COMPACT KIOSK-TYPE TRANSFORMER STATION GRÄPER
GBÜ-2000 (1TR)

Basic technical specifications:

- HV nominal voltage: 3 AC 22 kV 50 Hz
- LV nominal voltage: 3/PEN AC 420/242 V 50 Hz / TN-C,
- Transformer nominal power: to 1 600 kVA
- HV bus-bars nominal current: cable entry field - 630 A, TR outlet field: 200 A
- LV bus-bars nominal current: 16 kA
- HV switchgear nominal dynamic current: 40 kA
- LV bus-bars nominal current: up to 2 500 A
- LV distributor nominal insulation voltage: 1 000 V
- LV distributor short-time : up to 30 kA
- LV distributor dynamic current: up to 60 kA
- HV/LV distributor cover: IP 65 / IP 20
- Whole station cover: IP 23D
- Cover class: K 20
- External dimensions (LxWxH): 3 050x2 500x2 650 mm
- Empty skeleton weight: cca 8 600 kg
- Environment: 3.1.1. basic (within the kiosk-type TS rooms),
  4.1.1. ambient, ordinary (outside the TS rooms)
- Exposure class: for internal components: XC1; for external components: XC4, XF1, XA1.
- Operating conditions: ambient temperature $-40°C \leq t \leq +40°C$
  altitude up to 1 000 m asl.

Note: If the transformer substation is used in different climate and operating conditions, the TS supplier must be consulted.

Electrical current injury prevention: (STN EN 33 3201, STN EN 33 2000-4-41)

- in normal operation mode (of the live parts): in HV system by: 4.1.1 – out of reach placement
  4.1.1 – live parts insulation
  4.1.1 – barrier, cover
  in LV system by: 3.7.1. live parts insulation
  3.7.2. barriers or covers
  3.8.5. out of reach placement (position)

– in case of failure (of dead parts): in HV system by: 4.2.5. automatic feed disconnection with quick IT networks disconnections to be off (with low imped. neutral TR grounding)
4.2.9. bonding – uniform potential installation
in LV system by: 3.2. automatic feed disconnection
3.6.1. additional protection by residual current device (TS install.)

3.6.2. additional protection – additional protecting bonding

Station construction:

Externally controlled compact kiosk-type transformer substation is partially flush-mounted,, with external dimensions of 3 050x2 500 mm, total height of 2 650 mm, clear height of 2 380 mm, ground sinking depth of 780 mm, over ground height of 1 870 mm (with flat roof). The construction is self-supported and by default made of reinforced concrete Gräper LC 30/37, with 8/12 granularity Steel reinforcement frame composed of steel bars and mats is bilaterally welded and conductively connected together and takes part in the bonding, grounding, or even lightning protection system. The installation of the station skeleton does not require any foundations, but only a well flushed and rammed out cut. The transformer substation is type-approved, conforming to the STN EN 62271-202 norm and meets the resistance tests against internal arcing fault of the German PEHLA directive.

Station construction forms a compact unit consisting of two monolithic parts: basement tank with sidewals and a flat roof.
The basement tank and sidewall: Made of waterproof and oil proof concrete (crack width up to 0.2 mm guranteed) as an oil catch tank. The construction resistance against strong chemical influence of the liquids, soils and vapours conforms to DIN directive. The tank serves as a foundation for the non-freezing part and for lifting the whole station by means of 4 anchorage points (sealed chasing nuts) RD 36, placed in the shorter sides of the TS (as viewed on „B“, „D“). In order to join the external grounding, two M12 points of HV/LV switchgear are led out from the sidewalls of the station.The bell casting method was used to construct the tank and door frames, thus creating a monolithic unit which meets requirements for the impermeability of water and oil substances.

HV and LV cable entry holes are made on production in the lower part of the body (HV or LV distributor´s side). After cable installation, the entry holes are sealed by Hauff press fittings (HSI 150 for the HV cables, HSI 90 for the LW cables). After installation, the cables are sealed against water penetration with default lids with corresponding number and diameter of cable entry necks (corresponding to cable type – HSI 150 D3/60 for HV cables or HSI 90 D1/75 for LV cables), which are sealed by a closing lid with a thermal shrinking plastic sleeve. Optionally, the system lid can be fitted with a sleeve for sealing the cable protector (FXKV...) or thermal shrinking sleeve may by substituted by cold shrinking sleeves. Unoccupied inlets are sealed with system lid with bolt sealing and bayonet lock. Optionally, an inlet for the side pass of a temporary construction outlet (e.g. Gräper system or Hauff-BD) may be installed in the LV distributor space.

The entry opening for HV cables (cable space) is separated from the HV distributor with a steel plate. The distributor is placed on a steel construction including safety frame for the protection of maintenance personnel and personal protection agains internal arcing fault according to PEHLA standards.

Internal walls are standardly treated with white washable paint. The surface treatment of the external walls includes concrete with bare filler (exposed aggregate concrete) with 8/12 granularity. Other finishes are available on demand.

Roof: connected to the walls from inside at 4 points by screws and overlapping the wall contour by 10 cm. The roof can be lifted by 4 anchor points (sealed chasing nuts) RD 18. In order to increase the protection of the concrete surface against humidity, the upper roof is covered with additional hydrophobic coating, which fills capillary pores and acts against the hygroscopic properties of the concrete.

Surface treatment of the roof can be made of exposed aggregate concret, or fair-face concrete with rough surface and paint according to the RAL colour palette. The shape of the roof (flat, saddle) is optional as well.

Door: All metal parts including doors, frames, and ventilating parts are made by default of hot-dip galvanized 1,5 mm thick sheet steel, basic paint and two layers of the finish paint in RAL 7032 colour palette. The door is equipped with armour including external knob and internal handle with plastic lock cover and a pawl for fixing the door in open position at a 95° angle. For arrestment – the locking, bob weights and point-to-point bars are used within each door wing frame (four- point locking system Gräper). The lock is adapted for standard lock inserts. The outer side of the door is covered by warning plates in terms of the valid EN.

Optionally, the door and ventilating parts can be made of anodized aluminium and 2 lock inserts can be used for double lockout.

The access to the HV and LV switchgear of the substation is provided by a common single wing door with full ventilation (slit shades Gräper with approved DIN 40 050 V2A safety level) with internal dimensions WxH of 1 270x1 610 mm, on the HV/LV transformer´s side there is a 2-wing door without ventilation (HV) and ventilation (LV) with internal dimensions WxH of 2 200x1 610 mm. The door is equipped with an arresting pawl for fixing in an open position and door wings are connected with the frame by a copper conductor with 16 mm^2 cross-section area.

Air exchange calculation: Gräper GBÜ 2000

1. For the Oil transformer **22 kV, 1600 kVA, Type: BEZ TOHn 418/22, "BA"**

- Transformer strain in summer time: 50 % up to 60% of the nominal power
- Ambient air temperature: +35 °C
- no-load losses: Po = 2,60 kW
- load losses: Pkn = 20,0 kW
- Ventilators altitude difference: h = 1,6 m

1. Calculation :

no-load losses: Po = 2,6 + 0,26(10%) = 2,86 kW

load losses: Pk =20,0 + 2,0(10%) = 20,2 KW

N = 800 (50% of the nominal power)/1600(100% of the nominal power) = 0,5

Total losses: Pz = Po + Pkn x N^2 = 2,86 +20,2 x 0,25 = 5,76 kW

Heat losses for ventilation calculation: Pch = 0,6 x Pz = 0,6 x 5,76 = 3,456 kW

Ventilator diameter in m² :

- Air inlet: Sp = 0,1942 x (Pch/√h) = 0,1942 x (3,456/√1,6) = **0,531 m²**
- Air outlet: So = 0,2007 x (Pch/√h) = 0,2007 x (3,456/√1,6) = **0,548 m²**

Ventilators in transformer station GBÜ 2000:
Inlet vent :1250 x 1605 mm² = **2 m²** - TS door
Outlet vent : 1250 x 1605 mm² = **2 m²** - transformer space
Outlet vent : 2200 x 1605 mm² = **3,5 m²** - door next to HV switchgear

Air exchange: Air vents for the transformer space are located in the entrance door and in the door of the LV distributor. . There is an air vent in the transformer chamber wall with internal dimensions WxH of 1 270x1 610 mm. The vents´ dimensions are designed to provide for a sufficient air ventilation and transformer cooling. Air vents are equipped with grid (lamellas - blinds Gräper with the level of protection following DIN 40 050 V2A) and net against foreign bodies.
Note: The air vent can be substituted by another single-wing door with full ventilation on customer demand.

Grounding:

Composition of the TS internal grounding:
- **bonding bar** (BB) Cu 30x4 mm with M12 clips, located on the spreader insulator 1 kV, which is directly connected with all the technological components of the TS (vessel of the TR distributors tanks of the HV, LV, metal shield of the HV cables, branch bar PEN) and with individual installed components (construction components – tank and roof reinforcement, frames, door, grate, conducting „U"- beams of the transformer, bearing structures of the distributors...) using the Cu conductor with S_{min} 30 mm^2. Each conductor of the grounding connected to the BB is labelled.
- **earth artery** implemented by strip conductor Fe with S_{min} 125 mm^2, being part of the TS reinforcement and it is cast directly in the external walls and kiosk´s beam which serves as the connection of the common points of the grounding. Flexible parts are connected to the frame with copper (Cu) strip or Cu grounding cable with min. cross-section area of 16 mm^2.
- **2 nodes of the grounding feeder** by Hauff HDE-M12/X to connect the external grounding (in general FeZn stripe 30x4 mm) to the bonding bar (from the internal part of the node by a connecting screw M12-St 37 Zn, from the external part of the node through **test clips** of the **SZ1, SZ2** grounding with screw M12). Grounding feeder nodes are generally lead out of the opposite sidewalls of the station space for HV and LV distributor. The transfomer station may be equipped with lightning protection system on customer demand.

For each transformer station a common grounding system for HV and LV facilities must be constructed, its design needs to take into account the operating conditions – fault current value of the distribution network in the given region, power transformer node operation mode and local soil conditions (STN EN 33 3201, STN EN 33 2000-5-54,)

Installation:

The internal installation of the station includes interior lighting of the TS, consisting of 2 oval incandescent 60 W lamp fitting with gate switch lighting in the distributor´s space of high and low voltage and a one-phase socket of 230 V. Circuits feeding the lighting and socket installation are led out of the main LV distributor .
Further equipment – as specified by customer.

Internal TS space is divided into 3 compartments on the level of the basement tank: the transformer chamber, HV switchgear space and LV switchgear space. The TS over ground part comprises one common space, divided by supporting constructions parts into the 3 separate compartments.

Transformer:

Oil, hermetic or dry-type transformers up to the power of 1 600 kVA may be used in the substation located on rails and vibration absorbers made by Gräper. In case of oil leakage the seat of the transformer is designed as an impermeable oil catch tank. If the transformer is equipped with bolster, it is fixed against side movement.Transformer insertion and removal can be performed through an entrance door or by crane if roof is removed. Max. dimensions of the TR (LxWxH) are cca 2 250x1 400x2 300 mm.
Transformer cooling is atmospheric. Air renewal is provided by air vents in the door of the transformer substation (on the transformer´s side and LV distributor) and in the opposite wall of the transformer chamber. The protection of the transformer against over current, or shortcut is provided:
a) on HV side – by plugs or by switch with safety relay IEC 60 281-1,
b) on LV side – by air breaker with electronic trigger.

High voltage distributor:

In this transformer substation it is possible to use all the types of the commonly produced covered HV gas insulated distributors SF6 (for example GA, GA-C by Moeller, 8DJ10, 8DJ20 by Siemens, RM6 by Merlin Gerin,...), or type-approved vacuum distributors up to the width of 6 fields including measurement on the HVside. Depending on type used, the nominal current of the distributors is up to 630 A, shortcut resistance (nominal short-time withstand current 1 s) to 16 kA, optionally up to 20 kA. The HV distributor may be delivered by the customer or by Gräper company, including the zinc-coated supporting construction and a construction for decreasing pressure in the arcing fault in the HV distributor conforming to PEHLA standards. Max. dimensions of the HV distributor are ca: 2 100x1 600x900 mm.

Low voltage distributor:

The panel version of the LV distributor is covered with IP 20. The feeder is equipped with air breaker depending on the transformer´s power, breakage bar switches are inserted (set No. 1/SSE: 5 outlets with bar switches to 400 A and construction width of 100 mm or 2 outlets with bar switches to 160 A and construction width of 50 mm), or breakers with max. attachable cables with cross-section area of 240 mm^2. Standard nominal current of the distributor is up to 2500 A, shortcut resistance (short-time nominal withstand current 1 s) to 30 kA. Besides this, the distributor can include electricity consumption monitor, circuits for station lighting and service socket. The clips can be grounded on the main breaker´s feeder („ball pivots“) Ø 25 mm, which allow to protect the work place during maintenance of the LV distributor

via grounding tool (shorting set). Max. dimensions of one LV distributor (WxLxH) are ca: 2100x1500x400 mm.
The distributors meet STN EN 60439-1 norm and also DIN VDE 0660, part 500, VDE 0100, VDE 0414, UVV standard requirements.

Panel version of LV distributor is covered with IP 20. The feeder is equipped with air breaker depending on the transformer´s power, there are sank breakage bar switches (12-13 outlets with switches to 400 A and building width of 100 mm for one TR, or adequate number of outlets with switches to 160 A and building width of 50 mm), or breakers with max. joinable cables section of 300 mm^2. Nominal current of the distributor is standardly to 2 500 A, shorting resistance (short-time nominal withstand current 1 s) to 25 kA. Except for this, the distributor can include electric energy consumption measurement, circuits to plug the lightning of the station and service socket. The clips can be grounded on the main breaker´s feeder („ball pivots“) ∅ 25 mm, which allow to ensure the working place during the works on LV distributor via grounding tool (shorting set). Max. dimensions of one LV distributor (WxLxH) are cca: 2 100x1 500x400 mm.
The distributors meet STN EN 60439-1 norm and also DIN VDE 0660, part 500, VDE 0100, VDE 0414, UVV standard requirements.

Cable connections:

Cable connections include HV distributor connection with transformer 24 kV by single-core cables 24-N2XSY 1x35 mm^2 and LV distributor connection with transformer 1 kV by cables 1- NSGAFÖU 1x150 mm^2, or 1x240 mm^2 (identical to CHBU cable).
Cable connections for high voltage are checked in each production phase. Filed tests of the TE fractional discharges in Gräper company´s own test-room can be carried out , following VDE 0434, VDE 0472 technical norms. According to the regulations the maximum allowed value for TE is ≤ 20pC. The real achieved value is ≤ 5 pC.

Transformer station construction specifications:

The station is constructed according to the norms and rules of STN EN, DIN, UVV etc., directly following the bellow given normative standards:

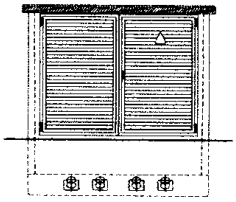
Cellular concrete	- DIN 4219
Reinforced concrete	- DIN 1045
VDE directives	- DIN 0141, 0101, 0100
Directive on the protection of ground waters	- GwSchV
Federal directive on waste disposal	- BimSchV
Electromagnetic radiation compliance	- BimSchV n.26

Individual structural components of the transformer substation are made of uninflammable materials, fire resistance of the station construction meets STN 73 0821 norms (fire resistance class required is F90, class documented is F120).

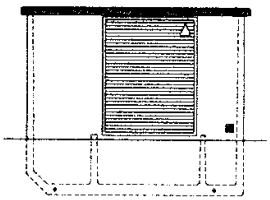
Delivery, assembly, ground cut for station placement:

The kiosk-type transformer station is delivered assembled and prepared for HV, LV cable connection and grounding. It is installed by crane into a prepared pit with compressed and flat surface according to the design project of the transformer substation´s producer – Gräper company (dimensions of the ground cut : 365x310 mm, cutting depth: min. 98 cm, compressed layer thickness: min. 20 cm).

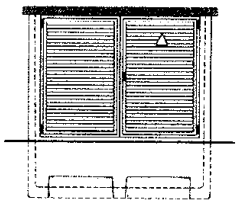
Views:



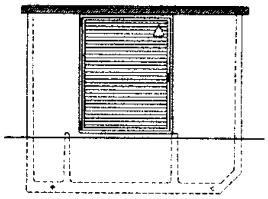
View „A“
(side of HV switchgear)



View „B“



View „C“
(side of LV switchgear)



View „D“
(side of the TR)