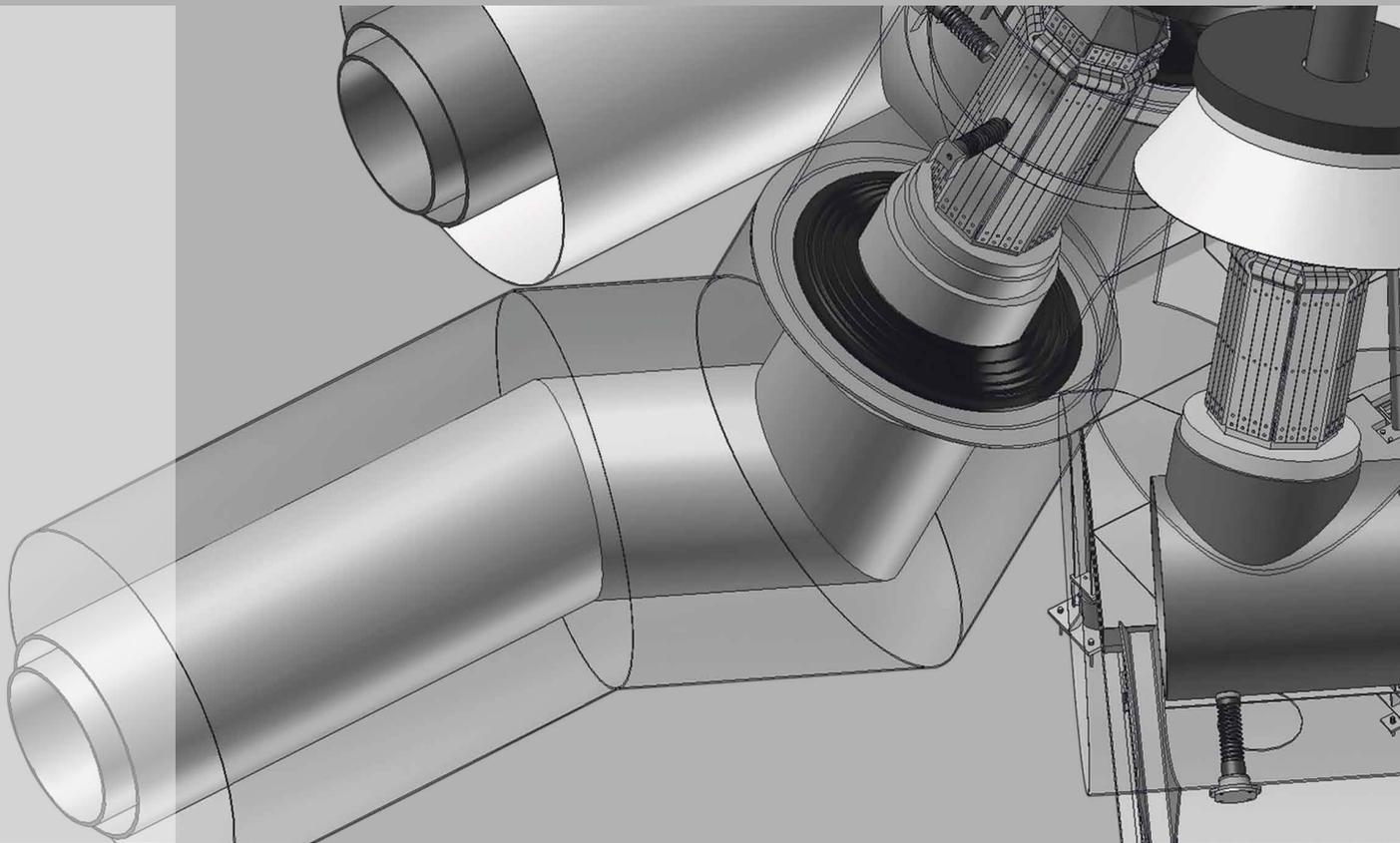


WAYS OF ENERGY



BUSDUCT AND
ALUMINIUM
PRODUCTS
DIVISION

EGE



EGE is a group of companies assembled in an internationally operating holding company which offers deliveries of special equipment for the power engineering industry all over the world. EGE's global customers benefit from our over 65 years of experience and tradition in quality production, from expert and reliable services, and from our flexibility in meeting customer-specific requirements.

The company's strategy is to offer a full range of products and services from technical training to after-sales service. Quality has been a key target to all of EGE's activities, and the company has been certified on quality in accordance with ISO 9001, ISO 14001, ISO 3834 and OHSAS 18001 standards. The quality level established by these standards has been adhered to through demanding audits which have covered the entire scope of EGE's business activities.

The parent company of EGE, spol. s r.o. primarily manufactures and supplies special equipment for the energy industry. The company's main spheres of business are three-fold: generator outlets – busducts and other aluminium products, special high-voltage electrical technology, and steel structures.



BUSDUCT DIVISION

SPHERE OF ACTIVITIES

The Busduct and Aluminium Products Division is engaged in a wide range of activities related to producing and installing busducts, particularly those required by power station generator outlets.

The history of busduct production at EGE dates back to the early 1970's. Since then, the division has diversified its products, which now include all common busduct varieties with air insulation.

Since 1971, EGE has installed more than 1000 busduct units in over 500 power plants worldwide.

RANGE OF ACTIVITIES

- Consultancy
- Studies
- Design
- Engineering
- Technical documentation
- Manufacture
- Workshops and acceptance tests

- Logistics
- Site erection & supervision
- After-sales service & technical support

The Busduct Division assures installation and commissioning as well as supervision by designers on building sites, maintenance, reconstruction work, and repairs of busducts throughout the life of equipment.

Furthermore, EGE designs and manufactures steel structures for supporting busducts.



BUSDUCTS FOR GENERATOR OUTLETS (IPB)

Generator busducts represent a special type of conductors capable of transmitting AC currents of high ratings and withstanding high short-circuit currents typically experienced in power plant generator outlets. The conductors are designed to achieve maximum operational safety and reliability.

Each phase conductor runs through the centre of a separate grounded sheath made of conductive and non-magnetic material. Its position is held concentric with the enclosure by insulators. Air gaps are allowed between the enclosures of lateral and central phase conductors, thus separating the phase conductors and the enclosure from each other. In the instance of a single-phase failure, ionized air cannot deteriorate the insulation capability of the other phases and short them out.

Shorted enclosures exert a significant shielding effect on the time-variable magnetic fields of adjacent conductors, thus diminishing electro-dynamic forces impacting upon conductors and consequently upon insulators during short-circuit transients. Generator busducts

featuring electrically shorted enclosures represent a standard type of large generator outlets.

BUSDUCTS AFFORD A GREAT NUMBER OF ADVANTAGES SUCH AS:

- Elimination of phase-to-phase faults
- Great short-circuit resistance
- Reduction of external magnetic fields to a minimum residual value
- Elimination of Joule and hysteresis losses transferred to surrounding steel structures
- Limitation of difficulties with electromagnetic compatibility
- Protection of insulators against unfavourable ambient conditions

Shielding the conductors inside the enclosures completely ensures attendant safety. Maintenance is minimized. The busducts are interconnected with conductive links at both ends. This results in connected enclosures forming a shading coil with induced current flowing lengthways through its full cross section. This current almost amounts to that flowing through the phase conductors, but its phase direction is inverse. Therefore, the magnetic field outside the enclosures is compensated to a low residual value.



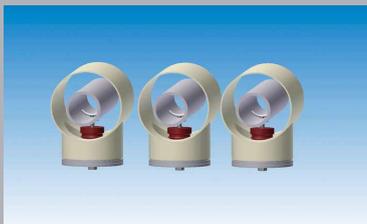
EGE BUSDUCTS



• ISOLATED PHASE BUSDUCTS (IPB) WITH TRIPLE SUPPORTING POINT

U* [kV]	Rated current [kA]	Outer dimension of enclosure [mm]	Phase distance [mm]
12/28/75	2,5 - 14	480 - 960	1000 - 1200
17,5/50/110	2,5 - 25	540 - 1440	1000 - 1800
24/60/125	2,5 - 30	640 - 1660	1000 - 2000
36/70/170	2,5 - 30	860 - 1820	1200 - 2100

* insulation level IEC 71-1 / power frequency withstand voltage / lightning impulse withstand voltage
 Busducts with a rated current up to 25 kA are designed as self-cooled IPBs, while busducts above 25 kA are designed as forced cooled. The „Double Tube“ conductor with air insulation can be used for the current value of 25 to 30 kA. EGE is licensed from Siemens PG for the production of this type of conductor.

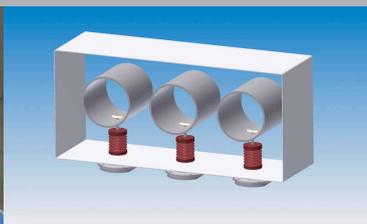


• ISOLATED PHASE BUSDUCTS (IPB) WITH SINGLE SUPPORTING POINT

U* [kV]	Rated current [kA]	Outer dimension of enclosure [mm]	Phase distance [mm]
7,2/20/60	2,5 - 4	270	360
12/28/75	2,5 - 4	300	400

* insulation level IEC 71-1 / power frequency withstand voltage / lightning impulse withstand voltage
 EGE offers busducts with a single supporting point which can fully substitute Non Segregated Phase Busducts /NSPB/. The main advantage over NSPB is a better screening effect of the enclosure by encapsulating each phase separately. Busducts with a single supporting point are used for heavy workloads in many power plants around the world.

• NON-SEGREGATED AND SEGREGATED PHASE BUSDUCTS (NSPB, SPB)



U* [kV]	Rated current [kA]	Outer dimension of enclosure [mm]	Phase distance [mm]
7,2/20/60	1,5 - 5	710 × 290 - 1130 × 430	180 - 320
12/28/75	1,5 - 5	830 × 410 - 1250 × 550	210 - 350
17,5/38/95	1,5 - 5	910 × 470 - 1410 × 610	250 - 390

* insulation level IEC 71-1/power frequency withstand voltage/lightning impulse withstand voltage
 Calculated for ambient temperature of 40°C and atmospheric pressure up to 1000 m above sea level without the effect of the sun.



DESIGN AND ENGINEERING

EGE has a team of specialised electrical and mechanical engineers experienced in designing and engineering generator busducts, using modern, highly sophisticated and computerised methods. A team of experts is ready to respond flexibly to any technical requirement of a customer as related to a particular project.

THE TECHNICAL DOCUMENTATION PROCESS

- Preliminary layout
- Technical documentation for approval
- Operation and maintenance manuals
- Erection procedures
- Process of approval
- Manufacturing drawings
- As-built documentation

STANDARD TECHNICAL DOCUMENTATION

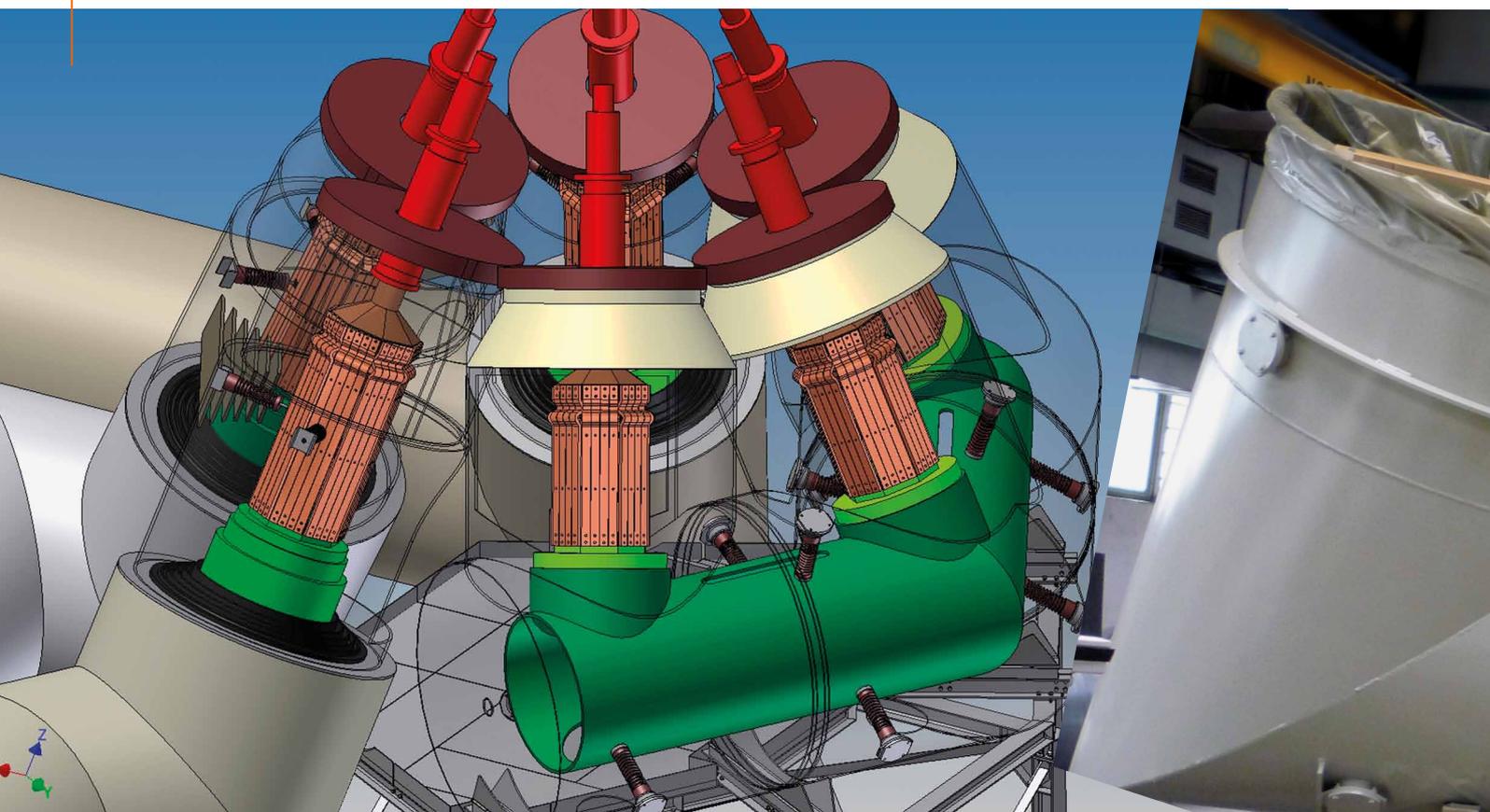
- Site layout
- Civil drawings including load calculation
- Drawings of detailed connections to equipment

- Earthing diagram
- List of materials
- List of modules
- Manufacturing documentation
- Operational and technological procedures
- Welding procedure specification
- Erection procedures
- Operation and maintenance manuals
- List of consumables
- Packing lists
- As-built documentation
- List of spare parts

MODELS AND CALCULATIONS

- SW Mathcad for IPB
- SW ANSYS for IPB, NSPB a SPB
- SW Autocad
- SW Inventor

TECHNICAL DOCUMENTATION



PRODUCTION

APPLICABLE STANDARDS

Technical preparation of production complies with the following standards:

- IEEE C37.23 /Standard for Metal Enclosed Bus and Calculation Losses/
- IEC 60071-1 /Insulation coordination, part 1: Definitions, principles, and rules/
- IEC 60071-2 /Insulation coordination, part 2: Application guide/
- IEC 61439 Low-voltage switchboards
- EC 62271 High-voltage switchgears and control gears
- IEC 60865-1 /Short circuit currents. Calculation of effects, part 1: Definitions and calculation methods/
- BS 159 /High-voltage busbars and busbar connection/
- CSA standard C22.2 Metal Enclosed High Voltage Busways
- ČSN EN ISO 3834 Welding process

The busducts are designed to meet the EU directive on electromagnetic compatibility 2004/108/EC. All products are also in accordance with other EU legislative requirements.

PRODUCTION CAPACITY EGE

- Three manufacturing halls - two in the Czech and one in the Slovak Republic
- Complete production facilities - warehouses, packing and shipping services
- ERP systems and IT networks associated to the production

MANUFACTURING MACHINERY AND EQUIPMENT

- Shearing machines capable of separating metal sheets

- Sawing machines with circular and band saw tools
- Numerically controlled /NC/ oxygen cutters enabling plane figures to be cut using both oxygen and plasma
- Drilling and pressing NC automated machines
- Bending machines and tilting press
- Roll bending machine for bending bars and sheets
- Machine tools for cut-machining
- Power sources for MIG and WIG inert gas welding and special welding operations
- Preliminary preparative blasting of surfaces
- Surface finishing and hot dip galvanization
- Paint spray boxes for painting busducts
- Test shops for electrical equipment testing
- High voltage laboratory for transport unit testing

TESTS PERFORMED

- Type tests
- Factory routine tests
- On-site tests

EGE



MATERIAL AND COMPONENTS

MATERIAL FOR BUSDUCT PRODUCTION

Conductors are manufactured of pressed tubes, or rolled, bent Al 99,5 EN 485.2 aluminium sheets, or, alternatively, Cu E57 copper tubes, encapsulated in aluminium Al 99,5 EN 485.2 coaxial enclosures.

The conductor is held concentric inside the enclosure by three support insulators. New, replacement insulators can be easily installed. In their standard form cast resin is used as a base material thus allowing for a greater creepage distance. This epoxy material substantially reduces water condensation levels due to its low thermal creep conductivity.

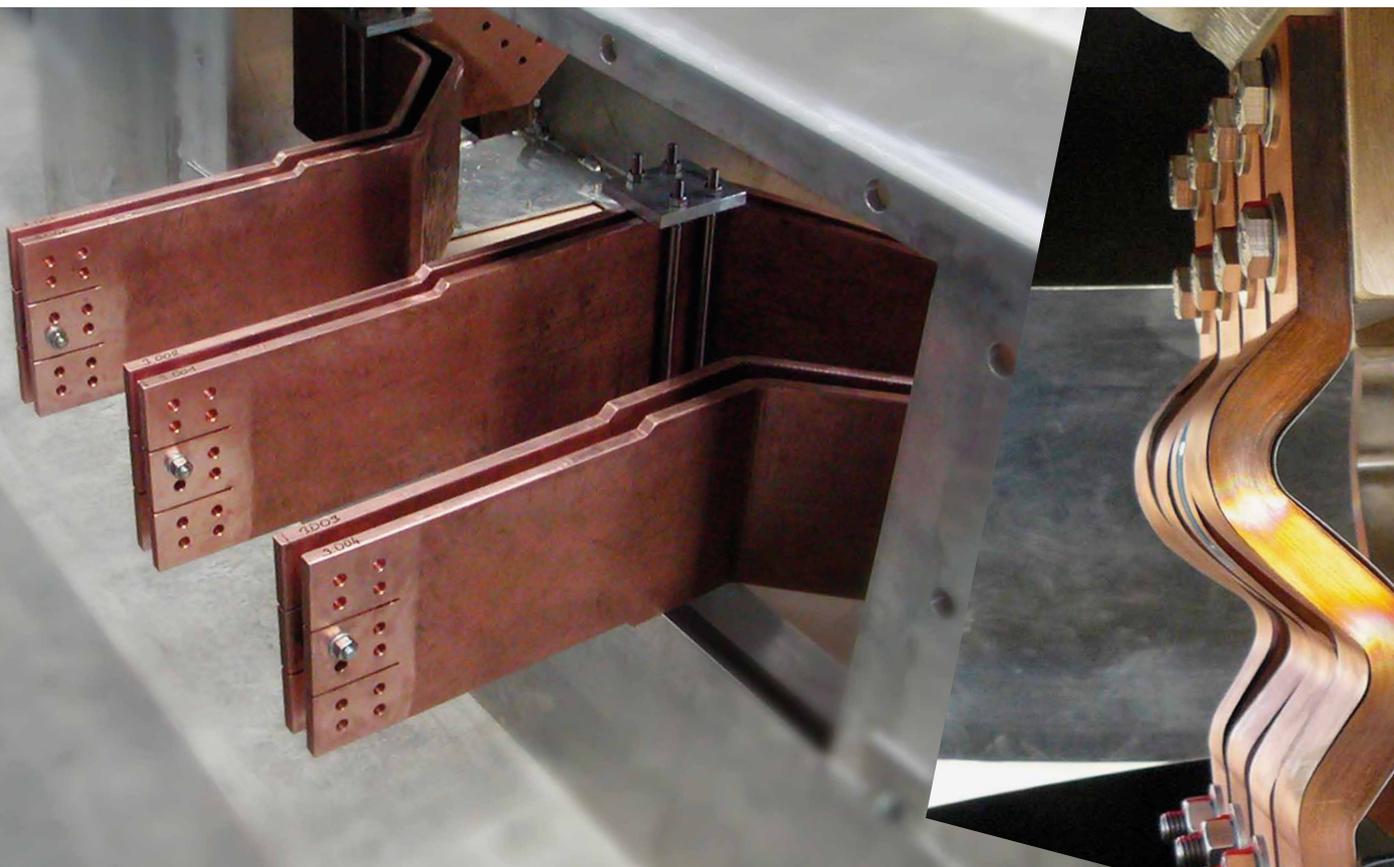
The insulators feature a spring-mounted head, allowing for both radial and axial dilatation in addition to the

attenuation of dynamic impacts during short-circuit transients.

T-branches, vertical, and horizontal elbows are designed according to project-specific requirements, site conditions, and the number of devices connected to the generator busducts.

The degree of protection of the route corresponds to IP 65 according to EN 60529. Flexible connections of conductors and enclosures allows for the use of busducts in areas with higher seismic activity.

NSPB conductors are made of stamped aluminium tubes Al 99,5 EN 485.2 or copper E-57. Additional insulation layers on the conductors can be proposed as an option. Conductors are enclosed in a rectangular aluminium casing made of aluminium sheets Al 99,5 EN 485.2.



MATERIAL AND COMPONENTS

BUSDUCT COMPONENTS

Aluminium connection terminals of conductors are silver-plated. Conductors are fixed in the proper position by supporting cast resin or porcelain insulators, removable from the outside of the enclosure. Axial thermal dilatation of conductors is ensured by flexible links made of aluminium if welded within the conductors, or of copper if installed at the connection terminals.

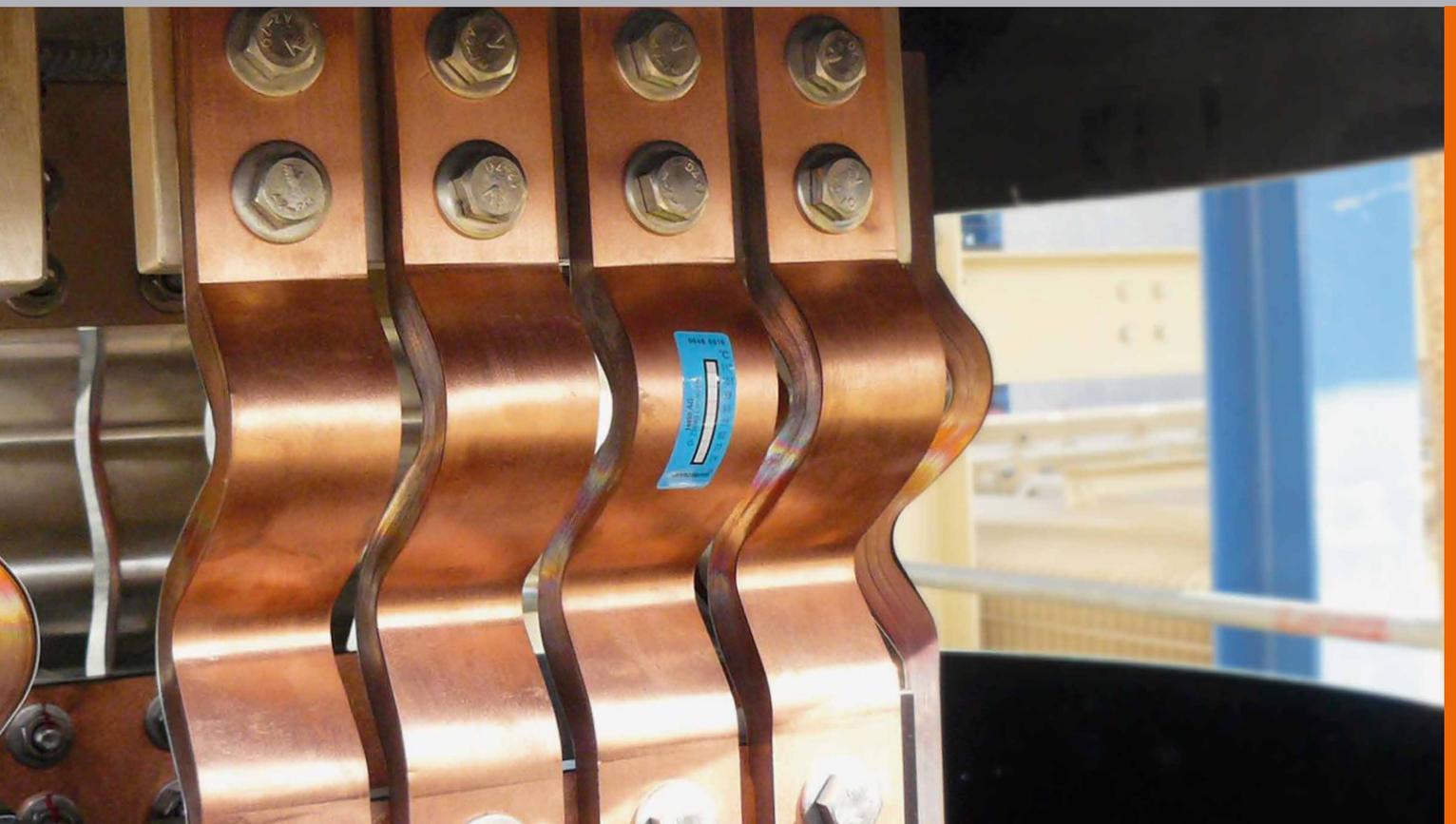
Rubber compensators allow axial dilatation and flexible connection of the enclosure. Transport units are manufactured at a maximal length of 11 meters. The final welding is performed on site according to the Welding Procedures, which are part of the Erection Manual.

Supporting insulators are designed with a long creepage distance and are made of cast resin or porcelain. The

manufacturer tests the insulators according to IEC 60660 standards. This design eliminates the need to take measures by cold energizing.

The overpressure system or dehydrating breathers preventing condensation inside the busducts are available upon customer request or based on site conditions. In locations affected by the sun, we supply protective sun shields.

Supporting steel structures can be included in delivery as hot dip galvanized or painted.



CONNECTIONS

GENERATOR CONNECTION

Generator busducts are usually connected to a generator through removable half shells' housing with silver-plated contact surfaces. This allows for a flexible and dismantable connection of the conductor as well as providing easy access to connection terminals and installed devices; this is especially useful for carrying out maintenance and improvements. Interface boxes and existing sections of conductors are designed to facilitate the replacement of bushings or even of the entire machine if necessary. On customer request, infrared thermometers can be added to the connection terminals of larger generators.

GENERATOR NEUTRAL POINT CONNECTION

Generator neutral point boxes are specifically designed for the type of generator used. They are equipped with openings for easy erection and maintenance on site. Inter-phase star connection is done using flat copper bars fixed with insulators to neutral point box casings, or using a special E-shaped aluminium tube fixed by insulators to a neutral point box. Neutral point boxes are fixed to generator casings by a flanged bolt connection.

GENERATOR CIRCUIT BREAKER (GCB) CONNECTION

Connections to generator circuit breakers can either be designed as a rigid or flexible connection depending on site conditions. Should a rigid connection be chosen, enclosures are directly welded to GCB casings. A flexible connection involves a circuit breaker flange being affixed by a rubber compensator which is connected to a busduct enclosure and conductively bridged by aluminium joints. The connection is designed in accordance with the specific type of the circuit breaker utilized. Conductors are connected to GCB terminals using flexible silver-plated copper joints.

GENERATOR CIRCUIT BREAKER STEEL PLATFORM

EGE also supplies the calculation, design and manufacture of a steel platform under a generator circuit breaker made according to the type of the circuit breaker in use, site conditions, the civil arrangement, and the customer's specific requirements. The standard surface treatment method is hot dip galvanisation. The steel support platform under a generator circuit breaker can be shipped together with the delivery of generator busducts.



CONNECTIONS

MAIN TRANSFORMER CONNECTION

Busduct enclosures are connected to a main transformer body using two flanged half shells bolted together which are fixed to busduct enclosures by rubber compensators thus allowing thermal and mechanical dilatation. The rubber compensators are bridged by aluminium links in one or three phases in order to maintain the conductivity of the enclosures. Earthing is carried out in accordance with a grounding diagram.

CONNECTION TO INSTRUMENT CUBICLES

Connection to instrument cubicles is facilitated using two flanged half shells bolted together which are fixed to busduct enclosures by rubber compensators, permitting thermal and mechanical dilatation. The entire system is designed for easy erection on site and to simplify future maintenance. The rubber compensators are bridged by aluminium links in order to preserve the conductivity of enclosures. Earthing occurs at only one place.

UNIT TRANSFORMER CONNECTION

Branch busduct enclosures are connected to unit transformers using two flanged half shells bolted together or are fixed using rubber compensators that allow for thermal and mechanical dilatation. The entire system is designed for easy erection on site and for the simplification of the future maintenance of flexible silver-plated copper joints connecting silver-plated aluminium terminals at connection points on both sides. Rubber compensators are bridged by aluminium links in one or three phases in order to maintain the conductivity of enclosures. Earthing is carried out in accordance with a grounding diagram.



CONNECTION COMPONENTS, TERMINALS, DILATATION

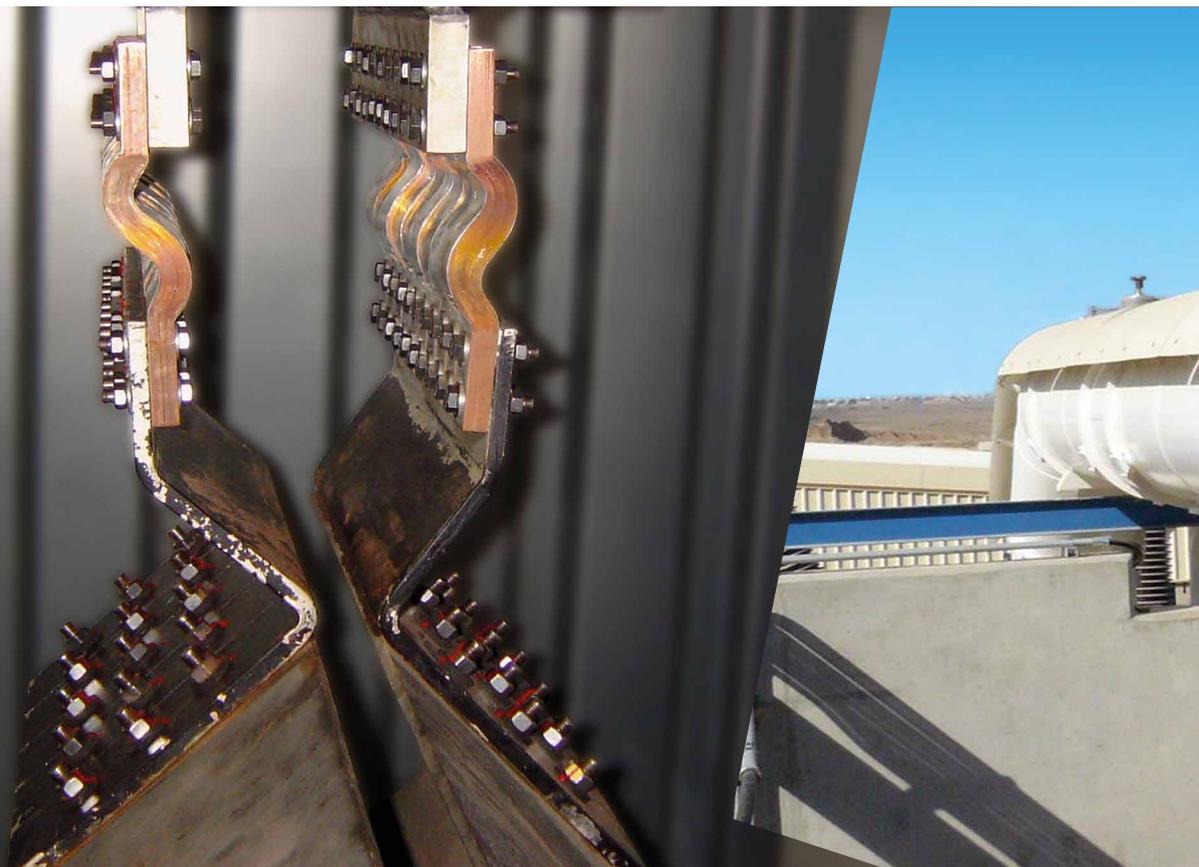
CONNECTION POINTS

Connection terminals are shaped silver-plated aluminium plates which are welded to a conductor. These terminals are equipped with holes for connecting silver-plated copper expansion links to relevant devices. All the conductors of transport units are shaped and made ready for connecting and easy welding on site. Bolted connections, as well as all other current carrying points, are fastened together with rust-proof, non-magnetic steel nuts and bolts.

CONDUCTOR AND ENCLOSURE DILATATION

The longitudinal dilatation of conductors is compensated for by flexible links made of thin aluminium sheets. The dilatation of an enclosure is enabled by the use of compensators made of specially formed aluminium sheets which are welded

in between enclosures. Dilatation couplings for both conductors and enclosures are welded and require no maintenance under operational conditions. Enclosure movement in a desired direction is facilitated by an array of fixed and sliding support feet welded to the steel support structures. Dilatation is further secured by rubber compensators fitted at the ends of transformer connections.



WALL PENETRATION, SUN SHIELDS, SUPPORTING STEEL STRUCTURES

WALL PENETRATION

To pass generator busducts through a wall, we use split wall penetration plates made of aluminium. A silicone sealing is used to seal the resultant interface gap. Single fire compartments are separated from each other with special material with the required fire resistance.

SUN SHIELDS

Sun shields are installed in areas of high solar activity, especially in tropical and subtropical territories. Their function is to reflect sun radiation and decrease the temperature of encapsulated busducts. Sun shields are produced from shaped aluminium sheeting which is fixed to busduct enclosures. A substitute for sun shields is to make conductors and enclosures from thicker material.

STEEL STRUCTURES SUPPORTING BUSDUCTS

The support structures are designed according to customer requirements. The supporting structures are primarily composed of HEA and HEB steel beams with zinc hot dip galvanized or painted surface treatment.

SADDLES AND ATTACHMENTS TO ENCLOSURES

Busduct enclosures are welded to fixed or movable saddle points whose steel base plates are welded to support structure cross-beams. The entire assembly can be adjusted to fit a support structure, and its total height can also be modified. This height adjustment is necessary on site due to building tolerances. Saddles are insulated from steel supports.



AUXILIARIES, OVERPRESSURE SYSTEMS

DEVICE FOR USE IN HAZARDOUS LOCATION

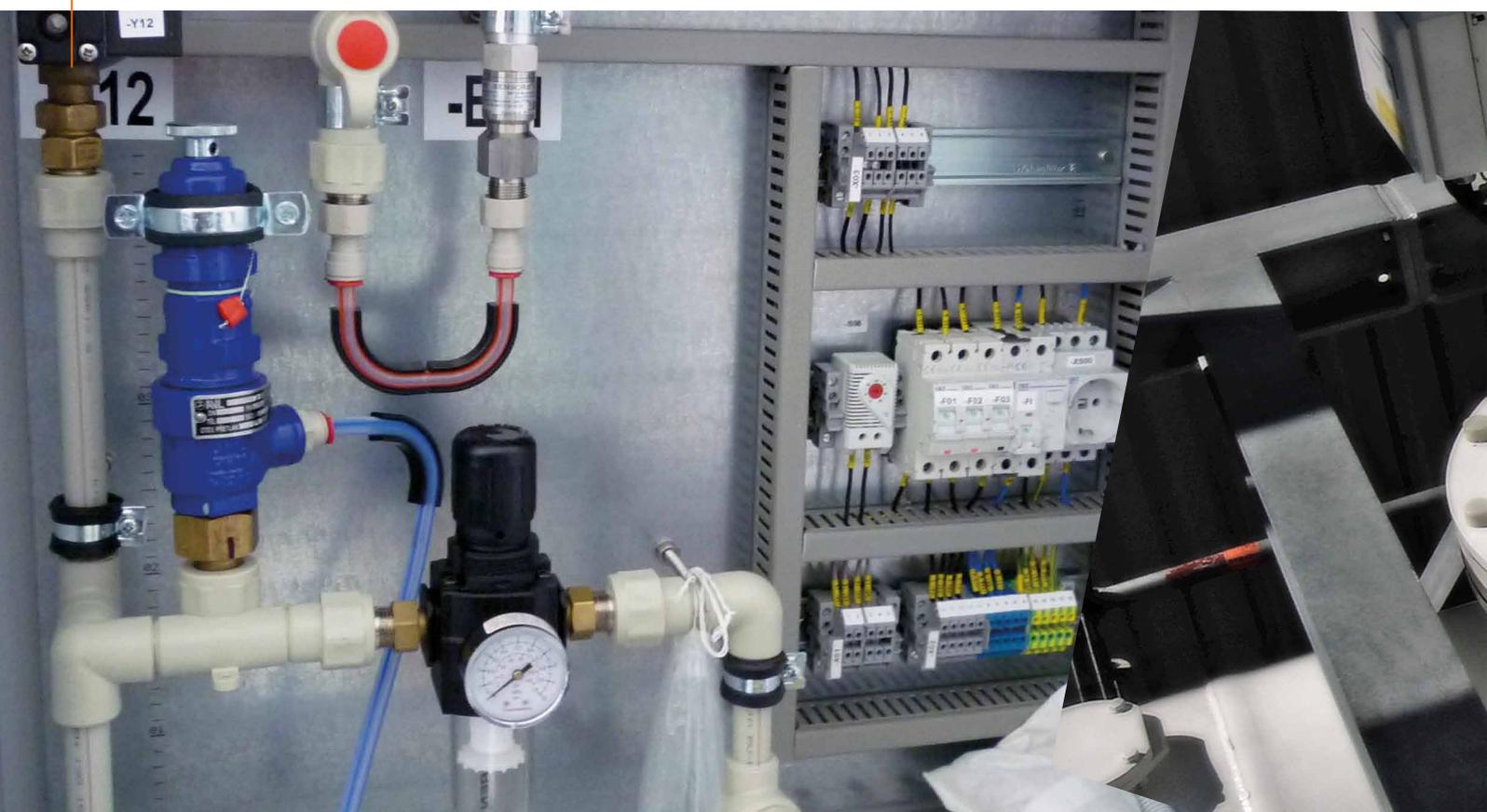
For connection of the busducts to the hydrogen-cooled generators EGE designs and supplies equipment for hydrogen leak detection and ventilation assembly to ensure safe operation of busducts in accordance with ATEX directive 94/9/EC.

DEHYDRATING BREATHERS

The internal space of busducts is separated from ambient influences based on the level of protection defined by equipment. Changes in air volume caused by alterations in temperature during the day and night are compensated for by air passing through a silica gel breather which dries the air flowing to busducts to prevent the condensation inside. The dehydrating breathers are of a type commonly used in conjunction with transformers or similar machines.

AIR PRESSURE REDUCING BOX

As an alternative, we can offer a pressurised air distribution system fed with treated air or recommend that a compressor be furnished with an air pressure reduction box connected through piping to busduct enclosures. Pressure at the inlet to the reduction box may be up to 10 Bars. Slight overpressure prevents the entry of air moisture and dust particles from the surrounding atmosphere and ensures a suitable environment inside the busducts. The pressure reduction box can be accessorised with remote signalling of operational statuses to a control room.



AUXILIARIES

SHORT CIRCUITING DEVICE

In the generator route, the Short Cir-
cuiting Device serves for testing and
setting the protection of the gene-
rator. It also serves as a single-pole,
mechanically controlled earthing. The
shorting device design allows for a
load of 8 kA for a period of 30 minu-
tes, or 12 kA for a period of 15 minu-
tes at the rated voltage 24 kV or 36 kV.

DRAINAGE EQUIPMENT

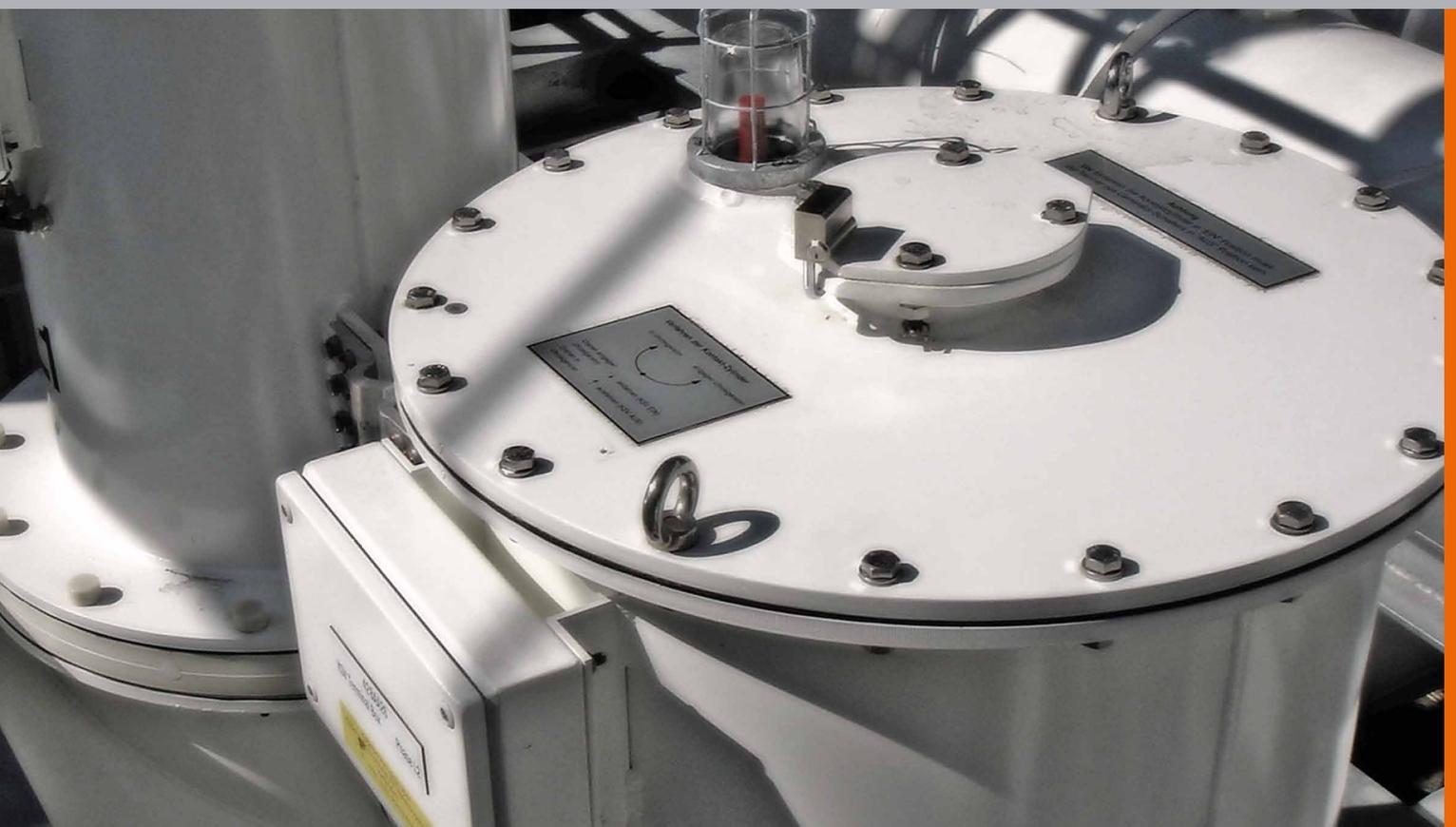
Should water condensation be present,
it is captured by the drainage equipment
and drained out of the system through
an outlet at the lowest point of a gene-
rator busduct unit.

AUXILIARY EQUIPMENT

According to customer requirements,
EGE can supply additional instruments
and equipment with generator busducts
such as:

- Voltage transformers
- Current transformers
- Surge arresters
- High voltage cubicles
- Remote infrared measurement system
- Grounding transformers
- Switchboard cubicles
- Temporary grounding devices

EGE is ready to deliver auxiliary devices
and equipment including the adaptation
of busducts for their installation.



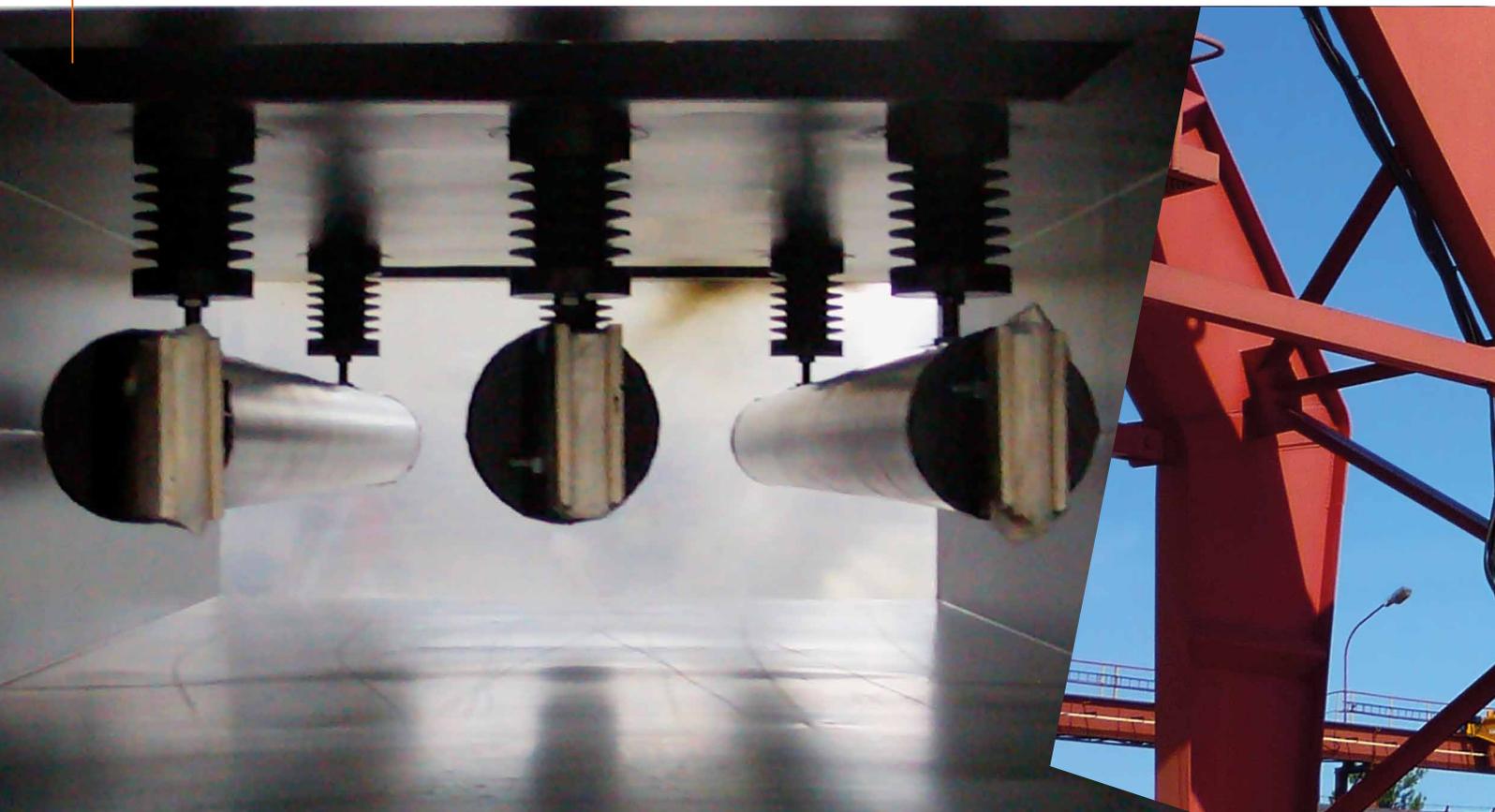
NON-SEGREGATED & SEGREGATED PHASE BUSDUCTS

UTILIZATION OF NSPB & SPB

Non-segregated phase and segregated phase busducts with air insulation are designed as specified by ANSI C37.23 for the transmission of medium currents. The insulation level follows IEC 60071-1 in the range up to 17.5 kV. IEC standards 60298 and 60694 are valid for each proposed design.

Non-segregated phase busducts are generally designed for medium voltage circuits of switch stations, auxiliary circuits, and outlets of small AC generators. Application for DC excitation

circuits of large generators is also possible. NSPB can be installed without other setup in places not protected against the weather.



PACKING AND LOGISTIC

PACKING FOR LAND TRANSPORT

Particularly for delivery across Europe, busducts are specially packed and prepared for transport by land haulage. Transport units are packed in wooden crates to prevent them from being damaged during delivery. Assembly materials for site erection are packed and well protected in wooden boxes.

PACKING FOR OCEAN SHIPPING

Packing for overseas delivery is done according to international standards for ocean shipping. Items are packed in wooden boxes and material is well protected against movement, humidity, dust, and salty air. Wooden boxes can be stored on site for several months without any damage occurring to the equipment inside. Materials used when erecting are separately packed and carefully signed for in accordance with packing lists and technical documentation.

CONTAINER PACKING

At the customers' request, EGE is able to transport busducts in containers. The busducts inside are packed as transport units in wooden crating, preventing any damage during delivery.

TRANSPORT

EGE can provide the transport of goods to the site or port of export based on valid Incoterms conditions. Shipment from EGE can either be by road haulage or via a factory railway.



ASSEMBLY, SUPERVISING

ASSEMBLY

The division's experienced assembly teams are capable of carrying out busduct assembly and other power constructions throughout the world. EGE possesses all the certification, authorization, tools and devices necessary to conduct assembly work. The company regularly organises training sessions for employees and enables them to monitor the latest trends while maintaining a high quality of the work performed. The EGE staff is able to provide the entire assembly of busducts, including commissioning.

SUPERVISING

Supervision on the sites of busduct installation worldwide is performed by

EGE employees. The supervisors are well informed on the specific project requirements and assist throughout the installation process, including dielectric strength tests and pressure tests. These specialists ensure that the installation is carried out in accordance with the technical documentation and assembly procedures. As-built documentation based on their reports is prepared after the installation.





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