

2018

Track Report

A world of knowledge

PANDROL

Partners in excellence

1/

Working together

Pandrol solutions for Bangkok MRT	4/5
Supporting Indian Railway's drive for increased capacity	6

2/

Safety first

A global network of welding knowledge	8/10
Ask the expert: Welding training in the Asia Pacific region	11
Theft-Resistant fastening system enhances security on the railways	12/13
Ask the expert: Emissions free maintenance	14

3/

Focus: Urban transit

Underpinning unprecedented urban growth	16/17
Barcelona Metro	18/19
Sydney Light Rail	20/21
Klang Valley Mass Rapid Transit	22/23
Santiago Metro	24/26

4/

Maximising uptime

Problem solving that changes what's possible: High Speed	28/31
Pandrol partnership saves contractor 30% on installation time	32/33
Evolution of the Re System	34/37
Ask the expert: Should rigid catenary be used on open tracks?	38

5/

Creating lifetime value

Fastclip FE System adds value in Scandinavia	40/43
Three new technical centres of excellence	44/45
Pandrol Connect: Driving greater weld traceability across the rail sector	46/47

1

Working together

“ At Pandrol we believe in creating long-term relationships with customers through our commitment to excellence across the business. Our strength is in the power of our collaboration and teamwork across our global network to deliver projects that meet and exceed expectations. ”

Fabrice Seewald
Executive Committee Member, Pandrol

Pandrol solutions for Bangkok MRT

Back in 1992, the Thai Government approved the establishment of a state enterprise for the creation of the Mass Rapid Transit Authority (MRTA) in Bangkok and its surrounding areas. The need for mass rapid transit was essential to enable the rapidly growing population to move quickly and easily around the region.

Pandrol supplied fastening solutions for the Purple and Green Line South, which were completed in 2016 and 2017 respectively.

Purple Line
23 km from Tao Poon – Khlong Bang Phai

Green Line South
12.6 km from Bearing to Samutprakarn.

Both lines were delivered with Pandrol's Double Resilient System (DRS), and additionally, Pandrol supplied Aluminothermic welding and the Pandrol QTrack® embedded rail system for the depot areas. The company also designed and supplied a complete composite conductor rail system for the electrification of these lines and this system is being developed for Green Line North.



Tao Poon City



3rd rail on Green Line



Louis Vandamme /
General Manager Sales
(Asia-Pacific) for Pandrol

“Our DRS assembly was the ideal solution for Mass Rapid Transit Authority because of its high performance and vibration reduction properties. DRS has benefits for the contractor, in terms of ease and speed of installation, as well as for the track operator, due to its durability and long term performance. It is widely used in major developing cities such as Hong Kong, Kuala Lumpur, Singapore and Dubai.

These were major projects in terms of volumes, with Purple Line involving 184,000 rail seats, Green Line South using 97,000 rail seats, and the upcoming Green Line North project requiring Pandrol to supply 140,000 rail seats, giving a total of 421,000 rail seats over the three projects.

Pandrol's DRS system was also recently specified for the northern extension of the Green Line elevated railway. This is operated by Bangkok Skytrain system and involves

approximately 19 km of track in a densely populated area close to Bangkok. Green Line North, which is due for completion in 2019, will carry axle loads of up to 17.5 tonnes.

→ INSTALLATION

For Green Line North, Pandrol introduced a new construction method which allowed the contractor to concrete up to the baseplate in one possession, dramatically improving construction productivity, by reducing installation time.

The Pandrol DRS system features a Pandrol e-Clip baseplate, mounted on a studded natural rubber pad that provides resilience. This can be tuned, within limits, to suit specific axle loads and stiffness requirements. The system is suitable for all rail inclinations and rail types and is optimised for top-down methods of construction, or bottom-up methods with alternative anchorage. DRS reduces the transmission of low frequency noise and vibration due to its low stiffness.

→ SOLUTION

Pandrol's DRS provides the advantages of an indirect rail fastening system, distributing the vertical deflections between the rail pad/clips and the baseplate pad/compression springs and separating the functions of the anchorage and rail fastening.

To cater for the interaction between the rail and the track structure, low toe load and/or zero longitudinal restraint (ZLR) fastening options are available.

The coil springs and baseplate pad absorb most of the vertical deflections and also play a part in countering the effects of end rotation where simply supported beams form part of the viaduct structure.

Vertical and lateral adjustment is provided for construction/maintenance requirements. Vertical adjustment typically up to 20 mm and lateral adjustment through lockable eccentric bushes (± 3 mm per rail and ± 2 mm by differential side post insulators) total ± 5 mm per rail.

Pandrol's DRS system is popular with contractors as it enables quick and simple installation. The system is installed on cast in-situ concrete plinths. The assembled baseplates are hung from the rail and the concrete can then be installed straight up to the bottom surface of the baseplate, in one operation. Special construction boltholders supplied to the contractor by Pandrol allow the anchor bolts to be very accurately installed. This enabled very rapid preparation and construction time for the installation contractor.

Pandrol has been supplying resilient fastening systems for non-ballasted tracks for more than 40 years, from the early Shinkansen tracks in Japan to the more recent South Korean and Chinese high-speed systems.

The Pandrol DRS assembly is well suited to high speed applications installed on pre-cast blocks, sleepers or slab. Pandrol has provided both technical product support and training for contractors on the installation of the DRS system. The MRTA projects are a great example of collaborative working to achieve the best possible solution for the customer. Pandrol DRS has also been specified for the Orange Line East, for which construction has not yet started.

→ ELECTRIFICATION



Frédéric Petrus /
Pandrol
Electrification
Manager

Pandrol built on experience and track expertise to provide full support for the development of an electrification package to suit the specific track infrastructure. A 3rd rail conductor solution using unique co-extrusion technology was chosen as this offers longevity and high performance for MRTA. As the project has challenging environmental conditions and is large in scale, Pandrol's Co-extruded technology was selected for its safety characteristics and reliability.

The use of 3rd rail has a number of benefits, including:

- greater expected lifespan than an overhead contact wire due to its rigidity
- eradicates the impact of electromagnetic interference on electrical components
- reduces maintenance costs because power supply equipment is virtually maintenance-free with only regular inspections and cleaning required
- high reliability and safety - with Pandrol's 3rd rail there is no need to control the thickness of the stainless steel.

All Pandrol's products are designed specifically for the railways and its technical engineers have extensive experience in 3rd rail. On this project, Pandrol designed, manufactured and supplied the 3rd rail, providing a detailed layout for approval by the customer. By working with Pandrol, customers can be assured that all track interfaces are managed and considered by an expert team. In addition, Pandrol provided theoretical classroom-based training for contractors, as well as practical training on site.

This project is a typical example of different divisions within the Pandrol business working together to deliver the very best solution to the customer. It demonstrates the company's commitment to innovation in design, manufacture and technical support to ensure the project is implemented to the highest standard.



“These fastening systems were specified as they offer durability and reliability for the project owner and a quicker and more efficient construction method for the contractor.

Dean Whitmore / Market Manager -
Pandrol Singapore

Supporting Indian Railway's drive for increased capacity

Pandrol is collaborating with Indian Railway's design team RDSO, to develop an aluminothermic welding solution for the specialised Cr-V alloyed High Strength rail which has been developed at Bhilai Steel Plant in India to increase capacity on India's rail network.



According to UN estimates, India will become the most populous country in the world in just 14 years' time, when it will have approx. 1.45 billion inhabitants. This rapid population growth has led to a rise in traffic and freight movement in the Railway which is creating robust demand for additional Rail Infrastructure. Projects such as those proposed by Dedicated Freight Corridor Corporation, the Ahmedabad to Mumbai high speed lines, the doubling and tripling of existing lines, and a host of new metro and light rail projects are all actively gearing up.

The advanced rails are designed to modernise and increase capacity on India's Railway Network, by allowing the track to cope with increased speed and heavier axle loads, and they have specific requirements for the aluminothermic welding process used during rail installation and maintenance.

The Pandrol team has been working closely with Indian Railway to develop a suitable aluminothermic welding process to suit the high strength, 110 Kg/mm2 UTS, rail.

→ A FOCUSED TEAM /

Pandrol continues to invest in the welding operations in India following the acquisition of Harshad Thermic Industries Private Limited in 2015. A range of improvements have been implemented to improve product quality and manufacturing techniques. The facility, which is located in Raipur is constantly moving towards quality through automation of production procedures.

A team of young and dedicated engineers and professionals have been recruited in Raipur to create a local center of excellence. The engineering team are working together with Pandrol's global aluminothermic welding experts to share knowledge and apply global best practice and know-how to the local Indian market.

In addition to the collaboration with Indian Railways, Pandrol's team are working closely with local associates of DFCC such as GMR, L&T and Tata to ensure timely introduction of the latest products and technology, such as the one shot crucible, and also offer full support and training to welding operatives.



Dinesh Viswanath
Managing Director

Our partnership with Indian Railways reflects our commitment to developing and strengthening our customer relationships to deliver technical expertise, innovative solutions and in-track services. We see that this approach has delivered a very positive result, with our business in India seeing growth from around 5% of the aluminothermic welding market in India to over 30% by 2018.

2

Safety first

“ There's a lot riding on the safety of our products. Millions of people use our rail infrastructure every day and that's a responsibility we take extremely seriously. We always go the extra mile to keep people safe. Safety is more than a priority at Pandrol, it's the foundation of everything we do. ”

Arnaud Pierrard
Manufacturing Excellence & Quality Certification Director

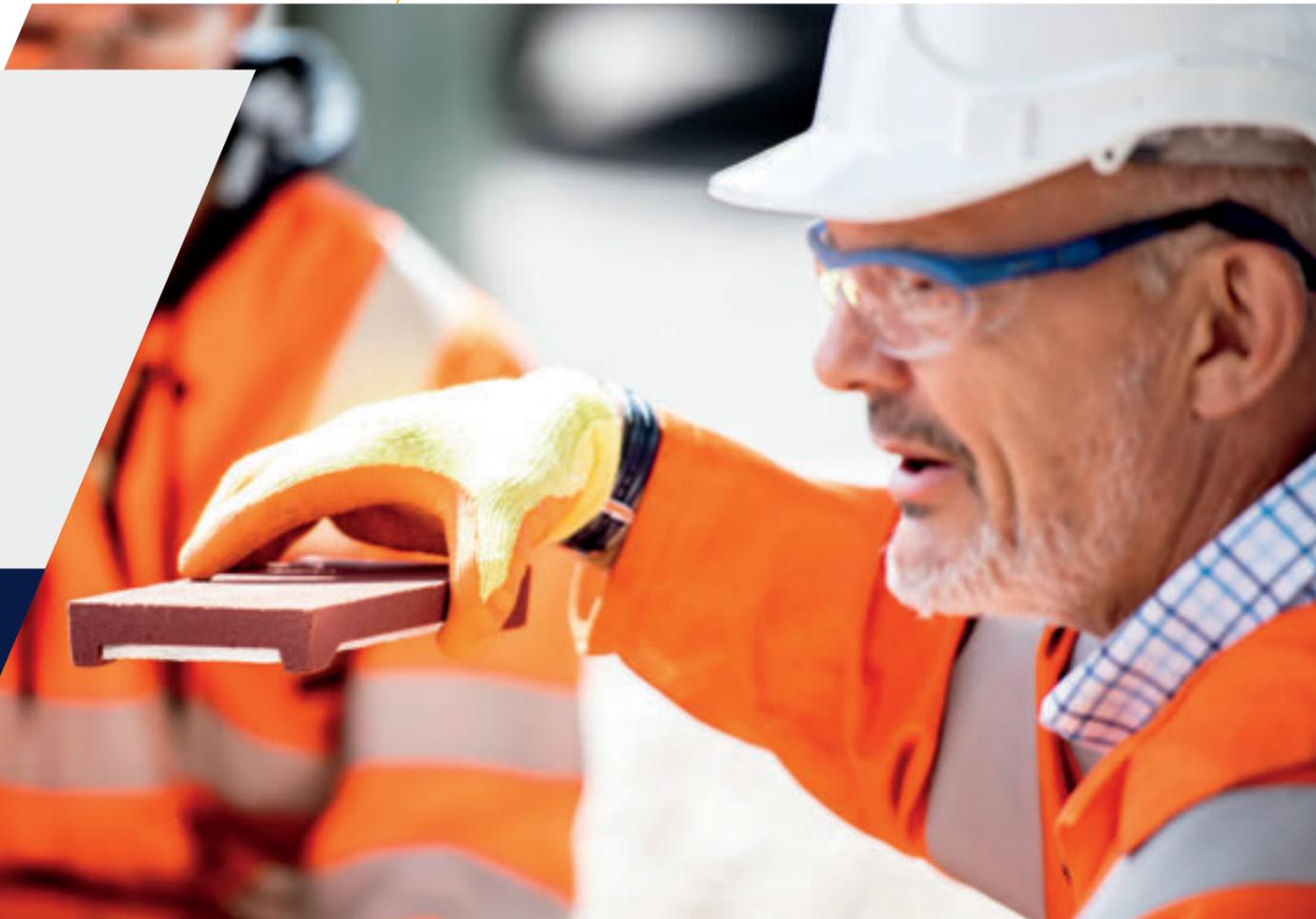
A global network of welding knowledge

Part of the Pandrol service which is particularly highly valued by contractors across the globe is the company's aluminothermic welding training.



Pandrol has a team of welding training specialists across its core international markets, each working to deliver training to meet individual country's regulatory requirements.

Thibaut Descamps / Director for Aluminothermic Welding



Pandrol has developed a Global Training Network, whereby Pandrol team members provide support for one another and ensure the continuous development of best practice in welding training.

→ TRAINING IN THE UK

For the UK market, Pandrol has recently opened a new purpose-built aluminothermic welding training centre at Worksop, Nottinghamshire. This is an all-weather facility with its own demo tracks and fully supported ballast rail. Pandrol also has two additional stillages to offer a complete range of different rail configurations.

Pandrol provides training on both its own and the main competitor's processes to meet Network Rail's specification. This training can be carried out at either the purpose-built training facility in Worksop or at customer's own premises, if a suitable training centre is available.

Training is carried out for an optimum number of four people, with a maximum of six per course. Each course is bespoke to customer requirements. The training is aimed at those directly involved in welding, for example, rail welders, or their direct management, being supervisors or team leaders.



Contractors can benefit from manufacturer training that is specific to their needs. We provide a full range of tailored training courses suitable for everyone from welding assistants, right through to the most advanced refresher training for experienced welders.

Chris McKeown / UK Head of Operations for Welding

For the UK market, Pandrol's training starts with:

→ Entry level assistant's course (2-3 weeks)

The first week is dedicated to fuel gas safety, the second week to Pandrol products and the third week to the competitor products training.

→ Trainee welder course (2 weeks)

Followed by the RT1 and RT2 certificates and the 1 and 2 yearly 'out of track assessments'. Here the focus is on different types of weld, such as wide gap weld and is covered over three days.

RT4 training takes place over 1-2 days and RT5 takes place over three days.

The key focus of Pandrol's training is safety and the ability to produce a weld correctly and to retain the integrity of the weld in today's demanding conditions.

→ TRAINING IN FRANCE

In France, Pandrol provides aluminothermic welding training from a trainee welder to advanced welder level. Welders are trained on a one-to-one basis using a mix of classroom and practical learning.

The French training centre is based in Raismes where training for local welders is delivered to meet the requirements of SNCF. Training is also delivered in many nations throughout the world from the team of experienced global trainers.



The French team carries out training in their home country and across the world, this means our teams need to tailor their global knowledge for a local approach.

Eric Casiez / Head of Welding Training Centre, France

Eric has recently organised training for the installation of a tramway from Lusail to Qatar, where the Nicolas Chevalier, our technical adviser, remained on site for two weeks to carry out instruction on the welding process for switchgear welds.



Fact file

Here are a few facts about Michel:

1. Michel Renaudin is one of our longest serving welding trainers in France.
2. Since starting his career in 1985, he has trained 1,500 welders.
3. He is seen as the reference point trainer of aluminothermic welding throughout Pandrol.
4. Michel has so far trained welders in 66 countries, across 5 continents.

→ TRAINING IN THE US

In the US, each railroad can have its own specifications, therefore the training offered is very flexible and tailored to the customer's requirements.

The US welding team offers a range of training on Pandrol's aluminothermic welding and hydraulic equipment product lines. Customers and end users can request specific weld training and product qualification for their projects and track work. We also offer after-sales training and maintenance to our customers on all of our equipment and tools. However, in some cases, the customer may require specialised procedures to complete their project, which the US training team can offer.

The US team encourages anyone interested in Pandrol's welding products and processes to attend the training classes and to observe the weld application during the certification process. In the past, safety managers, procurement personnel, project managers from other departments and engineers, have attended the training to gain a better understanding of the scope of the process.

One example of a recent welding training programme in the US was with the All Aboard project in Florida. All Aboard Florida's Brightline passenger service plans to run 32 trains a day between Miami and Orlando, with stops in Fort Lauderdale and West Palm Beach. Construction is nearly complete on Brightline's three South Florida stations and the tracks that span between them.

The Pandrol Team has been involved in this project from the start, by offering training and technical assistance to help contractors to continue work with no stoppage or delays. In turn, the project is nearly complete and passengers are already enjoying the first phase of the project.

Louis Flenner
US Welding
Training

Louis Flenner, Product Manager for aluminothermic welding in North America, explains: By undertaking Pandrol training the customer can be sure that the response will be accurate and efficient. Our technical teams have access to our Production Teams, Product Managers and Engineers to help resolve any issues encountered in the field. Perhaps one of the most important benefits with our training is the return on investment. Since our technicians are trained to use our various products, it ensures consistent high quality of customer's weld installations and ultimately increases the life of their project. This will save the customer money, maintain performance, and reduce downtime in the long run.

We find that, depending on the skill level and type of training being conducted, customers really enjoy learning about the features and developments of the product itself. Some of our moulds and weld kits are quite complex and we explain the intricacies of their design and the reasoning for this design. We try to give the customer a well-rounded explanation of why each specific product was developed and how they can be used to benefit them and the railroad. Over the years we have found that by educating our customers and end-users about all we offer and the role it plays in their work, they become more knowledgeable and understanding about our whole process on aluminothermic welding.

Tim Hoare
General Manager, Aluminothermic
Welding and Equipment, Asia Pacific

Ask the expert

→ Welding training in the Asia Pacific region



Q: Who is this training for?

A: Training is aimed at those directly involved in welding, either rail welders, or their direct management, i.e supervisors, team leaders or superintendents.

Training and information sessions are also conducted with Senior Level Engineers and Stakeholders to understand the importance and impact of rail welding in their projects and maintenance programmes.

Q: What do you see as the main benefits of Pandrol's training?

A: Pandrol's training is integral to the installation of welds that will provide their peak performance. Welding is a skilful role requiring expertise and we support the trainee to install welds of the highest quality with the lowest defect rate due to good welding practices. The Customer (or asset owner) benefits from welds that are structurally sound, providing a joint with a life that is equal to the life of the rail. It is a requirement that all welders be trained in the process they are installing, many network and asset owners insist on welders who have completed and obtained documented evidence of training.

Q: Can you give an example of a recent project where you trained an installation team?

A: Singapore has seen an increased focus on training over the past 12 months. This demonstrates a high level of commitment by the customer to increase and monitor the skills of their welders, and this monitoring and continual training has seen increases in productivity and quality of installations.

Q: Do you offer training in foreign languages?

A: Training is provided in local languages either via interpreter or local trainers who are bilingual, this is critical in South East Asia where the operators can be from a range of backgrounds.

Q: What feedback do you get from those who you train?

A: Those who complete our training tell us that the theoretical side of the training is an important reinforcement of the practical side. They understand the importance of the right equipment and following the procedures precisely.

Q: What type of training do you offer?

A: In the Asia Pacific (APAC) region we provide training, specifically for welding, for operators and supervisors. Each type of training has its own format and focus. For operators the key is performing the process correctly, safely and consistently. For supervisors we focus on aiding the operator and looking out for key indicators during the process of the achieving the highest quality outcomes. In both cases we cover the reasons that the parameters in the work methods are critical to follow. All training has a theory and practical component.

During training the use of machines from Pandrol's equipment division is usually discussed and demonstrated as the equipment for cutting, shearing and grinding. This adds another dimensional element to the training that makes Pandrol unique.

Q: Which countries do you work in?

A: We are responsible for training in South East Asia (Singapore, Hong Kong, Indonesia, Thailand etc.), Australia and New Zealand.

Theft-Resistant fastening system enhances security on the railways

Theft of rail fastening systems is an issue that creates significant safety and security challenges to rail operators in some parts of the world. Presented with this problem, some railways have even resorted to adding a bead of weld to the shoulders into which the clips are driven to discourage their removal. Although partially successful in reducing theft, this was time-consuming to implement and created difficulties when maintaining the tracks as the clips could not easily be removed without grinding the weld off.

To solve this problem, Pandrol has developed engineered theft-resistant fastening systems that make it very difficult to remove clips without specialist tools. These have proved to be popular in areas where theft of track infrastructure is a problem and Pandrol has recently won a major contract for delivery of eAT 20123 theft-resistant rail fastening system – for a new installation of 83,000 sleepers in Bangladesh.

→ ENGINEERING THE SOLUTION

The system was first developed back in 2007, when Pandrol's expert engineering team became involved in the design of the line between Dhaka and Chittagong in Bangladesh. Following a complete track survey, fastenings were proposed to strengthen the overall track structure and extend the life cycle of the track. One aspect of the project was that Pandrol was asked to solve the problem of theft rail clips from the track infrastructure. The Anti-Theft system incorporates e2000 series clips and is therefore known as the 'eAT2000' fastening. Once the clip has been installed, a notch on the clip's centre leg interlocks with a matching protrusion that is cast inside the housing on the shoulder. This mechanism is very difficult to see in the installed assembly, so that it is difficult for thieves to figure out how to remove the clip. They won't come out, but it's not obvious why not!

Extraction of the clips is extremely difficult unless performed by use of a special extraction tool – which makes it very difficult for an unauthorised person to remove the product from the track. Over the past 10 years the system has been widely used in Bangladesh, the Philippines and Cambodia. It has proven to be effective in preventing theft.

The eAT2000 delivers a heavy-duty fastening system that offers low maintenance, durability and long life. The system uses high-wear resistant materials in the insulating components that ensure the longevity of the rail fastening system in the track. It also offers a high level of creep resistance, it involves no threaded components that can strip or corrode, and it avoids the use of plastic dowels in the sleeper. Although primarily designed for use on concrete sleepers, the use of cast hook-in shoulders means that the system can be adapted for use on other types of track, such as with steel sleepers. The eAT shoulder design can also be applied to the baseplates used on timber sleepers and in turnouts. The high toe load generated by the e2000 series clips mean that it can be used on all track types, right up to heavy haul.

The eAT system requires a purpose-designed shoulder. In order to prevent theft of e-clips from existing track, that has not been built with sleepers with the special eAT shoulders, Pandrol developed the TR2000 system. The TR2000 system is a retrofit solution designed to provide effective anti-theft rail fastening for sleepers fitted with conventional e-clip



eAT 2000 - An integrated clip and shoulder design for new track installations



TR System - A retrofit solution designed to work with existing track

shoulders and already installed in the track. The TR System's anti-theft feature is engineered from an interaction between the end of the e-clip toe and an additional or replacement insulator or cast spacer. The system can be installed on sleepers originally designed for PR clips, e-clips and even for generic copies of original Pandrol designs. If the risk of theft is confined to specific areas of a rail network, it may be cost effective to install the TR2000 system only in the locations where clip theft is most likely to occur.



Pradeep Khaitan
Managing Director,
Pandrol Rahee
Technologies

We have made a very significant investment in our manufacturing capabilities in India, which we see as a key market growth sector over the next decade. Investing in a new manufacturing facility will mean we are best placed to service customers and capitalise on this growth. It will also give us greater capacity to respond to market requirements while creating new employment in the region. This will be a world class facility for rail fastening manufacture, fully supporting the 'Make in India' policy of the Indian Government.

Developing Local Production

The eAT2000 system is now being produced at Pandrol's new 3,500m² manufacturing facility in Hyderabad, India. The factory was inaugurated at the end of October 2018. Pandrol Rahee Technologies is a joint venture between Pandrol and Rahee Group. The facility includes an automated clip forming line that incorporates an advanced coating technology process and will produce a range of rail fastening systems for Metro, Heavy Haul and High Speed projects.

As well as the eAT2000 system, the plant will produce advanced Pandrol solutions that combine heavy duty performance with long life durability for the Indian subcontinent. PRT was established in 2005 and its success in India started with metro projects, supplying fastening systems for ballastless track.



The new factory at Hyderabad was officially opened by Mr Andrew Fleming, British Deputy High Commissioner for India

Oliver Dolder
Global Equipment and Control Director
at Pandrol

Ask the expert

→ Emissions free maintenance



Q: What is meant by emission free?

A: Emission free refers to an engine, motor, process, or other energy source, that emits no waste products that pollute the environment or disrupt the climate.

Q: Is emission free maintenance for railways possible?

A: Although battery technology is not 100% emissions free, it is a solution that drastically reduces emissions; creating a healthier and cleaner working environment for equipment operators.

Q: What are the benefits of using battery powered equipment?

A: Apart from the benefits to the environment that come from lower carbon emissions, battery powered equipment is compact and powerful bringing ergonomic benefits and high-quality performance. Batteries also offer a consistent source of power and require less ongoing maintenance between jobs, making them more reliable and easier to maintain than traditional solutions. From a financial perspective battery operated equipment has a long-life cycle and can offer cost saving opportunities through reduced maintenance requirements and reduced spending on fuel. Track teams can also see a benefit, equipment powered by battery is lighter and easier to carry than traditional railway equipment. Working conditions are also improved as the tools are operated without wires or cables making them less of a trip hazard. Perhaps the most noticeable improvement to track working conditions is the lack of fumes generated by the equipment verses traditional gas-powered solutions.

Q: What are you working on next?

A: We currently have 6 products in our battery-operated tool range and are working on further developments to both increase our offering and improve the products we have.

Q: What do you think the future of railway maintenance looks like?

A: We are seeing a global trend of environmental awareness, some of the largest railways in the world are committing to reducing carbon emissions and setting clear, measurable targets for improvement. Railways have also historically been dangerous places to work, we are seeing more and more countries look to reduce risk to track teams, improve working conditions and invest in safe working. I think these 2 drivers will push the future of railway maintenance to be safer, cleaner and greener than ever before.

3

Focus: Urban transit

“ With over 50% of the world’s population now living in cities there has never been more of a need for safe, efficient and cost effective solutions to deliver integrated urban transit. We have been working with customers around the world to overcome the challenges of developing urban transit solutions to keep cities moving. ”

Thomas Lorent
Head of Transit, Pandrol

Underpinning unprecedented urban growth

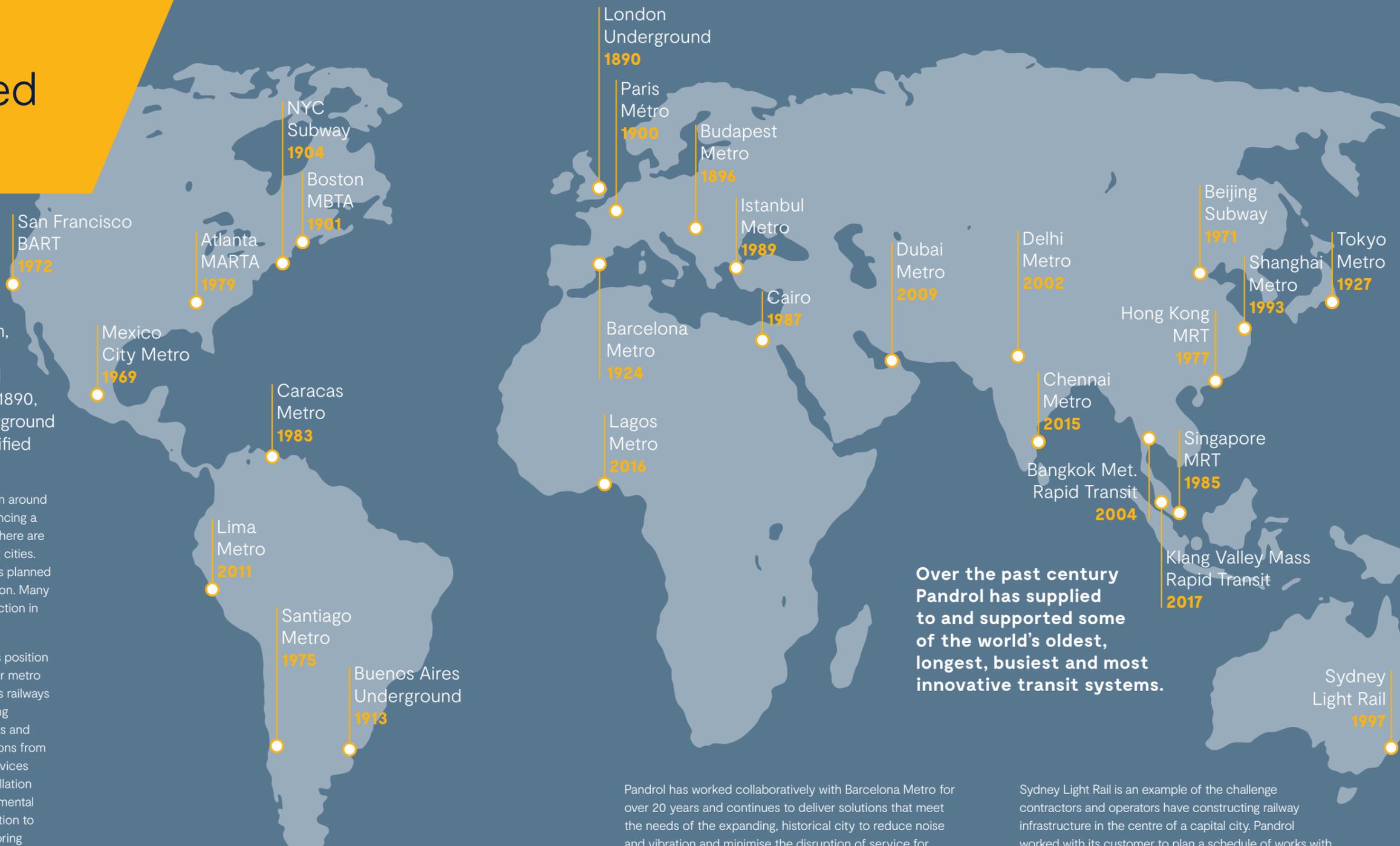
The Metropolitan Railway, now part of the London Underground system, was the first underground urban railway in the world when it opened under steam power in 1863. And in 1890, parts of what is now London Underground also became the world's first electrified underground railway.

Although underground and other light rail has been around for well over a century now, it is currently experiencing a resurgence of growth, particularly in Asia, where there are large, rapidly expanding populations in developing cities. India, for example, currently has 30 metro projects planned in its cities that have populations of over one million. Many urban transit systems are currently under construction in other parts of the Far East.

Over the past 20 years, Pandrol has developed its position as a global leader of rail infrastructure solutions for metro and light rail, with its systems installed in numerous railways throughout the world. Designing and manufacturing fastening systems, welding, electrification solutions and track equipment, Pandrol can offer multiple solutions from a single supplier. The company's products and services are designed to maximise efficiency of track installation and operation, and to address safety and environmental factors such as noise and vibration. A recent addition to the Pandrol service offering is track-based monitoring equipment which generates data that is then analysed using Pandrol innovative systems.

This offers customers insight into their metro and underground tracks that can be used to prevent maintenance needs occurring and maximise uptime.

The following metro feature looks at recent projects that Pandrol has delivered globally. Each project presented unique product and environmental requirements that the Pandrol team, in collaboration with their customers, worked to meet.



Over the past century Pandrol has supplied to and supported some of the world's oldest, longest, busiest and most innovative transit systems.

Pandrol has worked collaboratively with Barcelona Metro for over 20 years and continues to deliver solutions that meet the needs of the expanding, historical city to reduce noise and vibration and minimise the disruption of service for maintenance. For the Line 5 Barcelona Metro project Pandrol was asked to develop a solution that could offer the same high performance as the current system but was lighter, more ergonomic and quicker to install.

Sydney Light Rail is an example of the challenge contractors and operators have constructing railway infrastructure in the centre of a capital city. Pandrol worked with its customer to plan a schedule of works with minimal interruption to one of the busiest intersections in downtown Sydney enabling residents to live and work side by side with the transport system.

The priority for Santiago Metro is keeping the city moving, this is increasingly challenging as the city experiences regular disruptions to service following earthquakes. Pandrol worked in partnership to develop a value engineered solution that could offer reliability in extreme conditions.

The Klang Valley Mass Rapid Transit project in Malaysia started for Pandrol as a series of site visits to analyse the projects varying requirements for noise and vibration isolation. Pandrol's technical team worked in collaboration with Mitsubishi Heavy Industries to design, test and deliver products with a comprehensive package of technical support that included working with local teams on track during construction to ensure best practice.

“



Pandrol's teams are rail infrastructure experts, encouraging customers to collaborate to solve their problems and work together from design through to installation and beyond.

Thomas Lorent / Head of Transit

Barcelona

Pandrol makes light work of Line 5 for Barcelona Metro

The Barcelona Metro is an extensive network of 12 lines, which run mostly underground in central Barcelona and out into the city's suburbs.

Pandrol first worked with Metro Barcelona in 1997 to supply precast Floating Slab Track along a 14 km stretch where specific noise and vibration requirements had to be met.



New lightweight concrete block installed with VIPA fastening



Lightweight concrete block delivered pre-assembled



Completed installation for Barcelona Metro

“ The fact that Pandrol's VIPA DFC was delivered to track side fully assembled made installation very efficient.

John Porrill / Head of New Product Development

In total, Barcelona Metro has now worked with Pandrol for over 20 years because of the proven performance of its track fastening systems and the ongoing technical and site support that it provides. As part of a collaborative approach, both organisations work closely on new product developments, with a strong focus on safety and efficiency of installation.

Barcelona Metro has an ongoing programme of maintenance and improvement on its 120 km of track. Key areas of focus for Barcelona Metro are extending responsive maintenance intervals and making further improvements to noise and vibration levels within the large city area covered by its network. So work encompasses the replacement of track and sleepers that have reached the end of their service life, and in areas where an improvement in performance is now required – for example to reduce ground vibration. Safety is the main priority for the company.

“ The VIPA DFC system is light enough to be handled by one person, which, combined with its ability to fit in the existing slab cavities, made it a very cost effective solution.

/ from Barcelona Metro

→ THE CHALLENGE

Barcelona Metro was one of the first to benefit from a new Pandrol fastening system during refurbishment of Line 5 in 2017. The line required a retrofit to replace the existing booted sleeper blocks, because these had reached the end of their service life and were no longer performing as designed. The old sleeper blocks had also experienced corrosion problems in the tie bar.

Pandrol supplied its new light weight block solution to replace old booted sleeper blocks. The existing twin block system was first to be removed, leaving pockets in the slab. The new system would have to be installed into these pockets and would need to provide a stiffness similar to the performance of new booted sleepers. The concept was that in the new system, the required resilience would be provided above two individual blocks, rather than through a direct replacement for the boots that surround and support each end of the old twin-block sleepers. This puts the resilient elements where they are easier to inspect and maintain. The new individual blocks are smaller and easier to handle and can be rigidly grouted into place.

The Pandrol VIPA DFC fastening system, designed specifically for use on slab track, was selected. It is light in weight and has a small footprint that fits easily onto the new block. In total, 400 assemblies were supplied on this project. The Pandrol VIPA DFC System is optimised for use in pre-cast blocks, sleepers and slabs. It offers a cost effective, high performance solution for track where vibration ground borne noise mitigation is required.

→ INSTALLATION

Line 5 project demonstrated the methodology of installation of the new lightweight concrete block system in combination with the VIPA DFC fastening. Each block was placed into the empty pocket, the existing rails were lowered, and the Pandrol Fastclips were switched from the parked to the installed position using hand tools. Even with the pre-assembled VIPA DFC fastenings already fitted to them, the new blocks were light and safe enough to be handled by one person. This new low stiffness system provided an innovative solution for Barcelona Metro.

The lightweight concrete blocks were delivered to the worksite fully pre-assembled. The block is of the minimum size required to support and anchor the fastening assembly system, allowing it to be easily manipulated into position and attached to the rail prior to final adjustment and fixing. Reinforcement and anchor elements protrude from the underside of the block and are designed to tie it into concrete poured into the pocket around it to form the completed slab. The contractors carried out the fine track alignment before pouring the concrete to complete the installation.

Aided by pre-assembly off-site, the installation was simple and efficient, allowing the contractor to recover time lost on other sections of the job.

Throughout the project there was ongoing collaborative working between the Pandrol New Product Development team based in the UK and the local technical and customer liaison teams based in Spain. Together, they provided a full package

of technical support and assistance during the installation. Pandrol also worked closely with the Polytechnic University of Catalonia to complete the block design calculations.

As a result of the successful delivery of this project, the Pandrol New Product Development team is now working on developments that enable even quicker installation on track. This is of particular interest to Barcelona Metro.

Further installations of the VIPA DFC system are planned. In particular, it will be used in the tunnel sections on the new Follobanen line in Norway.

Increasing welding productivity

Pandrol also supplied the innovative One-Shot crucible and induced air plus propane preheat, to support the Spanish PLR welding process used on Barcelona Metro.

This solution both increases levels of productivity and reduces the possibility of errors in the welding works due to the very simple preheating system which minimises the possibility of human error.

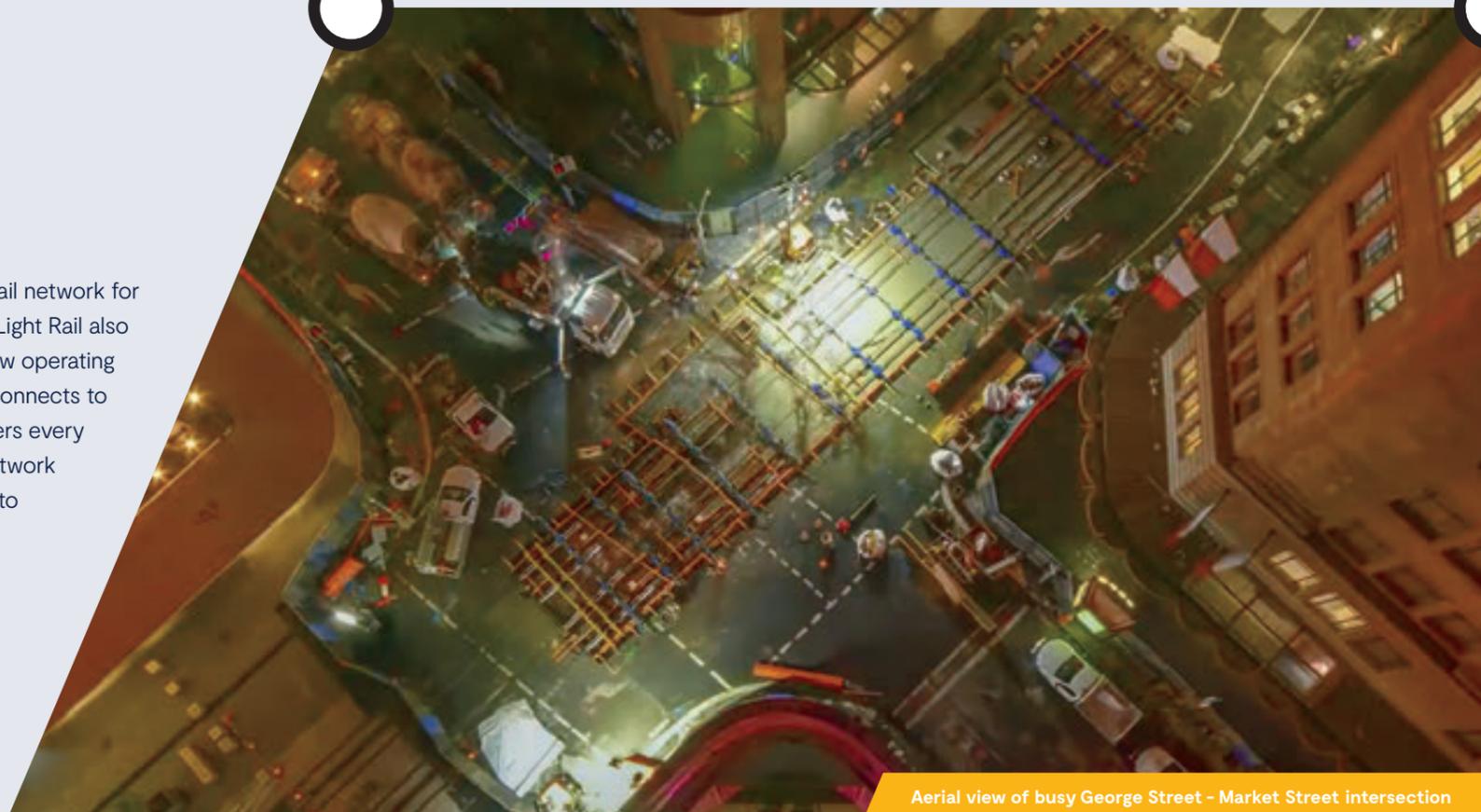
Pandrol worked with the welding contractor to ensure supplies were delivered practically “just in time” as it is very difficult for the welding team to store the materials on site.

Sydney

Pandrol's double solution for the Sydney Tramway

The CBD and South East Light Rail is a new light rail network for Sydney, with a 12 km route and 19 stops. Sydney Light Rail also incorporates the Inner West Light Rail which is now operating as the L1 Dulwich Hill Line – a 12.7 km route that connects to Central Station and is used by 9.8 million customers every year. It is expected that the expanded light rail network will significantly improve public transport access to major sporting and entertainment facilities.

The new line will serve the busiest areas in downtown Sydney from Circular Quay at the northern end of the Central Business District along George St and to the south-eastern suburbs of Randwick and Kingsford.



Aerial view of busy George Street - Market Street intersection



Pandrol QTrack® installed on the Sydney Metro

→ CONCLUSION

This was a high volume, demanding project, with great flexibility required in the planning process. The successful conclusion of the project demonstrates Pandrol's innovative approach to working proactively with the customer, and delivering high volumes to meet project requirements.

→ THE CHALLENGE

Due to its central location, the project required an innovative and flexible approach, including the necessity of a fast and forward installation taking place over weekends which could guarantee a minimum of interruption of the busy streets. Pandrol was appointed to this project in 2016, working alongside infrastructure contractor Acciona.

The main technical challenges lay in the need of mitigating the ground borne vibration issues of a project located in the Central Business District of Sydney, and the high electrical stray current isolation that was required.

A further requirement challenge was the high demand for large volumes and the need for great flexibility in the delivery programme. This challenge was met by Pandrol increasing factory production capacity, establishing several production moulds to work in parallel with each other.

→ SOLUTION

Pandrol solved these challenging project requirements by engineering a combined solution of two systems: Pandrol QTrack® and Pandrol floating slab mats (FSM) which provided the perfect solution for work in a congested urban environment.

Pandrol was chosen because of the company's high capacity for production – required on such a large volume project and also because of Pandrol's extensive global experience and the confidence of Acciona in its products.

The Pandrol QTrack® system was specified for the Sydney Tramway, which is a continuously supported and fastened embedded slab track system. The rail is encapsulated by elastic resin bonded rubber profiles providing a broad range of benefits, such as vibration mitigation and electrical isolation, which was especially important for this project. Pandrol has developed a specialist solution to issues with stray current named QT ELEC. The QT ELEC is an electrical insulating film used on the Sydney tramway project.

Pandrol QTrack® is renowned for being easy to install and the Pandrol team provided technical support throughout the process, from design to installation stage. On-site training was also provided by the Pandrol team from Hoeilaart, in Belgium.

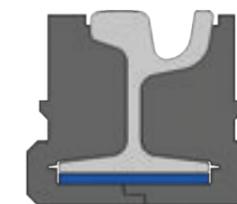
The system is widely recognised as a cost effective and long-lasting performance solution. It is consistent with the need to reduce ground-borne noise and vibration, and is compatible with special track works such as drainage and electrical boxes, insulation joints, axle counters, switches and crossings, and other typical depot equipment. It is compatible with the need for sustainability as it includes few components and is therefore eco-friendly. Pandrol QTrack® is renowned for being durable and maintenance-free and offers reduced life cycle costs. It is available for grooved and Vignola rails for different axle loads: LRT, Metro, Train, High Speed and Heavy Haul.

Pandrol QTrack® system was supplied in two different versions: XP and HP. XP covered the larger amount of track, almost 19 kilometres, where as the HP version of QTrack® was used over 10 kilometres.

Pandrol FSM was also specified in FSM-L13 and FSM-L4.5 systems, adapting to the level of vibration mitigation required by the project.



HP variation for LRT



XP variation for LRT

Kuala Lumpur

The first phase of the Klang Valley Mass Rapid Transit (KVMRT) project in Kuala Lumpur was recently completed. Here Pandrol developed and delivered the fastening systems for the 51 km Sungai Buloh to Kajang Line.

The line starts at Sungai Buloh, located to the north-west of Kuala Lumpur and runs through the city centre of Malaysia's capital city before ending in Kajang, a fast-developing town to the south-east of the city.

Following a competitive tendering process, Mitsubishi Heavy Industries (MHI) worked with Pandrol to propose compliant and cost effective solutions to the client. Pandrol's technical team recommended its VIPA DRS fastening system for the mainline areas while its Vanguard system is used in specific areas. Both systems are designed to control of rail roll on curves, but the lower dynamic stiffness that the Pandrol Vanguard system provides an even greater level of attenuation of transmitted vibrations. Pandrol also delivered an integrated third rail solution which provides 750V DC power supply.



Bringing power to the track

Through its joint venture company Railtech Alu Singen, Pandrol worked with MHI to develop and design the third rail system ensuring all interfaces, including rolling stock, track works, power supply and civil works, were considered.

The system supplied by Pandrol focused on coextruded rail technology which has two key benefits when applied to conductor rail solutions. Firstly, 100% of the stainless-steel strip is efficient, meaning it can be fully worn down to 0mm without any monitoring. A further benefit of the coextruded process is that there is no delamination of stainless-steel strip even if it becomes partially worn. These benefits add lifetime value to the railway through reliability and maintenance savings.

Pandrol takes pride in its history, expertise and commitment to quality. All components supplied are tested in in-house testing facilities and in external laboratories for specific test requirements. All tests are performed in accordance to Third Rail System technical specification, calculation notes results and international standards. To ensure a smooth and efficient installation, Pandrol supported the project by delivering installation, maintenance training and supervision on site.



Pandrol third rail system

The completed KVMRT Metro features:

- 51 km of track
- 400,000 passenger per day
- 80 km/h designed maximum speed
- Rail type 60E1 (mainline) EN 50E1 (depot)

The VIPA DRS fastening system is well proven in many metro projects worldwide. It offers a low vertical dynamic stiffness that leads to good levels of vibration isolation, and the proven technology of the Pandrol e-Clip. The baseplate system is easy to maintain and provides vertical and lateral adjustment capability.

As this was the first deployment of Vanguard in Malaysia, the Pandrol technical team supported the local team on-site with demonstrations on how to install and maintain this fastener.

The completed project will serve a local population estimated at 1.2 million people and is expected to carry approximately 400,000 passengers on four-car driverless trains, each with a capacity of 1200 people.

This is just one in a series of recent and current metro projects that Pandrol has delivered in Asia, such as two large underground schemes, DTL and TSL, in Singapore, the Ho Chi Minh City Metro in Vietnam, the Red Line in Thailand, and Jakarta Metro in Indonesia.

Pandrol focuses its innovation on quality, safety and cost, which is why metro customers choose the company to design and manufacture new rail engineering technology. Pandrol's aim is to generate increased productivity, reduced possession times and achieve improvements to railway and worker safety. Over the years, the company has developed a wide range of transit products to suit the diverse range of requirements set by rail authorities and contractors, adapting these to satisfy local, regional and global standards.

Using its technical expertise and dedicated product support teams, Pandrol can address specific design considerations, for example in relation to track structure interaction, corrosion protection, special track work, adjustability requirements, and many other particular needs of the client or contractor.

“ Pandrol's continued involvement and technical support on this project is greatly appreciated. The solution met the requirements presented by some significant challenges where areas of track are subject to high vibration sensitivity and require a more innovative approach.

Mr Ito / KVMRT Trackworks Project Manager from MHI



By its nature, metro tracks in tunnels or on viaducts can be more complex to install than ballast track on an open site. Pandrol's technical team can advise on different construction methods, such as top-down wet pour, use of embedded blocks or sleepers, or pre-cast plinths or slabs. Pandrol products can offer a wide range of stiffnesses and adjustment capabilities.

Andy Slowe / Product support Engineer

→ SOLUTIONS PROVIDER

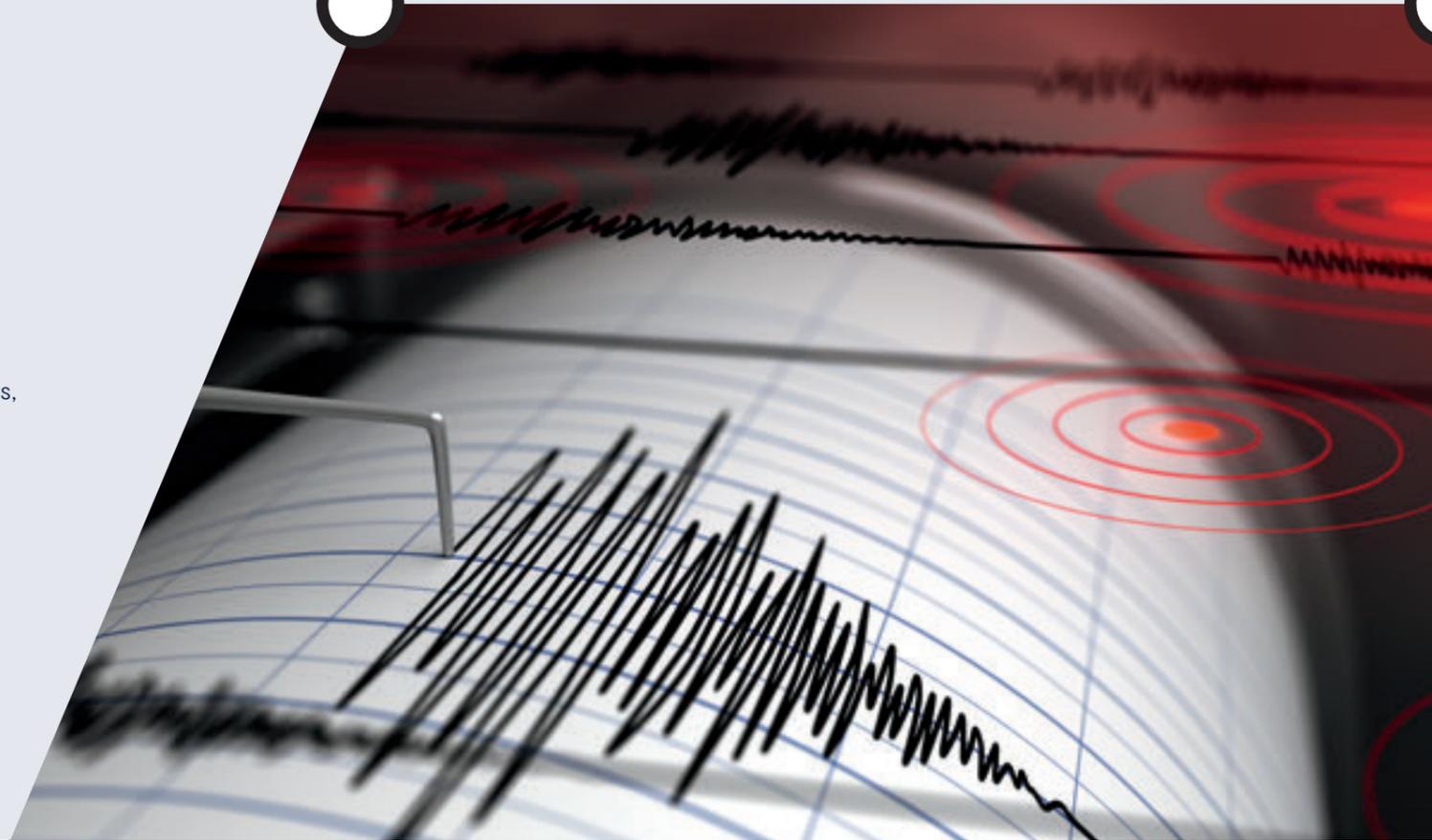
Pandrol's technical team often work with customers during the construction of metro lines because of the specific site challenges. As a complete solutions provider, Pandrol can offer the design, manufacture and implementation of fastenings, welding, equipment and electrification technologies, and can provide its renowned technical support in all these areas.

Santiago

Engineering a solution in an earthquake zone

Santiago Metro (Metro de Santiago) is one of the largest and most advanced underground railway networks in Latin America. It currently has six lines, 107 stations, running across 118 km and carrying around 2.5 million passengers every day.

Pandrol currently has a package of work which is part of a 20 year contract for the construction and maintenance of lines 3 and 6.



SEE-SD System

→ THE CHALLENGE

As Santiago is one of the locations in the world where earthquakes are most prevalent, the customer required a fastening solution that allowed for potential future adjustment of the track. In the last 12 months, there have been 67 earthquakes in Santiago, therefore the project requirements were for a +30 mm adjustment capability. The project required a fastening solution for 50 km of track and the requirements were for a lightweight baseplate and under-the-track rubber mats for noise and vibration mitigation.

→ SOLUTION

Pandrol delivered a multifaceted track solution including fastenings, catenary and floating slab mats. The unique and challenging requirements led to Pandrol developing a new composite plastic baseplate, the SEE-SD. This baseplate is designed to be embedded into fresh concrete or by wet pour methods. This would be more cost effective than a traditional aluminium/steel casting and would be easier to handle and install on the track. The SEE-SD provides adequate resilience (stiffness) to attenuate to the concrete slab and provides large vertical adjustments to the rail position. The Pandrol air evacuation system prevents trapped air entering under the baseplate. The SEE-SD plastic baseplate has a special feature of vents and channels that optimise insertion into concrete and ensures excellent resistance to lateral forces.

Once the system was developed, Pandrol's technical team carried out rigorous tests to demonstrate to the customer that their solution could meet both performance and cost requirements. This required technical validation of the

system, including a complete and fully tested assessment of Pandrol's recommended solution.

The SEE-SD assembly is designed to give a typical vertical dynamic stiffness of around 60 MN/m. It offers a wide range of pad stiffness levels, making it suitable for meeting noise and vibration mitigation requirements on this project. It also meets all requirements of the latest updates of EN 13146 and EN 13481-5 standards. In addition, its performance relating to electrical insulation complies with EN 13146-5:2012.

The baseplates used in the SEE-SD design is made from glass fibre reinforced polyamide material in order to provide maximum resistance to lateral loads. The baseplate is not 'laid' on the concrete but 'anchored' and integrated into the slab. There is consequently no risk of slippage. The stress level in the screws is significantly reduced even on tight curves, as a result of the anchoring system, which is based on the use of two screws.

The SEE-SD was designed for use with the SD clip, with its screwed design that optimises track construction costs and provides very high technical performance. SD stands for

'safely driven' which relates to the controlled clip guidance from the 'parked' to the 'in-service' position.

SD insulated blocks are designed to offer lateral adjustment of the track gauge in increments of 1.25 mm. The method to adjust the gauge is managed simply by adapting the insulated block combination. SEE-SD meets the requirements for all urban rail networks, from tram lines to modern light rail and high capacity metro applications.

Over the lifetime of the project Pandrol has manufactured more than 200,000 SEE-SD fastenings systems to the French rail consortium ETF and Colas Rail on behalf of Metro de Santiago.



→ VIBRATION

To meet with vibration minimisation requirements, Pandrol supplied its Floating Slab Mats (FSM), which are continuous resilient mats used for the isolation of train-generated vibrations in concrete slabs. These FSMs are manufactured from high quality resin-bonded rubber to achieve vibration attenuation, with a low resonance frequency.

Pandrol QTrack® embedded rail system was also supplied to Santiago Metro depots to help in achieving a maintenance-free slab structure.

Rails were elastically supported and fastened while embedded providing free and safe movement of workers and maintenance vehicles. Pandrol QTrack® system can also be developed to completely encapsulate the switches and crossings of a depot in the same manner as a regular track.

→ ELECTRIFICATION

Electrification was a major part of the Santiago Metro project too, which was completed in 2017. Santiago Metro required 60 km of Rigid Catenary for this project, for which we designed and manufactured the whole system. This was supplied mainly for use within tunnels. Our rigid catenary system was specified as it offers low maintenance, high performance and enhanced safety.

The project involved providing technical support and training to the contractor installing the system. This included on-site training and members of our technical team were present during installation to ensure the process ran as smoothly as possible.

Rigid Catenary is an overhead contact system that has advantages over the third rail or suspended bimetallic T-rail. It is manufactured via an aluminium alloy profile, which accommodates the copper contact wire, with a great cross section for the current that allows operative OCS voltages from 750 to 1.500 V, without any feeding supply.

Rigid Catenary offers many advantages over traditional flexible catenary system, including no traction stress as it allows more contact wire wear without the risk of it breaking off. Rigid catenary provides no mechanical stress on the contact wire, so there is less wear and fewer maintenance issues.



Rigid Catenary

SUMMARY

It is common practice that in earthquake zones around the world, once an earthquake is detected, trains are immediately stopped, after which operation is continued at reduced speeds or is suspended, depending on the strength of the shock.

Metro de Santiago has invested in an infrastructure which mitigates the impact of frequent earthquake activity, whilst ensuring their long term performance and resilience. An 8.8 magnitude earthquake shook the southern part of Chile back in 2010 but the majority of the Metro survived well. More recently in April 2017, an earthquake of magnitude 7.1 reached Santiago after starting around the Chilean coast, whilst the Metro remained largely unaffected.

Maximising uptime

“ Maximising uptime is a key requirement for our customers and everything we do is aimed at making this happen. At Pandrol we look to reduce the time and resource needed for installation. Through product design and development we aim to maximise the operating life of components while also minimising the chance of unscheduled and costly breakdowns through remote monitoring and predictive maintenance. ”

Erika Berg
Managing Director, Pandrol AB

Problem solving that changes what's possible: High Speed



Steve Cox

Fastening Systems
Technical Director
at Pandrol, looks at
innovation in high speed
baseplate and robotic
assembly.

High Speed train operation requires accurate alignment of the track. Where the possibility of significant levels of settlement after construction exists, or where seismic activity is likely, there will be particularly demanding requirements on the range and accuracy available for vertical and lateral adjustment of the rails. When the track is a non-ballasted track form, typically all of this adjustment must be provided for in the fastening system. Given the short periods available for maintenance, the accuracy, ease and speed with which these adjustments can be made are key attributes of fastening system.

Pandrol has applied its design and development capabilities to reduce the time taken to make adjustments, the number of parts to be exchanged and the complexity of this important maintenance operation.



The Pandrol Fastclip Baseplate is well suited to high speed. Adjustment is a fundamental requirement and there are several aspects. The range over which adjustments can be made in both the vertical and lateral directions; the accuracy with which this can be done; the ease and speed of adjustment and the number and complexity of any additional or exchange parts are all important.

Adjustment may be required on curved track made up of short straight panels, as the position of the fastenings clearly needs to be offset to achieve a smooth alignment. This applies particularly to the lateral baseplate position and becomes more of an issue the tighter the curve. The fastenings must be positioned very accurately to achieve the tight tolerances on track gauge required on high speed track.

Pandrol's baseplate is infinitely adjustable in the lateral direction. It can be tightened down and held firmly in position at the exact location required. The baseplates can also be slewed slightly relative to the axis of the slab, so that each baseplate is aligned exactly towards the centre of the curve that the particular slab to which it is fixed will form a part. This means that every slab can be identical to every other slab and every fastening is identically configured relative to every other fastening on initial track construction. Only the exact positions of the baseplates fitted to any one slab differentiate it from other slabs in the track. So 'spare' slabs needed for repairs are universal and do not need to be purposely constructed with the associated difficulties and lead times. Nor are any bespoke fastening configurations required to achieve exact track alignment.

→ ROBOTIC FUTURE /

The combination of universal slabs with universal fastenings is an attractive proposition – but is not new. However, what is new and innovative is the way that Pandrol proposes to fit its baseplates to the slabs. Robots will be used to pick baseplates and place them in the exact positions and orientations required – transferring the expertise that the company has built up from its use in its clip manufacturing production lines.

The combinations of baseplate positions on a given slab can be selected at the touch of a button. Scanning assists and confirms the baseplate positioning and the configuration of each slab (and which end is which!) is coded into an RFID tag that is affixed to the slab before it leaves the factory, so that the curve or transition where it is destined to be installed can be recalled at any time. This robotic installation increases the reliability and quality of the installation on which the ultimate quality of the track alignment depends. It also increases the rates of production and reduces the risks of delays or interruptions.

Robotic installation of baseplates is greatly facilitated by the fact that the Pandrol baseplate can be largely pre-assembled before it is installed on the slab in the factory. That's an advantage too when it comes to the second area where adjustment is essential. This is to maintain the track over its operating life.

A damaged baseplate could be replaced as a self-contained unit. There is no need to dismantle the fastening on track and no need to then know how to correctly reassemble it. Lateral adjustments are particularly advantageous. The baseplate just needs to be loosened off, moved to the correct position and retightened. No additional replacement parts are required and there is no need to disassemble the fastening. Vertical adjustments too are simple.

The baseplates are loosened off, any additional shims required are slid into place and the baseplate is retightened. The height adjustment shims themselves are a very simple planar design, easily manufactured to whatever precise thicknesses are required. There is no danger associated with assembling shims of different thicknesses in the wrong order.

→ THE NEED FOR ADJUSTMENT /

High speed lines built in earthquake zones such as Japan and Taiwan have in the past led to a need for relatively high levels of vertical adjustment – typically +50 mm – and requirements for HS2 in London, the requirement is even greater at +70 mm. The difference may not seem large, but the overturning moment that acts on the fastening is greater and any concrete upstands provided to react to lateral loads are further from the top level of pre-stressing or reinforcement in the base slab. Pandrol has tested the new maximum height adjustment requirement very thoroughly against the relevant European CEN requirement, running 3 million load cycles with a block configured so we could test adjacent assemblies at installation heights of 0 mm and +70 mm.

On slabs with rail seats, as vertical adjustments are made, the lateral position of the gauge face of the rail changes too. In order to maintain close control of track gauge, vertical adjustments may mean that the components that determine lateral alignment need to be replaced unless, like the Pandrol baseplate, the position of the baseplate itself can simply be adjusted. A +70 mm height adjustment on a 1:20 rail inclination as is the case for HS2 results in a 7 mm change in gauge, much greater than the 2.5 mm change that results from a +50 mm maximum height adjustment on a 1:40 track, as, for example, in China.

Speed of construction and maintenance are important and the Pandrol Fastclip Baseplate system allows machines to be used to switch the clips between the parked and

installed positions to allow for rail change and de-stressing. The rates at which the clips can be applied and extracted are exceptionally high and well known in the UK. Train-mounted optical track inspection systems that allow the positions and surety of non-threaded Fastclip system to be verified are readily available, and can operate at relatively high speeds – typically up to 160 km/hr. As well as speed, these maintenance and inspection systems also help to keep the workforce off the track and increase safety.

The global stiffness of the track controls several aspects of the behaviour of the vehicle-track system, but most track fastenings used on high speed lines incorporate at least one baseplate or steel plate, so that in principle at least two resilient layers can be introduced – one below and one

above the plate. Even for a predetermined and specified global stiffness of the whole fastening, the selection of the stiffness of these two individual elements can affect overall dynamic performance.

This in turn may influence level of wayside airborne noise, as well as the mechanical behaviour of the system in response to the loads applied to it – rail roll, dynamic gauge widening, and so on. This is a complex area where Pandrol has great understanding. But to confirm that its designs provide the best possible mitigation of airborne noise within the given constraints, Pandrol is working closely with the Institution of Sound and Vibration Research (ISVR) in Southampton to test different detailed design options.



Pandrol Fastclip Baseplate

Pandrol partnership saves contractor 30% on installation time

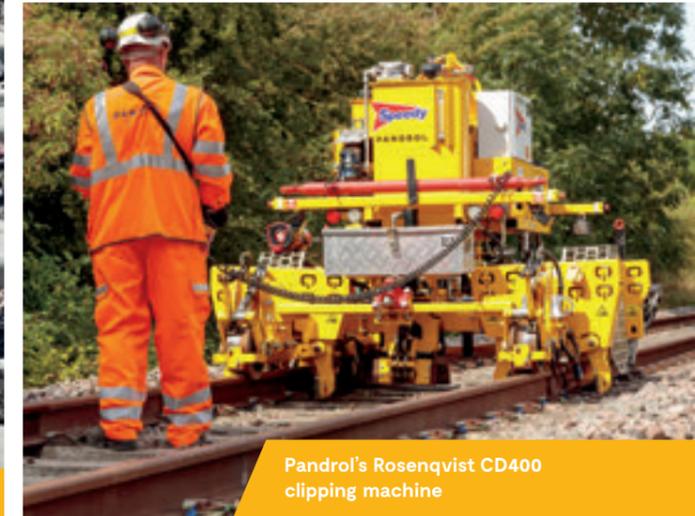
The Estonian railway network is approximately 1,217 km long, with 793 km of mainline track. It is run by the state-owned company AS Eesti Raudtee and the private company Edelaraudtee Infrastruktuuri AS.



Fastclip FE in track on the Tapa-Narva line

“The whole installation project was so much quicker and more efficient using CD400. We saved several weeks on site through its use. No other fastening system has the advantages that Pandrol offers and it is a huge benefit to be able to install the fastenings so quickly and safely.

Aldo Virula / Maintenance Department Project Manager at Leonhard Weiss RTE AS



Pandrol's Rosenqvist CD400 clipping machine

Pandrol has recently secured a new project with Eesti Raudtee (Estonia Railways) to supply 430,000 Fastclip FE fastening systems (4 per sleeper) for the 65 km stretch from the towns of Tapa to Narva in the north east of the country.

The contract is with German infrastructure partner Leonhard Weiss and follows another contract recently completed with the same contractor to supply fastenings for the Tapa – Tartu railway refurbishment. The contractor also acquired a Pandrol CD400 Clip Driver, which clips and unclips Pandrol Fastclip FE, as well as providing hydraulic power to raise low sleepers.

Leonhard Weiss reported that its use of Pandrol's Fastclip FE on the Tapa – Tartu rail line in combination with the CD400, saved the contractor 30% on installation time compared to working with traditional technologies. Pandrol supplied 105,000 sleepers for this project, which equals about 57 km of track. The project was a track refurbishment and use of the CD400 meant that unclipping and clipping 900 m of track for rail change or neutralising could be completed within a two-hour possession, minimising disruption and enabling the line to be back in operation sooner. Minimising the amount of labour required trackside also significantly reduced risks in Health & Safety.

→ OPTIMISING INSTALLATION TIME

Sleepers arrive on site fully pre-assembled with all Fastclip FE components held captive and the clips set at the parked position. Once the sleepers are placed and the rail has been threaded, clips are simply pushed from the parked to the installed position. Correct toe load is achieved automatically. Fastclip FE features the unique Pandrol 'switch on – switch off' function that enables fast, efficient track installation and reduced maintenance costs. Correct tensioning is automatically achieved when the clip is driven into the working position.

The cast-in shoulders of Fastclip FE hold the rail at the correct gauge and set the correct deflection. The shoulders are cast into the sleeper during the manufacturing process. The assembly provides excellent electrical insulation, whilst the cast shoulders are electrically isolated from the rail by the collars. The spring clips are also electrically isolated from the rail by the toe insulators.

“



Oliver Dolder

Global Equipment & Control Director at Pandrol

Increasingly contractors are moving towards automated installation equipment for fastenings, such as the Pandrol CD400 high performance clipping machine. This complements the drive towards reduced manual handling when installing rail fastenings, for health and safety reasons.

The Clip Driver CD400 is a walk-behind clipping machine that can be used to install all types of Pandrol fastclip systems, including Fastclip FE. Available in two different configurations, it has an in-built sleeper lift with hydraulic lifting capacity of 50 mm. The CD400 has an output of 40 sleepers per minute. It can be utilised by a single operator and has an electric starter and excellent lighting to improve visibility for work at night.

Lower installation and maintenance costs is the goal for any railroad operator and this is easily achievable because Fastclip FE system is fully pre-assembled and has no threaded components, eliminating costly maintenance. Used in combination with the Clip Driver CD400, which not only clips and declips Pandrol Fastclips, but also provides hydraulic power to raise low sleepers, the installation ran very efficiently.

The ability to install a section of track quickly and efficiently is really important, particularly on this project as Estonia experiences temperature changes of -40°C to +40°C throughout the year. Much of the track was completed during a very harsh winter, so being able to complete the project with a minimum amount of manual labour was a major advantage.

The Estonia Railways projects has shown just how labour and time saving an installation can be with use of Fastclip FE in combination with CD400. It is no surprise that it is being so widely adopted by contractors across the world.

Evolution of the Re System

Reducing the cost of installing rail fastenings and improving safety during the re-railing process are a constant focus for Pandrol's R&D team. In 2012, Pandrol developed the Re System, a rail fastening that not only delivers significant savings in manpower during the re-railing process, but also improves the durability of the rail fastening components installed on older types of concrete or steel sleepers. In 2018 the system was evolved with the development of a version for the UK's F40 sleeper.

“ The Re System is now our preferred system for all our re-railing jobs on concrete sleepers. We have also started to use it when we have any heavy maintenance to do, such as renewing pads and nylons, where there may be issues... we do replace the keys with the Re System.

Steve Preston / Works delivery assistant manager, Brighton
Network Rail



→ DEVELOPMENT PROCESS /

The original Re System was introduced in 2012 as a replacement for the Pandrol e-Clip on older types of sleeper. Instead of having five components (two separate insulators, two clips and a flat pad) the new design from Pandrol featured just three components; two clips with a toe insulator per rail seat. With the Re System, the rail pad is supplied with the side post insulators already attached, which reduces time and labour costs when laying out and installing the components on site.

The system is also supplied with toe insulators already in place on the toe of the clip, again reducing installation time and the number of loose components on site. The design improves rail threading and clipping rates and this leads directly to a reduced manpower requirement on re-railing sites.

The Re System also adopts the two-part insulator concept that was developed with the Pandrol Fastclip system. The separate parts can be made from the same or different materials to further tune track performance. Separating the insulator into two parts leads to greatly extended component life for these vital elements of the rail fastening assembly.

Pandrol's Re System is an innovation aimed at extending the life of components and simplifying the installation process. The result is faster, more cost-effective installation, with fewer components to handle. It also enhances safety in terms of positioning the pads and insulators during the installation process.



Pandrol Re System

→ RE SYSTEM ON F40 SLEEPER

Pandrol worked closely with Network Rail's contractors in the development phase for the Re System, with an additional assembly launched in 2017. This new assembly could be used on the F40 type of concrete sleeper. Pandrol worked with Network Rail to provide a timed trial of the new product at the Whitemoor Recycling Depot in Cambridge.

These trials showed that both the distribution of the components, and the installation needed less work, and this proved that increased yardage could be achieved in an engineering possession, with a 35% time saving, and using 40% less labour. The trial delivered a measured reduction in the work content of 61%. Pandrol developed a special tool to ensure that the Re System can be fully inserted and provide a safe stance for the operator during clip insertion, therefore enhancing safety.

The Time and Personnel savings measured at Whitemoor Depot					
Operation	Traditional e-Clip		Pandrol Re System		Percentage savings
	Staff	Time	Staff	Time	
Distribution	3	2 mins 40 sec	2	2 mins 16 sec	15% time 33% staff
Work content of installation	7.98 man minutes		4.5 man minutes		44% less work
Installation & clip insertion	5	4 mins 49 sec	5	3 mins 8 sec	35% time 40% staff
Work content of installation	24.1 man minutes		9.39 man minutes		61% less work

This means that contractors can achieve at least double the yardage in a single possession from previous operations, delivering faster installation times and with a reduced number of components compared to traditional e-Clip equivalents. This has a direct impact on minimising the track infrastructure downtime.

Pandrol provides on-site training for installation of the Re System, which can be retrofitted on existing Pandrol e-Clip and PR clip concrete sleepers. The composite pad also centralises the rail in the rail seat during the threading and clipping process.

In addition, safety for the contractor undertaking the re-railing work is improved because conventional side posts no longer need to be manually fitted between the rail and the shoulder, reducing the risk of finger injuries.

The flexibility of the Re System also means that rail pads can be provided in different materials and stiffness where required, such as EVA, or studded rubber.



By comparing the work content, it has been proved that the work savings are very large compared with the older systems, which used separate insulators. The savings arise not only from the insertion of the insulators, which need repeated bending by the operators on site, but also from having to move the rail across the pads, to insert the opposite insulator.

Gavin Livie
UK Marketing Manager Pandrol



→ SPEED AND EFFICIENCY

Network Rail's Western Route between Swindon and Bath in the UK was to undergo substantial 're-padding' of older F40 sleepers to reduce the risk of rail breaks across the network. This site at Hullavington became the pilot installation of the Pandrol Re System in order to evaluate the cost savings possible by use of the system for re-padding, even when replacing the rail clips. The installation rate achieved over a very limited shift of 3.5 engineering hours impressed the maintenance team, by achieving 30 Chains (600 metres) of re-padding over the single shift. This increased level of productivity has demonstrated that the savings of switching to the Re System recovers the cost of the extra new clips, by increasing output in very short track possessions.

The Re System was also used by the Network Rail Brighton depot at Patcham, where running rails were replaced on 1,600 sleepers over a single weekend possession.

Safety for contractors is a major issue on the railways and the Re System, offers major advantages during the installation process, because of its innovative design. When you factor in how much more work can be done within a single possession and how the Re System improves the longevity and durability of rail fastening components on older types of concrete sleeper, it really does go a long way to meeting project requirements.

Frédéric Petrus
Pandrol Electrification Manager

Ask the expert

5

→ Should Rigid Catenary be on open tracks?



Q...

Should a project use Rigid Catenary for electrification when the setting is mainly open tracks, not tunnels?



A...

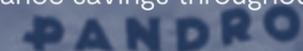
Rigid Catenary is known for being more expensive than conventional catenary as the supports required are closer together and more frequent. However, there are major advantages of Rigid Catenary for use on outdoor track as it involves less maintenance and there are safety benefits for the installation team. Conventional catenary requires tension in the wire in order to make it run straight, which is not required with rigid. Because there is no tension in the wire with Rigid Catenary, the wire is less subject to wear. It also means less risk of the wire breaking at random and causing ongoing stoppages for maintenance.

Rigid Catenary also reduces the risk of systems shutting down as it offers increased reliability, with an expected longer lifetime due to lack of wear of the wire. As a result of this, many urban transit networks are specifying Rigid Catenary on outside tracks. The ultimate benefit of Pandrol's Rigid Catenary is to maximise uptime and extend the lifetime value of the electrification system. With over 15 years' experience within Pandrol's team in delivering efficient, reliable, high performing Rigid Catenary systems, this represents a long term solution to the electrification of many global metro networks.

Creating lifetime value

“ When we look at adding value to our customers through our products and services we consider not only the initial cost of the products and the cost of installation but the value we can add through reliability and maintenance savings throughout the lifetime of the railway. ”

Steve Cox
Technical Director, Fastening Systems



Fastclip FE System adds value in Scandinavia

Over the last few years the drive towards lower carbon emissions in the production of goods has resulted in increased demand for environmentally-friendly products. To meet this demand, Pandrol has innovated within its range to design products that use less material, whilst delivering equal or better performance and with lower Carbon Dioxide emissions.



“

 Speed and efficiency is a major factor in the Scandinavian infrastructure market and use of Fastclip FE in combination with Pandrol's Clip Driver(s) means that 2.5 km of track can be covered in one hour. The installation process is therefore speeded up significantly. This is further enhanced by the Fastclip FE being delivered to track pre-assembled on the sleeper.
Erika Berg / Managing Director
 Pandrol AB

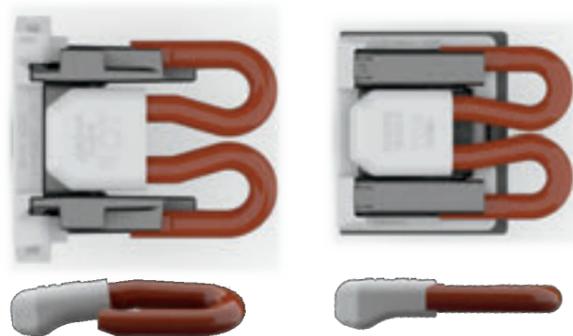


Norway has long been an early adopter of Pandrol's innovative fastenings and its national railway, Bane Nor, first switched to the Fastclip FE from Fastclip FC in 2011/12. The FE fastening system is now used on mixed traffic tracks, from high speed, standard passenger trains right through to heavy haul. Norway has now moved completely to using the FE System, in all its new tracks through a combination of engineering integrity, value for money and its environmental benefits.

Since then, Denmark, via BaneDanmark, adopted the patented FE System for its prestigious new high speed line Copenhagen - Ringsted. This was closely followed by Sweden also adopting the patented FE System which offers the same major benefits as a result of being lighter in weight and enabling a quick and straightforward installation and being environmentally sustainable.

In all three countries, Pandrol has worked very closely with the sleeper makers to bring the product to market.

→ COMPARISON /



Ø15 mm clip
0.56 kg

Pandrol Fastclip FC

Ø14 mm clip
0.44 kg

Pandrol Fastclip FE

→ LOWER CARBON EMISSIONS /

Through careful design, application of new manufacturing techniques and use of green energy sources where possible, Pandrol's new FE System reduces the amount of raw material consumed, the energy required to manufacture them and their associated transportation costs. Use of the FE System means a 30% saving in CO₂ emissions when compared to the FC fastening system.

FE has an innovative design which means it is less prone to damage by on-track equipment, due to the fact that it sits lower on the sleeper. Handling and transportation is improved due to the fact that it is lighter in weight. The FE System is a value engineered project which has been proven to deliver strong results in life cycle cost analysis.

→ WORKING TOGETHER /

Pandrol held a training day in Sweden in 2017, which was attended by railway maintenance teams and contractors from across Scandinavia, to provide a better insight into the benefits of the clip to facilitate a smoother transition to the Fastclip FE System. The event demonstrated how Pandrol ensure customers achieve the best possible service value from their fastening products.

→ A HISTORY OF PARTNERSHIP

→ 20 YEAR SWEDEN AGREEMENT



Wayne Peacock

Pandrol's Managing Director for the EMEA region

As market leaders, we want to lead by example in our practices and have a positive footprint for sustainable development. We commit to act as a strong and innovative link in our customers' value chain while controlling the impact of our operations and foster the well-being and development of people – in our teams and in the communities around us.

We have a 50 year history of working with Trafikverket and the Pandrol team placed customer focus at the heart of its efforts engaging positively with the sleeper makers to build alliances. Our bid was built on a recognition of TRV's environmental goals and will deliver value for money, sustained product quality and a high level of product support to the customer.

The FE System has undergone extensive testing in Pandrol's laboratory in accordance with CEN standards. Safety is paramount in the design and manufacture of Pandrol products.

Many other countries across the world are also switching to Fastclip FE. London Underground adopted Fastclip FE and it has introduced major efficiencies, meaning the track can be installed much more quickly and cost effectively.



Pandrol's Automated Clip Driver



Pandrol Under Sleeper Pads

Pandrol Fastclip FE System installed in Norway

The Fastclip FE fastening system was recently approved for Trafikverket's 20-year framework agreement with Swedish producers of concrete sleepers Strangbetong Rail AB and Abetong AB. Trafikverket (TRV) carried out a national procurement exercise to source pre-assembled fastening systems and under sleeper pads for Sweden's railways involving around 400,000 sleepers per year over the term of the contract.

The Fastclip FE System is the latest evolution of elastic rail fastening. The development of the FE system responds to commercial pressures to continually drive down costs within the railway industry and achieves significant overall cost savings for railway operators and infrastructure contractors, without any compromise to the performance of the assembly. The design reduces the working profile of the system whilst enhancing performance and functionality.

The Fastclip FE System is designed as a complete system in which all components are delivered to site

pre-assembled on the concrete sleeper. Once the sleepers are laid and the rail installed, the clip is simply pushed onto the rail by means of a simple drive action. This switch-on-switch-off capability encourages mechanisation of the installation and extraction processes for both renewals and maintenance. Pandrol's Clip Driver machines, such as the Rosenqvist CD500 provide accelerated installation capability of up to 70 sleepers per minute.

Pandrol has also been successful in being selected as a supplier of under sleeper pads on this tender exercise for 35 tonne axle loads. The under sleeper pads are tailor-made resilient systems designed to reduce track maintenance, increase the quality of the track by fixing elastic elements to the bottom surface of the sleepers. These under sleeper pads are proven to reduce rail corrugation, and ballast degradation, especially in tight radius curves, extending the grinding interval by at least a factor of two.

Excellence

Three new technical centres of excellence

Pandrol continues to build on its reputation for technical innovation and new product development by establishing three centres of excellence: Worksop in the UK for fastenings, Hudiksvall in Sweden for equipment and control and Raismes in France for welding.



→ SWEDEN

The new Centre of Engineering Excellence for the development of rail infrastructure equipment and controls is based at Hudiksvall in Sweden.

This is part of Pandrol's commitment to the development of equipment which improves productivity and supports the increased mechanisation of rail infrastructure.

The test laboratory features a number of test rigs and tracks including:

- An indoor test rig for simulation of worst-case track conditions, which can be altered to suit many track gauges.
- An indoor test track.
- Outdoor test track for standard gauge.
- An instrument for impedance (Ω) measuring according to European rolling stock standards.
- Capacity to rapidly build temporary track panels for any track gauge.
- Cordless electronical weighing system with four channel measuring capability.

A number of pieces of equipment have already been tested in our facility in Sweden including rail converted excavators, clipping machines, sleeper changing attachments and rail trailers.

The laboratory can simulate actual track conditions as the test rigs can be tilted to simulate different tracks, slopes and gauges. The test tracks can be adapted to suit different sleeper types and different clip assemblies, offering complete flexibility. The Sweden laboratory tests to EN15746 and draws on the competence and extensive experience of the Pandrol technical team based there.

“Our new laboratory has an industry-leading engineering department and a workshop where we can develop and prototype equipment. This supports our rail customers in managing their rail assets more efficiently, increasing uptime and maximizing availability of the railway.”

Erika Berg / Managing Director of Pandrol Sweden

“We have a strong and skilled team of engineers who are experts in developing rail equipment products for customers around the world. By concentrating our research and development activity in Hudiksvall, we can accelerate our equipment product development and focus our energies on market leading innovation.”

Oliver Dolder / Equipment and Control Product Line Director

→ TESTING TO STANDARDS

Testing is carried out to international standards such as CEN (Europe), AREMA (USA), RTRI (Japan), CRCCC and CARS (China) and any other local railway authorities.

Not only does Pandrol have an extensive and enviable test laboratories worldwide, we also employ technicians with extensive experience, degrees and affiliations to their relative professional institution, such as the institute of Mechanical Engineers.

The test laboratory has a technical support team, such as Product Development and Material Scientists on site that can advise on material selection and condition. The laboratory can offer the full suite of tests for any standard, including severe environmental, impact attenuation and electrical resistance testing.

Pandrol has the ability to run a full suite of tests in house, without the need to subcontract, providing customers with the highest level of service.

→ FRANCE

Pandrol has established two test laboratories in France for aluminothermic welding. One laboratory performs tests on the raw materials and the other analyses the welds. The type of testing carried out in the first laboratory is granulometry and also measure of the oxidation of the iron oxide. In addition, tests are carried out on the material being used to manufacture the moulds. This laboratory also carries out analysis on the welds (microscopy and electronic microscope) using highly sophisticated equipment for measuring the size of particles under electronic microscope (with magnification up to 200,000).

Featuring two test rigs, this laboratory performs product tests of raw materials, assesses the mixture for manufacturing the moulds and also carries out inspection of the welds. The second laboratory tests the welds for hardness, ultrasonic inspection, chemical analysis and slow bend. The equipment in the laboratory measures the hardness of the welds and provides an ultrasonic test, and also the chemical analysis with a spectrometer. For the welds tested, Pandrol performs two tests per batch, with weld testing carried out during the manufacturing process. High accuracy is retained as all equipment used to measure in the laboratories is calibrated and both laboratories operate to ISO9001 version 2015.

→ UNITED KINGDOM

In the UK, the former Product Testing Laboratory was expanded with the addition of new rigs to increase capacity and flexibility. The laboratory was redesigned in accordance with Lean Manufacture to enable a smooth work flow. The testing laboratory is also a showroom for customers to visit and observe their assemblies being tested. The new controllers can display exactly what is being tested, as well as the deflections and loads being applied.

The UK Fastening Systems Development and Testing Laboratory has the capability for suites of tests to be carried out on Pandrol brand rail fastening assemblies to ensure compliance with national and international standards. This includes, but not exclusively, BS EN 13481 and BS EN 13146 on concrete, timber and steel bearers/sleepers including slab track fastening systems.

This extensive testing facility ensures that the rail fastening assembly meets the necessary standard and trackwork specification required on a specific project.

The UK laboratory also has the facility to carry out testing on individual components, such as the rail pad, clips etc. which can be tested to ensure it exhibits the desired characteristics and properties.

All components are inspected before, during and after the tests. A typical test will run for 12 days and will include:

- Vertical stiffness
- Dynamic stiffness
- Clamping force
- Longitudinal rail restraint
- Repeated load test (3 m cycles)
- Electrical resistances
- Torsion
- Attenuation of impact
- Severe environmental test
- Vertical load test (Cast in compounds)

The UK laboratory features a suite of all servo and computer-controlled rigs, which can be used singly or in regimes involving two or three actuators that are synchronised to apply sequential loads to the components or full assemblies under test. The laboratory has seven test rigs, which are used to simulate vertical and horizontal components of loads with rail displacement measured using state of the art data acquisition systems.

Pandrol Connect: Driving greater weld traceability across the rail sector

Pandrol's new Connect app enables complete end-to-end data coverage across the aluminothermic welding sector. The technology reflects Pandrol's core ethos in offering an unrivalled customer experience – maximising rail infrastructure availability, safety and lifetime value.

The app was developed in response to the issues of weld traceability, which can be a major challenge in areas where many different contractors are involved. Efficient traceability is essential to gather, trend and spot anomalies in weld performance data – essential also for optimising costs. The app enables live data capture, a significant time saver for contractor teams.

The app has three modules:

- A mobile version for welders to record on-site data and for welding controllers to review data
- An online monitoring app to review weld information from the office
- An online administration tool to apply settings to local standards

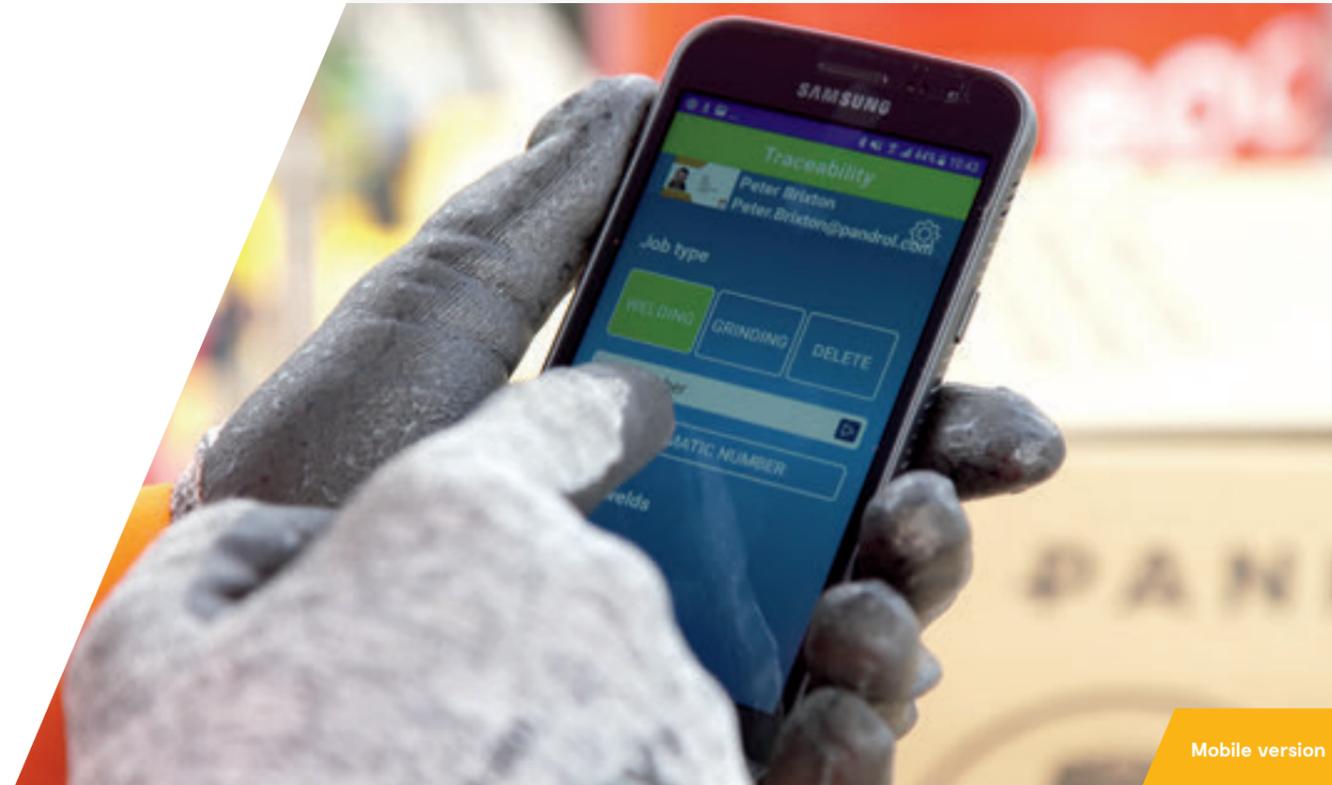
Pandrol Connect, an app with smartphone technologies to share data with multiple networks and companies – in one click– no paper, no emails – just simplified communication and responsibilities.

Pandrol defines the industry standard across the aluminothermic welding sector and has developed the Connect app with alignment to Industry 4.0, as a commitment to visibility and optimisation of the entire value chain.

Pandrol started work on developing the welding app back in 2016, the objective of which was to develop an open platform which would facilitate the recording and transmission of the data between all welding parties, including railway authorities, welding companies and welding kit suppliers. All data is stored in the cloud for easy sharing to contractors and the network, automatically.

Available for Android, the app has already been used, with great success, by Pandrol's welding services teams and contractors across the UK and France.

Feedback has been overwhelmingly positive and has resulted in enhancements to the app, including the latest innovation to include a news function that improves weld documentation opportunities and data sharing overall.



Mobile version

The app is already benefitting Pandrol's quality systems through the automation of the documentation of industrial processes and instantly available information at the touch of a button. Pandrol expects this to have a major impact on welding projects in the future and looks forward to demonstrating the benefits to customers.

Pandrol's research has shown that contractors appreciate the facility to record data before, during and after welding, even with no internet access. Compatible with all welding kit suppliers, data can be downloaded by technicians on location. In line with the product launch, Pandrol has released training videos to support contractors with using the new software, which can be easily located online.

Welders are extremely happy with the ergonomic aspects of the interface, such as immediate access to welding instruction manuals, the use of QR codes, the facility to add voice comments and compatible interface gloves.

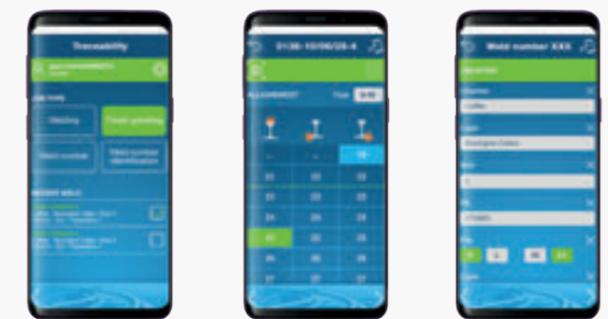
In addition, welding contractors welcomed the reliability of the report and the fact that data is automatically transmitted from site, with many weld parameters pre-filled (such as the Supplier Job Reference and Job Cost Number), so no need for input.

Data confidentiality is paramount - Pandrol Connect allows only authorised users to view data.



→ BENEFITS

- Enables cost optimisation and enhanced customer service across the supply chain.
- Provides a customisable cost-effective app with no capital outlay.
- Saves time for all users and drastically cuts down paperwork.
- Encourages efficiency and innovation through an incorporated news function.



Partners in excellence

pandrol.com



DELACHAUX GROUP