COMPACT KIOSK-TYPE TRANSFORMER STATION GRÄPER
GKP-S1

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,
- Frequency: 50 Hz
- Transformer nominal power: to 630 kVA
- HV bus-bars nominal current: regarding HV distributor´s type to 630 A
- LV bus-bars nominal current: to 1 000 A
- LV distributor nominal insulation voltage: 1 000 V
- LV distributor short-time nominal current: to 25 kA
- LV distributor dynamic nominal current: to 60 kA
- LV distributor cover: IP 20
- Whole station cover: IP 23D
- Temperature coefficient (cover class:): K 20
- External dimensions (LxWxH): 2 830x1 730x2 395 mm
- Empty skeleton weight with door: cca 5 300 kg
- Environment: 3.1.1. basic (within the kiosk-type TS rooms),
  4.1.1. external, ordinary (outside the TS rooms)
- Exp. 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 2 830x1 730 mm, total height of 2 395 mm, clear height of 2 210 mm, ground sinking depth of 750 mm, over ground height of 1 645 mm (with flat roof). The construction is self-supported and by default made of reinforced concrete Gräper LC 30/37, with granularity 8/12. Steel reinforcement frame composed of steel bars and mats is bilaterally welded and conductively connected together and takes part in 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.

Optionally, the default construction layout may be replaced by an insulated skeleton (g.g. For the purpose of switchgear stations without transformer) in two different version:
1/ „sandwich“ construction composed of self-supported three layer construction made of lightweight reinforced concrete Gräper LB25 with wall thickness of min. 10 cm, thermal insulation of hardened foam polystyrene of 4 cm (or 6cm) thickness and coating made of lightweight concrete LB25 with wall thickness of 7 cm. Individual layers are connected by a stainless steel reinforcement.
2/ standard construction made of lightweight, reinforced concrete Gräper LB25 with thermal insulation installed on site and formed by a thermal insulation layer of hardened foam polystyrene and structured plaster.

Station construction is formed by a compact unit comprised of two monolithic parts: basement tank with sidewalls and flat roof.
Basement tank with sidewalls: made of waterproof and oil proof concrete (crack width is guaranteed up to 0,2 mm) as an oil catch tank. The construction resistance against strong chemical action of liquids, soils and vapours conforms to DIN directive. The tank space is divided by a vertical oil-resistant separation wall into a compartment under the transformers and a compartment under the HV and LV distributors. The space under the distributors is equally divided into separate sections with the HV and LV cables entry holes. The tank serves as a foundation for the non-freezing part of the transformer station and allows lifting of 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 from the sidewalls of the station. The bell casting method was used to construct the tank and cable exchange label bodies, thus creating a monolithic unit which meets requirements for the impermeability of water and oil substances. All surfaces of the transformer substation touching the ground and cable feeder entry and exit seals may be treated with two layers of black penetrating insulation paint, if required by the customer. The inside of the tank can also be treated by waterproof and impermeable paint.

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, HSI 90). 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 bayonet lock and the neck is closed by 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.
Internal walls are treated with white washable paint by default. The surface finish of the external walls is available in the following selection:
- concrete with bare filler (exposed aggregate concrete) with 8/12 granularity,
- raw concrete in final finish colour according to the RAL colour palette
- from plastered concrete with material Reibeputz (scraped finish), or material Rollputz (plaster applied by roller), in final finish colour from the RAL colour palette,
- stone facing (for example Dupa-Stone), facade bricks, wood or other material as required by customer.

Roof: connected to the walls from inside at 4 points by screws and overlapping the wall contour by 9 cm. The roof can be lifted by 4 anchor points (sealed chasing nuts) RD 16, standardly corniced by 9 cm all around, thus providing additional protection of the joints between vertical walls and the roof .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 finish of the roof can be made of exposed aggregate concrete, or fair-face concrete with rough surface and paint according to the RAL colour palette. The shape of the roof (flat, saddle, cradle) 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 transformer substation is provided by a common single wing door on the side of HV and LV switchgear with ventilating aperture (lamellae Gräper safety class according to DIN 40 050 V2A) and internal dimensions WxH of 1 072x1 072 mm, on the HV transformer´s side the door has no ventilating aperture and with internal dimension WxH of 1 490x1 340 mm and a double wing door on the LV transformer´ side with ventilating aperture with internal dimensions WxH 1 660x1 340 mm. Door is equipped with arresting paw and door wings are connected with the frame using copper conductor with a cross-section of 16 mm^2.

Transformer air exchange calculation: Gräper GKP – S1

1. For the Oil transformer **22 kV, 630 kVA Typ : BEZ TOHn 378/22, „BA“**

- Transformer strain in summer time: 50 % - 60% of the nominal power
- Outside air temperature: +35 °C

- no-load losses: Po = 1,3 kW
- load losses: Pkn = 8,4 kW
- Air vent altitude difference: h = 1,6 m

2. Calculation :

no-load losses: Po = 1,3 + 0,13 (10%) = 1,43 kW

load losses: Pk =8,4 + 0,84(10%) = 9,24 KW

N = 315 (50%of the nominal power)/630(100% of the nominal power) = 0,5

Total losses: Pz = Po + Pkn x N^2 = 1,43 +9,24 x 0,25 = 3,74 kW

Heat losses for ventilation calculation: Pch = 0,6 x Pz = 0,6 x 3,74 = 2,244 kW

Air vent section in m² :

- Inlet: Sp = 0,1942 x (Pch/√h) = 0,1942 x (2,244/√1,6) = **0,345 m²**
- Outlet : So = 0,2007 x (Pch/√h) = 0,2007 x (2,244/√1,6) = **0,356 m²**

Air vents in the transformer station GKP:
Air inlet: 1660 x 1340 mm² = **2,14 m²** - TS door
Air outlet vent : 1072 x 1072 mm² = **1,15 m²** - transformer space

Air exchange: Air vents are placed in the door of the transformer station. The size of the vents was designed to provide for a sufficient air ventilation and transformer cooling. Air vents are equipped with grid (lamellas - blinds Gräper with safety level conforming to DIN 40 050 V2A) and net against foreign bodies (insect).

Grounding:

Internal groundng of the TS is made of:
- **bonding bar** (BB) Cu 30x4 mm with clips M12, 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 mount components (construction components – tank and roof reinforcements, frames, door, grate, conducting „U"- beam of the transformer,

bearing structures of the distributors...) using Cu conductor with S_{min} 30 mm^2. Each conductor of the grounding connected to BB is labelled.
- **earth artery** is made of Fe strip conductor 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, serving for connection of the common points of the grounding. Flexible parts are connected by appropriate Cu frame copper line or grounding Cu cable with min. section of 16 mm^2.
- **2 nodes of the grounding feeder** by Hauff HDE-M12/X to connect the external grounding (in general line FeZn 30x4 mm) to the bonding bar (form internal part of the node through connecting screw M12-St 37 Zn, form external part of the node through **SZ1, SZ2 test clips** with M12 screw). Grounding feeder nodes are generally lead out of the opposite sidewalls of the station space for HV and LV distributor.

The transformer substation in standard finish does not have external lightning protection system, as it is a ground object mostly located close to other higher objects. All the metal reinforcement built-in to the corresponding parts of the TS (roof, walls, false ceiling, basement tank) are welded into a single unit using Parts of the skeleton are welded together using conductive joints (e.g. Cu lines 35 mm^2) thus forming Faraday´s cage and after roof mountaing is mounted they are fully connected to the grounding. If customer wishes otherwise, it is possible to equip the transformer substation with external lightning rod with one collector and two wires connected to the common TS grounding via test clips in terms of the valid STN.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 33 3201, STN 33 2000-5-54, PNE 33 2000-1).

Installation:

The internal installation of the station includes interior lighting of the TS, consisting of oval incandescent 60 W lamp fitting with gate switch lighting in the distributor´s space of high and low voltage of the transformers and in the cable cellar, and one-phase socket of 230 V. Circuits to feed the lighting and socket installation are led out from the main LV distributor via installation breakers, or combined with current protector.
Further facilities (three phase socket,...) – as specified by customer.

Internal space of the TS is divided into the 3 compartments on the level of the basement tank: transformer space, HV switchgear space and LV switchgear space; TS over ground part comprises a single unit divided by supporting frame parts into the 3 compartments.

Transformer:

Oil, hermetic or dry-type transformers up to the power of 630 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 TR (LxWxH) are: cca 1 500x900x1 800 mm.
Transformer cooling is atmospheric. Air renewal is provided by air vents at the bottom of the door of the transformer substation (on the transformer´s side) and in transformer chamber´s walls. Transformer´s protection against over current, or short cut 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

High voltage distributor:

All types of commonly produced HV gas insulated distributors SF6 can be used in the transformer substation (e.g. GA, GA-C by Moeller, 8DJ10, 8DJ20 by Siemens, RM6 by Merlin Gerin,...), or type-approved vacuum distributors up to the width of 4 fields. Depending on the type of the distributor, the nominal current can be up to 630 A, shorting resistance (nominal short-time withstand current 1 s) to 20 kA, optionally up to 25 kA. HV distributor may be delivered by the customer or by Gräper company including the zinc-coated supporting frame and a facility decreasing pressure at arcing fault in the HV distributor conforming to the STN EN 62271-200 norm (to PEHLA standards). Max. dimensions of the HV distributor (WxHxL) are ca: 1 400x1400x900 mm.

Low voltage distributor:

The panel version of the LV distributor is covered with IP 20 panel. The feeder is equipped with air breaker depending on the transformer´s power. Outlets are equipped with breakage bar switches (12-13 outlets with switches to 400 A and construction width of 100 mm for one TR, or adequate number of outlets with switches up to 160 A and construction width of 50 mm), or breakers allowing the attachment of cables with max. cross-section area of 300 mm^2. Nominal current of the distributor is standardly up to 1000 A, shortcut resistance (short-time nominal withstand current 1 s) up to 25 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“) ∅ 25 mm, which allow to protect the working place during maintenance of the LV distributor via grounding system (shorting set). Max. dimensions of the LV distributor (WxLxH) are ca: 1 600x 1 400x 400 mm.
Note: The number of LV outlets is limited by customer´s demands for additional LV distributor equipment such as monitors etc.
The distributors meet STN EN 60439-1 norm and also DIN VDE 0660, part 500, VDE 0100, VDE 0414, UVV standard requirements.

Cable connections:

They include HV distributor connection with transformer 24 kV by single-core cables 24-N2XSY 3x1x35 mm2 and LV distributor connection with transformer 1 kV by cables 1-NYY-O 1x150 mm2, or 1x240 mm2.
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 made up according to the norms and rules of STN EN, DIN, UVV etc., concretely following the valid version of normative standards as described below:

Cellular concrete	- DIN 4219
Reinforced concrete	- DIN 1045
VDE Directives	- DIN 0141, 0101, 0100
Directive on the protection of underground waters	- GwSchV
Federal directive on waste disposal	- BimSchV

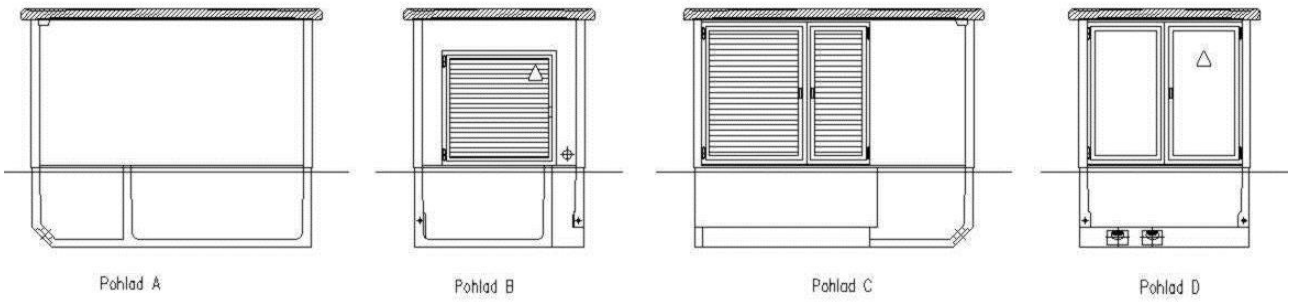
Electromagnetic radiation compliance - BimSchV č.26

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:

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: 343x233 cm, cutting depth: 95 cm, compressed layer thickness: min. 20 cm).

Views:



(side of the TR) (side of LV switchgear) (side of HV switchgear.)