IRSE News

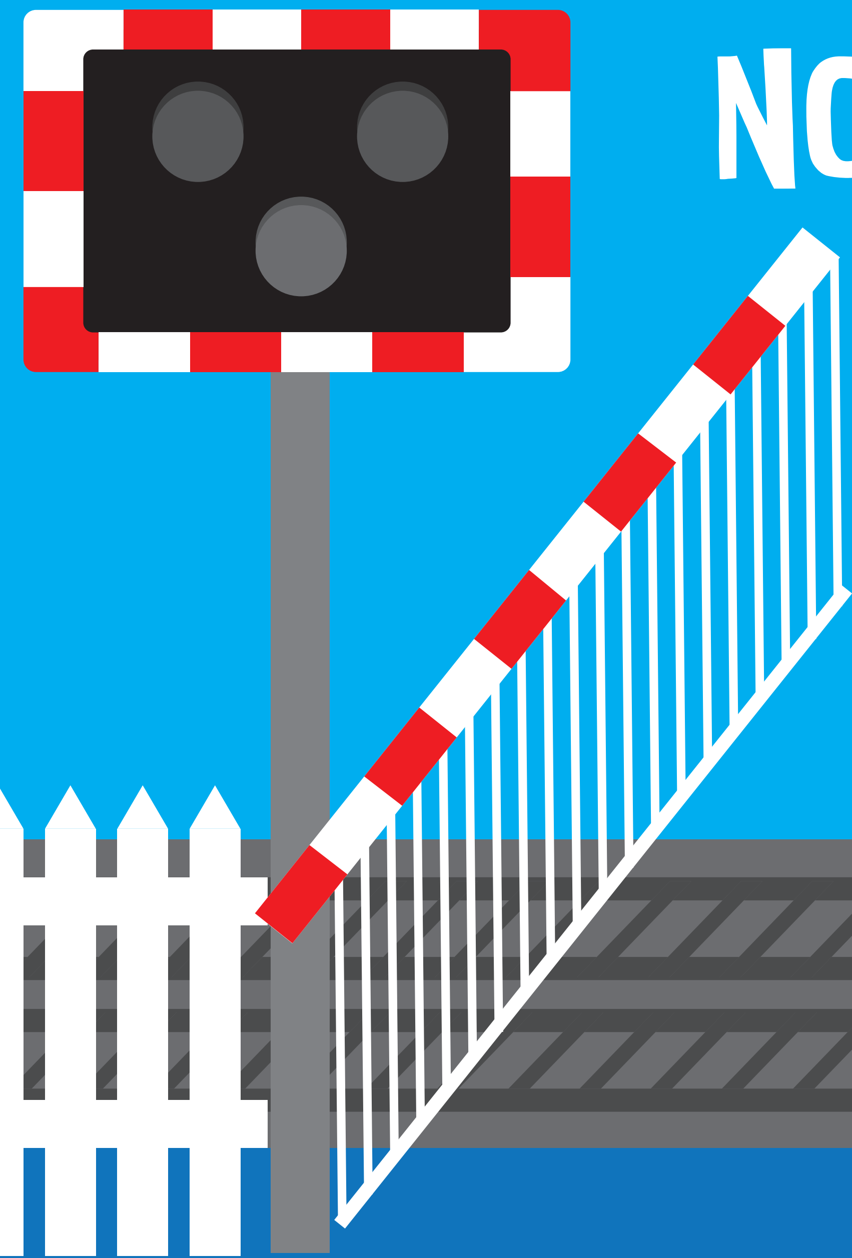
Institution of Railway Signal Engineers

April 2021

Level crossings
back to basics

Crossing predictors
the UK experience

Architecture
getting it right



IRSE///
Institution of Railway Signal Engineers

Issue 276
April 2021

In this issue

Feature articles

News and opinion

From the IRSE

From our Sections

Global, adaptive, resilient

Ten years ago while I was on the graduate scheme at Network Rail in the UK, my mentor approached me with – "I'm fronting a great new team to deliver ETCS for the Thameslink Project, I think you'd love it, fancy giving it a go?". From there, the rest is history. That chance opportunity sparked my interest in complex rail signalling and systems projects.

Now, six years after moving from London to Sydney, I am privileged to take on a role as the first female chairperson of the IRSE Australasia Section. I consider myself extremely lucky to be able to learn from the latest developments within the IRSE community and to mentor future minds. I often wonder where I would be now if I had not been as fortunate to have a forward-thinking mentor, who was committed to investing in our younger members to drive industry development.

2020 saw us adapt our working methods faster than anybody could have comprehended if we had been forewarned in 2019. I am proud of how the IRSE has demonstrated resilience in its response to 2020's challenges. We adapted the ways in which we inform and grow our capability; the IRSE Australasia held a webinar featuring a presenter in Canada, viewed by members across the globe! Additionally, the year brought opportunities for reverse mentoring and highlighted the value and contributions of our future leaders within the global community.

Going forward, it is our responsibility to embrace this momentum for change, not just within the Institution, but within our everyday work. We are gradually diversifying our membership; my appointment as chairperson is a great example of this. To maintain this momentum, we must ensure our emerging professionals are not isolated by lockdowns, but instead afforded the opportunity to challenge and grow our capability.

As 2020 has shown, the IRSE is a global, adaptive, resilient organisation and I look forward to seeing our continued success in 2021 – regardless of whether we are able to leave our home!

Georgina Hartwell
Chairperson, IRSE Australasian Section

Cover story

This issue of IRSE News includes a 'back to basics' article on level crossings and a detailed review of a near miss at Norwich Road Automatic Half Barrier (AHB) level crossing between Cromer and Norwich in England. Our cover photo is Three Horse Shoes No 1 AHB level crossing located between Whittlesea and March on the Ely North Junction to Peterborough line in England.

Photo Network Rail Air Operations

IRSE
Institution of Railway Signal Engineers

Back to basics: Level crossings

Ed Rollings

In this, our latest, "back to basics" article we look at how signal and telecoms engineers have to consider more than just the movement of trains around the network. The article makes reference to factors which should be considered in the provision and operation of level crossings, although legal and cultural differences prevail in many countries which may override the generic principles set out in this article.

Why do we need level crossings?

In some countries the railway came before roads while in others the construction of the railway divided land and roads where other rights had been established. Either way, it created the need for road and rail to cross each other. Level crossings vary considerably in type, often on the same railway, but members of the public may not appreciate the differences in operation as they just require a place to cross the railway safely if a bridge or underpass cannot be provided.

Terminology

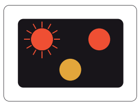
There are many different terms used to describe features of a level crossing around the world. Table 1 lists some terms associated with level crossings along with a description. Throughout this article we shall refer to 'level crossings', but they are also known as 'grade' crossings and 'rail' or 'railroad' crossings.

What is a level crossing?

So having determined the need to cross the railway on the level we can start to define this as a 'level' crossing. The form of this crossing may involve simply designating a place using signs, for example, where visibility is good to see trains approaching. Railways in many countries do not have continuous boundary fences, so it is important to designate safe places to cross the tracks. Although not usually part of the signal engineer's responsibility, the levelling up of the ground from the railway boundaries up to and in between the rails gives strength to the definition

Road crossing application and technology varies enormously around the world. This is one of several different types of half barrier crossing in the UK. Half barrier crossings are less expensive than full barrier crossings and prevent users being trapped inside the barriers. However there is a risk of crossing users 'weaving around' the closed half barriers.

Table 1 – UK signalling terminology.



Active warning	Warning or protection devices for road users which are activated by a train or railway staff.
Deck	The support and surface area of a crossing which carries users and/or their vehicles.
Full barrier crossing	A crossing fully fenced between road and railway when the road is closed. May use a single boom on each side or two half booms or equivalent equipment, e.g. gates.
Grounding	A vehicle stranded by coming into contact with the crossing surface/deck. Occurs when a long wheelbase vehicle traverses a crossing with a severe vertical curve or hump. This is often denoted by the sign on the left.
Half barrier	A crossing with a barrier closing the entrance lane(s) of each carriageway only.
Humped	The vertical profile of a crossing where it rises in the centre – see also 'grounding'.
Level Crossing	A designated place where the public can cross the railway safely on the level. May also be known as a grade crossing, rail crossing or railroad crossing. It may include a sign or other equipment to assist the user.
Passive crossing	A crossing where the user is responsible for assuring their own safety by checking for the approach of trains.
Protecting signal	A railway signal used to authorise train movements over a level crossing.
Saltire	St Andrews Cross or Crossbuck, commonly used to signify the presence of a railway crossing. This is shown to the left.
Wig-Wag or flashing light signal	A road traffic light signal with twin flashing red lights to warn road users of the approach of a train. May be used alone or in combination with barriers or gates.

"Some countries insist on measures to manage risk of collision with a train"

of 'level crossing'. By contrast many footpath crossings do not have a built-up deck, relying instead on users to step over the rails. Vehicle crossings mostly need a deck to reduce the risk of vehicles getting stranded. The design of the deck will be informed by the types of vehicle or traffic using it, especially the vertical curvature or hump which could lead to vehicles becoming stranded where the body of the vehicle between axles comes into contact with the crossing surface (that is, becomes grounded).

What does the law say?

Some countries insist on measures to manage risk of collision with a train, leaving the specific arrangements for the level crossing designer to decide based on risk. Others prescribe arrangements in detail; often a blend of these regulations will apply. In some countries it is the policy of the railway companies not to provide equipment unless required to do so by a government entity, as litigation may result where other similar crossings are not so equipped if there was an accident.

In some cases, the costs of provision and maintenance of a crossing fall on the railway authority, sometimes the government or other public body will require actions and fund those, in other cases costs may fall to the private user or be shared.

In some countries there are many different parts of law which can apply, especially where highways and road traffic is involved. Often different laws will apply for pedestrian crossings or for crossings between privately owned land such as farmers' fields or access to a single house.

Safety

Accident statistics demonstrate that level crossings are high risk sites for railway operators as well as contributing to large numbers of near-miss events. The reasons for this high level of risk should be obvious to railway professionals who are familiar with recognising hazards, but level crossing users come from a broad spectrum of society who may not be familiar with the characteristics of a train operations, where long stopping distances are normal, and trains are unable to deviate from the line of travel. Monitoring of crossing use is important as patterns of use (and therefore levels of risk) can change significantly over time. In recent years, for instance, there have been major changes of traffic pattern in some areas due to the use of satellite navigation devices and the popularity of home delivery courier services.

Selection of system

Where the law requires protection or warning systems to be provided, or the railway or other authority chooses to fund provision of equipment for their benefit or the benefit of the public, care should be taken in choosing the right combination of equipment to be safe and effective. Increasingly, convenience is being recognised as an important factor in system selection. Delaying users or trains has consequences, such as cost penalties either directly or in productivity loss and can lead to frustration which may result in users circumventing warnings.

Some railways have risk modelling tools to help choose equipment configurations that give the most effective risk reduction. Such tools also help to support a financial case for investment

An unprotected crossing in Chile. The safety of road user and the railway is very much dependent on the signs being obeyed.

in risk reduction and may include benefits to society through a reduction in lives lost or injuries incurred.

A key input to the selection process is understanding the use of a crossing both by the railway and by users. A census of use taken over several days is helpful to identify all of the different types and numbers of users, and their characteristics. It is important to understand how long they take to traverse the crossing and whether users can pass safely if they meet on the crossing. What are the approaches like, can vehicles stop easily? Do vehicles approach at speed, or is there a likelihood of becoming stranded on the railway?

"Some railways have dedicated level crossings specialists and in others it is a general signal engineering responsibility"

On the railway how many tracks are there? Do all trains pass through at line speed or are there some trains passing at slower speeds? Is there a station or junction nearby which affects speeds? Do trains pass in the area or closely follow each other and therefore keep the crossing closed for long periods? Can visibility of approaching trains and therefore warning time be improved by removal of lineside vegetation?

Pedestrian user characteristics may include mobility, hearing or sight impaired people; people with luggage, pushing cycles, or children/young adults or those with cognitive impairment who are less risk aware. Distraction factors such as mobile devices or moving in groups should also be considered.

When level crossings are renewed these factors may have changed considerably so it is vital that a thorough assessment is made whenever a change is proposed to a crossing.

Historically many crossings were operated by railway staff. Automation is now common on some railways which makes crossings cheaper to operate and manage but this relies on increased knowledge and discipline on the part of users. Understanding human behaviour factors and the interpretation of warnings is a necessary part of selecting the best combination of equipment to assist users.

Some railways have dedicated level crossings specialists while in others it is a general signal engineering responsibility. Level crossing management extends to engaging with users to educate them how to use level crossings safely, especially when changes are proposed or implemented. This may be through school visits, media campaigns or local meetings with individuals or groups.

Proposals to change a crossing or sometimes to renew it, may require consultation with stakeholders who have an interest. Typically, people representing interested groups such as the traffic authority, disability groups, the emergency services, planning authorities, or political representatives may contribute to these consultations and expect their views to be taken into account. Consultees may express views about safety, convenience, appearance, noise, lighting, accessibility, disruption during work, to list just some of the factors.

Technical protection or warning systems

The level crossings engineer has a lot of equipment available which can be configured to provide an appropriate solution. At the simpler end there are warning signs, or instructional signs. At the complex end there are complete barrier installations with sophisticated obstruction detection devices, which can identify people or objects on the crossing. These should have a high reliability and assurance of safe operation which allows them to automatically confirm the crossing is clear.

Crossings may have gates or barriers. These are operated either by the railway or by the road user. The road may have lights, usually twin flashing red, which are accepted as an absolute stop

"In some countries telephones are provided at some types of crossings to enable members of the public to seek permission to use a crossing"

signal, even by emergency services. Sounders may be provided to reinforce a warning and to assist vision-impaired users. The use of surface markings on a road or path to identify the safe place to stop is another feature along with signs and other carriageway markings to help the user navigate a crossing. Where railway signals are provided, they may be controlled to only allow trains to proceed when the crossing is closed and clear; they may also be interlocked to prevent the crossing being opened for road users once a train has been signalled until it has passed through or safely stopped.

In some countries telephones are provided at some types of crossings to enable members of the public to seek permission to use a crossing. These are normally provided where the warning time obtained by visual means is less than the time needed to cross safely, and no other active protection or visible warning is provided. The telephones need to be protected from water ingress, vandal damage and located in a position of safety and with clear instructions on their use to cross safely. The telephones are normally 'direct lines' to the controlling signaller. The signaller must only be able to talk to one crossing at any one time, and the crossing name must be displayed to the signaller throughout the call. There must be no overhearing, so that one crossing user cannot hear instructions intended for another crossing and the voice quality must provide clear communication. The identity and location of the crossing from which the call is being made must be clearly and accurately displayed to the signaller.

There are number of problems with telephone crossings. The signaller may not have an accurate knowledge of where trains are in relation to the crossing. This can lead to misunderstanding of messages and increases the workload for the signaller. Signallers are trained to use 'safety critical communications' protocols but communicating with the public requires an additional skill set. The crossing user may not bother to use the telephone or may misunderstand the message being given and cross with a train approaching. With signal control areas getting larger and potentially more telephone crossings per signaller the risks become even greater.

At some types of automatic crossing telephones are provided for users to alert the signaller if the crossing becomes occupied with a failed road vehicle. In such situations the telephone is the only way of protecting the crossing from an approaching train, assuming there is a protecting signal in the right place, or an emergency radio call can be made to the approaching train with time to stop. Such telephones must operate at all times and self-reporting fault monitoring can be provided to check the telephone is working.

Where a crossing is supervised the signaller may confirm the crossing is safe to allow trains to proceed by direct observation from the signal box or Closed-Circuit Television (CCTV) from a remote location. A crossing attendant may be employed to operate barriers or gates; this person would be provided with an indicator or other information to advise when a train is expected.

Automatic crossings may not have signals interlocked with the crossing and instead rely on highly dependable safety features to ensure the crossing operates for each train. It is important that when a crossing operates there is not too much time before a train arrives, or an inconsistent time between the arrival of trains, which might otherwise encourage poor discipline by users who may attempt to circumvent the protection or ignore the warning.

Automatic crossings are activated by the approach of a train and rely on train detection equipment; treadle, track circuit, axle counter or prediction device placed an appropriate distance from the crossing to guarantee timely operation. A crossing control device may be configured to deal with trains approaching from more than one direction.

Quad barrier crossing in the USA.

Above, open crossing with lights in New Zealand.

Right, a pedestrian crossing in Melbourne, Australia.

Sometimes automatic crossings are provided with an escape route or clear exit to avoid users being trapped if the crossing operates when they are part way across. Unfortunately this leaves an opportunity for malicious or unsuspecting users to enter the crossing from the opposite direction when a train is approaching.

"On some lines it can be useful for train crew to operate a crossing"

On some lines it can be useful for train crew to operate a crossing, typically where line speed is low and only infrequent and less time-critical services operate. This introduces additional hazards, similar to where a signaller has to push gates across a road; this is really only suitable where road speeds are low and traffic infrequent. Train drivers may also be required to observe a crossing is clear after it has activated automatically but before passing over it. This is only practical where train speed is low and there is good visibility approaching the crossing, allowing them time to stop short if there is an obstruction.

In-cab signalling

Systems such as the European Train Control System (ETCS) in-cab signalling presents both opportunities and challenges for the operation and management of level crossings.

Initially ETCS was only planned for high-speed lines where level crossings do not exist. As the use of ETCS has become more widespread, lines which have quite high populations of level crossings have been fitted. One feature of level crossing operation is the critical timing required. As ETCS transmits a movement authority to the train and the train reports its position there can be a small delay or even a loss of transmission in a message.

While this can be accommodated in the course of normal train movement it becomes important where reporting the position of a moving train in relation to a crossing is concerned. A slight delay in triggering an automatic crossing could result in the crossing not being closed for sufficient time before the arrival of the train.

Restrictions of speed can be embedded in the permitted speed profile to ensure that where users need a given number of seconds clear sight of an approaching train in order to cross safely this can be enforced precisely and cost effectively without additional line-side infrastructure.

A lightly used, yet fully equipped, crossing in Switzerland.

"Any prediction of the future will almost certainly prove to be wrong"

Automatic train operation

Automatic train operation is commonly associated with metros and other high density urban railways which do not have level crossings. Some heavy haul freight railways now use automatic operation of their trains over long distances. With remote management of the operation and driverless trains it is important that level crossing use does not impact the safety of the rail operation. Automatic operation of the level crossings is preferred. This is achieved, in some railways, through the use of predictor technology which allows for adequate warning times for road users and also ensures that the level crossing is open long enough for road users to clear the crossing once they have committed to crossing it. Obstacle detection equipment is used to identify any problem with the level crossing and in particular where road and rail intersect, which informs the train control system and revokes the movement authority through an emergency brake application. Where braking distances may be 2km or more advance notice of any problem is essential to manage the train to avoid a conflict. The ability to stop a train before a level crossing needs to occur outside the minimum stopping distance. Anything less than that is a situation that raises the likelihood of a collision.

Future opportunities

Any prediction of the future will almost certainly prove to be wrong. However, there are a few foreseeable developments which will impact the future of level crossings. The introduction of Future Railway Communications System (FRMCS) may allow more use of wireless technology in the control and operation of crossings, with 5G likely to be used both for FRMCS and autonomous vehicle operation. Artificial Intelligence (AI) could be harnessed to allow learning from current operations and to improve our understanding of user behaviours. The use of AI derived solutions could prove challenging to safety validate. Self-driving autonomous vehicles may have a significant impact on safety improvement where messages transmitted from the crossing may give advance notice to the road vehicle of the imminent operation of a crossing, possibly enforcing a controlled brake application. Radio communications could also be used to alert an approaching train if the crossing is occupied. These developments could reduce or eliminate human error or misunderstanding which contributes to many level crossing incidents.

About the author ...

Ed is a Chartered Engineer and Fellow of the IRSE with a MSc in Railway Systems Engineering and Integration from the University of Birmingham. His career began in 1977 as a signal and telecommunications trainee and he held various roles in British Rail Signal and Telecoms department including maintenance, design, and project support.

In 1993 he joined Railtrack as part of a team preparing for privatisation before becoming signal engineer for the Midlands Zone on its inauguration as the infrastructure owner.

His involvement with level crossings began in 1985 undertaking scheme development for signalling and level crossings projects.

Ed held the post of professional head of signalling and technical lead for level crossings engineering with Network Rail, the GB main line railways infrastructure owner. Today he runs a company providing signalling and level crossing systems engineering consultancy. He also edits IRSE News Presidential Papers.

Back to basics: using latched relays

BACK TO BASICS

John Alexander

This article continues the IRSE News series on 'back to basics' and looks at the different uses of latched relays. It is based on relay signalling practice in the UK which does differ elsewhere around the world. There is also a good chance there are errors or missing reasons in what follows so I expect the next issue of IRSE News to have a full postbag. IRSE News would also like to hear of other examples of circuit design from around the world.

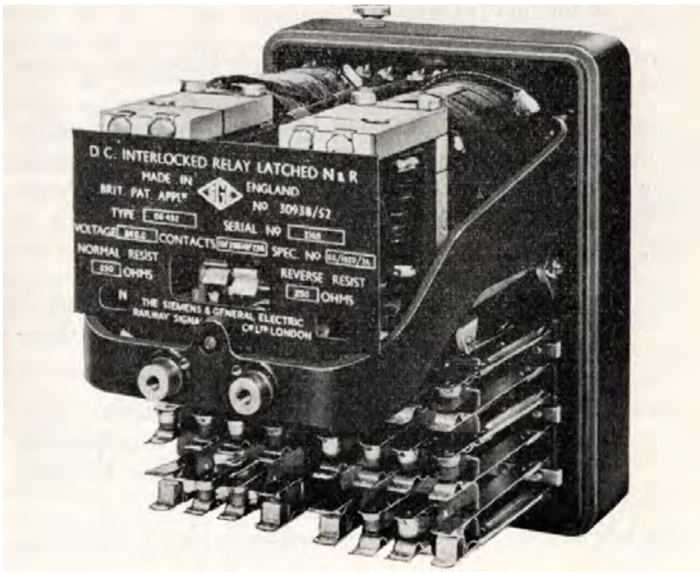
Some research and consulting with Derek Hotchkiss suggests the concept of latched relays was first introduced by SGE in the 1930s as part of their relay interlocking systems and were enhanced for schemes delivered on the Great Eastern in the 1950s. To quote from IRSE Green Book No 22 "The latched interlocking relay has been the centre of all SGE systems because it conforms closely to lever frame principles which remain the sound basis of all good signalling practice".

These relays were effectively two latched relays with the two armatures interlocked mechanically to prevent both the Normal and Reverse relays being 'energised' at the same time. For a set of points, they mimicked the lever with the Normal relay latched up representing the lever in the normal position, the sequence was then for the Normal relay to be unlatched so that both were unlatched (similar to a lever mid stroke) and then the Reverse relay to be latched up to represent the lever in the reverse position.

Types of relay

Relays come in many forms including neutral, biased, dual wound, AC immune, slow to operate, slow to drop and latched. With the exception of the latched types, they all share a common characteristic that when you remove the feed to the coil(s) the relay will revert to a de-energised state, sometimes with a short delay measured in up to several hundred milliseconds. The latched relay is different in that it remains in the state that it was last changed to by energising one of the coils in the unit.

For those of you more familiar with electronic technology and computing, a latched relay is the equivalent to non-volatile memory whereas the other types are more like random access memory in that when the power is lost the memory is lost too.



The BR930 series of railway safety relays, for example, comprise many different arrangements of coil, operation and contacts with some common characteristics. A first principle is that (except in the latched case) when the power is removed from the coil(s) it can be guaranteed that normally open (front) contacts will break and normally closed (back) contacts will make – the contact material is designed so that they should not weld and the armature is designed so that gravity assists its return to the de-energised position.

This ability to go to a known, safe state is used in many safety circuits to detect that all the conditions are met continually to display proceed aspects or to keep automatic level crossings open to road users. If the power is lost and then restored, the state of all the relays is predictable and where there could be a "race" between different parts of the system then a timer can be used to allow key inputs to stabilise before the inputs are combined to make safety critical decisions such as releasing route locking or clearing signals.

So back to the latched relay and why it is different. The first thing is that like your light switches at home it remembers the state it was last moved to. If you experience a power cut all the lights go off but when the power is restored those which had been on come back. For those of you who have experienced a fuse blowing or an MCB (Miniature Circuit Breaker) tripping in a distribution board, finding out which circuits are switched on, especially if they have two switches at top and bottom of the stairs, can be a challenge.

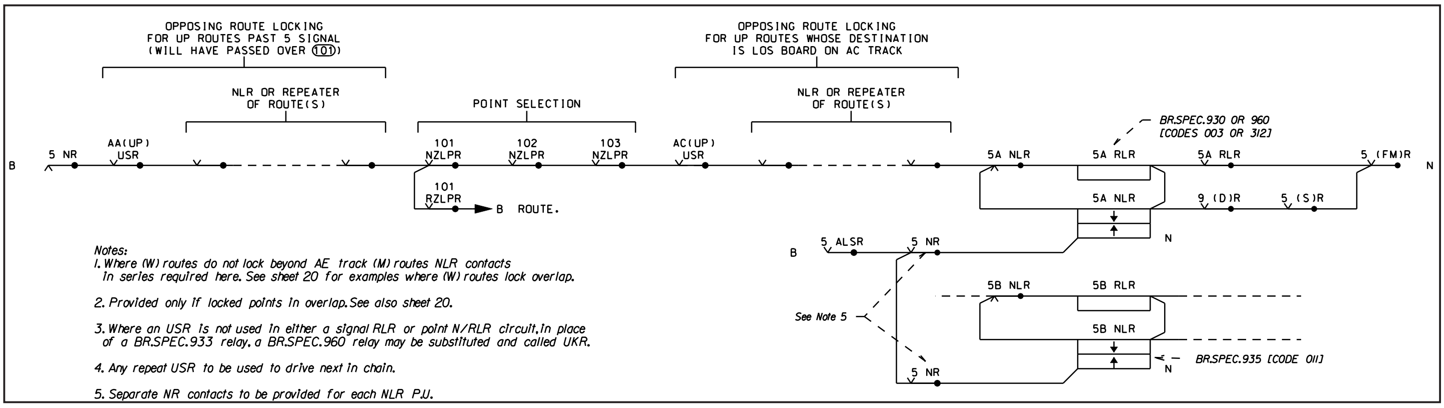


Figure 1 – Route relays. *All diagrams Network Rail.*

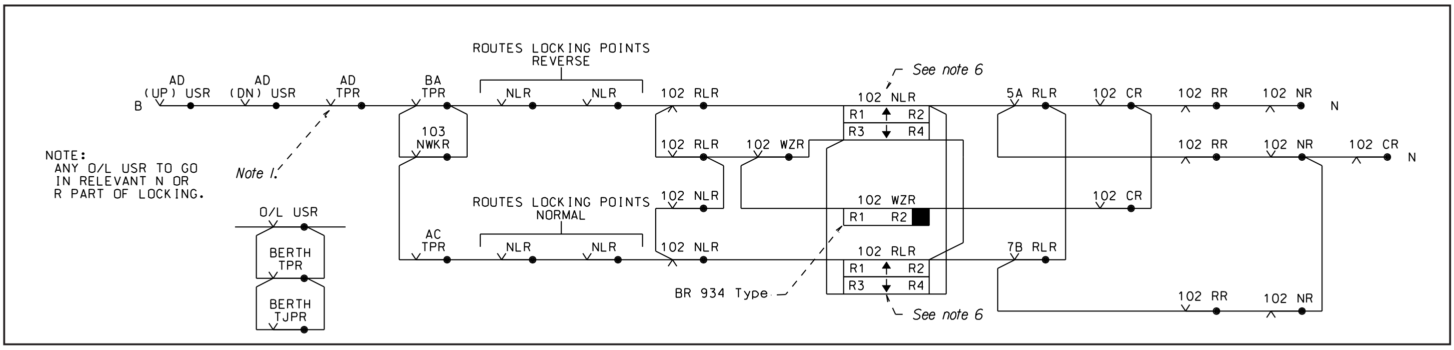


Figure 2 – Point control relays.

In a signalling system, if the power is lost the latched relays will remain in their last state and when the power is restored it is much harder to predict what the state of the system will be. However, it is that memory effect which can be very useful as it can record key states of the system to prevent changes after the power failure from compromising safety. A good example would be that if a route is set and a train authorised to take the path then, in the event of a short power outage, the train will still be committed and the points would not be moved or opposing routes set. The non-volatile memory of a route not being "unused and free" provided by a latched relay is therefore very useful.

Unfortunately, the fact that latched relays remember their state without power has also led to a number of incidents over the years where maintenance staff have caused unexpected behaviour and safety events. If a latched relay fails, or needs to be removed for any other reason, then maintenance staff need to be careful that the relay they re-insert is in the correct state. If not, a route may be released, points may move in front of a train or other controls activated or lost.

After that quite long introduction, it is time to consider how latched relays are used in signalling circuits and what precautions to take against staff errors or the memory effect. The two key options available to designers are to use a single latched relay – like a light switch, or a pair of relays where only one is in the latched state at a time. The question is which to choose!

Route relays

The first example, Figure 1, (taken from the BR-SW67 circuits but similar principles apply in other relay interlockings) is a route NLR (Normal Lock Relay) which is used to record, when in the latched position with front contacts made, that a route from a signal or origin has not been set. Unlatching the relay as part of setting a route prevents other conflicting routes being set and records that the route has been locked. Proving the route has been set and locked sufficiently to move on to issuing a proceed aspect/authority is typically done through a neutral RLR (Reverse Lock Relay) which is only energised while all the conditions are met.

When a route is to be cancelled the feed to the RLR is broken preventing a further proceed aspect being issued but the NLR remains in the unlatched position until it is safe to latch it – typically after the approach locking release conditions have been met. It is not uncommon for the RLR circuit to be configured so that it can only be energised once for the passage of a train and requires signaller action to reset it for a second train.

Point control relays

A second example, shown in Figure 2, is the control of points where a pair of latched relays is used – NLR (Normal Lock Relay) and RLR (Reverse Lock Relay). The control to move the points requires one of the two in the Latched position and the other in the Unlatched position. To move the points the currently latched relay needs to be unlatched and then, when proved in that position, the other relay can be latched. This sequential process reduces any risk that, as the relay changes state, both the latched and unlatched contacts could be made driving the points to both positions at once.

The change of state of points also often includes a timeliness function – the request is only valid if everything else was proved immediately prior to the request being made. The WZR (Point Special Relay) is often included to check that the points were not locked by the point key or a route immediately prior to them being requested to change state. The WZR, a slow to drop relay, allows the circuit to prove the point key was in the central position immediately before being keyed normal or reverse and that the other conditions are satisfied.

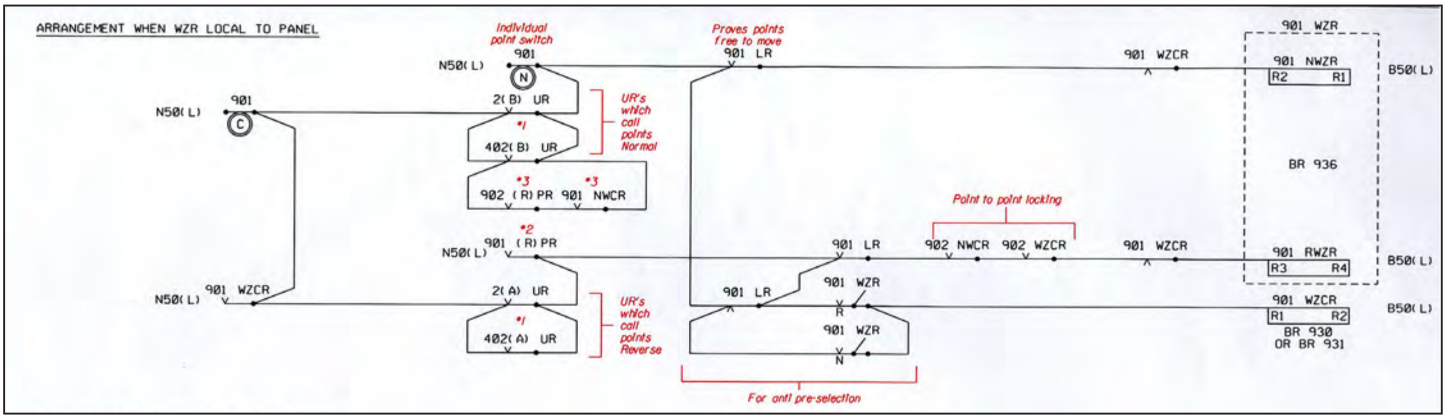


Figure 3 – An excerpt from the Network Rail standard WZR circuits.

The circuit to unlatch the current relay proves that the points are not required by any route, that there is a request to move the points (either point key or a route being set) and that the WZR is energised. Having unlatched the current relay, the other relay will be free to latch and the points to move.

Having done some analysis, and with the help of Derek Hotchkiss's memory, it appears the reason that points have two relays is mainly because they derived from the SGE circuits and relays mentioned earlier and were intended to mimic the action of a mechanical lever including the mid stroke where the motor would not be driven normal or reverse. Having undertaken some analysis it does not appear that there is a significant safety benefit in having two separate relays and it may have been a good ploy by some suppliers to sell extra relays. As far as I can ascertain there was little challenge to a tried and tested arrangement even when the physical interlock was no longer provided as in the SGE relays with it being achieved in the circuitry.

By now there will be a group of signal engineers based to the west of Paddington in the UK scratching their heads wondering what all this fuss with pairs of latched relays is all about. The E10k circuits used on the Western region use a single latched relay for points which is allowed to change state when a lock relay proves it is safe to do so. The WZR (shown in Figure 3) is a magnetic stick, subtly different from a mechanically latched relay, but fulfilling the same role. It acts as a bistate relay with the two coils commanding the normal and reverse positions.

Conclusion

A latched relay is a useful tool because it remembers the state it has been placed without a continuous feed as one would have for a stick relay circuit. It makes it easy to have different sets of conditions to trigger the change of state. Do you need a pair of latched relays to control points (based on the SGE interlocking relay) or can you use a single relay – well once again I have to accept that my colleagues on the Western may have got it right – I'm gutted!

About the author ...

John volunteers at the Great Cockcrow miniature railway in Surrey, UK. Recently he was teaching colleagues at the railway as they collaboratively designed some new circuitry and the subject of how latched relays worked and should be used came up. This article is the result of John's research looking at Network Rail's typical circuits. John was a former member of Network Rail's Signalling Circuit Standards Working Group and has over 40 years of railway experience. He has also served on the IRSE Exam Committee for many years.

Back to basics

BACK TO BASICS

We hope you've found this, the most recent in the IRSE News 'back to basics' series, useful.

If there's a 'back to basics' that you'd like to see – or better still, one you have particular knowledge on and would like to write about – do let us know.

Email **editor@irsenews.co.uk**.

IRSE News carbon capture

Planting trees to catch carbon · Planting trees to catch carbon ·

9444263
Printed on Carbon Captured paper

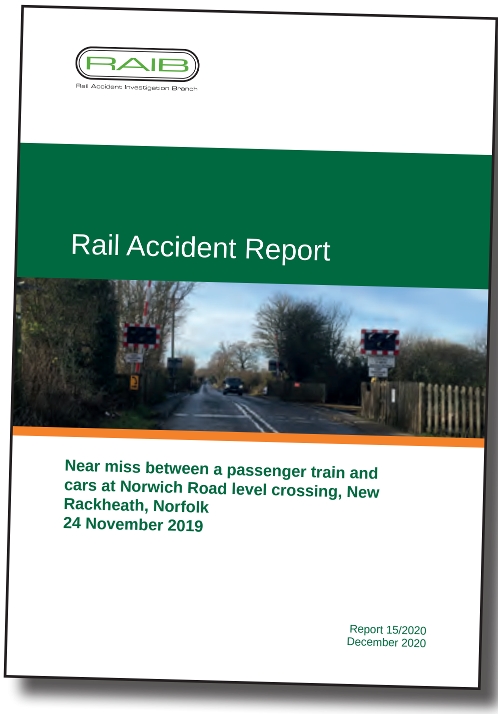
For the last two years IRSE News has been printed on carbon captured paper. Carbon capture is a method of mitigating CO_2 emissions and paper produced in this way is a reduced carbon solution for magazines such as ours. The scheme also assists with creating native woodland and habitats for wildlife, and green spaces.

The average amount of CO_2 emitted from the manufacture and distribution of a tonne of paper is calculated and verified by the UK Woodland Trust using Carbon Trust and the Department for Environment Food & Rural Affairs (DEFRA). A charge is then determined and paid directly to the Woodland Carbon & Woodland Trust registered charity to support their work planting trees to capture CO_2 in new native woodland.

In the three years the scheme has been running it has captured 66,712 tonnes of CO_2 and raised over £1.1 million for the Woodland Trust with over 266,000 trees planted (166.78 hectares). That is enough to stretch over 142 miles – if planted in a straight line.

Near miss at Norwich Road AHB level crossing

Robert Wood



During the evening of Sunday 24 November 2019, a passenger train from Norwich to Cromer and Sheringham (known as the "Bittern Line") was approaching Norwich Road Automatic Half Barrier crossing (AHBC) at around 45mph (72km/h). The crossing lights and barriers initially operated correctly, stopping the road traffic. When the train was less than 200m from the crossing, the driver saw the barriers rising ahead of the train and applied the emergency brake. The train just missed (by half a second) one of two cars crossing at the time.

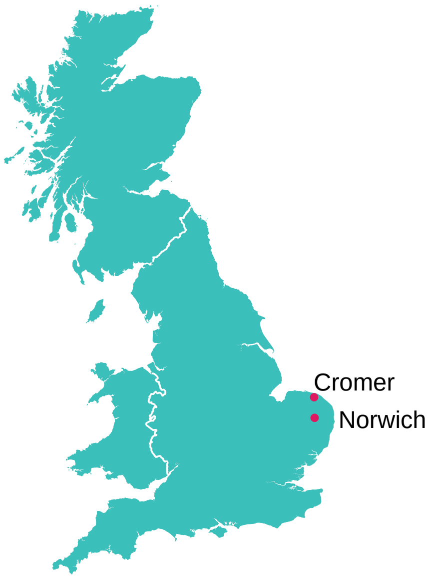
The driver noticed that the amber road traffic lights came on just before the train reached the crossing. Fortunately, no collision occurred, but there was a period of around eight seconds when the crossing was open to road traffic and the train was closely approaching. In the UK, there is of course no requirement for road users to slow down or check for the presence of trains, neither is there a requirement for the train driver to monitor the lights and barriers: all that is necessary is that road users obey the warning lights and signs, and the train does not to exceed the permitted speed.

The incident was investigated by the Rail Accident Investigation Branch (RAIB), part of the UK Department for Transport, and their report was issued in December 2020 [1]. This report concluded that the incident occurred because there was contamination of the railhead caused by leaf-fall and atmospheric conditions. This was compounded by the rapid introduction of new rolling stock with a different wheel profile to the existing stock, and the lack of railhead treatment at weekends.

The AHBC control systems on this route are HXP-3 Grade Crossing Predictors (GCP), designed and manufactured in the USA but approved for use in the UK. The term "grade crossing" is simply the American term for a level crossing. There are six crossings of this type on the route – three on double track and three on single track – and they have now been in use for 20 years.

Grade Crossing Predictors – background and basic principles

A little explanation is necessary, as although GCPs are common in the US, Canada, and Australia, they are not widely used elsewhere, and UK readers may not be familiar with their operation. They have evolved from an original design in the 1960s developed by the Marquandt Corporation, and are now produced by two railway signalling companies. Both companies' predictors are used in the UK: the HXP-3 is supplied by Alstom (previously GE Transportation, Vaughan Harmon, and Harmon Industries), whereas the GCP3000 (known as the WESTeX Level Crossing Predictor in the UK) is supplied by Siemens Mobility (previously Invensys Rail Systems, Westinghouse Rail Systems in the UK, and Safetran Systems in the USA). Both predictor systems provide a similar



function, however the terminology used to describe the various modules and parameters is often different. I've deliberately kept the explanation here very brief, so the reader can understand the basic principles of a predictor that relate to the incident at Norwich Road: the basic HXP-3 manual runs to well over 200 pages, and the GCP3000 UK manual runs to over 300!

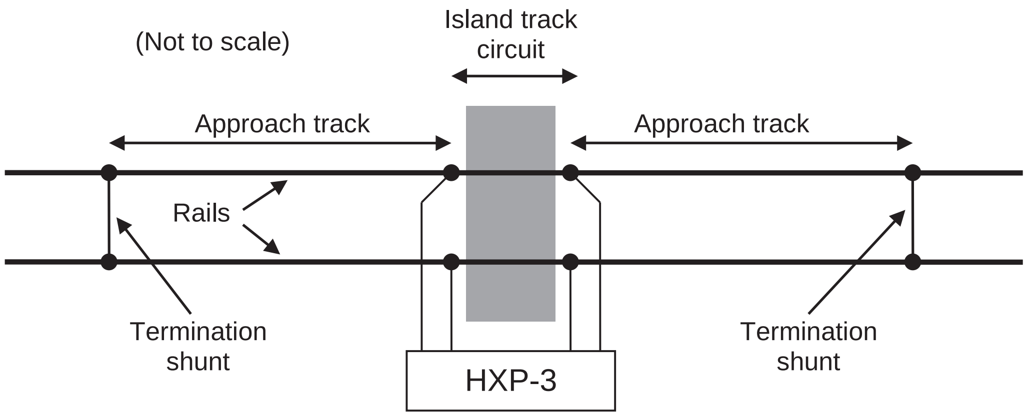


Figure 1 –General layout of a GCP, showing a single track.

The pilot installation of 6 HXP-3 crossings on the Bittern Line was commissioned in 2000, and at the time of the incident 10 HXP-3 crossings were operational on Network Rail, installed between 2000 and 2016.

The principal purpose of a predictor is to detect trains approaching an automatic level crossing and to provide a suitable control to the crossing equipment (road traffic lights and barriers) so as to always, as far as reasonably practicable, close the crossing at a time calculated to provide sufficient warning to road users, without excessive road closure times for slowly approaching trains. The departure of a train from a crossing is also detected, to permit the crossing to re-open.

The GCP operates by detecting impedance changes in the track as a train approaches the crossing. The rail circuit is largely inductive, whilst ballast is largely resistive, so changes in ballast resistance can be identified and allowed for. The predictor linearises these impedance changes to provide a software variable that can be used to calculate the position and speed of the approaching train, and uses this to determine the optimum time to initiate the crossing warnings (among other things, this linearisation corrects for the two approach tracks being connected in parallel in a bidirectional configuration). In the case of the HXP-3, this software variable is referred to as "RX".

In its simplest form, a GCP installation comprises a hard-wired termination shunt at the extremity of each approach track, and connections to the rails either side of the crossing. One pair of connections is used to inject a low frequency (less than 1 kHz) ac constant current signal into the track; the other pair is used to measure the voltage across the rails resulting from this signal. The connections are also used to inject and receive a higher frequency coded ac signal acting as a short overlay track circuit (the "island") covering the crossing area. This is shown in Figure 1.

The key benefits of GCP crossings for UK applications are:

- Broadly constant warning times for varying train speeds.
- All connections between the predictor and track are located at the crossing, and no cables are required to any other part of the approach tracks.
- Crossings can be very simply overlaid on existing track circuits or other GCP approach tracks, using wideband or tuned termination shunts, which may also be used to bypass insulated rail joints.

The approach track length is determined by adding the following distances travelled at the maximum permitted train speed in the following times:

1. The required minimum warning time (typically 27 seconds for an AHBC in the UK).
2. Any extra warning time required due to the crossing width (e.g. a skew crossing), to allow slow vehicles and pedestrians the extra time required to clear the crossing.
3. In the case of a double track crossing, an additional 10 seconds for Minimum Road Open Time (MROT).
4. Acquisition time – the time required for the GCP to detect a moving train and calculate its speed (typically 4-7 seconds).
5. Any extra allowance deemed necessary to cover overspeed, acceleration, or poor shunting conditions.

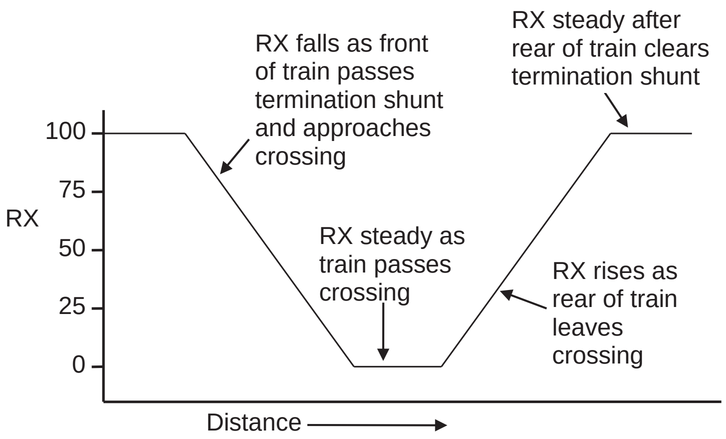
Note that unlike a conventional track circuit-based crossing, the actual warning time is not directly determined by the approach length, but the approach length must be at least sufficient to allow the programmed warning time to be achieved. This means there is little disadvantage in providing a longer approach than is actually required, in fact all the predictor crossings on the Bittern Line were designed for a maximum permitted speed of 75mph (120km/h), whereas the actual permitted speed is in some cases only 45mph (72km/h).

Initially the system will be calibrated so that with no train present, RX will be 100. When an approaching train passes the termination shunt, the voltage measured at the crossing will start to fall, causing a corresponding reduction in RX. When the train arrives at the crossing, RX will have fallen to zero, and the island track circuit will be showing "occupied". As the rear of the train clears the crossing, the island track circuit will clear and RX will start to rise, until it reaches 100 when the rear of the train passes the termination shunt. This is shown in Figure 2.

The predictor uses the value and rate of change of RX to determine the position of the train and its speed, and uses this to calculate the RX value at which the crossing warning needs to be initiated. The crossing will remain closed until RX is seen to rise and the island track circuit has cleared.

A predictor must necessarily assume that once the crossing warning has been initiated, the train will not accelerate: doing so means the train will arrive at the crossing sooner than predicted, thus reducing the warning time below the minimum required. The predictor can however allow for a train that is already accelerating before the crossing warning is initiated, and will assume it will continue to accelerate at the same rate. In the US and Australia, acceleration close to the crossing is largely covered by rules, regulations, and signage for train drivers, to ensure that a train does not arrive at the crossing before the road traffic has received the full warning sequence and any traffic has cleared the crossing. In the UK, this is instead addressed by adding a few seconds to the warning time, and by using a feature called "Positive Start": this ensures that regardless of train speed and acceleration, the crossing will always close when RX falls to the Positive Start value. This will, of course, slightly extend warning times for slow trains.

Figure 2 – The variation in RX as a train passes through the controlled area.



An option is available to maintain the crossing warning if a train, having been acquired (i.e. detected as an inbound movement) and initiated the crossing warning, subsequently disappears due to severe railhead contamination. This option – Loss of Shunt (LOS) – can be programmed to maintain the crossing warning for up to 99 seconds in the event of complete loss of detection. It is important to note that a sudden shunting and clearing of the track not preceded by detected inbound movement can also be detected, but uses a completely separate algorithm intended to identify an infrastructure fault. Similarly, an outbound train movement that leaves a short circuit behind (referred to as a "false shunt") will initially appear as a train that has stopped. This may be detected as a false shunt if it persists, however if it coincides with a noisy received signal it could be interpreted as a train that has stopped and then returned towards the crossing, causing the crossing warning to be restarted. Various programmable options are available to prevent this happening and ensure that train movements and faults are correctly identified and are handled correctly.

Although the rail-to-rail voltage is very low (typically less than half a volt), this is not normally an issue because:

1. The GCP does not require the received voltage to fall below a preset threshold in order to detect a train, but instead is merely looking for a small but measurable downward trend in the voltage measured at the crossing.
2. In the UK, a track circuit assister (TCA) fitted to a train will improve the train shunt in the presence of a rolled rust film in the same way that it will improve operation of a conventional track circuit.

In common with all conventional track circuits, a predictor cannot operate reliably if the wheel/rail interface is very heavily contaminated with dry leaf residue. A test I carried out many years ago on a wheel/rail test rig simulating a 10 tonne axle load showed that two leaves rolled then left to dry for only a minute were completely insulating to a 150V test voltage.

What went wrong?

The Bittern Line leaves the Norwich to Great Yarmouth line at Whittlingham Junction, and Norwich Road AHBC is about 4 miles from Norwich and 2 miles past the Junction. According to the RAIB report, the maximum permitted speed in the Down direction is 55mph (88km/h) for multiple unit trains, and 45mph (72km/h) for other trains. The normal traffic on this part of the route is a regular hourly passenger service, but occasional freight trains also run, taking tankers of gas condensate from a gas pipeline terminal at North Walsham.

Until the introduction of the Stadler Rail Class 755 electro-diesel units, passenger services were operated by Class 153, 156, and 170 ("Turbostar") diesel multiple units generally running in a shorter formation than the Stadler units. RAIB confirmed that both the Class 153 and 755 units had comparable wheel profiles and axle loads, however the Class 755s all had identical new wheels, whereas the other units would have wheels worn to various degrees. The rails in the area were 70 years old and worn, but still within acceptable tolerances. The earlier units would therefore have had varying wheel profiles that had probably "bedded in" to the worn rail profile. RAIB showed that when centred on the track, the Class 755 units ran on a much narrower band on the railhead than the Class 153, and when the units were displaced laterally (for instance on curved track), the two units ran on different parts of the railhead. The improved suspension on the later unit would probably have improved the riding to such an extent that it would have consistently run on the same very narrow band of railhead at the same location and speed.

The narrow band of railhead on which the Class 755 unit ran is clearly shown in Figure 3 taken from the RAIB report, using a photo taken by Network Rail shortly after the incident. Unfortunately, although a sample of the contamination was taken by Network Rail it was not retained for further analysis.

Since 2016, Network Rail had run a Railhead Treatment Train (RHTT) on a daily basis during the autumn, as railhead leaf contamination had been identified as an issue on this route. For reasons which are not entirely clear, the RHTT only ran on weekdays, and it is pertinent that the incident at Norwich Road happened on a Sunday evening, 57 hours after the last RHTT run, and after 48 hours of dry weather: this gave an ideal opportunity for leaves to be picked up and deposited on the railhead. The rails were also treated manually close to Norwich Road AHBC on the afternoon of the incident, as an earlier right side failure had been attributed to leaf contamination (this followed a train movement in the opposite direction to the incident train). The RAIB report does not provide any further information about the cause of this earlier failure.

The incident train was being driven by a trainee driver and instructor. The permitted speed for this class of train at the crossing was 55mph (88km/h), and the train was travelling at approximately 45mph (72km/h) on the approach. The crossing appeared to operate normally, initiating the crossing warning sequence when the train was 66 seconds away from the crossing. The predictor lost detection of the train when it was 28 seconds from the crossing, and 16 seconds later, after the LOS timer expired, terminated the crossing sequence prematurely and opened the crossing when the train was 12 seconds away. Due to the commendably quick response of the driver and instructor, an immediate emergency brake application was made, and the horn was sounded. The crossing closure sequence was subsequently

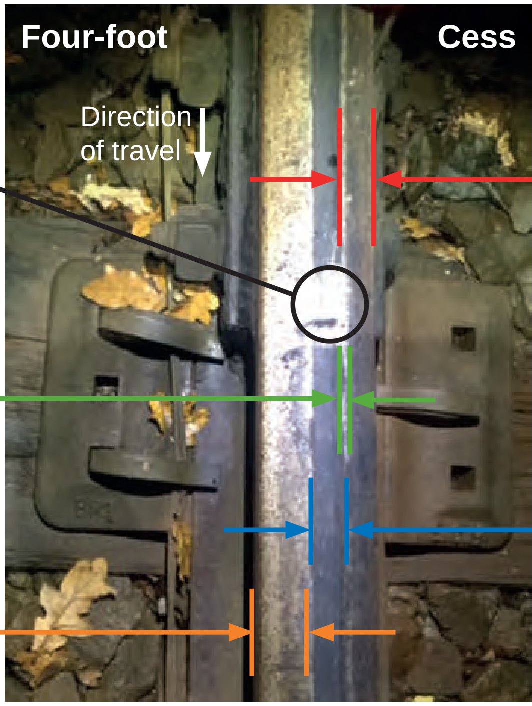


Figure 3 – Figure 14 of the RAIB report [1] shows the railhead on the night of the incident with positions of contact patches for class 755 and other stock.

restarted when the train was 4 seconds away. The emergency braking of the train did not initially achieve the expected high braking rate, as there was a 10 second delay between the brake application and operation of the automatic sander: this was due to a train design error which has subsequently been corrected.

The RAIB report includes lot more detail about the incident and subsequent investigation (including monitoring by the Atkins Technical Investigation Centre).

Actions taken, and recommendations made

Following the incident, RAIB reported a number of actions that have been taken, or are already addressed in existing instructions. These include:

- LOS timers on all HXP-3 crossings on Network Rail have been set to 99 seconds (this value has been used in all subsequent GCP installations in the UK, but had not been applied retrospectively on the Bittern Line).
- All HXP-3 crossings on Network Rail have been fitted with pairs of reinforcement treadles at the equivalent of the strike-in point for the fastest train.

Other actions include the removal of wheel flange lubricators fitted to the new trains, along with changes to the sanding equipment controls, and the frequency and pressure of wheel scrubber blocks (auxiliary tread brakes) have been increased. Although not directly relevant to the investigation, these actions should reduce the probability of wheels being heavily contaminated by any insulating film.

The recommendations made by RAIB are:

- Network Rail should take account of changes in rolling stock since the previous autumn, when planning autumn railhead treatment.
- Network Rail should provide additional guidance to accompany the standards on technical compatibility between vehicles and infrastructure, including risks associated with the introduction of new rolling stock with wheel/rail interface characteristics that, although compliant with standards, differ from the existing rolling stock.
- Network Rail should review and enhance its processes so that earlier installations are modified to reflect safety improvements implemented on later installations.

Please see the RAIB report for the full text of the actions and recommendations.

Reflections on the incident and its aftermath

This section reflects the author's personal view of the incident and the use of grade crossing predictors, and does not directly reflect the RAIB report.

Loss of Shunt (LOS) setting

The LOS timeout on the HXP-3 is sometimes used for purposes other than allowing for poor shunting in the USA (hence the wide variation in allowable values). It was not initially seen as an issue for UK applications, particularly as heavy railhead contamination had been dismissed for the Bittern Line by stressing the need for good and continuing vegetation management. The 16 seconds was later identified as being too short for general use. Current practice is for a much longer timeout to be used, in fact the UK GCP3000 manual (where LOS is called Pickup Delay Prime, and has a default value of 15 seconds) clearly states "under no circumstances must Pickup Delay Prime be left at 15 seconds for UK applications", despite the US manuals recommending it should generally not be changed. However, there was no retrospective action to update the Bittern Line installations: RAIB have noted that a retrospective change to 99 seconds on all HXP 3 installations has now been effected.

The current Network Rail signalling design manual for level crossings [2] includes a section on predictors (as an alternative to track circuits with treadles, and axle counters), so this would seem to be the place to provide more detail on generic UK predictor requirements, including an extended LOS setting.

Use of treadles

It is my understanding that treadles were originally used at strike-in points on conventional AHB crossings to mitigate a perceived timing issue: they ensured that in the case of poor shunting, the track circuit would drop immediately, as poor shunting could cause the relay operation to be delayed by a few seconds, causing a reduction in warning time. Only later were they deemed to be a protection against severe railhead contamination that could cause a complete loss of warning resulting from a total wrong side track circuit failure.

The use of treadles with a predictor is entirely different. They cannot be used to supplement the operation of the predictor train detection function directly, as it does not have a simple two-state output that a two-state device can duplicate. In some limited circumstances treadles can, however, increase the probability that at least the minimum warning time is provided in the event of severe railhead contamination. A predictor relies on "acquiring" a train by detecting inbound movement in order to determine when to initiate crossing closure. It can detect faults such as short circuits, but uses different algorithms to do this. A treadle shorting the track partway along the inbound approach will, if the predictor has not detected inbound train movement, probably be treated as a fault: the predictor can be programmed to detect this type of fault either immediately or after a short delay, and initiate crossing closure. If there has been some noisy inbound movement detected in the previous 4 seconds then it may just treat the short circuit as part of the inbound movement, and won't necessarily initiate the crossing warning at that point. If the treadle is located within the Positive Start region, it will however cause the crossing warning to be initiated immediately, provided inbound motion has been detected in the preceding 4 seconds. Only if the predictor has detected inbound motion and the crossing warning has been initiated by that inbound motion will the LOS function maintain the warning if the train ceases to be detected: if the warning is initiated by a treadle mimicking a short circuit fault, removal of that short (by the treadle resetting after the train) may well allow the crossing to re-open.

If a train operates treadles on the outbound approach (that have been designed to cover opposite direction movements), further steps will need to be taken to ensure the crossing warning is not restarted inadvertently.

A method developed for the GCP3000 predictor used treadles to disconnect the termination shunt. If a train is not shunting the track as it passes the termination shunt, its disconnection will be immediately detected (in HXP-3 terminology) as a "High Signal" fault, and will initiate the crossing closure. Other factors will need to be considered if this is used as a further mitigation.

If treadles are used with a predictor, maintenance staff need to be made aware that some recorded faults are not actually faults, but are caused by treadle operation without movement being detected. Extended warning times later followed by fault codes indicating treadle operation could be used to identify increasingly severe contamination at the wheel/rail interface and allow urgent remedial action to be instigated.

Wheel/rail compatibility

The effect on wheel/rail contact of different wheel profiles is well known, for instance over 40 years ago Iarnród Éireann (Irish Rail) took delivery of their Class 071 6-axle diesel locomotives [3]. These locomotives, weighing in at around 99 Tonnes, were delivered from the USA with wheel profiles suitable for the 1 in 40 rail inclination used in the USA, instead of the 1 in 20 used in the UK and Ireland. They failed to operate a number of track circuits even on a heavily used route, when travelling as a light engine.

It is understandable that providing new rolling stock with broadly the same wheel profile as existing stock could be considered a safe prospect, however the rapid change from worn to new wheel profiles and worn rails on the Bittern Line does appear to introduce risks that have unfortunately (and quite understandably) been overlooked. This issue was partly addressed by a Railway Group Guidance Note [4], but this has since been withdrawn and its replacement only covers on-track machines. This guidance note would appear to have gone some way to addressing RAIB's recommendations.

Vegetation management and railhead treatment

The RAIB report, in my opinion, has correctly identified the primary cause of the incident, namely that the severe contamination of the wheel/rail interface by dry leaf film prevented the HXP-3 from maintaining continuous detection of the train on the inbound approach to the crossing. The effect of leaf contamination can vary considerably from year to year: in a good year, the leaves will fall steadily throughout the autumn; in a bad year, good weather followed by a sharp frost coupled with strong winds can cause most trees to shed their leaves over a very short period. A good year will lead to only minor issues with train detection, but may still have a noticeable effect on adhesion. A bad year can cause sudden and pronounced adhesion problems if the weather is wet, or sudden and pronounced train detection problems if the weather is dry – and these problems may only be significant for a few days.

When the HXP-3 was introduced on the Bittern Line, extensive testing and analysis was carried out. It was well known that severe insulating railhead contamination would prevent safe operation, but this was ruled out on several counts. Firstly, the route was not shown in the Sectional Appendix as a leaf fall risk area. Secondly, historical evidence showed that no wrong side track circuit failures had been reported on the route (albeit there were not a large number of track circuits). Thirdly, although RHTTs were available for use in the area, none had ever been required to operate over the route (in those days they merely laid Sandite on the rails, and did not have water jets to clean the rails). Sandite is a mixture of sand and metallic particles suspended in a gel. When applied to the railhead it improves adhesion whilst maintaining satisfactory track circuit operation. Fourthly, a full lineside vegetation survey was carried out by ADAS (specialists in tree and vegetation management), examination of which confirmed that, subject to some remedial work being undertaken, the level of lineside vegetation was unlikely to cause a problem with train detection. Following this survey, this remedial work was undertaken, and Network Rail (then Railtrack) knew that the vegetation had to be maintained to an acceptable level for safe operation of the predictors. Finally, all the crossings were fully monitored during the first autumn.

During the preparation for the installation of HXP-3 predictors on the Bedford-Bletchley scheme in 2004, GE Transportation reported that in-service monitoring on the Cromer line had proven the HXP-3 to provide better detection of trains than DC track circuits, and simulations showed even the worst shunting trains will be acquired. They nevertheless recommended that, in areas of heavy vegetation, programmes of defoliation should be undertaken. This again highlights the requirement for good vegetation management where predictors are used. Was this forgotten in the intervening years, or just ignored?

In the intervening 20 years, it would appear that vegetation has not been managed as well as it should have been, and in several areas on Google Earth images, trees can now be seen completely obscuring the view of the track, which are much less evident in earlier photographs. The introduction of the RHTT in 2016 implies that leaf contamination was becoming an issue even with the original rolling stock on the route, and the vegetation was not being adequately maintained for safe operation of the HXP-3 installations.

The HXP-3 is well able to cope with a noisy input signal, and in this situation is designed to err on the side of initiating the crossing warning early (as seen when the incident train initiated the crossing warning at 66 seconds for a designed

The Class 755 Stadler FLIRT train of the type involved in the incident. Modern trains with smooth-riding suspension pose particular problems for traditional train detection systems. *Photo Shutterstock/Peter R Foster IDMA.*

warning time of 34 seconds), but like a track circuit it cannot cope with a lengthy section of insulation between wheel and rail. Had the incident train been running over a conventional track circuit, the train would have been completely lost for at least 20 seconds.

Given that the RHTT was deemed to be necessary for safe operation of the route, and would almost certainly have prevented the incident had it been run at weekends, I cannot understand how a decision not to run at weekends was ever arrived at – it's a bit like telling car drivers that they only need to wear seat belts on weekdays, and by Sunday can turn off their airbags! I do feel, however, that the RHTT is very much a second best solution to proper vegetation management, and had this taken place, the incident would almost certainly not have happened.

An afterthought

It is my view that the incident may have been made a little more likely by the trainee driver just possibly driving slightly more cautiously on the curve approaching the crossing, causing the train wheels to take up a slightly different lateral position on the railhead and providing further opportunity to build up wheel (as opposed to rail) contamination shortly before the crossing. This could not, of course, have been foreseen or prevented. I see it as possibly "the straw that broke the camel's back".

References

1. Near miss between a passenger train and cars at Norwich Road level crossing, New Rackheath, Norfolk, 24 November 2019, Rail Accident Investigation Branch, Report 15/2020, December 2020. irse.info/wldkf.
2. Signalling Design: Module X02 – Level Crossings: Common Design Requirements, Network Rail, NR/L2/SIG/11201/Mod X02, Issue 2, 2 June 2012.
3. Train Detection by Track Circuit – the Effect of the Wheel/Rail Interface, R A Wood (AEA Technology Rail), IRSE ASPECT Conference, London, September 1999.
4. Guidance on Vehicle Requirements for Reliable Track Circuit Operation, Rail Safety and Standards Board, GM/GN2576, Issue 1, August 2003 (withdrawn 2013).

About the author …

Robert retired from full-time employment in 2011, after nearly 40 years in railway signalling design, research, and consultancy. He specialised in wheel/rail and train interface issues for train detection systems, and was an independent safety assessor for the introduction of the HXP-3 predictor on the Cromer and Bedford-Bletchley schemes, and for the GCP3000 predictor in the UK. He spent much of his career with British Rail Research in Derby (which after privatisation became AEA Technology Rail then DeltaRail), before moving to Westinghouse/ Invensys Rail Systems (now Siemens Mobility) in York, to provide support for the application of the GCP3000 predictor in Europe, including training courses for maintenance staff.

What do you think?

Do you agree with Robert's assessment of the incident? Perhaps you have experience of the use of Grade Crossing Predictors in other countries that either supports or counters the analysis. Let us know, email editor@irsenews.co.uk.

French point machines with Network Rail standards – a unique challenge

Nathaniel Reade

High Speed 1 (HS1) previously known as Channel Tunnel Rail Link (CTRL), is a 67-mile (108km) high-speed railway linking London with the Channel Tunnel. Crossover 2361/2362 forms part of the Eurotunnel infrastructure, near Cheriton on the English side of the Channel Tunnel. Network Rail HS1 are contracted to inspect and maintain the crossover in accordance with Network Rail standards. What happens when the crossover drive and detection systems need to be replaced, in compliance with both British and French standards? This article explores the challenge.

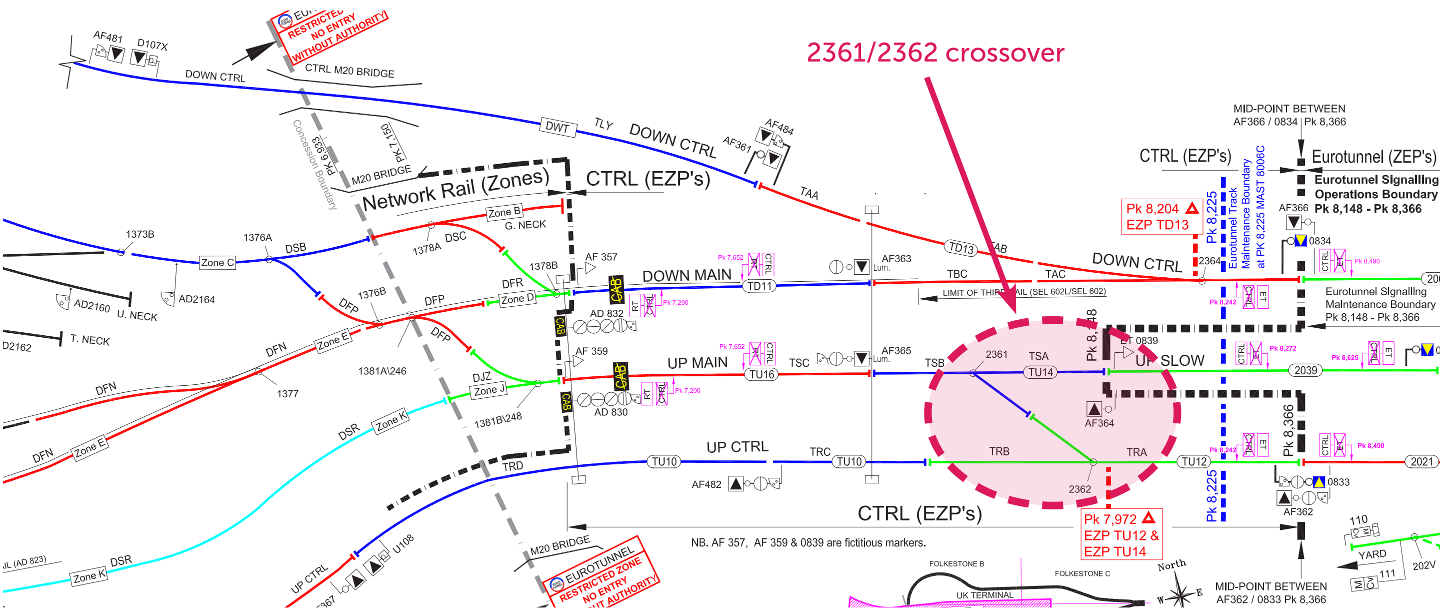
Background

The crossover, which used HW2121 point machines installed in British Rail days, was taken out of use in January 2019 following deterioration and subsequent failure. The complex nature of the interface area is shown in Figure 1, with 2361/2362 points in the middle of the Network Rail, HS1 and Eurotunnel area.

The loss of 2361/2362 crossover had an impact on the flexibility of operations in the area and restricted the availability of routes, as well as increasing the demand on the local maintenance and inspection teams. This was the only HW2121 point machine in the HS1 maintenance team area, so the decision was taken to renew 2361/2362 crossover and to convert the existing drive and detection circuits to utilise French MCEM91 machines. These are 400V three phase AC machines that are used on HS1 and Eurotunnel.

As Network Rail HS1 maintenance organisation did not have a dedicated project renewals team, the project was managed by the Switch & Crossing (S&C) South Alliance. Due to their previous experience and expertise in working on HS1 infrastructure, Amey Consulting was engaged ten weeks ahead of the planned commissioning to produce and deliver the designs, and to install, test and commission the signalling aspects of the S&C renewal.

Figure 1 – The Network Rail/Eurotunnel interface, showing location of 2361/2362 points.



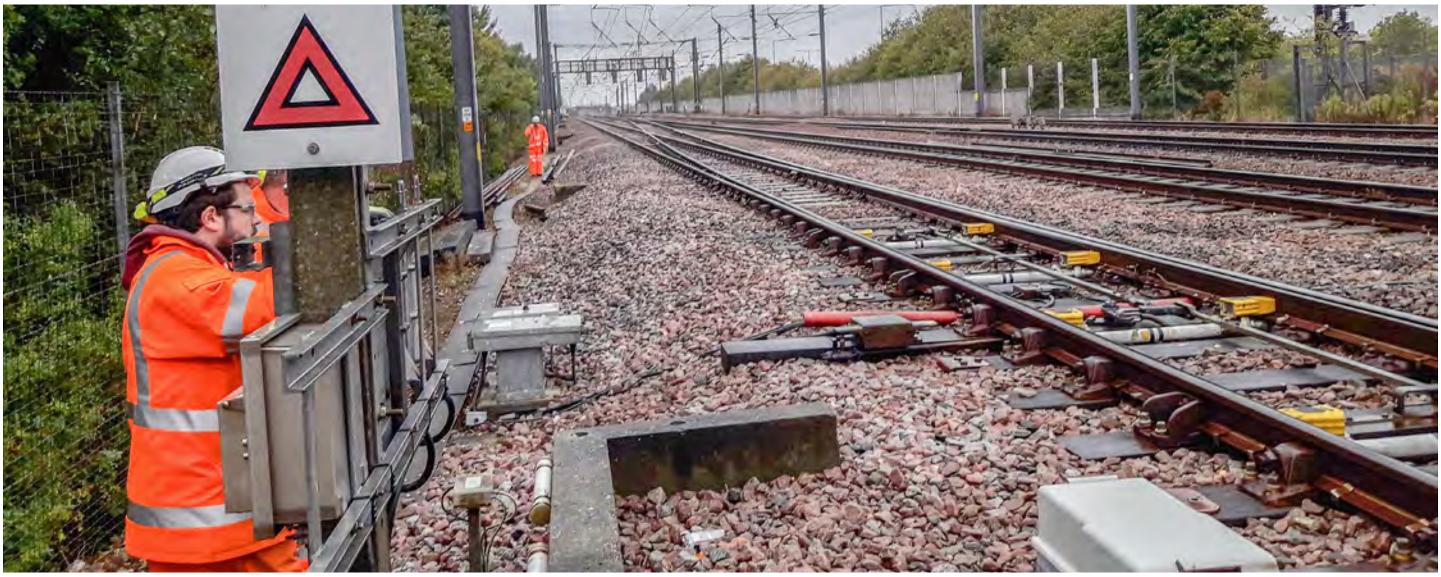


Figure 2 – Previous 2361/2362 crossover with HW2121 point machines and supplementary detector.

Technical challenges

In addition to the technical challenge of converting the existing 120V DC drive circuits to 400V three phase AC circuits, the location of the crossover at the interface, between HS1, Network Rail and Eurotunnel infrastructures, presented a number of unique challenges to be overcome. Many stakeholders were engaged throughout the design process to ensure the proposed solution met the client's needs, fulfilled the compliance requirements for use on railways in the UK, complied with the French regulations for powering and detecting the new point machines, and was also possible to build and maintain. Particular concerns were raised around the interfaces between the French and British methods of drive, detection and indication circuits, with difficulties ensuring the designs would be compliant with all relevant standards. Achieving either one of these was relatively simple, achieving both considerably less so!

Following previous experience of working on HS1, and with established relationships between all stakeholders, the design team was well placed to assist with the smooth management of the interactions between all involved parties and to resolve any issues associated with conflicting requirements as and when they arose. This experience was also used to apply the correct conventions and methods of presentation required for both Network Rail and HS1 infrastructure.

The first obstacle to overcome was the compressed timescales. The possession date had been firmly set ten weeks after the design team was engaged to complete the design activities. It quickly became apparent there was insufficient time to develop the unique design solution that would be required and to complete the essential engineering assurance processes. The design team instigated an engineering workshop with all involved parties to collaboratively outline the best way to complete the project given the tight timescales and challenging interfaces. The result was a two stage design and commissioning strategy:

- Stage 1: Use the existing possessions to lay in the S&C, clip and padlock (C&P) the crossing normal and provide point detection through the new MCEM91 point machines and Paulvé detectors.
- Stage 2: Commission the point control from the existing Ansaldo SEI interlocking.

At Stage 1 the existing crossover and point machines could be recovered and physically replaced with the new assets on site which would then be clipped and padlocked out of use. This approach provided enough time for the new drive and detection circuits to be completed ahead of the Stage 2 commissioning that would bring the renewed crossover into use. However, even with the extended timescales there were still a number of technical issues that needed to be resolved.

The HW2121 machines that had been in use at 2361/2362 crossover contained integral detection elements and circuitry, as per the usual arrangement for point machines of this type, with an additional supplementary detector for each point end. This is shown in Figure 2.

Whilst common on SNCF infrastructure, the MCEM91 point machine is not used in the UK outside of HS1. This machine requires external detection via Paulvé units, manufactured by Vossloh, in place of the integral detection in the HW2121, and also in place of each of the supplementary detectors. Paulvé detectors are a rotary system, with an arm connected to the switch rail that mechanically rotates the detection elements as the points move back and forth. A Paulvé detector is shown in Figure 3.

Figure 3 – Paulvé detector.

Figure 4 – Internal Paulvé detector connections.

The latest Paulvé detectors are designed to be used in conjunction with preformed tail cables, as shown in Figure 4. However, the manner in which these tail cables split the detection current paths between the detectors, and return the detection circuits to the interlocking, does not comply with the Network Rail standards and requirements. There was not sufficient time within the project programme for the circuits with preformed tail cables to pass through the circuit review committee and so it was decided to apply the design used for the existing HS1 Paulvé detector circuits, which used dedicated cables. Additionally, the new Vossloh style of preformed tail cables provided with the detectors (similar to the 'paddle' used on clamplock detectors) was a recent alteration to the French detection method that had not been encountered on any project before, either in the UK or in France. To complicate matters further, it was not possible to comply with Network Rail Notice Board 180 (which requires separate detection circuits for each detection element) whilst also complying with the SNCF detection circuit requirements.

As a compromise, the design team proposed a solution where the detection cables returned to the location case between each detection element, but without providing individual relays for each Paulvé detector unit. This enables simpler maintenance and fault-finding capabilities without breaking the continuous detection circuits required for the Paulvé detectors. These detection circuits were successfully installed and commissioned at Stage 1, in line with the ambitious timescales set out at the beginning of the project.

Stage 2 of the commissioning brought the new MCEM91 machines into operation, and the control and detection circuits fully migrated to the existing interlocking in Cheriton Signalling Room. The existing BR Spec relays driving the HW2121 machines had been taken out of use at Stage 1 and the new circuits were designed and commissioned using French style NS1 relays. Although fundamentally they perform the same function, the design and installation conventions are different – front contacts became 'travail' (working), armature became 'milieu' (middle), and back contacts became 'repos' (sleeping). Contact arrangements also changed drastically, with the analysis sheets referring to the hole in the trunking that the wires pass through, rather than corresponding to the rear of the relay.

As well as containing the sheet number the contact appears on, and the wire count, the French style contact analysis also contains the details for the other end of each wire. To correspond with this, the position of the relay on the rack is also presented beneath the relay contact shown in the wiring sheets. To complicate things further, the French numbering convention starts with Terminal 1 at the bottom of the row and works its way up – a subtle change to the British convention but another potential pitfall when designing and installing!

As with every S&C renewal, it was vital that full communication was maintained between the signalling designers and all other disciplines throughout the project. Careful consideration was given to the required power consumption for the new 400V AC three-phase point machines to ensure there was sufficient capacity. Although the required load was less than the HW2121s they were replacing, the three-phase supply came from a separate feeder so it was not possible to simply offset one against the other and assume a net reduction in power consumption.

The position of the Intermittent Transmission Loops (ITLs) – a key component of the in-cab signalling in use on HS1 – was also crucial, so close coordination was required with the track engineer to ensure the new layout and slewed area did not interfere with any of the existing positions.

The responsibility for providing points heating falls with the signalling designers and installers in France, so full communication was required throughout this project to ensure the power supplies were adequate, and documented within the signalling drawing set.

The team was able to provide the design, installation, and testing resources to successfully commission this challenging project in time, drawing from previous HS1 experience and maintaining full communication with all stakeholders throughout. The ability to interpret the requirements from different and often conflicting standards, and to provide a workable and compliant solution, enabled the crossover to be brought back into use thereby increasing the capacity and efficiency of the infrastructure and providing a common point machine for the HS1 maintenance team.

About the author ...

Nathaniel has been working in the UK signalling industry for 14 years. He is a senior systems engineer and has worked in the Swindon design office of Amey Consulting for the last four years. He has an engineering degree in innovation and design, and in addition to signalling design management is also a part-time author specialising in military fiction.

What do you think?

What is your experience of introducing systems and components to a country or railway for the first time, even though they are widely used elsewhere? How have you coped with issues such as acceptance, different design principles and asset management regimes? Have you found it straightforward to train installers and maintainers, or have you found challenges, perhaps to do with the way that messages are shared, different terminology, or even issues with translation?

We'd love to hear your views and experience so that we can share with other IRSE members as part of our ethos of inform, discuss, develop. Email us at **editor@irsenews.co.uk**.

The many aspects of architecture and their impact on system performance: Part 1

Rod Muttram
on behalf of the IRSE International Technical Committee

At the start of his Presidential year in 2019 George Clark asked me to write a paper on the importance of good architecture. It has taken some time but has now evolved into three parts in which we (the ITC) have tried to give as broad a perspective as possible. Our hope is to inform, particularly younger engineers who may not have encountered some of the issues yet in their careers, and to jog the memory of more experienced engineers who probably have but maybe not recently. We certainly will not have covered everything but hopefully enough to prove useful.

So, what do we mean by 'good architecture'?

The dictionary defines architecture as the process of planning, designing and constructing buildings or systems. Most lay people would associate architects with buildings or structures; and note the first dimension is planning; more on that later.

To most people it would be self-evident that an architect's job is to design buildings which are structurally sound, fit for purpose and safe. Many successful architects also design buildings and structures that are visually appealing; although while "beauty is in the eye of the beholder" and the visual appeal of some modern architecture can be a matter of taste, few can argue that structures such as the tower known as the "Gherkin" in London, or the Millau viaduct in France, are not striking and very impressive in looks, scale and achievement.

The architect's role later in the lifecycle is an interesting question. Many structures are maintained long beyond their original design life, to what degree is the original architect or design team then still responsible? A recent tragic example is the collapse of the Morandi bridge (named after its famous architect) in Genoa in Italy with 43 fatalities. The failure is thought to have been caused by a combination of corrosion in parts of the structure and much heavier traffic that anticipated when the bridge was designed in the 1960s. Maintenance and maintainability are also questioned with some parts being hard to inspect due to Morandi wanting the bridge to have 'clean lines'.

In rail we have many impressive physical structures particularly bridges and stations. Some of these have faced significant maintenance challenges. Few realise the huge maintenance backlog that Railtrack inherited after British Rail's later cash-strapped years, with iconic structures such as the Forth Bridge and Brighton station examples of those that were under severe threat prior to major renovation projects. Even the replacement Tay Bridge, re-built to be 'super strong' after the Tay Bridge disaster of 1879, needed more work when subjected to modern finite element analysis techniques.

But it is not 'civil' structures that are the subject of this paper; it is intended to focus more on the structure of control, communications and power systems – the 'systems' element of the definition.

It became clear in discussing a draft of the paper with the ITC that 'architecture' in that context exists at several levels, and I am particularly grateful to Rob Cooke for his help in bringing that out more clearly. There is the design and architecture of individual components and subsystems and then the overall architecture of the system, or 'system of systems' that delivers the desired service or outputs.

It is the second of these facets that tends to be more thought of as the 'system architecture' but such 'big systems' are critically dependent on the first element being correct if they are to deliver the reliability and safety performance required.

The ITC therefore decided to split the paper into three parts, the first (this part) covering aspects related more to the good design basics of components and sub-systems, focussing on hardware; the second covering software, normally distributed throughout the hardware of a bigger system but also having critical architectural dimensions; the third covering the bigger system and system of system issues. The three parts interact and are critically dependent on each other so those distinctions may not always be strictly maintained.

For the third part, certainly historically, a true 'system architect' was not always visibly involved. Many of our systems have not so much been 'planned and designed' at the overall system level as 'evolved' or simply happened as a consequence of other factors such as piecemeal renewal as assets became life expired.

Rail assets tend to be long lived. What were relatively simple systems in mechanical and electro-mechanical days have become increasingly complex and money is certainly not always abundant, so piecemeal and partial renewals have been common. This can mean that architectural choices are severely constrained, and the implications of some of the more subtle system level interactions or maintenance impacts may not always be immediately apparent.

With increasing system novelty and complexity, the importance of good architecture at all levels to being able to predict and assure system behaviour and maintainability cannot be overstated. As we move ever more towards software driven systems good software architecture is also a key part of facilitating approval, introduction, maintenance, updating and safe service. More on that in part 2.

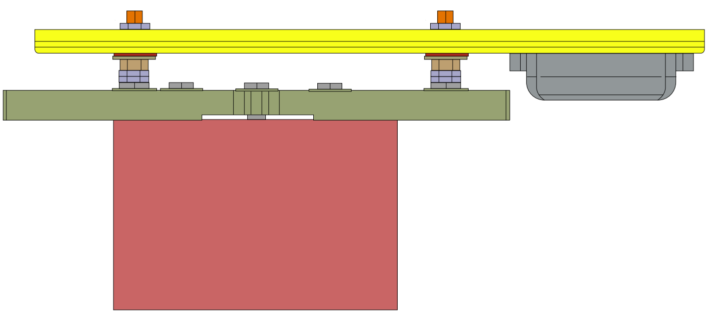
So firstly, in this part 1, let us consider hardware which is concentrated in the components, sub-systems and the communications between them.

Hardware architecture

So, what constitutes a good hardware architecture? Each sub-system needs be considered for and in its (maybe unique) operating environment. Most of what we cover next should be well known, and much is covered by standards and good practice but it is remarkable how many times in my long career I have seen things missed and errors not only made but repeated. Corporate memories can be remarkably short.

Structural, functional and environmental factors all need to be considered. Certainly, as a 'rule of thumb', it is always good practice to minimise complexity and the number of interfaces. These need to be considered together as minimising interfaces may involve additional complexity in each of the elements – there is always a trade off, and the optimum solution needs careful analysis. Hardware will have many requirements, some of which will likely come into conflict, and the simplistic application of specifications without considering a broader system context will often end in problems. But for 'generic' component and sub-system design sometimes that can mean working to a theoretical 'envelope' as the end system usage may not be fully known at the time –an important role for standards.

The well proven Serial balise has been in use for decades in EBICab and KVB ATP systems with no issues (shown yellow in the cross section of the mounting arrangement below) . When subjected to enhanced AREMA levels of swept sine vibration for the US PTC project a structural resonance occurred which caused cracking. Whilst no functional failures occurred modifications were necessary to ensure no long term moisture ingress could occur.
Photo Bombardier RCS.

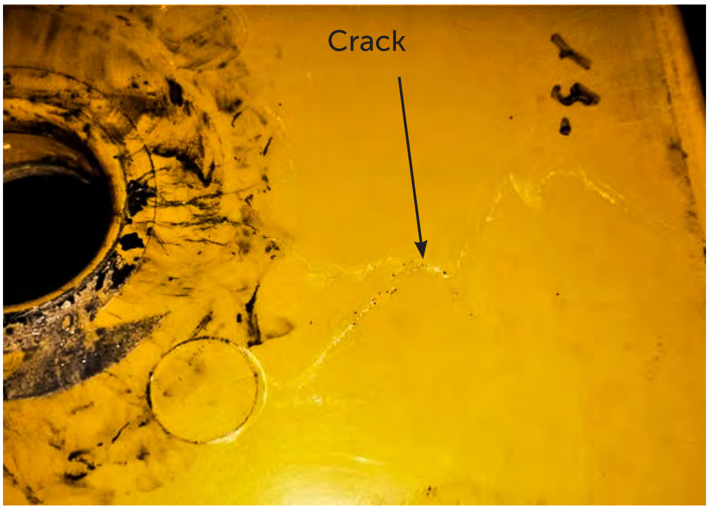


Thermal and environmental management

Hardware is the main element in securing temperature performance but it is important not to forget that in software driven systems, software can affect power dissipation and therefore temperature too. Software may also be used for some more complex aspects of thermal management. Designing and testing a piece of hardware to meet a specified temperature range in its own right is a fairly complex task but when we consider its application in a system it becomes even more complex. If several elements are combined in a cabinet, maybe from different manufacturers, then there can be interactions that lead to problems. Adding specific hardware like fans or air conditioning has cost, reliability and maintenance implications. It is also important to consider 'de-rating'; it is always tempting to choose a lower cost component or sub-system which just meets the power rating required, but that component/sub-system may run hot and affect others around it both in terms of performance and life. Including air conditioning or force cooling to remove that excess heat may solve some of the problems but it is quite likely that the item concerned will still have a reduced life perhaps compromising a reliability requirement. It may be better in life cost terms to use a component/sub-system capable of coping with higher power which runs cooler so may not require force cooling and/or be longer lived – this process is sometimes known as 'de-rating' because components are used at a lower rating than the maximum for which they were designed. A simple but classic example is to choose a transformer with a higher current rating. Wound with thicker wire it will run at lower temperature at the required level.

In Singapore the LTA now requires signalling suppliers to conduct thermal analysis of complete ATC cubicles during the design stage to consider the different operating scenarios including when air conditioning may not be available. It matters in thermal management terms where particular units are placed in a rack – higher power units such as power supplies are often placed near the bottom for weight distribution/centre of gravity reasons, but heat rises and may affect units above.

This is the first example of a very important principle that for any project or change there should be a clearly defined system integrator. Historically in the railway industry this was the client, but with increasing 'contractorisation' and the advent of contracts for Design, Build, Maintain (DBM) and DBMO (adding Operation) and Public Private Partnerships (PPP), it can be a contractor. That is fine if properly executed by a competent contractor with a long-term interest but we have



seen too many projects where the issue has been 'fudged'. For instance, some clients have attempted to get the cost benefits of competing different elements of a project separately and then, once the contracts are placed and companies committed, either told one of the suppliers they must take the integration role, without the full capability or funding; or simply told all of the contractors to 'sort it out between them'. We shall return to the subject of system integration in part 3 of this paper but suffice it to say we consider the above approach to be highly unsatisfactory and likely to lead a bad outcome for one, more or all of the parties.

Another important environmental factor is shock and vibration. This will involve not only the inherent capability of the components but also how they are mounted and the overall nature of the physical structure within which they sit and the way that structure is mounted in the overall system. With good design amazing performance can be achieved (I was once involved in the design and production of a system that reliably survived a 120,000g shock) but get it wrong and mechanical 'Q' factors can multiply inputs at the component level by many times and lead to failures. Shock and vibration may cause intermittent as well as permanent issues – this is particularly important for electromechanical components like relays, buttons and switches where shock and vibration can cause contacts to open, or even sometimes close, intermittently. This can even affect components designed specifically for safety applications and the author has witnessed a case where a multiple failure case, dismissed as 'incredible' in a Failure Mode and Effects Analysis (FMEA) report, happened on a shock test due to multiple contacts opening simultaneously under high shock. In terms of signalling such factors are particularly important for on-board systems, but can affect trackside assets too which are not immune from adjacent events such as track maintenance. Good architectural practice might include not only the overall structural design and the use of shock and vibration absorption features such as resilient mounts, but could also extend to measures such as consideration of mounting relays in the same circuit in different orientations to avoid common mode shock effects.

It is also necessary to consider issues such the IP rating (International Protection, also known as ingress protection). Sealing the unit may make the thermal management issues discussed more difficult but some dusts can be quite conductive and damaging to electrical as well as mechanical features. Conformal coatings or even encapsulation can help with both IP and vibration and shock performance but also make repairs much more difficult and should be used only where really necessary.

In, or close, to a marine environment the presence of salt can make corrosion and material compatibility issues worse, and of course those need to be considered anyway. Metals have very different electrochemical potentials; as a result, when they come into contact with one another in the presence of moisture, humidity or any other potential electrolyte, significant corrosion of the 'less noble' metal can occur. This is why steel boat and ship hulls are fitted with 'sacrificial anodes' which corrode whilst protecting the hull. Steel screws are often used for strength but in aluminium structures the difference in electrochemical potential can lead to rapid corrosion. This may lead to maintenance difficulties or even structural failures. Plating the screws with zinc, which is similar in potential to aluminium may reduce the effect considerably (historically cadmium was used which is even closer in potential but this is now banned for other reasons but there are still a lot of old cadmium plated parts in service). The corrosion properties of alloys are very hard to predict and may require empirical tests.

Another approach is to use insulating 'barrier' materials between incompatible components or exclude moisture by the use of measures such as conformal coatings. Aluminium components such as heat sinks are often 'anodised' to give them a tough corrosion resistant coating – but as soon as a hole is drilled after that process then a potential vulnerability is introduced. Similarly, steel chassis components are often plated or hot dipped in zinc (galvanised). Barriers must be capable of lasting the life of the system and not be subject to wear or damage, otherwise unexpected secondary issues may occur. A well-known example is the Statue of Liberty where the interface between the iron frame and the copper skin was protected with shellac which eventually degraded necessitating remedial action to prevent severe corrosion in the salty air of its estuary location. Copper is another commonly used material in electronic and electrical components. Material selection is often dictated by the component supplier but needs to be fully understood by the equipment designer.

Electromagnetic Compatibility (EMC) design (covered later) may require additional components such as filters as well as constraining the physical design in terms of wire/track lengths and routing and many require things like conductive seals on covers (which also need to use compatible materials). All of this may seem quite obvious to an experienced engineer, but it is remarkable how some engineers seem to think they can just buy parts and put them together without such considerations. It is often a highly complex trade off. A good physical architecture will minimise such issues both by selecting compatible materials and, where it cannot, keeping incompatible materials apart in a secure and sustainable way.

Power supply

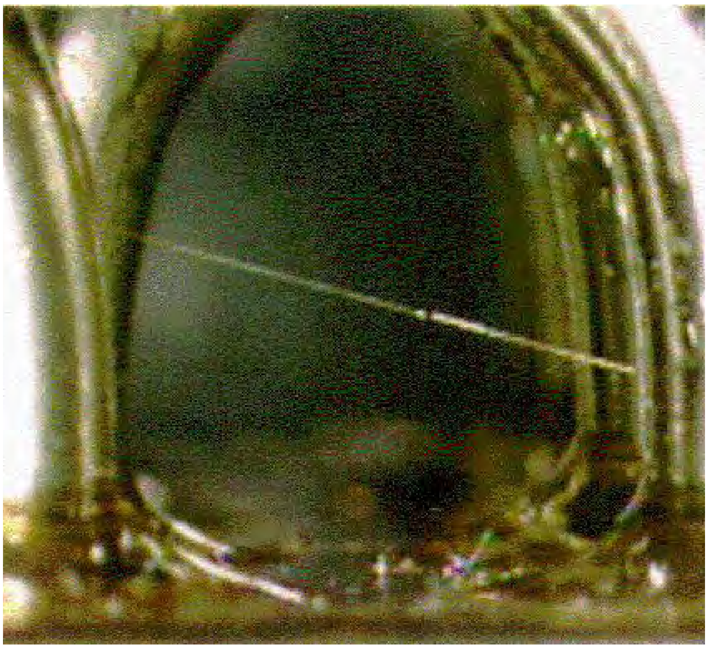
Too often an afterthought, simply a 'bought in' sub-system (not that there are not some very good power supply products out there) power supply is a critical part of the hardware for reliability and thermal management and EMC. So, if it is bought-in its specification is critically important. It is pointless having high reliability hardware if the power supply is a single point of failure and of course that also means determining where the system boundary is and whether provision of dual incoming supplies or a local Uninterruptible Power Supply (UPS) is needed. Power Supplies will be the subject of a separate ITC article which will be published in a future issue of IRSE News.common

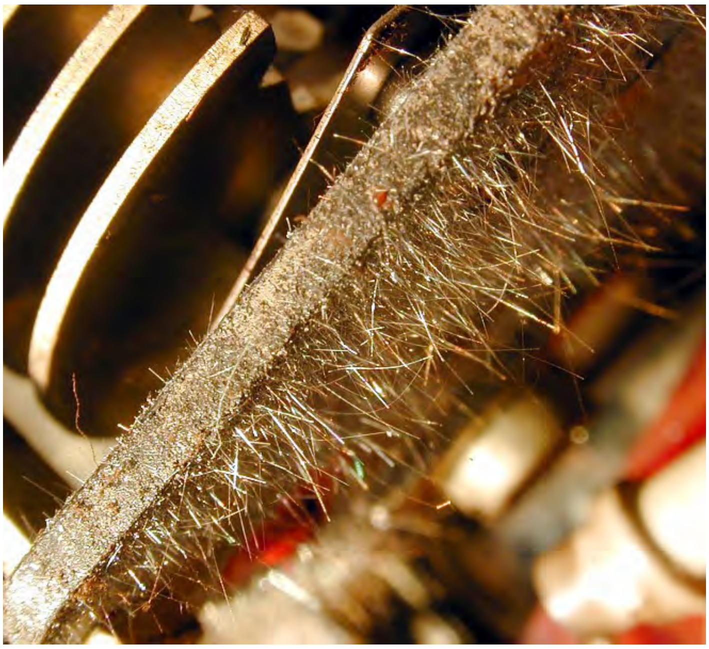
Electromagnetic Compatibility (EMC)

Electromagnetic compatibility is an area which critically depends on both sub-system and overall system design. This is true both for susceptibility (the potential for the system to be interfered with) and emission (the possibility that the system will interfere with something else). Also, the interconnections (communication systems) between units offer a mechanism by which radiated signals can be converted into conducted interference and visa-versa. Whether common or individual sub-system power supplies are used they will play a critical part in conducted EMC resistance and particularly resistance to transients on the incoming supply (both overvoltage and short interruptions).

To handle both conducted and radiated susceptibility and emissions at the unit/sub-system level often requires both good internal configuration and an enclosure that offers good shielding. Where connections pass through the enclosure wall filters may be necessary to prevent though transmission in either or both directions.

Good EMC performance requires more than just compliance with the standards. Many clients may require higher levels either in specific instances or more generally, so check the





These two images show a tin whisker bridging soldered wire terminations and a veritable forest of whiskers on the end plate of an air-gapped variable capacitor. *Photos NASA Electronic Parts and Packaging (NEPP) Program,* ***irse.info/d3y9q***.

contract. There are often local issues, requiring lower emissions or greater immunity than the standards mandate (and older infrastructure will often not comply with modern standards in this regard), more on this in part 3 to follow in a later issue.

Electrical insulation

Another important architectural consideration, particularly in safety systems, is electrical insulation and safe separation distances between conductors including printed circuit board tracks (depending on operating voltage). European and US standards contain parameters for the safe separation between circuit board tracks for safety applications but again considerations like the environment and particularly things like humidity and coastal environments high in salt must be taken into account as well as the particular characteristics of certain materials, and not only the insulators themselves.

How many in the rail industry now remember silver migration? British Rail and Railtrack in Great Britain spent millions of pounds replacing Bakelite relay bases because the silver used to plate the contacts to give low contact resistance 'crept' across the surface of the base and caused or risked short circuits which could compromise the integrity of the signalling system. The author has been told that silver migration has also caused power supply issues on the International Space Station (ISS).

Another example involves tin. For environmental protection reasons lead has been phased out of solder in favour of pure tin. But how many engineers know that in the right environmental conditions pure tin can grow conductive 'hairs' or 'whiskers' several millimetres long? In high power circuits this often does not matter as the 'hairs' simply get 'blown away' like a very thin fuse wire, but in a high impedance signal circuit a false connection can result and it has been known for a high current arc event to be initiated. The author has seen this issue result in several million pounds of re-work being required on a defence project due to shorted out crush switches on units that had been in unpowered storage. The addition of even a very small percentage of lead suppresses this effect (NASA recommend a minimum of 3 per cent to ensure at least 0.5 per cent locally) but pure tin is still usually specified. An issue to be aware of in storing spares, as it is environment (particularly humidity) dependent, although the mechanism is not fully understood and is thus hard to predict. This issue affects not only conductors and solder joints. Earlier we covered the plating of components for material compatibility reasons. Both Zinc and Cadmium can also grow whiskers, indeed there may be a 'carpet' of them on a sheet metal component which if disturbed by a shock or by maintenance handling may result in an electrically conductive shower onto any circuits below causing single or even multiple failures.

Historically some insulation issues were handled by using isolating transformers or opto-isolators but many modern techniques such as Internet Protocol (another IP) do not lend themselves easily to those methods. Nonetheless these issues remain very important, particularly for countries with a high prevalence of lightning leading to high levels of surge voltage.

Maintenance and producibility

In addition to such design configuration issues, for maintenance the physical architecture will be very important; can a part that needs maintenance be easily accessed? Can the required maintenance be carried out in a timely manner without the need for special tools, or if special tools and/or equipment are needed have these been identified and provided? If a part fails, can it be changed without specialised equipment and/or excessive disruption or risk to the rest of the system either in terms or interrupted functionality or secondary damage? During design and manufacture techniques such as 'select on test' for certain components may appear attractive for cost or reduced complexity reasons but through the life of the equipment may prove very much less so if the necessary equipment for setting up again after a repair is not available to the maintainer. Modern assembly techniques for electronics with multi-layer boards, surface mount components and very high complexity integrated circuits can be very hard to repair without specialised knowledge and facilities. This can create a lot of ill feeling in clients if they feel it leads to 'opportunity pricing' by suppliers, long turnarounds and the necessity for high spares stocks.

Obsolescence

This is another issue requiring careful through-life management and careful consideration at the start of any design/project not just when the equipment is in service or when a part becomes unavailable. The use of complex highly specialised components may seem very efficient at the beginning of the lifecycle but once such components become obsolete it may be very difficult, if not impossible, to find an equivalent to replace them. It may be possible, with careful planning, to lay down stocks of such components for future use but where components have a 'shelf-life' this may still be difficult. Specialist companies can sometimes produce components no longer made by their original suppliers, but at very high cost, particularly for small quantities. Hardware obsolescence can also have implications for software – if a component needs to be changed will the software still be compatible? Semi-conductor manufacturers often revise their designs to improve performance or to reduce production cost without changing part numbers – this can lead to software execution issues. An example witnessed by the author was the die (chip) size of a microcomputer being reduced by 20 per cent. This was facilitated by improved fabrication techniques and was intended to reduce costs and improve speed. But changed timings caused by a photographic mask error led to software halts on what was previously very well proven software. A major project was delayed several months as a result costing several million pounds; and microcomputer manufacturers limit their warranties to component replacement.

Safety considerations

For hardware an FMEA is a key tool for ensuring that single failures cannot lead to unsafe conditions and that the probability of multiple failures doing so is acceptably low. There will be many architecture/configuration options to achieve that outcome. Of course, underlying component selection issues are also important such as:

- Using components with known low failure rates.
- Designing with appropriate reserves mechanically and electrically (see de-rating above).
- Applying components with known safety characteristics (e.g., a preferential failure mode).
- Using components with 'non-volatile' characteristics (e.g., memories that retain their data through a power failure).

This of course also assumes that factors such as possible structural failures, sneak circuits or intermittencies resulting from issues like those described in the sections above have all been adequately considered and either the reserve factor is sufficiently high (for structural issues) or the mechanism has been eliminated or mitigated.

A very important class of components with known failure modes for railway control applications are safety relays. (It is for discussion whether a relay is a component or a sub-system). These are important in both trackside and on-board applications (for things like a fail-safe brake interface). Specifically, 'gravity drop' relays use gravity rather than springs to provide the force that will move them to a known state in the event of an energisation failure; and relays with 'force guided contacts' have an internal architecture that ensures that they can never have both a normally open and normally closed condition simultaneously. Should one contact become welded or stuck the internal design keeps any other contacts, whether normally open or normally closed, from changing states. Both these types can be very useful in safety applications but such designs are not immune from the problems of shock and vibration already discussed.

The above factors relate to all hardware but, (as will be explored more fully in part 2) when hardware is driven by software additional considerations often apply. For safety systems the objective should be to ensure that, to the required level of confidence (often expressed as a Safety Integrity Level [SIL] for particular functions), both random and systematic failures are controlled sufficiently well for the required integrity to be delivered for their safety functions. SILs are often erroneously applied to pieces of equipment but it is 'end to end' safety functions that should be analysed and secured. This requires detailed knowledge and analysis of the hardware, software and human interactions with the system. Any single component or piece of equipment cannot have a SIL (unless the safety function concerned is wholly executed within it), it can only have a failure rate capable of supporting a certain SIL when correctly incorporated into a system executing the safety function in question. Too often we see individual pieces of equipment advertised as being of the highest category (SIL4) and people making the erroneous assumption that if they connect several of them together they will get a SIL4 system.

For software driven systems with defined safety requirements 'special' hardware architectures are often used to provide protection against random failures. Two out of two (2oo2) systems use two processing channels that constantly 'cross-compare' with one another and shut the system down safely if they disagree. To secure this additional safety assurance whilst maintaining a high level of availability a third processor is sometimes added to make a two out of three (2oo3) architecture with a 'voting' system where if two processors agree and the third does not the two 'good' processors can safely shut down (or even blow the power fuse of) the 'bad channel'. The remaining two channels then carry on functioning as a 2oo2 system whilst issuing an alarm that maintenance is needed. This architecture was popular when electronic hardware was expensive as it needed only three processor systems; as hardware has become cheaper duplicated 2oo2 systems with 'hot standby' decision logic that rapidly changes over systems in the event of the primary system failing have become increasingly popular as whilst these use four processors the failure management is simpler to execute and analyse. Regardless of the architecture chosen considerable attention to detail is needed in the supporting hardware (such as power supplies, communications and I/O) which must also be protected from single point failures. Systematic failures must also be managed in the software as will be discussed in part 2.

In the now very well-known case of the Boeing 737 Max Manoeuvring Characteristics Augmentation System (MCAS), each part of a multi-lane system was fed from a single sensor (Angle of Attack sensor) with reversion to a second sensor dependent on manual intervention. The arrangements for managing data inputs, command outputs, data combination rules and failure management for multi-lane systems are all extremely important or such systems can become false friends. The IRSE ITC published a detailed article on the potential pitfalls of multi-lane systems in January 2020 (issue 273) so we will explore them no further here.

With the right hardware architecture and software techniques and architecture it is wholly possible to build a SIL 4 platform using Commercial off the Shelf (COTS) computer hardware rather than needing expensive custom-built platforms. This is very good for upgrading and obsolescence management as the relatively cheap hardware can be 'swapped out' for newer and/or higher performance models 'porting' the software with little or no change thus preserving what in many systems is now the highest value asset in terms of development cost.

Photo Rod Muttram.

With that discussion of these special 'systems within systems' to support safety critical and related computing let us then start to look at some of the more interactive issues between sub-systems and components as we move more towards consideration of the 'bigger system' issues in part 3.

Centralised vs de-centralised architecture

Whilst this is a 'whole system' or 'system of systems' issue it is covered here under hardware because decisions about it are primarily hardware driven, with software and civil matters consequential upon them. Decentralised hardware requires de-centralised software for the software operated elements. Similarly, the number of equipment rooms or locations follows the hardware architecture. Making it fit existing buildings falls into the 'force fit' category along with pre-existing hardware and software designs from other jobs, but may sometimes be justified by cost or 'heritage' considerations.

A centralised architecture can have advantages in terms of required operational manpower, maintenance manpower, maintenance equipment provision, spares access and repair response times. It is, however, more vulnerable to catastrophic damage from fire, flooding or terrorism. A decentralised architecture is less vulnerable and potentially has reliability benefits if configured in a way where parts of the system can operate independently in the event of a failure elsewhere. The geographical size of the overall system concerned will also be a consideration and, as always, timings and latency will impact available headway and thus capacity. Other factors are cost, power demand and cyber security; a centralised architecture may be easier to protect in terms of the number of interfaces through which an attack can be mounted but a decentralised structure potentially has more options for protection and recovery. A common architecture for signalling is rather 'hybrid' in that it centralises the interlocking where redundant power supplies and specialist maintenance and spares can be on-hand, but de-centralises object controllers for things like point machines to keep power cable lengths short and voltage drops low. Interconnects between the central location and the object controller cabinets using optical fibre are fast, have no voltage drops, are not vulnerable to EMC and are not attractive to thieves, unlike conventional copper. For metro systems where reliability and availability are an absolute priority it is not uncommon to have two complete 'centralised' control and interlocking systems in different locations – thus getting the 'best of both worlds' in technical terms but obviously at higher cost.

Photo Rod Muttram.

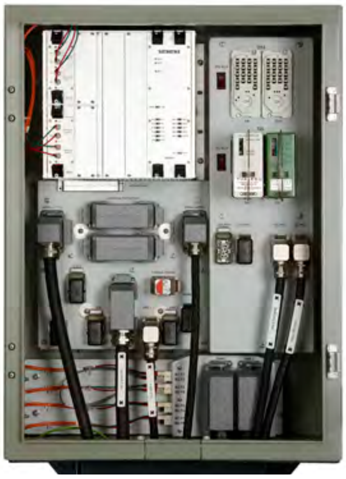


Photo Siemens Mobility.

The technology of early mechanical interlockings necessitated them being decentralised. Modern computer based systems allow highly centralised control desks (top) and interlockings (top left) with distributed 'object controllers' (above) optimising operational, maintenance and acquisition costs.

Other factors and combined effects

Depending on application, other parameters may be important at the equipment level. Examples are weight which will be particularly important for on-board equipment, and flammability and smoke/toxic emission which will be important in tunnel and other confined locations.

All of these factors can interact requiring trade-offs which may require considerable analysis and several iterations to get all of the many factors within specification.

For example, in high frequency electronic equipment there is usually a need to keep connection distances short to avoid stray inductance which may affect performance, but the need to dissipate heat generated by high power components may make it desirable to mount these on heatsinks on the outer skin of the equipment. Meeting those two design objectives simultaneously may prove challenging, particularly when other requirements are overlaid on them.

Sometimes it may not be possible to meet all of the requirements and then an informed discussion is needed with the client about which area, if any, could be subject to derogation. Usually unwelcome but much better than a nasty surprise at commissioning or in service.

Once again this presents a strong argument for having a knowledgeable and powerful system integrator, and on that thought I will close part 1. More on the software that configures and operates much of the hardware in part 2, and on the bigger system issues in part 3 which will feature in future issues of IRSE News.

Evolution of the railway RAMS management process



Vladimir Romanov, Zinan Cao and Aryldo G Russo Jr

Since the official approval of the first version of EN50126 in 1998 the standard has undergone a number of important modifications leading to the current version approved in 2017. The changes have made the standard more consistent and efficient for managing the RAMS process for railway systems.

The purpose of this article is to analyse the evolution of EN 50126 in order to identify the development trends of the RAMS management process.

The current version of the standard [1], [2] has undergone content changes and has been restructured in comparison with the previous version [3].

The first and second parts of the current standard have become normative, whereas in the previous version only part one was normative. When CLC/TR 50126-2 [4][5] was approved in 2007 it was as an informative part of EN 50126 -1:1999 and aimed to provide guidance on methods and tools to achieve safety; for more information refer to page 2 "Foreword" and page 8 "Introduction" of CLC/TR 50126-2. In the current version of the standard EN 50126-2:2017 the main part is normative and annexes are informative, as stated on page 6 "Introduction". This means the current version of the standard has two mandatory parts [1][2]. It is also worth mentioning that CLC/TR 50126-3:2008 is not superseded and is still applicable.

This article examines both the normative and informative content of the standard for a more comprehensive assessment of the RAMS management evolution process.

The article addresses three elements of the EN 50126 standard: factors influencing railway RAMS, safety assessment and risk management. Other changes to the content of the EN 50126 including the number and name of the lifecycle phases, system tailoring, impact analysis, safety case, etc. will be discussed in a second article to be published later.

Railway RAMS factors

During the system lifecycle, performance may be negatively affected by factors that cause failures. Analysis of factors affecting the system characteristics is a very important stage in the specification and design/development process, the result of which is a list of requirements or characteristics for the system. Possessing the required characteristics, the system would be immune to the effect of failures. To analyse the factors that affect the system, the standard suggests using lists of factors, as well as a diagram approach, to determine the factors and their effects.

One of the improvements made in the current version of the standard is the description of the categories of failures caused by the negative effects of railway factors– see clause 5.6.2 of part one. In addition, the checklists for identification of the railway specific influencing factors and human factors were modified.

Comparing the superseded version of the standard with the current one, we can see that systematic failure definition has changed and a random failure definition has been added. A definition of systematic failure was given in clause 3.42 of the first part of the superseded standard and CLC/TR 50126-2 in the clause 3.1.11 provided an alternative definition. A new definition of the system failure is proposed in the current version of the standard in clause 3.79. In this definition the word "safety" is excluded. That means the standard has started to consider RAM equivalents, not just hazards that impact safety, as it did in the previous version. RAM equivalents are defined in clause 6.3 of the first part of the current standard: "RAM equivalent to hazard is a condition that could lead to commercial loss related to RAM". That means the failure may lead to an unintended event that is not safety related.

The new version allocates railway specific influencing factors in four categories instead of five as in the superseded standard. Even though the categories were reduced the content was significantly extended. Clause 5.6.3 in the current standard corresponds clause 4.4.2.10 of the superseded standard, demonstrating this point.

The current standard also regrouped checklist categories and added new factors. Two separate categories "system operation" and "failure categories" were merged to form one category "system definition and system design". The "environment" category does not exist anymore. The content of this category is fully included in the "operation conditions" category. In turn the "operation conditions" content was moved to the "applications conditions" and "maintenance conditions" categories.

The names of factors in the current version of the standard are still exactly the same as the superseded version except one: the "trackside-based installation conditions" has changed to the "installation conditions".

A more visual comparison of the railway specific influencing factors checklists is provided in Figure 1. The figure shows two lists of factors that affect the system's RAMS. On the left side is a list from the superseded version of the standard, on the right side is a list from the current version. Connecting arrows between the two lists show the change in locations. New added factors are shown in black and the word "new" is added in parentheses .

Human factors are described in clause 5.6.4 of the first part of the current standard and corresponds to the first part of the superseded standard clause 4.4.2.11.

The human factors content was also modified: the checklist of clause 5.6.4 has been extended by adding two items on page 34, point e): "human reaction under different operation modes" and point f): "verification and validation". In the current version of standard attention is concentrated on human factors that may arise from maintenance and operation processes.

Figure 1 – Comparison of the checklists for railway specific influencing factors.

Safety assessment and ISA

Safety assessment was mentioned in the first part of the superseded standard and then CLC/TR 50126-2 introduced the concept of the independent safety assessment. The current version of the standard provides more details on the application process for both the safety assessment and the Independent Safety Assessment (ISA) in part one and part two.

Requirements for safety assessment are mentioned in the superseded EN 50126-1 clause 6.2.3.4 "System definition and application conditions" paragraphs f) and p). Furthermore clause 6.6.3.5 "Design and implementation" and the clause 6.9.3.3 "System validation (including safety acceptance and commissioning)" require a summary of the safety assessment activities in the safety case. However, the superseded version of the standard does not define how and by whom the safety assessment should be performed. The guide to the application of EN 50126-1 for safety [4] in clause 9.7 has additional information about the scope, independence and competence required for safety assessment. Clause 9.7.1 describes several kinds of safety assessment activities and their content and 9.7.2 provides the concept of independence of the assessor: "a safety assessor should not belong to the same organisation as the project team, the verifier or the validator". Clause 9.7.3 introduces qualification requirements for the safety assessor.

The current version of the standard continues to develop the safety assessment objectives. The requirement to conduct safety assessment is included in clause 7.3.2.3 point n) of the current standard and is actually the same as clause 6.2.3.4 point p) in the old standard. It requires the inclusion of safety audits and safety assessment in conformance with the safety plan. The project manager is responsible for fulfilment of the standards requirements, see Table G5 point 3) which states "allocate sufficient number of competent resources in the project to carry out the essential tasks including safety activities, bearing in mind the required independence of roles".

The first part of the current version of the standard defines the purpose of the ISA (clause 6.8) and provides more details on the content of activities. The independence of the assessor is outlined in the current version in clause 7 and the responsibilities of the assessor are defined in Annex G4. Furthermore, the ISA is included in the system lifecycle of the EN 50126-1 phase 3 (clause 7.4.3 point e) and phase 10 (clause 7.11.2 point b and clause 7.11.3). Independent Safety Assessment and the role of the assessor are both critical for ensuring system safety and are more detailed in the current version.

Although the circumstances when an independent safety assessment should be carried out are not specified in the standard, paragraph 6.8.1 of the current EN 50126-1, reasons for such assessment may be requirements of the project contract, legal requirements or specific standards. However, two general conditions requiring safety assessment can be derived from the definition given in paragraph 3.33 where it is clear that such an assessment should be carried out whenever it is necessary to determine the system meets the safety requirements defined for it and whenever it is necessary to decide the system is suitable for a specific area of use from a safety point of view.

It is important to note the standard gives some freedom as to which entities that can conduct an independent safety assessment, Clause 7.3 of EN 50126-2. These entities can include component suppliers, Railway Undertakings, and Infrastructure Managers. This is acceptable if the experts conducting the assessment are independent of the project manager, belong to another organization and if there are no additional legal or contractual requirements for accreditation (e.g. accreditation in accordance with the ISO 17020 standard). If the requirements for accreditation are presented, then the independent safety assessment activities should be performed by an accredited ISA body. The way the standard is drafted means there is the potential for contradictory interpretations between paragraph 7.3 and Appendix G4 where accreditation in accordance with ISO17020 is defined. However, the author of this article believes the above interpretation is correct.

Risk

The current standard offers a risk based approach for managing RAMS activities (refer to the clause 5.8 of the first part). The purpose of the approach is to identify risks, identify relevant requirements, and apply measures to eliminate or mitigate the risks. The risk based approach applies not only to safety but also to reliability of the system. In addition, the risk of harm to the environment must be taken into account.

The risk definition given in the part 1 clause 3.34 of the superseded standard was corrected in the CLC/TR 50126-2 clause 3.1.8. The current version of the standard extends the scope of the term risk by changing the word "harm" used in the definition of risk to the word "loss". Thus, the current standard implies the use of the term applies not only to system safety for people and the environment, but also in terms of reliability for calculating the frequency of the commercial loss.

RAP and RAC

The definition of the risk acceptance principles (RAP) and the risk acceptance criteria (RAC) has been changed. Comparing content of the superseded and current versions of the standard, we can see that ALARP (As Low as Reasonably Possible), MEM (Minimum Endogenous Mortality) and GAME (Globalement Au Moins Equivalent) methods for calculating level of risk were called risk acceptance principles in the old version of the standard. The current version of the standard defines the ALARP, GAME and MEM as methods to define risk acceptance criteria (see annex A of the second part of the current standard).

As for the risk acceptance principles, in the current version of the standard they are defined as: Code of Practice, Explicit Risk Estimation and Reference System. In the earlier version risk acceptance principles were named as strategies for demonstrating safety, with particular names: safety demonstration when using technical standards as a reference, safety demonstration by complete system analysis and risk calculation and safety demonstration by using an existing system as a reference.

In the new version of the standard, the names and contents of risk acceptance principles were unified with the Common Safety Method (CSM) [6] regulation. The direct linkage of the risk assessment principles described in the CSM with the risk assessment principles described by CENELEC allowed an improved correlation of risk assessment results. For example: Assessment Body (AsBo) under CCS TSI [7] certification is allowed to use the CENELEC standards (see Annex A, Table A 3 of the CCS TSI) to assess the risks associated with components or sub-systems.

Risk assessment

The risk assessment process described in clause 5.3 of the guide to the application of EN 50126-1 for safety CLC/TR 50126-2 is better described in the current version of the standard, see clause 5 of the EN 50126-2. The boundaries and tasks inherent in the processes of: risk assessment, risk analysis and risk evaluation are more clearly described. Relationships between these terms may be easily understood from the definitions of each of them given in part one of the current standard.

The second part of the new standard in clause 5 provides an hourglass model that clearly shows the inputs and outputs of each process, as well as their relationship. Furthermore clause 8 of the second part gives detailed information about risk analysis, selection of risk acceptance principles and their application. The information provided in clauses 5 and 8 is essential for the risk management process. Systematic presentation of this information has a positive impact on the performance of the risk analysis conducted by users of the standard.

Risk model

The content set out in paragraph 5.2 and Annex D of the CLC/TR 50126-2 has been revised. The current version of the EN 50126-2 in clause 8.2.2 focuses on barriers as a means to reduce the frequency and consequences of hazards. Barriers used in the risk model to reduce the negative impact of hazards should be recorded. Another difference concerns the fact that the old version focused on the risk impact for human beings, while the current version does not mention this, implying risk can be applied not only to people but also to physical objects causing commercial loss.

Risk reduction strategy

Risk reduction was often mentioned in the previous version, but a theoretical basis describing a sequence of risk reduction processes was not provided. The current standard specifies the theoretical basis, describing steps to eliminate risks or to reduce risks to an acceptable level.

Clause 5.9 of the first part of the current standard describes an approach to minimize risks related to safety (refer to the clause 5.9.2) and to RAM (clause 5.9.3) and step by step recommendations are given to eliminate risks or decrease them to an acceptable level.

Sensitivity analysis

In the CLC/TR 50126-2, of the superseded standard paragraph 5.4.5 sets out requirements for conducting a sensitivity analysis to evaluate the results of quantitative risk calculation. If the quantitative risk assessment contains assumptions with a high degree of uncertainty, then it is suggested the application of a factor from 2 to 5 to numbers used in the assumptions. If this makes a material difference to the level of risk, then it is necessary to review the assumptions in more detail, or confirm that the existing barriers are sufficient to control the risk.

In the current standard, the concept of sensitivity analysis has been changed. If there is a large amount of uncertainty in the risk calculation, then the following methods should be used: "Worst possible scenario", "Reasonable estimates" or "Reasonable worst case", see EN 50126-2 paragraph 8.4.2.

Hazards lists

Hazard identification should be carried out systematically. The approaches described in the third phase of the RAMS lifecycle of the current and superseded standards are the same. However, the CLC/TR 50126-2 introduces the concept of hazard clusters or c-hazards. The essence of this concept is grouping hazards according to the same cause or same consequence (refer to the clause 4.4.1), which allows for a more rational analysis, as well as the distribution of hazards by key safety functions. Also, clause 5.5.2 suggests grouping hazards according to the needs of interested parties. To avoid repetition, since hazards can be grouped according to different principles, the superseded CLC/TR 50126-2 proposed unified lists for c-hazards in Appendix B2, as well as the distribution of hazards by functional principle and the principle of inherent properties in Appendix B3. These lists are given as examples and are not comprehensive, but the lists can be used for additional verification of the completeness of the list of hazards as recommended in paragraph 5.5.3 of the CLC/TR 50126-2.

The current EN 50126-1 in paragraph 7.4.2.1 recommends using structured hazard/RAM equivalents lists, but it does not provide sample lists of hazards as was done in the superseded standard. The understanding of the authors of this article is that the lists of hazards were removed to prevent erroneous use, such as taking the list as final or complete and failing to identify specific hazards inherent in each project. The idea of the new standard is to stimulate the project owners to use the hazard lists already used for similar systems or products in their project.

Such lists are available in every company that develops a new version of a product or system and usually applies part of the solutions from the previous version, or the hazards lists can be obtained from the project stakeholders. Based on the hazard lists obtained from similar products or systems, and taking into account the system definition and application environment of the newly developed product, a new hazard analysis should be conducted for the new version of the product or system. This approach of the current EN 50126 standard allows the project owner to focus on the features of the new system, without losing sight of the main hazards inherent in systems and products of a similar type; this is similar to the approach described in the international Engineering Safety Management good practice handbook [8].

Conclusion

Based on the comparative analysis of the EN 50126 standard's content that was conducted for factors influencing railway RAMS, safety assessment and risk management processes, it can be concluded that the standard has become more mature in terms of systematic presentation of the content.

Factors affecting the RAMS system parameters have been revised and extended in content. This will allow them to more comprehensively form requirements for the characteristics of the system, creating a system with greater immunity to both safety related and non safety-related failures.

More detailed information is added about the independent safety assessment.

The EN 50126 has become more unified with CSM for risk evaluationand that allows use of the standard not only for RAMS management, but also supports effective application of the standard to the TSI (Technical Specification for Interoperability) certification of projects.

The approach based on risk management is described more thoroughly, allowing more effective control of the risks that affect the safety and reliability of the system.

What do you think?

Do you think that the new version of EN50126 achieves what it is required to do? For example, do you think that the changes made, for example the renewed description of risk management or the increased relevance to the use of TSIs are appropriate and sufficient? What would you like to see in future updates? Indeed do you think that the standard is still relevant and fit for purpose?

Let us know so that we can share your views with other IRSE members via the 'Our Letters' section. Email us at **editor@irsenews.co.uk**.

References

[1] CENELEC, EN 50126-1: 2017: Railway Application – The Specification and Demonstation of Reliability, Availability, Maintainability and Safety – Part 1: Generic RAMS process, Brussels: CENELEC, 2017.

[2] CENELEC, EN 50126-2:2017 Railway Application – The Specification and Demonstation of Reliability, Availability, Maintainability and Safety – Part 2: Systems Approach to Safety, Brussels: CENELEC, 2017.

[3] CENELEC, EN 50126-1: 1999 Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) Part 1: Basic requirements and generic process, Brussels: CENELEC, 1998.

[4] CENELEC, CLC/TR 50126-2: 2007 Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) Part 2: Guide to the application of EN 50126-1 for safety, Brussels: CENELEC, 2007.

[5] CENELEC, PD CLC/TR 50126-3: 2008 Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) Part 3: Guide to the application of EN 50126-1 for rolling stock RAM, Brussels: CENELEC, 2008.

[6] European Union Agency for Railways, Commission Implementing Regulation (EU) No 402/2013 on the Common Safety Method for risk evaluation and assessment, Valenciennes: European Union Agency for Railways, 2013.

[7] European Commission, "Commission Regulation (EU) 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union," Official Journal of the European Union.

[8] Technical Programme Delivery Limited, The international Engineering Safety Management Good Practice; Volume 2; Issue 1.2, Technical Programme Delivery Ltd, 2018.

[9] European Union Agency for Railways, "ERA 1209/063 V 1.0 Clarification Note on Safe Integration," European Union Agency for Railways, Valenciennes, 2020.

Industry news

For more news visit the IRSE Knowledge Base at irse.info/news.

Main line and freight

Full Implementation of Positive Train Control in USA

USA: At the end of December 2020 the U.S. Department of Transportation's Federal Railroad Administration (FRA) announced that positive train control (PTC) technology was in operation on all 57 536 required freight and passenger railroad route miles, prior to the statutory Congress deadline of 31 December 2020. In addition, FRA had certified that each host railway's PTC system complied with the technical requirements for PTC systems. All effected railways also reported that interoperability has been achieved between each applicable host and tenant railway that operates on PTC-governed main lines.

PTC systems are designed to prevent train-to-train collisions, over-speed derailments, incursions into established work zones, and movements of trains through switches left in the wrong position. The announcement was the culmination of over a decade of sustained and direct engagement and collaboration among FRA and the 41 railways subject to the statutory mandate, including seven Class I railways, Amtrak, 28 commuter railways, and five other freight railways that host regularly scheduled intercity or commuter rail passenger service.

The FRA said the accomplishment encompassed thousands of hours of testing and deployment, innovative technological solutions, and a tremendous amount of coordination among nearly 100 host and tenant railways, railroad associations, material suppliers, and service providers.

The Rail Safety Improvement Act of 2008 (RSIA) mandated the implementation of PTC systems on Class I railways' main lines over which five million or more gross tons of annual traffic and certain hazardous materials are transported, and on any main lines over which intercity or commuter rail passenger transportation is regularly provided. RSIA and FRA's implementing regulations also require PTC systems to be interoperable, meaning that the locomotives of host and tenant railways operating on the same main line must communicate with and respond to the PTC system, including during uninterrupted movements over property boundaries.

For additional information, please visit irse.info/przm3. To view related FRA correspondence, visit irse.info/mydgx.

ATS in Artengina

Argentina: TAI (Argentinean Trains Infrastructure) has completed the installation of an Automatic Train Stop (ATS) system on the 26km line between Buenos Aires and San Miguel.

The system was supplied by Marubeni and manufactured by Nippon Signal, Japan, under a $63m (£46m, €52m) contract awarded in 2016. The system comprises of track-based device, an onboard device, and a trackside unit, which indicates whether to stop, go, or reduce speed. ATS had already been installed on the Maipú – Delta Tren de la Costa commuter line and the Roca commuter line, with work still ongoing on the Miter, Sarmiento, San Martin and Belgrano Sur lines. Belgrano Norte is scheduled for completion in the near future.

ETCS fitment for ELECTROSTAR trains

UK: Bombardier Transportation has announced it has signed a framework agreement with rolling stock company Porterbrook, to fit ETCS signalling to Bombardier ELECTROSTAR trains in the UK. Under the framework agreement, Bombardier will deliver the design work needed for the fitment of ETCS equipment, and the Bombardier EBI Cab 2000 onboard Automatic Train Protection (ATP) system, to all ELECTROSTAR fleets in the UK – the most numerous Electric Multiple Unit type currently operating on Britain's railways.

The initial agreement is worth £11.3m (€12m, $15m), to design and fit First in Class (FiC) ETCS equipment to a Porterbrook-owned Class 387 ELECTROSTAR train operated by Govia Thameslink Railway (GTR). Once the FiC unit receives regulatory approvals, all other ELECTROSTAR train owners and operators will then be able to obtain the EBI Cab 2000 for their trains under the same framework agreement.

Transport Canada amended Crossing Regulations

Canada: There are approximately 14 000 public crossings and 9000 private crossings along the 40 000km of federally owned railways in the country. The Crossing Regulations and the Crossing Standard will require railways, highway authorities and private owners of existing crossings to comply with the requirements of the Regulations by 28 November, 2021.

Over the past year, stakeholders have begun to express concerns about the approach to compliance time and their ability to meet it. Many public crossings still require improvement and they say with less than a year left to comply the deadline is at risk. There has been difficulty identifying private crossing owners, which has delayed their assessment of the work to be done and there are concerns with the costs and access to properties in the future, and say it is unlikely that all private crossings will be compliant on time.

Transport Canada has reviewed the situation and is considering a risk-based approach to making changes to the Regulations. They say this will help to address stakeholder concerns, while ensuring that the originally planned safety objectives are maintained. This is planned to change the scope of the Regulation so that crossings deemed low risk do not have to meet all requirements and the compliance time will be extended using a risk-based approach. Transport Canada proposes to extend the compliance period by one year for high-risk crossings, and three years for all other crossings. A measurable criterion will be developed for determining whether a crossing is high risk.

Egypt high-speed rail system

Egypt: Siemens Mobility and the Ministry of Transport of Egypt have signed a Memorandum of Understanding (MoU) – together with local companies Orascom Construction and The Arab Contractors (Osman Ahmed Osman & Co) – to design, install and commission Egypt's first ever high-speed rail transportation system. Siemens Mobility will also be providing maintenance services. The agreement is for a 1000km rail system network, with the first stage being a

460km high-speed line to connect the city of El-Alamein on the Mediterranean Sea to Ain Sokhna on the Red Sea, passing through the New Administrative Capital. The line will also be capable of operating freight trains to foster economic growth in the region. Siemens Mobility is to provide both high-speed and regional trains, locomotives, rail infrastructure, system integration and other services as part of the MoU.

Sleeper night train services

Europe: Four European rail companies have announced plans to revive night train services. Deutsche Bahn and main national train operators in France, Switzerland and Austria say the routes from Vienna to Paris, via Munich, and Zurich to Amsterdam, via Cologne, will be re-established starting December 2021. Further international connections from Vienna and Berlin to Brussels and Paris will be created in 2023, and a Zurich to Barcelona sleeper will begin rolling in 2024.

Night services were successively shut down due to lack of demand and cheaper and faster budget flights. However, sleeper services and train travel are now more sustainable than flying so the routes are being reintroduced. Leonore Gewessler, Austria's transport minister, said "Night trains are the future of climate-friendly mobility in Europe".

ERTMS and ATO for Stuttgart rail freight hub

Germany: The European Commission has approved a €200m (£178m, $244m) scheme to upgrade the area of Stuttgart with European Rail Traffic Management System (ERTMS) and Automatic Train Operation (ATO). The financial support in the form of direct grants to owners and operators of trains will last until 2025.

Although ERTMS and ATO are part of the development of railways in Europe, the area of Stuttgart is undergoing a specific development. The German Transport Ministry has launched a programme, which aims to transform the Stuttgart metropolitan region into a digitised rail hub. The overall investment is in the order of €500m (£445m, $609m).

The upgraded network will include a new central train station and more than 100km of route provided with ETCS train control and ATO to support full automated operations. The plan is to invest in interoperability and digitalisation so that rail freight can acquire a better position in the transport market, and impact a modal shift from road to rail and help the country and Europe reach their climate goals.

Hybrid Level 3 ETCS for India

India: Alstom has been awarded a €106m (£94m, $129m) contract from the National Capital Region Transport Corporation Ltd. (NCRTC) in India to design, supply and install the signalling, train control, platform screen doors, and telecoms systems for the 82km Delhi – Ghaziabad – Meerut Regional Rapid Transit System (RRTS) Corridor.

NCRTC is a joint venture between the government of India and States of Delhi, Haryana, Rajasthan and Uttar Pradesh. RRTS is a semi-high speed rail route and the scheme will reduce the journey time between Delhi and Meerut to 60 minutes from the current 90-100 minutes. The line speed will be up to 160km/h and the route will be the first in India to adopt ETCS hybrid Level 3 signalling system.

Metros and city railways

New fully automatic driverless GoA4 line in China

China: With the introduction of five routes exceeding 160km, China's fourth largest urban rail network is now in Chengdu; one of the three most-populous cities in Western China with a population of over 10 million. Four new metro lines and one express metro extension have taken Chengdu's network to 558 route-km, including two suburban 40km tram lines.

The new routes include Line 9 which is equipped for fully automatic driverless operation to GoA4. Line 9 orbital line loops 22.2km around the southwestern quadrant of the city centre, running from Huangtianba near Chengdu Xi main line station to Financial City East. It serves 13 stations of which 11 are interchanges to other routes, with a dedicated depot at Wuqing. The line is equipped with signalling and train control systems provided Alstom, who also provided the traction system.

CRRC Changchun, a Chinese rolling stock manufacturer, have supplied a fleet of 25 eight-car Type A trainsets for the line. Each is fitted with more than 6000 sensors, including CCTV cameras, obstacle, and derailment detectors. Line 9 connects at Financial City East with Line 6 northwest – south which opened on the same day. Running 69km from Wangcong Temple to Lanjiagou, this is believed to be the longest metro line in China to be opened at one time, serving 56 stations and has three depots.

Line 8 runs for 29.1km, linking Shilidian in the northeast with Lianhua in the southwest, serving 25 stations including 14 interchanges. Two extensions are expected to open in 2024, running northeast from Shilidian to Guilong Lu and southwest from Lianhua to Longgang. CRRC Changchun has supplied 43 140m long six-car Type A trainsets for Line 8.

Communication and radio

Private LTE/5G radio networks

USA: A new report from International Data Corporation (IDC) says worldwide sales of private LTE/5G infrastructure will grow from $945m (£691m, €776m) in 2019 to an estimated $5.7bn (£4.2bn, €4.7bn) in 2024 with a five-year compound annual growth rate (CAGR) of 43.4 per cent. This includes aggregated spending on Radio Access Network (RAN), core, and transport infrastructure.

Private LTE/5G infrastructure, which will include the Future Railway Mobile Communication System (FRMCS), is any 3GPP-based LTE and/or 5G network deployed for a specific industry that provides dedicated access. It includes networks that may utilise dedicated (licensed, unlicensed, or shared) spectrum, dedicated infrastructure, and private devices embedded with unique SIM identifiers. Private LTE/5G infrastructure carries traffic native to a specific organisation, with no shared resources in use by any third parties.

"Private LTE infrastructure is already used by select verticals worldwide to solve mission-critical networking challenges. However, the barrier to consumption has remained high, limiting adoption to organizations possessing in-house competency and access to dedicated spectrum," said Patrick Filkins, senior research analyst, IoT and Mobile Network Infrastructure. "With more spectrum being made available for enterprise uses, coinciding with the arrival of commercial 5G, interest has grown toward using private LTE/5G solutions as a basis for connectivity across a multitude of mission-critical, industrial and traditional enterprise organizations."

Many organizations are deploying private LTE today, and a select few are beginning to deploy private 5G in limited instances. While many of these verticals overlap in both use case and network needs, the market opportunity can be categorized in three segments:

Mission-critical: Verticals that require 'always on' connectivity addressable through redundancy and dedicated resource, as well as the clear need or desire for mobile site connectivity. Loss of connectivity would likely result in significant negative business or operational outcomes.

Industrial: Verticals whose primary focus is process and industrial automation for Industry 4.0. It also generally involves providing high-capacity and ultra-reliable low-latency communication (5G URLLC) either with time-sensitive networking (TSN), or as an alternative.

Traditional enterprise or "Business-Critical": These are verticals that require deterministic wireless networking beyond traditional Wi-Fi, but where redundancy and automation needs are lower. These include "business critical" applications, where loss of connectivity could result in loss of revenue.

Old trains – extremely fast wireless!

UK: A video by FirstGroup showing their Blu Wireless 2.5Gbps train connectivity trial on the Isle of Wight can be seen at **irse.info/nu03b**.

This took place at the end of 2020 using the 82-year-old Class 483 trains on the Island Line. The Class 483s have travelled more than 3 million miles, but have now been retired – with one going to the Isle of Wight Steam Railway and another unit to the London Traction Transport Group for use on the Epping Ongar Railway. The 1938 trains were first used on the London Underground network before transferring to the Isle of Wight in 1989.

Before retirement, the trains trialled the First Group mmWave 5G beamforming technology. This is capable of delivering 2.5Gbps for passenger and train connectivity. The trial took place on a ten-mile (16km) stretch of Island Line with the trains equipped with antennas on the front and rear roof sections. Masts were located every 400m to 2km depending on the topology of the track, to deliver 'line of sight' beamforming to the train. The line side base stations were connected by a single fibre cable and only required 40W of power. Blu Wireless say in future the base stations will be self-powered.

Research & Development and Universities

First transmission of 1 Petabit/s using single-core optical fibre

World: The National Institute of Information and Communications Technology (NICT, Japan), NOKIA Bell Labs (Bell Labs, USA) and Prysimian Group (Prysimian, France) have succeeded in the world's first fibre transmission exceeding 1 Petabit per second in a single-core multi-mode optical fibre. 1 Petabit per second = 1000 Terabits per second = 1 Million Gigabits per second. See **irse.info/2514w**.

The study demonstrated the possibility of combining highly spectral efficient wideband optical transmission with a current industry standard 0.125mm optical fibre and a coating diameter of 0.245mm, guiding 15 fibre modes. This was enabled by mode multiplexers and an optical fibre supporting wideband transmission of more than 80nm over a distance of 23km. The study highlights the large potential of single-core multi-mode fibres for high-capacity transmission using fibre manufacturing processes similar to those used in the production of standard multi-mode fibres.

Compared to multi-core optical fibres, multi-mode fibres can support a higher spatial-signal-density and are easier to manufacture. However, using multi-mode fibres for high-capacity space-division multiplexed transmission requires the use of computationally intensive digital signal processing. The study increased the current record transmission in a multi-mode fibre by a factor of 2.5.

French and UK wireless track monitoring

France: SNCF Réseau and UK technology company Senceive, who provide wireless structural and geotechnical monitoring solutions, have agreed a R&D contract to evaluate the technology on French railways. If it proves suitable for robust rail infrastructure inspection, SNCF say the technology could be rolled out across their network. The trail will mainly focus on Senceive's triaxial tilt sensors, a technology that could measure and control the condition of unloaded tracks (as distinct from dynamic measurement during the passage of a train).

Senceive say their rapid and continuous measurement sensors (sampling every second if necessary), could make track monitoring more reliable and be particularly useful when a risk of ground movement or structural disturbance has been identified. In the long-term, the wireless solution could facilitate more efficient track maintenance interventions. It is estimated that with one measurement per half hour, with little maintenance/calibration required, a battery durability in the order of 15 years may be possible. The result of the trial is expected in December and SNCF Réseau say if successful could lead to national deployment.

Safety and approval

Learning from Ladbroke Grove

UK: The Ladbroke Grove rail crash (also known as the Paddington rail crash) was a rail accident which occurred on 5 October 1999 at Ladbroke Grove in London, United Kingdom. With 31 people killed and 417 injured, it remains one of the worst rail accidents in 20th-century British history and was caused by a Signal Passed At Danger (SPAD). Dr Greg Morse is the Rail Safety and Standards Board (RSSB) lead operational feedback specialist and he extracts and shares learning from a variety of sources, rail and non-rail, GB and non-GB. He is also RSSB's single point of contact with Rail Accident Investigation Branch (RAIB), using this position to try to shape investigation reports for the good of learning and the good of the industry.

A video presentation by Greg looking at the causes of the SPAD at Ladbroke Grove can be found at **irse.info/cwm9l**. Greg looks at driver training, signal sighting, the management of change and the failure to learn from previous incidents. In doing so, he points to the need to learn from the past when we consider the future, and promotes in particular the value of getting into the detail of previous accident reports.

Government, regulators and standards

"Only with the railways will we achieve our climate goals"

Germany: Angela Merkel has been chancellor since 22 November 2005 and she plans to leave office after the German parliamentary election in 2021. She has recently given her thoughts on the rail industry.

"For many people, day-to-day life would be very difficult to manage without the railways. They wouldn't be able to get to work or school as they are accustomed to, or see friends and relatives. But the railways are more than that. In normal times, when we are not in the midst of a pandemic, the railways can also satisfy our longing to travel – something we are all really missing at the moment."

"The railways also have a special role to play in helping us to achieve our climate protection goals. We want more people to shift from cars and planes to the railways, and we want to transport greater volumes of goods by rail. To do that, we need a modern railway network and an improved service offering. We (in Germany) are investing 86 billion euro in maintaining and modernising the railway network over the next ten years. The German Rail Masterplan lays the foundations for a timetable coordinated throughout Germany, more freight on the railways, innovation and digitalisation, as well as better noise and climate protection. And that doesn't stop at the border. With the expansion of the trans-European networks, we want to make the railways attractive for everyone in Europe."

"It is very important for our society that trains run and that goods transport flows – the coronavirus pandemic has served as a reminder of that. Railway personnel are doing tremendous work for the common good in these times, and my gratitude goes to all those involved. The railways get people to work safely and keep the necessary supply chains going. Rail transport is and remains the backbone of sustainable mobility and logistics. It is essential in achieving our climate goals."

"Shorter travel times and rapid expansion of the railway network are important to encourage more passengers to shift from planes to trains. There is still room for improvement in terms of digitalisation because signalling and communications technology is currently lagging far behind the technical capabilities. According to the railways' calculations, around 20 per cent more traffic could be handled on the network by deploying digital solutions more efficiently. This would also help to improve punctuality".

The interview is available in full in DB MOBIL's anniversary edition and can be found at **irse.info/dx1p4**.

Blueprint for levelling up the UK with transport investment

UK: The New Green Age; A Step Change in Transport Decarbonisation by Alstom, calls for a £10bn (£11bn, $14bn) investment programme in UK rail and mass transit systems, after research revealed that the UK is lagging behind in comparable infrastructure. France has over double the number of mass transit systems (light rail, trams and underground trains) as the UK, while Germany has four times as many.

Alstom say investing in mass transit schemes would help boost many regions of the UK which are struggling with the pandemic, and which the government have promised to 'level up'. Leeds is the largest city in Europe not to have a mass transit system, while other areas like Tees Valley, Hull, Doncaster, Leicester, Bristol and South Wales, are all identified as places which require investment.

As well as the economic benefits, the report reveals the true scale of the environmental advancements that such schemes bring, including tackling carbon emissions, cleaning air, and supporting modal shift. Transport is the most carbon emitting sector in the UK and to support green transport options the report also calls for rolling out fleets of clean, zero emission hydrogen trains to replace polluting diesels. 300-400 hydrogen trains could be launched with a like for like replacement of diesels and would deliver huge environmental benefits. As well as investment in hydrogen, the report calls to speed up electrification projects as well as existing initiatives such as Northern Powerhouse Rail and Midlands Engine Rail. These will all serve the multiple purposes of benefiting the economy, jobs, commuters, and the environment.

Emerging technologies shaping the future of communications

UK: Telecoms regulator Ofcom has published a report that takes a look at some of the emerging technologies that could shape the future. See **irse.info/z8vqr**.

Ofcom carried out interviews and invited technology experts from around the world to contribute to their report and to provide an insight into a range of new technologies for the future.

The 96-page report highlights potential future developments such as:

- Innovative technologies that will help providers to roll out better mobile and broadband services by using automation and robots.
- Satellite technology that can be used to provide connections for hard-to-reach areas.
- Developments in the broadcast sector, such as enhanced, bespoke coverage of sporting events that could provide custom crowd noise, dedicated commentaries, and user selectable camera angles.
- New immersive technologies to bring a sensory element to communications services, enabling people to 'touch' – and even smell – while they interact at a distance.
- Immersive virtual environment technology (VET) for education. While on average, a regular student can remember 30 per cent of what they hear and 20 per cent of what they see, statistics indicate that students remember 90 per cent if taught using VET.

Regulator proposes new guidance for level crossing safety

UK: The Office of Rail and Road (ORR) has proposed simpler and more accessible guidance on level crossing safety in Britain to support the industry, traffic authorities and local authorities in their decisions about level crossing safety. The draft proposals in the new principles for managing level crossing safety are designed to improve risk assessments at level crossings and provide practical advice on how to identify and manage risks that affect the safety of people who use them.

The proposal moves away from the current, more prescriptive document and aims to give industry greater confidence in putting forward innovative designs to reduce risks. It focuses on the need to consider how level crossings are actually used and encourages a whole system approach by considering the user, railway, and highway.

The principles also emphasise the importance of collaboration to remove and manage risks and explains how cost benefit analysis can be used in decision making to allow for consideration of all relevant costs and benefits. Consultation on the new principles closed at the end of February with formal publication planned for the end of April. For more information on the new guidance see **irse.info/5c4dm**.

Companies and products

Programmable Logic Controller based level crossing

UK: SELLA CONTROLS and Amey Rail Signalling & Systems are undertaking a trial of a safety PLC controller-based level crossing. They have been developing a Commercial Off The Shelf (COTS) safety PLC based level crossing solution for over four years, based on a range of safety PLCs. They say using standard industry safety PLCs in level crossings and railway signalling is a logical step and has been done by railway administrations in other countries.

The main advantages are significant cost reductions and increased system performance. Use of safety PLCs simplifies the design and testing. PLCs have significant design tools to simplify the design process and further reduce costs, and the function block logic used in PLCs is easily suited and understood by signalling engineers.

Amey Rail and SELLA CONTROLS have produced the Generic Application Safety Case (GASC) for the introduction of a safety PLC into the UK and the Specific Application Safety Case (SASC) for application to Network Rail level crossing work.

The purpose of the trial site is to gain Network Rail Product Acceptance which will then allow the PLC control system to be used by Network Rail and tier one contractors to renew relay-based level crossing systems.

News from the IRSE

Blane Judd, Chief Executive

IRSE subscriptions renewal

We will shortly be getting in touch with all members to invite you to renew your IRSE subscription. Please check that all your contact details are correct online **irse.info/details** (requires login) or by contacting the team directly (see below).

Accurate email, postal address and telephone contact details are essential for us to deliver the best service possible to you and all our members.

Now is also the time to tell us about any changes to your circumstances or subscription preferences. If you wish to change to / from an e-member (receiving IRSE News via e-bulletins only) then please change this online or contact us. If you have retired recently then please contact us to discuss whether you are eligible for a concessionary subscription rate.

Annual General Meeting

In another 'first' for the Institution, because of Covid 19 social distancing restrictions and by order of the Council, the AGM this year will be held online starting at 1730 UTC, adhering to strict procedures as advised by our lawyers.

The meeting will be chaired by IRSE president Dr Daniel Woodland and included in the business to be conducted is a special resolution "To adopt the recommended changes to the IRSE Memorandum and Articles of Association." All members are welcome to 'attend' but only corporate members (Honorary Fellows, Fellows, Members and Associate Members) are eligible to vote.

Our incoming president for 2021-22, Eur Ing Ian Bridges (professional head of signalling & engineering director, Balfour Beatty) will be inaugurated, and his address will be available to watch online during the live AGM or later via the IRSE website. To attend please register online at **irse.info/2021agm**.

Council elections

Thank you to all members who took the time to return your ballot form in this year's elections to make it another excellent year for the number of votes received by post and online. Results will be announced at the annual general meeting.

Signalling striders

Members of the London office team at the Institution of Railway Signal Engineers are taking on a 'virtual' walking challenge to raise funds for the Neurology Department at Charing Cross Hospital. This is in support of Hilary Cohen, a long-standing member of our team, who some of you may know. Hilary suffered a serious stroke in November last year.

Hilary is making good progress in her recovery thanks to the world class treatment and outstanding care she received at Charing Cross. Her journey has inspired her colleagues to raise funds for this highly specialist national/regional Unit which brings cutting-edge research to the bedside. All funds raised will be used across the Neurology Department.

We hope to raise £1000 by walking 1000 miles as a group, using the World Walking website and app. We have chosen to walk along the 'Wonders of the UK' route and will be taking the opportunity to check out UK railway stations and landmarks and check in with IRSE local sections as we pass by. We will be following Covid 19 guidelines and each of us will count our daily steps and add them to the cumulative total.

We will be saying a virtual "hello" to section representatives as we virtually pass their area. Look out for your invite to give the team a virtual wave as we make our progress. We would also like to collect messages of support for Hilary as we pace the length and breadth of the UK.

If you would like to support our efforts by sponsoring our walk and leaving a message you can do so through our JustGiving online page **irse.info/h6zm1**.

British Railways Telecommunications Engineers

In 2010, Ken Burrage, the last director of signal & telecommunications engineering before British Rail (BR) was privatised in 1995 and a former chief executive of the Institution, produced a booklet entitled Chief Signal and Telecommunications Engineers of the BR era. It was published by the IRSE in 2010 and revised, updated and re-published in 2019.

The booklet researched all the senior S&T engineers over the period 1948 to 1994 who had held the title chief signal & telecommunications engineer either at BR HQ or the BR regions and covered the various regional re-organisations including the phases to dismember BR under the Railway Privatisation programme in the 1990s.

Clive Kessell, who was the last holder of the post assistant director (telecoms) of BR (effectively heading up the telecom discipline at BR HQ), has now written as similar booklet "British Railways Telecommunications Engineers from 1948 until privatisation in 1994". This can now be downloaded from the IRSE website at **irse.info/yza75** along with the original signalling version.

Minor Railways Section

Minor Railways S&T Technician of the Year returns for 2021

The IRSE Minor Railways Section was set up over ten years ago with one of its main aims to encourage the transfer of knowledge to those working in signalling and telecoms for the various minor railways, but who might not be professional signal and telecoms engineers. These aims include the purchase, preservation, restoration, installation, maintenance and operation of signalling and telecommunication and associated equipment, installations and buildings.

To further the aims, the Minor Railways Section undertakes technical visits, technical seminars, and technical training workshops to support and further the aims of the IRSE within the minor railway and heritage S&T community.

Dominic Beglin, second from left, receiving the award in 2011, Dominic is now Chair of the Minor Railways Section. Also shown, left to right, are Mike Tyrrell, Charles Hudson, John Francis and Dave Helliwell. *Photo Ian J Allison.*

The section provides for a transfer of knowledge in the format of technical guidance notes on S&T subjects and a range of training workshops and through an award scheme for all those working in the S&T sections of minor railways, either as volunteers or paid staff. The guidance notes are freely available on the section's pages of the IRSE web site at irse.info/mrs.

The award for the sections Minor Railways S&T Technician of the Year, recognises the role of the S&T engineer and is open to candidates nominated by any of their peers, to receive the award and the trophy for the year. This year's award will be a cheque for £250, a place on one of the sections training workshops together with a small sum to help with subsistence, membership of the IRSE in an appropriate grade for one year, and of course a small miniature trophy and certificate to hang on the wall.

But to identify our candidate we need nominations, it is simple to do, it can be for an individual or a team, it can be the boss or the new recruit and anyone on the minor railwaycan nominate, not just S&T people. There is a form with all the points described that you can fill in. Anyone over 16 years of age working in S&T on a minor railway can be nominated and we are now accepting nominations for the minor railways S&T staff members. All the necessity information can be found on the Minor Railways section of the IRSE website at irse.info/0xp2o.

The award will be presented at the Minor Railways Section's seminar in November and nominations will close in the middle of September.

Quotes from past winners

Geoff Harris, winner 2015

"I was Initially shocked and then proud to be mentioned as to what I/we have done. I certainly felt that I had achieved recognition for the work I'd done and that of my colleagues, but also to put the 'telecoms' part on view.

"I still would like to pass my skills on, I feel that it's worth doing as we see so much waste because the culture of "buy a new one", or "it can't be repaired" when using often simple techniques, you can fix quite a few failures. Working through a failure keeps the brain active, teaches you to fault with knowledge and logic together (and occasionally illogic).

"I was pleased, proud and putting the "telecoms" up in lights, I still feel that the Minor Railways Section is worthwhile and people on both sides have a lot to give and equally learn from our peers. I still love it and am still proud to been able to mix and be part of that organisation".

Rolland Johnson, winner 2017

"I am not sure what I think about my friends and colleagues who nominated me, if you asked me before winning it I would have thought it was some kind of wind up as all I have ever done, is my job to the best of my ability and lent a hand here and there when people have asked for the specialist knowledge I have.

"I have always been more than happy to help others out and pass on my knowledge to others as they grapple with their signalling and locking conundrums. I feel delighted to have been considered for the award, overwhelmed by winning it and humbled that there are those in my peer group (who are all pretty handy themselves with S&T matters) that think I deserve it. Thanks to all of you".

Professional development

Results of the 2020 exam

We are pleased to announce the results of the 2020 IRSE Professional Exam modules and to congratulate all those listed, especially those who have now achieved the IRSE Professional Exam and the Advanced Diploma in Railway Control Engineering.

As previously mentioned within IRSE News, 2020 was the first year that candidates could sit the Certificate in Railway Control Engineering Fundamentals (Module A) and the last year they could sit up to four modules from the numbered module exam structure. All modules were sat remotely for the first time in the history of the IRSE Professional Examination. At present, arrangements have not been made for Signalling the Layout (Module 2) to be taken online.

Thank you to all those who have supported candidates through their studies by organising study groups, acting as sponsors, and running the exam forum. Thanks also to the examiners for the considerable amount time involved with setting and marking the papers. Without your time the IRSE Professional Exam would not be the success it is.

The successful candidates for each module are identified in the tables below. In each case 'P' indicates a pass, 'C' a credit and 'D' shows that the candidate passed with distinction.

The exam review was held on 9 February and the videos of this can be seen at irse.info/oxp03.

Certificate in Railway Control Engineering Fundamentals and Advanced Diploma in Railway Control Engineering results

The table below details the candidates who have not only successfully passed the Certificate in Railway Control Engineering Fundamentals (Module A) but who have now completed their exam journey, having previously passed a combination of three numbered modules (see irse.info/exam). These candidates have therefore achieved the Advanced Diploma in Railway Control Engineering, the new name for the IRSE Professional Examination. Jehad Mahmoud and Matthew Slade had previously passed the IRSE Professional Examination before taking this module.

Name	MA
Emily Bramble	P
Robert Gunn	P
Tsz Yin Law	C
Andrew Laz	C

Name	MA
Jehad Mahmoud	C
Matthew Pylyp	C
Matthew Slade	D
David Snelling	P

Name	MA
Kwok On Wong	C
Feng Zhang	P

The table below details those who have successfully passed the Certificate in Railway Control Engineering Fundamentals (Module A), a stand-alone qualification and the start of the new Advanced Diploma in Railway Control Engineering journey.

Name	MA
Shalini Aithal	P
Osama Ali	P
Mozahir Anwar	P
Divya Aramalla	P
Daniel Barton	C
Robert Baxter	P
Muhammad Komail Bin Akram	P
Daniel Bowen	P
Peter Briton	P
Michael Brouder	P
Ewan Burns	P
Scott Cao	P
John Chaddock	D
Ching Yin Chan	P
Cho Yee Cheung	P
Tsz Hei Cheung	C
Ka Kwan Chu	P
William Clark	C
Martin Cooper	C
Agnes Darazsi	C
István Darázsi	C
Chetan Devikar	P

Name	MA
Malcolm Dobell	C
Neal Dodge	C
Philip Dubery	C
Veera Duggirala	P
Richard Fisher	P
Dominic Fleming	P
Gareth Fussell	P
David Gardner	P
Emily Glover	C
Stephen Goodwin	C
Russell Grinham	P
Paul Gueneau	C
Harry Hammond	C
Stephen Hatton	C
Hongyang He	C
Anthony Hewitt	P
Ming Hsia	P
Dani Indrianto	P
Joe Inniss	P
Mukul Jetmalani	C
Christopher Johnson	C
Rhiannon Jones	P

Name	MA
Manroshan Singh Jusbir Singh	P
Akash Reddy Kankanala	C
Gaurav Kaushik	C
Jonathan Kelly	P
Timothy Kelman	C
Atif Khan	P
Yiu Nam Kwok	P
Yung Ho Lam	P
Chun Yeung Law	P
Tsz Ki Lee	P
Man Cheng Lei	P
Joseph Little	P
Hiu Tung Lo	C
Virun Lokavirun	P
Stuart Maddock	C
Oliver Marshall	D
Gregory Martin	P
Diatta Mbaye	P
Ian McNerlin	P
Paul McSharry	P
Israel Mendez Tovar	P
Paul Morris	D

Name	MA
Stanley Mudyawabikwa	C
Ashley Murray	C
Mehmet Narin	P
Paul Naylor	C
Siamak Nazari	C
Alfred Ng	P
Daniel Oakes	P
Henry Pang	P
Stuart Park	P
Toby Parker	P
Karthik Raja	P
Simon Read	C
Aneurin Redman-White	D

Name	MA
David Roebuck	P
Nicholas Rook	C
Ian Ross	P
Daniel Scourfield	P
Davelia Sihombing	P
Shashi Singh	P
Trevor Stevens	P
Mark Styles	P
Arvind Kumar	P
Vangelis Tsiapalas	P
Tajamal Tuffail	C
Ayberk Ustaoglu	P
Ben Vallely	P

Name	MA
Tanay Verma	P
Vikrant Vishal	C
Robert Watson	C
Robert Wheeler	P
Bill Raymond Wilkinson	P
Hiu Tung Wong	C
Man Lok (Wilson) Wong	C
James Wood	C
John Woods	P
Richard Wright	C
Li Xie	P
Rui Zou	C

Results for the IRSE Professional Exam and passes in numbered modules

Candidates in the table below have successfully passed the IRSE Professional Exam by being successful in Safety of Railway Signalling and Communications (Module 1) and three other modules from the numbered module exam structure available up to and including October 2020. We would particularly like to congratulate Ewan Campbell, Kin Sum Lee and Hey Man Joshua Ma for not only passing the examination, but also successfully passing five modules. Colin Hamilton-Williams had previously passed the exam but has also now passed five modules, and Aaron Sawyer who had also passed the exam previously, has now been successful in six modules.

Name	M1	M3	M4	M5	M6	M7
Martin Allen	C			P		
Ewan Campbell		P		P		
Clare Crooks		P				
Colin Hamilton-Williams			P			
Kauser Ismailjee	D					P
Elliott Jordan	P			P		
Peter Kelly						P
Michael Kingston		P				P
Praveen Kumar				P		
Ching Yin Lau	P					C

Name	M1	M3	M4	M5	M6	M7
Kin Sum Lee		P		P		
Hey Man Joshua Ma	C			P		P
Aaron McConville		P				
Rory Mitchell		P				
Michael Murphy		P				
Gabor Nemeth	P	C				P
Aaron Sawyer			P		P	
Phuoc Tran						P
Susannah Walker						P
Jordan Wallis	C					P

The table below shows those who have successfully passed modules in 2020 but have not yet achieved sufficient passes to complete the exam. Candidates will be able to continue their exam journey by passing a combination of new modules, see **irse.info/exam**.

Name	M1	M3	M4	M5	M6	M7
Kevin Banks		P				
Paven Bhatti	P					
Arjun Chauhan	P					
Chong Lam Cheong			P		P	P
James Darlington				P		
Shane Dowling		P				
Thomas Franklin	P					
Sean Gorman		P				
Alex Grant	P					
Kieron Hadlington	D					
Oliver Hains	P					
Jordan Harris		C				
Ho Ka Man	P					
Harshvardhan Kodam						P
Dabi Laniyan						P

Name	M1	M3	M4	M5	M6	M7
Ka Seng Lio		P				
Samuel Loveless						P
Sam Mitchell		P				
Aisling O'Connor		P				
Antonis Phasouliotis						P
Andrew Plumb		P				
Hiu Chun (Jack) Pun		P				
Suhanya Saenthan	C					
Chou Tek Sam Ti			C			C
Ming-Tak Shum	P					
James Stanley	D					
Natcha Sujaritworakun	P					
Mark Williamson						P
Hai Tao Wu				P		

The next opportunity to sit the Certificate in Railway Control Engineering Fundamentals and modules for the Advanced Diploma in Railway Control Engineering will be Saturday 2 October 2021, for further details see **irse.info/irseexam**. The IRSE Younger Members are organising study workshops, so keep an eye on **irse.info/events** for further details.

Your letters

To blockade or not to blockade

Clive Kessell's letter in the February edition of IRSE News has prompted me to write agreeing with his sentiments regarding total shutdowns of railway corridors.

This has been occurring in Melbourne, Australia since privatisation of the previously government owned and run railway system and the outsourcing of the majority of its labour force.

When the Victorian Railways completely reworked the inner metropolitan system to accommodate the Melbourne Underground Rail Loop, the works were all carried out by in-house labour, accustomed to working in a 'railway' environment with generally only weekend shutdowns.

Yes, the staging was complicated and required a considerable amount of cross-discipline planning, but it worked!

We even managed the replacement of more than one interlocking, each over a weekend. (After last service Friday and before first on Monday morning.)

The other 'difficulty' which has occurred with the outsourcing of technical staff, is the reduction in the breadth of railway operational knowledge of the current technical staff, not just engineers, but also technicians and other non-professional staff and the loss of 'corporate memory'.

In light of all the above, it is all too easy for project managers to just shut the service and hire a fleet of road coaches and add the cost of the bus hire to the cost of the project, ignoring the 'hidden' cost of alienation of the travelling public.

Richard Bell, Australia

Learning from another railway

The article from Karl Davis in December's IRSE News, particularly in relation to the (UK) signal engineers' seeming predilection for approach control of signal aspects, does resonate with me. I have long had concerns about this practice and its increasing complexity over the years, which, unfortunately, will clearly be with us for many years to come until phased out by one form of cab signalling or another. I fully agree with Karl that approach control sets traps for train drivers – as was revealed at Colwich and – to some extent – at Ladbroke Grove, as well as eroding network capacity, by making trains progress more slowly through block sections than the maximum speed those block sections are designed for, and certainly at a lesser speed than a driver might wish to adopt given his route knowledge about the state of the line ahead, and the type and capability of the train being driven.

I think the practice of approach control as has been practised in the UK has detracted from the safety benefits that have otherwise accrued from the replacement of mechanical signalling by colour light signalling, due to the apparent difficulties in conveying adequate information to train drivers as to the route set ahead as a train approaches a facing diverging junction. Only generally providing that route information explicitly at the last stop signal approaching the facing points (and under some rules which stop signal can be up to 880 yards from the junction facing points) is not exactly, in my view, effective communication of the state of the line ahead. It seems to me that approach control has been used as a form of "patch" applied to cover a gap in which the UK colour light signalling system has long been deficient, and never properly addressed at a system level. I fear this situation may also have been compounded (as Karl suggests) by the various types of approach control having been developed in (what used to be) smoke-filled rooms full of signal engineers, with perhaps not so much consideration for the impact on the end user, i.e., the train driver, or on the capacity of the railway, of which we are now aware (painfully.)

Near where I live in the south west suburbs of London, there is a triangular junction between two different railway routes, the main route along the base of the triangle and the other route joining at the tip of the triangle being subject to 60mph speed restrictions, and the divergences along each side of the triangle being subject to 20mph speed restrictions (due to the curvature). Each of the two routes, the main route and one side of the triangle are used regularly by both passenger trains and freight trains, and the third side of the triangle is used by passenger trains only. When semaphore signalled, there was a signal box at each point of the triangle, each route on the approach to the triangle having "splitting distant" as well as "splitting homes" (despite the 60mph/20mph difference in speed at each junction) so that it was clear to a train driver which way the route was set at the junction ahead at braking distance from the junction. In consequence a train driver was able to select the appropriate speed to approach the junction, depending on the type and braking capabilities of his train, without further "interference" from the signalling system. The driver was also in a position to bring his train to stand before the junction if he became aware from the distant signal the signalman had selected the wrong route for his train. When this arrangement was replaced with 4- aspect colour light signalling in the 1970s, the junction colour light "home" signals were subject to "approach release from red," meaning that as the train approached the junction there was no equivalent exact confirmation of the route to be taken equivalent to the "splitting distant" that used to exist with mechanical signalling until the junction "home" signal cleared "in the driver's face." This arrangement means that a train using one of the 20mph divergences has to creep up to the junction signal under the prevailing train operating company's defensive driving policies (not that the existence of defensive train driving policies was initially much known about in the signal engineering fraternity either) with the consequent impact on line capacity, although at least the installation of TPWS has assisted with a train driver anticipating the usual clearance of a junction signal from red, on the odd occasion when it doesn't.

The basis of UK railway signalling since the middle of the 19th century can be summarised as "how far you can go" plus "where you are going", and does not explicitly convey any speed requirements at all to a train driver. System safety on the approach to junctions has traditionally – to a greater or lesser extent – depended on being a function of factors such as the driver's route knowledge, the capability of the train's braking system, the integrity and quality of the information given to the driver by the lineside signalling system – including the drivers comprehension of the signalling information- and the quality of the adhesion between the train's wheels and the rails. As is clearly indicated in Karl's article, the only element of system safety that the signal engineer should get involved in is the means of conveying information to the train driver – although interestingly having provided information on how the signalling operates to the operators, in the UK the signal engineer has rarely, if ever, formally been directly involved in the actual interpretation and dissemination of information on signalling system functionality to train drivers (although we are well aware of many informal communication lines between signal engineers and train drivers!).

I remember being responsible for the development of the signalling arrangements at Saltwood Junction (between Ashford and Folkestone – where the "Continental Main Line" towards Eurotunnel diverges from the Charring Cross to Dover Route) as part of the HS1 Channel Tunnel Works- where it was necessary to make sure there were sufficient safeguards in place for the four available routes at that junction to make sure a Eurostar Train towards Paris or Brussels didn't head off towards Dover, or a humble Electric Multiple Unit from Charing Cross to Margate via Sandwich didn't have an unintended excursion towards Paris or Brussels (!) It was also necessary to manage a further situation that applied where Class 92 electrically hauled Freight Trains for the Continent had to coast for a length of the reception siding in Dollands Moor Yard just after Saltwood Junction without power applied due to the transition between 3rd Rail and 25kV power in Dollands Moor Yard. Following considerable debate with the operators concerned, the (then) Railtrack professional head of signalling and RSSB, the solution developed was a pair of "four way" preliminary routing indicators (PRI) overlaid over the four-aspect signalling on the approach to Saltwood junction combined with a Main Aspect Approach Release from Yellow on Saltwood Junction "home" signal. The PRI application was a development of that at Southall on the Great Western Main Line for the approach to Airport Junction. The PRIs are positioned just ahead of the double yellow and single yellow aspects on the approach to the junction signal at Saltwood Junction – so that the driver could see them soon after the aspect – but was not distracted by them from reading the aspect. Provided that the junction signal at Saltwood junction was "off" and junction indicator alight (except for the route to the Down Main), the preliminary routing indicator would show an arrow corresponding to Junction Indicator Position 3 (Dollands Moor Yard), Junction Indicator Position 2 (Through Passenger Line), Vertical (Down Main), Junction Indicator Position 4 (Folkestone Central). If the junction "home" signal was on or the junction indicator is not proved alight, the PRIs are blank. The train driver therefore has sufficient information about the route ahead to be able to manage the train appropriately without "interference" from the signalling system. I believe this installation to have met its objectives (although there was a dispute between signal engineers about the suitability of the installation even during commissioning!) and was accepted by train drivers of at least three different nationalities – and other installations of preliminary routing indicators have been made elsewhere since, although I would accept PRIs can be a somewhat expensive addition to the signalling system when capital costs are considered, so possibly need to be applied sparingly. However, when life-cycle costs are considered, particularly making better use of line capacity by enabling train drivers to use their trains' capabilities better, they may well be more cost effective than might appear at first sight.

With Junction Signalling in the UK with approach control, "we are where we are", and with the advent of cab signalling, we could be in sight (excuse the pun!) of not needing it – however if the transition from colour-light signalling to cab signalling is as long as the transition from mechanical to colour light signalling (which hasn't been completed yet!) it might be a good idea to have another think about it- and open the door to "end users" when we do it!

Ian Harman, UK

CBTC interoperability

With regards to the article on CBTC interoperability, IRSE News issue 268 July – August 2020 Dr Frank Heibel. The international working group of IEC for IEC 62290 believes the article contains errors and inaccuracies in the analysis of the CBTC market and related standards. The article does not accurately reflect our working group and standard series, which we would like to correct.

CBTC is only considered in the article through the perspective of interoperability, which for urban networks is not the core priority. Interoperability underpins an operations principle. If this principle is not applied for the daily operations of a line or network (or not possible due to the topology of the network), then CBTC system interoperability is not the main expected outcome. What is expected by urban network operators is an exceptionally reliable system, providing extremely high performance in terms of RAMS (all the more for GOA4 systems), achievable minimum headways, and procurement competition. This being achieved with a reduction of purely proprietary solutions through standardisation initiatives and the approaches applied (for example) in New York and Paris.

The IEC is not a European but an international standards organisation, acting at worldwide level, covering all topics related to electrotechnology, except those related to telecoms which are covered by ITU (International Telecom Union) and topics such as mechanics and services. The development of the IEC 62290 series of standards has been done by WG40 of TC9 with experts representing many countries all around the world (15 countries being represented in WG40). Part 1 was published initially in 2006, and revised in 2014. Part 2 was released in 2011, and then maintained in 2014. Part 3 was published in September 2019.

Currently an update of the full series is in progress and is expected to be completed in 2022, as the standardisation work is based on consensus and it takes time to meet the needs of different stakeholders.

A division between "established CBTC suppliers" and Chinese suppliers is suggested in the article, whereas the CBTC market is an open one, already involving many manufacturers. This market and these actors are constantly evolving, especially with merging/acquisition of companies (the last one having occurred recently with Alstom and Bombardier, and previously Hitachi and Ansaldo STS). No doubt this will continue in the future, with suppliers from China, or some new international players from some other parts of the world or industry.

The main drivers for CBTC are the market and requirements such as high level of performance, availability, safety, innovative functionalities, and lifecycle costs. It has to be noted that operating a network through interoperability principles has to be assessed on all aspects, including economic ones, as interoperability generates additional costs for development, commissioning, and certification of related products.

MTA in New York has promoted interoperability involving three suppliers, which was related to work done by the IEEE . For the RATP Paris network a set of interchangeability documents (three interchangeable subsystems: onboard, wayside and data communication system) has been developed with the involvement of three different suppliers. This corresponds to the CBTC generic program called OCTYS (GOA2), with the 1st revenue service in 2010 (line 3), and which is now deployed on several lines (line 5, 9, and in progress on lines 6 and 11).

Stéphane Dubois,
convenor of IEC/TC9/WG40 experts

Past lives: Brian Hesketh

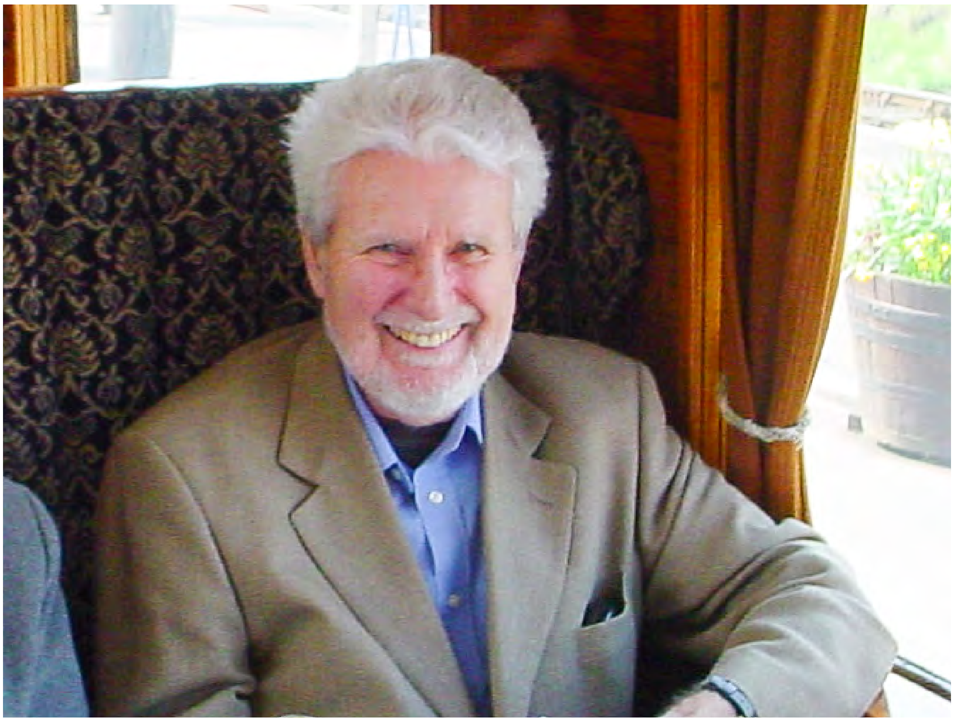
Brian Hesketh was born 5 March 1932. He was educated at Crewe Grammar School and joined the British Railways signalling engineers department Crewe in August 1948 as an engineering apprentice. He quickly became a thoroughly professional, competent signal engineer and in all aspects of railway signalling engineering. Many good engineers specialise in one area of signal engineering, but Brian is remembered as being good at everything!

The engineering apprentices were then paid weekly, not monthly like engineers, and received no paid holidays or pension. The starting rate was 10 shillings (50p) a week at 16 years of age, rising in increments to £1 at twenty.

The 1950s and 60s was a time of railway modernisation, and Brian was involved with signalling design and testing of signalling on the West Coast Main Line (WCML). Not only did Brian become an exceptional signalling designer, but he also mastered the roles of logistics, planning, contract management and finance. He became assistant chief draughtsman Manchester, chief draughtsman Crewe, signal engineer works Crewe, and assistant divisional signalling and telecoms engineer Crewe.

He joined the IRSE as a Student Member in 1953, and was elected as a Technician Engineer 1960, Associate Member April 1970, and a Fellow October 1987. Brian is also remembered for mentoring, encouraging, and developing many young engineers, and was always looking for opportunities to achieve the potential he saw in them.

In the 1970s Brian instigated and implemented many minor schemes, especially along the Trent Valley section of the West Coast Line, by abolishing signal boxes and extending the control areas of those remaining, with the ultimate aim of creating small Power Signal Boxes (PSBs). This was all within the local divisional budget and by working closely with all other local departments he created and drove a united strategy from which all would benefit.



Brian Hesketh, FIRSE. 1932-2021.

In 1977 he delivered an IRSE paper in London called "The lifeline of control, communications and power – cable routes". The paper is as relevant today as when it was produced 44 years ago. Brian explained "the increasing complexity and importance of the vital link provided in modern communications and data control schemes by the cable network, and the integrity and value of these cables, is only as good as the protection provided by the cable route. In addition to signalling controls and telephone conversations, data is transmitted in connection with finance, stores control, traffic movements and pay. The engineering operative who severs the lineside cable with his excavator may be severing the data used in the calculation of his personal pay for the ensuing week."

Brian was instrumental in leading innovative and complex projects, such as the major remodelling and resignalling of Crewe in 1985. This was achieved in just seven weeks. Similar projects today can take months to implement. All the extensive track layout and signalling was removed and replaced. Plug couplers were used to enable clamp lock tail cables to be prepared and tested, and quickly installed in the relatively short blockade. Today, the use of plug-coupled cables is common.

In December 1985 he moved to Birmingham and was promoted to become responsible for all signalling new works activity on the London Midland Region. In May 1989 he was appointed as British Rail HQ signal engineer (projects) in charge of all signalling projects for the whole of BR, a role which he performed with considerable success and distinction. Creative schemes such as the IECC at York, Marylebone and Newcastle were commissioned during this time, and he created a new signalling project office in Birmingham, and a new major works depot at Swanley, specifically to undertake work for the Channel Tunnel project.

His final task after his retirement in 1991 was to undertake a review and inspection of all the major signalling installations on the whole of BR and to produce a report on their condition and likely timescale for renewal. This was a major study carried out with meticulous care and attention to detail, which came to be known as the 'Hesketh Report'. This was a valuable source of information on the signalling asset condition before Railtrack was created and the railway privatised in 1994.

He also came back to Birmingham to help teach the next generation of signal engineers. Many working today still value the considerable knowledge and experience that he passed on.

Outside of the rail industry in his youth he was a keen motor cyclist and took part in competitive hill climbs. Brian was also an excellent mechanical engineer and produced many engineering models of locomotives and road vehicles, which included a 3 1/2" track gauge model of the steam locomotive "Llywelyn" from the Vale of Rheidol Railway. This was created with no drawings available. He also built and sailed, with his brother-in-law and other railway enthusiasts, a superb Ferro-Cement Ketch yacht with twin masts. Cars were another favourite; a fan of the Lotus 7, he built several Westfields and Caterhams.

Many in the industry remember Brian as a loyal, supportive colleague and they are extremely grateful for all he contributed to the industry. He passed away on 10 February after a long illness and his funeral took place on 22 February.

With thanks to: Barrie Ashmore, Ken Burrage, Alan Fleet, Brian Hassall, Alan Joslyn, Ron Richards, Mike Simpson, and Mike Stubbs.

Quick links

IRSE
Institution of Railway Signal Engineers

The IRSE Knowledge Base, an invaluable source of information about our industry.

Our sections, IRSE activities taking place near you.

Our examination, the ultimate railway signalling, communication and control qualification.

Licensing, our unique scheme to help you demonstrate your competence.

Use your mobile phone in camera mode to read the QR codes above and go straight to information relevant to you.

IRSE News is published monthly by the Institution of Railway Signal Engineers (IRSE).

Website

For latest information about IRSE events, news and how to become a member, visit our website at www.irse.org. We welcome all those who are interested or involved in the fields of railway control systems, communications, data management or systems engineering.

Contributions

Articles of a newsworthy or technical nature are always welcome for IRSE News. Members should forward their contributions to one of the editors listed.

If you have a view about something you've read in IRSE News, or any aspect of railway signalling, telecommunications or related disciplines, please write to the editor at editor@irsenews.co.uk.

Chief Executive, IRSE

Blane Judd e-mail: blane.judd@irse.org

Managing Editor, IRSE News

Paul Darlington e-mail: editor@irsenews.co.uk

Contributing Editors

David Fenner e-mail: david.fenner@irsenews.co.uk

Ian Mitchell e-mail: ian.mitchell@irsenews.co.uk

Ed Rollings e-mail: ed.rollings@irsenews.co.uk

Assistant Editors

Harry Ostrofsky (Africa)
e-mail: thehzos@icon.co.za

David Thurston (N America)
e-mail: thurston@temple.edu

Mukul Verma (Asia)
e-mail: mrverma@gmail.com

Allan Neilson (Australasia)
e-mail: allanecneilson@gmail.com

Alexander Patton (Local Sections)
e-mail: alexander.patton@siemens.com

David Stratton

Production, typeset and layout

Mark Glover
e-mail: mark.glover@irsenews.co.uk

Printed by Herald Graphics, Reading, UK
www.heraldgraphics.co.uk

Planting trees to catch carbon
9444263
Printed on Carbon Captured paper

IRSE
Institution of Railway Signal Engineers

London Office

IRSE, 4th Floor, 1 Birdcage Walk, Westminster, London, SW1H 9JJ, United Kingdom

Enquiries – Membership or of a general nature

Tel: +44 (0)20 7808 1180
Fax: +44 (0)20 7808 1196 e-mail: hq@irse.org

Licensing

Tel: +44 (0)20 7808 1191 e-mail: licensing@irse.org