INFORMED SOURCES e-Preview June 2022

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This month's column takes a critical look at traction and rolling stock developments, from the performance of the classic Mk 3 coach in high speed accidents to futuristic ideas on freight traction.

Alternative freight traction study undermines TDNS

Carmont report triggers Mk 3 safety scare

800 Series cracking – ORR final report

Network Rail's re-evaluation of the potential use of hydrogen to power freight locomotives is certainly futuristic. It came about following the display of the two hydrogen fuel-cell powered multiple unit test beds at the COP26 climate change conference. Neither was actually running under hydrogen power, but never mind.

Hydrogen is, of course, one of the government's current enthusiasms, but I was concerned by Network Rail's decision to take a fresh look at its application to freight locomotives for two reasons.

First, freight traction is nothing to do with Network Rail. It is the private freight operators who procure and supply their own locomotives. The operators would like to run more electrically-hauled trains.

Second it provides the Department for Transport with a further excuse for deferring decisions on the rolling electrification programme. For example as Julian Worth outlined in Modern Railways (April 2021) six 'quick-win' infill electrification schemes – 50 route miles in all – would increase electric freight haulage by 2 million miles a year.

Top of Julian's quick wins is the 2 miles from the London Gateway container terminal to Thames Haven junction. However, according to Informed Sources, when the issue of making provision for future connections to the Thames ports as part of the current Thameside electrification renewals programme was raised, the official instruction from Network Rail to the contractors was that the requirements of future electric freight haulage were not to be considered.

Fortunately, freight operators can't afford to wait for the future. As the current orders for Class 93 and Class 99 Stadler locomotives are showing, freight operators are already taking long term traction decisions. As GBRf Chief Executive John Smith said to me recently 'We're not a technology business we operate trains, so the logic of battery or hydrogen locos working any time soon just seemed to be very unlikely. We needed a solution that a manufacturer was prepared to build and that had proven technology. Thus the Class 99'.

Research

Following up the hydrogen freight loco project, I asked Network Rail for details of the brief given to the research team. The Public Affairs press team did even better, arranging an interview with Group Safety & Engineering Director, Martin Frobisher.

Martin began by reminding me of the TDNS statement that hydrogen didn't have the power density needed for freight haulage. However he believes that 'technology is moving on', hence the decision to 'revisit those assumptions'. But, ammonia is emerging as much more interesting than hydrogen. I cover this work in detail in my write-up of the interview.

According to Martin, research to date suggests that a modern traction diesel engine could be converted 'very easily' to run on ammonia, with a pilot injection of either diesel fuel or hydrogen. This is a 'really attractive option'.

Now, I know a bit about diesel engines, and indeed, they can made to run on a wide range of potential fuels. Rudolf Diesel used peanut oil as the fuel when developing his engine. I've included a separate note on this for the technically minded.

But, overall, if you are going to use green hydrogen, produced by electrolysis, to create ammonia, then I reckon that it would be more efficient all round to use green hydrogen plus captured carbon dioxide to produce synthetic diesel fuel (e-diesel).

Mk 3 structural strength revisited

References to the 'crashworthiness' of the Mk 3 coaches of the ScotRail Inter7City high speed trains in the Rail Accident Investigation Branch (RAIB) final Report into the Carmont derailment raised a number of concerns in the media over the safety of these trains. Stock designed before 1994 lacks a number of modern 'crashworthiness' design features. RAIB considered it 'more likely than not', that the outcome would have been better if the train had been compliant with modern crashworthiness standards.

Now, the use of 'crashworthiness' in this context is potentially misleading. The specification for crashworthiness features is based on low speed collisions. In high speed accidents, it is structural integrity which saves lives.

Despite being created in the dawn of computer aided design the Mk 3 meets current structural strength standards, such

as end-loadings. Indeed, RAIB notes that ‘the bodyshells of the Mk3 coaches ‘generally performed well in the accident, resulting in only limited loss of survival space.

However, when the leading end of the leading coach D struck the trailing end of the power car, ‘there was complete loss of survival space in the leading vestibule’. The vestibule is protected by four vertical body-end pillars.

All the pillars at the leading end of Coach D were sheared off at their bases. RAIB argues that because the Mk3 ‘pre-dates the current requirements for vehicle ends to be energy absorbing, when the pillars shear off, the body- end structure loses its ability to resist intrusion into survival spaces’.

I don’t believe this claim stands up to the brutal reality of a high energy accident. First, in modern stock the vestibule end is the crumple zone.

Second is the assumption that a crumple zone would have mitigated the effect of the impact. Crashworthiness regulations require vehicle ends to have a ‘crumple zone’ able to absorb 1 MegaJoule (MJ) of energy with a maximum compression of 1 metre.

I calculate that at the instant of impact the Inter7City had 155 MJ of kinetic energy. Would 1MJ of crumpling metal have made that much difference in a split second? I doubt it.

RAIB also raises the possible effect of corrosion of the steel weakening the end structure of Coach D. Back in 2011 I was invited to Chair a seminar organised by the Railway Division of the Institution of Mechanical Engineers on the topic ‘High Speed Trains - what next’?

Papers presented described the work initiated when it became clear in 2005 that the IC125 fleet would continue in service. Industry took this decision very seriously and long term structural integrity of the Mk 3 coach was high on the agenda.

Serco was commissioned to produce a new full Finite Element Analysis (FEA) model of the Mk 3 bodyshell. This was then validated by measuring actual forces in services.

Finally, the computer model was run to simulate the effects of potential service out to 2035. This model included a ‘margin of error’ reflecting heavier passenger loads and the fleet being worked harder than ever before. In addition, the metal was assumed to have thinned with age in a number of critical areas.

The results showed that the vehicle structure was a ‘a lot better than expected’ and sound to remain in service to ‘at least 2035’. As for corrosion, from the start of the life extension programme, coaches had been stripped to bare metal, shot blasted and any corrosion repaired.

In the column, I also go into the practical implications of some of the recommendations in the RAIB report, including the recommendation that industry should develop and issue formalised guidance for assessing and mitigating the risk associated with the continued operation of main line passenger rolling stock designed before the introduction of modern crashworthiness standards.

I have gone into the issue of structural integrity versus ‘crashworthiness’, at length because the historic record shows that it is the key factor in saving lives in rare high speed accidents. I hope readers will be reassured that, in a Mk 3 coach they are travelling in an engineered product which retains the properties which have resulted in a distinguished record of protecting passengers in high energy accidents.

800 Series cracking update

In April, the Office of Rail & Road (ORR) published ‘Learning the lessons’, the final report of its review into the Hitachi rolling stock cracking. It’s fair to say that Informed Sources were underwhelmed.

This was because the review was based on the documentation arising from the industry’s work and ORR had not commissioned its own independent technical analysis. As a result, the detail is effectively as told to ORR by Hitachi, its consultants and other players.

That said, the conclusions are unambiguous. Fatigue cracking of the yaw damper bracket was due to the loads being greater than allowed for in the original design. The degree of fusion in the weld between the bracket and and the car body was also likely to be a factor in relation to the emergence of the cracking. And the poor weld fusion was down to the geometry of the components making it difficult for the welder.

In other words inadequate design was compounded by poor manufacturing quality, itself compromised by a design which was difficult to manufacture. All these were further exacerbated by the choice of an unsuitable material at 17 locations – 7000 Grade aluminium which is known to present Stress Corrosion Cracking (SCC) problems when welded.

Hitachi attributes its troubles, in part, to the wrong kind of standards. ORR, gently, points out, that the applicable standards define the accelerations to be taken into account when designing rolling stock and cautions that standard do not ‘directly mandate the strength of components, which will depend on the individual vehicle design’.

But Regulators have to regulate and ORR argues that since the design was aligned to the applicable industry standards, ‘the industry should evaluate whether applicable standards take into account the loads arising from operation over track in Great Britain’. Oh dear, this overlooks the fact that bidders for the original IEP contract were also provided with

recording car traces taken over samples of the Great Western and East Coast Main Lines at line speeds.

There’s more of the same when it comes to the separate Stress Corrosion Cracking (SCC) where 7000 Series aluminium was employed. According to ORR, this material is particularly susceptible to SCC in chloride-containing environments, referring in the media briefing to ‘the presence of ‘endemic chloride contamination of the atmosphere certainly in the UK’.

So I asked ORR whether it had made any measurements of atmospheric chloride content to support its theory. Japan is also an island nation, had any comparative data been obtained from there, or even from measurements in a coastal areas of France perhaps? Unfortunately not. None of the engineers I have spoken to take this unique British air theory seriously.

I conclude with the current crack monitoring regime and the planned remedial programme. Hitachi has installed two production lines for remedial work at the former Eastleigh, Depot. Current expectations are that yaw damper bracket replacement for a 9-car unit will take just over a month, with a 5-car set requiring just under 3 weeks. The programme is expected to run to 2028.

Roger’s blog

Highlight of the month was a day spent at the Railtex Exhibition. Meeting real people face-to-face, as opposed to on-screen, was invigorating. With InnoTrans at Berlin in September, most of the major players were saving their publicity budgets for the big show, but there was plenty of interest to see on the specialist stands.

When digitisation is seen as the universal solution, I found plenty of physical products on show. This was a reminder that the railway’s end-product is moving people and freight which essentially depends on mechanical and electrical engineering. Examples ranged from Geordie metal bashers who are doing well, to my steel-casting chums at Leeds who are supplying bogies for Light Rail Vehicles in Canada.

Back in the 1970s, I was Britain’s leading writer on train vacuum toilets – admittedly in a field of one. While I have retained an interest, I missed the application of bio-rector toilets to trains in the UK. There was a full size unit on show, so that is a development I must catch up on.

The month ahead is looking busy. It starts with an interview on cyber security, followed by a morning at the screen as DfT presents ‘Rail reform – one year on’. Next comes a visit to Liverpool to see a newly installed Traffic Management System in operation. Finally, at the end of the month it is Modern Railways’ 60th anniversary reception and the launch of a new freight vehicle.

But for now, it’s head down on my analysis of the prospect for fares reform. Not one of my specialist areas, so I will need to get up to speed.

Roger