ENERGI FÖRETAGEN

A report from Swedenergy


# Connection of customer facilities >1-36 kV to the grid

## A translated version of IBH21

March 2023

# Foreword

A fundamental part of a customer connection is where the electrical facility is connected to the grid operator's network and where the metering takes place. This document informs how to design the point of connection to be able to maintain service of the metering system, as well as the routines for notification and inspection procedures.

These are important requirements for efficient and safe grid connections of customer facilities to be able to meter the amount of supplied energy.

This document, IBH 21, applies to the connection of medium-voltage facilities (>1–36 kV) and changes to existing ones. Please note that this document is a translation of the original Swedish version. In the event of discrepancies between the original Swedish version and this translation, the original Swedish version shall prevail.

IBH 21 is the 6th version of the installation regulations for medium-voltage facilities.

The first version was published in 1979 (IBH 79) by Svenska Elverksföreningen (the Swedish Electricity Provider's Association).

During the audit, a review of the entire content has been carried out.

March 2023

Energiföretagen Sverige – Swedenergy – AB

# Contents

# 1. General information

## 1.1 Scope

The provisions relate to an electrical installation in customer facilities connected to or intended to be connected to the grid operator's network with a nominal voltage >1–36 kV, here referred to as medium-voltage. (The provisions apply to both consumption and production facilities.)

## 1.2 Terms and definitions according to current ESA

| | |
|---|---|
| *Anslutningspunkt*<br>**Connection point** | The point at which electrical energy is transferred to an installation. |
| *Elanläggningsansvarig*<br>**Person responsible for an electrical installation** | The proprietor or person appointed by the proprietor to take responsibility for operation and maintenance of the electrical facility by deciding on rules, organization and work routines. |
| *Eldriftansvarsgräns*<br>**Boundary of responsibility in electrical operation** | Boundary between the grid operator's network and the customer's areas of operation. |
| *Eldriftledare*<br>**Operation Manager** | Nominated person in control of an electrical installation during work activities. |
| *Elnätsföretag*<br>**Grid operator** | Organisation engaged in grid operation in accordance with the Swedish Electricity Act. |
| *Elsäkerhetsledare*<br>**Electrical Safety Manager** | Nominated person who ensures that every worker onsite is well educated and aware of safety risks within perimeter of the facility and who is in control of a work activity. |
| *Innehavare över anläggningen*<br>**Proprietor of an electrical installation** | The proprietor of an electrical installation is the person responsible of it.<br><br>*Note: The proprietor is not necessarily the owner of the facility – it could be the occupant/tenant.* |
| *Innehavaransvar*<br>**Responsibilities as the proprietor** | The proprietor of the electrical installation is required to ensure that the installation is designed, maintained and operated in a way that provides the safety for the people and the property.<br><br>Where applicable, the proprietor of an electrical production facility is also required to ensure that the electrical equipment is of the correct design, is maintained and used in a way that presents no risk to safety. |

| | |
|---|---|
| *Mätpunkt*<br>**Metering point** | The place in a facility at which unit is connected. |
| *Mellanspänning*<br>**Medium-voltage** | Voltage range >1–36 kV. |
| *Relationsdokument*<br>**Relational document** | The document describing the current design of the facility. |
| *Servis*<br>**Customer supply** | A collective term for the connecting cable from the grid operator, the service fuse and, if applicable, associated switches/circuit breakers together with the cable entry (if any). |

Other terms in the provisions are used with the meaning defined in the following applicable documents: the Swedish National Electrical Safety Board's regulations, Swedish standards, the EBR's electrical safety instructions (ESA in Swedish) and the IEC's online vocabulary, Electropedia.

# 2. Administrative provisions

## 2.1 Contracts and agreements

Before any installation and construction work can start, an agreement must have been reached on the following:

- Premises and restricted access area.
- Power consumption and voltage level.
- Any minimum short-circuit power requirement in the connection point.
- Future plans.
- Design of switchgear.
- Backup power facility/production facility.
- Customer supply, cable paths.
- Boundary of responsibility in electrical operation.
- Access to buildings and operations rooms.
- Emergency evacuation, fire ventilation, transport routes and cooling of transformers.
- Local power.
- Grid protection system (e.g. control equipment for production).

Contracts for the supply of electricity must have been concluded between the customer and the energy supplier before the facility is energised. If there is no such contract at the time of the connection, it is the grid operator's responsibility to assign a supplier.

## 2.2 Prenotification/ordering of connection

The prenotification for a new facility or a change to an existing facility must be submitted to the grid operator. The notification must be accompanied by:

- A new build plan, supplemented by a sketch showing the position of the medium-voltage facility in relation to surrounding buildings and traffic routes, which should be supplemented by, where relevant, a drawing showing where the facility is located within the building.
- Drawings showing the planned routing of the customer supply line within the plot and the building.
- An overview diagram of the medium-voltage facility.
- Installation drawings and circuit diagrams of the medium-voltage facility.
- Selective plan of the facility.
- Summary of rating data for equipment connected directly to the supply voltage if not shown on drawings.

- Details/diagrams of any generator units that may be connected to the supply voltage directly or via a transformer.
- Connection data (AMP/ASP) data for production facilities.
- Make and type.

*Note: Single-line diagrams are normally sufficient as overview diagrams.*

After reviewing the documents received, the grid operator issues its installation consent with any additional instructions, and also provides information about the design voltage, the maximum inrush current, the dimensioning short-circuit current, connection details, equipment, etc.

The dimensioning data provided takes due account of anticipated technological development, e.g., concerning the voltage level and the short-circuit power.

If the installation work is started before any consent has been obtained, the installation may need to be rebuilt, at the expense of the customer or the electrical installation company.

## 2.3 Notification of completion and inspection

Before the commissioning, a completed medium-voltage installation must have undergone an approved joint inspection. The grid operator appoints an authorized inspector. No later than 10 working days before the desired inspection date, the electrical installation company must complete notification of completion of the medium-voltage installation.

No longer than 5 working days before the inspection, protocols from performed self-inspection, as well as relational documents, including drawings, relay test reports, earth resistance values and other relevant information for the specific installation about the completed installation, must be handed over by the electrical installation company to the electricity grid operator.

In the event of an unapproved inspection, the inspection report must state which remarks need to be addressed before commissioning the facility, or when a possible re-inspection can be performed. In the absence of representation from the electrical installation company, a re-inspection must be performed, at the expense of the electrical installation company. This will take place after renewed registration.

*Note: Normally, the grid operator's inspector normally establishes a record of the completed inspection and informs the authorised electrical of the result from the inspection. The form in appendix 2 – Inspection report regarding medium-voltage, may be used as an inspection protocol. The review of documents and inspection by the grid operator does not release the authorised electrician from his or her statutory and regulatory responsibility.*

## 2.4 Connection

Before the facility is connected, the proprietor must appoint an *elanläggningsansvarig* [person responsible for an electrical installation] (see 1.2). He or she must have the required competence for such activities and must be responsible for servicing and ongoing supervision of the facility

Connection of the facility to the distribution grid may only be carried out or ordered by the grid operator's *eldriftledare* [Operation Manager: nominated person in control of an electrical installation during work activities] or by the person with switching responsibility after consultation with both the electrical installation company's *eldriftledare* and with the *elanläggningsansvarig* for the facility.

*Elsäkerhetsledare* [Electrical Safety Manager: nominated person who ensures that every worker onsite is well educated and aware of safety risks within perimeter if the facility and is in control of a work activity] must submit a certificate of commissioning for the completed facility to the grid company's *eldriftsledare* [Operation Manager: nominated person in control of an electrical installation during work activities] or to the nominated person with switching responsibility for the completed facility.

# 3. Technical provisions

The facilities must be constructed and operated according to applicable laws, regulations and standards. For example, the electrical safety instructions (ESA in Swedish) may be used for connections and work activities.

## 3.1 Cable paths for the grid operator's cables

The routing and type of ducting for the incoming customer supply are determined in consultation with the grid operator on the basis of its requirements, concerning cable types and methods of installation. The selection of cable protection pipes and laying must comply with Swedish standards as well as with EBR. Swedenergy recommend that pipes with a diameter of 160 mm are used. Laying of cable protection pipes are considered as an electrical installation and must therefore be accordingly performed by an electrical installation company.

When necessary, all pipes and penetrations for cables must be sealed against gas, liquid or dust, as well as the spread of fires between fire cells. Unless otherwise agreed, the sealing of the ducting must be performed by the electrical installation company at the expense of the customer.

Prior to laying of cables and connection to switchgear by the grid operator, following must have been carried out:

- Preparations for laying the cables, such as penetrations, cable conduits, anchor rails, cable trays, cable ducts and line protection, must be completed.
- The affected part of the construction site must be cleared and flat, alternatively, the necessary cable conduits must be placed according to the grid operator's instructions.
- Unless otherwise agreed, the cable terminations for incoming customer supply are both provided and installed by the grid operator.

## 3.2 Switchgear

For the operating voltage, switchgear and transformer connections must, in their entirety, be dimensioned for the short-circuit current which are specified in EBR KJ59. However, contact must always be made with the grid operator before the switchgear is dimensioned.

Described below is an example of the design of a medium-voltage switchgear in a customer substation that cover most areas of use. For environmental reasons, SF6-free switchgear is recommended. In particular cases, the grid operator has the authority to approve a different design.

For safety reasons, Swedenergy recommend switchgear where incorrect operation is impossible. Essentially, incorrect operation refers to manoeuvre of the earthing switch against a live installation.

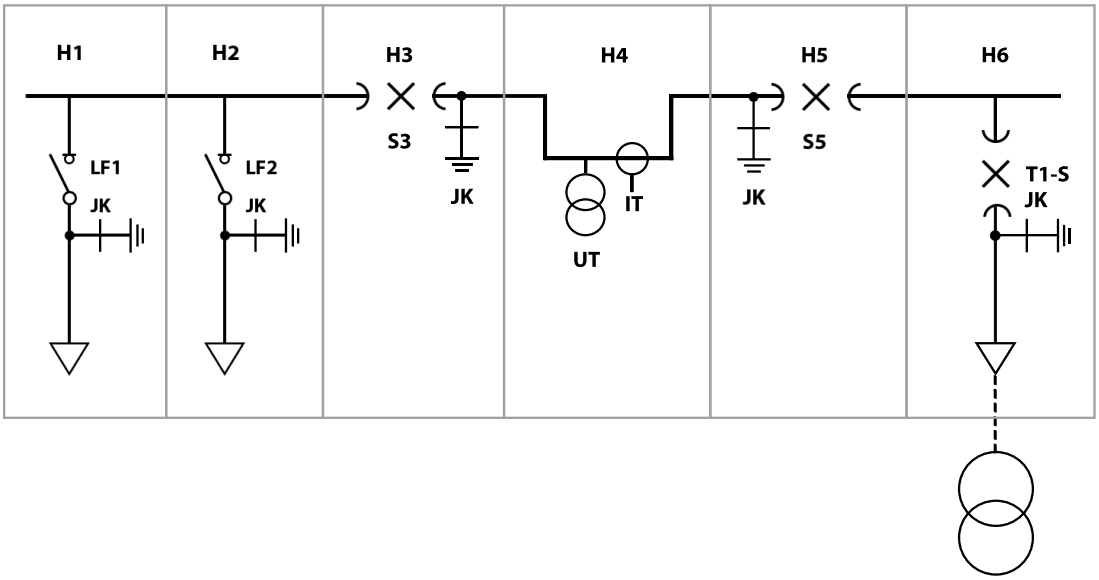


Image 1. Medium-voltage switchgear at a customer substation.

**Contents**

| | | |
|---|---|---|
| H1 | Grid cable 1 | Load disconnector (LF1)/Circuit breaker (S1) with Earthing function (F1LJ) to Grid cable1. |
| H2 | Grid cable 2 | Load disconnector (LF2)/Circuit breaker (S2) with Earthing function (F2LJ) to Grid cable2. |
| H3 | Sectioning/Meter compartment | Sectioning switch (S3) with Earthing function (S3SJ) to Meter compartment/Load disconnector (LF3) with Earthing function (F3SJ) to Meter compartment cable. |
| H4 | Meter compartment | See section 4. Earthing of switchgear must take place in H3 and H5. |
| H5 | Sectioning/Meter compartment | Required where there are multiple outgoing compartments. Sectioning switch (S5) with Earthing function (S5SJ) to meter compartment (to prevent the risk of backfeeding when working in H4). One advantage of isolation and earthing on both sides of the meter compartment is the possibility of bypassing the meter compartment with cables, and the customer stays supplied while the instrument transformers are replaced/ disconnected.<br><br>Load disconnector (LF5) with Earthing function (F5SJ) to meter compartment cable.<br><br>If there only is one outgoing compartment (H6), H5 is equipped with a busbar connection and a earthing function with earthing ball points. |
| H6 | Transformer 1 (T1) customer | Fuse load disconnector or circuit breaker with customer earthing switch to Transformer T1 customer. |

**Extended standard customer subtraction**

| | | |
|---|---|---|
| H7 | Transformer2 (T2) / Cable to Transformer (T2)/ Backup power generator | Fuse load disconnector or circuit breaker with Earthing Switch to T2/T2 cable/Backup power generator. |
| H8 | … | |
| H9 | … | |
| … | | |

…and so on.

*Note: If compartment H7 or higher contains a backup power generator, compartment H5 must instead contain a circuit breaker or a switch-disconnector, which will function as a grid switch during backup power operation. In this case, it must also be possible to operate the circuit breaker manually, and to lock it while disconnected as well as to include an earthing switch (SJ5) against the meter compartment.*

**Circuit breakers and protective relays**

Circuit breakers, fuses and values for protective relays must always be selected in consultation with the grid operator. See also *4.5. Protective equipment.*

In order to reduce harmful effects of possible arcing, the switchgear must be designed in such a way according to one or more of the following:

- Arc proof switchgear with pressure relief channels.
- Device, which without auxiliary voltage, instantaneously short-circuits the switchgear in the event of an electric arc.
- Arcing is prevented by single-phase encapsulation.

## 3.3 Switchgear rooms

Switchgear rooms in which the grid operator store equipment*), are preferably located on the ground floor, with an external wall and direct access to the outside. If access or evacuation routes pass through the customer's locked rooms, routing through rooms with special access restrictions must be avoided.

The medium-voltage areas must be accessible to the grid operator's personnel at all times, using one of the following options:

- 24-hour staffing of the building containing the medium-voltage area.
- A reserved connecting route with doors equipped with the grid operator's lock cylinders.
- One set of key cylinders (or a key cabinet).
- Two sets of keys required for access to the facility are handed over to the grid operator.

*Note: The first three options are recommended before the fourth.*

A two-pole wall outlet for 230 V 10(16) A with earth and permanent lighting must be provided in switchgear rooms as well as a five-pole CEE outlet for 3-phase 230/400 V, 16 A.

*) The concept of "equipment" can also include communication cabinets and motors for remote sectioning of supply networks.

## 3.4 Switches

Switches in compartments for the grid operator's cables must either be lockable load disconnectors or circuit breakers designed as pull-out units, or in series with lockable disconnectors. It must be possible to operate switches manually with independent manual control and in a de-energised state.

Circuit breakers intended to isolate faulty components from the grid operator's equipment must be equipped with a shunt trigger. Isolation must be possible even if the control voltage is lost.

## 3.5 Protective equipment

The customer facility must be equipped with short-circuit protection, and in some cases earth fault protection. The customer is responsible for ensuring that they meet the single failure criterion (n-1).

The short-circuit protection must consist of a protective relay in combination with a circuit breaker, or of fuses in combination with a load disconnector. The protection must selectively isolate faulty components in the customer facility (apart from the busbar) from the grid operator's network. The grid operator assesses the need for earth fault protection.

All protective relays must have their own core in the current transformer. The core must have the necessary rated burden and an overcurrent value above 10. For earth current protection, the use of a cable current transformer is recommended instead of three sum-connected current transformers (otherwise there is a risk of unauthorised asymmetrical currents).

*Note: A short-circuit protection and possible earth fault protection can either be carried out jointly for the entire facility, or individually for each connection to the busbar. With regard to selectivity and the desire to keep the trigger times short, the permitted rated current for fuses is limited. For transformers larger than 800 kVA, circuit breakers are therefore required as the isolating device.*

## 3.6 Other protective devices

In generation, battery storage or backup power (category 4), where continuous input to the power grid can occur, the installation must be supplemented with an asymmetry protection (called NUS protection) according to the document *"Anslutning av elproduktion till lågspänningsnätet − ALP"* by Swedenergy.

Facilities that can be used as backup power during islanding operation, must meet the requirements set according to the document *"Stationära reservkraftanläggningar"* by Swedenergy.

Delayed zero-voltage triggering must be provided for motors connected to the supply voltage.

## 3.7 Testing of relays

The testing of protective devices must be conducted in such a way that the whole chain of functions is thoroughly tested and documented together. The commissioning test also verifies that the instrument transformers of the protective devices are connected correctly.

Protective relays must be designed to be tested without the need to take the facility out of operation.

## 3.8 D.c power supply

The d.c power unit must be equipped with the following:

- A battery system equipped with an automatic charging device with a nominal voltage of at least 24 V. The selected voltage level must be adequate for the intended function.
- A voltmeter — permanently installed — for routine monitoring of the charge voltage.
- A rectifier with a nameplate stating the battery supplier's recommended normal charge voltage.
- Connectors for external voltmeter.

## 3.9 Transformers

Transformers with vector group Dyn 11 and tap changer +2x2.5% are normally required.

The vector group and tap changer for transformers must be selected in consultation with the grid operator, taking applicable voltage conditions and any future voltage changes into account.

## 3.10 Earthing

The grid operator's equipment and the customer's medium-voltage and low-voltage equipment are usually earthed to a common earth terminal block. It may be necessary to separate the earth system, for example if the rail infrastructure of Trafikverket (The Swedish Transport Administration) is connected. See current standards for earthing and screening from Trafikverket.

Earth electrode conductors must:

- Be dimensioned to prevent double ground fault.
- Consists of insulated single conductors of type RK or equivalent.
- Be clearly marked and routed to a common earthing terminal installed on a permanent part of the building where it is easily accessible and visible.

It must be possible to test and verify the earth electrodes in the customer installation.

*Note: Uninsulated earth electrode conductors on earthed structures must be laid in such way to minimise the risk of burning caused by high fault currents.*

## 3.11 Earthing for work and screens

Earthing to switchgear, transformers, etc. for work must be possible in accordance with ESA instructions. Switchgear, transformers (medium-voltage and low-voltage sides), etc. should therefore be equipped with the necessary number of earthing switches or fixed conductors for earthing devices. The earthing switches described in 3.2. meet this requirement.

Necessary earthing tools must be available in the switchgear room or in direct proximity to it.

Planning for earthing equipment for temporary work should, where possible, be designed as such to allow earthing to take place behind closed switchgear doors.

When work takes place near live parts, the necessary screening equipment must be in the switchgear room or in direct proximity to it.

# 4. Metering

Three-phased billing metering must be used in accordance with the specification below and in appendices 3:1 and 3:2.

Billing metering normally comprises the following equipment:

- Three current transformers.
- Three single-pole voltage transformers.
- Meters for active and reactive energy.
- Meter terminal/meter accessory (may be built into modern meters).
- Meter cabinet with one metering terminal per meter.
- Communication equipment (may be built into modern meters). *)

*) If necessary, the customer is obliged to provide ducting from the meter cabinet to the outer wall antenna, as well as to provide space for the antenna on the outer wall.

## 4.1 Division of responsibilities

The installation and supply for metering equipment normally take place as shown in table 1. The grid operator can choose delivery according to table 2, after agreement with the customer.

The grid operator must:

- Own and pay for instrument transformers as well as metering terminals and meters in meter cabinets for billing metering.
- Provide the customer with the specification of instrument transformers, load resistance and metering terminals if supply according to table 2 is selected.

The customer must:

- Follow the grid operator’s specification for measuring transformers and meter terminals upon delivery according to table 2.
- Provide the grid operator with traceable test reports for the measuring transformers well in advance of the inspection of the facility if supply according to table 2 is selected.

**Table 1**

| Component | Grid operator | | Customer | |
|---|---|---|---|---|
| | work | equipment | work | equipment |
| Voltage transformer | | X | X | |
| Load resistor | | X | X | |
| Current transformer | | X | X | |
| Meter terminal | | X | X | |
| Rating plates on compartment front | | X | X | |
| Meter | X | X | | |
| Meter cabinet | | | X | X |

**Table 2**

| Component | Grid operator | | Customer | |
|---|---|---|---|---|
| | work | equipment | work | equipment |
| Voltage transformer | | | X | X |
| Load resistor | | | X | X |
| Current transformer | | | X | X |
| Metering terminal | | | X | X |
| Rating plates on compartment front | | | X | X |
| Meter | X | X | | |
| Meter cabinet | | | X | X |

*Connection diagram for the metering system will be provided by the grid operator.*

If metering other than billing metering is to be implemented, e.g., verification metering or other special metering equipment, the space required and the design must be determined in consultation with the grid operator. The grid operator is responsible for performing regular on-site inspections to guarantee the operation and quality of the energy metering system, so the primary and secondary connections of the instrument transformers must be easily accessible.

In addition, it must be possible to replace the instrument transformers with ***reasonable work effort.*** A copy of the rating plates of the instrument transformers must be provided on the compartment front to enable reading of the rating data during operation.

*Note: **"Easily accessible"** means that the grid operator easily can check secondary connections and connect test equipment to the primary outlet for ratio/polarity testing, or connect the primary auxiliary conductors to bushing type current transformers.*

***"Reasonable work efforts"** means no more than a few hours of downtime for connections and for replacing instrument transformers.*

## 4.2 Instrument transformers and meter compartment

- Instrument transformers intended for billing metering must not be used for any other purpose without the approval from the grid operator.
- The customer's measuring and/or control equipment may only be installed on customer's side of the billing measurement.
- The primary windings of single-pole voltage transformers must be conducted to the earth rail of the compartment using at least 35 $mm^2$ Cu-conductors.
- Secondary outlets must be equipped with a screw connection or with fixed cables, and they must be sealable.
- Connectors or plug-in connections must not be used on the primary or secondary outlets of the instrument transformers, or in secondary cables in the case of billing metering.
- The measuring transformers normally have secondary earthing directly on the secondary outlets or on terminals in the connection area of the compartment.
- Secondary cables from current and voltage transformers must be connected to sealable and non-isolatable terminals in the connection area of the compartment.
- All circuits on the transformer must be pulled up and connected to the terminal in the connection space.
- The secondary fuses of the voltage transformers – sealable 10 A diazed type fuses with voltage control device – are installed in the connection area of the compartment to make them accessible while the facility is in operation.
- Load resistors for the voltage transformers' open delta windings should not be mounted in the connection space but must be mounted in a well-ventilated place and provided with contact protection.

*Note: A conventional meter compartment is defined as an air-insulated single-phase encapsulated compartment in which instrument transformers of the conventional type will be installed and used. Instrument transformers of the conventional type are manufactured and supplied by several suppliers, and the design allows installation in all switchgear.*

## 4.3 Meter cables

A detailed instruction of dimensioning can be found in *Appendix 4.*

- Conductors from the voltage and current transformers should be of type FK, MK or RK, which are laid in separate conduits.
- Conductors from current transformers to terminals in the connection area of the compartment must have a cross-sectional are of at least 2,5 $mm^2$.

- Conductors from voltage transformers to terminals in the connection area of the compartment must have a cross-sectional area of at least 1,5 $mm^2$.
- Cables between the connection area of the meter compartment and the meter cabinet are dimensioned according to Appendix 4.
- The cables between voltage transformers and the meter must be dimensioned as such that the voltage drop does not exceed 0.1% for category 3 and 0.05% for category 4 and 5. (See the note below)
- Cables between the connection area of the compartment and the meter cabinet must be laid as a single length.
- Meter cables and terminals between instrument transformers and the connection area of the compartment are marked as described in Appendix 3:1 and 3.2.
- Cables must be marked throughout their length in the form of colour-coded/ numbered conductors.
- Meter cables must be laid separately from other conductors and must be protected against mechanical and magnetic influences.

*Note: Category 3 refers to metering of a load< 2 MW and carried with a voltage > 1 kV. Category 4 refers to a load 2 — 10 MW with the same voltage.*

## 4.4 Meter cabinet/meter board

- The design is determined in consultation with the grid operator according with the relevant standards.
- The location is determined in consultation with the grid operator.
- Is supplied by the customer.
- Is earthed separately to a common earthing terminal.
- Penetration and channelling for antenna cable must be provided and paid for by the customer if necessary.
- Is equipped with a wall socket (schuko 230 V), fused 10 A from a separate circuit without earth fault circuit breaker.

# 5. Normative references

The document refers to the following publications:

| | |
|---|---|
| SS 424 17 20 | Power cables and house wiring cables – Marking of cores and sheath |
| SS-EN 61869-1 | Instrument transformers – Part 1: General requirements |
| SS-EN 61869-2 | Instrument transformers – Part 2: Additional requirements for current transformers |
| SS-EN 60 044-2 | Voltage transformers, suspended and replaced with SS-EN 61869-3 Instrument transformers – Part 3: Additional requirements for inductive voltage transformers |
| SS-EN 61869-3 | Instrument transformers – Part 3: Additional requirements for inductive voltage transformers |
| SS-EN 61869-5 | Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers |
| SS 424 14 37 | Underground installation of cables |
| SS 430 01 10 | Meter cabinet |
| SS 430 01 15 | Meter cabinet and meter board for measuring transformer |
| SS 437 01 02 | Low-voltage electrical installations |
| SS-EN 50522 | Earthing of power installations exceeding 1 kV a.c. |
| SS-EN 61936-1 | Power installations exceeding nominal voltage 1 kV AC – Part 1: Common rules |
| SEK Handbok 438 | High-voltage handbook with high-voltage guide |
| Energiföretagen/EBR | KJ 41 Kabelförläggning i mark |
| Energiföretagen/EBR | KJ 59 Nätstationer 12–24/0,4 kV |
| Energiföretagen/EBR | Applicable ESA |
| Energiföretagen | Allmänna avtalsvillkor för högspänning |
| Energiföretagen | Stationära reservkraftanläggningar |
| Energiföretagen | Anslutning av produktionsanläggningar till mellanspänningsnätet (AMP), Anslutning av större produktionsanläggningar till regionnätet (ASP) |
| Trafikverket | TDOK 2015:0223, Elsäkerhetsföreskrifter för arbete på eller nära järnvägsanknutna högspännings- och tågvärmeanläggningar |
| Trafikverket | TDOK 2014:0416, Trafikverkets grundläggande jordningskrav |

# 6. Appendices

Appendix 1 Prenotification and notification of completion: medium-voltage

Appendix 2 Inspection report

Appendix 3:1 Connections of voltage transformers

Appendix 3:2 Connection of current transformers

Appendix 4 Dimensioning for meter cables

# Appendix 1 – Prenotification and notification of completion: Medium-voltage

| Grid operator | PRENOTIFICATION/NOTIFICATION OF COMPLETION: MV<br>Connection point: | | | |
|---|---|---|---|---|
| | ☐ Prenotification | | ☐ Notification of completion | |
| | Date of receipt | Signature | Date of receipt | Signature |
| | Reference number | | Installation consent | |

| Address | | Switchgear compartment | Location |
|---|---|---|---|
| Registry entry of property | Municipality/district | Facility number | Switchgear/Tf.subst. no. |

**CUSTOMER (Proprietor)**

| Name | | Name | |
|---|---|---|---|
| Address | | Address | |
| Postcode | Town/city | Postcode | Town/city |
| Phone (with area code) | Personal ID/company reg. no. | Phone (with area code) | Personal ID/company reg. no. |

| NOTIFICATION CONCERNS: | FACILITY TYPE | POWER DATA | |
|---|---|---|---|
| ☐ Temporary facility<br>☐ New connection<br>☐ Addition<br>☐ Customer supply change | ☐ Switchgear in standalone building<br>☐ Switchgear integrated in the property | Total power: kW<br>Calculated reactive power: kVA | Medium-voltage motors<br>Total kW<br>Largest kW<br>Transformers: kVA<br>Backup power: kVA |

| Construction starting date | Connection date | ELECTRICAL INSTALLATION COMPANY<br>Company/Name and address | |
|---|---|---|---|
| Notes | | Company registrations no. | Reg no. |
| | | Phone no. (with area code) | Mobile phone |
| | | Administrator | |
| | | Date | Signature |

**NOTIFICATION OF COMPLETION (PARTIAL NOTIFICATION)**

| Facility ready for connection | | | I hereby certify that the installation work has been completed as described above and in accordance with the applicable regulations and the applicable installation rules. | | |
|---|---|---|---|---|---|
| Year | Month | Day | Date | Signature | Name in block letters |

| **Invoice/quotation text** |
|---|
| |

| Meter location<br>☐ Transformer substation<br>☐ Switchgear room, customer<br>☐ Switchgear, grid operator | | | | | Location code |
|---|---|---|---|---|---|
| | Existing meter | | New meter | | Notes |
| Number | | | | | |
| Type | | | | | |
| Ampere | | | | | |
| Meter constants, energy | Active | Reactive | Active | Reactive | |
| Meter constants, power | Active | Reactive | Active | Reactive | |
| Voltage transformers | / | | / | | |
| Current transformers | /5A | | /5A | | |
| Billing costs, energy | | | | | |
| Billing costs, power | | | | | |
| Reading, energy | | | | | |
| Reading, energy | | | | | |
| Reading, energy | | | | | |
| Reading, energy | | | | | |
| Removed/installed/read | Year, month, day, signature | | Year, month, day, signature | | Year, month, day, signature |

| Tariff | Consumer group | Quotation number | Delivery agreement number | | Issued for action on | |
|---|---|---|---|---|---|---|
| Connection fee | Signature | Invoice number | Invoice date | Signature | Paid | Signature |
| Annual cons. | Consumption code | Subsc. class | Agreed power | | Balance provider | |
| Notes | | | | | | |

## Appendix 2 – Inspection report

Date of inspection:

Facility:

Address:

Facility proprietor:

Address: Tel:

*Elanläggningsansvarig*
[person responsible for an electrical installation]: Tel:

Electrical installation company: Tel:

Other: Tel:

**Persons present during the inspection.**

Representative of the grid operator:

Representative of the electrical installation company:

Representative of the facility proprietor:

Representative of the electrical consultant:

Other representative:

The protocol will be distributed to:

**Documents submitted to the grid operator:**

☐ Relational document
☐ Relay test report
☐ Earth electrode test report
☐ Notification of completion
☐ Self-audit report
☐ _____

**The grid operator has been guaranteed access as follows:**

☐ Grid operator's locks
☐ Handover of keys
☐ Key cabinet
☐ 24-hour staffing by the facility proprietor

**Conclusion**

☐ 1. Rooms containing medium-voltage installations including cable routes are correctly performed.

☐ 2. Evacuation and access routes are correctly performed.

☐ 3. The following equipment is provided in the rooms for the medium-voltage installation and to the required extent:

- ☐ Earthing tools
- ☐ Barriers/screening equipment
- ☐ Control tools
- ☐ Warning signs
- ☐ Overview diagrams
- ☐ Compartment and equipment marking

☐ 4. Medium-voltage switchgear including relief system (if any) is satisfactorily executed.

☐ 5. Transformers including transformer encloser are satisfactorily executed.

☐ 6. Permanently installed earthing equipment (earth electrode conductors, earthing conductors, earth electrode terminals, connections, earth electrodes) is satisfactorily executed.

☐ 7. Auxiliary equipment (control batteries and charging equipment) is satisfactorily executed.

☐ 8. The grid company’s metering equipment is correctly connected.

☐ 9. A grid agreement is in place.

☐ 10. Supply agreement is in place.

| Notes: | Comment. Action | Action |
|---|---|---|
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| | | |

Other _____

_____

_____

_____

☐ The facility is ready for operation.

☐ The facillity is ready for operation when following points have been addressed: _____

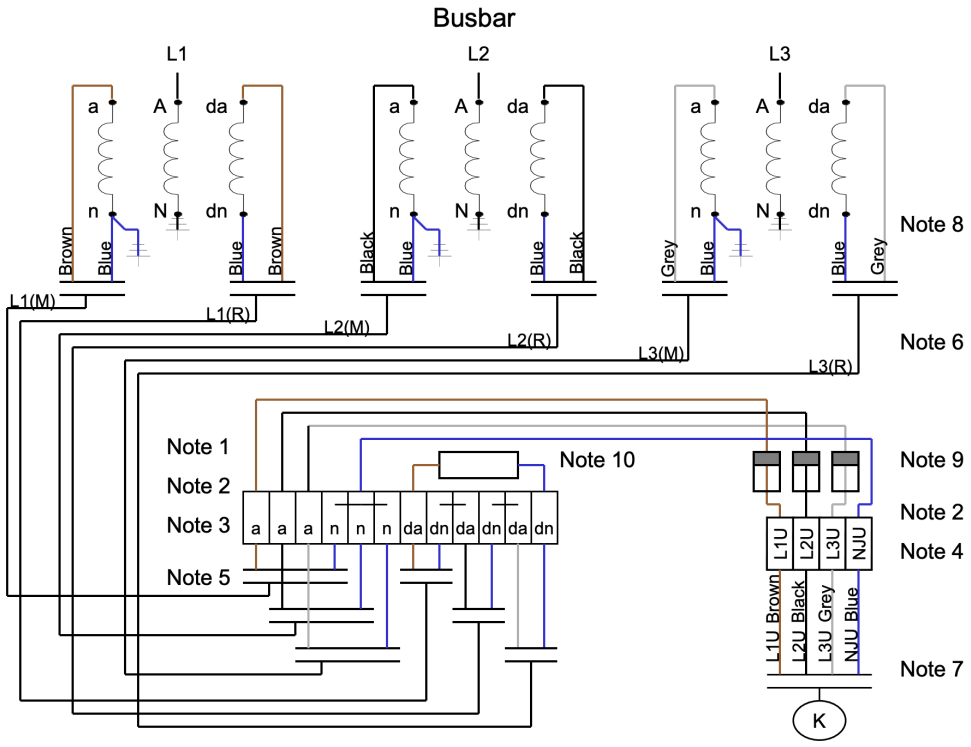
_____

☐ New inspection is required.

Place/Date _____

The grid operator's inspector _____

## Appendix 3.1 – Connection of voltage transformers




Note 1 Terminals located in the connection area of the compartment must be accessible during operation. All circuits on the transformers must be pulled up and connected to a terminal in the connection space. Cabinets or terminals and fuses included in the measuring circuit must be sealable.

Note 2 Terminals (isolatable) must be fitted with test outlets.

Note 3 Terminals are marked according to the relevant standard for voltage transformers (to voltage transformers).

Note 4 Terminals are marked with L1U, L2U, L3U and NJU or according to the grid operator's requirements (to the meter).

Note 5 Cables between voltage transformers and terminals are marked with phase designations.

Note 6 The cross-sectional area is normally 1,5 mm$^2$ between voltage transformers and terminals. It can also be > 1,5 mm$^2$. See table in *appendix 4.*

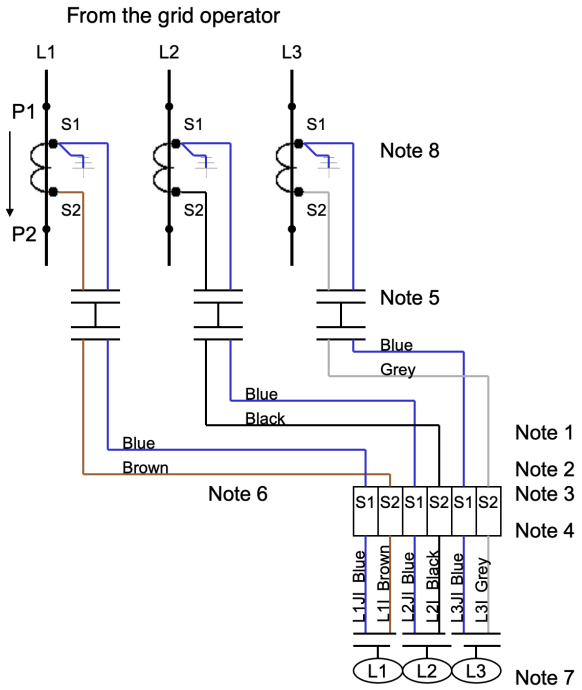
Note 7 The cross-sectional area for the voltage cable depends on the distance between the connection area of the compartment and the meter, and on the load in the voltage circuits. *See appendix 4* or as determined by the grid operator.

Note 8 Voltage transformers normally have secondary earthing in the connection space next to the device.

Note 9 There must be space for the required number of secondary fuses (10 A fast diazed) and associated terminals. The number of secondary fuses is determined by the grid operator.

Note 10 A suppression resistor rated 27 ohm, 450 W or other ratings determined by the grid operator, is connected over the open delta.

## Appendix 3.2 – Connection of current transformers




Note 1 Terminals located in the connection area of the compartment must be accessible during operation. All circuits on the transformers must be pulled up and connected to terminals in the connection space. Cabinets or terminals must be sealable.

Note 2 Terminals (isolatable) must be fitted with test outlets.

Note 3 Terminals are marked according to the relevant standards for current transformers (to current transformers). Note that if current transformers have two cores, the designations are 1S1-1S2 for core 1 (relay core) and 2S1-2S2 for core 2.

Note 4 Terminals are marked with L1Jl, L1l, L2Jl, L2l and L3l or according to the grid operator's requirements (to meter).

Note 5 Cables between current transformers and terminals are marked with phase designations.

Note 6 The cross-sectional area is normally 2,5 $mm^2$ between current transformers and terminals. It can also be > 2,5 $mm^2$ depending on the length of the current cable. See table in *appendix 4.*

Note 7 The cross-sectional area of the current cable depends on the distance between the connection area of the compartment and the meter, and on the load in the current circuits. See *appendix 4* or as determined by the grid operator.

Note 8 Current transformers normally have secondary earthing in the connection space.

## Appendix 4 – Dimensioning for meter cables

Meter cables between instruments and meter cabinets must be dimensioned according to the distance, the number of meters, the dead load of the metering equipment and the technical data of the instrument transformer.

The cables must be dimensioned as such that:

- The connected burden in current circuits are in terms of the rated burden of the current transformer.
- The total voltage drop between voltage transformers and the meter does not exceed 1 % for category 3 (rated power <2 MW) or 0,05 % for category 4 and 5 (rated power 2-10 MW).
- The trigger conditions of the secondary fuses are met.

The following table contains the smallest meter cable dimensions with different cable distance and connected load according to SS 437 01 02.

| Distance meter — transformer | Total length of current circuit | Area of current conductor | Area of voltage conductor | Area of neutral conductor | Burden calculated with secondary current = 5A |
|---|---|---|---|---|---|
| m | m | mm² | mm² | mm² | VA |
| 0.5–5 | 1–10 | 2.5 | 1.5 | 1.5 | 0.2–1.8 |
| 5–10 | 10–20 | 4 | 1.5 | 1.5 | 1.1–2.2 |
| 10–15 | 20–30 | 6 | 1.5 | 1.5 | 1.5–2.2 |
| 15–25 | 30–50 | 10 | 1.5 | 1.5 | 1.3–2.2 |

For distances exceeding those stated in the table above, the grid operator decides the area in each individual case.

The cables specified in the table are valid for a rated burden of 0.1–5 VA for indoor current transformers and 0.1–10 VA for outdoor current transformers, and the connected burden for meters is < 0.1 VA.

The grid operator may also issue instructions to use meter cable sizes other than those stated in the table.

For connection and marking, see section *4 Metering.*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