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<th>Page</th>
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<td>49</td>
</tr>
<tr>
<td>8</td>
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<td>50</td>
</tr>
<tr>
<td>8.1</td>
<td>Bevel gear CD 6400, dimensional drawing (892916)</td>
<td>50</td>
</tr>
</tbody>
</table>
1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

It also includes safety instructions and general information about the product.

This technical file is intended solely for specially trained and authorized personnel.

1.1 Validity

This technical file applies to the following type of drive shaft:

▪ Explosion-proof drive shaft with insulator

1.2 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg
Tel.: (+49) 9 41/40 90-0
E-mail: sales@reinhausen.com

Further information on the product and copies of this technical file are available from this address if required.

1.3 Completeness

This technical file is incomplete without the supporting documentation.

The following documents apply:

▪ Supplement (included in the scope of delivery)
▪ Dimensional drawings (included in the scope of delivery)

Also observe generally valid legislation, standards, and guidelines as well as specifications on accident prevention and environmental protection in the respective country of use.

1.4 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.
1.5 Notation conventions

1.5.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.5.1.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical file. Warnings relating to sections use the following format:

⚠️ WARNING

Type of danger!
Source of the danger and outcome.
► Action
► Action

1.5.1.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

⚠️ DANGER!
Instruction for avoiding a dangerous situation.

1.5.1.3 Signal words and pictograms

The following signal words are used:

<table>
<thead>
<tr>
<th>Signal word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</td>
</tr>
<tr>
<td>NOTICE</td>
<td>Indicates measures to be taken to prevent damage to property.</td>
</tr>
</tbody>
</table>

Table 1: Signal words in warning notices

Pictograms warn of dangers:

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warning of a danger point</td>
</tr>
</tbody>
</table>
1 Introduction

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Warning of dangerous electrical voltage" /></td>
<td>Warning of dangerous electrical voltage</td>
</tr>
<tr>
<td><img src="image" alt="Warning of combustible substances" /></td>
<td>Warning of combustible substances</td>
</tr>
<tr>
<td><img src="image" alt="Warning of danger of tipping" /></td>
<td>Warning of danger of tipping</td>
</tr>
<tr>
<td><img src="image" alt="Warning of danger of crushing" /></td>
<td>Warning of danger of crushing</td>
</tr>
</tbody>
</table>

Table 2: Pictograms used in warning notices

1.5.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:

Important information.

1.5.3 Instruction system

This technical file contains single-step and multi-step instructions.

**Single-step instructions**

Instructions which consist of only a single process step are structured as follows:

Aim of action

✓ Requirements (optional).

► Step 1 of 1.

⇨ Result of step (optional).

⇨ Result of action (optional).
**Multi-step instructions**

Instructions which consist of several process steps are structured as follows:

- **Aim of action**
- ✓ **Requirements (optional).**
- 1. **Step 1.**
  - ⇨ **Result of step (optional).**
- 2. **Step 2.**
  - ⇨ **Result of step (optional).**
  - ⇨ **Result of action (optional).**
2 Safety

- Read this technical file through to familiarize yourself with the product.
- This technical file is a part of the product.
- Read and observe the safety instructions provided in this chapter.
- Read and observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets due to the function may arise in the event of improper use.

2.1 Appropriate use

The drive shaft is the mechanical connection between motor-drive and on-load tap-changer head / de-energized tap-changer head.

The bevel gear changes the direction from vertical to horizontal.

When installing, the vertical drive shaft has to be mounted between the drive and bevel gear, and the horizontal drive shaft between the bevel gear and on-load tap-changer or de-energized tap-changer.

The following is considered appropriate use:
- Only operate the product in accordance with this technical file and the agreed delivery conditions and technical data
- Use the equipment and special tools supplied solely for the intended purpose and in accordance with the specifications of this technical file
- Use the product only with the transformer specified in the order
- You will find the standard valid for the product and the year of issue on the nameplate
- The serial numbers of on-load tap-changers and on-load tap-changer accessories (drive, drive shaft, bevel gear, protective relay etc.) must match if the on-load tap-changers and on-load tap-changer accessories are supplied as a set for one order

2.2 Fundamental safety instructions

To prevent accidents, malfunctions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:
Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This poses a danger to life and limb.

- Wear appropriate personal protective equipment such as a helmet, work gloves, etc. for the respective activity.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

Work area

Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

Drying the transformer

Drying the drive shaft while drying the active part of the transformer will lead to damage as well as malfunctions on the drive shaft.

- Never dry the drive shaft.

Working during operation

The product may only be operated in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.

Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.

- Observe all safety markings on the product.
- Make sure all safety markings on the product remain intact and legible.
- Replace safety markings that are damaged or missing.

Ambient conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe the specified operating conditions and requirements for the installation location.
Auxiliary materials and operating materials

Auxiliary materials and operating materials not approved by the manufacturer can lead to personal injury, damage to property and malfunctions of the product.

- Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.
- Only use lubricants and auxiliary materials approved by the manufacturer.
- Contact the manufacturer.

Modifications and conversions

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

- Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.

Spare parts

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may lead to physical injury, damage to the product and malfunctions.

- Only use spare parts that have been approved by Maschinenfabrik Reinhausen GmbH.
- Contact Maschinenfabrik Reinhausen GmbH.

2.3 Standards and regulations

The standards and regulations which apply to the explosion-protected product are described in the following.

2.3.1 Application range of the drive shaft

The drive shaft is certified for Ex II 2G IIC T4. Refer to the following overview for the resulting application ranges.

<table>
<thead>
<tr>
<th>Number</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sign for explosion protection</td>
</tr>
<tr>
<td>2</td>
<td>Equipment group</td>
</tr>
<tr>
<td>3</td>
<td>Equipment category</td>
</tr>
<tr>
<td>4</td>
<td>Ex: Symbol for explosion-protected equipment</td>
</tr>
</tbody>
</table>

Table 3: Example of the application range
2 Safety

<table>
<thead>
<tr>
<th>Number</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Ignition protection type</td>
</tr>
<tr>
<td>6</td>
<td>Explosion group</td>
</tr>
<tr>
<td>7</td>
<td>Temperature class</td>
</tr>
<tr>
<td>8</td>
<td>EPL (Equipment Protection Level)</td>
</tr>
</tbody>
</table>

**Equipment groups (number 2)**

<table>
<thead>
<tr>
<th></th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Equipment in this category is intended for use in underground parts of mines as well as those parts of surface installations of such mines endangered by firedamp and/or combustible dust.</td>
</tr>
<tr>
<td>II</td>
<td>Equipment in this category is intended for use in other areas in which explosive atmospheres may be present.</td>
</tr>
</tbody>
</table>

Table 4: Equipment groups

**Equipment category / zone classification (number 3)**

<table>
<thead>
<tr>
<th>Designation for gases</th>
<th>Designation for dusts</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G</td>
<td>1D</td>
<td>Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures of air and gases, vapors or mists or by air/dust mixtures are present continuously, for long periods or frequently.</td>
</tr>
<tr>
<td>(0)</td>
<td>(20)</td>
<td></td>
</tr>
<tr>
<td>2G</td>
<td>2D</td>
<td>Equipment in this category is intended for use in areas in which explosive atmospheres caused by gases, vapors, mists or air/dust mixtures occur occasionally.</td>
</tr>
<tr>
<td>(1)</td>
<td>(21)</td>
<td></td>
</tr>
<tr>
<td>3G</td>
<td>3D</td>
<td>Equipment in this category is intended for use in areas in which explosive atmospheres caused by gases, vapors, mists, or air/dust mixtures are unlikely to occur or, if they do occur, are likely to do so only infrequently and for a short period only.</td>
</tr>
<tr>
<td>(2)</td>
<td>(22)</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Equipment category / zone classification

**Ignition protection types (number 5)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>d</td>
<td>Pressure-proof enclosure</td>
</tr>
<tr>
<td>e</td>
<td>Increased safety</td>
</tr>
<tr>
<td>l</td>
<td>Intrinsic safety (ia, ib)</td>
</tr>
<tr>
<td>m</td>
<td>Encapsulation</td>
</tr>
<tr>
<td>o</td>
<td>Oil immersion</td>
</tr>
<tr>
<td>p</td>
<td>Pressurized apparatus</td>
</tr>
<tr>
<td>q</td>
<td>Powder filling</td>
</tr>
<tr>
<td>n</td>
<td>Ignition protection type</td>
</tr>
</tbody>
</table>

Table 6: Ignition protection types
Explosion group (number 6)

<table>
<thead>
<tr>
<th>EN/IEC</th>
<th>Gases, vapors (examples)</th>
<th>Min. ignition energy (mJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIA</td>
<td>Ammonia</td>
<td>-</td>
</tr>
<tr>
<td>IIA</td>
<td>Acetic acid, acetone, benzene, diesel, ethane, ether, fuel oil, hexane, methane, petrol, petroleum, propane</td>
<td>0.18</td>
</tr>
<tr>
<td>IIB</td>
<td>Ethylene, isoprene, town gas</td>
<td>0.06</td>
</tr>
<tr>
<td>IIC</td>
<td>Acetylene, carbon disulfide, hydrogen</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 7: Explosion groups

Temperature classes (number 7)

<table>
<thead>
<tr>
<th>Temperature class</th>
<th>Maximum equipment surface temperature</th>
<th>Ignition temperature of the flammable substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>450 °C</td>
<td>&gt; 450 °C</td>
</tr>
<tr>
<td>T2</td>
<td>300 °C</td>
<td>&gt; 300 °C &lt; 450 °C</td>
</tr>
<tr>
<td>T3</td>
<td>200 °C</td>
<td>&gt; 200 °C &lt; 300 °C</td>
</tr>
<tr>
<td>T4</td>
<td>135 °C</td>
<td>&gt; 135 °C &lt; 200 °C</td>
</tr>
<tr>
<td>T5</td>
<td>100 °C</td>
<td>&gt; 100 °C &lt; 135 °C</td>
</tr>
<tr>
<td>T6</td>
<td>85 °C</td>
<td>&gt; 85 °C &lt; 100 °C</td>
</tr>
</tbody>
</table>

Table 8: Temperature classes

Equipment protection level (EPL) (number 8)

The EPL indicates the level of protection defined for a device based on the level of probability of ignition and taking account of the differences between potentially explosive gas atmospheres, potentially explosive dust atmospheres, and potentially explosive atmospheres in mine workings affected by firedamp.

2.4 Measures for ensuring compliance with explosion protection requirements

To comply with explosion protection requirements, measures stipulated by both the manufacturer and transformer manufacturer/operator must be undertaken.

2.4.1 Measures taken by the manufacturer

Explosion-proof drive shaft

The explosion-proof drive shaft is supplied with an insulator.
2.4.2 Measures to be taken by the transformer manufacturer/operator

Insulator

With the horizontal drive shaft, you have to mount the insulator on the side facing the bevel gear.

With the vertical drive shaft, you have to mount the insulator on the side facing the drive.

Grounding the covers of the drive shafts and bevel gear

You have to ground the following components separately:
- Telescopic protective tube of vertical drive shaft
- Protective cover of horizontal drive shaft
- Bevel gear

2.5 Personnel qualification

The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.

Electrically skilled person

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:
- Can identify potential dangers independently and is able to avoid them.
- Is able to perform work on electrical systems.
- Is specially trained for the working environment in which (s)he works.
- Must satisfy the requirements of the applicable statutory regulations for accident prevention.

Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.

Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.
2 Safety

Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

2.6 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.

<table>
<thead>
<tr>
<th>Protective clothing</th>
<th>Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety shoes</td>
<td>To protect against falling heavy objects and slipping on slippery surfaces.</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>To protect the eyes from flying parts and splashing liquids.</td>
</tr>
<tr>
<td>Visor</td>
<td>To protect the face from flying parts and splashing liquids or other dangerous substances.</td>
</tr>
<tr>
<td>Hard hat</td>
<td>To protect against falling and flying parts and materials.</td>
</tr>
<tr>
<td>Hearing protection</td>
<td>To protect against hearing damage.</td>
</tr>
<tr>
<td>Protective gloves</td>
<td>To protect against mechanical, thermal, and electrical hazards.</td>
</tr>
</tbody>
</table>

Table 9: Personal protective equipment

2.7 Drying transformer

2.7.1 Drying transformer in autoclave

Observe the following information when drying the transformer in an autoclave.
NOTICE

Damage to drive shaft, on-load tap-changer and transformer!
If the drive shaft is dried in a furnace, this may cause damage to the drive shaft and restrict its correct function.
► Do not dry drive shaft in an autoclave.

2.7.2 Drying transformer in the transformer tank
If you dry the active part in the transformer tank, the drive shaft may remain fitted to the transformer.
3 Product description

3.1 Function description

The drive shaft is the mechanical connection between the drive and the on-load tap-changer head.

The bevel gear changes the direction from vertical to horizontal.

Accordingly, the vertical drive shaft has to be mounted between the drive and bevel gear, and the horizontal drive shaft between the bevel gear and on-load tap-changer or de-energized tap-changer.

The explosion-proof drive shaft consists of a square tube with insulator and is coupled by two coupling brackets and one coupling bolt at both ends to the drive or driven shaft end of the device to be connected.

![Figure 1: Explosion-proof drive shaft with insulator](image-url)
3.2 **Scope of delivery**

The product is packaged with protection against moisture and is delivered as follows:

- Explosion-proof drive shaft with insulator
- Bevel gear
- Operating instructions
- Supplements
- Dimensional drawing

Please note the following:

- Check the shipment for completeness on the basis of the shipping documents.
- Store the parts in a dry place until installation
- The product must remain in its airtight, protective wrapping and may only be removed immediately before installation
3.3 Design/Model

The design of the explosion-proof drive shaft is described in this section.

Figure 2: Components of the explosion-proof drive shaft

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bevel gear</td>
</tr>
<tr>
<td>2</td>
<td>Hose clip</td>
</tr>
<tr>
<td>3</td>
<td>Screws</td>
</tr>
<tr>
<td>4</td>
<td>Telescopic protective tube</td>
</tr>
<tr>
<td>5</td>
<td>Coupling bracket</td>
</tr>
<tr>
<td>6</td>
<td>Insulator</td>
</tr>
<tr>
<td>7</td>
<td>Double coupling bracket</td>
</tr>
<tr>
<td>8</td>
<td>Square tube</td>
</tr>
<tr>
<td>9</td>
<td>Pin</td>
</tr>
<tr>
<td>10</td>
<td>Adapter ring</td>
</tr>
<tr>
<td>11</td>
<td>Protective cover</td>
</tr>
</tbody>
</table>
Configuration | V 1 min | Intermediate bearing
--- | --- | ---
Middle of hand crank – middle of bevel gear (maximum permissible axial offset 2°) | 706 mm | If the maximum value of 2472 mm is exceeded, the use of an intermediate bearing is necessary.
V 1 ≤ 2472 mm (without intermediate bearing)
V 1 > 2472 mm (with intermediate bearing)
3.4 Identification plate

The identification plate is on the telescopic protective tube.

Figure 3: Position of the identification plate
4 Packaging, transport and storage

4.1 Packaging

The products are sometimes supplied with sealed packaging and sometimes in a dry state, depending on requirements.

Sealed packaging surrounds the packaged goods with plastic foil on all sides.

Products that have also been dried are identified by a yellow label on the sealed packaging. In the dry state, delivery is also possible in a transport container.

The information in the following sections should be applied as appropriate.

4.1.1 Suitability

**NOTICE**

Property damage due to incorrectly stacked crates!

Stacking the crates incorrectly can lead to damage to the packaged goods.

► The outer marking on the packaging states if, for example, the on-load tap-changer or selector has been packed upright. Never stack these crates.

► General rule: Do not stack crates above a height of 1.5 m.

► For other crates: Only stack up to 2 equally sized crates on top of one another.

The packaging is suitable to ensure undamaged and fully functional means of transportation in compliance with local transportation laws and regulations.

The packaged goods are packed in a sturdy crate. This crate ensures that, when in the intended transportation position, the packaged goods are stabilized to prevent impermissible changes in position, and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.
4.1.2 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Protect against moisture" /></td>
<td>Protect against moisture</td>
</tr>
<tr>
<td><img src="image" alt="Top" /></td>
<td>Top</td>
</tr>
<tr>
<td><img src="image" alt="Fragile" /></td>
<td>Fragile</td>
</tr>
<tr>
<td><img src="image" alt="Attach lifting gear here" /></td>
<td>Attach lifting gear here</td>
</tr>
<tr>
<td><img src="image" alt="Center of mass" /></td>
<td>Center of mass</td>
</tr>
</tbody>
</table>

Table 10: Shipping pictograms

4.2 Transportation, receipt and handling of shipments

**WARNING**

Risk of severe injury or death!

Danger due to tipping or falling load!

► Only trained and appointed persons may select the sling gear and secure the load.

► Do not walk under the hanging load.

► Use means of transport and lifting gear with a carrying capacity of > 500 kg.

**NOTICE**

Damage to packaged goods!

Damage due to tipping or falling load!

► Only trained and appointed persons may select the sling gear and secure the load.

► Use means of transport and lifting gear with a carrying capacity of > 500 kg.

In addition to oscillation stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If a crate tips over, falls from a certain height (e.g. when slings tear) or is subject to an unbroken fall, damage must be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):

- Completeness based on the delivery slip
- External damage of any type

The checks must take place after unloading when the crate or transport container can be accessed from all sides.
Visible damage  If external transport damage is detected on receipt of the shipment, proceed as follows:

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen GmbH and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately onsite together with the carrier involved. This is essential for any claim for damages!
- If possible, photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- Name the damaged parts.

Hidden damage  When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damages can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

4.3 Storage of shipments

Packaged goods can be stored outdoors when the following conditions are complied with.

When selecting and setting up the storage location, ensure the following:

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the crates on timber beams and planks as a protection against rising damp and for better ventilation.
- Ensure sufficient carrying capacity of the ground.
- Keep entrance paths free.
- Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.
4.4 Unpacking shipments and checking for transportation damages

- Wherever possible keep the crate packaged for transport to the place where installation will take place.
- When unpacking, check the condition of the packaged goods.
- Check completeness based on the delivery slip.
5 Mounting

This chapter describes how to fit and connect the explosion-proof drive shaft.

5.1 Fitting drive shaft

Observe the following during mounting:

**NOTICE**

**Damage to drive and on-load tap-changer or de-energized tap-changer!**

Trouble-free operation of the drive and the on-load tap-changer or de-energized tap-changer cannot be guaranteed.

► The shaft ends to be connected must be exactly aligned.

**Permitted axial displacement**

Minor axial displacement can be tolerated as long as it does not exceed 35 mm per 1,000 mm square tube length (that corresponds to 2°).

![Figure 4: Permitted maximum axial displacement of vertical drive shaft](image)
Resistance to corrosion of components

Square tubes, coupling brackets, coupling bolts, screws, and locking washers are corrosion-resistant. We therefore recommend not applying the same external coating to these parts as to the transformer tank.

Cutting square tubes, telescopic protective tubes, and protective cover

The square tubes, telescopic protective tubes, and protective cover are supplied in overlengths (graded standard lengths). You must cut these parts to the required size before mounting on the transformer. In rare cases, you also have to cut the inner tube of the telescopic protective tube to the desired length. The maximum total drive shaft length of the drive - last column = 15 m.

<table>
<thead>
<tr>
<th>Standard lengths</th>
<th>Ex TAPMOTION® ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>•</td>
</tr>
<tr>
<td>600</td>
<td>•</td>
</tr>
<tr>
<td>900</td>
<td>•</td>
</tr>
<tr>
<td>1,300</td>
<td>•</td>
</tr>
<tr>
<td>1,700</td>
<td>•</td>
</tr>
</tbody>
</table>

Table 11: Graded standard lengths of square tubes for explosion-proof motor-drive unit TAPMOTION® ED-Ex
5.1.1 Fitting vertical drive shaft with insulator

To fit the vertical drive shaft, proceed as follows.

1. **CAUTION!** Switch off motor protective switch Q1 in the motor-drive unit (position O). If this is not done, the motor-drive unit may be started inadvertently and cause injuries.

2. Screw down the bevel gear for fastening on the transformer on both sides with the contact washers provided to ensure permanent grounding. Screws are not included in the scope of supply.

3. Determine dimension A between shaft end of drive and shaft end of bevel gear. Shorten the square tube to length of A–179 mm, taking the insulator into account.

![Figure 6: Bevel gear](image)

- 2x M16
- 24
- 130 Nm
4. Deburr the cut surfaces on the square tube.
5. Screw down the double coupling bracket with the insulator supplied and the square tube. Mount the insulator on the side facing the drive.

6. Slide the loosely screwed-together coupling part onto the insulator until the stop is reached.
7. Insert the coupling bolt into the shaft end of the drive. Grease the coupling part, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32). Slide the square tube with the coupling part onto the shaft end.

![Figure 11: Sliding the square tube with the coupling part onto the shaft end](image)

8. Attach the square tube to the drive.

![Figure 12: Attaching the square tube to the drive](image)

9. Pivot the square tube away from the axis.
10. When installing the telescopic protective tube, shorten the inner tube on the side without slots if necessary. The minimum dimension for overlapping the two protective tubes is 100 mm.
The inner tube must not be deformed and must be deburred in order to slide easily in the outer tube.

**Figure 14: Deburring the inner tube**

<table>
<thead>
<tr>
<th>Dimension A (= distance between the shaft end of the drive and the shaft end of bevel gear)</th>
<th>Inner tube</th>
<th>Outer tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>170 mm...190 mm</td>
<td>Shorten to 200 mm</td>
<td>= 200 mm</td>
</tr>
<tr>
<td>191 mm...1130 mm</td>
<td>Dimension A + 20 mm</td>
<td>= 200 mm</td>
</tr>
<tr>
<td>1131 mm...1598 mm</td>
<td>= 700 mm</td>
<td>= 1150 mm</td>
</tr>
<tr>
<td>1,599 mm...2,009 mm</td>
<td>= 1150 mm</td>
<td>= 1,150 mm</td>
</tr>
</tbody>
</table>

11. For the separate grounding with 110 mm spacing (viewed from the slotted side), drill an 11 mm diameter hole in the inner tube.
12. Slide the outer tube over the inner tube. When doing so, make sure that the non-slotted side of the inner tube is facing upwards. Slide the telescopic protective tube onto the square tube. Then slide the hose clips over the telescopic protective tube.

Figure 15: Producing grounding hole on the telescopic protective tube
13. Place the adapter ring over the bearing collar of the bevel gear and slide upwards. Insert the coupling bolt into the shaft end of the bevel gear. Pivot the square tube back to the axis.
14. Grease the coupling brackets, coupling bolt and shaft end (e.g. ISOFLEX TOPAS L32) and secure the square tube with the coupling brackets on the bevel gear. Set a unilateral axial clearance of 3 mm between the coupling bolt and the upper coupling piece.
5 Mounting

15. Use a grounding cable and the supplied screw with contact washers to establish a connection between the bottom protective tube (inner tube) and the functional ground. Due to the risk of collision with the screw head, fit the fixing screw for the grounding cable from the inside.

Figure 18: Mounting the coupling brackets

Figure 19: Screwing down the grounding cable on the telescopic protective tube
16. Attach the bottom protective tube (inner tube) with a hose clip to the bearing collar of drive 1. Then slide the upper protective tube (outer tube) over the adapter on the bevel gear 2. Secure the upper protective tube to the second hose clip at top end 3.

17. Drill two holes (4.5 mm in diameter) in the two tubes, roughly in the center and offset by 180°. Then, screw in the two tapping screws provided and lock the protective tubes against one another to produce a galvanic connection.
5.1.2 Fitting horizontal drive shaft with insulator

Aligning upper gear unit on the on-load tap-changer head

In order to correctly install the horizontal drive shaft, under certain circumstances you may have to first align the upper gear unit such that the horizontal drive shaft is flush with the shaft end of the upper gear unit.

To do so, proceed as follows:

1. **NOTICE!** Damage to the on-load tap-changer due to alignment of the gear unit when the oil compartment is not completely full. Ensure that the oil compartment is filled completely with insulating fluid.

2. Loosen screws and turn pressure ring segments to one side.
3. **NOTICE!** Align gear unit such that the horizontal drive shaft is flush with the drive shaft of the gear unit. While aligning the gear unit, turn the unit’s drive shaft such that its output shaft retains its original position. Failure to do so may result in damage to the de-energized tap-changer and transformer when starting up.

![Figure 23: Aligning gear unit](image)

4. Swivel pressure ring segments back towards gear unit and tighten screws. Ensure that the locking washer is between the screw head and pressure ring segment and that the pressure ring segments are firmly in contact with the gear unit housing.

![Figure 24: Securing pressure ring segments](image)
Fitting the horizontal drive shaft

To mount the horizontal drive shaft, proceed as follows:

1. Calculate dimension A between the shaft end of the upper gear unit and the shaft end of the bevel gear and shorten the square tube to length A–179 mm taking the insulator into account.

2. Calculate inside width B between the housings of the upper gear unit and the bevel gear. Cut down the protective cover to B-2 mm and deburr the cut edges.

3. For the separate grounding with 110 mm spacing from the bevel gear, drill an 11 mm diameter hole in the protective cover. Protect the protective cover against corrosion with a coat of paint.
4. Screw down the double coupling bracket with the insulator supplied and the square tube. Mount the insulator on the side facing the bevel gear.

5. Slide the loosely screwed-together coupling part onto the insulator until the stop is reached.
6. Grease the coupling bolt, coupling part and shaft end of the bevel gear (e.g. ISOFLEX TOPAS L32) and insert the coupling bolt into shaft end. Thread the hose clip onto the square tube and slide the square tube with the coupling part onto the shaft end.

Figure 30: Sliding the square tube with the coupling part onto the shaft end

7. Secure the square tube onto the bevel gear.

Figure 31: Securing the square tube on the bevel gear

8. Grease the coupling bolt, the coupling brackets and the shaft end of the upper gear unit (e.g. ISOFLEX TOPAS L32) and insert the coupling bolt into the shaft end. Secure the square tube with the coupling brackets on the upper gear unit. Set a unilateral axial clearance of 3 mm between the coupling bolt and the upper coupling piece.
9. Attach the shortened protective cover to the housing lugs on the on-load tap-changer head and the bevel gear. Secure each end of the protective cover with a hose clip.

Figure 32: Secure the square tube on the upper gear unit.
5 Mounting

10. Use the grounding cable and the supplied screw with the contact washers to establish a connection between the protective cover and the functional ground. Due to the risk of collision with the screw head, fit the fixing screw for the grounding cable from the inside.

Figure 33: Fitting the protective cover
5.1.3 Centering on-load tap-changer and motor-drive unit

► Center on-load tap-changer and motor-drive unit as described in relevant MR operating instructions for motor-drive unit.
6 Commissioning

Once you have fitted the explosion-proof drive shaft and centered the on-load tap-changer with the explosion-proof motor-drive unit TAPMOTION® ED-Ex, you can start to commission the transformer.
7 Maintenance

Electric shock!

An energized transformer could cause death or serious injuries.
► Switch off transformer on high and low-voltage side.
► Lock transformer to prevent unintentional restart.
► Ensure that everything is de-energized.
► Visibly connect all transformer terminals to ground (grounding leads, grounding disconnectors) and short circuit them.
► Cover or cordon off adjacent energized parts.

Electric shock!

Working on the on-load tap-changer when on-load tap-changer components are energized can lead to death or serious injuries.
► De-energize all auxiliary circuits, such as the tap-change supervisory device, pressure relief device, pressure monitoring device.
► Make sure that everything is de-energized.

Danger of explosion!

Explosive gases in the oil compartment of the on-load tap-changer, transformer, pipe system, oil conservator and at the dehydrating breather opening can deflagrate or explode and result in severe injury or death.
► Ensure that there are no ignition sources such as naked flames, hot surfaces or sparks (e.g. caused by the build-up of static charge) in the transformer's immediate surroundings and that none occur.
► Do not operate any electrical devices (e.g. risk of sparks from impact wrench).
► Only use conductive and grounded hoses, pipes, and pump equipment that are approved for flammable liquids.

Damage to motor-drive unit!

Damage to the motor-drive unit due to condensate in protective housing of motor-drive unit.
► Always keep protective housing of the motor-drive unit tightly closed.
► In the event of operation interruptions of more than 2 weeks, connect and operate the anti-condensation heater in the motor-drive unit. If this is not possible, e.g. during transportation, place a sufficient amount of desiccant in the protective housing.
7.1 Inspection

Monitoring the on-load tap-changer and motor-drive unit is limited to occasional visual checks of on-load tap-changer head, protective relay, and motor-drive unit. For efficiency reasons these visual checks can be combined with the usual checks on the transformer.

Check the following:

<table>
<thead>
<tr>
<th>Interval</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>annually</td>
<td>Check the drive shaft’s lubrication points for sufficient lubrication.</td>
</tr>
<tr>
<td></td>
<td>You will find the lubrication points in the installation description.</td>
</tr>
<tr>
<td></td>
<td>(see page [Section 5.1, Page 26]).</td>
</tr>
<tr>
<td>annually</td>
<td>Check upper gear unit and bevel gear for seal integrity and damage.</td>
</tr>
<tr>
<td>annually</td>
<td>Check door seal, cable bushings, and ventilation of protective housing</td>
</tr>
<tr>
<td></td>
<td>of motor-drive unit.</td>
</tr>
<tr>
<td>annually</td>
<td>Check coating of all painted parts of the drive shaft.</td>
</tr>
</tbody>
</table>

Table 12: Inspection plan
8 Appendix

8.1 Bevel gear CD 6400, dimensional drawing (892916)

The direction of rotation is defined during ordering.

Der Drehsinn wird bei Bestellung festgelegt.