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Kjell Oberger

TECHNICAL SPECIFICATION PREFABRICATED SECONDARY SUBSTATIONS UP TO 800 KVA AND SWITCHING STATIONS

REVISION HISTORY

Revision	Date	Comment	Reviewed by
1.0	2022-10-24	Revised and restructured content. CSS 12 kV withdrawn. 2x800 kVA and RTU added	Nätkommittén

CONTENTS

1 GENERAL

This technical specification contains the general technical requirements for the delivery of prefabricated secondary substations and switching stations, for locations with public accessibility, in Sweden, as listed below.

- Compact Secondary Substation 12 kV ≤ 200 kVA (CSS)
- Secondary Substation 12 and 24 kV ≤ 315 kVA
- Secondary Substation 12 and 24 kV ≤ 800 kVA
- Secondary Substation 12 and 24 kV 2x800 kVA
- Switching Station 12-36 kV.

The equipment for different models is summarised in Attachment 1 Model overview.

Unless otherwise specified in this specification, the prefabricated secondary substation is designed to be used under normal outdoor service conditions according to IEC 62271-1.

The equipment shall be contained in an enclosure.

All transformers are supplied by the purchaser. All cables, cable terminations and other equipment for the connection of the transformer to medium voltage and low voltage switchgears are part of the supplier scope.

The equipment shall be able to operate and store in an ambient temperature range of –40 °C to +40 °C.

Prefabricated secondary substations shall be designed so that normal installation, service, inspection, and maintenance can be carried out safely. Additionally, the substation shall be designed and constructed in such a manner that the risk of unauthorized access is minimized. Supplier shall describe how this is fulfilled. Technical lifetime of prefabricated secondary substations shall be longer than 40 years. Attention shall be paid to hinges, vent covers, locking mechanisms, etc.

The design of the substation and its equipment should promote live work. It may be, for example, location of devices, welded nuts or rails spaced so that you can access in an easy way with live work tools or other solutions that facilitate the maintenance work. Supplier shall describe how this is fulfilled.

Switchgear containing SF6 gas is not accepted.

2 APPLICABLE STANDARDS AND REGULATIONS

The substation and all components shall be designed and tested according to the following list of priorities:

1. Elsäkerhetsverkets föreskrifter ELSÄK-FS (The Swedish National Electrical Safety Board’s Regulations)
2. Ellevio’s specifications

3. High-voltage switchgear and controlgear - Part 202: High-voltage/low voltage prefabricated substation SS-EN 62271-202
4. Substations 12-24/0.4 kV (EBR KJ 59:19)
5. Other applicable SS and EN standards
6. Applicable IEC standards

The substation shall be designed so that at least one of ESA-working methods can be used for installation and maintenance. (ESA, Electrical safety instructions)

3 CONSTRUCTION

3.1 Structure and foundation/plinth

The enclosure shall allow easy access to all ingoing components, which means that all components shall be accessible with open doors. The housing shall be designed to withstand corrosive environment, at least class C4 high according to EN-ISO 12944.

The foundation/plinth of the substation shall be designed such that incoming cables can be easily connected to the switchgear.

The foundation/plinth shall be equipped under the doors of the switchgear with easily demountable sections, for the connection of high voltage and low voltage cables.

The secondary substation shall have a prefabricated concrete base to prevent structure bending changes and prevent corrosion. The foundation/plinth shall be included in standard delivery.

Packing/seal against ground shall be included for all cables, low voltage as well as high voltage.

It shall be possible to lift the complete construction, including the foundation and the transformer, as a single unit. For this purpose, the requisite lifting system shall be cast into the concrete foundation.

Lifting hooks or similar shall be fitted for removing the roof if necessary.

Specify maximum weight for transformer when fitted before transport and lifting for each different size of housing.

The design shall be such that internal condensation is prevented from damaging equipment and reliability. Supplier shall describe methods on how internal condensation shall be prevented.

Option 1: Saddle roof > 30°

Option 2: Sheet steel profile with "wood panel" look

3.2 Transformer space

The space for the transformer shall be separated from other spaces in the substation, with a protection class of at least IP2X.

The design of the transformer space shall be such that on the walls splashed oil drains into the oil containment pit. The oil containment pit shall be able to retain 100% of the oil volume.

The space for the transformer shall be provided with natural ventilation that results in the achievement of protection class 15 (as specified by EN 62271-202) with respect to losses from the low voltage switchgear and the transformer.

The transformer space shall be possible to equip with a three-phase ONAN distribution transformer fulfilling the maximum size as below.

Manufacturer shall state what is the maximum physical size (l*w*h) of transformer which meets the cooling requirements when installed in the types the manufacturer is offering to the purchaser.

Ellevio's maximum allowed size and total weight for transformers up to 800 kVA are stated below.

Distribution transformer ONAN				
Rated power	**Length mm**	**Width mm**	**Height mm**	**Weight kg**
50, 100, 200 kVA	1070	740	1200	1100
315 kVA	1270	900	1400	3500
500, 800 kVA	1600	1000	1700	3500
Distribution transformer with reactor ONAN				
Rated power	**Length mm**	**Width mm**	**Height mm**	**Weight kg**
100, 200 kVA	1400	800	1700	3500
315	1800	1000	2000	3500

For additional technical specifications for the supplied transformers, see TS EN Technical specifications oil-immersed distribution transformers.

3.3 Doors

The design of the doors on the building and MV bays shall be such that there will be no risk of sagging. The doors shall fulfil the electrical safety in every position during the operations.

The doors shall be built with minimum two point closing and be possible to lock in open position.

Doors on MV enclosures shall be attached with hinges, removable and easy to manoeuvre. The locking system shall allow for locking with padlocks and have a protection house with cover for the padlock. Padlock shall be easily accessed.

Padlocks shall be possible to install at the prefabricated secondary substation factory. The purchaser delivers needed lock series to the supplier.

Doors shall be equipped with pockets, for documentation, that is securely fastened. Pockets shall not be glued but riveted or attached with solid screws. The supplier shall describe the documentation holder solution.

3.4 Service connection

The enclosure shall be equipped with a hatch for temporary service/emergency power connection at the low voltage side. The hatch shall be lockable or possible to remove with tools from the inside. It shall be possible to close the doors when the cables have been connected.

3.5 Surface treatment

The colour shall be according to NCS colour system and will vary among projects. The supplier shall be able to provide different colours of the substations. It may be that the roof and the walls are painted in two different colours. Colours are decided by the purchaser at call-of. Supplier shall describe which standards are followed for painting and for corrosion protection.

Option 10: Graffiti protection shall be offered as an option. Supplier shall describe which solution is used.

4 MEDIUM VOLTAGE SWITCHGEAR

The normal configuration of the switchgear will be as follows.

Compact Secondary Substation ≤ 200 kVA:
2 feeder connections

Secondary Substation ≤ 315 kVA:
2 feeder bays, 1 transformer bay
(Larger 315 kVA substations are referred to Secondary Substation ≤ 800 kVA)

Secondary Substation ≤ 800 kVA:
2 feeder bays (3 or 4 feeder bays may be necessary), 1 transformer bay

Secondary Substation 2x800 kVA:
2 feeder bays (3 feeder bays may be necessary), 2 transformer bays

The equipment for the different models and their electrical data can be found in Attachment 1 Model overview.

All connecting equipment shall have mechanical indication of position on the front of the bay. The indication shall be visible and safe during the whole lifetime for all types of equipment and in all weather conditions.

There shall be unambiguous descriptions available regarding operating and locking of disconnectors and circuit breakers.

It shall be safe to manoeuvre each actuator including switchgears, load disconnectors, circuit breaker, fuse switch disconnectors, disconnectors, contactors, and earthing switches.

The switchgear shall be of an approved design such that internal arcing cannot arise, or such that any arcing is extinguished so rapidly that dangerous excess pressure or dangerous gases are not emitted from the switchgear.

RMU shall be used for all 24 kV substations and substations with RTU from level 2 (control). Switchgear containing SF6 gas is not accepted.

Disconnectors and switches shall be three-pole operated.

Clutch-pipes or similar disconnection solutions shall not be used.

Earthing switches shall be available for all bays with circuit breakers or disconnectors. All earthing switches shall be equipped with hand-operated preloaded spring units for closing and opening. They shall have a lock mechanism.

MV fuses shall be possible to change with voltage in no-load situation.

The structure and protection of MV bay shall be such that phasing of high voltage cables are possible in a safe way. Supplier shall describe how phasing of high voltage cables is performed.

Empty MV bays shall be possible to take in use later in a safe way; busbars shall be mounted and prepared for connection of additional equipment.

MV Fuse Unit and/or disconnector/switches shall be mounted on the rear wall in the bay for easier access at the live work.

Medium voltage switchgear shall be protected from accidental access when cabinet is open for installation of transformer.

Option 21: Additional cost for voltage level 24/0.42 kV.

4.1 Transformer bays

The transformer bays shall be provided with fuse switch disconnectors.

Option 14: Circuit breaker including relay protection RMU

4.2 Feeder bays

The feeder bays shall be equipped with ball studs or earthing switches.

Option 13 & 16: Load disconnector instead of clutch-piece

Option 15: Circuit breaker instead of clutch-piece

Option 17 & 18: Cable fault indicator

Option 19: Motor operated switching device to enable remote control. Operating voltage 24 VDC. Auxiliary contacts enabling double-point information for operating mode.

Option 20: Additional feeder bay, 12 kV

4.3 Cable installation

An anchor rail or its equivalent for fastening of high voltage cables shall be placed at a suitable level. Connection may take place through three-conductor cable with shielding mounted above the anchor rail. Single conductor cables may also be used.

To enable location of the attached cables, it shall be possible for a person to safely connect the signal generator to the cable screens, without taking cables out of service. Supplier shall describe their solution.

4.4 Accessories

Tools required for operation and overhaul shall be included.

In the case of disconnectors and breakers there shall be possible to mount motor drive for supplier independent remote control. This is defined by the purchaser in ordering phase.

4.5 Ball studs or earthing switch

Earthing switches shall be used with circuit breakers and disconnectors.

In the case of clutch-piece disconnection solutions ball studs shall be available.

All earthing switches shall be equipped with hand-operated spring units for connection, and they shall have lock mechanisms.

Earthing switches shall have mechanical indication of position on the front of the bay. The indication shall be visible and safe during whole lifetime for all types of equipment and in all weather conditions.

Ball studs with a diameter of 20 mm shall be available in all feeder units for connection of earthing devices.

It shall be possible to lock doors in closed position when cable in MV/LV bay is connected to earth.

5 TRANSFORMER

Transformers are supplied by the purchaser. The supplier of the secondary substation shall install the transformer in the factory. The substation shall be possible to equip with one three-phase ONAN distribution transformer.

For technical specification for the supplied transformers, see TS EN Technical specifications oil-immersed distribution transformers.

5.1 Other installations (transformer)

The supplier is responsible for installing a suitable connection between the medium voltage switchgear and the transformer, of sufficient length and with suitable terminations, for connection to the transformer terminals. It may be necessary to adjust the selected dimensioning following type testing of the substation.

High voltage cable terminations shall be of type cold shrink. High voltage and low voltage cables shall be connected to the transformer by cable lugs.

Screen shall only be connected to the medium voltage switchgear.

Connection between the transformer taps and the medium voltage switchgear shall be:

A connected to phase L1

B connected to phase L2

C connected to phase L3

Connection between the transformer taps and the low voltage switchboard shall be:

a connected to phase L1

b connected to phase L2

c connected to phase L3

It shall be possible to change transformer without interruption of feeding network. In the case of clutch-pieces short interruption is allowed.

The supplier shall describe how the transformer replacement is done and which equipment shall be available.

Option 9: Transformer temperature operated shunt trip coil for transformer load disconnector.

6 LOW VOLTAGE SWITCHBOARD

6.1 General

The secondary substation shall include a low voltage switchgear that shall be built and equipped as in the following sections.

6.2 Configuration and design

The switchboard shall be designed with an insulated low voltage busbar min IP2X, to improve live work capability.

In secondary substations with transformers maximum 200 kVA the low voltage switchboard shall be connected with a fuse load disconnector for 400 A. In addition to fuses and earth connection terminal the busbar shall have space for auxiliary power connection with a width of 50 mm.

6.3 Switchgear cabinet

The switchgear shall be contained in metal also at the rear. It shall be possible to service and inspect all equipment from the front (switchgear).

6.4 Busbar

All phase busbars shall be equipped with 20 mm ball stud for earthing placed in a vertical line and equipped with a cover. When using insulated rail system specially adapted grounding tools shall be used.

Size of low voltage busbar shall be according to Attachment 1 Model overview.

The protective earth and neutral (PEN) busbar shall be suitable for the connection of 300 mm^2 Al/Cu. The earth connection terminal shall be equipped with a 20 mm ball stud. Connecting terminals shall have minimum protection class IP2X.

Option 3: Connection to low voltage busbar with breaker 1600 A

Option 4: Connection to low voltage busbar with fuse switchgear 630 A

Option 5: Connection to low voltage busbar with breaker 2x1600 A

Option 6: Busbar switch 1600 A

7 ADDITIONAL EQUIPMENT

7.1 RTU (Remote Terminal Unit)

There are three (3) different RTU solutions: RTU level 1 (monitoring), RTU level 2 (control) and RTU level 3 (automation). All 800 kVA and 2x800 kVA should be at least level 1.

Part of Option 12:

The RTU with modem and firewall, all installed in a cabinet, are supplied by the purchaser. The antenna and the antenna cable are supplied and installed by the purchaser. The Pt100 sensor for the transformer temperature, used for 800 kVA transformers, is supplied by the purchaser and installed by the supplier of the secondary substation.

Maximum dimensions for the RTU cabinet W x H x D = 600 mm x 800 mm x 300 mm shall be possible to install. The RTU cabinet includes a UPS.

Components shall have auxiliary contacts or equivalent that enables connection to an RTU for monitoring of the secondary substation and remote control of the feeder bays according to table below.

Component to monitor	**Type of information**
Position of circuit breakers in transformer bays:	
Medium voltage	Double-point information
Low voltage	Double-point information
Position of switch disconnectors in feeder bays	Double-point information
Position of earthing switch feeder bays and transformer bays	Double-point information
Feeder bays remote not ready (if applicable)	Single-point information
Remote control switch disconnectors in feeder bays	Double command
Fault indicators in feeder bays:	
Over current	Single-point information
Earth fault	Single-point information
Fault indicator reset (combined for all feeder bays)	Single command
High temperature	
T11	Single-point information
Pt100	Analog value
Low voltage measurement	Analog value

The RTU cabinet shall be installed at a suitable location within the secondary substation.

A secured placement for the antenna shall be prepared. Antenna cable routing and antenna placement shall be safe from vandalising. The solution shall be specified in the tender.

7.2 230V AC outlet

Option 7: A 230V AC outlet connected to the fuse box. It shall be protected with 1 x 10 A fuse. The outlet shall be mounted in space for low voltage switchgear.

7.3 Low voltage energy meter

Three (3) current transformers class 0.2S should be installed in all secondary substations with transformers ≥ 315 kVA, to enable future installation of low voltage meters without any interruption.

Option 8: A complete meter installation for measurement of the whole energy flow in the substation. The installation shall include measuring transformers class 0.2, short circuit terminals and wiring to meter board. Size of the meter board shall be for normal AMM meter. Shall be mounted in space for low voltage switchgear.

Option 11: Lockable hatch or cabinet for AMM meter, available from the outside of the substation, with separate configuration of the locking system. The meter shall be connected to the low voltage busbar.

8 EARTHING

The structure of prefabricated secondary substation shall be such that temporary earthing is possible when it's needed.

One earth terminal shall be located on the wall within the high voltage section, and an earthing connection in each MV bay.

The remaining connection points are intended for cables that follow ground lines, the earth conductor and as reserve capacity, minimum 8 connections.

All earth connections are to be carried out using cable lugs.

The earth conductor shall be located in the station in the form of a ring with clip-on units. Objects connected to this earth conductor ring are not allowed to be a part of the ring itself.

9 TESTING

Each component shall be tested as described in this document and specified by relevant norms or standards for the component.

Type testing and routine testing of the substation shall take place as specified in EN 62271-202.

The type testing is demanded for both of the appearances of the construction and shall for each of the appearances be valid for the variant that has the greater total transformer losses.

Type tests of an equivalent substation can be appended to the bid.

The purchaser is to determine whether an attached type test is to be regarded as equivalent, or if the additional tests are to be ordered. All additional type tests the purchaser requires shall be paid by supplier. Type tests shall be approved before the first delivery.

The purchaser shall be given the opportunity of being present at the tests.

In the event of a failing of a type test, the purchaser has the right to demand a new type test within 14 days, paid by the supplier of the substations.

Installed relay protection shall be function tested at the factory.

Part of Option 12: All signals and manoeuvres shall be tested from component to the RTU according to agreed test protocol.

10 LABELLING

All signs required shall be included in the delivery, according to national standards and Ellevio's own label instructions.

Both phase conductors and busbars in the high voltage section shall be labelled L1, L2 and L3.

Labelling of main current busbars shall be done on incoming feeders, busbars and on both sides of any electrical coupling equipment.

Busbars in the low voltage section shall be mounted and labelled downwards L1, L2, L3 and PEN.

The same type of labelling shall be used for the whole switchgear.

External signs shall be resistant to UV-radiation.

A sign shall be installed close to documentation section, giving the manufacturing number (serial number) of the supplier and the order number of the purchaser.

All internal cabling in the substation shall be labelled in both ends with a label sleeve.

All signs shall be in Swedish.

11 DOCUMENTATION AND INFORMATION

Information to be given with enquiries, tenders and orders according to EN 62271-202-9

Type documentation including descriptions about the instructions written in Swedish together with other drawings relevant for the substation that are required for its commissioning, inspection, troubleshooting and repair.

- Documentation regarding the chemicals which have been used in the prefabricated secondary substation or some of its parts or apparatus is required upon request, since those could affect the operational safety.
- Documentation and information shall be sent with each delivery according to EN 62271-202-10. One copy in paper form accompanying the substation and one electronic copy to the person specified in the purchase order. Single line diagram shall be attached to the documentation.

- All above documents shall be in Swedish.

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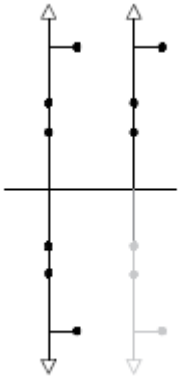
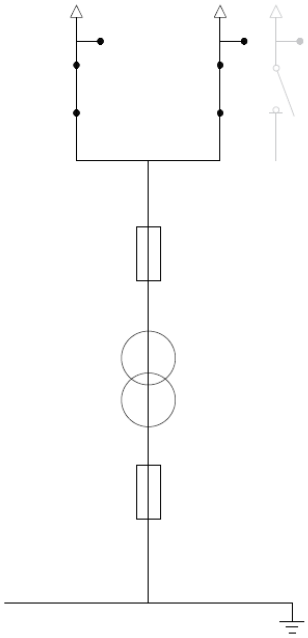
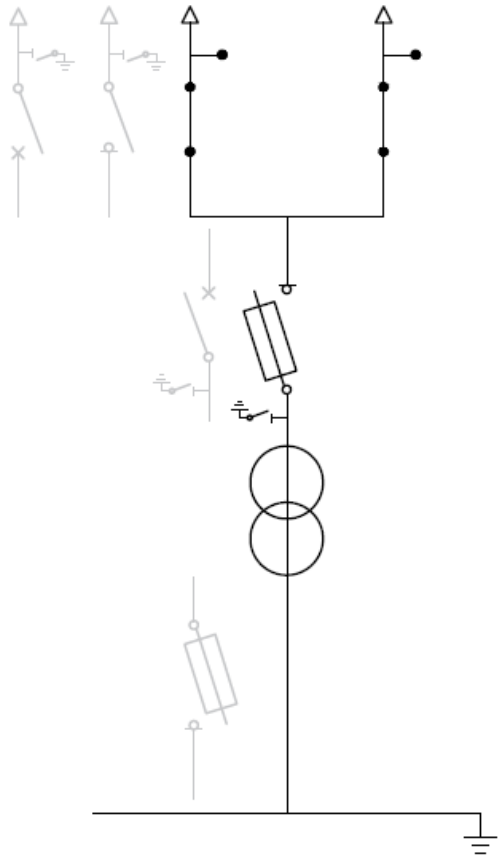
ATTACHMENT 1 – MODEL OVERVIEW

Note that the single-line diagrams do not include all options.

Model	Description
	**Switching Station 12-36kV** Switching station, without high voltage switchgear, for three (3) or four (4) high voltage connections
	**Compact Secondary Substation 12 kV ≤ 200 kVA (SS2) – Air insulated** Compact Secondary Substation for 12 kV, with high voltage switchgear 200 kVA Two (2) incoming medium voltage cables equipped with clutch-pieces Low voltage busbar full width of substation, min. 400 A Connection to low voltage busbar with fuse switchgear 400 A Options: • Cable fault indicator (feeder bay) • Low voltage energy meter



Secondary Substation 12 and 24 kV, ≤ 315 kVA (N3) – Air insulated or RMU

Secondary Substation for 12 or 24 kV, with high voltage switchgear 315 kVA

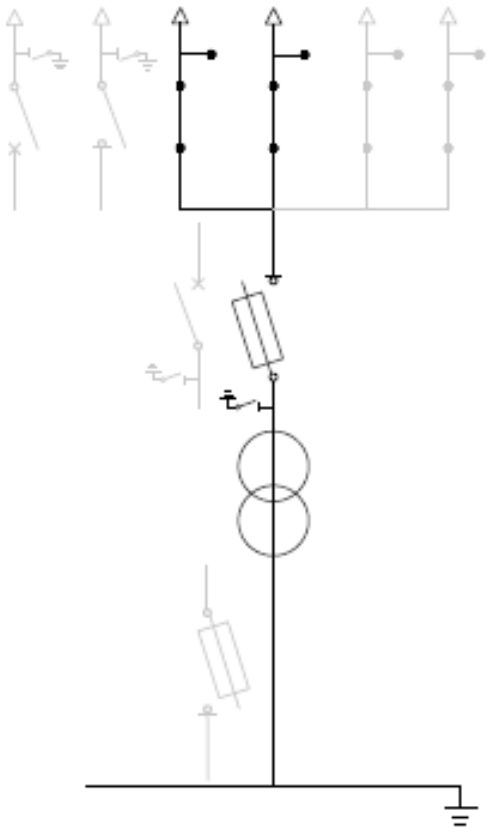
One (1) medium voltage transformer bay with fuse switch disconnector

Two (2) medium voltage feeder bays for incoming cables equipped with clutch-pieces

Low voltage busbar 1200 mm, min. 630 A

Options:

- Load disconnector instead of clutch-piece
- Circuit breaker including relay protection, instead of fuse switch disconnector (transformer bay)
- Circuit breaker instead of clutch-piece (feeder bay)
- Cable fault indicator (feeder bay)
- Motor drive for remote controlling (feeder bay)
- Connection to low voltage busbar with fuse switchgear 630 A
- Low voltage energy meter
- 230 V AC outlet fused 10 A
- RTU for Monitoring, Control or Automation



Secondary Substation 12 and 24 kV, ≤ 800 kVA (N8) – Air insulated or RMU

Secondary Substation for 12 or 24 kV, with high voltage switchgear 800 kVA

One (1) medium voltage transformer bay with fuse switch disconnector

Two (2), three (3) or four (4) medium voltage feeder bays for incoming cables equipped with clutch-pieces

Low voltage busbar 1600 mm, min. 1600 A

Options:

- Load disconnector instead of clutch-piece
- Circuit breaker including relay protection, instead of fuse switch disconnector (transformer bay)
- Circuit breaker instead of clutch-piece (feeder bay)
- Cable fault indicator (feeder bay)
- Motor drive for remote controlling (feeder bay)
- Connection to low voltage busbar with fuse switchgear 630 A
- Connection to low voltage busbar with breaker 1600 A
- Transformer temperature operated shunt trip coil for transformer load disconnector in air insulated MV-switchgear.
- Low voltage energy meter
- 230 V AC outlet fused 10 A
- Lockable hatch or cabinet for AMM meter, available from the outside of the substation.
- RTU for Monitoring, Control or Automation

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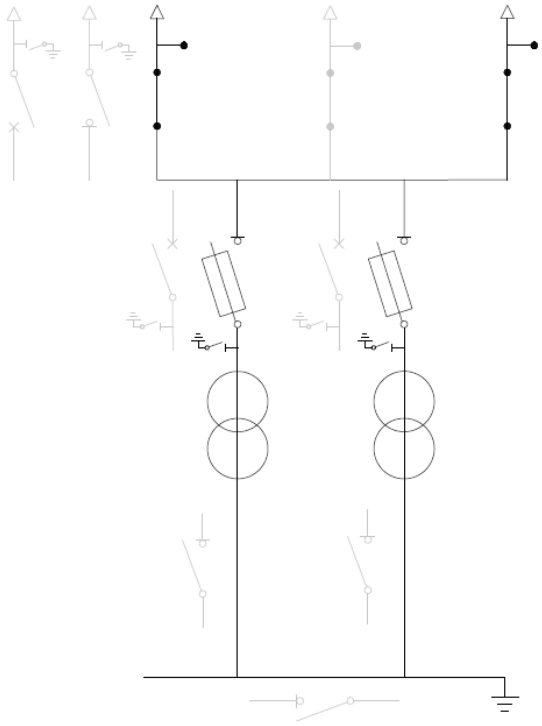

Secondary Substation 12 and 24 kV, ≤ 2x800 kVA (N2x8) – Air insulated or RMU

Secondary Substation for 12 or 24 kV, with high voltage switchgear 2x800 kVA

Two (2) medium voltage transformer bays with fuse switch disconnector

Two (2) or three (3) medium voltage feeder bays for incoming cables equipped with clutch-pieces

Low voltage busbar 2x1600 mm, min. 2x1600 A

Options:

- Load disconnector instead of clutch-piece
- Circuit breaker including relay protection, instead of fuse switch disconnector (transformer bay)
- Circuit breaker instead of clutch-piece (feeder bay)
- Cable fault indicator (feeder bay)
- Motor drive for remote controlling (feeder bay)
- Connection to low voltage busbar with breaker 2x1600 A
- Busbar switch 1600 A
- Transformer temperature operated shunt trip coil for transformer load disconnector in air insulated MV-switchgear.
- Low voltage energy meter
- 230 V AC outlet fused 10 A
- Lockable hatch or cabinet for AMM meter, available from the outside of the substation.
- RTU for Monitoring, Control or Automation