COMPACT KIOSK-TYPE TRANSFORMER STATION GRÄPER SKP

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 to HV distributor type: to 630 A
- LV bus-bars nominal current: to 1 000 A
- HV/LV distributor nominal insulation voltage: 24 kV / 1 000 V
- HV distributor short-time / dynamic current: 16 kA / 40 kA
- LV distributor short-time / dynamic current: to 25 kA / do 60 kA
- LV distributor cover: IP 20
- Whole station cover: IP 23D
- Temperature coefficient (cover class): K 20
- External dimensions (LxWxH): 3 100x1 350x2 400 mm
- Empty skeleton weight with the door: cca 5 300 kg
- Environment: 3.1.1. basic (inside the kiosk-type TS room),
  4.1.1. external, ordinary (outside the TS room - STN 33 03 00)
- 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 has to 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 100x1 350 mm, total height of 2 400 mm, clear height of 2 200 mm, ground sinking depth of 750 mm, over ground height of 1 650 mm (with flat roof).Self-supporting construction of the TS is by default made of reinforced concrete Gräper LC 30/37, with 8/12 granularity. Steel reinforcement frame is composed of steel bars and mats, it 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.

Station construction forms a compact unit comprised of two monolithic parts: basement tank with sidewalls and a flat roof.

Basement tank with sidewalls: made of waterproof and oil proof concrete (crack width up to 0,2 mm guaranteed) as an oil catch tank. The construction resistance against strong chemical action of liquids, soils and vapours conforms to the DIN directive. The tank serves as the foundation for the non-freezing part of the TS and for lifting the whole station by means of 4 anchor points (sealed chasing nuts) RD 30, placed in the longer sides of the TS (as viewed on „A", "C"). 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 door frames, 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 are painted by two layers of black penetrating insulation paint, and the basement tank can be treated with waterproof and impermeable coating from inside upon customer request.

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 D3/60 or HSI 90 D1/75). 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), which are closed by a bayonet lock and the neck is sealed 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 by default 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 by a steel plate. The distributor is placed on a steel construction.

Internal walls are by default treated with white washable paint, surface finish is by exposed aggregate concrete with 8/12 granularity, other finish types are available on client demand.

- 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 (scraped finish), or material Rollputz (rolled-on plaster), in final finish colour according to the RAL colour palette,
- stone facing (for example Dupa-Stone), facade bricks, wood of other material as required by customer.

Roof: Connected to the walls by 4 bolts from inside, overlapping the wall contours by 10 cm.The roof can be lifted by 4 anchor points (sealed chasing nuts) RD 16. 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) 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.
On the transformer side, the TS is equipped with standard single wing door with full ventilation (shades-blinds Gräper with protection level DN 40 050 V2A) with internal dimensions WxH 1072x1 072 mm. There is a single wing door without ventilation on the HV/LV transformer´s side with internal dimension WxH of 1 1150x 1 280 mm. All doors are equipped with arresting pawl for fixing in open position and door wings are connected with the frame by copper conductor with 16 mm^2 cross-section .

Transformer air exchange calculation: Gräper SKP

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
- Ventilators 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

Ventilators diameter in m^2 :

- Air inlet : Sp = 0,1942 x (Pch/√h) = 0,1942 x (2,244/√1,6) = **0,345 m^2**
- Air outlet: So = 0,2007 x (Pch/√h) = 0,2007 x (2,244/√1,6) = **0,356 m^2**

Air exchange in the transformer station SKP:

- Air inlet: 1070 x 1070 **= 1,5 m^2** - in the TS space wall
- Air outlet: 1070 x 1070 **= 1,5 m^2** - in the TS space door
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Air exchange: Air vents for the air exchange in the tranformer chamber are placed in the door wing of the TS and in the opposite wall, with internal dimensions 1072 x 1072 mm. The size of the air vents is designed such as to provide sufficient air exchange and transformer cooling. Air vents are equipped with grid (lamellas - blinds Gräper) and net against foreign bodies (insects) from inside.

Grounding:

Internal grounding of the TS is composed 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 individually mounted components (construction components – tank and roof reinforcement, frames, door, grate, conducting „U"- beam of the transformer, bearing structures of the distributors...) by the Cu conductor with S_{min} 30 mm^2. Each conductor of the grounding connected to BB is labelled.
- **earth artery** is made of an Fe strip conductor with S_{min} 125 mm^2, being part of the TS reinforcement and it cast directly in the external walls and kiosk´s beam, connecting the common points of the grounding. Flexible parts of the door 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 **test clips** of the **SZ1, SZ2** grounding with screw M12). Grounding feeder nodes are generally taken out on 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

conductive joints (e.g. Cu lines 35 mm^2) thus forming Faraday´s cage and after roof mounting 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 lamps fitted 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 feeding the lighting and socket installation are led out of the main LV distributor through installation breakers, or combined with residual current circuit breaker.

Further facilities (three phase socket,...) – as specified by customer.

The internal TS space is divided into the 3 compartments on the basement tank level: transformer space, HV switchgear space and LV switchgear space; TS over ground part comprises a single space, divided by supporting constructions parts into the 3 separated 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: 1 500x950x1 900 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 cut off is provided:
a) on HV side – by plugs or by switch with safety relay
b) on LV side – by air breaker with the electric trigger

High voltage distributor:

In transformer substation it is possible to use all common types of covered HV gas insulated distributors SF6 (e.g. GA, GA-C by Moeller, 8DJH, 8DJ20 by Siemens, RM6 by Merlin Gerin,...), or type-approved vacuum distributors up to the width of 3 fields. Distributor nominal current is depending on type of the distributor and may reach up to 630A, shrotcut resistance (nominal short-time withstand current 1s) up to 20kA, optionally up to 25 kA. The HV distributor may be delivered by the customer or by the Gräper company, including zinc-coated bearing frame and a facility decreasing pressure at arcing fault in the HV distributor conforming to the PEHLA standards. Max. dimensions of the HV distributor (WxHxL) are: 1 150x1 400x850 mm.

Panel version of LV distributor is covered with IP 20. The feeder is equipped with air breaker depending on the transformer´s power, breaking bar switches (8-10 outlets with switches to 400 A and construction width of 100 mm for one TR, or adequate number of outlets with switches to 160 A and construction width of 50 mm) are inserted in the outlets, or breakers with max. attachable cable section of 300 mm^2. Nominal current of the distributor is by default up to 1000 A, shorting resistance (short-time nominal withstand current 1 s) to 25 kA. Besides this, the distributor can include electric energy consumption monitor, circuits for the lighting of the station and a 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 working on the LV distributor via grounding system(shorting set). Max. dimensions of the LV distributor (WxLxH) are ca:1 100x 1 400x 350 mm.
Note: The number of LV outlets is limited by customer´s demands for LV distributor to be equipped with further devices 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, resp. 1x240 mm^2or NSGAFÖU (identical with CHBU cable)
Within the production process the cable connections for high voltage are checked in each phase, it is also possible to make file TE tests of the fractional discharges in Gräper company´s own test-room, following VDE 0434, VDE 0472 technical norms. According to the regulations the prescribed value is TE ≤ 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., directly following the bellow given normative standards:

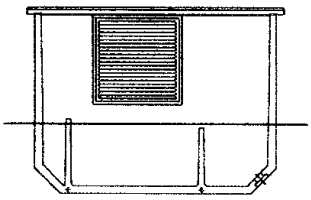
Cellular concrete	- DIN 4219
Reinforced concrete	- DIN 1045
VDE Directives	- DIN 0141, 0101, 0100
Directive on the protection of underground waters	- GwSchV
Federal directive on waste disposal	- BimSchV
Electromagnetic radiation compliance	- BimSchV č.26

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

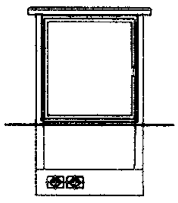
Delivery, assembly, ground cut:

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 (dimension of the cutting bottom: 370x167 cm, cutting depth: 95 cm, compressed layer width: min. 20 cm).

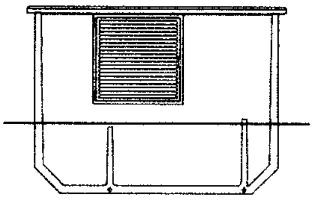
Views:



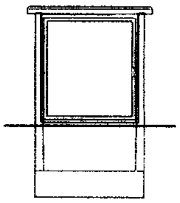
View „A“



View „B“
(HV distributor side)



View „C“
(TR side)



View „D“
(LV distributor side)