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**Front Cover:** A GSM-R Mast and typical relocatable building installation at Morfa Mawddach on the Cambrian Coast Line near Barmouth, Wales.  
*Photo: IRSE NEWS*
Our current thoughts go out to the many members who have been affected by the closing down of various companies related to signalling and telecommunications engineering within the United Kingdom in the past weeks. It has to be a difficult and worrying time for all those who no longer have a job through no fault of their own.

However, it is a well known fact that there is plenty of signalling and telecommunications work that requires to be undertaken on the railway infrastructure in the UK as well as many other parts of the world and that there is not enough skilled, competent and experienced staff to undertake it! It is worthwhile noting that forward-going, full time permanent jobs may be a thing of the past and shorter term contracting may well be the answer in order to find work.

The editors of IRSE NEWS would like to find out and understand the issues and problems related to the recent events in the UK and how they have affected our members. We would like understand the issues in order to make the signalling and telecommunications industry aware of them and to see if we can help where possible. It may well be that we can put members in touch with companies interested in obtaining their skills or assisting with where to get IRSE Licensing re-certification at reasonable cost.

Until those affected tell us what they need, we are unable to help. So, don’t despair! Get communicating with this magazine and the Institution to see how we can help.

We look forward to hearing from you soon.

The Editors

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PRESIDENTIAL ADDRESS 2010

IRSE Presidential Address
By Paul A Jenkins FIRSE

Introduction
Firstly, I would like to thank the Membership and Council for their support over the years, and for electing me as President for the coming session. I am honoured.

This address is in three sections: First, a little about my background in S&T, then a few words on some of the issues that the Institution currently faces, and finally a view of our industry today and an introduction to next year’s agenda, with some of the reasoning behind it.

A path to president
Some of you will know me from my 27 years on the railway, but for those of you who do not, here is a brief summary of my career so far.

I joined British Rail Southern in 1983 following a curious interview with Clive Kessell and the late Ron Hurst. I was asked how I thought a telephone exchange worked, and as a recently graduated Geologist brimming with ridiculous confidence I was, of course, able to explain.

Despite this, I was offered the job, and so began my career on the railway. My first boss, John Jordan, was wonderful. He set me on the straight and narrow and I was, of course, a little pathetic. However, he was kind enough to offer me the job of running a small consultancy, providing management services to the industry.

Management positions with BRT and Racal engineering, project and business engineers in order to make it all work.

Contractors, signallers and the other jobs my small team, Thames Valley lines, and I thoroughly enjoyed working with my small team, contractors, signallers and the other engineers in order to make it all work.

I progressed through a series of positions with BRT and Racal Telecom in Reading, York and London.

I went to Reading Tech and got some more appropriate qualifications, and I progressed through the professional & technical grades at Croydon and Reading Project Offices. I was involved with the transmission and cabling for Westbury and Exeter MAS schemes and spent many happy months on the railway in Somerset and Devon.

I was responsible for implementing Cab Secure Radio systems on the Chiltern and Thames Valley lines, and I thoroughly enjoyed working with my small team, contractors, signallers and the other engineers in order to make it all work.

I progressed through a series of engineering, project and business management positions with BRT and Racal Telecom in Reading, York and London.

We went through privatisation and I even tried to find out how telephone exchanges worked.

In 2000 I joined Railtrack, as Head of Telecoms. By this time Railtrack had managed to lose control of the railway telecoms network. This was a consequence of the rushed privatisation and a subsequent lack of management focus. The network was doing very well in its role as cash cow for Railshare shareholders, but it wasn’t doing so well when it came to supporting railway operations, and there was a need for drastic action.

We saw the opportunity to create a new railway telecoms network, and built a design and business case for what became the national Fixed Telecoms Network (FTN) and GSM-R cab radio in the UK. The plan survived Railtrack in Administration and was embraced by Network Rail. There was the small matter of £2 Billion to pay for it, but we eventually negotiated the funding with the Strategic Railway Authority and the Rail Regulator.

We managed to persuade Network Rail’s Signal Engineer that all new signalling systems should be specified to work over open communications networks, and thus the stage was set to remove some of the unnecessary costs involved in having dedicated telecoms systems for railway signalling.

I spent four years at Network Rail as Programme Director, building, integrating, testing and commissioning the FTN and GSM-R networks, and during this time we proved that FTN and GSM-R worked. We also ended up developing a unique GSM-R train radio for the UK, despite the interoperability laws. This was because of the incomplete nature of the European Standards and the misaligned business incentives within the UK rail industry.

For the last two years I have been running a small consultancy, providing engineering, project and business management services to the industry.

27 years summarised
So to summarise, I have spent 27 years in railway telecoms projects and business management. I have always enjoyed working at the interface with railway signalling, and have seen the industry from many angles - but I still need a little help from my friends when it comes to telephone exchanges!

Issues facing IRSE today
I now turn to some of the issues that face the Institution, and what I think we should be doing about them.

When I joined British Rail it seemed that the IRSE was an exclusive clique of the senior and the superannuated, organised by a distant group of very old gentlemen, up in London. To this young engineer it all seemed very staid, very dull, and definitely not for me. I managed not to join for ten years.

We know that a perception remains that IRSE is still some kind of exclusive gentleman’s club, and that it’s a bit old fashioned, backward looking and reluctant to change.

Being a bit old fashioned might be a good thing, but I do think that this general perception is unhelpful to a body that wants to appeal to younger people, and aspires to serve a growing worldwide community of engineers working in modern transport systems.

I am happy to report that there are lots of good things going on within the institution. There seems to me to be a far greater openness about how things are run, and a great willingness to find out what members want and then attempt to serve the majority of them.

There has been significant change over the last ten years, and as membership numbers have grown so the staffing has increased and we have a small team of hard working staff, and a large number of volunteers who put in an enormous amount of time and effort for IRSE. They are a modest lot, who don’t blow their own trumpets, but I think that they have taken great strides in modernising the IRSE.

Growing membership
We should not overlook the fact that we have a steadily growing membership and we are evolving into a truly international organisation. We now have about 4600 members, with much of the recent growth
coming from overseas, and this trend looks set to continue. In India, for example, we now have almost 400 members, but this is a small proportion of the S&T engineers in the sub-continent, and with an active Section there we soon expect to welcome many more Indian members.

Of course, it is possible that over time I have become institutionalised, and my conveniently rosy view of IRSE could be because I am now become one of those very old gentlemen up in London, part of the clique, and part of the problem - You can be the judge of that, but it doesn’t seem so to me.

Modernisation must continue, and there are three areas, all related to each other, where I believe the IRSE should make faster progress.

**Communications strategy**
Firstly, we need to develop and implement a communications strategy which is focussed on improving communications between IRSE and the engineering community, in order to promote a more positive perception of IRSE beyond our membership.

Our Institution includes telecommunications and IT in its specialist skill set and we should exploit this technology to the full. We could and should go much further, more quickly in developing our use of the internet, social networks, webinars and video conferencing.

We need to do more to communicate the fact that IRSE is an open, international institution with a lot to offer, with many opportunities for meeting interesting people and for seeing and hearing interesting things.

We should take closer control of the content that we publish, ensuring that our main emphasis is on signalling and telecommunications for the future, modern technology for modern transport systems. The aim, of course, is to increase our appeal to younger engineers worldwide, wherever English is used as a unifying technical language.

We should not slow our own progress by allowing IRSE to be seen as anything other than a progressive technical institution, run for the benefit of its membership and society at large.

**Serving the international membership**
Secondly, the growth in overseas membership means that we must continue to change. We have to consider what all these members, who may never come to London, want from the Institution, and how best to provide value for their membership money. Even with the currently battered pound sterling, our subscription in Rupees and other currencies can be a very significant sum.

There is a huge resource of technical information here in London, and in the Sections worldwide, and it should all be made available, via the web site, to members wherever they are.

Proceedings should also be available to members on the internet, as a searchable database, removing the need for thousands of CD’s to be posted round the world every year. Lectures should be available to watch, whether they are given in London, Sydney, Swindon or New Delhi. Highlights of conventions and technical visits should be made available to the majority of members who are not able to attend.

These things should all be cross indexed and searchable to make it possible to look up all Institution resources on a specific subject, be it Internet Protocol architecture for operational telecommunications or the design of interlocking.

**Managing the international institution**
Thirdly, inside IRSE we are improving the way we get people involved in helping to run and shape the institution. Changes have been made with the aim of getting better involvement in Council affairs from the sections overseas, but we need to go further in this direction. As overseas membership grows so the need to get overseas representation in the management of the Institution grows.

Best practice should be identified and spread more rapidly and again, better communications and use of the available technology would help here.

I am very pleased to say that much of the work on these three issues is underway. Those of you who have seen our latest strategy document, published in April’s IRSE NEWS, will know that these issues all have action plans, and in the coming year I will be pushing for more resources to be devoted to these, so that we can make faster progress.

In this last section of my address, I will offer a view of our industry today, and introduce the programme for the next session.

**The railway industry today**
Railway men have long appreciated that steel wheel on steel rail is a very energy efficient basis for transport. As technology has developed the advantages of rail have grown and many improvements have become possible:

- Have an electrified railway to avoid lugging your fuel and a generator about;
- Have regenerative braking to recover energy when you need to slow down;
- Have a signalling system that optimises traffic flow and reduces energy consumption.

Factor in the potential to power the whole lot with electricity generated from renewable sources and the case for rail compared with road or air transport, has surely been obvious for some time.

There has been terrific progress in recent years in building new mass transit rail systems in cities, and high speed rail links across countries and continents, and many more projects are in the planning and design stages. Many countries have seen that as their population grows and energy costs rise, rail makes sense. Add to this the increasingly widespread concern for the damage we are doing to our environment, and it does seem that we might, at last, have reached the age of the train.

Alas, this picture has until recently applied to almost everywhere in the developed world except here. In the UK, birthplace of the railway, we have some catching up to do.

The Government in the UK, and the main political parties, are all saying that they support plans for a new high speed railway to the North, and both Crossrail and large scale electrification seem to be gathering momentum. Making such significant investment in rail at this point in the economic cycle seems to me to be exactly the right thing to do. The political support for the development of the
railway reflects the fact that the public at large wants to see an improved railway in the UK. Of course, we have a general election here on 6 May, so it remains to be seen whether we can trust our politicians or whether these plans will turn out to be yet another episode of short term political posturing.

I do hope that at last, even in the UK, we have caught up with the idea that railways are an important part of the future, rather than a quaint relic from the past!

Whether or not the UK is going to catch up soon, the worldwide drive for more and better railways brings a growing demand for engineers to harness technology to provide services that make the railway more efficient to run, and for passengers, more convenient to use.

**Improving the railway with S&T**

There is plenty of scope to improve things, based on communications and information technology that is available now, and here are some examples:

A more efficient railway will have signalling centres that manage traffic over a much larger area. It has been a long time since it was necessary to look out of a window to manage trains, and we have technology available now that makes regional or even national control centres a realistic proposition. A greater number of signals (where they still exist) and interlockings can be controlled from a central location, and train running data can be collected over a wider area and organised in order to optimise the management of traffic.

Optimisation can of course be tailored to suit the specific type of operation, and can be set up for the most appropriate balance between capacity, speed and energy conservation.

There will be less trackside infrastructure as we move to in-cab signalling and automatic train operation worked over radio. There are cleverer ways to monitor where trains are, and track circuits and axle counters will be reduced in number as systems combining video positioning, satellite and radio triangulation are used on-board to report the train’s position.

The essential remaining infrastructure such as switches and crossings will continuously report its condition to the control centre, and this data can be used to present an organised picture of the state of the infrastructure, and in many cases allow things to be fixed before they affect the train service. Some call this intelligent infrastructure, I see it simply as the intelligent application of available technology.

When an infrastructure fault does occur, the traffic management system can make sensible adjustments to optimise train running. So when a set of points fails the impact is managed, and timetables are adjusted in near real-time to optimise traffic flow.

Of course, with a digital radio link trains can report much more than their position and the data can be integrated with the other asset information at the control centre so that if a fault is developing a sensible plan of action can be calculated. Data from trains can provide infrastructure condition information through continuous ride quality monitoring. It can also be used to manage passenger flows: if you inform the traffic management system which carriages are full, then you can tell the passengers waiting on the platform where to stand. You could use a similar arrangement to manage seat reservations in real time, and perhaps this could lead to empty seats being sold at a last minute discount, because, of course, the most efficient railway has all its trains full.

Data from trains could tell you how much fuel or coolant is on board, and how much energy is being consumed.

Train running information will be available as a by-product of the traffic management system, and can be made available to passengers, wherever they are, even on trains, and if you have a wagon or a container in transit then that too can be tracked using a combination of satellite and railway systems.

Security is a growing concern and the increasing number of CCTV cameras brings growing demand for bandwidth and for clever ways to manage and present the data. The efficient management of larger railway stations demands integrated systems so that security, passenger information, passenger flows and crowd control can all be optimised under the different conditions that prevail.

Last, but not least, railway signalling systems have to be designed to take full advantage of available communications technology, in order to reduce cost. For example, the use of circuit switched GSM-R for the low speed telemetry required to control trains is hugely expensive and inefficient in terms of the utilisation of radio spectrum. S and T engineers are going to have to embrace IP, swiftly.

**An exciting challenge!**

There are so many things that we can do, and this presents a major challenge for engineers who need to communicate their ideas with facts and with enthusiasm, so that business cases can be produced, investment found and the railway improved for the public benefit.

So what an exciting time to be an S&T engineer on the railway, and what a wonderful career opportunity for today’s science and engineering students!

**Next year’s session at the IRSE**

It is against this background that I have been considering what to do in the coming year. I have chosen an agenda that will allow us to explore the differences between the current state of telecoms and information technology and that in use on the railways, and in so doing highlight the areas for railways to consider for their future use. I hope to provoke some debate on the interfaces between telecoms and railway signalling, and we will look at the future development of signalling, in the context of the available telecoms and information technology.

I am delighted to say that the Convention this year will be held in New Delhi, India. There are many new, relatively young members in India, and a recently re-established IRSE section. There is tremendous scope for IRSE to serve the S&T community there. Also, there is a lot going on in Indian Railways. It’s the biggest railway in the world, and the biggest employer. There is 5 billion US Dollars of investment planned in S&T in the next ten years. The railway is seen in a very different social context to that currently pertaining in Europe and the Indians have a different way of doing things. I believe we have much to learn from each other. The Indian Section is incredibly enthusiastic and a lot of effort is being put in to make this convention something very special. It will be fun, and I hope that many of you will be able to attend.
This summer we will have a technical visit to Network Rail’s ETCS trial site on the Cambrian Line in Wales, to see the first implementation of ETCS in the UK, and hopefully to see it working. We’ll combine this with a visit to the newest railway in the UK, which somehow still manages to be a heritage site, the Welsh Highland Railway to Caernarvon.

As usual there will be a series of London lectures, and I have been able to tempt a number of colleagues who are experts in their fields to help enlighten and entertain us.

The papers will explore the possibilities that modern telecoms and information technology offers to railway operations in general, and to railway signalling in particular. We’ll also look at some of the issues of capacity in the radio spectrum – something we are all increasingly reliant on.

There will be topical papers in which S&T on very different railways will be discussed: on London Overground’s East London Line, and at the other extreme, on High Speed Two.

There will be a technical seminar on railway telecoms, where we will look in detail at emerging telecoms technology and how it might find application on rail.

This will include some consideration of how the adoption of technology off-rail drives expectation and demand on-rail. We will discuss how this could influence the development of railway signalling.

There will also be a technical seminar on Communications based train control, where we will have the opportunity to review the latest developments in this field, and of course, look at the telecoms technology on which these systems depend.

We will consider what lessons mainline rail can learn about train control, capacity & reliability from the Metros, and we will have speakers from around the world to discuss the differing approaches to migration on operational railways.

Conclusion

So it is an exciting time for S&T engineers, and it looks as if it will be another busy year at the IRSE. I hope that it will prove to be both entertaining and thought provoking.

I will do my best to be a worthy President, and to advance the aims of the Institution, as relevant today as when they were written in 1912 – The advancement for the public benefit of the science and practice of signalling.

Thank you for listening.

INDUSTRY NEWS

Products Used in ERTMS Level 2

Banverket, the Swedish rail operator, required a solution that would allow Internet Protocol (IP) traffic to be transmitted on long stretches of existing telecoms grade twisted pair cables running along the trackside. The Westermo Wolverine products were the perfect fit for this application and allowed a completely IP based system to be implemented without the need for the installation of costly fibre optic cables.

The requirement arose from the installation of a system conforming to the European Rail Traffic Management System (ERTMS). ERTMS is a major project developed by a number of major manufacturers in close cooperation with the European Union, railway stakeholders and the GSM-R industry. ERTMS aims at replacing the different national train control and command systems across Europe. The deployment of ERTMS will enable the creation of a seamless European railway system and increase European railway’s competitiveness.

ERTMS is specified at different levels and the definition of the level depends on how the route is equipped and the way in which information is transmitted to the train. At Ådalsbanan in Sweden, Banverket together with Bombardier provided a section of railway with ERTMS level 2. This application is unique as it is the first level 2 installation ever to include equipment such as railway crossing barriers. In an ERTMS level 2 system the engine driver can receive basic track and rail information via the GSM-R radio network. This driver information is sent from Banverket’s control centre via an IP network, which is connected to control and monitoring devices along the railway.

Reliability and Bandwidth

The equipment along the trackside has been linked to Banverket’s IP network using pre-existing twisted pair copper cables and the Westermo DDW-225. The DDW-225 uses SHDSL technology (Symetric High speed Digital Subscriber Line) that allows data to be sent at a maximum speed of up to 5.7 Mbit/s at shorter distances with ranges up to 15 km possible at lower speeds. In this installation however, network resilience and reliability were prioritised rather than bandwidth. The best balance between range and signal to noise ratio was achieved at 2.3 Mbit/s over distances from 2 km to 7 km.

The requirements for high reliability called for a redundant network solution, which is why the National Rail Administration created two individual networks connected to duplicated control equipment. The different networks are completely separate and connected to the backbone network by separate routers. Even if one network should fail, full access to the entire route can be achieved through the redundant network. In addition, the DDW-225 supports a number of features that allow configuration for optimal control. VLAN, QoS, SNMP, SSH, and extended diagnostics were part of the requirements from the Administration.

The DDW-225 is a robust Ethernet extender designed for harsh environments and can operate in an extended temperature range (-40°C to +70°C). The DDW-225 has contributed to significant cost savings as new fibre installation could be avoided. The DDW-225 is also future-proofed as it can be upgraded to support future networking standards as and when they are required.

Metra to Install High-Tech Safety System

A high-tech safety system worth $100m is to be installed on the Metra in Chicago, US by 2015. The technology, known as Positive Train Control (PTC), is a complex system of computers, GPS devices, radios and other communications equipment.

PTC could override human errors to prevent fatal accidents, according to chicagotribune.com. Metra, which serves the city of Chicago and its suburbs, said it expects to have the system running before 2015.

The Chicago region handles more than 1300 trains, 800 passenger and 500 freight every day. In 2005 a Metra train derailed on Chicago’s South Side, killing two and injuring 117 others. In another incident in 2008 a commuter and freight train collided due to a distracted engineer, killing 25 people. This crash prompted the US Congress to pass a law requiring large railroads to install PTC by 2015.
Signalling So Far As Is Reasonably Practicable

By George Nikandros
BE CPEng RPEQ FIRSE MIEAust MACS, Chairman aSCSa

Summary

In Australia, both the model rail safety legislation and the model workplace health and safety legislation require the reduction of safety hazards and risks so far as is reasonably practicable. Railway signalling evolved both as a profession and as a technology because of accidents and the realisation that safety with respect to the movement of trains over a network needed improvement. But will the signalling systems in use or planned satisfy the “so-far-as-is-reasonably-practicable” test; a test that is determined by a Court with the benefit of hindsight and the influence of public opinion? Demonstrating compliance with rail industry signalling standards may not be a sufficient to demonstrate that the railway operation is safe so far as is reasonably practicable. This paper discusses the SIL concept and what is needed to strengthen the argument for so far as is reasonably practicable.

Introduction

In the early 1990s railways in Australia began the transition to commercialisation, be that as government enterprises or private companies.

To facilitate this transition the Commonwealth and State governments introduced legislation to regulate these commercialised railways both from a safety perspective and to cater for competition to access monopoly owned rail assets.

Suffice to say that each jurisdiction had substantially different rail regulatory regime. This resulted in a railway operator having to gain the appropriate accreditation for the jurisdiction it wished to operate.

To minimise the burden of obtaining many accreditations as would be the case for nationally-wide operators, the Australian Transport Council [ATC 2006] agreed to adopt uniform rail safety laws and in June 2006 approved the national model Rail Safety Bill for Australia. Because Australia is a federation, each jurisdiction needs to formally enact this national model Bill; the intent is that any specific jurisdictional requirements would be minimal and in no way change the thrust of the national model Rail Safety Bill.

The model Rail Safety Bill introduces the laws which require railway owners and operators to manage Safety risks So Far As Is Reasonably Practicable (SFAIRP). Before this, railways were merely required to have a safety management system acceptable to the regulator, and have the competence and capacity to manage risk i.e. there was no railway safety legislative requirement to minimise risk.

There was and still is a requirement under the various workplace health and safety laws to minimise safety risk although the enforcement focus is very much on workplaces.

As with disparate jurisdictional rail safety laws, there are disparate jurisdictional workplace health and safety laws. On December 11, 2009, the Workplace Relations Ministers’ Council [WRMC 2009] endorsed the model Work Health and Safety Act to harmonise workplace health and safety laws. The model legislation is also based on the SFAIRP principle.

In summary, the SFAIRP principle is increasingly being enshrined in Australian legislation. How does a railway owner, operator or railway industry supplier ensure compliance with the SFAIRP requirement? Is the application of the As Low As Reasonably Practicable (ALARP) principle sufficient to demonstrate SFAIRP?

Railway industry safety standards CENELEC 50126, 50128 and 50129 specify unsafe failure probability and use the concept of Safety Integrity Levels (SILs) to guide the development of systems and produce the appropriate supporting evidence. How does one determine the SIL required and is this determination sufficient to demonstrate SFAIRP?

This paper discusses the SFAIRP principle, the ALARP principle, and the SIL concept and highlights the issues in satisfying the SFAIRP legislation from a signalling perspective.

Notation

- AHFW: Australia Institute of Health and Welfare
- ATC: Australian Transport Council
- ATP: Automatic Train Protection
- ATSB: Australian Transport Safety Bureau
- CBTC: Communications-Based Train Control
- COAG: Council of Australian Governments
- DIER: Department of Infrastructure, Energy and Resources, Tasmania
- ETCS: European Train Control System
- FRA: Federal Railroad Administration within the US Department of Transportation
- GAO: US Government Accountability Office
- HSE: Health & Safety Executive, UK
- MOP: Members of the Public
- NTC: National Transport Commission
- ORR: Office of Rail Regulation, UK
- RSSB: Rail Safety & Standards Board, UK
- TMR: Department of Transport and Main Roads, Queensland
- WRMC: (Australian) Workplace Relations Ministers’ Council
Train Safe Working

Railways have been operating trains well before rail safety and workplace health and safety legislation was in place.

Various train safe working systems have evolved over time offering different performance capability and inherent safety integrity.

<table>
<thead>
<tr>
<th>Safe Working System</th>
<th>Traffic Density</th>
<th>Technology Safety Integrity</th>
<th>Reliance on procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train Order</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Train Order (Computer Assisted)</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Token (Electric)</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Power signalling</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Power signalling with ATP</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>ETCS/CBTC</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 1: Typical train safe working systems in use today — capability and integrity

The decision to adopt a safe working system for a railway operation was traditionally based on commercial grounds i.e. the need to cater for the required train traffic throughput and the cost involved. If safety could not be engineered via the supporting technology, procedures were introduced to address the short fall.

Whilst there have been standards for the technology supporting train safe working systems, albeit they have improved over time, there have not been any standards to guide the decision to adopt a particular train safe working system for a particular rail operation.

Most of the train safe working systems and technology in use in Australia existed prior to the enactment of rail safety legislation. Railway operators and owners are now exposed, particularly in the event of an accident; they need to be able to demonstrate to the rail regulator and the Courts that they are compliant with the rail safety legislation, in particular demonstrate that the rail operation is safe as is reasonably practicable.

Ararat Accident

In November 1999, two trains collided at Ararat, Victoria resulting in two people being seriously injured. From the accident report [ATSB 2000], a key factor was the lack of interlocking between signals and points; interlocking which was removed in April 1995. Because of branch line closures, the interlocking was deemed no longer necessary, thus enabling signalling staff changes.

Whilst this action was found to be compliant with the rail safety legislation at the time, it is unlikely that it would comply with the SFAIRP requirement in current legislation if the accident happened now.

SFAIRP

The phrase so far as is reasonably practicable has its origins in English Common Law [Redmill 2009] and that the judgement of reasonableness by the Courts, where there is no definitive prescription for such that decisions, need to be determined in a manner that is understandable and acceptable to those engaged in the case.

The determination of reasonableness is made after the fact i.e. with the benefit of hindsight and the community expectations at the time of the determination; not those expectations that may have existed when the undertaking began.

The National Transport Commission [NTC 2008] recognises SFAIRP as a “legislative qualification” which in essence:

“...requires weighing the risk against the resources needed to eliminate or reduce the risk. It does not require every possible measure to be implemented to eliminate or reduce the risk, but it places the onus on the person holding the duty to demonstrate (or be in a position to demonstrate) that the cost of the additional measures to control the risk (over and above those risk controls already in place) would be grossly disproportionate to the benefit of the risk reduction associated with the implementation of the additional risk control.”

The phrase “to demonstrate (or be in a position to demonstrate)” applies to the defence of court action following an event which resulted in harm.

The phrase “grossly disproportionate” also has its origins in English Common Law; it originates from guidance from the courts as to how one could discharge their obligations to do what is reasonably practicable.

Edwards v. The National Coal Board

Lord Asquith’s judgement in this 1949 case established the test for establishing reasonable practicability [HSE 2001], [NTC 2009], [Redmill 2009]. Lord Asquith said:

A computation must be made in which the quantum of risk is placed on one scale and the sacrifice, whether in money, time or trouble, involved in the measures necessary to avert the risk is placed in the other, and that, if it be shown that there is a gross disproportion between them, the risk being insignificant in relation to the sacrifice, the person upon whom the duty is laid discharges the burden of proving that compliance was not reasonable practicable. [Edwards v. The National Coal Board 1949]

But does Lord Asquith’s judgement apply in Australia? The High Court considered the meaning of ‘reasonably practicable’ in Slivak v Lurgi (Australia) Pty Ltd (2001) concluding that whether a measure is or is not reasonably practicable involves a value judgment on the basis of what was known at the relevant time, and balancing the likelihood of the risk occurring against the cost, time and trouble necessary to avert that risk. [Bluff 2004]
**Rail Safety Legislation**

The current status of rail safety legislation in Australia is summarised in Table 2.

<table>
<thead>
<tr>
<th>State</th>
<th>Legislation based on Model Bill</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>Yes</td>
<td>Rail Safety Act 2008 No.97</td>
</tr>
<tr>
<td>Queensland</td>
<td>Expected</td>
<td>Transport (Rail Safety) Bill – introduced 09-Feb-2010</td>
</tr>
<tr>
<td>South Australia</td>
<td>Yes</td>
<td>Rail Safety Act 2007</td>
</tr>
<tr>
<td>Tasmania</td>
<td>Yes</td>
<td>Rail Safety Act 2009</td>
</tr>
<tr>
<td>Victoria</td>
<td>Yes</td>
<td>Rail Safety Act 2006</td>
</tr>
<tr>
<td>Western Australia</td>
<td>Expected</td>
<td>Rail Safety Bill 2009 – referred to Standing Committee on Uniform Legislation and Statutes Review on 24-Nov-09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>Act</th>
<th>SFAIRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commonwealth</td>
<td>Occupational Health and Safety Act 1991</td>
<td>Yes</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Occupational Health and Safety Act 2000 No.40</td>
<td>No – reasonable practicable can only be used as a defence</td>
</tr>
<tr>
<td>Queensland</td>
<td>Workplace Health and Safety Act 1995</td>
<td>No – reasonable practicable “can” only be used as a defence</td>
</tr>
<tr>
<td>South Australia</td>
<td>Occupational Health, Safety and Welfare Act 1988</td>
<td>Yes</td>
</tr>
<tr>
<td>Tasmania</td>
<td>Workplace Health and Safety Act 1995</td>
<td>Yes</td>
</tr>
<tr>
<td>Victoria</td>
<td>Occupational Health and Safety Act 2004</td>
<td>Yes</td>
</tr>
<tr>
<td>Western Australia</td>
<td>Occupational Health and Safety Act 1984</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**SFAIRP – Rail Safety Bill**

The rail safety legislation based on the national model Rail Safety Bill [NTC 2007] imposes the responsibility for managing safety risks on those undertaking the rail-related enterprise (Part 4, Division 2, Regulation 34); it is the owners, operators and designers that have the obligation to ensure that the risk of the enterprise is safe, so far as is reasonably practicable.

The concept of ensuring safety is defined in Part 2:
- To avoid doubt, a duty imposed on a person under this Act…to ensure, so far as is reasonably practicable, safety requires the person —
  - (a) to eliminate risks to safety so far as is reasonably practicable; and
  - (b) if it is not reasonably practicable to eliminate risks to safety, to reduce those risks so far as is reasonably practicable.

To avoid doubt, for the purposes of this Act and the regulations, regard must be had to the following matters in determining what is (or was at a particular time) reasonably practicable in relation to ensuring safety —
- (a) the likelihood of the risk concerned eventuating;
- (b) the degree of harm that would result if the risk eventuated;
- (c) what the person concerned knows or ought reasonably to know, about the risk and any ways of eliminating or reducing the risk;
- (d) the availability and suitability of ways to eliminate or reduce the risk;
- (e) the cost of eliminating or reducing the risk.

Whilst the model Bill defines the basis for judging SFAIRP, there is no practical guidance from the rail regulators as to when the SFAIRP requirement is likely to be satisfied.

**Accreditation**

The rail safety laws require railway owners and operators to be accredited. The rail safety regulator in each jurisdiction is responsible for granting accreditation provided the accreditation requirements are deemed to be satisfied. The accreditation requirements (Part 4, Division 2), include the following:
- (i) has the competence and capacity to implement the proposed safety management system; and
- (ii) has the financial capacity, or has public risk insurance arrangements, to meet reasonable potential accident liabilities arising from the railway operations;

There is no requirement for the applicant to demonstrate that the safety risks of the intended railway undertaking are safe so far as is reasonably practicable to gain accreditation.

There is no responsibility imposed on the rail regulator to be satisfied that the undertaking is safe as is reasonably practicable.

**Relationship with WH&S Laws**

The workplace health and safety legislation takes precedence over rail safety legislation Rail Safety Bill [NTC 2007], Part 2.

If a provision of this Act or the regulations made under this Act is inconsistent with a provision of the occupational health and safety legislation, the provision of the occupational health and safety legislation prevails to the extent of any inconsistency.

As there are separate regulators for workplace health and safety and rail safety, it is possible that directions provided by regulators may conflict.

The workplace health and safety laws apply to workplaces, and therefore their application depend on the definition of a rail workplace. In Queensland, a railway workplace has a broad definition (Transport Infrastructure Act 1994):

railway workplace means either of the following places —
- (a) a place that is, or at which is located, rail transport infrastructure or other rail infrastructure;
- (b) another place used by an accredited person to conduct activities in relation to managing a railway or operating rolling stock on a railway.

In some jurisdictions, Queensland and New South Wales, the workplace health and safety laws impose more onerous safety requirements on a railway owner or operator than those under the Rail Safety Bill.

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8 The National Partnership Agreement for the single national rail regulator will be considered in 2011. COAG also agreed to establish a strengthened national regulators’ panel to provide better national harmonisation of rail safety regulation in the period in which the national regulator is being established [COAG 2009].
In Queensland and New South Wales, the workplace health and safety laws require appropriate measures to prevent or minimise safety risk. However in New South Wales, one is able to use reasonable practicability as a defence whereas in Queensland it may be possible.

**Guidance for Industry**

Neither the model rail safety laws nor the workplace health and safety laws provide any practical guidance as to how anyone undertaking a rail enterprise in Australia can be certain that they have discharged their obligations in relation to safety.

The SFAIRP principle is often only tested “after-the-fact” i.e. after the harm has occurred; it is a judgement by the Courts, the Rail Regulators and Workplace Health and Safety Inspectors after harm has been done, that is, with the benefit of hindsight.

Only the Tasmanian rail regulator [DIER 2004] provides any practical guidance; the guidance largely being that published by the Health & Safety Executive, UK (HSE).

**Possible versus Practicable**

Satisfy the SFAIRP requirement does not require everything possible be done; however it does require everything possible that is practicable to be done irrespective of the magnitude of the risk.

Lord Asquith’s judgement [NTC 2008] defines practicability as being some subset of possibility; for a safety risk control measure to be practicable, it needs to be possible. However a measure that is possible may not be practicable; there may be a gross disproportion between the sacrifice to implement the measure compared to the benefit to be gained.

**Rail Safety Regulation Guidance in the UK**

Prior to Her Majesty’s Railway Inspectorate moving to the Office of Rail Regulation (ORR) in April 2006, rail safety was regulated through the Health & Safety Executive (HSE), since 1993.

The SFAIRP principle is enshrined in UK law, and as in Australia, the law is vague on how this is expected to be achieved.

The HSE developed the as-low-as-reasonably practicable (ALARP) principle as a guide to making risk tolerability decisions [Redmill 2009]. The ALARP principle is the regulator’s model of how compliance with the law should be addressed and assessed.

Demonstrating that the safety risks are ALARP should give confidence that the SFAIRP legal requirement is satisfied. The SFAIRP requirement does not preclude a dangerous activity, provided that it is supported by a strong reasonableness justification; ALARP does.

**ALARP**

The ALARP principle is based on the premise that there is a limit beyond which the level of safety risk is considered to be unacceptable (the limit of tolerability threshold), and a level of safety risk below which the risk is considered to be negligible (the broadly acceptable threshold).

The region between the limit of tolerability threshold and the broadly acceptable threshold is defined as the tolerability region; the region in which the risk is tolerable only if it is as-low-as reasonably practicable; a concept of a willingness to live with a risk so as to secure certain benefits [HSE 2001].

**ALARP Residual Risk**

The ALARP principle assumes there is always some risk of harm in any enterprise, but the risk may be so low that it is negligible compared with other risks that are encountered in every day life.

ALARP is not about eliminating all risk; it puts focus on the more significant risks where the effort needs to be.

**ALARP Thresholds – UK**

ALARP requires the definition (quantification) of the limit of tolerability threshold and the broadly acceptable threshold for the particular enterprise.

The HSE made recommendations to the nuclear industry [HSE 1988, 1992] as to the ALARP threshold limits that should be used for rating safety risk. The HSE recommended one in a million (10⁻⁶) per year as the broadly acceptable threshold, one in ten thousand (10⁻⁴) per year as the limit of tolerability threshold for members of the public (MOP), and one in one thousand (10⁻³) per year as the limit of tolerability threshold for employees.

Although these threshold values were derived for the nuclear industry, they have been adopted as the benchmarks for other safety-related industries; the railways in the UK being one of those industries. Figure 2 depicts the ALARP thresholds used in the UK rail industry.

**Individual versus Societal Risks**

The ALARP thresholds relate to individual risks; the risks each individual of the group under consideration that has exposure to the risk, a member of the public, passengers, or employees.

Societal risk [HSE 1988, 1992] is usually applied to major events; the consequences of a major incident go much wider than injury to individuals or groups. Things considered in quantifying societal risk are society’s aversion to multiple loss of life, land rendered unproductive, foregone future investment opportunities, and the disruption to social fabric of the community.
**Value of Preventing a Fatality – UK**

A key task in the application of the ALARP principle is the assessment of the costs to implement the risk reduction measure compared with the benefits to be gained.

This requires placing a monetary value of the safety benefit. Assigning a value for a life is a complex and controversial task. Adding to the complexity is who makes the determination; the creator of the risk or those who suffer the risk.

To enable a cost-benefit analysis [HSE 2010] of the risk reduction measure/s, the UK Department of Transport defines a value of preventing a (“statistical”) fatality (VPF) to be used in such analyses. The VPF is not an assessment of the value or price of life; it is a value to be used when assessing safety risk mitigation options. The RSSB [RSSB 2006] provides the following illustration as to the meaning of VPF:

To illustrate this concept, suppose a group of 100,000 people enjoy a safety improvement that reduces the probability of premature death during a forthcoming period by, on average, 1 in 100,000 for each and every member of the group. While the safety improvement might, in the event, prevent no deaths, or one death (in fact, the most likely outcome) or two deaths (with a lower probability), or three deaths (with an even lower probability) and so on, the mean (or statistical expectation) of the number of deaths prevented is precisely one and the safety improvement is thus described as involving the prevention of one “statistical” fatality.

Thus if a safety measure results in the prevention of one statistical fatality, then the monetary value assigned is the “benefit” in the cost-benefit analysis.

The VPF used by the UK Department of Transport [HSE 2001] was £1,000,000. The value is derived to reflect the current economic conditions.

**Gross Disproportion**

Assume the assessed safety benefit is one statistical fatality i.e. £1,000,000. If then the cost to implement the safety measure is ten times this amount, would the law expect the measure to be implemented, given the origins of SFAIRP?

Would the law expect the measure to be implemented if the cost was twice the safety benefit?

The intent of gross disproportion qualification between the benefits and the costs is to err on the side of safety when making safety risk decisions. It is reasonable to expect the bias towards safety would be more the nearer the risk is to the limit of tolerability threshold.

In the UK the HSE [HSE 2001] in regulating safety applies bias when comparing risks against costs. The extent of bias is relative to the magnitude of the risk and precautionary approach that the nature of the risk warrants.

**USA Positive Train Control Rule**

In response to the US Government decision to mandate the implementation of positive train control (PTC) systems for certain passenger and freight lines through the Railway Safety Improvement Act of 2008, the US Federal Railroad Administration (FRA), issued a major rule, entitled “Positive Train Control Systems” (RIN: 2130-AC03) in January 2010 as a “final rule; request for comment on specific issues”. The stated effective date for this rule is March 16, 2010.

The US Government Accountability Office (GAO) issued an assessment report [GOA 2010] on FRA’s procedural compliance with respect to this rule. Included in the report was an assessment of a cost-benefit analysis for positive train control. The ratio of cost ($13.2 billion) to benefit ($673 million) is around twenty; this is in any one’s terms a large disproportion (bias) in favour of safety.

The GAO report did not however provide any insight as to how the FRA quantified the safety benefits in monetary terms; the number and severity of casualties that PTC is expected to prevent over the nominated 20-year life was not provided.

Does this now set a new benchmark in rail safety for the rail industry? Will this be a consideration by the Australian courts and rail safety regulators in assessing SFAIRP?

**Harm Quantification**

ALARP considerations are based on an individual suffering a fatality. However not all harm that may be incurred is fatal; individuals many suffer a range of injuries. To fully quantify the harm, all incident scenarios and harm outcomes need to be considered.

The concept of equivalent fatality [RSSB 2007] allows the aggregation of harm to people by regarding major and minor injuries as being equivalent to a certain fraction of a fatality; the equivalence factors being:

- One fatality equals ten major injuries;
- One major injury equals twenty minor injuries.

The guidance on the use of ALARP, is unclear as to what criteria to use when setting the thresholds; should they reflect individual fatality risk or individual equivalent fatality risk?

---

1. PTC is a system designed to prevent train-to-train collisions, over-speed derailments, incursions into established work zone limits, and the movement of a train through a switch left in the wrong position [FRA 2010].
Given that the origin of ALARP is from the nuclear power industry where fatality would be the most likely outcome, it is reasonable to set thresholds based on individual fatality probability.

But is this reasonable for the rail industry?

The Waterfall (NSW) commuter train derailment [McInerney 2004] resulted in seven fatalities (includes the driver who is believed to have suffered a heart attack) and 42 injuries, equating to 9.1 equivalent fatalities if one assumes that half of the injuries were serious.

The Berajondo (QLD) tilt train derailment [TMR 2005] resulted in no fatalities, 38 serious or moderate injuries and 74 minor injuries, equating to 3.8 equivalent fatalities.

The derailment speed was essentially the same for both the Waterfall and Berajondo derailments, but the consequences were very different.

This contrast is not peculiar to Australia; one can easily find many examples of rail accidents of a similar nature but with contrasting severity outcomes. An over-speed derailment at Amagaski (Japan) in 2005 resulted in 107 fatalities and 555 injuries; the derailment speed was the same as for Waterfall and Berajondo.

Given that probability of a fatality does not dominate the expected outcome of a rail accident, safety targets should be based on equivalent fatalities.

Assessing Safety Risk

Assessing risk is not a precise science; the less frequent the event the greater the statistical uncertainty. For a typical railway operation, high consequent events are fortunately relatively rare and as such the uncertainty in their estimated frequency is high.

For ALARP to be effective there needs to be confidence in assessed risk and confidence in the amount of the risk reduction to be gained by the risk mitigation measures being considered. For example if the assessed risk is above the limit of tolerability threshold, the amount above will influence the possible mitigation options:

If the assessed risk is higher than it really is, then a higher than needed risk reduction measure may be deemed necessary, that is one with a higher SIL if the mitigation measure is an engineering solution;

If the assessed risk is lower than it really is, then a lower than needed risk reduction measure may be considered sufficient.

It is better to overstate the risk and understate the mitigation that can be achieved i.e. err on the side of caution.

Signalling as Risk Mitigation

Traditionally signalling was used to prevent a train from colliding with another train, derailing over points and crossings and colliding with vehicles and pedestrians at actively controlled level crossings. However the effectiveness of the mitigation was limited by the reliability of the driver. Adding movement authority and speed enforcement significantly enhances the safety mitigation potential.

However, the effectiveness of the mitigation depends on the signalling functionality employed, the trustworthiness, reliability and availability of the particular technology used, and the correctness of the application design.

The safety risk that remains depends on the level of risk that existed (or could have existed) prior to the introduction of the signalling mitigation and the risk reduction provided by the mitigation.

Implementation of a fully featured European Train Control System (ETCS) is not likely to be practicable for a rural low volume freight line. However for a busy intercity line the practicability of ETCS is not that obvious.

SFAIRP versus ALARP

The SFAIRP legislative requirement is a minimum requirement; it is not about reducing risk as much as possible; but it is about reducing risk as much as practicably possible irrespective of the magnitude of the risk; it makes no difference if the risk is high or negligible.

SFAIRP forces the rail industry, be that owners, operators, or suppliers on to a never-ending quest to ensure that everything practicably possible has been done and be able to demonstrate that this is so. This quest is made more difficult if there is no agreement as to how safety risk is to be quantified in monetary terms.

For ALARP, the requirement is to reduce the risks within the tolerable region by doing everything practicably possible. If the risk is above the limit of tolerability threshold then the undertaking is not allowed. If the risk is below the broadly acceptable threshold, there is no need to demonstrate that the risk is as low as reasonably practicable.

ALARP provides more certainty; there is a risk level above which the risk cannot be tolerated and there is a level below which the risk is negligible when compared to every day risks. This certainty however is predicated on there being agreement between the regulators (rail and workplace health and safety) as to the threshold limits.

Signalling-related Risk

So how do railway owners and operators determine whether the signalling-related risk is SFAIRP or ALARP for that matter?

The safety risks associated with the railway undertaking need to be assessed, preferably by conducting a quantified safety risk analysis.

For each of the possible risk mitigation options, a cost benefit analysis [HSE 2010] needs to be undertaken to assess practicability. All benefits need to be assessed, not just the safety benefits. Any adverse safety risks that the option could introduce also need to be included.

It is therefore necessary to know the limitations of the considered mitigation technology options to determine the safety benefit contribution i.e. what equivalent fatalities will be prevented by this option?

Signalling Technology

Much of commercial-off-the-shelf (COTS) railway signalling technology being deployed today contains software.

The nature of software is such that it does not fail randomly and hence the failure rate for this technology is not probabilistic, i.e. a failure probability can not be defined. Software is however prone to systemic failure; an error in the software will continue to manifest each time the conditions that trigger it occur. Once fixed, the failure will never again occur.

Standards such as EN 50126, 50128 and 50129 specifically aim to address the systemic failure issue in railway signalling.
technology containing software. These standards are based on essentially two safety tenets:

The concept of vital and non-vital to define those parts of a signalling system that are necessary for safety and those that are not is no longer appropriate;

Safety is a continuum between absolute safety (no chance of harm) and certain catastrophe [Redmill, 2000].

EN 50126, 50128 and 50129 assume the ALARP principle applies.

These standards address systemic failures by imposing greater development rigour for higher levels of integrity: the underlying premise being that more rigour results in less latent errors.

It is not practical to specify a development process for a continuum; hence the adoption of discrete levels for which there is a specified development process. EN50126, 50128 and 50129 are based on the safety integrity level (SIL) concept. There are four levels with Level 4 relating to the highest level of safety.

It is important to highlight that there is no convincing evidence that applying greater rigour during development ensures a safer product [Short 2009].

SIL
ENS018 provides two SIL definitions; one relating to system, the other to software:

System safety integrity level – a number which indicates the required degree of confidence that a system will meet its specified safety features.

Software safety integrity level – a classification number which determines the techniques and measures that have to be applied in order to reduce residual software faults to an appropriate level.

IEC 61508 and ENS0129 assign failure probability values to each SIL. Table 4 shows the failure probability values for continuous/high demand mode operation for a safety risk reduction measure:

<table>
<thead>
<tr>
<th>Safety Integrity Level</th>
<th>Probability of dangerous failure per hour (continuous/high demand mode)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>$3 \times 10^{-6}$ to $&lt; 10^{-6}$</td>
</tr>
<tr>
<td>3</td>
<td>$3 \times 10^{-8}$ to $&lt; 10^{-7}$</td>
</tr>
<tr>
<td>2</td>
<td>$3 \times 10^{-7}$ to $&lt; 10^{-6}$</td>
</tr>
<tr>
<td>1</td>
<td>$3 \times 10^{-6}$ to $&lt; 10^{-5}$</td>
</tr>
</tbody>
</table>

The intent of such failure probability values is to equate the extent of risk reduction to a SIL. If say a safety system with dangerous failure rate of $10^{-5}$ per hour is required to achieve the safety risk reduction required, then that system has to be developed as a SIL 4.

If however a dangerous failure rate equal to SIL 2 is sufficient to reduce the risk to be within the ALARP region, then the practicability of the SIL 2 option needs to be assessed against SIL 3 and SIL 4 options.

Also, if a dangerous failure rate equal to SIL 2 is sufficient to reduce the risk to be less than the broadly acceptable threshold limit i.e. below the ALARP region, there is no requirement to assess practicability against high safety options. However to satisfy the SFAIRP requirement, other higher SIL options must be assessed for their practicability; SFAIRP requires a practicability assessment of ETCS for a rural freight operation, whereas ALARP may not (depends on where the risk level is).

SIL 4 however is the best one can do. The European Commission [2009] in their regulation on the adoption of a common safety method on risk evaluation and assessment state:

For technical systems where a functional failure has credible direct potential for a catastrophic consequence, the associated risk does not have to be reduced further if the rate of that failure is less than or equal to $10^{-6}$ per operating hour.

However there is no guarantee that compliance with the development requirements for a particular SIL will result in a system having that failure probability [Short 2009].

It is becoming increasingly common for safety technology suppliers to advertise their products as meeting a particular SIL. It is a serious misuse of the SIL concept to assume that the failure probability is the probability value assigned to that SIL by standards.

Limit of Tolerability for Australia

Is the limit of tolerability threshold for members of the public used in the UK appropriate for Australia?

One way this may be answered is to consider road harm statistics. Figures 3 and 4 depict road fatality rates for OECD countries with respect to population and registered vehicles respectively.

Per 100 000 people, the UK (Great Britain) rate in 2007 was 5; the Australian rate was 7.5. Per 10 000 registered vehicles, the UK rate was 0.9 in 2007; the Australian rate was 1.1. Road fatality rates in the UK and Australia are therefore comparable.

In 2006-07 there were some 1600 road fatalities [DITR 2009a], and 32 800 serious injuries [AIHW 2009] in Australia. This equates to 4880 equivalent fatalities. Australia’s population at the time was 21 m.

Assuming that 50% of the population spends significant time on the road, the probability of a regular road user suffering a fatality is around 5 in ten thousand per year. Therefore a one in ten thousand per year fatality probability for a member of the public, for a rail passenger, and for a train driver would seem reasonable as a limit of tolerability threshold for Australia.
**VPF for Australia**

Demonstrating SFAIRP necessitates a cost-benefit analysis and as such requires the safety benefit to be expressed in monetary value.

Whilst there is such a monetary rate for the rail industry defined in the UK [RSSB 2009], there is no comparable value in Australia.

The (Australian) Bureau of Industry, Transport and Regional Economics (BITRE), formerly the Bureau of Transport Economics, provides some guidance [BITRE 2000] as to what this monetary value might be:

**Countries using the willingness to pay approach to value human life for road safety purposes include Finland, New Zealand, Sweden, Switzerland, United Kingdom and United States.**

Willingness to pay values used in European countries range from $1.8 million to $4.2 million (1998 Australian dollar equivalents), while in the United States a value of US$2.9m (in 1994 prices) is used for all transport accident fatalities. New Zealand, as at June 1998, was using a figure of NZ$2.25 m.

Based on the value of life in other countries, in today’s terms, a VPF of around $3 500 000 would seem reasonable for the rail industry in Australia.

**Conclusion**

The lack of uniformity of workplace health and safety legislation, and the number of rail regulators across all legal jurisdictions creates additional compliance costs for the rail industry. Whilst a national rail regulator should improve things, there also needs to be uniform workplace health and safety laws which are consistent with rail safety laws.

Whilst SFAIRP has its place in law, its application is a complex area that requires a number of regulatory strategies to be considered. This is something that rail regulators should be considering.

**REFERENCES**


ENSO126-2001, CENELEC, Railway applications – The specification and demonstration of reliability, availability, maintainability and safety (RAMS)
A Case Study of a Complex Computer Based Interlocking

By Satish Vuppala

Krishna Canal Junction (KCC) is a complex interlocking having 209 routes, 68 signals, 36 points, 70 track circuits and eight lines. It is the largest interlocking in India which is commissioned with computer based interlocking technology.

The Customer was the South Central Railway, Indian Railways.

WESTRACE, a product of Invensys, was used as the technology behind this computer based interlocking.

New design concepts were introduced to achieve more simultaneous moves and to cater for customer requirements. The total yard is divided into three zones. Inputs and Outputs for each zone are assigned to one WESTRACE. So totally there are three WESTRACE’s for reading inputs and driving outputs, as can be seen in the Track Plan below.

The most appropriate data structure would be a master-slave structure. In this structure all the circuits will be in a master system and slave system only reads an input and transfers it to master system or drives an output as per the command from master system. For this type of system we had to consider logic space since all the circuits should be one single system.

If the logic space cannot accommodate the complete data, we have to split the logic across the systems and arrive at a data structure. Data structure is a template that defines which circuits have to be accommodated in which system to decrease the overall time delay.

WESTRACE compiles the program statement by statement instead of whole program at a time. So when such technology is chosen, there is a necessity to formulate a data structure which not only defines the location of the circuits but also defines the order of circuits to achieve less time delay in setting a route and clearing signal and the design has to be in an order according to the data structure. All the circuits that are defined in a system are called logical circuits since no wiring is involved.

We need to take care of loss of communication when circuits are divided across the systems. If a relay in one system is driven by a relay back contact of other system, then its type of design always calls for trouble. One way to overcome this problem is to formulate the data structure such that no back contact status one from system is driving a relay in other system. The second way is to define loss of communication back contacts in series in all the circuits. So whenever there is failure in communication the back contact opens up thus isolating all the relays from being driven.

At KCC, the following data structure was implemented. W1 means first WESTRACE system and similarly others like W2, W3 and W4 can be understood. In the Vital Logic module (VLM), all the vital circuits will be loaded and in Network Communication Diagnostic Module (NCDM) all the non vital logic will be loaded. Communication (comms) between VLM and NCDM is robust.

As you can see from the Data Structure on the opposite page, there are actually four WESTRACES. The fourth WESTRACE has been introduced to provide additional logic space.

KCC called for innovative designs. Some of them are briefed below:

- Swinging Isolation Circuits;
- Point Failure Circuits;
- Cascading Circuits.
SWINGING ISOLATION CIRCUITS:

In KCC, there are two sets of isolation points for critical routes which means that the route can be set if any one set of isolation points are detected and locked. This called for “Swinging Isolation” circuits. Take the case that a signal has been cleared to a route with first set of isolation points detected and locked, now if any other route requires any of first set isolation points which are already locked to be driven, then a circuit has to be designed in such a way that first set of isolation points are released only when the second set of isolation points are driven, detected and locked. This is achieved through swinging isolation circuits. This is special and complex feature introduced at KCC.

Data Structure

<table>
<thead>
<tr>
<th>Sec’s</th>
<th>W4 NCDM comms N to W4</th>
<th>W4 VLM</th>
<th>W1 NCDM comms (N to V) W1</th>
<th>W1 VLM comms W4 to W1</th>
<th>W1 VLM comms W3 to W1</th>
<th>W2 VLM comms W4 to W3</th>
<th>W3 VLM comms W4 to W3</th>
<th>W1 to W3 comms W2 to W3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>receives control buttons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>if available sets route command</td>
<td>transfer</td>
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<td>transfer Aspects read</td>
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<td>Indication</td>
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COMPUTER-BASED INTERLOCKING

POINT FAILURE CIRCUITS:
Where there are two sets of isolation points for a route, there is always an option to drive the other set if one set fails. The following can be termed as failure conditions for a point to be operated:
- Point track relay did not pick up.
- Point detection failure.
So keeping this in mind, “Point Failure Circuits” are designed to operate the other set of isolation points if one set fails.

CASCADING CIRCUITS:
Cascading is achieved through logical circuits itself, thus avoiding a lot of wiring and use of physical relay contacts in the relay room which in turn decreased the number of relays.

1. The system Panel Processor
2. The WESTRACE cubicles
3. Indian Railways will not accept any input/output to be fed to the equipment directly, so the WESTRACE systems read inputs from the field and drive outputs to the field through relays.
4. In order to gain experience, an Operator’s VDU system is also provided.
Train Control goes Wireless

Thales’ SelTrac is the world’s most widely used communications-based train control system. Now, Thales has perfected a radio-based transmission system that allows metro operators to harness the capacity benefits of SelTrac CBTC more easily than ever before.

“There’s a large market shift towards radio-based CBTC” says Colin Bantin. “Radio offers higher bandwidth and much greater flexibility for expansion than conventional induction loop communications”. Thales has more than a dozen radio-based CBTC projects in revenue service and a number of others currently being implemented. Among the Thales revenue projects are the Las Vegas monorail, which was the world’s first such system installed in 2004, the Hong Kong Disney Resort Line operational in 2007, and the Washington Dulles Airport People Mover put into revenue service early this year. A further six metro lines in Shanghai and Beijing are also in revenue service with the radio-based CBTC network.

Thales has adopted a design philosophy that employs industry-wide open standards for implementing a radio-based solution for CBTC. This provides many benefits to the railway operator, such as diversity of suppliers and interoperability of the equipment from different suppliers. The communications network is fully redundant and independent of the actual train control applications, which allows expansion without disruption to existing train operations.

The radio solution uses the 802.11 radio standard. This choice of standard provides the best solution for mobile Ethernet networks because it is a self-managing network that requires no Internet Protocol (IP) address management. It also provides fast seamless handovers between the mobile radios and the wayside radios as the train moves along the tracks, even at speed up to 150 km/h. The wayside radios are interconnected using an industry standard Ethernet network and high speed fibre optics.

Protecting operations

Security is at the heart of Thales’ offer. “We have implemented a unique solution to support open-standard radio” says Dr. Bantin. “By providing multiple links to each train, the risk of service interruption caused by interference is reduced to the absolute minimum”. Radio access points are located along the trackside such that there is uninterrupted and redundant signal coverage. The on-board mobile radios have antennas that are located at each end of a train and can “see” at least two access points ahead and behind the train at all times.

Thales’ radio incorporates authentication protocols to ensure that messages picked up by trains have come from a trusted source. “This goes beyond encryption” emphasises Dr. Bantin. “Thales’ authentication process uses the IPSec open standard with a dynamic key management system that provides maximum security from the train control computer right through to the train itself”. This is the kind of high strength security used for on-line banking, for example, and is considered to be virtually impossible to break during the lifetime of a key.

Resilience and flexibility

As well as offering enhanced security, radio-based CBTC eliminates vulnerabilities associated with conventional train-to-wayside communications. There is less lineside equipment and no loop between the rails that can be damaged during maintenance. Thales’ solution is much less susceptible to vandalism and the risk of cable theft is cut, because copper cable is not used.

Radio is comparatively easy to install and maintain. “The system is also readily expandable to include additional lines and can be modified without service disruption, thanks to our overlapping coverage philosophy” adds Dr. Bantin.

Radio coverage, and the supporting fibre network, can be added as existing lines are extended or new lines are added. The fact that the network is independent of the train control equipment means that multiple lines can be covered by the same network even if there are multiple train control systems, perhaps from different suppliers. The extra bandwidth provided by radio makes it possible to handle additional services that may be beneficial to the train operator and passengers. Audio (voice) circuits directly from the trains to various control centres can be readily added in using voice-over-IP technology; real-time video (CCTV) monitoring from within a train can be implemented and integrated with emergency alarms and voice circuits. Internal WiFi access can be implemented on each passenger car and fed through the CBTC radio to a wayside server providing Internet connection. These features open up the prospect of a range of new onboard services to enhance passenger comfort, safety and personal productivity. Thales advocates increased interoperability and works with rail industry partners, including the New York City Transit Authority in the United States, and the EU-backed MODURBAN research project in Europe to develop common standards for urban rail.

SEAMLESS RE-SIGNALLING

The radio-based solution means operators can minimise the disruption associated with CBTC re-signalling – and reduce the time needed for installation and commissioning.

“Conventional induction loops are intimately connected with the train control system” explains Dr. Bantin. “But with radio communications, it’s completely different: the solution is installed as an overlay. It’s not tied to the signalling system, so it does not intrude on the operation of the railway”. 
The ERTMS “levels” define different uses of ERTMS as a train control system, ranging from track to train communications (Level 1) to continuous communications between the train and the radio block centre (Level 2). Level 3, which is in a conceptual phase, will further increase ERTMS’ potential by introducing a “moving block” technology. Whilst it is commonly acknowledged that to date, ERTMS level 2 offers considerable benefits, the use of level 1 already brings significant advantages for the railways and allows for High Speed travel.

**What is ERTMS level 1?**

ERTMS level 1 is designed as an add-on to or overlays a conventional line already equipped with lineside signals and train detectors.

Communication between the tracks and the train are ensured by dedicated balises (known as “Eurobalises®”) located on the trackside adjacent to the lineside signals at required intervals, and connected to the train control centre. Receiving the movement authority through Eurobalises, the ETCS onboard equipment automatically calculates the maximum speed of the train and the next braking point if needed, taking into account the train braking characteristics and the track description data. This information is displayed to the driver through a dedicated screen in the cabin. The speed of the train is continuously supervised by the ETCS onboard equipment.

**What is ERTMS level 2?**

As opposed to level 1, ERTMS level 2 does not require lineside signals. The movement authority is communicated directly from a Radio Block Centre (RBC) to the onboard unit using GSM-R.

The balises are only used to transmit “fix messages” such as location, gradient, speed limit, etc. A continuous stream of data informs the driver of line-specific data and signals status on the route ahead, allowing the train to reach its maximum or optimal speed but still maintaining a safe braking distance factor.

**What will be the features of ERTMS Level 3?**

ERTMS Level 3, still in its conceptual phase, introduces a “moving block” technology. Under ERTMS level 1 and 2, movement authorities are determined using “fixed blocks” - section of tracks between two fixed points which cannot be used by two trains at the same time.

With ERTMS level 3, accurate and continuous position data is supplied to the control centre directly by the train, rather than by track based detection equipment.

As the train continuously monitors its own position, there is no need for “fixed blocks” – rather the train itself will be considered as a moving block.
Is it possible to upgrade from one level to the other?

Yes – ERTMS allows for a smooth migration from one level to the other. For instance, upgrading level 1 to level 2 mainly necessitates the installation of the radio network, the Radio Block Centre and some additional balises for positioning. Introducing Level 3 will enable the train to monitor and report its own integrity thus releasing the need for track detection circuitry e.g. axle counters and/or track circuits.

Why should I opt for one ERTMS level or another?

ERTMS has been designed to meet the railways’ needs and this is reflected by the different levels available. The existence of another signalling system on the line, the possibilities to equip the line with GSM-R technology, the maximum speed allowed or capacity upgrades, are amongst the factors which come into play when choosing a particular ERTMS Level. However, it is commonly acknowledged that ERTMS Level 2 brings the full benefit of the system to a reality, as it allows for increased capacity and significant costs savings for maintenance through the removal of lineside signals.

What is the difference between ERTMS “levels” and ERTMS “versions”?

ERTMS “versions” (or System Requirements Specifications – SRS) designate the technical baseline of the ERTMS software – the current legal version if known as “2.3.0d”, whilst the so-called “baseline 3” will be available by 2015.

All currently operating levels are defined in each version of the SRS. Want to know more about ERTMS? Please check www.ertms.com or contact UNIFE at unife@unife.org

Life Extension of RETB Systems

By Clive Kessell  BSc, CEng, FIET, FIRSE

First Published in the Rail Engineer Magazine

Radio Electronic Token Block was born out of necessity in the early 1980s. In 1978 a huge storm destroyed the overhead pole route on the Far North line from Inverness to Wick / Thurso. Restoration was out of the question economically, so how to solve the problem and keep the lines open? The then BR S&T Department in conjunction with BR Research, instigated the design of a radio bearer system to transmit the bell and control signals generated by the single line token instruments over the ‘air’. In effect the radio had to mirror the pole route, sounds simple but was actually quite a challenge. The kit was duly manufactured, installed and commissioned using the then National Radio Network (NRN) Frequencies (104 – 138 MHz). It worked well after a few teething problems but the high operating costs of signalling the line remained.

Could something more effective be devised? So came about the concept of an electronic token. If complete radio coverage of the line could be provided – with a guarantee that radio signals at passing loops would be robust – together with an In-Cab control unit, then it should be possible to transmit ‘electronic tokens’ to and from trains under the control of an SSI interlocking and associated Control Console. Designs and trial equipment were assembled, which quickly proved that it was feasible.

Key to success was the design of the radio system, with train radios needing to be identical to the Band III sets (180-190 MHz) then being introduced under the NRN programme. The radio infrastructure had also to be compatible and a chain of radio stations was established that required no radio or landline links. This took the form of: Base Station > Repeater Station > Base Station > Repeater Station > Base Station etc until the end of the line is reached. The layout is shown in the diagram. Each base station is allocated its own Band III channel. Once the token signal is sent from the control point to the first base station, it is transmitted on air and received by any trains in that section as well as the first repeater station. This latter changes the signal to the channel of the second base station and repeats it on. Received by the second base station, the signal is again broadcast to any trains in that section as well as to the second repeater. So the process continues to the end of the chain. To guard against equipment failure that would break the chain, the end station is provided with a landline link back to the control point, thus allowing the chain sequence to be fed from the far end. So emerged Specification BR1654 and later the associated Group Standard GK/RT0054.

As well as the Far North lines to Wick / Thurso and Kyle of Lochalsh, the West Highland line, the Cambrian and the Ipswich – Lowestoft (East Suffolk) routes were all converted to RETB operation. Storno, a Danish radio company, who also supplied the essentially similar equipment for the NRN, provided all equipment for the RETB radio infrastructure. Storno was acquired by Motorola in the late 1980s and obtaining equipment became more and more difficult. Eventually, a last buy of spares was made but over time, these have been used up and the systems are becoming unmaintainable.

The solution for the Cambrian Lines has been to replace the RETB with ERTMS Level 2 and use this as the UK test bed for the ETCS equipment and the GSM-R radio when used as a signalling data bearer, also to get experience for the fitting of trains. This will be commissioned during 2010.

Re-equipping all the RETB lines with the ERTMS system may be an aspiration in the longer term but in Scotland, a more pragmatic way forward has been found.
The Life Extension Programme

With performance deteriorating, remedial work started in 2006 on both the West Highland and Far North lines to improve all the obvious deficiencies. The Glasgow office of Network Rail engaged Babcock Rail as managing contractor to co-ordinate and control all the necessary work. Initial activities concentrated on:

- Renewal of aerials and feeder cables;
- Testing and upgrading of earth systems;
- Provision of new or refurbished equipment rooms with improved heating and ventilation;
- Renewal of some base station battery chargers;
- Putting in place an improved maintenance regime.

In addition, the poor radio coverage in certain known sections of route needed to be put right and this resulted in:

- Moving the base station from Achnasheen to a Vodafone owned hill top site at GlenCarron;
- Replacing the mast at Tain with one of twice the height;
- Development of a ‘cell enhancer’ to increase the coverage at Inverness.

Operational reliability improved but a full solution was not possible until a supply source of new base station and control equipment could be found.

Replicating the Radio Equipment

The radio piece parts are nearly 30 years old, and the challenge has been to find a specialist firm who could develop a base / repeater station and a RETB control rack that replicated the original Storno kit. Network Rail in Scotland dug out the original technical and functional specifications and updated these to incorporate a number of features that would not have been realisable back in the 1980s. Rising to the challenge came Comms Design Ltd (CDL) based at Wetherby in East Yorkshire. They undertook to design a new Base / Repeater Station, a new Signaller’s Console and to develop a remote condition monitoring system that would enable faults and operational problems to be easily diagnosed. The products are now real and are going through an extensive testing programme centred on Banavie – the West Highland Line control point – plus five radio sites at Banavie Signal Box (launch signal), Banavie Hill Top (base station), Lochielside (repeater station), Crianlarich (landline link to launch signal on to Oban section) and Arisaig (base station and far end landline link). The complete package incorporates the health monitoring system to give an early indication of any performance problems.

As with all product development, gremlins crept out of the woodwork. It became apparent that the original equipment had been adapted to make it work. The new equipment built to the specification was found to suffer from operational problems:

- Non-conforming data produced by the existing control equipment was causing the repeaters to remotely switch off;
- Timing problems associated with the interface to the SSI and in-cab equipment caused some token telegrams to be lost.

Resolving these problems has taken time as the people who did the ‘adjustments’ are long gone and solutions have had to be worked out from first principles. However, the trial has been in service for 17 months without a single equipment failure and a noticeable improvement in quality. The new audio console at Banavie is so successful that the signallers would resist going back to the old one. The health monitoring system is already showing its worth but will not reach full potential until all the base station equipment is changed over.

Type approval certificates have now been issued for the various types of new radio equipment. The trail is now coming to an end and Network Rail in Glasgow has set about producing a roll out plan for all the RETB lines in Scotland.

RETB Base Station Rollout

A continuation of the development phase includes:

- Extend the West Highland line trial to obtain associated product approval for the use of the newly developed Base Stations and Signaller’s Console on the Far North Line (FN) System;
- Produce the detailed designs required to implement the remaining replacement RETB base stations on the West Highland and those on the Far North lines. The West Highland section includes the White Corries site, which, at 1100 metres, is the highest piece of Network Rail infrastructure in the UK;
Obtain product approval for use of the newly developed Base Station cell enhancer to improve the radio coverage at Inverness and thus eliminate the known coverage gap. Once approval is obtained, a trial will take place and if successful, the cell enhancer will remain in service. The product will be available for use at other locations where coverage is reported to be poor.

Key Project milestones:

**Activity** | **Date**
--- | ---
Inverness cell enhancer trial commenced | September 2009
Signaller’s audio console trial commenced | September 2009
Far North base station trial commenced | January 2010
End of Project Development Phase | June 2010
Investment Authority to implement the Rollout of New Base Stations on all Scottish RETB routes | June 2010
Commence Rollout of New Base Stations | September 2010

**RETB Control Rack Renewal**

As well as the Base Stations, the life extension programme includes the development and implementation of a new RETB control rack to facilitate and improve the integration of the signaller’s voice communication with a variety of radio interfaces. CDL has proceeded with this development in parallel with the base station upgrade work. It will however require a separate product approval and must be independently safety verified in line with the requirements for equipment being introduced into service on the operational railway.

Key Project milestones:

**Activity** | **Date**
--- | ---
Software and Hardware development complete | February 2010
Prototype Control Rack available | March 2010
FAT (Factory Acceptance Test) | March / April 2010
Control Rack install – Banavie and Inverness | May 2010
Control Rack SAT (Site Acceptance Test) and trial commissioning | May 2010
Control Rack trials | June - August 2010

The new control racks will therefore be available before the rollout of the base stations starts and the latter can be progressively connected as they become ready for service.

**RETB System in Retrospect**

The life extension of this system comes out of necessity just like the original need back in the 1980s. Network Rail, Babcock and CDL engineers have worked hard to find a solution to the problem of obsolescence and unreliability. There will be a continual need to ensure that electronic sub-components are available from industry (or that modern equivalents are backward compatible) and that the Band III frequencies can continue for the foreseeable future. The train radios remain unaltered but one oddity is that arrangements have to be made to fit steam engines with radios when they are used on tourist trains. The revamped system, with its remote diagnostic facility, should perform well for many years and thus stave off another equipment renewal crisis that could trigger suggestions that the overall economics of the lines might mean closure.

With the design perfected in Scotland, it is the intention that the Ipswich – Lowestoft RETB is similarly upgraded.

But what of RETB, did it ever reach its full potential? The answer is No: many more lines could have been converted to RETB operation if more money had been put into ongoing development. The concept of operating secondary lines without any lineside cabling and minimal signalling infrastructure has to be appealing. The control and monitoring of level crossings as part of RETB was never properly resolved and this would need pursuing. Ironically, the financial situation with ERTMS Level 2 is such that equipping secondary lines might never be an economic proposition. Maybe Level 3 will be more attractive but a low cost version (Level 4?) might provide the answer. Early proposals as produced by the Germans show a remarkable similarity to RETB and so perhaps the wheel will come full circle.

Thanks are expressed to Ian Findlay, Ian MacDonald and Alan Simpson of Network Rail, Glasgow for information to prepare this article.
IRSE Centenary 2012-2013

In late 2008 the Institution began to consider what should be done to recognise the Institution’s Centenary in 2012-2013.

In order to progress this thought process a Centenary Working Group comprising Colin Porter, Francis How, Ken Burrage, Buddhadev Chowdhury, Ian Mitchell, Lynsey Hunter and David Weedon has been formed.

The name/theme for the year is to be “100 Years of Shaping the Future”, and the main event will be a Convention and Aspect Conference. It is proposed that the six-day event in the year 2012 will be made up as shown below:

| Monday-Wednesday 10-12 Sept | Aspect Conference at QE11 Conference Centre, Churchill Room, with main dinner function on one evening. |
| Friday 14 Sept | Convention. Longer trip technical visits. |

The ASPECT Committee has been reformed under the chairmanship of Ian Mitchell and they are considering the themes for the conference.

A centenary publication with a working title of “100 Years of Signalling and Telecommunications” is being written by a working group under the chairmanship of Ken Burrage. Local sections are being invited to contribute to the book.

The objective is to include:

- Record and Development of IRSE;
- General developments in S&T engineering – not too equipment specific;
- People who have worked in and contributed to the industry;
- To be forward looking as well as historical;
- To not repeat material contained in the OS Nock book on 50 years of railway signalling.

It is hoped the publication date will be of Jan 2013, and the book will launched at the 100th anniversary meeting on 25 Feb 2013.

All local sections have been contacted advising them of the centenary plans, and seeking their support in arranging their own programmes within the theme.

Initial thoughts for the main “London” programme for the year are:

- Envisaging what might be radically different in the future- technology and processes – pushing the boundaries;
- How the railway might become more customer-centric;
- Cover the breadth including light rail and personal public transport (airport type systems);
- How the IRSE might contribute to the vision – what are the barriers – technology transfers from other industries;
- A “competitions” evening to find the most significant advance in railway signalling and telecommunications over the century, using IRSE NEWS to obtain suggestions. Shortlist and debate on night;
- Re-enactment on 25 February 2013 of original paper “Signalling and its Connection with the Construction and Management of Railways.” Could have some form of interactive debate, what was said then, what we would say today, and what might be the position in 100 years time;
- What the IRSE could/should do for members over the next 100 years – could be seminar or evening meeting/debate;
- What lessons from the past are still relevant and need to be taken forward.

Plans are in hand to produce a photographic archive. Colin Porter, Tony Howker and Roger Button have formed an initial working group to investigate how this could be done and what material should be sought.

Throughout the deliberations of the working group, they have striven to ensure that the focus of the centenary will be on the future, whilst fully recognising the important part played by the Institution and more particularly many of its members, in the past.

Colin Porter

If any readers would like to volunteer to provide some help, please contact me at colin.porter@irse.org
Application of Modern Digital Design Techniques for RETB Radio Equipment

By Dr Paul Clark (Comms Design Ltd) and Alan Blackwood of Babcock Rail at the Section meeting on Wednesday 10 February 2010 in Glasgow.

BACKGROUND

Radio Electric Token Block (RETB) has always held a special relationship with S&T Engineers in Scotland since the severe storms in the winter of 1978/79 destroyed the aerial wire route between Tain and Georgemas in the far north of Scotland. The signalling system was maintained by the use of a form of Train staff and ticket working but superseded in 1980 with the reinstatement of Electronic Token Block working over radio in seven sections between Tain and Georgemas.

In October 1984 RETB was commissioned between Dingwall North and Kyle of Lochalsh. This band 2 radio based system was the test bed for RETB and following successful trials was introduced on other rural lines in the UK.

A number of modifications and upgrades have taken place over the years with the Far North RETB system prior to today’s working network.

RETB LIFE EXTENSION PROJECT.

An outline of the West Highland Line RETB system was given, this extends from Helensburgh Central via Crianlarich, where the line splits; one line extends to Oban with the other line to Mallaig via Fort William. A basic overview of how a token is exchanged at working token exchange points.

The RETB Life extension project commenced on the West Highland Line in July 2004 with 17 objectives. This was followed in February 2005 on the Far North Line phase 1, Highland Line in July 2004 with 17 objectives. This was the network layout in this particular network.

The RETB Life extension project commenced on the West Highland Line in July 2004 with 17 objectives. This was followed in February 2005 on the Far North Line phase 1, addressing Base Stations and dial up units. After that the Far North Line phase 2 took place, providing spares and exchanging equipment in service.

The following stages then took place:

- January 2007 base stations were replaced;
- October 2007 Banavie Audio console was replaced.
- October 2008 6 radio base stations were replaced on the west Highland Line;
- September 2009 the signallers audio console in Inverness was replaced;
- December 2009 the trial started on the Far North Line.

Currently 50 RETB base Stations are being manufactured.

Comms Design Ltd have re designed the Radio base station to replace the existing Storno radio base stations supplied twenty years ago and designed some time before that. Their new base stations benefit from the following:

- Reduced weight from the existing 18kg to 7kg;
- Reduction in physical size but still capable of being located on the original Storno wall mounted T bar;
- A design based on modern digital design practice;
- A base station that can be programmed into one of four configurations (Type A,B,C or D ) depending upon the requirement, thus reducing the spares holding and numbers of equipment types required to be taken to site, often remote, at any one time.

Paul then introduced the concept of “Cell Extender” variant using the new base station. This allows for the local cell network to enhance coverage in areas of poor coverage such as token exchange points.

A Cell Extender mini-trial was undertaken at Spean Bridge in February 2009. This trial was to improve radio coverage at a token exchange point that had historically been in a poor reception area. The Fort William Operations Manager was extremely impressed with this trial with the clear audio and faultless token exchange was considered a complete success.

(It should be noted that this concept was used in April 1989 when the Far North System was equipped with band 2/3 base stations to cater for the new class 156 sprinters that were fitted with band 3 radios.)

A replacement control rack is under construction and is expected to enter trials in Quarter 2, 2010.

Paul then explained how digital signal processing allows the new base stations to achieve an enhanced level of performance compared with their current equivalents.

The lecture concluded with an explanation of the health monitoring features of the new base stations and repeaters and how this can be used to monitor a wide range of parameters to ensure network integrity.

The lecture concluded by Dr Clark reviewing that of the six base stations currently being trialled in one of four configurations, none had failed in service.

A lively question and answer session followed. A vote of thanks was given by Ian Findlay who has worked closely on this project for Network Rail. The discussions continued in the Iron Horse Pub in West Nile Street, Glasgow!

Australasian Section Committee (opposite)

Front Row from the left
Trevor Moore, Brian Luber, Geoff Willmott (Sec/Treas), Steve Boshier (Chairman), Robert Baird (Vice-Chairman), Frans Heijnen (President IRSE), Peter Symons (Country Vice-President)

Back Row from left

Photo: Les Brearley
Annual General Meeting
Held in Brisbane Saturday 27 March 2010

The Australasian Annual General Meeting for 2010 was held on 27 March in the Garden Theatre of the Queensland University Campus in George Street, Brisbane. The meeting was chaired by John Aitkin with the Secretary Geoff Willmott in attendance. Apologies were taken followed by the confirmation of the minutes of the 2009 AGM held in Adelaide, and approval of the accounts followed.

The Chairman then announced the awards as follows:

- **Byles and Calcutt** Award for the best paper by a young engineer – Noel Burton (Invensys Rail) and his paper “How many Interlockings does it take to signal a freight train?”
- **Semaphore Award** – No award this year
- **Shining Light Award** – Jason Cheah (Ansaldo-STS) and Brett Cox (Invensys)
- **Chairman’s Award** – Ken Kwong (Central Queensland University)
- **Scholarships** - Mai Binh Nguyen – Vietnam and Puwanai Weeranooi - Thailand

The Chairman then announced the composition of the Section Committee and duly handed over the badge of office to the incoming Chairman, Steven Boshier.

For the first time within living memory there were more candidates for positions on the committee than vacancies so an election was held.

The Office Holders and Committee members were as follows:-
- **Country Vice-President** – Peter Symons, NSW
- **Chairman** – Steven Boshier, Victoria
- **Vice-Chairman** – Robert Baird, Victoria
- **Secretary/Treasurer** – Geoff Willmott, South Australia
- **Auditor** – Glen Cumming, Victoria

Ordinary Committee Members:
- Les Brearley – Queensland
- Peter Stringer – Queensland
- Peter McGregor – NSW
- Mark Lyons – NSW
- Warwick Talbot – NSW
- Trevor Moore – NSW
- Martin Dewhurst NSW
- Richard Stepniewski – NSW
- John Aitkin, – NSW (Past Chairman)
- Glen Miller – Victoria
- Brian Luber – Victoria
- Gary Pallister – Victoria
- Nick Thompson – Victoria
- Tony Howker – Victoria
- Michael Forbes – S Australia
- Brett Baker – S Australia
- Gary Crowther – W Australia
- Alan Neilson – New Zealand
- Simon Wood – New Zealand

The AGM was then concluded and it was again noted that the meeting had not exceeded the 15 minutes allowed in the agenda!

Steve Boshier, the Australasian Section’s New Chairman

Steve Boshier’s signalling career spans over 28 years in the railway industry. He started in the industry with New Zealand Railways as an engineering cadet and gained a broad range of experience and training on various signalling systems. Steve then progressed to a position of signal engineer, where he worked on a number of major station upgrade projects, telemetry system expansions, numerous new level crossing protection systems and the implementation of new technologies. He also taught signals maintenance staff and technicians at their in-house training school.

Having a desire to further expand his signalling experience, Steve then moved to the north west of Australia to work for Hamersley Iron (now Rio Tinto). As their specialist signals engineer and project manager, Steve headed up the re-signalling of their total railway network which saw him implement “In Cab Signalling”, “Automatic Train Control”, new communications systems and removal of the wayside signalling. This was a major undertaking at that time and included the provision to expand the system to Automatic Operation (ATO). Rio Tinto is only now moving towards the implementation of ATO on their network, based on the foundation work he implemented in the 1990s.

Steve then established an international consulting company, working with a range of major government and private railways. During this time, along with his team, he carried out a range of feasibility studies for new and expanding railway systems, provided a range of signalling solutions for operational systems and managed multi million dollar projects.

For the last 10 years, Steve has been working for Invensys Rail (previously known as Westinghouse Rail Systems Australia). As their Business Development Manager – Australia/New Zealand, he heads up their Marketing & Sales Department.

Steve has been a strong supporter for many years of the IRSE working on both local and national committees. He is looking forward to building on the work of previous Chairmen, whilst adding his own touch for the benefit of all members.
Following a conversation with the late President, Alan Fisher, the M&NWS Committee decided to adopt his slightly unusual idea of presenting the same lecture twice during one season.

The subject matter, ‘Axle Counter Applications on the Settle to Carlisle Line’ was applicable to areas in the south western part of the catchment area, where the technology may be applied in the future; but also had local interest in the north west of the area. The lecture was presented by David Teasdel of Babcock Rail and Steve Moore of Siemens, first in Banbury during February, and again in Preston during March. Attendance was good on both occasions, proving the theory does work.

The lectures considered how the Siemens AzS350U Microcomputer Axle Counting System (U for Universal) has been applied on the Settle to Carlisle line, both as an axle counting system and as a simple vital data transmission system. The existing 30 minute headway on the line meant that it was proving difficult for the client to increase throughput. 15 minute headways were required to enable more freight to use the line, freeing up much needed capacity on the West Coast Main Line. This was to be facilitated by the provision of additional Intermediate Block (IB) signals and axle counters, providing track circuit block operation. Early planning of the scheme had to consider the remoteness of the line. The problems of getting power supplies to the area, as well as the equipment having to be very reliable due to the difficulty for faulting staff to attend should something go wrong, were uppermost in the designer’s mind.

Steve spent some time explaining how the system is capable of detecting train axles using the Siemens ZP43 double head detector mounted on the running rail at speeds of up to 400 km/h (plenty for the S&C!). Having been processed by the lineside ZP43E ‘mushroom’, the signal can be transmitted using two different frequencies (3.6 kHz and 6.52 kHz) up to 6.5 km. This distance can be extended to 21 km with the use of powered amplifiers. The d.c. power to the ‘mushroom’ and the heads is sent the other way down the cable. The SIL4 2oo2 computer system is also capable of being used as a vital transmission system, enabling simple control of the new IB signals. Inputs to the Az350U are by means of opto-couplers and outputs are by means of voltage free contacts. The set-up process for the system is simple, with each unit being configured by 12 banks of DIP switches. The system has a target Mean Time between Failure (MTBF) of 50 000 hours, which is currently being exceeded by 100%. A single scratch buried cable was used on the scheme to connect the various sites along the line.

A new IB section at Low House formed the trial site for the system. At this stage there was no connection to the operating signalling system, but experience of how it was operating was gained as trains passed through the area, monitored by a Balfour Beatty Asset View system. This eventually became the first section to be commissioned into operational use on Sunday 16 November 2008. Following the success of this first stage, seven more IB sections and 21 axle counter sections have been commissioned. A later addition to the project was for a similar but smaller project between Blackburn and Hellifield, commissioned towards the end of 2009.

The issue of possessions using rail vehicles which may pass over counter heads in a random fashion was dealt with by installing a mode switch. The switch being used to put the system into ‘engineering’ mode before the work starts. Once the engineering work is completed and vehicles have left the track, the switch is turned back to ‘normal’ and system completely resets. If a failure occurs, the switch is tuned to a 3rd position and normal reset protocols are used. The evaluators are configured for immediate reset with the circuitry controlling the preparatory part, being external to them.

The Section’s thanks go to Steve and David for not only giving the lecture once, but for the second occasion as well.

Ian R Bridges

2010 IRSE PROFESSIONAL EXAM

Please remember that the deadline by which we must receive your application to sit this year’s Exam is 30 June. Forms are available to download from the IRSE website at www.irse.org.

Please note that applications can only be processed from those who are fully paid up members of the Institution at the time of applying.
Spring Technical Meeting - R&ER

On a sunny Saturday 10 April, some 25 members and guests attended our Spring Technical Meeting at the Ravenglass and Eskdale Railway, which is a 15 inch (381 mm) gauge heritage railway in Cumbria, United Kingdom. The seven mile line runs from Ravenglass, a shared station on the Cumbrian Coast Line, to Dalegarth station near Boot in the valley of Eskdale, in the Lake District. The railway is owned by a private company and supported by a preservation society. The line is known locally as Lla’l Ratty and its three foot (914 mm) gauge predecessor as Owd Ratty.

History

The original Ravenglass and Eskdale Railway was a three foot line opened on 24 May 1875 to transport hematite iron ore from mines around Boot to the Furness Railway standard gauge line at Ravenglass. Passengers were permitted from 1876 and were carried until November 1908. It was the first public narrow-gauge railway in England. The line was declared bankrupt in 1897 although it operated for many years afterwards. It was forced to close in April 1913, due to decline in demand for iron ore and small volumes of passengers in summer.

In 1915 Wynne Bassett-Lowke and RP Mitchell, two model makers, converted the line to the 15 inch gauge that it is today. The first train operated over the regauged line on August 28, 1915. By 1917, the entire line had been converted to the 15 inch gauge with trains running along the whole length. As well as passengers, the line transported granite between Beckfoot Quarry and Murthwaite crushing plant. From Murthwaite to Ravenglass the track ran as dual gauge for a time, with standard gauge track straddling the 15 inch gauge rails. A diesel locomotive was obtained in 1929 to work this section and the line carried much of the goods and produce for the valley.

By the mid-1920s, the line had been extended to its present terminus at Dalegarth Station. Passenger trains did not run during World War 2. Following the war, the line was purchased by Keswick Granite Company, the quarries closed in 1953 putting the railway up for sale, 1960 was the last season of passenger traffic. Locals and railway enthusiasts formed the Ravenglass and Eskdale Railway Preservation Society to save the line, with financial backing by others it was purchased as a whole. The structure, the railway owned and operated by private company, with the backing of the preservation society, is still in place today.

Signalling

The railway uses radio control train orders between Ravenglass and Dalegarth, with the Ravenglass station area being operated by a conventional mechanical signal box. The line is single track with passing loops at Miteside, Irton Road and Fisherground. Train drivers communicate by voice radio with the line controller at Ravenglass signal box and all locomotives have radios installed upon them.

At passing loops and the terminus station, drivers contact the controller (who is also the Ravenglass Signalman), using reporting numbers (even numbers for up trains ex-Ravenglass, and odd for down) Trains are given authority by the controller to
occupy sections moving towards the loops and when the train is within the loop and is clear of the preceding section the driver notifies the controller by radio. When the next forward section is clear the controller will notify the driver giving him authority to occupy that next section. This is the procedure as the trains move section to section along the line. No fixed signals are used outside Ravenglass station area. Points at passing loops are spring-loaded with points-set indicators, requiring no human intervention. Elements of the operation were used by British Rail to simplify signalling on remote lines. What became known as Radio Electronic Token Block (RETB) signalling shared features with the Ratty, such as centralised control, spring-loaded points at loops, and on-train equipment rather than fixed equipment at remote locations.

The Day’s Events

The members and guests were split into two groups upon arrival and given a guided tour of the Ravenglass site including the engine restoration and maintenance sheds, signal box with its Midland Style frame and the former Furness Railway Signal box, which previously controlled the Cumbrian Coast Line and access to the station yard and line to Murthwaite which has been restored as a visitor attraction. Here we found the membership certificate of past member Gordon Nichol who had previously installed and was responsible for the signalling and telecommunications upon the railway until his death some years ago. Stuart Marsh is the present Signalling and Telecommunications Engineer for the railway and is also a Director of Signal Aspects Ltd.

We then all boarded our reserved accommodation upon the service train at 11:30, which hauled by one of the lines diesel engines, which took us the full length of the line up to Dalegarth station resplendent with the S&T Engineer headboard attached (with thanks to the M&NW Section), where we partook of a buffet lunch within the station building. Also located here were display stands provided for the event by Henry Williams Ltd and Green Dragon Rail Ltd the event sponsors.

After Lunch, we were given a historical presentation by Dave Jenner the railway’s historian and archivist and Trevor Stockton, General Manager who brought us right up to date with current methods used on the railway. This was then followed by a presentation by Grahame Taylor regarding trials of a new signalling system called TERN (Token Exchange using Random Numbers). This is a simple computer-based signal control system designed for use on minor railways. Grahame provided the background to this equipment and provided an offsite demonstration with the assistance of Stuart Marsh.

Upon completion of the presentations and demonstration, thanks were given on behalf of the section by Ian Hughes the event organiser, Mr Stockton was presented with a Section Tie in commemoration of the visit. All members and guests boarded the return train back to Ravenglass, hauled by 2-8-2 steam locomotive “River Mite”, built in 1966 by Clarkson & Sons for the railway. The Section Chairman was then afforded the chance to undertake a cabride for the full length of the line, where the Cumbrian countryside could be observed at close quarters! Upon arrival at Ravenglass, some members departed, whilst a few remained to enjoy the sunshine and the rest of the afternoon until the service trains had stopped running.

After possession of the line had been taken by the S&T Engineer, the remaining members and guests were afforded the opportunity to observe the first live trial of the TERN control system on the railway, in a special train diesel hauled to Irton Road run round and back to Ravenglass.

Upon return to Ravenglass, we also had the opportunity to view at close hand with the lid off the narrow gauge point machine which featured in the November 2009 issue of IRSE NEWS.

Thanks must go to Trevor Stockton and the employees and volunteers of the Ravenglass & Eskdale Railway, along with Stuart Marsh and Grahame Taylor for such an enjoyable day. Thanks must also go to Ian Hughes of Green Dragon Rail Ltd and Brian Blareau of Henry Williams Ltd for providing their respective display stands and sponsoring the event and finally Ian Hughes for organising the event on behalf of the Minor Railways Section. We look forward to seeing more of you, our members and friends, at our next event and section AGM in York on Saturday 5 June.

Ian James Allison, Section Chairman
New appointment to drive Turnkey Project growth in Asia Pacific

Ansaldo STS has appointed Denise McMillan-Hall to lead the commercial activity of its Transportation Solutions business unit in the Asia Pacific region. The former General Manager for the ARTC’s Hunter Valley will be responsible for driving Ansaldo STS’s rail transportation operations in the Asia Pacific, where demand for turnkey rail transportation projects is expected to expand rapidly in the next three to five years.

Ansaldo STS President of Transportation Solutions Lyle Jackson said planning for numerous mass transit and metro projects in Thailand, India, Malaysia and South Africa had already commenced. “As the drive by governments and administrations to improve the safety and environmental efficiency of their rail systems gathers momentum, this demand is expected to increase,” he said.

Mr Jackson said Ms McMillan-Hall’s broad business and financial expertise, extensive operational knowledge and depth of experience in the rail industry would add significantly to the strength and planned growth of the Ansaldo STS Transportation Solutions business in southern Africa, India and in the Asia Pacific region.

“As Ansaldo STS has undergone an extensive restructure of our Transportation Solutions and Signalling businesses worldwide. We have realigned Operations and Delivery and expanded our capability. Our objective is to vigorously compete for new business opportunities from a position of strength and proven commitment to our customers,” Mr Jackson said.
Rail Tech Training

Rail Tech Training is widely considered to be one of the top providers of Signalling and Telecoms training within the UK. Hosting a fully indoor 10,000 square feet Network Rail approved training academy, Rail Tech Training provides a real life approach to a range of diverse training modules.

Since its inception as a training provider it has continued to achieve the high standards expected by its customers. These standards were recently recognised by the UK Skills body and it was awarded a prestigious National Training Award as the Best Medium Sized company in the East of England.

Some of the many training courses available:

- SMTH / BS1 / BS2 / Signal Appreciation / Diagram Reading / SFI
- AC / DC / Aster / TI21 / HV1 / Reed / Digital TI21 Trrn Circuits
- Clamplock & HW Points Installation & Maintenance
- Signal Works Testing Courses MOD 5 / MOD 3C / MOD 3BL / MOD 4
- Fibre Optic Jointing and Splicing
- Signalling Design Courses BST / IST / AST
- Basic and Advanced Telecoms Principles / TMTH Initial
- Relay Interlocking (RI) / Route Relay Interlocking (RRI) / Solid State Interlocking (SSI)
- Basic ERTMS Training
- PTS / Lookout / COSS / ES / Core Planner / IWA / Hand Trolley / Safety Critical Assessments
- IOSH Management Courses
- 17th Edition Electrical Courses

For more information on any of the above courses please contact Richard Willsher directly on 01473 242344 or email richard.willsher@railtech.co.uk or visit www.railtech.co.uk/training-services/
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