KS... z series substations

Transformer substations in concrete enclosures operated from the outside
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1. Subject of the paper

The subject of the paper is transformer substations operated from the outside, housed in reinforced concrete enclosures:

- **KS 19-28 z substation** ....................... with transformer of up to 630 kVA
- **KS 22-30 z substation** ....................... with transformer of up to 630 kVA
- **KS 25-36 z substation** ....................... with transformer of up to 1000 kVA
- **KS 25-36 z substation** (special version) ....................... with transformer of up to 1250 kVA
- two-transformer substations

The substation is made as a complete, self-contained power device. It comprises a transformer, medium-voltage switchgear and low-voltage switchboard, a measurement circuit on the medium-voltage or low-voltage sides, cables and associated equipment; it’s a ready-to-use product to be placed directly in the desired location.

<table>
<thead>
<tr>
<th>Substation designation</th>
<th>KS</th>
<th>-</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of substation buildings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of KS in the set-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>KS</strong> Compact transformer substation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substation building dimensions (dm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z – operated from the outside</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Application of the substation

The **KS...z** type transformer substations are designed for providing electrical power supply to public and industrial customers from medium-voltage networks of up 20 kV, and low-voltage networks of 400/230 V in TN-C systems.

3. Technical specifications

The substation, depending on the building type, is designed for the following equipment:

**Building KS 19-28 z** (→ page 13)

- medium-voltage switchgear: ....................... with SF₆ insulation - SafeRing or SafePlus
- up to 4 bays
- low-voltage RNTw type switchboard...... 1250 A
- transformer ................................. up to 630 kVA
Building KS 22-30 z (→ page 14)

- medium-voltage switchgear: ........................ with SF₆ insulation - SafeRing or SafePlus
  - up to 5 bays
- low-voltage RNTw type switchboard...... 1250 A
- transformer................................................ up to 630 kVA

Building KS 25-36 z (→ page 15, 16)

- medium-voltage switchgear: ........................ with SF₆ insulation - SafeRing or SafePlus
  - up to 5 bays
- low-voltage RNTw type switchboard...... 1250 A (1600 A)
- transformer.................................................. up to 1000 kVA

3.1. Substation building

The KS...z substation buildings are made of concrete using permanent moulds (walls and base are made of B35 type concrete, roof is made of B45 type concrete – walls are 10 cm thick).

**Die-cast concrete building**
(deformations and cracking of the building in the construction, transportation and operation processes are eliminated)

**Substation concrete components:**
building, base and roof

The supporting constructions as well as fixing and transporting fittings are metallically joined with building reinforcement.

All metal components of the building are hot-zinc-coated.

Substation doors and ventilation grates are made of aluminium sheets and sections (or tinned steel), and painted with polyester powder paints (→ fig. 06). Ventilation doors are standard equipped with insect screens. The door frame of the transformer room is equipped with protection railing hooks (for the upper voltage – connector transformer type), and with hooks for safety nets (for the transformers with traditional ceramic insulators).

The building roof is made of B45 type concrete (→ page 18), and is fitted with threaded transportation sockets (with PVC plugs – the plugs and lifting slings for roof removal are delivered with the substation as standard).

**Equipment can be installed inside the substation after removal of the roof.**
**The transport fittings are approved for permissible loads.**

The building contain medium-voltage, low-voltage, and transformer compartments.
The medium-voltage switchgear and low-voltage switchboards are accessed after opening service doors, separate for the medium- and low-voltage sections. The transformer is accessed after opening the transformer room ventilation door.

The medium-voltage and low-voltage cables are passed into the building base through type P50 (P70) (→ fig. 05) cable bushings or HD cable bushings.

The KS 19-28 z contains 9 type P50 (p70) cable bushings as standard – for the dry medium-voltage cables, and the low-voltage cables are run directly from the ground.

In the KS 22-30 z buildings and KS 25-36 z buildings, the medium-voltage cables, and the low-voltage cables are run through the P70 cable bushings.

The substation building internal walls and roof are painted with white waterproof acrylic paints; the walls, base floor and substation building floor are multi-layer painted with sealing paints. The external walls structural plaster finish and the roof are painted with sealing paints according to the RAL colour palette.

The base trim and the roof are painted – from the outside – with sealing paints in the substation door colour.

The standard substation external finish is shown in fig. 01.

<table>
<thead>
<tr>
<th>The buildings can be set-up in groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>(if e.g. two-transformer substations are required → page 17)</td>
</tr>
</tbody>
</table>

3.1.1. KS 19-28 z substation building specifications (→ page 13):

| Width: |
|-----------------|-----------------|
| Substation building | 1900 mm |
| Substation roof | 2050 mm |

| Length: |
|-----------------|-----------------|
| Substation building | 2800 mm |
| Substation roof | 2950 mm |

| Height above the ground |
|-----------------|-----------------|
| 1740 mm |

| Base foundation depth |
|-----------------|-----------------|
| 650 mm |

| Total building height |
|-----------------|-----------------|
| 2390 mm |

| Substation building weight (without equipment) |
|-----------------|-----------------|
| 6500 kg |

| Equipped substation weight (without transformer) |
|-----------------|-----------------|
| 7500 kg |

| Substation weight with the transformer (up to 630 kVA) |
|-----------------|-----------------|
| 9500 kg |

| Building area |
|-----------------|-----------------|
| 5.35 m² |

3.1.2. KS 22-30 z substation building specifications (→ page 14):

| External width |
|-----------------|-----------------|
| At base | 3000 mm |
| At roof | 3150 mm |

| External length |
|-----------------|-----------------|
| At base | 2200 mm |
| At roof | 2350 mm |
height above the ground: 1800 mm
base foundation depth: 700 mm
total height: 3320 mm
substation building weight: 8000 kg
equipped substation weight (without transformer): 9500 kg
substation weight with the transformer (up to 1000 kVA): 12300 kg
building area: 6.6 m²

3.1.3. KS 25-36 z substation building specifications (→ pages 15,16):

width:
- substation building: 3600 mm
- substation roof: 3750 mm

length:
- substation building: 2500 mm
- substation roof: 2650 mm

height above the ground: 1800 mm
base foundation depth (including surface): 700 mm
total building height: 3320 mm
substation building weight: 10500 kg
equipped substation weight (without transformer): 12000 kg
substation weight with the transformer (up to 1000 kVA): 14800 kg
building area: 9 m²

3.1.4 Building supplementary data:

- protection degree: IP 43
- enclosure impact strength: 20 J
- roof load strength: 2500 N/m²
- enclosure class: 10
- fire resistance: B
- fire resistance of walls and ceilings: 120 min
- substation fire load (depending on the amount of oil in the transformer housing and size of the substation building) e.g.:
  - 19-28 z substation with 630 kVA transformer: 3660 MJ/m²
  - 22-30 z substation with 630 kVA transformer: 2890 MJ/m²
  - 25-36 z substation with 630 kVA transformer: 2165 MJ/m²

the minimum distance from other objects (depending on the type of the neighbouring buildings)

* distances can be reduced:
  - by 50% if the neighbouring building wall has a 60 min fire resistance, and there is only one door of at least 30 min fire resistance;
  - by further 25% if the neighbouring building is equipped with fixed, automatic fire extinguishing system.
The transformer substation can be located adjacent to a building, with a solid wall (no openings) towards the building, if the distance to the window and door openings is more than 1.1 m, and the horizontal and vertical distances from rooms with permanent presence of people is higher than 2.8 m.

### 3.2. Equipment arrangement

The devices installed inside the building are operated from the outside. The medium-voltage switchgears and low-voltage switchboards are located in the medium-voltage and low-voltage compartments on two opposite sides of the building, divided by the transformer room. The switchgears and switchboards are accessed after opening service doors, and the transformer room is accessed through the ventilation door (→ figs 02 and 03).

The concrete moulding production process allows for individual location of doors, division walls (or their removal), and special equipment holes.

### 3.3. Substation technical specifications

The KS...z series transformer substations are type-tested at the Electrical Power Institute in Warsaw.

- transformer substation type: **KS 19-28 z** (up to 630 kVA) certificate no.550
- transformer substation type: **KS 22-30 z** (up to 630 kVA) certificate no.569
- transformer substation type: **KS 25-36 z** (up to 630 kVA) certificate no.569 attestation no. 021/2002
- transformer substation type: **KS 25-36 z** (1000 kVA) certificate no.596

Scope of substation testing:

- general requirements regarding construction and functionality,
- mechanical strength of the building against impacts and loads,
- protection degree, heat increase inside the station building,
- electric strength of insulation,
- fault current load, main circuit and earthing connections
- inspection and evaluation of internal arc fault effects.

**General substation data:**

- substation rated power ....................................................... 630 kVA (1000 kVA)
- rated frequency  ....................................................... 50 Hz
- number of phases  .............................................................. 3

**Medium-voltage side data:**

- rated voltage .......................................................... 17.5kV or 24 kV
insulation rated level ....................................................... 125 kV / 50 kV
busbar rated continuous current ........................................ 630 A (400 A)
    line bay ................................................................ 630 A (400 A)
    transformer bay ...................................................... 200 A
peak withstood rated current:
    busbar .................................................................. 31.5 kA
    line bay and earthing switch .................................... 31.5 kA
short-term withstood rated current:
    busbar .................................................................. 12.5 kA
    line bay and earthing switch .................................... 12.5 kA
rated fault duration .................................................... 1 sec.

Low-voltage side data:

    rated voltage ............................................................ 400 V
    insulation rated level .................................................... 660 V
    busbar rated continuous current ................................. 990 A (1440 A)
    main switch disconnector (circuit breaker) ................. 1250 A (1600 A)
    feeder bay .................................................................. 400 A (630 A)
    peak withstood rated current .................................... 40 kA
    short-term withstood rated current ............................ 16 kA
    rated fault duration ................................................... 0.5 sec

Transformer data:

    transformer type ....................................................... sealed, oil cooled
                                                               (or dry, resin type)
    transformer power ................................................... up to 630 kVA (1000 kVA)
    upper-voltage connection .......................................... connector-type
                                                               (or insulators with terminal lug)

3.3.1. Standards:

EN 61330 : Prefabricated transformer high-voltage/low-voltage stations
EN 60298 : 2000 – AC switchgears in metal enclosures for voltages above 1 kV.
IEC 439-1+AC : 1994 – Low-voltage switchgear and controlgear. Requirements for fully and partially
tested sets.
for testing under conditions of arcing due to internal fault.

3.4. Medium-voltage switchgears (→ page 19, and the ‘SafeRing and SafePlus’ catalogue)

3.5. Low-voltage switchboard (→ pages 20-22)

The transformer inside the substation building is standing on shock absorbing cushions, and fixed to the hooks provided in the building’s transformer room. (→ fig. 04).

The transformer is connected with the medium-voltage switchgear using three single-phase cables 1 x 50 (70) mm², in cross-linked polyethylene insulation for up to 20 kV voltage (one per phase). The cables from the medium-voltage switchgear side are terminated with elbow jack heads e.g. type EASW 20/250 (type and kind of head on the medium-voltage switchgear side is defined in the switchgear assembly and operation documentation).

3.7. **Medium-voltage and low-voltage cable connections** (→ page 24)

The cables for transformers with connectors are terminated on the upper-voltage side with alternatively: elbow jack heads e.g. type EASW 20/250 or straight jack heads e.g. EASG 20/250.

For the transformers with insulators, the cables on upper-voltage side are terminated with indoor heads e.g. type TI 24.

The low-voltage cables of the RNTw switchboard are terminated with traditional KU 240 type cable terminals, and connected on the transformer side using e.g. PFISTERER type terminals or KU 240 type cable terminals. The transformer lower-voltage side terminals can be insulated with insulating covers.

3.8. **Substation earthing** (→ page 25)

The electric shock protection of the transformer substation is made with safety earthing. The low-voltage service earthing as well as the medium-voltage and low-voltage safety earthing are all connected to common earth.

**Safety earthing:**

The substation equipment and structures are connected to the earthing busbar with the 1 x 50 mm² cable in (yellow and green insulation). The earthing busbar is connected through the measurement contact (1 → page 25) with external substation earthing (flat section 200mm²). The building reinforcement is used as a common, metallic connection of all the substation structure components.

**RNTw switchboard service earthing:**

The PEN terminal of the RNTw switchgear is connected through the measurement contact (3) with the substation external earthing.

**Transformer service earthing:**

The transformer neutral point is connected through the measurement contact (2) with the substation external earthing. The measurement contact (2) is connected to the transformer neutral point using the LgY 1 x 50 mm² cable – blue insulation (1 x 120 mm² or zinc-coated flat-section 25 x 4 mm² – acc. to the directives of Power Distribution Administration).

To facilitate substation earthing installation, flat-section FeZn 50 x 4 segments are provided to connect the earthing points no. 1, 2, and 3 with the circumferential earthing.
4. Substation assembly and foundation (→ page 26)

The substation has been designed to be transportable to the construction site using traditional transportation means (weights of buildings are given in the substation building specifications → page 6). A special lifting sling or a traverse is delivered with the substation for the setting up purposes (we can guarantee assistance in proper substation installation).

4.1. Substation foundation trench and installation of the substation

The substation should be placed in a foundation trench filled with water draining sub-crust breakstone or gravel of $0 \div 16 \div 25$ mm granularity. In case of embankment grounds (unstable) a 15 cm thick concrete foundation slab should be made (B15 concrete with $\varnothing 12$ mm wire reinforcement in $15 \times 15$ cm mesh), dimensions as given on page 26.

Because of cable runs, the oversizing of the concrete foundation slab should be avoided (an oversized concrete slab can limit cable runs to the bushings).

The depth of the substation foundation trench can be obtained as the total depth of the trench plus surface thickness, as given in the infrastructure design.

<table>
<thead>
<tr>
<th>Substation Type</th>
<th>Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS 19-28 z</td>
<td>650</td>
</tr>
<tr>
<td>KS 22-30 z</td>
<td>700</td>
</tr>
<tr>
<td>KS 25-36 z</td>
<td>700</td>
</tr>
</tbody>
</table>

After setting up the substation, the transportation holes should be secured with PVC plugs (supplied with the substation).

5. Environmental protection

The KS...z substations do not create any ecological threat. Buildings, doors, and all associated structures are made of environmentally friendly materials. The building base contains a leak-proof oil pit that prevents the transformer oil permeation into soil, and ground waters through the building base.

We guarantee assistance in scrapping of accidentally damaged equipment. (e.g., switchgears with SF$_6$ gas).
6. Warranty

The manufacturer gives a limited warranty for transformer substations, equipped as ordered, for a period of minimum 24 months – excluding other vendors’ equipment, which is covered by a 12-month warranty. The manufacturer accepts no liability for damages and faults resulting from incorrect operation and usage, lack of maintenance or improperly performed engineering works. We guarantee assistance in choosing and commissioning of the substation, training of personnel, delivery of spares and consumables.

7. Documentation acceptance

| The KS... series transformer substations are accompanied by type documentation |

During the preparation of the transformer substation documentation, apart from the legal and formal steps related to substation architecture and location, the following should be done:

- substation electrical diagram co-ordination and design, based on technical conditions issued by the relevant Power Distribution Company
- co-ordination with the Power Distribution Administration the way and type of electric power measurements, and design of the measuring circuit (if applicable)
- design of the external distribution networks
- design of the substation earthing, using natural earthing, based on soil resistivity measurements
- planning of the substation assembly procedure, with regard to transportation conditions

8. Ordering a substation

When ordering a substation, the following should be defined:

- type of substation (building)
- operating voltage of the medium-voltage side
- type and number of bays in the medium-voltage switchgear
- configuration of the RNTw low-voltage switchboard
- additional equipment of the RNTw low-voltage switchboard
- transformer type, rated power, and voltages of the lower and upper-voltage sides
- types of cables supplying power in the medium-voltage line bays
- transformer cable connections (connectors and insulators)
- substation exterior colour and contents of the warning labels (→ page 18)

9. Substation transportation and hand-over

We deliver the substation with our own transportation means, and provide lifting slings and traverses to unload and set-up the substation. Location preparation and the crane to unload the substation are provided by the client.

| We guarantee assistance in setting-up of the station |
KS 19-28 z substation building

General specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>building width</td>
<td>1900 mm</td>
</tr>
<tr>
<td>building length</td>
<td>2800 mm</td>
</tr>
<tr>
<td>building height above ground</td>
<td>1700 mm</td>
</tr>
<tr>
<td>depth of building foundation</td>
<td>650 mm</td>
</tr>
<tr>
<td>Protection degree</td>
<td>IP 43</td>
</tr>
<tr>
<td>building weight less equipment</td>
<td>~6500 kg</td>
</tr>
</tbody>
</table>

supplementary building dimensions fig.s 02 and 03

Materials

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>building</td>
<td>reinforced concrete (B35)</td>
</tr>
<tr>
<td>roof</td>
<td>reinforced concrete (B45)</td>
</tr>
<tr>
<td>joinery</td>
<td>aluminium (or aluzinc)</td>
</tr>
</tbody>
</table>

the building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015)
the building roof is covered with sealing paints (standard – brown RAL 8016 or ash RAL 7032)
joinery is painted with powder paints in the roof colour

operated from the outside
equipment installation after roof removal

1. substation building
2. building roof
3. service door
4. ventilation door
5. exhaust grate
6. sealed cable bushings
7. temporary cable inlet
8. medium-voltage compartment
9. low-voltage compartment
10. transformer room

building wall thickness is 100 mm
The KS 22-30 z substation building is operated from the inside and equipment installation after roof removal. The building has a width of 3000 mm, length of 2200 mm, height above ground of 1800 mm, depth of building foundation of 700 mm, protection degree of IP 43, and weighs 8000 kg.

**General specifications**
- Building width: 3000 mm
- Building length: 2200 mm
- Building height above ground: 1800 mm
- Depth of building foundation: 700 mm
- Protection degree: IP 43
- Building weight less equipment: 8000 kg

**Materials**
- Building: reinforced concrete (B35)
- Roof: reinforced concrete (B45)
- Joinery: aluminium (or aluzinc)

The building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015). The building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015). The building roof is covered with sealing paints (standard – brown RAL 8016 or ash RAL 7032). Joinery is painted with powder paints in the roof colour.

1. Substation building
2. Building roof
3. Service door
4. Ventilation door
5. Exhaust grate
6. Sealed cable bushings
7. Medium-voltage compartment
8. Low-voltage compartment
9. Transformer room

The building wall thickness is 100 mm.
KS 25-36 z substation building

General specifications
- building width: 3600 mm
- building length: 2500 mm
- building height above ground: 1800 mm
- depth of building foundation: 700 mm
- protection degree: IP 43
- building weight less equipment: 10500 kg

Materials
- building: reinforced concrete (B35)
- roof: reinforced concrete (B45)
- joinery: aluminium (or aluzinc)

The building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015)
The building roof is covered with sealing paints (standard – brown RAL 8016 or ash RAL 7032)
Joinery is painted with powder paints in the roof colour

Building features:
1. substation building
2. building roof
3. service door
4. ventilation door
5. exhaust grate
6. cable bushings
7. medium-voltage compartment
8. low-voltage compartment
9. transformer room

Building wall thickness is 100 mm
KS 25-36 z substation building

General specifications
- building width: 3600 mm
- building length: 2500 mm
- building height above ground: 1800 mm
- depth of building foundation: 700 mm
- protection degree: IP 43
- building weight less equipment: 11000 kg

Materials
- building: reinforced concrete
- joinery: aluminium (or aluzinc)

Joinery are painted with powder paints in the roof colour.

The building walls are finished with structural plasters in the ordered colour (standard – sand RAL 1015)

The building roof is covered with sealing paints (standard – brown RAL 8016 or ash RAL 7032)

Joinery is painted with powder paints in the roof colour.

1. substation building
2. building roof
3. service door
4. ventilation door
5. exhaust grate
6. cable bushings
7. medium-voltage and low-voltage compartment
8. transformer room

* building wall thickness is 100 mm
The set of two buildings allow to create a two-transformer substations.

Construction of such substation with typical buildings significantly facilitates the substation set-up and allows free choice of architecture.

Division of substation weights e.g. two-transformer substations, allows use of traditional transportation means (especially in difficult locations).
Building roofs KS...z

Building roofs:

- KS 19-28 z and 2 x KS 19-28 z
- KS 22-30 z and 2 x KS 22-30 z
- KS 25-36 z and 2 x KS 25-36 z

Outside operated substation roofs:

- Single or double slope reinforced concrete slab, covered with sealing paints on outside in the joinery colour
- The roof is fitted with threaded transportation sockets (plugged with PVC plugs – the plugs and lifting slings for roof removal are supplied with the substation)

1. Flat, single slope, reinforced concrete, 2.5% pitch
2. Flat, double slope, reinforced concrete, 5% pitch

Drainpipes and decorative roofs are provided for the KS...z type substations

External designations of the KS...z substations

- MV/LV Transformer
- MV switchgear service door
- LV switchboard service door
- Warning label with inscriptions: 1. DO NOT TOUCH, 2. ELECTRICAL DEVICE, 3. DANGER

Ground level

18
As standard, the substation is designed for SF₆ insulated switchgear, SafeRing or SafePlus type.

The MV switchgear transformer bays are equipped with a circuit breaker or a fuse. In the switchgear equipped with the isolation switch (200 A), the transformer is protected by a combination of a high-power isolation switch, and high-voltage HRC fuse links type CEF. The isolation switch rated current in the transformer bay is limited by the fuse link rated current (see table below).

Detailed information on switchgear design and operation is given in installation and operation documentation of the MV switchgears.

**Phase order**

Each bay in the MV switchgear (SF₆) is standard equipped with neon lamp voltage indicators, and with test sockets for setting phase of the medium-voltage cables (in each phase). Phasing devices are fitted on clients request.

**MV switchgears in SF₆ insulation**

<table>
<thead>
<tr>
<th>type</th>
<th>SafeRing</th>
<th>SafePlus</th>
</tr>
</thead>
<tbody>
<tr>
<td>rated voltage</td>
<td>17.5 and 24 kV</td>
<td>17.5 and 24 kV</td>
</tr>
<tr>
<td>transformer bay:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- with fuse</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>- without fuse</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>number of bays</td>
<td>2 3 4</td>
<td>2 3 4 5</td>
</tr>
<tr>
<td>A (mm)</td>
<td>696 1021 1346</td>
<td>696 1021 1346 1671</td>
</tr>
<tr>
<td>B (mm)</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>C (mm)</td>
<td>1345</td>
<td>1345</td>
</tr>
</tbody>
</table>

- application of different switchgear requires consultation

**Table of fuse MV links selection in MV switchgear transformer bays**

<table>
<thead>
<tr>
<th>upper voltage</th>
<th>transformer power</th>
<th>fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kV</td>
<td>100 kVA</td>
<td>10 A</td>
</tr>
<tr>
<td></td>
<td>160 kVA</td>
<td>16 A</td>
</tr>
<tr>
<td></td>
<td>250 kVA</td>
<td>25 A</td>
</tr>
<tr>
<td></td>
<td>400 kVA</td>
<td>25 A</td>
</tr>
<tr>
<td></td>
<td>630 kVA</td>
<td>40 A</td>
</tr>
<tr>
<td></td>
<td>1000 kVA</td>
<td>63 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>upper voltage</th>
<th>transformer power</th>
<th>fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 kV</td>
<td>100 kVA</td>
<td>10 A</td>
</tr>
<tr>
<td></td>
<td>160 kVA</td>
<td>16 A</td>
</tr>
<tr>
<td></td>
<td>250 kVA</td>
<td>16 A</td>
</tr>
<tr>
<td></td>
<td>400 kVA</td>
<td>25 A</td>
</tr>
<tr>
<td></td>
<td>630 kVA</td>
<td>40 A</td>
</tr>
<tr>
<td></td>
<td>1000 kVA</td>
<td>50 A</td>
</tr>
</tbody>
</table>

**Note:** overcurrent CT settings (for the MV switchgear with circuit breaker)
– acc. to directives given in the MV switchgear documentation.
RNTz switchboards

RNTz - for outside operated substations

- allows hanging on the substation bearing structure
- incomer from above, feeder from below
- module design: 6, 10, 12 feeder bays gr. 2 (3)
- ready to add:
  - control/measurement system PK
  - measurement/counter system PR (current transformers)

RNT switchboard specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>rated continuous current</td>
<td>1250 A (1600 A)</td>
</tr>
<tr>
<td>rated feeder current</td>
<td>160 / 400 / 630 A</td>
</tr>
<tr>
<td>rated voltage</td>
<td>230 / 400 V</td>
</tr>
<tr>
<td>insulation rated voltage</td>
<td>660 V</td>
</tr>
<tr>
<td>1 second withstanded rated current</td>
<td>16 kA</td>
</tr>
<tr>
<td>peak rated current</td>
<td>40 kA</td>
</tr>
<tr>
<td>protection degree</td>
<td>IP 20</td>
</tr>
<tr>
<td>standard colour</td>
<td>RAL 7032</td>
</tr>
</tbody>
</table>

Example

Additional equipment RNTz
**Busbars**

1. **Incomer:** L1, L2, L3 - busbar Cu 60x10 (Cu 80 x 10)*
   PEN - busbar Cu 40x10 (Cu 60 x 10)*
   *Busbars as standard are fitted for busbar current transformers installation*

2. **Feeder:** L1, L2, L3 - busbar Cu 50x10 (Cu 80 x 10)*
   PEN - busbar Cu 40x10 (Cu 60 x 10)*
   *Execution for - 1600 A*

**Connections with the transformer**

- ... connection using a traditional cable terminal

**Example:**

The RNTz switchboard busbars (10 feeder bays) with SOCOMEC Sirco 1250 A (1600 A) insulating switch

**RNTz incomer options:**
- 1250 A OETL insulating switch
- 1250 A fuse insulating switch
- 1250 A circuit breaker
- Without main circuit breaker

**RNTz feeder options:**
- SLBM gr. 2 (3) insulating switch
- XLBM gr. 2 (3) insulating switch

The RNTz switchboard with network-generator or automatic stand-by switching incomer supply, requires a customised design.
PR, PK - measurements

The RNT switchboards allow addition of the following measurement systems:
PR – energy counter measurement
PK – control measurement

PR and PK systems measurement boards

The TT type measurement boards are adapted to install directly on the wall or in measurement cabinets. The TT-2 and TT-3 boards are fitted only with typical 3-phase counter boards. The TP-2 and TP-3 boards are fitted additionally with the terminal strip, voltage protection, control lamps etc.

TT-2 and TT-3 in OTT-2 (OTT-3) housing

TP-2 and TP-3 in OTP-2 (OTP-3) housing

Selection of current transformers for the measurement systems

<table>
<thead>
<tr>
<th>Transformer power</th>
<th>Current transformer ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 kVA</td>
<td>200 A / 5 A</td>
</tr>
<tr>
<td>160 kVA</td>
<td>300 A / 5 A</td>
</tr>
<tr>
<td>250 kVA</td>
<td>400 A / 5 A</td>
</tr>
<tr>
<td>400 kVA</td>
<td>600 A / 5 A</td>
</tr>
<tr>
<td>630 kVA</td>
<td>1000 A / 5 A</td>
</tr>
</tbody>
</table>

Internal load and additional equipment

All RNT switchboards are equipped with internal load system: service outlet, and station lighting circuit. The RNT switchboards allow installation of a transformer idle run capacitor.

<table>
<thead>
<tr>
<th>Transformer power</th>
<th>Capacitor power *</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 kVA</td>
<td>2 (2.5) kVAR</td>
</tr>
<tr>
<td>160 kVA</td>
<td>2.5 (3) kVAR</td>
</tr>
<tr>
<td>250 kVA</td>
<td>3 (5) kVAR</td>
</tr>
<tr>
<td>400 kVA</td>
<td>5 (7.5) kVAR</td>
</tr>
<tr>
<td>630 kVA</td>
<td>7.5 (10) kVAR</td>
</tr>
</tbody>
</table>

* - acc. to the transformer operation recommendations
The KS... type substation permit installation of dry type transformers:
- cast wil technology transformers
- RESIBLOC technology transformers

Transformer – medium voltage switchgear and low-voltage switchboard connection (see page 10)
Medium-voltage and low-voltage cable connections

Transformer – medium-voltage switchgear connections

- single wire cables YHKXs with 20 kV insulation
  - up to 250 kVA 35 mm²
  - from 400 kVA to 630 kVA 50 mm²
  - from 800 kVA to 1250 kVA 70 mm²

Transformer – low-voltage RNTz switchboard connections

- single wire cables YHKXs with 1 kV insulation:
  - up to 250 kVA 1 x 240 mm²
  - from 400 kVA to 630 kVA 2 x 240 mm²
  - from 800 kVA to 1250 kVA 4 x 185 (240) mm²

The medium-voltage switchgears in SF6 insulation permit connection of dry or oil cables.

Cable heads

<table>
<thead>
<tr>
<th>SF6 insulated switchgears</th>
<th>F&amp;G</th>
<th>EUROMOLD</th>
<th>RAYCHEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>head manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>line bays – incomer cables</td>
<td>ASTS 20/630; AWKS 20/630</td>
<td>K400 TB; K400 LR</td>
<td>RICS</td>
</tr>
<tr>
<td>transformer bay – cables to the transformer</td>
<td>EASW 20/250</td>
<td>K 158 LR</td>
<td>RSES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>air insulated switchgears</th>
<th>F&amp;G</th>
<th>EUROMOLD</th>
<th>RAYCHEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>head manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>line bays – incomer cables</td>
<td>EAVI 20; TI 24</td>
<td>ITK; OTK</td>
<td>IXSU; OXSU</td>
</tr>
<tr>
<td>transformer bay – cables to the transformer</td>
<td>EAVI 20; TI 24</td>
<td>ITK; OTK</td>
<td>IXSU; OXSU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>transformers</th>
<th>F&amp;G</th>
<th>EUROMOLD</th>
<th>RAYCHEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>head manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with traditional connectors (insulators)</td>
<td>EAVI 20; TI 24</td>
<td>ITK; OTK</td>
<td>IXSU; OXSU</td>
</tr>
<tr>
<td>with jack connectors</td>
<td>EASW 20/250; EASG 20/250</td>
<td>K 158 LR</td>
<td>RSES</td>
</tr>
</tbody>
</table>
Substation earthing

Safety earthing:

- the substation equipment and structures and connected to the earthing busbar with a green and yellow insulated cable – 1 x 50 mm².
- the earthing busbar is connected through a test clamp 1 with external substation earthing (flat section 200 mm²).
- the building reinforcement is used as additional, common metallic connection for all substation structure components.

RNTz switchboard service earthing:

- the PEN terminal of the RNTz switchboard is connected through the test clamp 3 with external substation earthing.

Transformer service earthing:

- the transformer neutral point is connected through the test clamp 2 with external substation earthing.
- the connection of the test terminal with the transformer neutral point is made with the 1 x 50 mm² cable (1 x 120 mm² or 25 x 4 mm² tinned flat section – according to Electric Power Distribution Company) – with blue insulation.
- to facilitate creation of substation earthing, flat-section FeZn 50 x 4 segments are included to connect the earthing points number 1, 2, and 3 with the circumferential earthing.
Substation installation and placement

Substation placement (with equipment)

KS 19-28 z

16 T crane

- the installation traverse is supplied with the substation
- the lifting sling for roof removal is supplied with the substation

KS 22-30 z

16 T crane
(25 T in case of difficulties)

- the installation traverse is supplied with the substation
- the lifting sling for roof removal is supplied with the substation

KS 25-36 z

16 T crane
(25 T in case of difficulties)

- the installation traverse is supplied with the substation
- the lifting sling for roof removal is supplied with the substation
Transformer substation

KS 19-28 z
KS 22-30 z
KS 25-36 z

Substation equipment options - standard

- substation building
- MV switchgear: option: SF₆ - insulation – SafeRing or SafePlus:
  - up to 4 bays (24 kV)
- LV switchboard: RNTz - 6, 10, 12 bay
- transformer: max. 630 kVA

Equipment placement

1. reinforced concrete building
2. medium-voltage switchgear, max. 4 bays, with SF₆ insulation
3. MV/LV transformer
4. low-voltage RNTz switchboard, 6, 10, 12-bay
5. additional equipment space
6. substation service door
7. ventilation door
8. exhaust grate

Examples of low-voltage side of the 19-28 z substation

- RNTz – 10 bay switchboard in standard version
- RNTz – 10 bay switchboard with PK and PR measurement
- RNTz – 10 bay switchboard with PK and PR measurement, and external lighting module
- RNTz – 10 + RNTz – 6 with PK measurement, and transformer idle run compensation

fig. 8.1
The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.
Transformer substation

KS 19-28 z
KS 22-30 z
KS 25-36 z

Substation equipment options – with medium-voltage side measurement

substation building:

MV switchgear: option: SF6 insulation – SafeRing

- 2 bays (24 kV) – with circuit breaker or fuse
- MV measurement bay

LV switchboard: RNTz - 6, 10, 12 bay

transformer: max. 630 kVA

Equipment placement in the KS 19-29 z substation

1. reinforced concrete building
2. medium-voltage switchgear, with SF6 insulation
3. medium-voltage measurement bay
4. MV/LV transformer
5. low-voltage RNTz switchboard
6. additional equipment space
7. substation service door
8. ventilation door
9. exhaust grate

The KS 25-36 z building allows installation of 3-bay medium-voltage SafeRing switchgear and medium-voltage measurement module

fig. 9.1
The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.

**fig. 9.2**
Two-transformer substation

2KS 19-28 z
2KS 22-30 z
2KS 25-36 z

Substation equipment options – example of two-transformer substation

substation building 2 x
MV switchgear: e.g. 2 x SafeRing or SafePlus
LV switchboard e.g. 2 x RNTz - 6, 10, 12 bay
transformer e.g. 2 x 630 kVA

Equipment placement in the 2 KS 19-29 z substation

1 reinforced concrete building
2 medium-voltage switchgear, max. 4-bay, with SF6 insulation
3 MV/LV transformer
4 low-voltage RNTz 6, 10, 12-bay switchboard
5 additional equipment panel
6 substation service door
7 ventilation door
8 ventilation grate
9 exhaust grate

![Diagram of substation equipment placement](image-url)
The transformer, type and number of medium-voltage and low-voltage switchgear bays, and additional substation equipment are determined by the client.
Equipment Placement

KS 19-28 Z Substation

Leak-proof oil pit
Exhaust grate
UK 40/60 cable holders
NOTES:
1. Transformer installation is performed after substation roof removal.
2. The transformer is placed directly in the oil pit:
   - on vibration dampers (version 2), or
   - on shock absorbing cushions (version 3)

Transformer mounting strips

Version 1 (with level adjustment)

Version 2

Version 3

Transformer

W1 vibration damper

W2 shock absorbing cushion

Mounting strips

Transformer
Cable bushings

fig. 05

Version 1
P50 cable bushing (50 mm)

Version 2
P70 cable bushing (0 mm)

Version 3
HD125 (150)
Technical specifications:

1. Material – aluminium or aluzinc sheet
2. Anti-rust coating – polyester powder paint
3. Ingress protection – IP43

Ventilation door:
- Insect screen

Service door:
- Casement bolt lock
- Turn/tilt handle