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for Railway Substation



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PFISTERER
Customer Magazine
Issue 2 **2014**



Jörg Fries

Editorial

The right material

Standard or custom-manufactured? We prefer to use an "and" there instead of "or". And we supply the most efficient solution for a specific application:

This is why you can find PFISTERER railway technology in the longest railway tunnel in the world (starting page 4), on a train trip through Austria (starting page 8), and on the new high-speed rail line in Ankara and Istanbul (starting page 10). Our versatile connection components conduct traction current production in a new outdoor substation (starting page 14).

Our line vibration analyses and damping systems for overhead lines (pages 18 to 21) prevent millions in damages. The new solid-material insulated HV-CONNEX joint provides reliable connections in offshore wind parks and anywhere you want to avoid SF₆ gas monitoring (starting page 22).

We wish you an exciting reading journey through the many worlds of application. And we're also certain we have the optimum solution for your application!

Sincerely,

Jörg Fries

CSO
PFISTERER Holding AG

Safety Equipment for Record-Breaking Tunnel

The Gotthard Base tunnel is making history as the longest railway tunnel in the world even before its official opening in 2016. Earthing device from PFISTERER is being used to operate it safely over 57 km. Whether smart, custom solutions or time-tested classics, each component also meets the highest requirements: safe handling and reliable function under extreme conditions.

"The greatest challenge in this project was finding a solution for safely and feasibly earthing and short-circuiting the traction current supply lines," reports Jürgen Finsinger, PFISTERER Product Manager for Safety Equipment, "because the usual procedure with standard equipment could not be used in this tunnel."

In classic earthing and short-circuiting of open-air railway lines, earthing equipment would be connected so that a train would break it away as it passed (page 6, lower left image). Therefore, in this configuration, the train operation would be regulated according to sections of track. Unlike the stipulations of the Alp-Transit Gotthard AG (ATG): In the Gotthard Base tunnel, the rails must be able to be used for diesel-powered maintenance vehicles at all times.

Unrestricted travel in this sense allows unobstructed earthing and short-circuiting while the passage corridor remains accessible. Instead of the usual earthing on the rail line, the return line should be bypassed with the feeder line. In the Gotthard Base tunnel, these lines run parallel on the tunnel floor at 5.5 m high.

Easy handling at a lofty height

The PFISTERER engineers developed a suitable solution for this use case by testing with various models. They ended up with earthing equipment whose reliability and simple handling persuaded the demanding operator consortium. The earthing cable is 1.5 meters long enough for installing the clamps on the lines and also



short enough that it does not hang into the passage corridor. As long as the equipment is installed correctly, the earthing rod can be removed.

A mounting bracket and torque-controlled mounting head for the earthing rod make the earthing equipment easy to handle. These features work together ideally during installation: First, the return conductor clamp is put on the earthing rod to hoist and suspend the return conductor. To allow the clamps to withstand the enormous dynamic forces if a short circuit occurs, they are screwed down to the line reliably by means of the earth-

For reliable use under hard conditions: PFISTERER supplied a time-tested and custom-built earthing device for the new Gotthard Base tunnel, which counts as the world's longest railway tunnel to date at 57 km total length. (© AlpTransit Gotthard AG)



ing rod. Once a specific torque is reached, the mounting head releases the return conductor clamp, which is now attached optimally, and only after this happens can the installer remove the earthing rod from the clamp. Thanks to the mounting bracket, installing the subsequent feeder conductor clamps to the feeder conductor is almost child's play. The bracket holds both clamps. When the return conductor clamp is being hoisted, the feeder conductor clamp is also hoisted and remains there in a stable position. It does not disrupt the return conductor clamp installation and, at the same time, is perfectly positioned for the next installation step: Despite the 5.5 m

« The greatest challenge in this project was finding a solution for safely and feasibly earthing and short-circuiting the traction current supply lines.»

Jürgen Finsinger
PFISTERER Product Manager for Safety Equipment



First test drive through the new Gotthard Base tunnel:
View of the flat, straight railway from the conductor's cab.
(© AlpTransit Gotthard AG)

height, it can be precision mounted with the earthing rod, attached to the neighboring feeder conductor and then also screwed on.

Strength in all positions

The earthing equipment has proven its unique durability at an external testing institute: The clamps held onto the conductors, without shifting, at a stipulated, maximum short-circuit current of 40 kA/100 ms. The SBB personnel can reliably check that the power is cut off before earthing and short-circuiting according to five safety rules – using the KP-Test 5R voltage testers. Even in unfavorable environmental conditions, these worldwide, time-tested devices clearly relay the test results due to the optimally harmonized acoustic and visual signals. When the equipment is switched on, a self-test checks the



Field test passed with distinction.

functionality of the voltage tester, including the contact electrode extension.

All safety devices must be effortless to use. Therefore, voltage testers, such as the earthing equipment, should not only be at hand in the Gotthard Base tunnel at a distance of no more than 1000 m, they should also be protected from the rough conditions in the tunnel: Temperatures of - 20° C to + 40° C, more than 70 % humidity, heavy contamination, and pressure and suction forces of +/- 10 kPa when a train passes at 250 km/h. PFISTERER also makes custom solutions for that: Custom-built storage cabinets – rust-free, dust-proof and pressure-resistant.



Poor visibility, loud ambient noise? This is no problem for the railway voltage detector, KP-Test 5R: Its visual and acoustic signals are optimally designed for continuously distinct detector readings.



12 Codes for railway technology in the Gotthard Base tunnel

Track system

- 31 km ballasted track system
- 115 km non-ballasted track system (incl. MFS rail switch connection)
- 131,000 m³ concrete
- 290 km rails (incl. MFS rail switch connection)

Railway catenary

- 115 km railway catenary in the tunnel
- 39 km railway catenary in open stretches
- 2,860 tunnel framework
- 3,200 spring framework

50-Hz power supply and cable systems

- 3,200 km copper cable
- 2,631 km optic fiber conductor
- 250 transformers
- 10,000 lights

New Routes Through the Alps

The New Railway Link through the Alps (NRLA) is the first flat railway through the Alps, from Altdorf in northern Switzerland to Lugano in the South. The new Gotthard Base tunnel is the heart of the railway. At 57 km in length, it is anticipated to go into operation as the world's longest railway tunnel in 2016. In 2019, the Ceneri Base tunnel, at 15.4 km total length, should complete the flat railway. Alp-Transit Gotthard AG (ATG), founded in 1998 as a 100-percent subsidiary of the Swiss Federal Railways (SBB) is constructing the NRLA.

Lower height. Less incline.

The Gotthard Base tunnel traverses the base of the Saint-Gotthard Massif at about 550 m above sea level and, thus, spares trains from the laborious climb to the "old" tunnel, which has been operated at over 1,150 m and a maximum incline of 26 ‰ since 1882. The Gotthard Base line gets by with an incline of just 12 ‰.

Faster travel. More freight.

A significant feature of the Gotthard Base line is its mixed operation. The passenger trains will pass through the Gotthard Base tunnel at a max. 250 km/h; freight trains will pass through at up to 160 km/h. The Gotthard Base line shortens the route from Basel to Chiasso by 40 km and an inter-city express (ICE) trip from Zurich to Milan from 4 hrs. 20 min. to 2 hrs. 40 min. The annual freight capacity will increase from the current approx. 20 million tons to around 50 million tons.

Patented efficiency. Not just for tunnels.

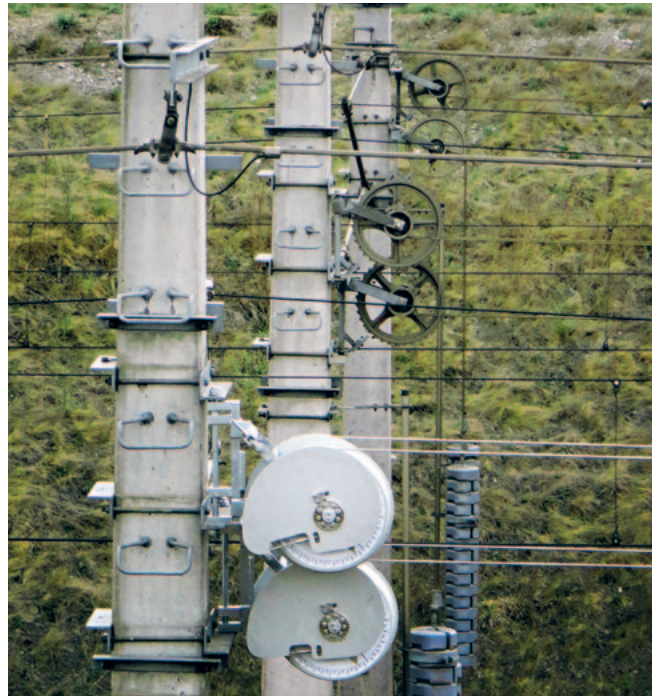
Streamlined construction, simple installation, reliable tension force – the ÖBB-Infrastruktur AG demands these and other qualities from tensioning devices for future use in exposed areas of the Austrian railway system. The TENSOREX C+ by PFISTERER qualified as a suitable test candidate for this. The patented tensioning system for contact wires and messenger wires proves its strengths during one multi-month test installation.

The ÖBB-Infrastruktur team identified ideal conditions for testing a tensioning device on the dual-track New Western Railway at St. Pölten: At one of the tunnel entrances, trains fly over the track at up to 160 km/h; there is very little space for installed technology and workers. Even with the first installation, the TENSOREX C+ scored its first bonus points.

Its unique tensioning system is based on a custom spring mechanism, making the TENSOREX C+ much more compact and lighter-weight than the traditional solutions. For example, the ubiquitous tensioning wheels require massive weights to be installed on or integrated into the supports. TENSOREX C+ manages without that and even at a slim 630 mm length, 400 mm width and 600 mm height – the perfect size not only for use in tight spaces, but also wherever an inconspicuous appearance is desired.

Unequaled light weight

TENSOREX C+ was a sensation among the ÖBB technicians who first installed the tensioning system in spring 2014. "It was remarkable how easy it was!" This and other similar statements were made about the handles. For example, even though assembly tips from Renato Capacchione were a welcome service, they did not need his help: "The more a solution deviates from the known standard, the more questions there are about it," says the PFISTERER product manager for spring tensioning systems, "that's why we are available on site as a contact partner even if a product like TENSOREX C+ is already self-explanatory."



Test installation of TENSOREX C+ in the ÖBB system: The patented PFISTERER solution (front left) is significantly slimmer and less conspicuous than traditional tensioning wheels (back right).

Unlike tensioning wheels, which need to be assembled from individual parts, the TENSOREX C+ arrives on site ready to be installed. The tools and load-handling devices used for overhead lines are sufficient for installing the TENSOREX C+ – the installers do not need any special training. Its comparatively low weight of a max. 180 kg also makes the work easier.

Unique efficiency

"Efficiency is an important aspect when assessing new implementations," says Franz Kurzweil, Team Leader for Regulation of Overhead Lines at ÖBB-Infrastruktur. The proposals for product approvals for the ÖBB network pass his desk, and he is the one who initiated the test installation of the TENSOREX C+. Wolfgang Kapfenberger had pictured the exact intrinsic values of the tensioning system in advance. Therefore, the system specialist for overhead lines at ÖBB-Infrastruktur visited the PFISTERER factory in Passirana di Rho in Milan along with Rudolf Russmair, Engineering Specialist for Overhead Lines ASC St. Pölten at ÖBB-Infrastruktur.

At that time, Capacchione used a public example of the patented TENSOREX function concept (see detailed info at the right), which he had a significant hand in developing. For René Neubauer, Sales Manager at PFISTERER Vienna Ges.m.b.H., this was a good way to coordinate inquiry and supply: "First and foremost, customer focus means finding an optimum solution for a specific need. This happens ideally when you can speak with the customer on site and give insight into the product."

At that time, the tensioning device presented even more advantages: As a purely mechanical system, it is maintenance free during use and constantly and reliably keeps contact wires and messenger wires tensioned during the entire lifecycle. "Viewed as a whole, TENSOREX C+ ensures high efficiency at many levels," says Kapfenberger. The consistent, positive results of the test installation, so far, speak for the smart tensioning system being able to meet the expectations of ÖBB-Infrastruktur even in the long term.

ÖBB technicians install TENSOREX C+ for testing in the ÖBB railway system. Their unanimous conclusion: "Remarkably easy to install!"



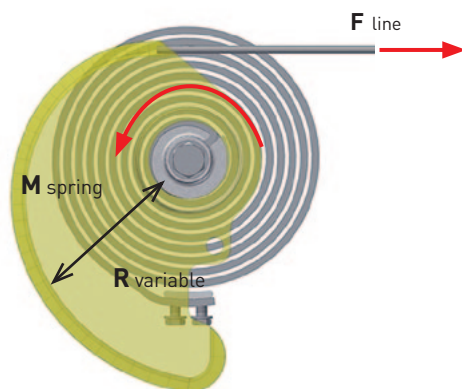
Patented System for Consistent Tension Force

One thing needs to stay consistent for smooth rail travel: the tension force for contact wires and messenger wires that expand or contract due to fluctuating temperatures. Otherwise, the current conduction between the current collector and the contact wire can be interrupted. TENSOREX C+ prevents this.

Its core forms a spiral spring package. This formation is mounted on the same axis with two disks with a variable radius. The maintenance-free, encapsulated roller bearing serves as the axle bearing. The disks are firmly connected to the contact wire and/or messenger wire with short wire rope.

Using increasing rotation angle, the spring creates increasing torque that is balanced by the increasing radius of the pulleys. This is how this purely mechanical system transforms the temperature-dependent changes to the tension force into a constant tensioning force.

$$F_{\text{line}} = \frac{M_{\text{spring}}}{R_{\text{variable}}} = \text{constant}$$



With a unique, spring-based tensioning system, TENSOREX C+ consistently and reliably retains the tension force on contact wires and messenger wires over the entire lifecycle (also see the detailed info at the right of this page).

At High Speed Through Turkey



The new high-speed railway between Ankara and Istanbul reduces the current travel time by half. PFISTERER supplied full-service, versatile railway technology for the mega-project. Time-tested railway catenary systems and components support reliable electrification in a dual-rail segment of over 185 km; field-tested installation material provides for easy installation.

With a maiden trip from Ankara to Istanbul, the Turkish Prime Minister, Recep Tayyip Erdoğan, inaugurated the new high-speed railway on July 25, 2014. It is one of the latest large projects with which the government, the ministry for transportation and the public railway association TCDD is striving to advance the infrastructure to the European standard.

Around 12 million passenger trips and freight transports take place annually between the capital city Ankara and Istanbul, the most populated city in the country with 14.6 million inhabitants – a volume of traffic that pushes the old railways, through roads and highways to their limits. The modern high-speed railway should relieve this issue. The railway designs show the first positive effect: Instead of 6 to 8 hrs., a trip between the two major cities takes only 3.5 hrs.

The way there was divided into two phases, each with several stages. During the first phase from 2003 to 2009, the 251 km long stretch between Sincan in Ankara and İnönü was developed. During the second phase, starting in 2010, more complex terrain was developed. The first 158 km long segment between İnönü and Köseköy is shaped by bridges and viaducts. The total length of the new railway connection is 533 km. It was designed

for high-speeds of up to 250 km/h and is electrified with 25 kV/50 Hz alternating current.

Sophisticated competence

TCDD commissioned the China Railway Construction Corporation (CRCC) with erecting the railway catenaries. The Chinese state-owned enterprise for railway construction cooperated with PFISTERER, among others, on the electrification. "We are not limiting ourselves to only product offerings;" says Thierry Metrat, PFISTERER Product Manager for Railway Catenary Systems, "we supply application-specific solutions based on our expertise. As we did for this project."

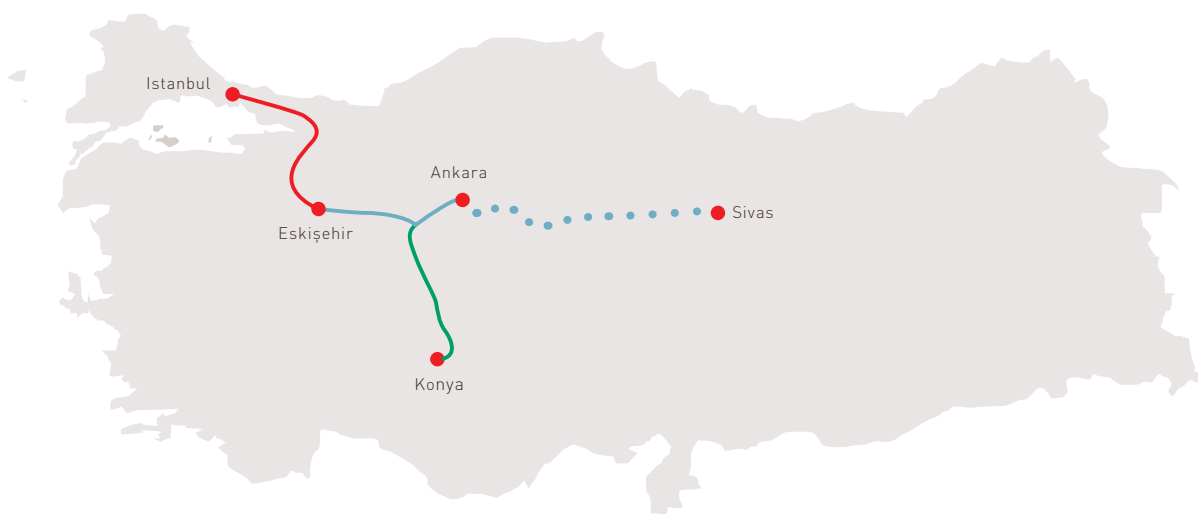
PFISTERER has developed and produced components and systems for railway catenaries for more than 30 years. They are installed in rail lines worldwide and have become the industry standard for railway associations. If you explore the segment of the new high-speed railway between İnönü and Köseköy, you will not only find a large portion of the PFISTERER railway portfolio, you will also gain an impression of the experience, which is also related to this.

Slim and strong

A custom clamp for connecting steady arms and registration tubes is among the many connector elements

High-speed rail (HSR) in Turkey

- HSR 1: Opening 03/2009
- HSR 2: Opening spring 2011
- HSR 3: Opening 07/2014
- HSR under construction



«We supply application-specific solutions based on our expertise. As we did for this project.»

Thierry Metrat
PFISTERER Product Manager for Railway Catenary Systems



Managers of the railway association TCDD and the railway construction company CRCC inspect the installation of a TENSOREX C+.

that PFISTERER supplied for the various cantilever designs by the engineering firm UBM-INECO, which is involved in the project. It is a component of the dual beam PFISTERER developed during a pilot project for use in constricted space (image at right). The unique shape of the clamp supports an overall slim design, and at the same time, the clamp withstands the typical mechanical loads during operation. "The more elements work together, the more complex the design is," says Metrat. "Therefore, we develop every new component, whether cantilever or single component, using computer simulations. This is how we can realize project-specific solutions efficiently."

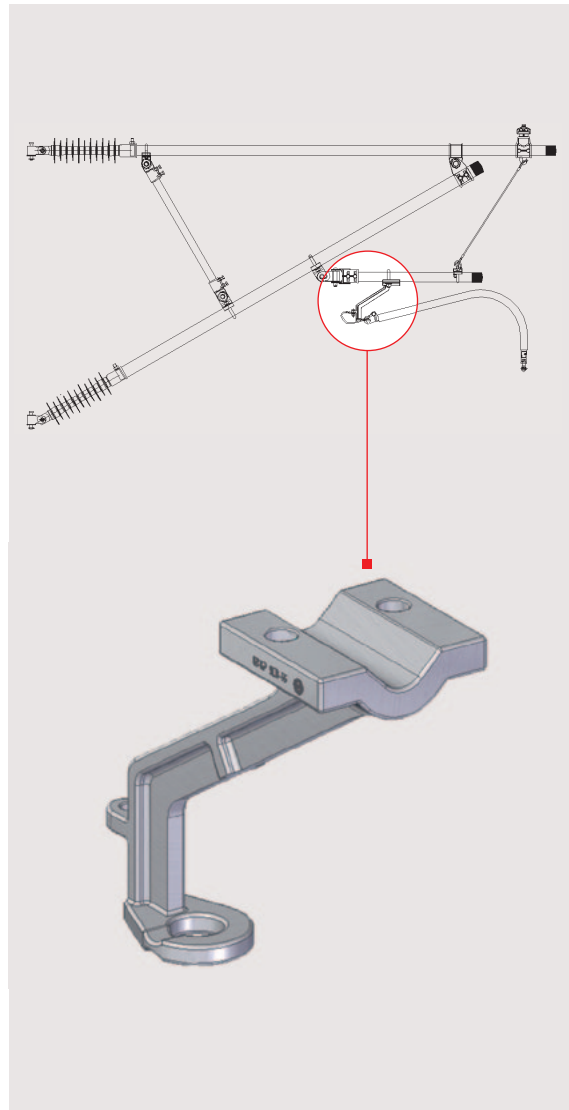
TENSOREX C+ is also designed for efficient use in tight spaces. The patented tensioning system retains constant tension in the messenger wire and contact wire (for details, see the aforementioned report). It is easy to install and its compact construction saves space inconspicuously. A good reason for CRCC to use TENSOREX C+ in selected tunnel areas.

Can be installed flexibly

PFISTERER supplies flexible droppers and installation materials for current-proof suspension of the contact wire and messenger wire. The length of the dropper is oriented toward the space between the contact wire and

the messenger wire, which can vary depending on the place where it is used. Two PFISTERER installation plates, equipped with cutting and pressing tools, simplify pre-installation of the dropper with the respective lengths required. During installation, the suspender position could be optimized conclusively – thanks to dropper wires that can be adjusted in length.

And even more PFISTERER products are being used on the new rail line, for example light C and E clamps, highly durable fix point clamps, Y-wire-clamps and wedge terminal clamps. All of them conduct safe power supply for smooth, fast rail transport between Ankara and Istanbul.



PFISTERER custom develops entire cantilever or components using computer simulations. The lower image shows a special clamp that provides a slimmer shape for a secure hold in a dual cantilever (above image).

Highly durable fix point clamps by PFISTERER are in use (large image above).



For more information,
use this QR code.

Many PFISTERER rail components provide reliable electrification on a 185 km long dual-rail segment of the first high-speed railway between the major Turkish cities Ankara and Istanbul.



The new Verbois substation was erected in Geneva for fast rail travel between France and Switzerland without frequency change. PFISTERER supplied the most varied connections for its reliable connection to the inter-urban network, among them the unusually durable terminal chain and field-tested clamps. Included in the extensive service package: Safety equipment and custom solutions.

When trains pass the border between France and Switzerland, they have to overcome a historically increasing obstacle: the change of regular operation voltage or railway system frequency from 25 kV/50 Hz in France to 15 kV/16.7 Hz in Switzerland, and vice-versa. This also happens on the stretch between the French municipality of Bellegarde-sur-Valserine and the train station in Geneva, Switzerland. To allow the French high-speed TGV trains to zip through seamlessly, the Swiss Federal Railways (SBB) modernized the stretch of railway in cooperation with France's state railway company SNCF. The core of the renovation was the electrification of the railway catenaries with 25 kV/50 Hz continuing up to the Geneva train station.

There is a well-placed energy hub in the vicinity of the Geneva train station: At the Verbois site, the infrastructure company Services Industriels de Genève (SIG) operates a hydroelectric plant, two solar power plants and a 145 kV substation; the national Swiss network company, Swissgrid, maintains a 420 kV substation and a 245 kV substation here. The latter was selected as the power source for the new Verbois substation (SS), which diverts a portion of the 245 kV current and transforms it into traction current at 25 kV/50 Hz. The Verbois SS was erected on behalf of SBB Energie AG and SIG from the Lausanne Alpiq Enertrans SA, a subsidiary of Alpiq AG Enertrans, which has built high voltage systems and switchgear for energy transportation and distribution for over 80 years.

"Connecting the Verbois substation required numerous different connectors, at which time many new standards needed to be met," said Pierre Gabriel, Project and Group Manager for Secondary Systems Engineering at Alpiq in Lausanne, Prilly. "Therefore, we gave high value to a supplier with a broad portfolio and comprehensive expertise." The general contractor decided on PFISTERER. Specializing in contact and insulation systems, the company has developed and manufactured connection and jointing elements for power grids since 1921 and counts as an innovation leader in many areas of its industry. PFISTERER supplied outstanding connection technology for this project as well.

Strict standard. Accurate design.

For example, terminal chains that are the first to be operated in accordance with the Swissgrid standards that



Full-Service Supplier for Railway Substation

came into effect in 2014. These standards are not only recent, they are also extremely demanding. Many exceed the internationally recognized guidelines by 20% or more. Therefore, the terminal chains for use in the Verbois SS need to withstand a 50 kA short circuit current for 1 second and carry 300 kN maximum load. Internal tests as well as external tests at testing institutes prove that the PFISTERER chains can withstand both and even more.

Their merit is based on time-tested components that are developed continuously. As a highly experienced and successful global provider of complete insulator chains, PFISTERER offers a component system with which insulator chains can be designed optimally according to customer needs. The advantages of systematically designed insulator chains are obvious: The responsibility for the technical functionality during operation and the

Pierre Gabriel, Project Manager for Alpiq Enertrans, checks for correct installation of the earthing-isolator boxes in the cable cellar. This PFISTERER solution serves for flexible screen handling even during operation.



The new Verbois substation (in front with dark green portals) connects to an existing 245 kV substation (in the background with yellow-green portals). PFISTERER supplied an extensive package of connection technology for long-lasting, reliable connection.

compatibility of individual components is clearly defined and the chains are tested according to engineering standards.

Along the way, the development engineers harmonize all components of a chain with each other — up to the last link in the chain. For good reason. "The whole chain is only as good as the interplay of its parts," says Elia

Husmann, Development Engineer for Insulator Chains and Fittings at PFISTERER. "For example, a strong insulator alone is no guarantee for lifetime reliability of the chain. It may withstand a short-circuit current, but what use is that if the attachment fittings break at that time and release from the portal? Nothing. The entire chain breaks."

Versatile. Available. Trusted.

Even the outdoor switchgear terminals that PFISTERER supplied in large numbers and versatile variations to connect various conductors and many devices in the Verbois SS need to function reliably for decades. The connection specialist knows what works best from its over 70 years of experience. In the meantime, the company has more than 12,000 cast models for a variety of outdoor switchgear terminals in stock.

"This figure reflects not only our ability to supply all popular types of outdoor switchgear terminals, but also our



PFISTERER terminal chains and FSK clamps were used for connecting the new transformers to the current transformer (small image on the left).



Installation of PFISTERER products at the changeover from the new Verbois substation to the existing 245 kV substation (left image) and after installation (right image): Post insulators standing on the portal; the high-load terminal chain is projecting horizontally toward the left.

profound expertise — which we are happy to provide when consulting customers during terminal selection,” says Reto Aeschbach, PFISTERER Sales Manager for Switzerland. “Therefore, our customers can rely entirely on us when it comes to this product range, too. You can even reorder the same outdoor switchgear terminal from us after several decades.”

Now the employees of the SBB are using a proven product in new design when they test system parts for voltage in the Verbois SS. For this, PFISTERER supplied voltage testers of the KP-Test 5R model, among other things, from its safety technology program, which are now also

being used in the variant for 25 kV/50 Hz for the first time on the Swiss rail system. The staff does not need to make a switch for that: The “new” version works like the voltage tester for 15 kV/16.7 Hz already widely used in the SBB system. However, the two testers cannot be mixed up – variously colored labels make sure of it.

In the meantime, transfer of goods and expertise has been concluded: All PFISTERER components and custom solutions (see image at the lower left and at the top of page 15) are installed and have been in operation since April 2014. And now the TGV trains have been roaring over the modernized railway since August 2014.



PFISTERER custom solution for connecting the new transformers in the Verbois substation: Connection from the transformer implementation to the energy arrester with integrated surge protection technology.

Products & Solutions from PFISTERER for the New Verbois Railway Substation:

- Complete 245 kV dual and single terminal chains according to new Swissgrid standards
- 245 kV support insulators
- substation clamps 245 kV & 15 kV for all device connections
- Earthing and short-circuiting devices & components
- KP-Test 5R 25 kV/50 Hz voltage tester
- substation clamps, flexible transformer connections
- Earthing isolator boxes for cable earthing (used in cable cellar)

Safe from Cable Failure

Wind displaces overhead line cables through vibration – a physical phenomenon that can cause damage in the millions. Wiener Netze GmbH guards against this: The Austrian distribution network operator commissioned PFISTERER to supply a custom damping system for a 110 kV line. The effect of the Stockbridge damper was reviewed during several months of cable vibration measurement. Only PFISTERER manufactures the vibration recorder required for this.

Broken conductors, loose fittings, cracked mast foundations – the list of damages wind-induced cable vibrations can cause fuels the bitter experience of network operators worldwide. And they warn of even worse things to come. Because when this kind of material damage arises insidiously, it is only a matter of time before it brings the current flow abruptly to a halt. "Whether a local or large-scale failure, the consequences would be anywhere from unpleasant to costly for all parties involved. That's why we put measures in place in advance and build on the expertise of the PFISTERER company," says Andreas Baumühlner, an expert on 110 kV and 380 kV overhead lines at Wiener Netze GmbH.

Wolfgang Huiber, Sales Manager for Overhead Lines at PFISTERER, explains how the effects of wind-induced cable vibrations are related to the modern overhead line construction: "These days, overhead line masts are being constructed to be more compact and lower than before. Moreover fewer masts are being set for an overhead line route, which increases the distances between them. The consequence of this optimization is that the overhead lines need to be tensioned more tautly. Otherwise, they would hang too low and the required minimum distance to the ground would not be met. The higher the tension in the stranded conductor, the lower its internal damping. The reduced internal damping results in greater vibration amplitudes at the same wind intensity."

At the same time, the individual wires of the overhead lines bend, expand and rub, which creates additional tension in the line from bending fluctuations. At corre-



sponding vibration forces, the kinetic energy migrates from the line to the attachment fittings and, from there, through the insulator chain to the mast right down to its foundation. Everything starts to vibrate. This repeats, and it patiently shakes and wears every material it contacts for years — until the materials succumb to fatigue failure. Or, you seek preventative measures, like Wiener Netze did.

Zero point or on point

The company conducts electricity, natural gas and district heating to more than two million customers in Vienna, parts of Lower Austria and Burgenland. All lines of

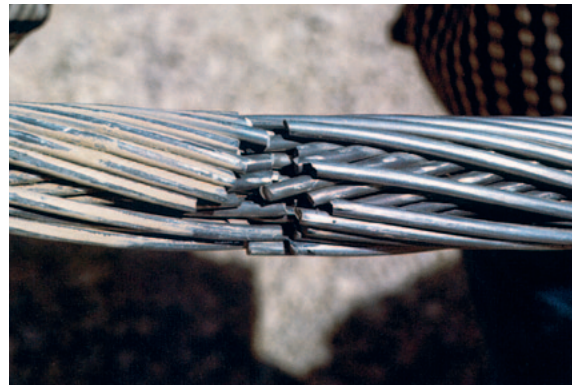
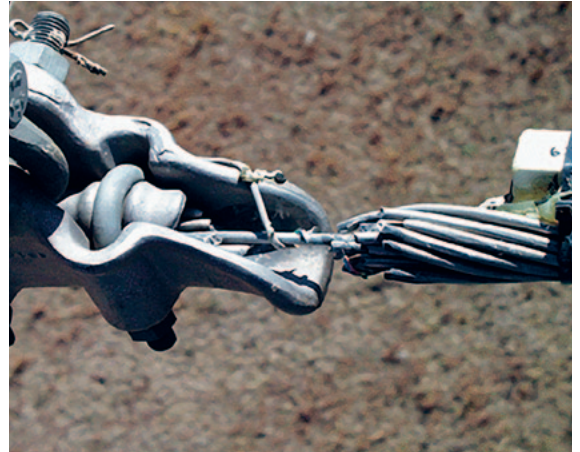


Wiener Netze are strung together into a length of more than 30,000 km.

A part of this route is the 110 kV line between the Southeast substations and Liesing. "It crosses a field, blows in critical winds and, at the same time, lacks in well-placed natural barriers, such as landscape elevations or dense forests," says Kurt Hosinger, employee in the Application Sales Team at PFISTERER Ges.m.b.H in Vienna.

For effective protection of the overhead line, PFISTERER designed a damping system that absorbs the vibration energies. To succeed, it is not enough to know the right

Winds trigger vibrations on the overhead lines. Under certain conditions, they can heavily damage the stranded conductor and other parts of the overhead line, and expensive failures can occur. This can be prevented with precisely designed damping elements from PFISTERER.



Stranded conductor failure is typical damage resulting from wind-induced line vibrations.

Evaluate Vibrations intelligently

Line vibration measurements provide valuable knowledge. In every use case:

- Damping system acceptance test
- Comparison with various damping systems
- Prognosis for the lifecycle of the stranded conductor
- Investigation of the cause of damage to the overhead line
- Analysis of natural and other environmental conditions, e.g., influence of neighboring wind-power plants



As of yet, only PFISTERER manufactures instruments for stranded conductor vibration measurements that not only measure vibration amplitudes and frequencies, but also measure important influencing factors such as wind speed and environmental temperature. Here, a VIBREC500WT model vibration recorder for measurements on individual conductors used on an 110 kV line from Wiener Netze.

type of damper. Patrick Sommer, PFISTERER Product Manager for Insulator Chains and Fittings explains why: "A vibration moves like a wave on the line. Like every wave, it has peak and zero points. Dampers set at zero points are useless because they are not stimulated and therefore do not work."

The position of the zero points varies. Depending on the vibration frequency, they follow each other closely or further apart. The frequency varies with the wind speed, and consequently several vibration frequencies overlap, which is typical of Aeolian vibrations. PFISTERER solves the dilemma with expertise and techniques.

Count on experience

"We know from experience which of our dampers we can recommend in which stranded conductor," says Sommer. "We adjust their damping behavior in computer simulations, in which we incorporate all other factors that need to be considered, including: the expected wind speeds and directions, the characteristics of the stranded conductor used, the distance between the masts and more."

The calculations not only show the optimal type of damper, but also the points on the line at which the damping elements need to be installed. Valuable knowledge that PFISTERER provides in black and white with every

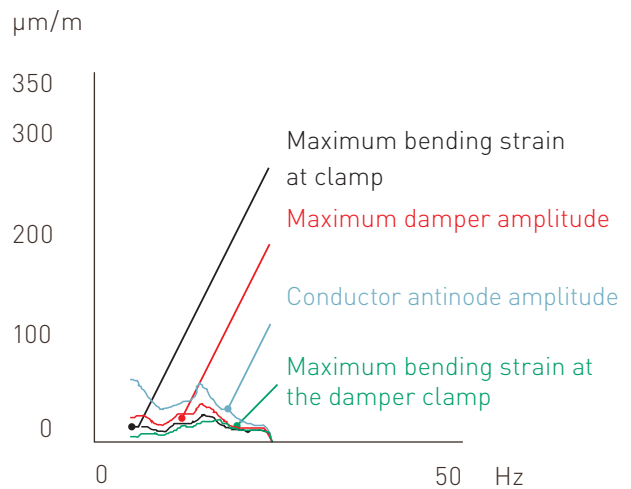
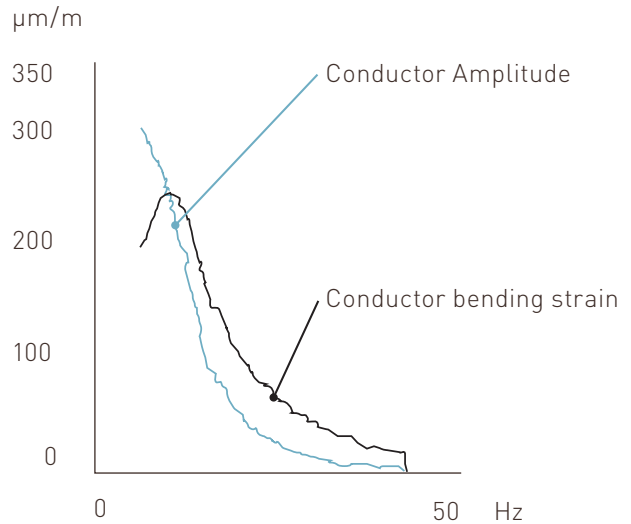
Manfred Landauer, Head of Installation of Wiener Netze is coordinating the installation of the PFISTERER vibration recorder from the ground (small image at the top). Peter Feldhofer, Managing Director at Vienna Ges.m.b.H. is monitoring the installation of the recorder on a line at a height of 35 m.



«A vibration moves like a wave on the line. Like every wave, it has peak and zero points. Dampers set at zero points are useless because they are not stimulated and therefore do not work.»

Patrick Sommer
PFISTERER Product Manager for Insulator Chains and Fittings

damper supply. For additional safety, PFISTERER will check the effectiveness of an operating damping system upon request. The same as it did for the Wiener Netze 110 kV line. A vibration recorder measured and stored the vibration amplitudes, vibration frequencies, wind speeds and ambient temperatures from February to April 2014 — months in which winds and temperatures wreaked havoc in this area. Result: These effects can no longer harm the line – thanks to the precisely designed damping system from PFISTERER.



Exemplary data comparison of cable vibration measurements on an overhead line in Africa: Without a damping system, the bending strain of the line reached 250 $\mu\text{m}/\text{m}$ (upper graphic) as a result of wind-induced vibrations. After dampers are installed, it drops to values well below 50 $\mu\text{m}/\text{m}$ (lower graphic). Internationally recommended max. values are at approx. 150 $\mu\text{m}/\text{m}$.



For more information, use this QR code.

Joints for new 66-kV- Inter-Array Networks in Offshore Wind Farms

Flexible use without monitoring, certified for offshore use: With the new HV-CONNEX connection joint for up to 72.5 kV, users benefit from the advantages offered by no other joint overall for this voltage level.

For the first time, this newcomer brings together the strengths of different PFISTERER joints for high voltage in one product: Pluggable and insulated with solid-material at the same time, the connecting joint is easy to install and disassemble; as used it creates maximum safety for the system and environment – the ideal solution to meet the demands of world markets.

The more sparsely offshore wind farms are built, the higher the power that can be transferred between wind turbines and substations. For power transmission, this results in either larger cable diameters or higher voltage levels. The trend is following the cost optimization

for the latter. For this, the new HV-CONNEX joints provide safe high-voltage cable connections under the harshest conditions.

Waterproof. UV resistant. Gas-free.

It is not just resistant to salt water and UV rays, it's also submersible: If water manages to enter one of the connected cable as a result of a cable failure, the integrated longitudinal water barrier prevents penetration of the others. DVN GL, the largest ship and offshore classification association in the world, confirms the offshore qualities of the HV-CONNEX joints.

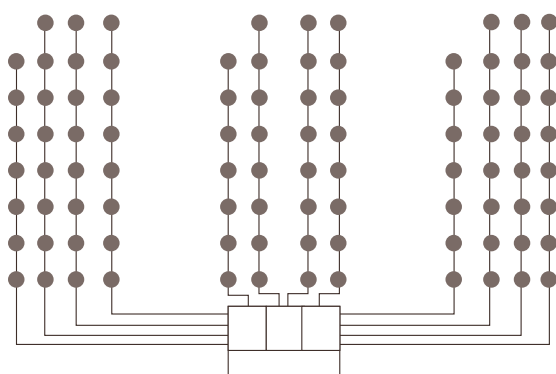
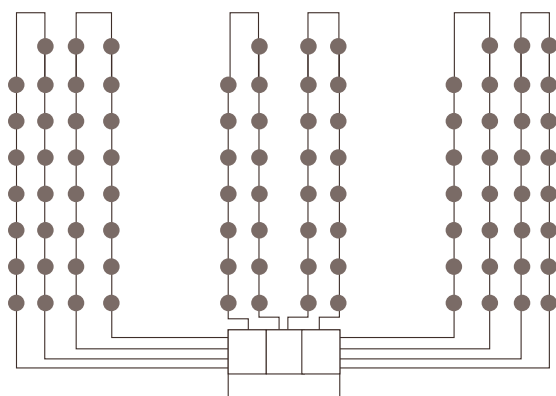
The solid-material insulation makes it possible to manufacture the cast resin joints without SF₆ gas, which means gas monitoring is no longer needed. An enormous advantage even in light of the revised F-gas regulation of the European Union. Among other things, it stipulates laborious SF₆ gas monitoring. Otherwise, sheathing error testing is simpler: It can now be performed after the joint installation without modification of the plug system – thanks to insulated contact rails for the cable shield.

The new HV-CONNEX connection joint for up to 72.5 kV: certified for offshore use and maintenance free thanks to solid-material insulation.





Field-tested predecessor: CONNEX connection joints of size 3 in use at high sea, such as here on an offshore substation.



New network configuration increases reliability: Ring-shaped networks in offshore wind parks (schematic diagram in figure 1) make sure that all wind-power systems can supply power to the transformer station when there is a cable interruption. Unlike in the previously preferred radial network configuration (schematic diagram in figure 2): During a cable interruption, individual systems can be cut off from the network.

HV-CONNEX connection joint size 4

Applications

- Long-lasting connection to homogeneous or various HV cables
- Flexible connection of cables during testing
- Nominal current up to $I_N = 2,500$ A
- Maximum operating voltage up to $U_m = 72.5$ kV
- Cu or Al cable of 95 to 1,600 mm²
- Tested according to IEC 60840

Features & Benefits

- Dry plugging
- Quick and easy installation, without laborious gas work
- Shock proof, waterproof and maintenance-free
- Fully-encapsulated and solid-material insulated
- More compact than conventional systems insulated with SF₆ gas
- Resistant to salt water and UV radiation
- Longitudinal water barrier increases cable protection
- Offshore certified

Why is Voltage Increasing in Offshore Wind Parks?

The voltage levels in offshore wind parks are increasing in power transmission from the wind park systems to the offshore substation. One reason for this is the ever-increasing performance of wind turbines. While in the first commercial offshore wind parks, turbines with two to three MW actual power output were still used, 6 to 8 MW is standard in current offshore projects. The rotor diameter is increasing too: from the previous 80 to 100 m to 150 to 171 m today. And that has not yet exhausted what is feasible: Systems at 10 MW and up to 200 m rotor diameter are already being developed.

In addition, the network configuration is changing. So far, wind turbines have been connected to offshore substations via radial networks. The disadvantage of this: If a cable is interrupted, all wind turbines behind the fault location are cut off from the network. Therefore the tendency is increasingly toward the ring-shaped network. In a ring-shaped network, each wind turbine is connected to the platform on two different current paths. In this case, if a cable is interrupted in one ring, every wind turbine of the same ring can transmit its power over another cable. At the same time, in an extreme case, a line must transmit double the power. For that to work successfully, the transmission voltage is doubled. This is also how in the case of the same cable cross-section, almost double the power can be transmitted over just one cable.



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The compact, automatic tensioning device for electric rail overhead lines.

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- Can be used for any type of mast
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- Movable parts cannot be accessed – no protective cage required
- Very compact, supplied ready for installation
- Lower total weight than tensioning wheel systems