RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

FASTTRACK

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INSIDE THIS ISSUE – WHAT IS SHAPING THE RAIL INDUSTRY TODAY AND INTO THE FUTURE

Bringing Induction Welding to Australia

Induction Welder on Track (Source: Mirage Ltd)

Rail welding is one of the most fundamental practices in the construction and maintenance of rail infrastructure.

In Australia most rails are welded using either Aluminothermic (AT) or Flashbutt welding, however in the UK the process of induction welding has been under investigation with Network Rail recently acquiring its first Induction welder from Mirage Ltd.

Induction welding has several potential advantages over the current conventional methods used in Australia including:

- a short welding process of less than six minutes
- a smaller welding head than typical flashbutt configurations, allowing ease of welding around turnouts
- weld hardness closer to that of parent rail when compared to flashbutt welds
- weld strength in excess of 1330kN
- a clean and linear weld surface
- less susceptibility to bond line defects than flashbutt welding.

Further to above, as the weld process applies heat to the rail side without contact it can be undertaken on a rail that has not been cut, unlike both AT and flashbutt welds. The induction welding process has an approximate consumption of ~20mm (mirage are also developing a higher consumption welding head).

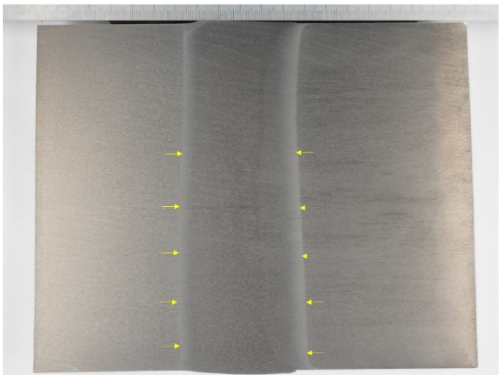
This could potentially be used over the top of an in-situ transverse rail defect, removing the defect without having to cut the rail or install a closure. Currently the removal of such a defect required a section of rail to be removed and replaced with a closure rail and two new welds, requiring 2-3 hours of track time.

The use of induction welding could reduce this time significantly with no time required for cutting, removal, replacement and alignment of rail. Based on the promising potential of this welding processs, ARTC engaged Monash IRT in 2020 to review two induction test welds completed using standard carbon 54kg European rail (R260 54E1).

The rails were tested to the Australian welding standard and these tests found that induction welding was considered suitable for further trial.

Key findings included:

- the microstructure of the weld complied with standard, however there was no apparent bond line in the weld
- while the heat affected zone width exceeded the allowable limit for a flashbutt weld, this may not be appropriate metric for an induction weld
- hardness was within the requirements of the standard
- tensile strength exceeded parent rail and residual stress were low compared to typical flashbutt welds.



Macro of 54E1 Rail (Source: Monash IRT)

Following the initial examination ARTC has supplied several strings of AS60 standard carbon rail to Mirages Ltd to prove the induction welding process with Australian rail. This work will result in several strings of AS60 rail with centrally located induction welds being supplied back to ARTC. The Australasian Centre for Rail Innovation (ACRI)has been engaged with a research task backed by industry to undertake a detailed review of the induction welds supplied by ARTC.

ACRI has engaged the service of both Monash IRT and the University of Wollongong to undertake laboratory testing to qualify these welds against the Australian standard (http://www.acri.net.au/hh09b-rail-welding /).

Following successful results from the testing ARTC has plans to install these rails into track to monitor their performance in field. Currently the rails are scheduled to arrive in Australia in September 2021.

Why can’t rail workers follow rules?

Source: Network Rail

Safeworking rule breaches are continuing to increase in the Australian rail industry, according to the 2018-2019 ONRSR Rail Safety Report.

In the period between 2015/16 and 2018/19 they increased from around 12 to around 15 safeworking breaches per thousand kilometers.

So why can’t our workers follow the rules? The answer is a complex one that organisations, managers, safety professionals and academics continue to wrestle with.

Even as far back as the early 1980s, research was finding more complex rule sets could actually increase the safety risk within an organization (see *Normal Accidents: Living with High-Risk Technologies* by Yale sociologist Charles Perrow for one such example).

Keryn Pauley is a Human Factors expert, specialising in the rail industry. She believes the key to reducing these breaches is to have more principles based, simpler rule sets and to reduce reliance on administrative controls.

“In the rail industry, our workers are given no autonomy in decision making or control of their work environment,” Keryn said.

“We expect them to follow the rules, but we have created hugely complex rule sets that rely heavily on the ability for workers to remember these rules and how they are to be applied to each slightly different scenario,”

“In other industries such as health and aviation rules are approached more like guidelines with the workers being given more flexibility, as professionals, to manage situations as they arise”.

Peter Lassen has been writing safeworking rules for the rail industry for more than ten years and says while rules will always have a place in the industry we need to do more to improve how they are developed.

“A lot of work needs to be done in harmonising a core set of rules like they do overseas,” Peter said.

“We need to train workers to understand the safeworking and signalling principles and support this with simplified rule sets and specific procedures,”

“I think it would also be a good initiative for the industry to develop a national competency skillset and competency based training for current rule authors and people interested in learning and developing these skills.”

DC Bus-tie Arrangements for Improved Traction System Performance at Junction Substations

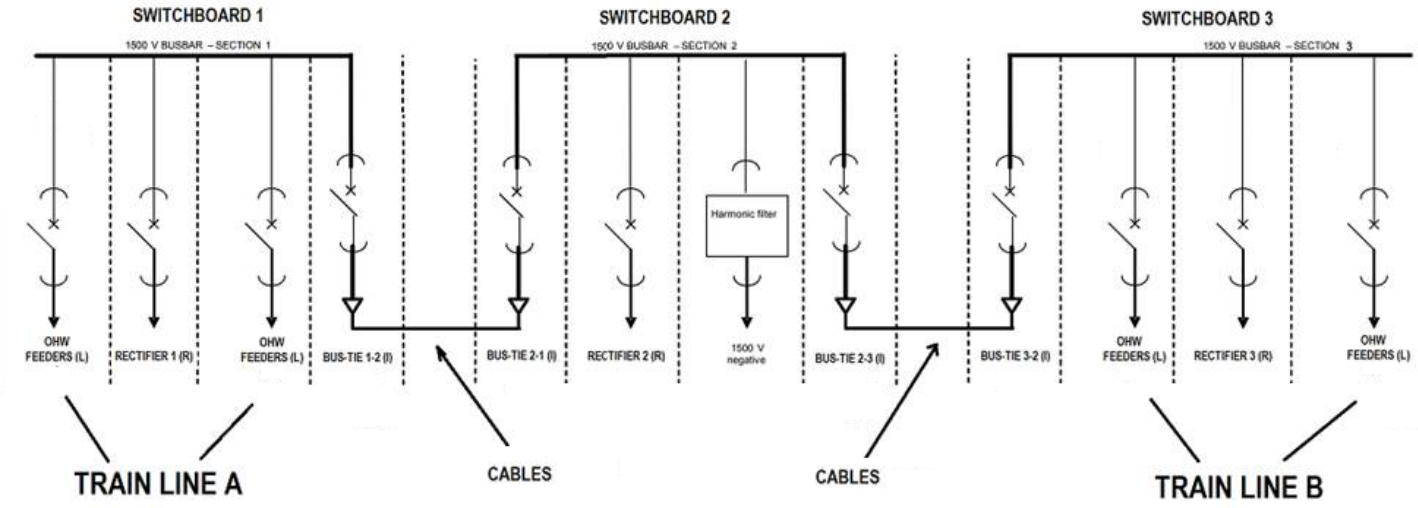


Figure 1 – Multiple switchboard arrangement concept for supply to a rail junction

Rail junctions are critical locations in the rail network where two or more rail routes converge, diverge or cross. These locations are critical from the perspective of traction supply as a failure of the traction equipment at these locations may cause train delays on multiple train lines simultaneously with the result being a negative impact to customers, business, the community and organisational reputation.

Traditional direct-current (DC) switchboards utilise open busbars with shelf-type or truck mounted type DC circuit breakers which extinguish the arc by stretching and directing the arc upwards into the open air above the DC switchboard. Newer technology uses metal-clad switchboards which extinguish the DC arc within an enclosure contained within the switchboard cubicle (these boards are similar in appearance to an HV AC switchboard).

The standard arrangement for traction substation designs is to have a single DC busbar energised at the nominal voltage of the traction system (600V DC, 750V DC, 1200V DC, 1500V DC or 3000V DC). Inherent to the DC busbar arrangement is a risk of a busbar fault and resulting loss of supply to the traction system. The outage may be short-lived if the fault is cleared without causing damage. However, if damage is sustained to the busbar system, the time to repair may be a significant period. Generally speaking, switchboard and busbar faults have a relatively long mean time to repair (MTTR) in the order of days to weeks. If a single busbar system is used at a junction substation, the impact of the resulting loss of supply is experienced by customers on multiple train lines for an extended period of time.

A further consideration is maintenance of the DC switchboard and busbar system. Maintenance on DC busbar systems can usually only be performed during periods when trains are not running, such as, during closedowns and track possessions. In the case of a junction substation, a shutdown of multiple train lines is required in order to carry out any required maintenance work.

To reduce the risk of a single-point failure of the DC busbar impacting multiple train lines and to improve maintenance access and maintainability, a multi-section DC busbar arrangement can be used. A multi-section DC busbar is comprised of separate DC switchboards connected to each other via bus-tie cables (or other method such as bus duct). This arrangement has the effect of separating the DC busbar into multiple sections, such that failure of any one section can be separated from the other sections by opening the bus-tie circuit breakers. Furthermore, the frame leakage protection can be separated into zones, to enable clearing of a frame fault for the busbar connected to one train line without affecting the other train lines.

These arrangements are now possible through newer DC circuit breakers which overcome some of the issues associated with bi-directional DC fault interruption. Furthermore, metal-clad switchgear arrangements are more compact and thus require less substation floor space in which to implement such an arrangement compared to the traditional open busbar arrangement.

In terms of maintainability, the bus-tie switching arrangement enables maintenance to be carried out on an individual switchboard during shutdown of the train line to which its feeders connect. This is a huge advantage to maintainers as it allows for appropriate access windows to be planned for essential maintenance to be carried out.

UV light to kill COVID-19 on public transport

Source: MTA New York City Transit

Cleaning and disinfecting of public transport systems is a labour and cost intensive process that includes scheduled cleaning at end of line maintenance facilities as well as ongoing cleaning throughout the duration of scheduled services where possible. An example of some of the costs of regular cleaning and disinfecting was brought to light when, in June 2020, the Victorian government announced a $500million Working for Victoria initiative in which 300 workers were hired to sanitise trams between 7am and 6pm seven days a week on carriages, in depots and at high-patronage stops across the network.

Cleaning of public transport systems before the outbreak of coronavirus involved a general clean of windows and most touch points within the vehicle using ammonia-based chemicals and soap solutions done mainly at end of line maintenance facilities. Cleaning and disinfection since the beginning of the pandemic has been intensified through more regular and more intensive practices. Such practices include the manual disinfection of the entire vehicle by hand, followed by workers wearing protective clothing and masks spraying disinfectants throughout these vehicles.

New York's Metropolitan Transportation Authority (MTA) announced in May 2020 that it would be looking into opportunities for the use of Ultraviolet (UV) light as an alternative method to kill the coronavirus in their public transportation systems. The technology is based on the use of UVC light, rather than traditional disinfectant sprays currently used at end of line maintenance facilities.

UV light is classified by the different wavelengths of each type. There are three different UV rays: UVA and UVB which most people are familiar with, as well as UVC. Some key aspects of each are summarised below:

- UVA rays have the longest wavelength but lowest energy levels. They are not absorbed by the ozone layer and make up approximately 95% of the UV rays that reach the earth. These rays tend to penetrate the skin and affect cells deeper in the skin causing ageing and some skin cancers.
- UVB rays have a shorter wavelength than UVA but higher energy levels. They are partially absorbed by the ozone layer and make up approximately 5% of the UV rays that reach the earth. Overexposure to these rays causes sunburn and most skin cancers.
- UVC rays have the shortest wavelength and highest energy levels. They can cause serious harm to all life forms but are luckily fully absorbed by the ozone layer and as such never reach the ground.

UVC radiation is a known disinfectant for air, water, and nonporous surfaces and has many germicidal applications. UVC radiation is used in the sanitisation of air, water, laboratory equipment and operating theatres. Conventional UVC lamps have one major drawback in that they are harmful to all life forms and as a result are generally only used in unoccupied spaces. However, some of the latest research into the use of UVC light has uncovered the benefits of UVC light with an even shorter wavelength, known as "far UVC light". Far UVC light cannot penetrate the outer layers of the skin and eyes and could thus be used in the presence of life forms whilst maintaining the germicidal properties of UVC light.

New York's MTA has continued testing the use of UVC light disinfectants in subway cars at end of line maintenance facilities and have since been exploring opportunities for use of the safer "far UVC light" as a way to continuously disinfect subway cars whilst in operation. It has, however, been noted that the installation and operation of far UVC light disinfectant technologies into an old subway system such as the New York subway has formidable logistical challenges.

The Moscow Metro and the Shanghai public transport firm Yanggao are some of the other public transportation systems in the world that have been experimenting with germ-killing ultraviolet light with promising results. Further applications in other passenger transport services of note include trials by a Swiss start-up, Uveya, for the use of UV light robots as well as a UV wand being developed by engineers at Boeing, both to destroy germs on the inside of airplanes.

Although the use of this technology in public transport systems is in the early stages of development and likely capital intensive at first, UVC light could prove to be an effective tool for safer, less labour-intensive sanitisation. Initially this technology shows promise for application at end of line maintenance facilities where vehicles are cleaned without passengers but through ongoing research and development, this technology could find applications for use as an onboard, continuous public transport sanitisation tool used to disinfect vehicles while passengers are onboard.

Wayside Systems in Proactive Maintenance

Source: Aurizon

Wayside systems have become an integral part of safely running an efficient railway. These systems were initially reactive, detecting urgent safety critical faults just prior to failure. As the technologies improved they became a key part of predictive rollingstock maintenance that increases reliability while also reducing inspection and maintenance costs. Continuous increase in sophistication have now made these systems a useful part of a proactive maintenance strategy that look to eliminate defects altogether.

Wayside systems vary wildly in the underlying technology however they all share the ability to monitor the condition of rollingstock for defects during the asset's normal operation. The following are a few examples of wayside systems currently used:

- Wheel Impact Load Detectors that can detect wheel tread defects via rail-mounted strain gages
- Hot Wheel/Bearing Detectors that can detect defective bearings or sliding wheels via infrared temperatures sensors
- Acoustic Bearing Detectors that can detect defective bearings via microphone arrays
- Wheel Profile Monitor's that can monitor the wheel condition via laser profilers
- Machine vision fault detectors that detect a range of faults via wayside cameras and machine vision algorithms

A number of these waysides systems act as a safety net to detect safety critical faults preventing catastrophic failure. In addition to detecting critical faults, they can also monitor the condition of assets allowing for early failure predictions that can be repaired without significant impact to operations. These systems form part of reactive and predictive maintenance strategies and rely on examining assets to detect faults.

A proactive maintenance strategy if often more effective as it focuses on removing the defects altogether by eliminating the root causes. As these wayside systems become more advanced and capture a wider range of information on the asset, they become a useful tool in understanding the root causes of failures.

Wayside data provides several benefits in these types of investigations that is not possible or difficult using other methods. Their ability to monitor all assets continuously allow for a historical review of a single asset's condition. This is valuable to help understand the root cause of a defect when establishing the timeline of events that led up to the failure. The sheer volume of data collected also helps to remove the need for manual data collection and provides insights into the population trends that may be a factor in the root cause.

It may be difficult to quantify the benefits new wayside technologies will have on proactive maintenance as they may not be obvious when the system is introduced. However, it is clear that they will add value in this space and these benefits should be factored in when considering investments in new wayside systems.

Use of Passive SCADA signalling System at Level Crossings

Rail systems are complex networks with its infrastructure consisting of different discipline systems ranging from rolling stock, signalling, traction power, overhead wiring, and communication systems. Each of these systems must operate reliably and simultaneously. If a fault occurs in any of the different areas, e.g., a trip in the traction substations, defective track, or loss of communication systems - the entire network is affected.

A small fault in the critical infrastructure can lead to service interruptions and in worst case scenario accidents. Such faults result in delays which affect the service operations, which in turn can impact KPIs of an operator resulting in fines. A good solution is the use of Supervisory Control And Data Acquisition (SCADA) systems, which allows remote monitoring in real time, control different remote devices that provide field visibility and operational condition. Another major benefit includes recording field data for fault investigations and simulations. As such, a SCADA system in railways is a critical component of any maintenance and operations setup.

The introduction of a SCADA system to an existing network is itself a complex process, where the commissioning process is meticulous and involves rigorous function testing. Hence SCADA is commonly introduced as part of major upgrades with significant cost attached to it. SCADA is a very useful tool which can be used in several ways.

So how do you introduce such a useful system into an existing network at low cost yet retain most of the benefits?

A smart solution is to start small by

a) Use of SCADA at critical locations, e.g., in our case level crossings, and

b) Use monitoring function of SCADA and forego the control functions, (passive SCADA).

This still gives the operator the ability to get field data in real time and despatch maintenance teams to investigate and resolve the issue. Existing field devices such as PLC's in the track circuits can be integrated into a SCADA system, by configuring their outputs to broadcast data to a connected communication device.

Traditionally SCADA is preferred over optical fibre cable as it provides a dedicated line and is less susceptible to interruptions. However, to gather telemetry(monitoring) data such a luxury is not required, and the use of 4G/5G wireless routers is employed with an added layer of security by using Statice IP routing. These 4G/5G routers are connected to the field devices and configured to report data to the server router device.

The field devices data is routed wirelessly to the main router connected to the SCADA server. At the server end, the SCADA software is setup to only receive the data from the network and display on the configured network map (i.e., showing level crossings only). This setup includes viewing the configured network faults and operational conditions of the field devices.

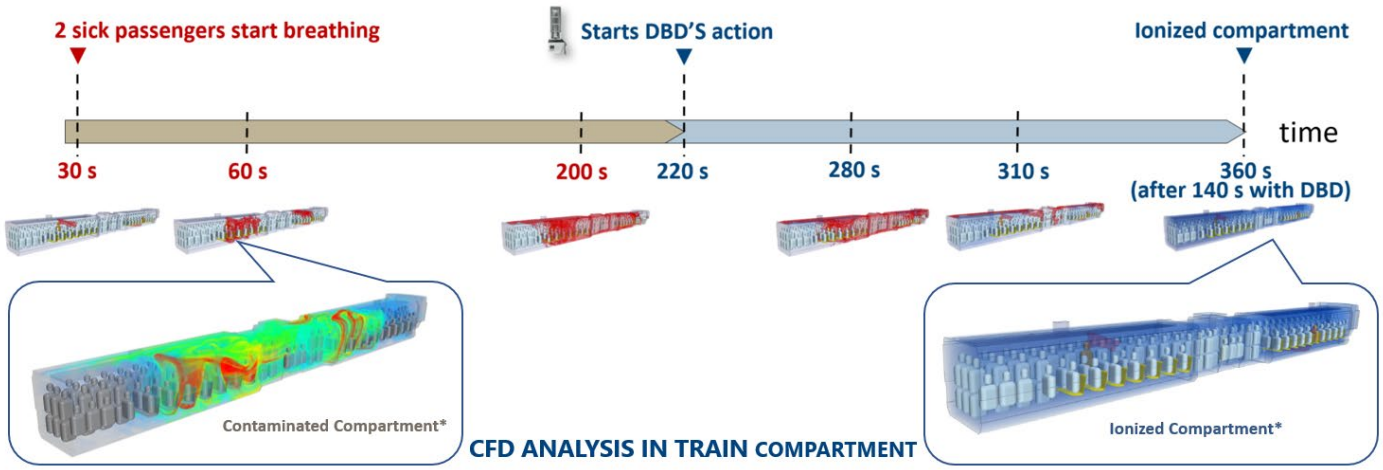
Although this passive SCADA setup limits the control of field devices, yet, it is very useful tool to monitor the network condition, record data of fault conditions which can be used to simulate fault conditions. This SCADA monitoring data map is also useful for use in operations control centre where a network fault can be visually confirmed and reported to maintenance technicians.

The overall cost of the passive SCADA system includes 4G/5G routers setup, SCADA server setup for monitoring. The savings include the cost/use of dedicated fibre links, full license of SCADA with control options, new field devices, and potential staff competency training required for control functions.

This method of small-scale monitoring can be expanded to other areas if the field devices have the ability to communicate via a PLC and so on.

SCADA is a powerful tool, and its use is not limited to its full functions, it can also be changed or reduced in our case to match the network requirements.

Sanitise Inside the Railcar with Ionised Air

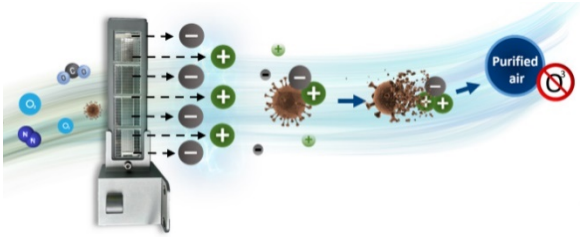


CFD ANALYSIS IN TRAIN COMPARTMENT

Highest risk of COVID transmission is within enclosed spaces, with large numbers of people, which public transport has both. In railcars air needs to travel past other passengers to recirculate via the air conditioning system. Even with an effective filtration inside the air conditioning system, transmission between passengers is highly possible. While, on the other hand, it is a labour and cost intensive process to remove surface-borne contaminants by cleaning and sanitising inside the railcars.

KB Merak innovated an air ionizer technology called Merak Dielectric Barrier Discharge (MDBD) which is effective on both airborne and surface-borne contaminants continuously during HVAC operating. It has been lab tested effectively kills MS2 virus (MS2 virus is widely considered a valid indicator of effectiveness against COVID-19). This constitutes a turning point for passengers' safety in the railway sector.

The MDBD device ionises air as it passes and generates a large number of + and - ions, which get further distributed into the vehicle air duct and passenger compartment by the supply airflow. These ions attack molecules of various compounds (viruses, bacteria, mould, VOCs etc.) breaking them down and reducing to harmless products (primarily CO2 and H2O).



The MDBD is a small device with low power consumption that can be integrated in HVAC units and/or car ducts. It is applicability to new HVAC system as well can be planted into and upgrade existing HVAC systems.

Size, Weight	205mm x 87mm x 65mm 450 g
Power Supply	24 VDC
Power Consumption	< 5 Watts per MDBD device
Operation Temperature	-25°C to +80°C
Storage Temperature	-40°C to +80°C

Air ionizer is the preferred method among possible air purifier types, it comes with the smallest downsides and have the biggest benefits at the same time. The only concern regarding air ionizers is the emission level of ions is not high enough; while the only downside is that most air ionizers produce ozone, which is a lung irritant. Therefore, tests have been carried out to verify ions generation level and side products of MDBD operating.

In December 2020, KB Merak performed "On-Car" measurement checks for the MDBD technology fitted on the two HVAC units located on a single Motor Car. The results exceeded the target levels, as average Total Ionization Levels above the Target of > 10,000 Ion Count/cm^3 total (based on available literature, biological test lab result and estimate from consultant to achieve 99.9% sanitization levels). Ozone level measured very low (<0.02 ppm), well below the health safety threshold of < 0.1 ppm (Source: EPA & WorkSafe Australia recommendations)

In February 2021, KB Merak carried out extensive measurement checks on a 3-Car Train fully fitted with the MDBD devices. Metro Trains Melbourne (MTM) has supported this test with test train set (705M-2603T-706M) at the Newport Rail Depot. Tests re-confirmed the performance of MDBD technology in achieving the Total Ionization and Ozone Level target on the full 3-Car Train and showed good repeatability in terms of Ion Count distribution along the cars, similar to the December 2020 single car results.

BioSafety, as an independent lab, attended and carried out a set of tests at Newport Rail Depot studied a range airborne chemical hazards included Ozone, Formaldehyde, CO, CO2, TVOCs and $PM_{2.5}$. Their report concludes, 'no evidence of Ozone or Formaldehyde production, in the presence of operational ion count levels. Within experimental limits, there was no elevation of common airborne hazards observed in the carriages with the MDBD operational.'

So far, the MDBD device has been verified for railway compliance, eg. Shock & Vibration Test, Electro Magnetic Compatibility (EMC) Test, and etc. Next step is testing with real passengers before go live with a revenue service trials leading to deployment.

Thanks for reading

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