

connect

4 New 420 kV cable accessories
12 145 kV surge arrester in operation

16 Connectors for distribution stations
out of one hand



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Jörg Fries

Editorial

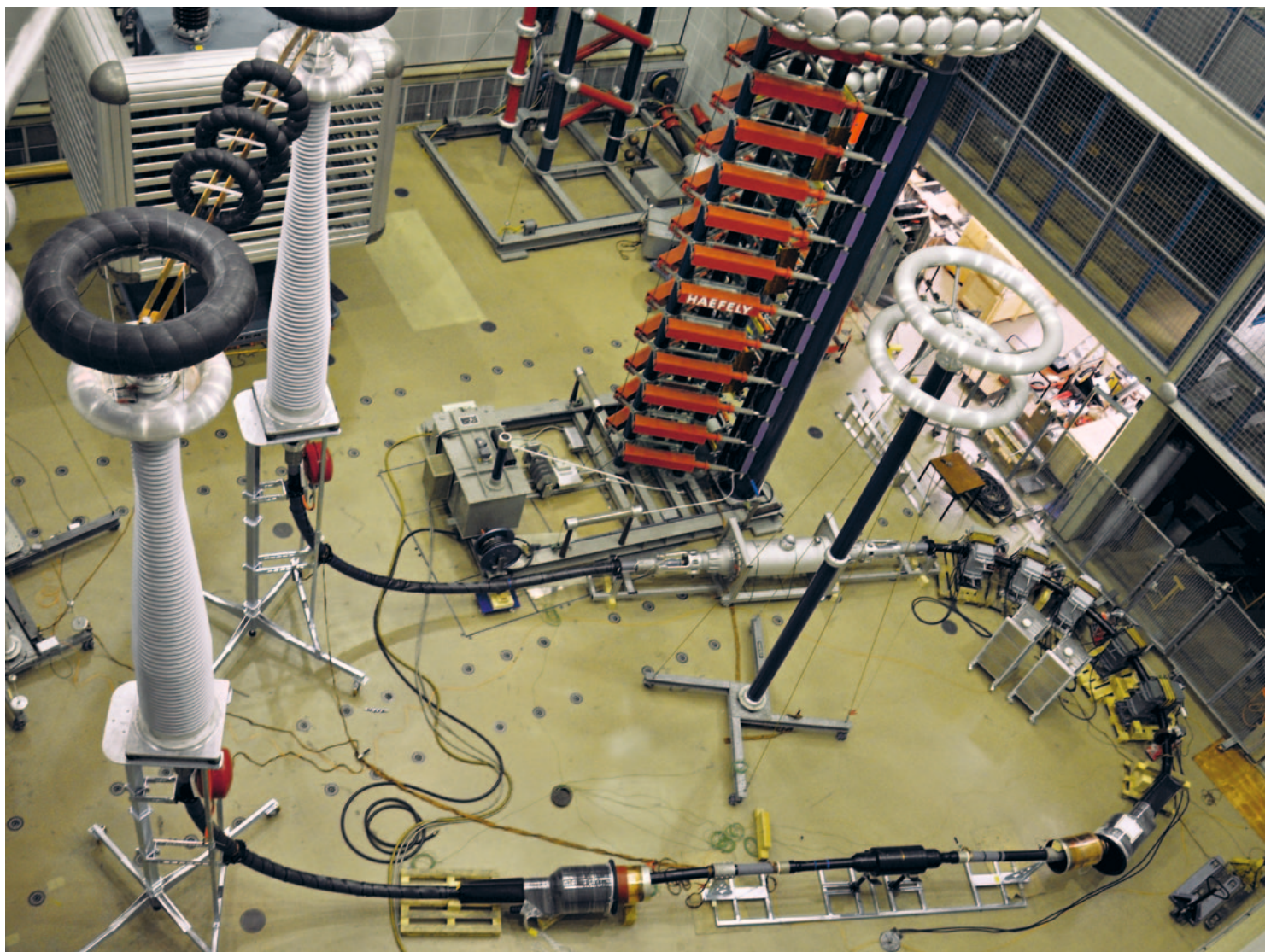
The question of usage

As much as contact and insulation technologies are multifaceted, the decisive factor is: Do they offer economical solutions? Do they accomplish sustainable usage? We ask these questions daily. You will read about which solutions are offered and which ways the user can profit from them in this edition of CONNECT: Our new 420-kV cable accessories have successfully passed the first cable-specific type test. We present their strengths starting at page 4. Starting at page 12, you can read about how worldwide use of the new HV-CONNEX surge arresters for 145 kV support efficient transformer operation with the most compact design. At page 8, you'll get insight into the development of a remarkably heavy-duty 420-kV insulator crossarm, and on page 16, you'll learn about what kind of economical distribution stations we make available to you. We hope the information is useful to you. Furthermore, we are happy to be your supply and development partner for practical action!

Sincerely,

Jörg Fries

CSO
PFISTERER Holding AG



For type testing in installation: Test circuit in the high-voltage lab at the University of Duisburg-Essen with the new PFISTERER accessories for 420 kV: IXOSIL outdoor terminations (left) and the gas-insulation CONNEX joint equipped with dry-type CONNEX cable termination system size 8 (center) are fully installed; the housing still needs to be closed and the cable shielding still needs to be installed on the solid-material insulated IXOSIL joint (lower edge of image).

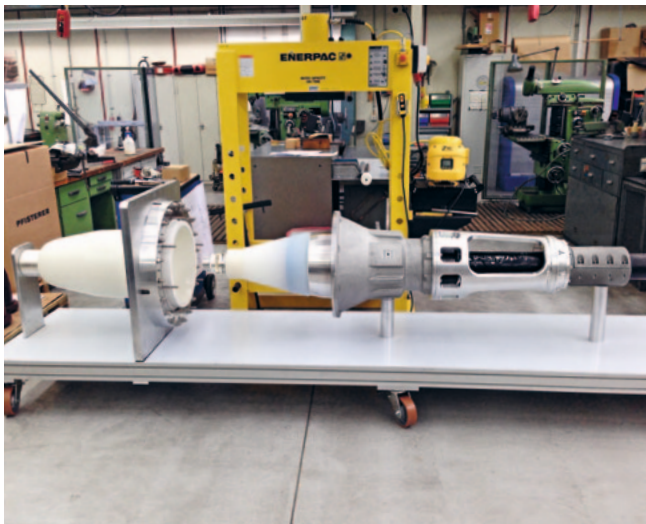
Ready to launch: New accessories for 420 kV

“Passed successfully” – that is the result for the first type test of the new 420-kV cable accessories in the summer of 2013, in accordance with IEC 62067. This allows PFISTERER to be the first independent accessory manufacturer to provide universal cable accessories for operating voltages up to 420 kV on the basis of cable-specific type tests – for system use in all current equipment and distribution systems, including joints for testing and special-purpose solutions.

If you look at photos of the type test in the high-voltage lab at the University of Duisburg-Essen, and based on the test circuit installation, you can well imagine the PFISTERER accessories being used in a substation: IXOSIL outdoor terminations form the interface between the overhead line and the cable section. The gas insulated CONNEX joint is used to simulate the cable connection to the switchgear or the power transformer for each plug-in CONNEX system of the new size 8: The CONNEX socket, which holds the cable-side CONNEX connector, is pre-installed in the joint housing. Aside from using them for tests, as we did here, you can use the CONNEX joint to connect cables with various cross sections. On the other hand, the solid-insulated IXOSIL joint serves as an extension for homogeneous cable sections.

Versatile connections. In all situations.

Each of these accessories has its specific strengths for high-voltage operation. (See product information on pages 5 and 7 for details). For use at the 420-kV level, PFISTERER also provides an integrated cable bracing system in the CONNEX cable connector and IXOSIL terminations. "This allows for two points that are typical for this application, and at the same time, are potentially critical for the function of the connection components." explains Peter Müller, product expert in CONNEX product management at PFISTERER, "the relatively heavy weight of 420-kV cables and the frequently tight space in which they are installed."



The new CONNEX cable connection size 8:
The prefabricated cable connector (right) is connected to the socket (left) in the actual application.

For further information
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EHV-CONNEX cable connection system size 8



Uses

- Connecting a transformer or substation
- Nominal current up to $I_N = 4,000$ A
- Voltages up to $U_m = 420$ kV
- Cu or Al cable up to $3,000$ mm²
- Tested according to IEC 62067

Features & benefits

- Dry plug-in
- Quick and easy to install, without laborious gas or oil work
- Shock proof, waterproof and maintenance free
- Fully encapsulated and solid-material insulated
- More compact than conventional systems in accordance with EN 50299/IEC 62271-209
- Suitable for offshore, as they are salt-water resistant
- Available with extensive accessories



IXOSIL ESS 420 cable termination

Uses

- Connecting an overhead line with a cable section
- Maximum nominal current limited only by high-voltage cable
- Voltages up to $U_m = 420$ kV
- Cu or Al cable up to $2,500$ mm²
- Tested according to IEC 62067
- Pollution class (65 mm/kV) in accordance with IEC 60815

Features & benefits

- Prefabricated, transparent silicon control unit, inspected electrically and visually for safe operation
- Highest mechanical stability thanks to the glass fiber reinforced hollow insulators
- Silicon shielding for ideal water-repellent behavior
- Easy installation of the head armature
- Maintenance free
- Available alternatively: ESP420 with porcelain insulator

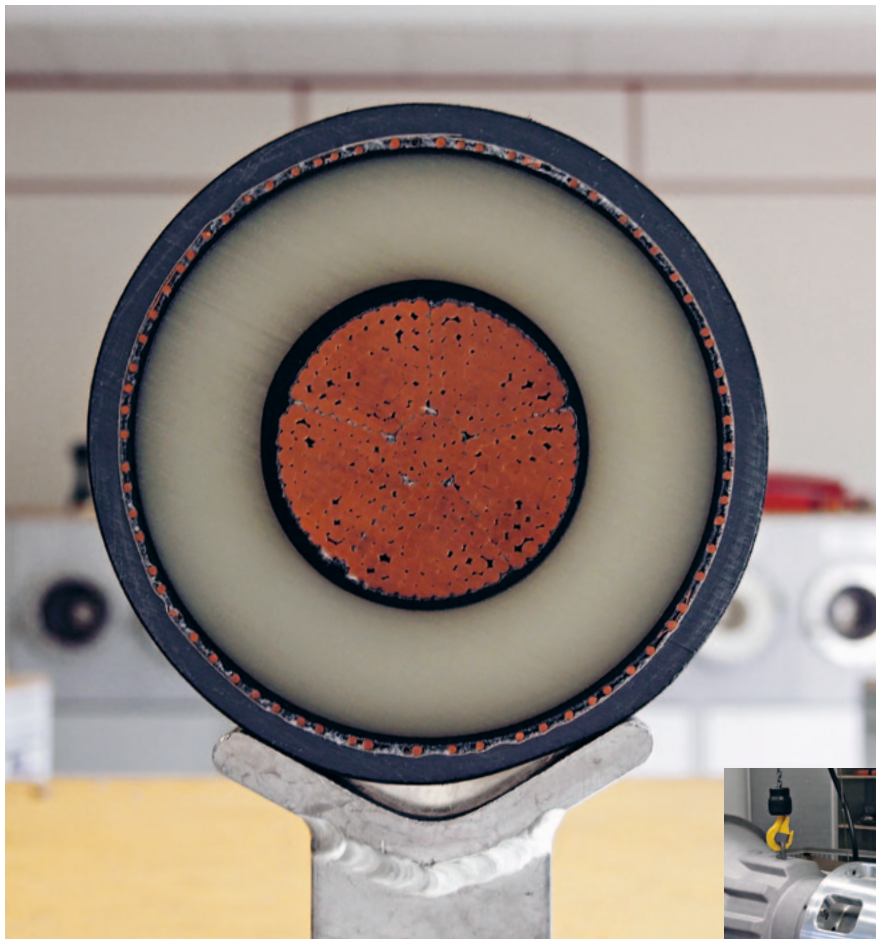
The effect of the weight a 420-kV cable has on a connection is in and of itself enormous on horizontal and end-to-end, platform-supported cable leads. However, this kind of installation requires space, which is rare. If cables are connected vertically from below, they weigh that much more heavily on the connection. If the system space is especially narrow, the cable is commonly guided directly onto the system around the corner. In both cases, the platforms cannot be used or used only conditionally, and also in the latter case, it causes further counterforce on the connection: The rigid cable wants to return to its straight initial form.

No matter whether optimal or complex installation conditions are involved, the cable bracing system provides constant, central cable affixing in every situation – and important requirement for reliable contact and insulation of the connection over the lifetime of several decades.

Basis for partnership

“This product detail refers to an important superior aspect: The higher the voltage, the greater the demand on safety for the user,” remarks Christian Späth, product manager for CONNEX at PFISTERER. “It’s not for naught that the tendency for use of complete systems is becoming more and more pronounced in the 420-kV area as more projects are being implemented worldwide at this voltage level.”

Equally lively is the response to the new accessory assortment, as Matthias Freilinger, head of sales cable transmission at PFISTERER, reports: “The first type test was one step many that will follow. In the meantime, we are working together with various cable manufacturers with the goal of implementing more cable-specific type tests for 420 kV in the near future. We have already created the foundation for efficient cooperation.”



With the new CONNEX accessories, cables with cross sections up to 3,000mm² can be connected.



CONNEX connector plug with integrated cable bracing system for constant cable attachment in all installation locations

There is a department at the PFISTERER location in Altdorf, Switzerland that is allocated exclusively for consulting with the cable manufacturers and supporting them with project management. And when 420 kV accessories need to be expertly and quickly installed, the PFISTERER installation team is flexible with service. That can be at many sites, as the overview of the developments in worldwide energy markets shows.

Worldwide demand. Growing assortment.

Cabled substations are being increasingly implemented where two conditions prevail: Power needs to be transported over long distances; so that this succeeds without much loss, the transmission takes place at increasingly greater voltage levels. If the target site is a metropolitan area where a lot of energy is used and which has no space for an outdoor substation, one deviates toward cabled substations, which are significantly more compact and can be housed in buildings.

Every world region with large, sparsely populated areas, such as Africa, areas of the former Soviet Union and Southeast Asia, are faced with the challenge of transmitting energy over long distances. 20 of 30 of the the world's largest mega cities with 10 million or more residents are in the Asiatic area and in Latin America. And the urban growth continues on: Currently half of the world's population live in cities; the UN estimates that this proportion will increase to just under 69 percent by 2050. Huge infrastructure projects are being accomplished in the Near East shortly. However, even in well-developed Europe, cabled solutions are on the upswing due to the space-saving that accompanies this development.

Meanwhile, the pulse of worldwide high-voltage networks is beating at increasingly higher voltage levels. PFISTERER completed development of suitable cable accessories for the top of the crop in the cable accessories market, 550 kV, last year; the first test for 2014 are in the works.

«We have already created the foundation for efficient cooperation..»

Matthias Freilinger, sales manager for cabled power transmission systems at PFISTERER

IXOSIL MSA 420 slip-on joint



Uses

- Connecting a homogeneous cable for extending a cable section
- Maximum nominal current limited only by high-voltage cable
- Voltages up to $U_m = 420$ kV
- Cu or Al cable up to 2,500 mm²
- Tested according to IEC 62067

Features & benefits

- Prefabricated, transparent silicon control unit, inspected electrically and visually for safe and efficient energy transmission
- Time-tested slip-on technology and simple installation of the waterproof external housing ensure fast installation and maximum operational safety
- Can be delivered in customer-specific variants in terms of cable shield treatment

CONNEX joint size 8



Applications

- Final testing of cable systems
- Connecting various cables
- Nominal current up to $I_N = 4,000$ A
- Voltages up to $U_m = 420$ kV
- Cu or Al cable up to 3,000 mm²
- Tested according to IEC 62067

Features & Benefits

- Fast installation: Can plugged in simply thanks to device-side, preinstalled sockets
- Compact construction for space-saving connections
- Pre-tested in the factory
- SF₆ gas insulation
- Integrated, full-pressure monitoring

Partner for uncharted waters

When operators of overhead line networks consider using new technologies, PFISTERER is a preferred partner. Because the safest way to tread unknown terrain is with a partner experienced in the field. As such as partner, PFISTERER delivers not only advanced insulation sets but also supports development of foundational models for future projects. What the overhead line specialists provide for that gives insights into their development work for a remarkably durable 420-kV insulator crossarm.

Before Patrick Summer, product manager for insulation sets and armatures at PFISTERER, and his colleagues let anyone take a look over their shoulders, he proposes: “Fundamentally, it does not make a difference whether we design insulator sets for concrete use or we develop a foundational model here that can be modified for future use. The challenge is always to bring various requirements into a practical, implementable figure. At the same time, almost all requirements influence each other, and there are a lot of them. See for yourself...”

He hands over the requirements catalog for the 420-kV insulator crossarm. You don’t need to leaf through it long, before the question arises: Which requirements do you choose as the jumping-off point during the design? “The most critical thing for functionality and safety of the entire system,” says Elia Husmann, development engineer for insulation sets and armatures at PFISTERER. In this case, it is a vertically active peak load of 150 kN. One of their critical points of action on the insulator crossarm is the horizontally arranged pressure insulator, more exactly, the internal fiber glass rod that has to absorb this force.

Stress field of the extremes

“The longer and thinner the rod, the more quickly it snaps under the load,” explains Husmann, “because of this, the rod must be as short and thick as possible. However, implementation of electrical requirements would thwart that.” This is how the rod length determines the insulation length, and it defines the space between the end armature, through which the insulator is connected to the rod, and the head armature at the other end of the insulator, where the phase



The more space overhead corridors require, the more laborious the permit procedures. An advanced alternative is space-saving compact cables (see illustrations on page 10 and 11).

conductors are attached. The overvoltage can discharge a flashover between these points. To prevent this, the following applies: The higher the supply voltage, the greater the insulation length. To that effect, the insulator rod must be sufficiently long.

“The challenge is in creating a design that is optimized both technically and economically,” adds Wolfgang Huiber, sales director for overhead line systems at PFISTERER, “after all, insulator sets are installed in large quantities. Therefore, we need to realize optimum functionality with as little use of material as possible. The sense of economy is also mirrored in the design process at PFISTERER: Before a prototype is built and tested, the dimensions are calculated using a computer and its suitability is reviewed.

The art of the interpretation

The overhead line specialists draw upon experience for the foundation of the design, for example, from previous projects with comparable job criteria. These are adjusted to the current requests, which are then harmonized with each other step by step. PFISTERER uses computer simulation for this, meaning the finite elements method (FEM) for mechanical requirements.

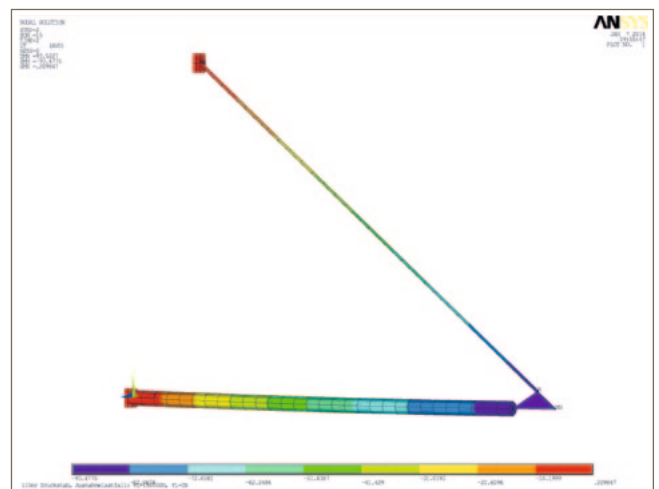
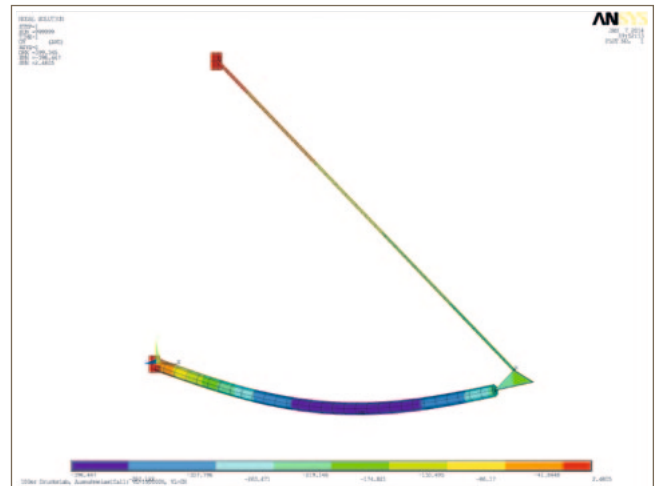
“FEM is based on solving differential equations that describe the mechanical behavior of the insulator crossarm. Since this is a complex behavior, the solution functions can be obtained only in numerical approximation procedures,” explains Husmann, “Simply said: You handle a lot of output values, work in intermediate steps and have to interpret results. For this, you need knowledge about FEM and overhead line technology and ideally experience with both.”



Interior of a silicon composite insulator: Its backbone forms the rod running through the center, which is made of fiber glass reinforced plastic. This must be able to absorb high mechanical forces without breaking.

The reality in the lab

Even when the accuracy of the simulation is proven, nothing more than actually testing on real prototypes is convincing. This was also the case in mid-December 2013 when a customer delegation visited the PFISTERER test lab in the Swiss Malter. There, the PFISTERER test engineers built the mechanically relevant insulator crossarm structure for a load test exactly as it would be installed on a compact pole.



Computerized for optimum design: The upper simulation image shows the model of an insulator crossarm whose pressure rod is greatly deformed under the impact of 150kN. Otherwise, the model in the simulation image below. Here the pressure rod diameter was increased so that no critical deformation occurs at this maximum load.

In actual use, each insulation set bears the weight of the overhead line cables, and the heavier they are, the greater the span length. In addition, the line attachment points absorb all forces that affect the cables, for example, wind, snow or ice. These forces are simulated in the lab using a chain pull. It is installed where the cables are usually hung, in the angle that reflects the net force that results from the horizontally and vertically acting forces.

Maximum load. Minimum bending.

The engineers increase the load gradually in load increments of 10 kN, – at every step, they capture the behavior of the insulator crossarm by means of measuring points at their critical points. Does the pressure insulator rod bend? How far is the head armature displaced? At 150 kN, the peak load is held for five minutes. What happens? Almost nothing. The head armature remains intact, without exceeding its usual movement play room. The pressure insulator rod reveals a hardly perceptible bend that completely neutralizes once the forces are discharged.

You could see visitors were pleased with the test result; it was an important step forward, as the work on the 420 kV insulator crossarm continues. In the meantime, further requirements have been identified with new peak values. Expertise is needed to implement these new requirements. The expertise of PFISTERER.

«The challenge is in creating a design that is optimized both technically and economically.»

Wolfgang Huiber, sales director for overhead line systems at PFISTERER



Test set up for the 420-kV insulator crossarm for the Netherlands



Experience for development work: PFISTERER insulator crossarm for 420-kV compact cables in Dubai (in upper left image) and in the Netherlands (see computer graphic at the right). The insulator crossarm unifies the insulation function and the load-bearing pole arm function. This double function creates their special construction of at least two insulators, one angled tension insulator and one horizontal or slightly tilted pressure insulator.



News

Distinguished

PFISTERER's expertise and commitment in the field of overhead line technology were distinguished in 2013 with two awards: The Claude-de-Tourreil Award from the International Insulator Magazine INMR and the Technical Committee Award at CIGRE were presented to Dr. Frank Schmuck, head of composite insulator technology at PFISTERER, as recognition of this longtime activity in publishing for overhead insulation technology and in the CIGRE Overhead Line Study Committee. Both awards also recognize the almost 40 years experience and service of PFISTERER SEFAG AG as the pioneer in composite insulator technology and competent systems provider.



Dr. Konstantin O. Papailiou and Dr. Frank Schmuck pool their extensive knowledge on this topic in the text book entitled "Silicone Composite Insulators" published by Springer and available in German and English.



Advanced energy supply for city and surroundings: Very close to the picturesque historic city center of Schaffhausen in the narrow Oberrheintal district, two 110-kV transformers were able to be integrated inconspicuously into one station building – with the space-saving CONNEX system, including the compact HV surge arrester.

CONNEX makes substations invisible

Since November 2013, the CONNEX surge arrester 5-S for supply voltages up to 145 kV have been being used for the first time in Schaffhausen, Switzerland: At the Mühlenstrasse substation, eight units complete the all-around configuration of two retrofitted regulating transformers with the CONNEX connection system. This is how the EKZ (Elektrizitätswerke des Kantons Zürich) was able to implement a unique retrofit solution for economical transformer operation in confined spaces – with optimum protection for humans and equipment.

Even the surroundings of the Mühlenstrasse substation point to the demanding requirements on the internal systems: The location of the substation in the city constrains the available space; its direct location on the Rhine results in a network topology with cables that run under the river bed to the opposite shore.

The EKZ system planners kept this and other things in mind when they started execution of a Switzerland-wide retrofit that is still continuing today. For consistently high security for increasing energy needs, the energy supplier gradually converted its system voltage from 50kV to 110 kV. During this time, two 110 kV overhead line regulating transformers were retrofitted for the Mühlenstrasse and then completely converted to the CONNEX cable connections system.

Securing systems. Protecting humans.

Why CONNEX becomes apparent after a few steps through the two transformer cells: Each one houses one transformer with at a weight of around 57 tons – on a surface of 46 m² and 41 m² in a room volume of 377 m³ and 336 m³ respectively. Very little space that becomes even smaller when system and human safety are taken into account.

The importance of protecting high voltage systems from overvoltages is indisputable. The more complexly designed the construction is for the surge arrester used for this, the more factors that need to be taken into account. In addition, the traveling wave nature of transient overvoltages limits the protected zone offered by arresters (see CONNECT 2/2011). Therefore following applies: The best possible protection is reached when the arrester is installed directly on the equipment that is exposed to the risk of overvoltage. For the Mühlenstrasse, it was requested that the protection be installed directly on the transformer.

And humans need to be protected too. This is the case for maintenance staff when they perform inspections or take oil tests. If it is possible the staff could come into contact with uninsulated, power-conducting system components, barriers should prevent this – a condition that complicates work in confined spaces. And each hindrance hides new risks. The goal of the EKZ was the opposite: To minimize risks and decrease expenditures – in all relevant aspects of system operation in the most confined spaces. This describes a usage scenario that is predestined for CONNEX.



Unique surge protection for multiple advantageous retrofit applications: Four dry, pluggable CONNEX surge arresters, size 5-S, in use on a 25-MVA regulating transformer that is equipped with 110-kV and 16-kV cable connections and therefore completely converted to the CONNEX connection system.

Compact and surprisingly quick to install.

Unlike air insulated arresters or lead-ins, the solid-material insulated CONNEX components allow for a very compact construction. Minimum clearances between phase connections do not need to be accounted for, and complex busbar constructions do not need to be used for the line connection. Time and cost sensitive oil or gas work, such as that which specialized staff need to perform on installation of gas-insulated arresters, also falls by the wayside: All CONNEX components are simply plugged into a CONNEX socket that is pre-installed on the equipment.

And here too: When the EKZ transformer specialists were retrofitting the regulating transformers, they were able to situate all required connection sockets for medium-voltage and high-voltage cables and 8 arresters on the transformer cover. They discovered another advantage of the connector system during the final testing: They needed only to plug in the test leads into the high-voltage sockets. The CONNEX system's ease of installation even astounded the PFISTERER technicians, Heiri Bissig and Peter Barmettler, when they installed four surge arresters, size 5-S, on one of the two regulating transformers.

Four days were scheduled for that, and it ran according to plan the first two days: After the old connections were disassembled, they prepared for installation of the six-foot arrester. So that the arrester could be hoisted safely onto the transformer cover in this confined space, EKZ had a crane transported there in advance. "On the third day, everything went much more quickly than planned," reported Barmettler, "after nine hours, we had installed the four arresters." Even for Bissig, who has 30 years of installation experience, it was a remarkable experience: "Whoever installs arresters of this size knows that it will go unusually quickly."



Easy to install meets installation experience: The PFISTERER technicians Peter Barmettler (left) and Heiri Bissig (right) installed four of a total of eight CONNEX HV surge arresters 5-S in nine hours total. Foreground of image: With CONNEX multi-angle connection pieces, medium voltage cables and arresters can be installed directly next to each other and also set up horizontally. This not only saves space, it can also guide the critical field lines closely alongside the system as to maintain the system thresholds.

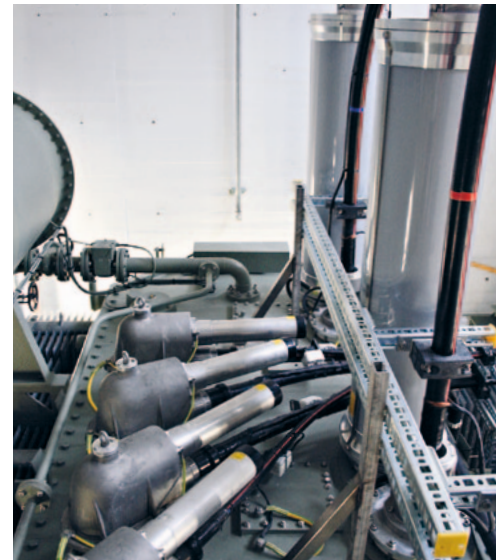


Visible advantages of the pluggable, solid-material insulated CONNEX system as compared to air insulated solutions: You do not need to adhere to minimum clearances or install busbar platforms on the transformers and substations.

Touch proof. Low emissions.

CONNEX also makes efficiency a reality for the daily routine in the Mühlenstrasse substation – coupled with safety for the staff: The combination of solid-material insulation and plugability results in a system that is maintenance free and touch proof. And since CONNEX is used universally on both regulating transformers, the transformer cells can be operated safely without barriers.

Even beyond the cells, use of CONNEX is advantageous: The full encapsulation of the system and the compact design and flexible combination of its components make it possible to meet even the most stringent limits of the Swiss Ordinance on protecting against non-ionizing radiation (NISV) (see detailed information) – as a result, the rooms above the two transformer cells can even be used as storage or an office with permanent work stations. Conclusion: Whoever equips high-voltage systems with CONNEX gains valuable play room – even in the literal sense.



Uniquely compact: All CONNEX connectors have space on the transformer cover. That is four surge arresters, size 5-S, for up to 145 kV per transformer and four surge arresters, size 3, for up to 42 kV for very third phase, including star points and three HV cable connections and four MV cable connections.

At a glance: HV-CONNEX surge arrester, size 5-S

For protection of metal-encapsulated substations and transformers that are equipped with plug connectors.

Possible uses

- Connection of a transformer or a gas-insulated substation to cable or overhead line systems
- System voltage of up to $U_r = 145$ kV

Features & benefits

- State of the art active component with metal-oxide resistors built without spark gap
- Silicon rubber insulation of the active component against metal housing
- Resistors with high thermal stability
- Corrosion proof and shock proof due to aluminum housing
- Hermetic enclosure of the active component against environmental influences such as humidity or pollutants
- Maintenance free due to solid-material insulation
- Durable for outdoor use
- Any installation position
- Easy to assemble due to plug-ins
- Burst disc directional ventilation opening for defined pressure discharge in case of an error

Detailed information: CONNEX against electro-smog

The most stringent regulations in concerning electromagnetic fields and radiation in Europe and probably worldwide are formulated by the regulation on protection against non-ionizing radiation (NISV). It was put into effect in Switzerland on Feb. 1, 2000 and applies to operation of stationary systems such as transformer stations and substations. Therefore, the locations at which persons stop regularly and for a longer time must have a system threshold of a maximum of $1 \mu\text{T}$ (microtesla) load.

Numerous projects implemented in Switzerland demonstrate that this threshold can be adhered to with modern technology in economical ways – sometimes with remarkable results. This is how a restructured transformer station bordering on a residential area can emit 40 times less than a clock radio, which most people put in their bedrooms without a second thought.

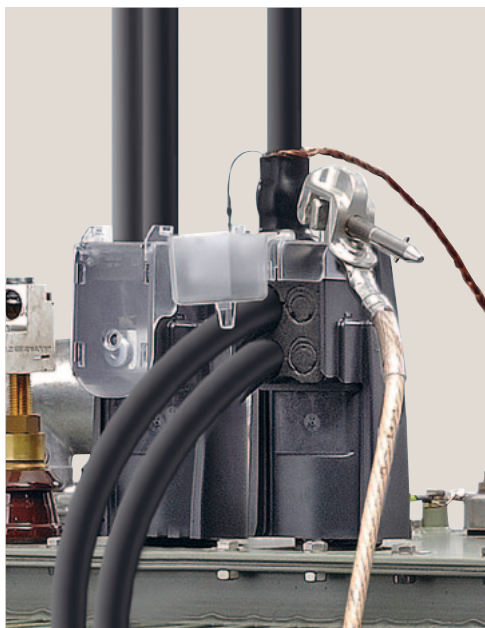
CONNEX supports NISV conformity too: Full encapsulation of the system creates heavy shielding of the electromagnetic fields around the connected cables and components. In addition, you can use CONNEX systems in a way that allows the $1\text{-}\mu\text{T}$ boundary to run closely alongside the system instead of radiating throughout the room – thanks to the compact construction and installation that can be implemented in any position.

Multi-faceted for distribution stations

What economic efficiency calculations recommend for distribution stations, PFISTERER can deliver: Advanced connection technology that reduces installation time, failure ratios and maintenance expenditure, and also has multi-use safety technology and smart grid interfaces. All in all, an assortment that consistently serves a purpose for many products: efficient and safe station operation.

«Connection technologies can avert risks or at least limit them.»

Hagen Berroth, application consultant at PFISTERER



Earthing on 2DIREKT transformer terminal clamp

Easy installation. Powerful contact.

“Most failures have to do with faultily designed contacts. Experience from the global energy markets indicates this,” says Martin Schuster, senior advisor at PFISTERER, “that’s why we design connection techniques that minimize the risks that commonly occur during installation and in operation.”

An example of this is the cable lugs for non-insulated low- and medium voltage connections. Their patented center-piece, the SICON screw, is designed as a stepless shear bolt with thrust washer. Regardless of their characteristics, the interaction of these features ensures optimum contact force in use on various conductors; in addition, they can come into contact with stranded conductors of class 5 without suffering damage (for details see CONNECT 2/2013, pp. 19 et. seq.). If the necessary contact force is reached when it is being screwed on, the SICON screw breaks away below the surface of the terminal – without sharp-edged screw protrusions. Therefore, there are no filings and there is no risk of flashover due to metal shavings.

The 2DIREKT transformer terminal clamps for low voltage also simplify installation in terms of lasting contact quality. They replace, for example, conventional connections that are often complexly constructed with busbars: The cable is pressed into a terminal, screwed onto a busbar, which in turn is connected via a terminal lug to the transformer lead-in. Many work steps, each of which can be a source of error. And plenty of contact resistance, which increases the thermal load of the overall construct. Unlike with 2DIREKT: The cable is simply inserted into the terminal block, which is directly mounted on the transformer lead-in. Depending on the variant, a 2DIREKT terminal clamp accepts up to eight cables, in a horizontal or vertical position.

Where busbar links are essential in a distribution station, contact disks (Al, Cu) provide defined contact points, over which the current can flow freely. The Al-Elast contact disc also serves as a spring element that introduces elasticity into the connection, thus retaining the natural shrinkage of the contact force due to flow and stress actions in acceptable limits – over the entire lifetime.

Protection for many cases

However, even with optimal contact quality, the flow of current can run dry, as Hagen Berroth, application consultant at PFISTERER explains: “Each distribution station is



The wide range of 2DIREKT transformer terminal clamps has a solution for every application.



Voltage testers and earthing accessories from PFISTERER within reach for distribution with PFISTERER connecting blocks

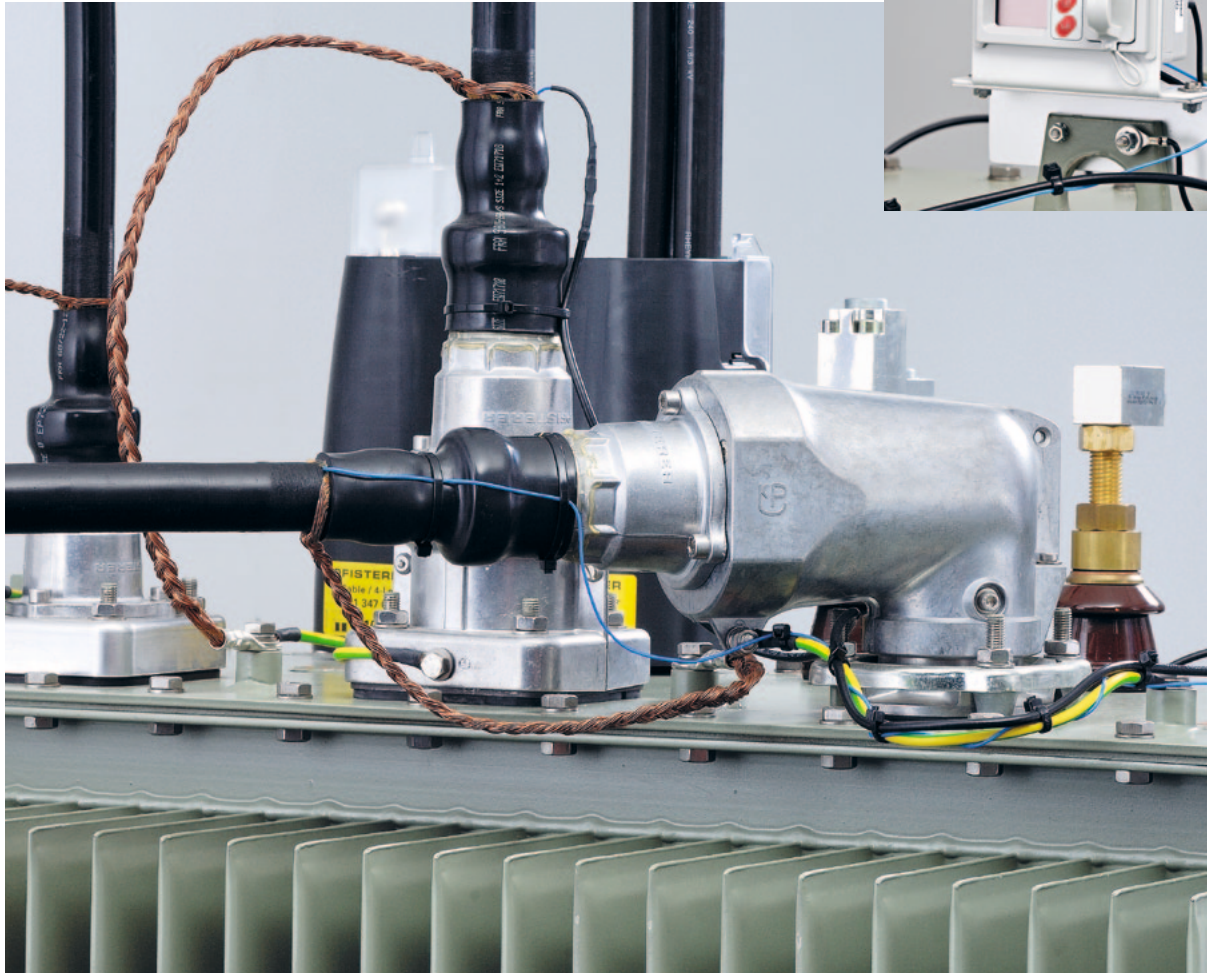
exposed to external, partially unpredictable influences that may affect its operation. Conversely, the systems can pose a risk to the environment. Connection technologies can avert risks or at least limit them in both respects."

Thus, the MV-CONNEX connectors or the outer-cone plug. Thanks to their full encapsulation, unwanted visits are without consequence: If a small animal, such as cat, raccoon or rat, runs through the system, it can touch two connectors at the same time – they are fully insulated, nothing happens. Conversely, on non-insulated connectors, the bodies of animals can bridge the distance between the conductors and the power beats a new path: through the animal. With fatal results: The animal dies a gruesome death, there is a short-circuit, and in the worst case, the system fails.

Transformers are threatened by a total failure when lightning strikes or a substation switched is on abruptly under

full load. If the resulting overvoltages reach the transformer or the substation, they can overload the active components and even destroy them mechanically. That can be avoided with pluggable MV-CONNEX surge arresters. Placed directly on the equipment, they accomplish the best possible system protection in that their metal-oxide capsules accurately disperse incoming overvoltage before they can do damage.

And PFISTERER also has helpful connection technologies for the most extreme emergencies. If an emergency generator needs to step in, the compact and powerful PLUG connection system is recommended: Coded and modular, parts cannot be mixed up and assembly is fast. Whoever combines the PLUG connector and the MV-CONNEX connectors not only connects transformers so that they are all-around shock proof, but also creates dust-free and waterproof connections in accordance with protection class IP68.



For the highest demands on safety: All-around touch proof transformer connections and continuous voltage display DSA-i3 (inset above) from PFISTERER

Safe & efficient maintenance

“Touch protection also holds advantages for normal,” adds Berroth, “because it provides work safety and efficiency.” The more compact a distribution station is built, the greater the likelihood that non-insulated, conducting parts will be touched during maintenance. Various countermeasures are feasible. Switch off the system or erect barriers to the live system parts. The most efficient variant: Systems are designed in complete isolation – with the fully encapsulated MV-CONNEX connections of outer-cone plug. The 2DIREKT assortment also work with them: The pressure screw with fixed ball point allows direct earthing of the transformer, the cover plate provides protection against contact.

In addition, PFISTERER supports maintenance of distribution stations with sophisticated safety technology: The custom-designed earthing and short-circuit accessories are reliably tough due to dual cable kink protection. With strong and clearly distinguishable visual and acoustic signals, the voltage tester from the KP-Test 5 series provides precise test results even in poor visibility conditions and

noisy soundscapes. DSA continuous voltage indicators allow voltage display without direct contact with live parts. The phase comparator EPV combines three test functions into one intuitive device.



Voltage tester KP-detector 5 gives a green light for maintenance work.

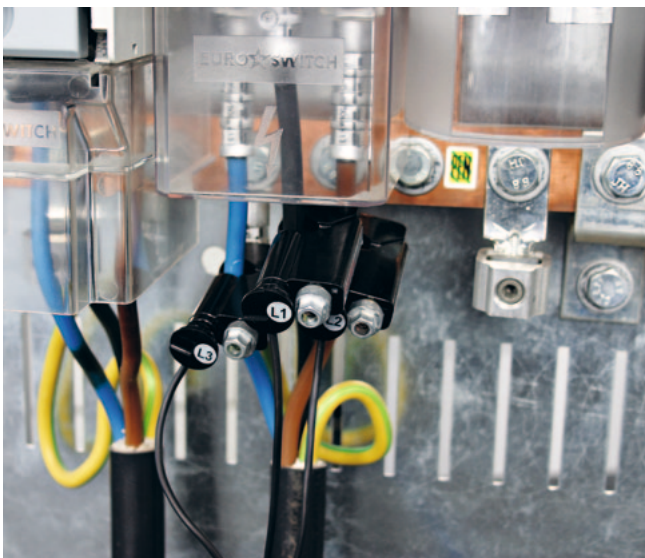
Smart interfaces

And even where IT-heavy smart grid applications pose electro-mechanical issues, PFISTERER provides solutions. By request: the 2DIREKT transformer terminal clamp with integrated measuring port for data collection directly on the transformer. For connecting data concentrators or other measuring and control devices to LV distributions, PFISTERER offers a hitherto unique terminal clamp: PLCON. It can be installed in any conductor position in the blink of an eye. Without special tools, by hand. Thanks to the small construction and shear bolts.

And that's still not all. You can find an overview of the PFISTERER assortment for distribution stations at the right hand side of this page.



Powerful not just in emergencies: PLUG connection



PLCON for connecting data concentrators

At a glance: The PFISTERER assortment for distribution stations

Connection technology for medium voltage

- MV-CONNEX system for MV substations and transformers

Surge protection

- MV-CONNEX surge arrester for optimal protection on transformers and substations

Connection technology for low voltage

- 2DIREKT transformer connection blocks for 1 to 8 connections from 16 to 400 mm² with assortment of covers for contact protection
- Cable lugs and connectors with patented SICON pressure bolt for optimal contact force on all non-insulated conductors
- Flexible belts according to customer specification for non-insulated connections
- PLUG connection for waterproof connections and emergency power supply
- Traditional terminal clamps and flat connectors

Low-voltage distributions

- Ready to install, low-voltage distributions according to customer specification or as standard design

For smart grid applications

- PLCON terminal clamp for connecting data concentrators
- 2DIREKT transformer terminal clamps with integrated measurement port

Technical-contact devices for maintenance-free screw connections

- Al-Elast contact discs
- Contact protection paste P1

Safety features and equipment

- Voltage detectors KP-Test 5
- Earthing and short-circuit accessories
- Continuous voltage indicator DSA
- Phase comparator EPV

Accessory installation

- Compression equipment
- Tools



Compact. Pluggable. HV-CONNEX surge arresters.



- Solid insulated
- Compact design
- Can be changed without gas or oil work on the GIS or transformer
- Size 4 up to 72.5 kV interchangeable with all pluggable components in the Size 4 HV-CONNEX system
- Size 5-S up to 145 kV interchangeable with all pluggable components in the Size 5-S HV-CONNEX system