Valve gear design with packaging machinery design.
- Firebox design with combustion in other contexts.
- CAD on steam work with CAD applied elsewhere.

- Finite Element Analysis as applied to coupling rod design, which is also applicable to racing cars.

A third axis could then be added which references the kinds of personal attributes needed, such as practical skills (apprentices, drawing office skills, metallurgists, mathematicians, project managers etc.).

Such a three dimensional map could then form the basis for setting up an outreach function, aimed at organisations such as the Rail Alliance or universities (as well as supporting the recruitment of new members).

14. In Summary

As I sought to make clear in the beginning, the ASTT already knows how to reach out and has done so successfully, such as in relation to the York Rotary Engine Project. Likewise, the website and newsletter already do a great job of sharing the work of the ASTT with large numbers of people.

What I am proposing is to seek to build on this existing good work in a way that seeks to harness the potential for partnership, rather than trying to do everything ourselves. Again, this is not new. I have merely sought to apply the principles of outreach to the work of the ASTT.

Obviously, this can only be done in a way which matches the people and resources we have available and it could ultimately take many years to fully develop an outreach function. The initial focus being on what the Committee sees as low-hanging fruit.

A natural consequence of outreach will, I believe, be a membership base which ultimately becomes more diverse than it is at present.

I hope this stirs up some debate and that members will start sharing their own thoughts and ideas!

Please feel free to post *on the Thread on the Discussion Forum on the ASTT website* with your feedback.

David Gibson,
ASTT Associate Member

16th April 2018

Minutes of meeting with Hargreaves Wholesale, coal distributors

Date: 19/03/18

Venue: Hargreaves Wholesale,

7, The Courtyard, Stenson Rd., Coalville LE67 4JP

For Hargreaves: Ian Moulson & Peter Prince

For ASTT: Iain Jack, Jamie Keyte, David Pawson, Richard Coleby

Purpose:

To ascertain the medium to long term continuation of coal supply in the UK suitable for steam locomotives.

Overview of current position by Hargreaves

Due to the diminishing requirement for coal for power stations and heavy industry it is no longer necessary to rely to any great extent on imported product. In fact the facilities for off-loading coal at UK ports are already becoming scarce and Hargreaves are now able to service their market almost wholly from three UK open-cast sources producing bituminous coal.

These are Killock in Scotland, Shotton in North East UK and Ffos-y-fran in Wales. All coals from these producers are suitable for use in steam boilers. There are other open-cast sites still working in the UK but they are small by comparison and may not have extended life.

The Heritage / Tourist and Mainline requirements account for 20 / 25k tonnes per annum and this is a small percentage of the total current UK requirement. With a target for complete cessation of energy generation from coal fired power stations by 2023/5 the market for coal will be mainly for domestic heating and some specialist requirements by industry such as steel making.

The future for coal

Much depends on the outcome of the present investigation into the continued use of coal by DEFRA and its recommendations to the Government. Allied with this is the ongoing push by the environmental lobby for a complete ban on the use of coal.

If the regulations severely restrict the use of coal for domestic consumption, the economics of opening new open-cast sites might not make sense. It should

also be noted that there is growing resistance to any expansion of existing sites and this could be a threat on a 5-10 year time scale. If the current mines go, with it would go their washing and grading facilities so it would be necessary to import washed and graded coal at a greatly increased cost.

The percentage of lump coal obtained from present production is around 20/25% of the total, the remainder being used for industrial and other products such as briquettes. If the requirement for this latter proportion is reduced by environmental and legislative issues then the supply of lump coal will also diminish.

Hargreaves have had discussions with the HRA (Mr Hillier?) who have intimated that they are already making dispositions to DEFRA about the necessity of continuing availability and use of coal for the Heritage and Tourist sector. So far there has been no information as to whether or not this is being looked at in a favourable light. However, given the still large use of coal for home heating and the absence of an economic alternative for many, it seems very unlikely that there would be any outright ban for many years.

This being the case Hargreaves are totally confident of being able to supply suitable product for at least the next five years and after that much will depend on the legislation and when it finally becomes law.

The cost of future product

It is inevitable that with reducing demand the cost of coal is going to rise steadily into the future. The benefits of cheap imported product for power stations are already lost and with it the secondary benefits that this gave to other sectors of the market that 'lived' off the back of it. To some extent the continuing availability of home mined coal has offset this but as the total UK demand continues to fall the cost must rise.

Alternatives

Hargreaves have already had their attention drawn to the work being carried out by the CSR but were interested to actually see a sample of their product. They do themselves already produce a range of coal briquettes (see also below) so are familiar with the mechanics of the actual production of a briquette. They pointed out that to produce a large briquette such as would be required for normal hand firing would entail extremely expensive and heavy equipment which in turn would naturally require a considerable market size to justify.

The problem with bio-coal as an alternative is that the quantity of feedstock required is unlikely to be met within the UK and therefore would have to be imported. Together with the above production equipment it would almost certainly make the product non-viable.

They are, however, interested in exploring the possibility of whether they could produce a larger briquette from their existing machinery that would be suitable for hand fired steam boilers. This could be of advantage in using the fines from current production and have some ongoing handling assets over lump coal. It is theoretically possible that a bespoke briquette with better environmental characteristics could also be designed for the Tourist and Heritage market They are therefore going to supply us with a small quantity of their Maxibrite product, which is a small briquette, for some initial testing at either Stapleford or Wells.

Have any questions been answered?

1. Is a coal-less future in the UK a realistic proposition

It really is an impossible question to answer at the present time. There are strong lobbies in favour of this, for one reason or another, but it would require a degree of legislation that would surely take years to put in place and fully operate and the Co2 saving from the Heritage sector would be miniscule in the overall scheme of things. Of course it may happen eventually but unlikely for a generation at least.

2. Will the Mainline and Heritage movement acknowledge this and be willing to move with the times and will this stimulate development of a supply chain?

As the prospective cost of alternative bio-coal is very high (£1400/ US ton has been quoted) and homegrown feedstock and techniques unlikely, then the affordable options are somewhat limited. Oil? Probably even less environmentally acceptable in a steam locomotive unless millions is spent on research. Keeping fingers crossed that common sense prevails may be the only solution in the end.

3. In the absence of others in the UK do we want to be the Group to raise awareness of the issue and develop solutions?

It appears that others are well aware of the situation but as yet there does not seem to be any viable alternatives in the UK to Old King Coal.

4. Are CSR willing to cooperate with us if there is a problem with coal supply in the UK?

They probably would – but the cost is likely to be prohibitively expensive and therefore a non-starter.

5. What is the medium term future for coal in the UK?

If its five years it looks very good.

If it is ten years it looks a reasonable bet

If it is 15 years there could be legal restrictions by then

If it is 20 years.....our children or grandchildren will be making the decisions so you had better start a pro-active campaign now!

Appendix note 26/03/18

The following two notes subsequent to the above Minutes have been received from Ian Moulson today –

Obviously since our meeting you will have seen that the Secretary of State has turned down Bank's application for a new site. This will affect production in the medium term. Therefore without appearing too negative I think your scenario in regard to the next 15 years should be revised. I think there will be enough production to cover the next 5 years. From that point I think a coal ban will come into effect and we could find ourselves looking at a very different scenario. I expect further info will come out later in the year when The Air Quality Committee reports to Government. A case of watch this space.

We estimate the market is no more than 800000 tonnes possibly a little less. Made up of 80000 tonnes of Anthracite , 160000 tonnes of bituminous coal and 500000 of manufactured briquettes. The Heritage Rail market is no more than 25000 tonnes which is included in the 160.000 except Ffos Y Fran which accounts for 10,000 tonnes within the 25,000 tonne figure.

Anthracite sales into briquette manufacture is circa 150000 tonnes.

I believe the UK Power Station market is now burning between 5 and 8 million tonnes.

NEW-BUILD STEAM LOCOMOTIVE PROPOSAL:

INTRODUCTION AND OUTLINE

James Evans

This could be a very long story, in fact more or less a whole lifetime 'prologue' with just the main 'act' to come perhaps, so I will get the personal stuff out of the way briefly. I am not a trained engineer, but I am from a family of engineers going back to the start of the Industrial Revolution. Great (many times) grandfather was a merchant supplying charcoal amongst other things, to factories in the Midlands probably for refining iron into steel. He or his son got into the iron founding business, making ironware including cooking stoves or 'grates'. This general work was refined and specialized over the next couple of generations to become one of the largest pump manufacturing companies in the world: Joseph Evans and Sons, Wolverhampton.

My own education was an absolute disaster, with abusive teachers and the least said the better, so that when I finally escaped at the age of eighteen the last thing I wanted was to spend one more day in 'education'. However, I had learnt the basics of engineering at my father's knee so to speak, he had studied at Birmingham University, and worked in all departments of the family business. At the age of ten I was firing and driving a model road engine, and through my teens cut my teeth on Austin Sevens, one of which I purchased from a scrap yard whilst at school for the sum of two pounds and ten shillings. Having rebuilt the engine, which had nettles growing out of the cylinder bores, and re-profiled the body into something a bit sporty, it passed the very early MOT test. With my mother bravely sitting alongside me it took us one hundred and twenty miles home to Cornwall.

Whilst still at school I found and subsequently purchased for thirty pounds a derelict steam roller, and also discovered and arranged to visit the Dinorwic Slate Quarries in North Wales. Amazingly I was able to persuade my father to purchase a couple of the old quarry locomotives that were still valued as little more than scrap metal. These details perhaps make it easier to understand why I had no wish to continue in academia. So I spent the next few years rebuilding and operating these engines, including building a railway round our fields. There were also many road trips by steam power to rallies all over Devon and Cornwall, this was before the awful traffic that we are used to nowadays. By pure luck I happened to be in just the right place at the right moment to save a steam tug from the scrap yard, and we steamed this for a week every year in the Exeter Maritime Museum. Later I joined the Locomotive Department of the West Somerset Railway, and have recently retired after 25 years (on and off) with many interesting and enjoyable experiences. In between times, with my brother we set up a micro-hydro electric enterprise which he still runs, and I became a professional bee keeper, even selling honey through Fortnum and

Mason in London! Currently my wife and I are custodians of one of the largest private collections of apple, cherry and pear trees, conserved for their genetic diversity and about which we have published a couple of books.

So, I have always been 'steam mad' and what I lack in theoretical expertise is partially offset by my practical experience. This madness led me in the mid nineteen seventies to propose building a replica Lynton and Barnstaple Railway Manning Wardle locomotive, for which I eventually managed to acquire an original set of works drawings. This I was told by the 'experts' (I still have their letters) would be "impossible and uneconomic"; my father always said "the impossible takes a little longer". Indeed I could find nobody who would give me any practical support at that time, so I made a start anyway in my own workshop, with the frames, tyres and the cylinders. Due to my own 1886 Hunslet locomotive 'Velinheli' visiting the Ffestiniog Railway in 1993 for their Hunslet Hundred Gala, I had the good fortune to meet up with Paul Lewin who was then a volunteer driver. With his leadership and the support of the Ffestiniog Company the building of LYD is now history.

So, what is the 'madman' proposing now? I had made a rod for my back with LYD, where I was determined that we would build the best possible 'replica' but within the constraints of the original external dimensions and visible details. A locomotive that would be able to earn its living hauling reasonable length trains on the Ffestiniog Railway (the rebirth of the L&BR had yet to lay two rails on the ground). This meant that someone had to draw up the various alterations that seemed essential, mainly in the boiler, pony trucks and methods of construction, and since money was tight and I had the ideas, I had to volunteer myself for that task. The Manning Wardle design, being very tight in width and height, resulted in the slightest modification having consequences for all adjoining components. This meant that I ended up having to produce over two hundred new drawings; all done the old way with pencil and paper. This set me wondering what could one design for the narrow gauge if one started with a blank sheet of paper, and incorporated the best of modern ideas developed since the original L&B design in 1897?

Obviously before starting a 'design-from-scratch' I had to envisage a particular railway where such a machine might be profitably employed, and came up with the idea of the Welsh Highland. This is a line that I know very well having studied it all my life, and I've contributed my small bit to help bring it back to life. As reincarnated it is virtually a new railway, except for the Garrett locomotives that are its regular motive power, and without which the rebirth would not have been possible. However, they are not only old fashioned and thus labour intensive and inefficient, but they have had long and stressful lives and will need ever more extensive repairs. They are also somewhat over specified for the actual task they have to perform: more on this later. But the time has not yet come for fresh thinking on the WHR, partly due to the fact that there is an ample supply of Garratts, and also it seems the money to rebuild them, and they are more or less one class.

Basic basics: what would one wish to do better than has been done in the past, especially bearing in mind how the world has changed since the steam locomotive ruled? My thinking is directed primarily towards narrow gauge railways, especially long ones with demanding gradients, because their locomotives are required to work at near maximum power for extended periods. This may apply to a few standard gauge preserved lines and of course to main line operations, but the financial implications of narrow gauge new-build appear more realistic. However, 'whole life' cost must be considered as well as initial construction cost because the steam locomotive, whilst 100% recyclable, is also such a long lived beast. In the past labour was cheap, plentiful and accustomed to hardship; long hours, grime and lack of on-board 'home comforts'. Everything should be done I believe to minimize labour requirements in preparing, operating, disposing, servicing and overhauling any modern era steam locomotive. Every design detail needs to be considered in terms of ergonomics, accessibility, maintaining cleanliness, safety and longevity; and making use of the best materials.

Starting from the observation that the locomotive would be required to work at sustained high power alternating with periods of light running, it must also be equally functional running forwards and backwards, and on switchback gradients. Combined with these challenging conditions must be an awareness that crews may be part time, often volunteers, with widely varying experience and skills. Next we have to expect that good quality, relatively smokeless coal will probably not be available by the time the locomotive enters traffic, also that with the likelihood of more stringent pollution/emissions control production of excessive smoke will not be tolerated. We may be allowed to burn coal, but it may be of inferior quality, hopefully we will have torrefied organic waste (killing two birds with one stone).

Apart from the requirement for a powerful locomotive all the foregoing suggest that the boiler would need to be as large as possible, within the constraints of loading gauge and track limitations. A large boiler containing plenty of water has more reserve compared with a smaller hard pressed one, and with a large grate the potential for burning less than ideal fuel cleanly, even with variable firing skills, is increased. A long grate and brick arch, by providing a longer flame path and in combination with a modest rate of combustion, would reduce particle carry over and loss of unburnt volatiles. The next essential is a large steam space over the firebox combined with a sloped crown sheet, so that sudden changes of extreme gradients can be accommodated without too much trouble.

So I am looking at an over-sized boiler especially in regard to the firebox, and this will be heavy. It follows that in order to achieve a high power to weight ratio the rest of the locomotive needs to be as light as possible. The lighter a locomotive can be (given sufficient adhesive weight) for a given power the higher its overall efficiency, before we start to look at thermal and mechanical considerations. Narrow gauge conditions of very sharp curvature and tight loading gauge, plus the need for a large, long and reasonably deep firebox, dictate the use of an articulated layout

with the firebox slung between the two power bogies. Returning to power to weight ratio, and bearing in mind that anticipated speeds are modest, it is essential that the bogies must avoid the extra weight of carrying/guiding wheels: gaining the advantage of 100% adhesion.

Next, considering cylinders, wheel diameters, boiler pressure, superheat and tractive effort, we obviously need to start with an idea of the loads and speeds required. We also have to remember that a prime requirement is to produce a low 'lifetime maintenance' machine, ie one that is not over stressed. I have therefore opted for the highest boiler pressure that is practical without making the boiler excessively heavy or too demanding for maintenance. The advantages being to maximize thermal reserve and improved thermal efficiency, but mainly to minimize the size and weight of the cylinders; also heat loss from them. Importantly this feature and smallish wheels, result in the pistons/crossheads and connecting rods being as light as possible, easing balancing which is important for power bogies with no guiding wheels; however their wheelbase is reasonably long to reduce hunting and spread axle loads. Superheat also has to be modest, partly because making the boiler big enough to give high degree superheat would make it too large and heavy to fit the loading gauge and fulfill the requirement for a high power-to-weight locomotive; the theoretical extra gain in thermal efficiency with high degree superheat could be wiped out by the cumulative extra weight of the locomotive (heavier boiler, weight of larger superheater, weight of an extra axle: the latter requiring higher first-cost and ongoing lubrication/maintenance). High superheat, even with the benefits of modern lubrication, inevitably demands higher maintenance, and if this is not achieved then steam leakage past piston and valve rings, plus losses through stuffing glands can soon negate the theoretical advantage. Wheel diameter is chosen to give a reasonably high piston speed at design running speed to gain theoretical advantage, and cylinder dimensions chosen to give favourable bore/stroke ratios based on experience; in combination with long lap valves of course.

'Nice-to-have' features can so easily be incorporated at the concept stage of a totally new-build, but in a cramped narrow gauge envelope they can be exceedingly difficult to fit into the space available. I feel that crew comfort and safety are prime requirements for a twenty first century steam locomotive, especially considering a machine that would be running half its time backwards, and often in inhospitable climatic conditions. The driver must have comfortable access to all controls while facing in either direction, and why not provide a decent seat, every farm tractor has one? The cab also needs to be fully weatherproof, warm in winter and cool in summer, therefore sliding doors and windows

combined with good insulation of the boiler and all pipework; the latter being largely kept outside the cab for safety reasons. A small point but worth a lot in terms of labour saving, all 'brightwork' of which there needs to be sufficient as it adds much to eye-appeal, needs to be low-maintenance. All hot pipes would be insulated, with only a few cold copper pipes to polish, and other items would either be made of stainless material or suitably plated if possible. Keeping the cab clean, and a pleasant working environment can be so much easier with a little

extra thought at the design stage, and efficient coal doors/shoveling plate on the bunker front would reduce dust entering the cab when loading fuel: this combined with 'coal watering' and a built-in drain gutter. Needless to say, a quality wooden floor and a proper seat for the person doing all the hard work; perhaps even a Windermere steam kettle!

Technical novelties: These have to be very carefully considered: why were things done the way they were rather than the new way proposed, perhaps new materials have been developed, new construction/design techniques become available, or there are now suitable off-the-shelf components? Novelties should be few in number (I do not propose a narrow gauge 'Leader'), and be justified in terms of lower first and/or ongoing maintenance/running costs; preferably contributing to weight saving; intending to ease servicing, maintenance and overhauls. The most radical suggestion is that the whole structure of both the 'main frame' and the power bogies should be made as all-welded monocoques, using relatively thin plate-work: this is an idea that M. Chapelon was considering: think ship building technology. Feed water heating is nothing new, but in this Meyer type arrangement it appears logical to conserve the heat in the exhaust steam from the trailing power unit rather than pipe the exhaust (with great difficulty and some weight) to the blast pipe where it would be of limited benefit (even River Mite, R&ER 1928 did this, though without the advantage of a Lempor exhaust). The exhaust system would of course be to the best modern design, making use of the nearby cylinders and resulting in minimal back-pressure. Hot water feed permits a smaller boiler requiring less draft and/or a lower rate of combustion, all of which are sought.

The second novelty, which is particularly applicable to a locomotive with two articulated power bogies, is to operate the two weigh shafts from the cab electrically (geared motors working cranks linked to the weigh shafts). This would not only save a lot of expensive engineering and weight, but would also overcome extreme difficulties routing mechanical linkages. By controlling each unit independently and in combination with separate air brake controls a unique system of traction control would be achieved (important with a divided drive), it could even be automatic. The locomotive type 'Golwe' did this mechanically by shortening cut-off (I think they meant 'lengthening') on the trailing unit as the water tanks emptied, using a float. Garratts, with a single regulator, depend on reliable sanding, and like all conventional locomotives have a rattling great 'reverser' taking up limited space in the cab.

Electric operation proposed for sanding gear and cylinder drain cocks for the same reasons.

Some important details for major parts of the locomotive:-

BOILER:-

The superheater of the 'field tube' arrangement as trialled on locomotive LYD, primarily because it fits well in a compact tube pattern, but also because it can be made up in all- welded sections eliminating most of the difficult to access nuts and bolts within the narrow gauge size smokebox.

Pop safety valves: these are the most diabolically clever solution to an engineering difficulty that 'never was' (thanks to the friend of an American railroad director, or some similar story), but may be excused on the largest locomotive boilers. See notes in Full Description.

Very best lagging of boiler, smokebox, all hot fittings and pipe work.

The barrel tapered slightly to provide better water flow paths to the firebox sides, and to allow a higher water level (more tubes/free gas area) whilst maintaining an adequate steam space.

The throat plate inclined, normal to the sloped centre line of the tapered barrel, so that the join is perfectly circular without manipulation. Increased water space below tubes. Longitudinal and casing cross stays to be threaded but firebox (steel) side stays to be fillet welded not full prep. (German Standard), extending their effective length, reducing cost and facilitating replacement.

Twin regulators and steam circuits but a single operating handle: with traction control this allows the two units to be independently 'driven'.

POWER BOGIES:-

Steel box frame construction, double framed between cylinders and horn guides: cut away to allow access to springs.

Leading pivot is not load bearing (pads/rollers at sides).

Walschaerts valve gear with small return crank throw to optimize geometry and keep the profile low. Long travel for valves produced by rocker shaft which also brings valve chests INSIDE cylinder centre lines (critical for loading gauge), allowing for large steam chest volume and good insulation.

Manganese steel horn guide facings as on locomotive LYD but set into pockets machined in the horn fabrications: greased.

Axle boxes: Due to the axle loads being too great for plain bearings, these would use pairs of spherical roller bearings arranged to be oil lubricated, and the cranks would if possible be made easily removable (taper locking bushes and keys).

Parking brakes applied by twin coil springs and released by twin air cylinders, plus graduated air brakes for traction control: all cylinders etc. mounted externally for access. Reversing gear electrically operated: also drain cocks and sanding gear.

The trailing bogie mounted on a spherical seating (with side springs to give roll stability) assuring full compensation between the two axles (heavily loaded when bunker and tank are full).

A vertical drive shaft from the trailing unit drives auxiliary equipment behind the bunker:- rotary vacuum pump (to maintain train vacuum when running), air pump, boiler feed water pump, twin alternators with batteries.

CAB:-
Driver's seat rotates WITH the main control console around a fixed pillar, giving a clear line of sight in either direction.

TANKS:-
A stop valve provided between the back and front water tanks to maintain adhesion (or reduce axle load) on the trailing unit, and to prevent overflow on steep gradients.

A few technical points:-
Grate area/free gas area, also tube length/diameter ratios depart from standard gauge 'normal' for reasons laid out in the "Full Description".
Smokebox lagging and a built-in chimney cover: there is no point aiming for 'super efficiency' during the day and then wasting heat all night (better for the boiler, better for the balance sheet).

Back-head mounted clacks with internal feed pipes (crew access, compact/heat conservation, and avoiding difficult external pipe runs.
Single spring draw gear as on LYD (simple and no pins to wear).
Tube pattern with horizontal rows and 55.5 degree angle, giving closest tube spacing in diagonal rows of 3/4" and minimum firebox tubeplate ligaments of 1" (tubes and flues reduced at back ends to increase water adjacent to tubeplate).

Lubrication to be centralized as much as possible, and manually with grease except for sliding components (slide bars/expansion links, little ends, etc.) to be oil fed.

A Final Thought:-
A narrow gauge 'super power' locomotive, even though it needs to work hard for significant periods, is quite a different beast from its standard gauge sisters designed within a more generous loading gauge, and intended to run flat out for long periods on high speed track.