COMPACT KIOSK-TYPE TRANSFORMER STATION GRÄPER
MKP 800

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: according to HV switchgear 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: do 25 kA / do 60 kA
- HV/LV distributor cover: IP 65 / IP 20
- Whole station cover: IP 23D
- Cover class: K 20
- External dimensions (LxWxH): 2 160x1 900x2 350 mm
- Empty skeleton weight: cca 5 100 kg
- Environment: 3.1.1. basic (inside the kiosk-type TS room),
  4.1.1. external, ordinary (outside the TS room)
- 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 2 160x1 900 mm, total height of 2 350 mm, clear height of 2 030 mm, ground sinking depth of 680 mm, over ground height of 1 670 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.

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Station construction is formed by a compact unit consisting of two monolithic parts: basement tank with sidewalls and 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 (1 piece HSI 150 D3/60 or 8pcs HSI90 D1/82). 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 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. The entry space for HV cables (cable chamber) is separated from the HV distributor chamber by a metal sheet and the distributor is placed on a steel construction, which also includes personnel protection frame against internal arcing fault confirming to PEHLA standards.

Internal walls are standardly treated with white washable paint. Surface finish of the outer walls is available in concretewith bare filler (exposed aggregate concrete) with 8/12 granularity. Other types of finish are available upon customer's demand.

Roof: The standard flat roof is fixed to the walls from inside at 4 points by screws and overlaps the wall contour by 9 cm. It is possible to lift the wall by means of 4 anchorage 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.

The access to the HV and LV switchgear of the substation is provided by a common double wing door with partial air ventilation (slit shades Gräper with approved DIN 40 050 V2A safety level) with internal dimensions WxH of 1 640x 1 410 mm, on the HV/LV transformer´s side there is a single wing door without ventilation (HV) and ventilation (LV) with internal dimensions WxH of 1 150x1 040 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.

Transformer air exchange calculation: Gräper MKP – 800

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

- Transformer strain in summer time: 50 % up to 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 air exchange calculation: Pch = 0,6 x Pz = 0,6 x 3,74 = 2,244 kW

Air vent diameter in m²:

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

Air vents **in the transformer station MKP 800:**
Air inlet: 1640 x 1410 mm² = **2,3 m²** - TS door
Air outlet : 875 x 1350 mm² = **1,01 m²** - transformer space

Air exchange: The air vents in the the transformer space are placed in the door wing, supplemented by another vent on the opposite wall of the TS with internal dimensions of WxH 875x1 390 mm. The vents´ dimensions are designed in order to provide for a sufficient air exchange and transformer cooling. Air vents are equipped with grid (lamellas - blinds Gräper) and net against foreign bodies (insect).

Grounding:

Internal ground 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 individual mount 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** implemented by strip conductor Fe with S_{min} 125 mm^2, being part of the TS armouring and it is cast directly in the external walls and kiosk´s beam, serving for the connection of the common points of 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 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 lead out on the opposite sidewalls of the station space for HV and LV distributor.

Transformer substation in standard finish is not equipped with external lightning rod, as it is a ground object mostly located close to other higher objects. All the metal reinforcements cast in to the corresponding part of the TS (roof, walls, false ceiling, basement tank) are welded into a single unit, using conductive attachments (e.g. Cu lines 35 mm^2). Reinforcements are welded together, thus creating a Faraday´s cage and after the installation of the roof can be immediately connected to the grounding. On customer demand, the transformer station can be equipped with with external lightning rod with one collector in the middle of the roof and two leads connected to the common TS grounding via test clips in terms of the valid STN, EN.

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, PNE 33 2000-1)

Installation:

The internal installation of the station includes interior lighting of the TS, consisting of an 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 via installation breakers or coupled with residual current device.
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 a single common space, divided by supporting constructions parts into the 3 separate compartments (one tranformer compartment and two distributor 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 500x850x1 800 mm.

Transformer cooling is atmospheric. Air exchange 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.

High voltage distributor:

In 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 3 fields, e.g. 8DJ20 by Siemens including 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 (WxHxD) ca: 1170x 1 400x 850 mm.
Dimensions of the HV distributor 8DJ20.10 (2RK+1T): 1060x 1 400x 775 mm)

- Bus-bars nominal current – lead in field 630 A
  – TR lead out field 200 A
- Distributor short-time current: 16 kA
- Distributor dynamic current: do 40 kA
- HV/LV distributor cover: IP 65

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 (max 8 outlets with switches to 400 A and construction width of 100 mm for one TR, or corresponding number of outlets with switches to 160 A and construction width of 50 mm), or breakers with max. attachable cable section of 300 mm^2. Standard nominal current of the distributor can be up to 1 000 A, shorting resistance (short-time nominal withstand current 1 s) 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 work place during maintenance of the LV distributor via grounding tool (shorting set). Max. dimensions of one LV distributor (WxLxH) are cca: 800x1 400x400 mm.

Note: The number of LV outlets is limited by customer´s demands for LV distributor to be equipped with further devices such as measurement, etc.
The distributors meet STN EN 60439-1 norm and also DIN VDE 0660, part 500, VDE 0100, VDE 0414, UVV standard requirements. Bus-bar span 185 mm. The distributor contains circuits for feeding station lighting system and and a service socket

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 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 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 underground waters - GwSchV
Federal directive on waste disposal - BimSchV
Electromagnetic emission compliance - BimSchV č.26

Individual structural components of the transformer substation are made of uninflammable materials, fire resistance of the building structure meets STN 73 0821 (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: 276x250 cm, cutting depth: 88 cm, compressed layer thickness: min. 20 cm).