Technical Conditions for Connection

to the medium-voltage network

Translation from German:

“Technische Anschlussbedingungen für den Anschluss an das Mittelspannungsnetz“

TAB Mittelspannung 2008

bdew

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Introduction

These guidelines summarize the essential aspects which have to be taken into consideration for the planning, construction, connection and operation of customer facilities to the network operator's medium-voltage network. They include important information about the operation of those facilities and shall serve as a basis to the network operator as well as to the installer and the operator of the facility in the planning and decision-making process.

These BDEW guidelines shall replace the technical guidelines dealing with the construction and operation of transfer stations for the supply of customers from the medium-voltage network („Bau und Betrieb von Übergabestationen zur Versorgung von Kunden aus dem Mittelspannungsnetz" - VDN; 2003 issue) and the associated check lists for acceptance tests, initial start-up and documentation. They were completely re-shaped and organized more clearly in terms of their logical structure.

In June 2008, BDEW will confer the Network Technology/Network Operation Department which previously belonged to the sphere of responsibility of the Association of Network Operators (VDN) to VDE. Thus, setting of technical rules for electricity networks will henceforth be realized within the „Forum Netztechnik / Netzbetrieb" (FNN) [Network Technology/Network Operation Forum] under the umbrella of VDE. After set-up of the FNN, the 2008 Technical Conditions for Connection to the Medium-Voltage Network („TAB Mittelspannung 2008) will be formally transformed into a technical rule.

These technical guidelines and network-operator-specific supplements can be used as an integral part of the network connection agreements and possibly of the connection utilization agreements concluded with the customers.

The Annex comprises forms for the collection of the requisite data of a customer facility from the stage of planning of the network connection to its initial start-up and commissioning of the customer facility.

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Contents

1 General principles

1.1 Scope of application

These Technical Connection Conditions (TCC) shall apply to the connection and operation of plants connected or being connected to the medium-voltage network of the network operator.

Furthermore, the TCC shall apply to facilities which are essentially extended or modified. For the existing part of the customer facility, there is no adjustment required by the TCC provided that secure and undisturbed electricity supply is ensured.

In particular, the TCC determine the network operator's, installer's, planner's and customer's obligations to act. Customers within the meaning of these guidelines are connection owners and connection users.

The TCC apply along with Article 19 („Technical rules") of the German Energy Industry Act, and are thus an integral part of network connection agreements and connection utilization relations.

The TCC shall be valid from 1st June 2008.

The Technical Guidelines on the construction and operation of transfer stations for the supply of customers from the medium-voltage network (VDN; 2003 issue) will cease to be effective on the same day. There will be a transitional period of one year for facilities at the stage of planning or under construction. During this period, the previous VDN Guidelines can still be applied.

Questions arising in terms of the application of the TCC shall be solved by planners, installers, connection owners and connection users with the responsible network operator.

The transfer stations described in the TCC are mainly composed of

- the structural element
- the medium-voltage switching station
- the transformers
- the low-voltage distribution
- protection and control equipment
- measuring devices
- auxiliary equipment

1.2 Specifications and provisions

Customer facilities are to be installed and connected according to the acknowledged rules of technology, particularly in conformity with DIN VDE, accident-prevention rules and other rules / specifications of the network operator, taking official regulations or decrees into consideration.

The customer must ensure proper functioning as defined by DIN VDE 0105 – 100 /8/ and the technical condition of its transfer station according to the relevant guidelines, standards and maintenance requirements. The customer may also entrust third parties with the operational management of the transfer station.

Every customer facility is connected through **one** transfer station to the network operator's medium-voltage network. Deviations from this rule have to be separately agreed with the network operator.

In this context, particular attention has to be paid to the following issues:

- network connection agreement and connection utilization agreement
- voltage level and network connection point
- type of connection (e.g. underground cable, overhead line, looping-in, spur connection)
- integration into the network protection scheme of the upstream medium-voltage network
- integration into the remote control scheme of the upstream medium-voltage network
- operational equipment with likely network interactions
- arcing fault safety of the switching station in conjunction with the station room
- measuring devices
- ownership structures; current extract from the land register, if required
- network operator's line route on private property

1.3 Application procedure and connection-relevant documents

The application and connection procedure is divided into the following sub-processes:

- application
- rough planning, verification, project planning, connection offer, connection acceptance / assignment

- installation and acceptance of the transfer station
- setting-up of the network connection
- initial start-up

The connection owner shall give notice in due time of the connection of electrical installations to the medium-voltage network or of modifications to the connection or the electrical installations, according to the procedure usually applied by the network operator. These requirements shall apply to

- new installations (supply and / or production facilities)
- facilities that are to be extended (e.g. if the power agreed in the network connection agreement is exceeded) or facilities that are to be modified
- facilities temporarily connected, e.g. stations for building-site power supply

and additionally to commissioning and re-commissioning and after separation or grouping of customer facilities. The installation of the facility must be entrusted only to specialized electrical firms.

With a view to enabling the network operator to dimension the network connection in conformity with demand, and to determine the type of measuring devices required and assess possible network interactions, the connection owner shall provide, together with the application, the necessary information about the electrical facilities to be connected (see Annex D.1 Application):

- facility address, designation of the construction project,
- connection owner,
- property owner,
- facility installer,
- type of facility (new construction, extension, dismantling),
- location of the property to be supplied (map on the scale of at least 1:1.000) with proposals on possible station sites,
- the expected power demand, its characteristics and extension stages, if required,
- particular requirements upon the reliability of supply,
- building-site power demand,
- network disturbances (see Annex D.2: Data sheet for the assessment of network distur-

bances),

- time schedule of construction sequences and date of initial start-up.

The network operator shall determine the type of connection while taking the customer's legitimate interests into consideration. The network operator and the customer shall commonly agree on the following items (see Annex D.3 Network connection planning):

- the location of the transfer station and the network operator's line route,
- the structure of the medium-voltage switching station,
- the type of neutral point treatment,
- the necessary network protection equipment for feed-in, transfer and outgoing feeder bays
- the requisite remote control / remote monitoring and automatic change-over equipment,
- the type and layout of the measuring device,
- borderlines of the property and of the area at disposal (These data have to be entered in the station's basic circuit diagram. The ownership structures of the transfer station are described in the network connection agreement.),
- the customer's and the network operator's scope of supply and performance. The customer is responsible, inter alia, for all official authorizations and notifications.

Not later than 6 weeks prior to the commencement of construction, the customer shall submit the following documents to the network operator in electronic form, if possible, or in two (paper) copies (see Annex D.4 Construction planning):

- Scale plan of the site showing the location of the transfer station, the network operator's line route and the existing and scheduled structures.
- Basic circuit diagram of the entire medium-voltage installation including the borderlines of the site and of the area at disposal, transformers, measuring, protection and control equipment (data of the auxiliary power source, if available); the technical parameters have to be indicated (examples are given in Annex C).
- Drawings of all medium-voltage bays showing the arrangement of appliances (assembly drawings).
- Layout of the measuring device with facilities for data telecommunication.
- Ground plans and sectional drawings on the scale of 1:50, if possible, of the electrical

operating rooms for the medium-voltage switching station and transformers. These drawings must also show the route of the lines and the switching station entrance.

- Arrangement by mutual consent concerning the location and operation of the transfer station and the network operator's line route between the house and land owner and the installer or operator of the transfer station, if they are different persons.
- Evidence of the fulfilment of the network operator's technical requirements according to these guidelines.

A copy of the documents endorsed by the network operator shall be returned to the customer or to its authorized representative. This endorsement has a limited validity of six months and only confirms the interests of the network operator. Endorsements of the network operator have to be taken into consideration by the installer of the facility. The construction and assembly work must not be started until the documents endorsed by the network operator are available to the customer or its authorized representative and the confirmed connection offer is available to the network operator.

At least two weeks before the desired date of commissioning of the transfer station, the customer shall inform the network operator so as to enable the latter to put the network connection into operation in due time.

At least one week before commissioning of the network connection, the following documents and a list of the customer's contact persons shall be delivered to the network operator so as to enable the organization and implementation of switching operations to be carried out:

- Updated project documents (with evidence furnished of the fulfilment of possible requirements of the network operator),
- Order of initial set-up (see Annex D.5),
- Earthing protocol (see Annex D.6),
- Inspection records / Certificates of measurement for current and voltage transformers

Subsequently, the network operator shall timely inform the connection owner of the network connection's initial start-up date.

1.4 Initial start-up

Prior to the transfer station's commissioning, the connection owner shall submit to the network operator the completed order of initial start-up signed by the responsible persons (see Annex D.5) as well as further documents required by the network operator. Without the signed order of initial start-up, the station will not be put into operation.

The initial start-up records completed during the network connection's initial start-up (see Annex D.8) shall remain with the network operator.

The network operator reserves the right to carry out a visual inspection. Should any defects be ascertained during the network connection's initial start-up, the network operator may defer the network connection's commissioning until the defects have been remedied. With the initial start-up, the network operator does explicitly not assume any responsibility or liability for the operational safety of the customer's own facility.

As a prerequisite for the network connection's initial start-up, secure access to and lockability of the electrical service rooms as well as an appropriate escape route must be ensured.

Initial start-up of the network connection is implemented by the network operator up to the transfer point.

2 Network connection

2.1 Principles for the determination of the network connection point

Customer facilities shall be connected to the network at an appropriate point, the network connection point. On the basis of the documents mentioned in Chapter 1.3, the network operator shall determine the appropriate point of connection to the network which ensures secure network operation taking the customer's facility into consideration. The decisive criterion for the assessment of the network connection is always the behaviour of the customer facility at the network connection point and within the network of public supply.

The assessment of the connection possibility under the aspect of network disturbances shall be based upon the network impedance at the junction point (short-circuit power, resonances), the connection power and the type and operation mode of the customer facility.

2.2 Dimensioning of network equipment

The operation of the customer facilities gives rise to higher loading of lines, transformers and other network elements. Therefore, it is indispensable for the network operator to examine the loading capacity of network equipment in the light of the connected customer facilities according to the relevant dimensioning rules.

2.3 Operating voltage at the network connection point

According to DIN EN 50160 /10/, the operating voltage at the network connection point must be at 95 % within the tolerance $U_c \pm 10$ % as 10-minute medium value of the effective voltage value of each weekly interval. The operating frequency usually varies by a few mHz. Further voltage and frequency characteristics are described in DIN EN 50160 /10/.

2.4 Network disturbances

2.4.1 General

The electrical equipment of the customer facility need to be planned, constructed and operated in such a way that retroactive effects on the network operator's network and on other customers' facilities are permanently limited to an admissible degree. Should nevertheless any retroactive effects occur on the network operator's network, the customer must take

appropriate measures in its facility which need to be agreed with the network operator. The network operator is entitled to disconnect the transfer station from the network until the faults are eliminated.

The Technical Guidelines on „Generating plants connected to the medium-voltage network„ of BDEW /54/ and the specifications of the network operator shall be applied to the parallel operation of the customer's own generating plants with the network of the network operator.

The limit values given below in terms of network disturbances are deduced from the reference values given in the Paper on „Technical Rules for the Assessment of Network Disturbances" /55/.

2.4.2 Rapid voltage changes

Strong or frequently recurring load changes, e.g. attributable to switching-on of large motors, welding sets or electric arc furnaces lead to voltage changes whose disturbing effects depend on their frequency and amplitude. Rapid individual voltage changes must not exceed the following value at the junction point of the customer facility with the public network:

$$\Delta u_{max} \leq 2\ \%\ \text{(related to } U_c\text{)}$$

Moreover, this limit value must not occur more frequently than one time within 3 minutes.

Possible countermeasures are e.g. the use of motors with a higher starting reactance, changes of the cycle frequency, use of soft-start devices, and reciprocal interlocking between several appliances or their graded start-ups, dynamic reactive compensation equipment or connection to network points with higher short-circuit power.

2.4.3 Flicker

Flicker describes a phenomenon which is characterized by voltage fluctuations whose frequency and amplitude are so large that electric lamps supplied by this voltage show fluctuations in the lighting density.

The maximum admissible flicker strengths caused by a customer facility in the medium-voltage network amount to

- $P_{lt\,i} = 0.5$ for the long-term flicker strength
- $P_{st\,i} = 0{,}8$ for the short-term flicker strength

2.4.4 Harmonics and inter-harmonics

Harmonics are mainly generated by operating equipment of power electronics (static con-

verters, power supply for electronic devices, lighting actuators) and discharge lamps. These appliances impress harmonics currents on the network which give rise to harmonic voltages at the upstream network impedances. These harmonic voltages exist at the connection points of all appliances operated on the network, and must not exceed specific certain values.

With a view to avoiding disturbing retroactive effects resulting from the aggregate impact of harmonics injections in public networks, the network operator shall determine upper limits (depending on the power intake of the customer facility) for harmonic currents injection which are based upon the values specified in the „Technical Rules for the Assessment of Network Disturbances" /55/.

For the most important converter-specific ordinal numbers ν, the following harmonic currents I_ν (related to the current I_A) which may be maximally injected by the entire customer facility into the network operator's medium-voltage network shall be applicable:

$$\frac{I_\nu}{I_A} \leq \frac{p_\nu}{1000} \cdot \sqrt{\frac{S_{kV}}{S_A}} \quad [1]$$

I_A *current of the entire customer facility ($I_A = S_A / (\sqrt{3} \cdot U_c)$)*
S_{kV} *short-circuit power at the junction point*
S_A *connection power of the customer facility*
$p\nu$ *factor or proportionality for selected harmonics*

ν	3	5	7	11	13	17	19	> 19
p_ν	6	15	10	5	4	2	1,5	1

Table: Factor of proportionality p_ν as a function of the harmonics ν

The harmonic currents injected into the network can be reduced e.g. through higher-pulse static converter switching, time-based interlocking of various harmonics generators against one another and/or through filters. Such measures, in particular the installation of filter circuits, must be agreed with the network operator.

Particular attention must be paid to direct and indirect converters, as they generate not only harmonics but also inter-harmonics. Should these frequencies coincide with the pilot frequency of the audio-frequency centralized ripple control applied by the network operator, the limit values given in Chapter 2.4.7 need to be taken into consideration.

[1] Particular situations, such as the consideration of resonances, should be subject to a specific investigation.

2.4.5 Voltage phase unbalances

Voltage phase unbalances are caused by single-phase loads or asymmetrical three-phase loads. Such asymmetrical loads are for instance induction furnaces, arc furnaces or welding machines.

Possible countermeasures are a symmetrical distribution of single-phase loads to the three outer conductors of the three-phase system and the installation of balancing equipment.

The customer facility must not exceed a resultant degree of unbalance of

$$k_{U,i} = 0.7\ \%$$

with averaging over 10 minutes.

2.4.6 Commutation notches

The relative depth of commutation notches d_{kom} through line-commutated converters must not exceed the value of

$$d_{kom} = 5\ \%$$

at the junction point in the most unfavourable operating condition ($d_{kom} = \Delta U_{kom} / \hat{U}_c$ with $\hat{U}_c$ = peak value of the agreed service voltage U_c).

2.4.7 Audio-frequency centralized ripple-control

If the network operator runs an audio-frequency centralized ripple-control installation, he may insist upon measures to be taken to avoid that audio-frequency centralized ripple control be inadmissibly impaired by operating equipment of the customer facility.

Inappropriately designed filter circuits may draw off an unreasonably high share of the audio frequency energy from centralized ripple-control installations. This has to be taken into consideration for the design and coordination of filter circuits /57/.

The operation of the customer facility may lead to a reduction of the audio-frequency level U_f in the medium-voltage network of maximally 2 % U_f. Furthermore, the customer facility must not inject more than 0.1 % U_c with the audio frequency applied, and not more than 0.3 % U_c at frequencies having a difference of $\pm$ 100 Hz from the audio frequency applied.

If the customer uses electrical equipment whose function may be adversely affected by centralzed ripple-control transmissions, the customer itself has to take care that the installation of appropriate technical means or the selection of appropriate devices enables an impairment to be avoided /57/.

The network operator has to be addressed for information about the centralized ripple-control frequency.

2.4.8 Carrier utilization of the customer's network

If the customer operates a facility with carrier utilization of its network, appropriate devices (such as carrier-frequency barrier) have to ensure that disturbing effects on other customers' facilities and on the network operator's installations are avoided.

The customer may use the network operator's network for carrier transmission of signals only with the approval of the network operator.

2.4.9 Precautions against voltage reductions and interruptions of supply

If customer facilities are sensitive to short-time voltage reductions or interruptions of supply, the customer shall take appropriate precautionary measures.

The utilization of facilities for equivalent current generation (emergency generating sets) is to be agreed with the network operator. Details in terms of connection and operation are given in the VDN Guidelines on „Notstromaggregate"(emergency generating sets) /56/.

3 Transfer station

3.1 Structures

3.1.1 General

For routing the service lines into the customer facility and, where required, for the installation of further equipment of the transfer station, the customer shall make appropriate areas and / or rooms on his premises available free of charge to the network operator within the scope of a real servitude at the latter's request. Should the installation of the necessary equipment affect the property of third parties, the customer shall provide written evidence of their approval prior to the installation.

The design of the transfer station's structures with due respect to possible enlargements shall be initiated by the customer upon the consent of the network operator.

The switchgear and transformer rooms have to be planned and installed as closed electrical plants according to DIN VDE 0101 /7/, and operated in accordance with DIN VDE 0105–100 /8/.

Factory-built stations have to be set up according to DIN EN 62271-202 (VDE 0671-202) /25/ (values according to IAC AB ..kA / 1s; casing category ..).

Transfer stations to be integrated into an existing building are to be constructed at ground level on outer walls. Furthermore, the building of the transfer station must be able to withstand the overpressure that is to be expected from an arc fault. The installer of the facility must provide pertinent evidence.

3.1.2 Details on the constructional design

The following specifications apply to all types of station construction, as long as they are applicable to the selected station type.

The components used shall be corrosion-resistant.

Entrances and doors

The doors are required to open outwardly and need to be equipped with a doorstop unless they are inside a building. Doors must be constructed in a way that they can only be opened with a key from the outside (e. g. fixed knob) while persons must be able to leave the plant without a key (anti-panic function).

The doors of the rooms of the medium-voltage plant and of the transformers have to be provided with warning signs D-W008 (warning against dangerous electrical voltage) with additional signs D-S002 (High voltage! Danger to life!) according to DIN 4844-2 /37/. The entrance to the low-voltage room is to be fitted with the warning sign D-W008.

The locking system of the access doors must be agreed with the network operator. All doors in the course of the station access shall be fitted with locks for two closing cylinders. The network operator shall make available a closing cylinder for each lock with its closing device. Should the installation of such locks not be possible, an equivalent solution must be agreed with the network operator.

Windows

For security reasons, the transfer station must have windowless rooms.

Climatic strain, ventilation and pressure relief

It is essential to provide sufficient exhaust and ventilation as well as the necessary pressure relief. The values given in DIN VDE 0101 /7/ in terms of climatic strain (indoor climate) have to be observed. Unless otherwise agreed, the following climate classes have to be adhered to:

The lowest ambient temperature is – 5 °C (class „minus 5 indoor").

Within a period of 24 hours, the mean value of the relative humidity shall not exceed 70 % (class „humidity 70 %").

The formation of condensation water is avoided through appropriate measures (e. g. heating and ventilation).

Ventilation of the transformer rooms is to be designed for the transformers' expected aggregate heat due to losses. The intake and exhaust air openings are to be led directly into the outside. All exhaust and ventilation equipment must ensure protection against infiltration of rainwater and foreign matter as well as security against poking according to a protection degree of at least IP 23-DH corresponding to DIN VDE 0470 Part 1 / EN 60529 /15/ and protection against insects.

Pressure relief openings are designed in such a way that an arcing fault in the switchgear does not give rise to pressure stress exceeding the structure's design. Protection to passers-by against accidental injury must be ensured.

Floors

If medium-voltage switching stations are put on intermediate floors, the supporting structure of the intermediate floors including the pillars has to be solidly linked with the structures.

The bases of the intermediate floors must correspond at least to the materials class B2 according to DIN 4102 (flame resistant building materials) /36/. They must remain in situ in the case of pressure stress attributable to arcing faults, and must not endanger the operator. The use of gratings is not allowed in medium-voltage switchgear rooms.

Noise protection measures and collecting basins

Noise emission from transformers (air-borne and structure-borne noise) are taken into consideration for project planning. Limit values according to the technical guidelines on noise control (TA Lärm) /72/ have to be observed.

For liquid-filled transformers, it is required to collect the insulating liquid leaking in the event of faults. The collecting basins are designed according to DIN VDE 0101 /7/ and in conformity with the Water Management Act /61/ and the related plant ordinances /70/ of the respective German Federal States.

Routing of the network connection cables

The area of cable routes must not be overbuilt and there must not be any deep-routed plants /65/. Cables must be accessible at any time for fault clearance.

For routing the network connection cable into the building, it is necessary to provide for a sufficient number of wall apertures on site according to the network operator's specifications. Where necessary, special constructions of the cable entries have to be used. Likewise, the design of cable channels, cable conduits, cable racks and cable basements which are to take in network connection cables, shall be agreed with the network operator, paying particular attention to the cables' bend radiuses. The shortest cable connection has to be realized from the entry to the medium-voltage switching station.

The customer cables and other lines have to be laid within the transfer station without any crossovers to network operator's network connection cables.

Pipes and lines not required for the operation of the transfer station must not be passed through this transfer station.

Lighting, socket outlets

Earthing-contact socket outlets with 230 V, 50 Hz and 16 A have to be mounted by the installer for the connection of non-stationary consumers.

In walk-in rooms of a transfer station, lights and socket-outlets must have separate circuits. The lights have to be fixed in a way so as to enable lamps to be exchanged without danger and to ensure sufficient light intensity.

Foundation grounding electrodes

In buildings where medium-voltage switchgear is to be installed, foundation grounding electrodes have to be provided with a connection lug to be led-through in the transfer station. For further specifications, cf. DIN 18014 /37/. Further details on the subject of protective grounding are given in Chapter 3.2.10.

3.1.3 Electric and electromagnetic fields

The customer is responsible for the observance of the German Federal Air Quality Control Act (Ordinance on electromagnetic fields – 26. BImSchV /71/) of its transfer station and downstream electrical installations. This ordinance /71/ specifies limit values for the electric field strength and the magnetic flux density of low-frequency plants with an operating voltage of more than 1 kV. Evidence is to be furnished by way of calculation or through measurement.

The installation of a facility or essential modifications to it have to be announced to the responsible authority prior to commissioning of the facility

3.2 Electric part

3.2.1 General

The network operator shall specify the parameters required for the transfer station's dimensioning at the network point of connection (e.g. rated voltage and rated short-time current). Furthermore, the network operator shall make the following data available to the connection owner upon request for the dimensioning of the connection owner's own protection equipment and for analyses of network disturbances:

- initial symmetrical short-circuit current from the network operator's network at the network point of connection
- fault clearing time of the main protection equipment from the network operator's network at the network point of connection.

Examples of basic circuit diagrams of transfer stations are given in Annex C.

3.2.2 Insulation

Transfer stations shall be insulated according to the higher values of Table 1 under DIN VDE 0101 /7/.

3.2.3 Short-circuit current capability

Electric installations must be designed, constructed and erected in such a way that they reliably withstand mechanical and thermal effects of a short-circuit current. The connection owner shall furnish proof of the short-circuit current capability for the entire transfer station.

If the short-circuit current in the medium-voltage network exceeds the rated value of the latter due to the operation of the customer facility, appropriate measures, such as limitation of the short-circuit current from the customer facility (e.g. by using I_S-limiters) shall be agreed between the network operator and the connection owner.

3.2.4 Protection against arcing faults

Switchgear must be installed in a way so as to protect individuals against the impact of arcing faults. To this end, it is essential that the requirements of DIN VDE 0101 /7/ and DIN EN 62271-200 /24/ with the IAC classifications and test values specified by the network operator be satisfied without restrictions.

Note: State of the art parameters are the classifications IAC A FL ..kA / 1s (commonly for wall mounting) and IAC A FRL ..kA / 1s (for free installation within the room).

3.2.5 Surge diverters

The use of surge diverters for the protection of the customer facility has to be agreed with the network operator.

3.2.6 Switchgear

3.2.6.1 Switching scheme and structure

The switching scheme and structure of the transfer station depend on the customer's power demand and operating requirements and on the network operator's network conditions at the network point of connection, and have to be agreed with the network operator.

If there is more than one outgoing feeder panel at the customer side, it is usually necessary to provide for a transfer switch. The type of transfer switch to be used is determined by the network operator (load disconnector or circuit breaker with secondary protection equipment).

Safe earthing and short-circuiting must be possible in every bay. Feeder bays have to be equipped with making capacity earthing switches; for outgoing feeder panels, it is recommended using earthing switches. Fixed earthing points have to be arranged in such a way that mounting of the earthing and short-circuiting device can be freely implemented by

means of an earth rod.

3.2.6.2 Implementation

For the construction of switchgear, the following requirements have to be satisfied in consultation with the network operator in terms of operation and personal safety:

- implementation of a phase comparison and verification of an off-voltage condition,
- capability of connecting devices for location of cable faults,
- locking mechanisms
- possibility of mounting short-circuit indicators,
- possibility of measuring the total fault current in the event of earth faults, if necessary by installing cable current transformers.

The switchgear operation and assembly aisles shall be dimensioned by taking escape routes according to DIN VDE 0101 /7/ into consideration. The escape route must not be hampered by open switch panel doors or by open remote control and battery cabinet doors.

Should special means (such as transporter wagons for drawing out the circuit breaker) be required for the control and operation of the switchgear, these means shall be made available by the customer (see also Chapter 3.3).

For panels within the network operator's area of disposition, it must be possible to take measures against unauthorized operation of switches and opening of doors.

In the case of **air-insulated switchgear**, the different panels are to be structurally separated by intermediate walls.

It must be possible to operate all switching devices with closed switching panel doors. The switch position must be reliably recognizable from the outside.

Panels shall be prepared in a way so as to enable insulating protecting plates to be put in guide rails, with panel doors closed, over the entire panel width between the open switch contacts of the isolating switches and load disconnectors. Distances from live parts and admissible shock protection levels must comply with the provisions applicable to the plant type of construction according to DIN EN 62271-200 /24/ or DIN VDE 0681 /34/, respectively.

Switchgear with removable switching devices is to be installed according to DIN EN 62271-200 /24/. Furthermore, the following conditions shall apply:

- Electric shock protection must be maintained even if switching devices are in an isolated

position.

- If the switching devices are in an opening / maintenance position, it is required that at least the IP2X protection degree be observed (e.g. by means of insulating protecting plates).
- Instrument transformers of the network operator must be installed within the stationary part of the switch bay.

For **gas-insulated switchgear,** it is necessary to comply with DIN EN 62271-200 /24/ and with the VDEW recommendation "Betriebliche Anforderungen an hermetisch metallgekapselte Lasttrennschalteranlagen" /52/ or "Betriebliche Anforderungen an gasisolierte metallgekapselte Leistungsschalteranlagen" /53/. The following basic criteria need to be met, among others:

- All operational inspections and measurements at the switchgear and on cables must be feasible without removing parts of the installation or cable connectors. Test adapters must be existent, where necessary.
- High-voltage HRC fuses must be totally enclosed so as to show under unfavourable environmental conditions (pollutions and high air humidity) operational characteristics in line with the remaining parts of the gas-insulated switchgear.
- It is not admissible to screw plates immediately to the hermetic enclosure of the switchgear.
- The effectiveness of the pressure discharge must not be affected by the switchgear mounting. Attention must be paid to the specifications of the switchgear manufacturer (e.g. distance from walls, ceilings, baffle plates).

The installation of short-circuit indicators, capacitive voltage indicator systems or systems for ground-fault recording required in switchgear shall be agreed with the network operator. Voltage test systems complying with DIN EN 61243-5 /21/ are to be installed.

3.2.6.3 Identification and labelling

Conductors in the customer's medium-voltage switchgear have to be labelled in the same way as in the network operator's plant components. As for the rest, DIN EN 60446 /14/ is to be observed. All switch bays and metering panels as well as transformer rooms shall be labelled in an easily readable, clear-cut and durable manner. This applies as well to possibly existing cable galleries or cable basements. Panel inscriptions must be clearly recognizable both with the panel door open and closed.

The designations of feeder bays are determined by the network operator. Designations of outgoing feeders of overhead lines have also to be posted underneath the line on the station's outside.

The property boundary and the disposition area boundary between the customer facility and the network operator's installation are to be marked on the basic circuit diagram placed in the transfer station. The switch position and the moving direction of the switching devices' hand-operated mechanisms must be clearly recognizable and homogenous. Operation symbols shall be represented according to DIN 43455 /42/.

Earthing switches as well as their drive mechanism opening and operating levers shall be marked in red.

3.2.7 Operating equipment

3.2.7.1 Switching devices

Switching devices in the feed-in cubicles and, where necessary, in the coupling cubicle need to be operable on the spot. An agreement with the network operator on a possible remote control of these cubicles must be brought about in due time.

If switch disconnectors with HV HRC fuses are used in the follow-up outgoing switch cubicles, fuses have to be grouped behind the switch disconnectors from the network side. Switch disconnectors must be designed as multi-purpose load switches as defined by DIN EN 60265-1 /13/. A three-pole trip-free release has to be installed so as to cause opening of the switch disconnector on all poles through activation of the striker pin upon response of a fuse. The opening operation energy storing device must be compulsorily loaded during switch-on. Operation levers for switch disconnectors and earthing switches shall be designed in a non-interchangeable manner.

If a switch-disconnector-safety-fuse combination is used, the requirements of DIN EN 62271-105 /23/ have to be met.

Earthing switches must have sufficient short-circuit making capacity.

For dimensioning switching equipment, short-circuit currents both from the network operator's network and from generating plants need to be taken into consideration. In high-capacity customer facilities (approximately 1 MVA of installed capacity per transformer; to be specified by the network operator), a circuit breaker or a switch disconnector is required for the transfer.

For power-operated circuit breakers, it must be possible to identify the state of the energy storing device from outside. Circuit breakers, particularly in incoming feeder cubicles, must be capable of switching an automatic re-closing cycle if required by the network operator.

3.2.7.2 Locking mechanisms

Interlocking of switching devices shall be designed in accordance with VDE standards (series of standards VDE 0670/0671) and according to the requirements of the network operator. Plant-specific locking devices have to be adequately taken into consideration. The locking mechanism must be operative both in the case of remote control of the plant and for local operation.

As a matter of principle, control of the switching devices of the medium-voltage transfer station must be designed in such a way that operation of the switching devices according to DIN VDE 0105 /8/ is ensured (particularly protection against arcing faults).

3.2.7.3 Transformers

Transformers must comply with DIN VDE 0532 /30/ and need to be selected in accordance with the following DIN standards:

- Oil-filled distribution transformers DIN EN 50464-1 /40/
- Dry-type transformers DIN 42523-1 /41/

Transformers shall be selected by taking account of their specific place of installation (e.g. meeting places, hospitals, water protection areas). Relevant specifications (such as DIN VDE 0100-718 /6/) need to be taken into consideration for this purpose. The Ordinance on hazardous substances /66/, the ordinance concerning installations for handling of substances hazardous to waters and specialist firms (VAwS) /70/, the chemicals prohibition ordinance /67/, the noise-control guidelines /72/ and regional construction rules have to be taken into consideration.

Inquiries about the agreed service voltage and transformation ratios have to be directed to the network operator. For the sake of better adaptation to the existing operating voltage, it is advisable to use transformers with taps that can be changed from outside.

In medium-voltage networks for which a changeover of the service voltage is provided, transformers shall be used which can be switched over from the previous to the new voltage.

3.2.8 Neutral point treatment

Measures resulting from neutral point treatment shall be agreed with the network operator (e.g. protection equipment).

3.2.9 Secondary technical equipment

The secondary technical equipment is installed within closed rooms which satisfy at least the requirements of DIN VDE 0101 /7/.

The place for network operator's equipment required for the connection of the customer facility (e.g. secondary technical equipment) is made available by the connection owner.

3.2.9.1 Remote control

For secure network operation, it is necessary to include the customer facility into the network operator's remote control scheme on request of the network operator, such as for example the control of the circuit breaker, in particular opening of the circuit breaker in case of critical network conditions (remote switch-off). On the basis of the network operator's remote control scheme, the necessary data and information (for processing in the network operator's control and communication system) required for system operation management shall be made available by the connection owner.

Customer facilities with remote control are equipped with remote / local change-over switches preventing remote control signals in the case of local control.

3.2.9.2 Auxiliary energy supply

The customer facility must be equipped with auxiliary energy supply. Should the function of protection equipment or tripping of switching devices require an auxiliary voltage source, auxiliary energy supply that is independent of the network voltage must be additionally available (e. g. battery, condenser, current transducer). Where applicable, remote control must also be equipped with a network-independent auxiliary energy source.

If auxiliary energy supply is required over a longer period of time, its capacity must be dimensioned so as to enable the customer facility in the event of a loss of network voltage to be operated for at least eight hours with all protection, secondary and auxiliary equipment. Direct-voltage circuits are to be operated in a free-of-ground manner, and subjected to earth-fault monitoring. Auxiliary service and auxiliary energy for secondary technical facilities of the network operator shall be made available by the connection owner.

The functional efficiency of auxiliary energy supply is to be permanently ensured by means of appropriate measures; furthermore, it is to be verified at regular intervals and documented through inspection records.

3.2.9.3 Protection equipment

With a view to avoiding that faults occurring in the customer facility give rise to disturbances in the network operator's network, protection equipment shall be installed in the

transfer station which automatically disconnect the faulty network or the entire transfer station. The protection equipment must be selected and adjusted in a way so as to function selectively with the remaining disconnection facilities in the network operator's network.

The plant operator is responsible himself for the reliable protection of his plants (own protection, e.g. short-circuit, earth-fault, overload protection and protection from electric shock, etc.). To this end, the plant operator must install an adequate amount of protection equipment.

Protection equipment connected to transformers at the voltage level of the network connection must comply with DIN EN 60255 (DIN VDE 0435) /49/ and with the technical guidelines for digital protection systems /59/.

The network operator shall determine whether and which protection equipment is to be sealed or otherwise protected against alterations.

HV HRC fuses

The rated current of HV HRC fuses has to be selected according to DIN VDE 0670 part 402 /31/ and DIN EN 62271-105 /23/. In consideration of the selectivity with regard to the upstream protection equipment, the network operator shall indicate maximum permissible rated currents or characteristic areas. In consideration of the selectivity of the upstream protection, the network operator shall indicate the maximally admissible rated currents or characteristic areas. It must be possible to replace fuses easily and safely.

Incoming feeder and coupling cubicles

If protection equipment is required for incoming feeder or coupling cubicles, it is necessary to install current transformers or, where applicable, voltage transformers as specified by the network operator.

It is for the network operator to specify the type of protection (e.g. distance or definite time-delay over-current protection, where necessary with automatic re-closing; fed by transformer current or auxiliary energy), and the necessary range of functions as well as the setting of facilities for protection, earth fault or earth fault direction measurement and detection of feeder and coupling cubicles. The downstream plant constellation has to be taken into consideration (e.g. blocking lines).

Essential changes to the protection equipment of feeder and coupling cubicles shall be agreed in due time between the network operator and the customer.

Outgoing feeder cubicles

Instantanesously operating short-circuit protection is usually required for all outgoing feeder cubicles (three-phase tripping). Selective short-circuit protection is to be provided for outgoing feeder cubicles to the customer's downstream electric facilities.

Required space

The space required for protection and auxiliary equipment has to be adequately taken into account by the customer. Auxiliary equipment includes battery installations, remote control devices, and the like. The place of mounting must be free from vibration and protected against contamination as well as against weather and temperatures influences (temperature changes leading to condensation) and against mechanical damage.

Test terminal

For the implementation of functional tests on protection equipment, a terminal block with sectionalizer and test sockets has to be provided as interface and mounted at an easily accessible place.

The type and structure of the test terminal need to be agreed with the network operator. Instead of the test terminal, the network operator can also require that a test socket be used.

Parallel connection of transformers

Where several transformers are connected in parallel, tripping of the medium-voltage switch must give rise to opening of the associated low-voltage circuit breaker by means of inter-tripping. Also with opened medium-voltage switch, it must be ensured that the low-voltage circuit breaker cannot be closed even for a short time (tip-safe).

Inspection of protection systems

The functional efficiency of protection systems has to be tested by the plant operator prior to commissioning. The results of the inspection are to be documented and submitted to the network operator at the latter's request. A transfer protection inspection record is represented in Annex D.7. Cyclical inspections on protection systems are to be carried out according to the technical guidelines for digital protection systems /59/. The results shall be documented and presented to the network operator upon request.

3.2.10 Earthing system

Earth-fault currents to be used as a basis for the electrical rating of earthing systems in medium-voltage networks have to be requested from the network operator.

The values of the earthing impedance of high-voltage protective earthing are specified by the network operator.

The installer of the station earthing system shall demonstrate the electrical efficiency of the earthing system by measurement prior to the connection to the network operator's earthing system (see Annex D.5 Earthing records).

If inadmissible contact voltages cannot be excluded in installations with rated voltages of up

to 1 kV, replacement measures as defined by DIN VDE 101 /7/ have to be applied (e.g. potential grading, disconnection of earthing systems).

Requirements for the connection of plants with rated voltages of up to 1 kV to joint or separate earthing systems are given in DIN VDE 0101 /7/ and DIN VDE 0141 /27/ and in DIN VDE 0100-442 /2/. Touchable metal parts of electrical equipment (frames) not belonging to the operating circuit, which are part of the electric network need to be earthed. Metal parts which do not belong to electrical equipment need to be earthed if dangerous voltages can occur on the latter in the case of fault, e.g. attributable to arcing faults. Such metal parts are for instance

- metal ladders, door frames, ventilating grating,
- metal flanges of bushings,
- metal switch structures and safety grids.

All earth electrodes have to be connected in a detachable manner to the earth bus within the station. The different connections need to be labelled.

Fixed earthing points must be rated according to maximum short-circuit currents occurring in the distribution network, and must not be used as screwed joint.

It must be possible to earth transformers on the high-voltage and low-voltage side.

The earthing sets used shall comply with DIN EN 61230 /22/.

It must be possible to isolate artificial earth electrodes (e.g. surface electrodes or depth earth electrodes) from the facility to be earthed for measuring and testing purposes. Close to the isolating point, the earthing conductor leading to the earth electrode is to be designed in such a way that it can be grasped by an earth clamp without any problems. The feed line to the earth electrode (earthing conductor) must not be exposed to a further contact with earthed parts (except at the earth circuit connector).

3.3 Signs and accessories

3.3.1 Signs

- Safety signs and prohibition signs according to DIN 4844 /38/
  - „Do not switch / work in progress"
  - „Earthed and short-circuited"
  - Where necessary: „Caution! Feed-back voltage"

- Bulletin-board notices
  - If required: Leaflets of the social insurance against occupational accidents (e.g. information on first aid in the event of accidents caused by electricity and on fire prevention)
  - Mandatory sign „5 security rules"
  - Basic circuit diagram of the medium-voltage plant with indication of the operating and rated voltage and of the property boundaries / borderlines of the area at disposal

3.3.2 Accessories

- operating levers for switching devices
- switch stick according to DIN VDE 0681 part 2 /34/
- earthing and short-circuiting device with earth rod according to DIN EN 61230 /22/; number and cross-section as specified by the network operator
- insulating protecting plates according to DIN VDE 0681 part 8 /34/ in a sufficient quantity
- circuit-breaker truck for the use of draw-out circuit breakers
- key to cubicle door
- wall holders for the aforementioned accessories
- technical documentation of the equipment installed

Depending on the size and design of the transfer station, the accessories mentioned above may be multiply required or foregone, or additional accessories may be needed.

4 Measuring for accounting purposes

4.1 General

The installation, operation and maintenance of measuring devices shall be carried out according to the „MeteringCode" /58/ and in line with the connection requirements defined by the network operators.

The installation and operation of measuring devices shall be agreed in due time between the connection owner and the network operator or meter operator. According to the Metrology and Verification Act, only certified and verified meters and transformers shall be used in business transactions. Locks with lead seals are fixed or removed exclusively by authorized representatives of the network or meter operator. They must not be opened by third parties.

The minimum requirements to be satisfied by measuring devices are specified by the network operator concerned. Usually, the following accuracy classes shall be provided in accordance with the „MeteringCode" /58/:

- meters: class 1 (active energy) or 2 (reactive energy)
- transformers: class 0.5 (voltage transformers) and 0.5S (current transformers).

Load-profile meters shall be used for the continuous registration of metered values for contractually agreed energy directions at ¼-hour intervals. The following customer facilities where also energy meters may be used are exempted from this rule:

- Generating plants as defined by the Renewable Energy Sources Act (German abbreviation: EEG) for which the use of load-profile meters is obligatory only for plant capacities from 500 kW;
- all other customer facilities with an energy consumption (extraction from the network) or an energy quantity supplied to the network on the basis of the Co-generation Act (German abbreviation: KWK-G) of up to 100,000 kWh annually.

The connection owner shall provide a meter cabinet according to DIN 43870 /44/ for the installation of the measuring, control and communication equipment. For measuring devices in walk-in stations, a mounting height of 1.10 – 1.80 m from the floor shall be observed. The place of installation must be vibration-proof and protected against contaminants and weather and temperature effects as well as against mechanical damage. It has to be determined in consultation with the network operator and entered in the planning documents.

4.2 Transformers

From the perspective of the network operator's network, the measuring voltage transformers have to be connected ahead of the measuring current transformers. Transformers need to be clearly arranged and their secondary lines must be easily accessible. The instrument transformers' secondary lines shall run in an uncut (i.e. uninterrupted) manner from their terminals or fuses to the meter's place of installation. The secondary lines shall be selected on the basis of DIN VDE 0100-557 /4/. Unsecured voltage-transformer lines have to be laid according to DIN VDE 0100-520 /3/.

Attention has to be paid to the fact that measuring devices have a clockwise phase sequence. Line lengths, cross-sections and labelling of measuring transformer secondary lines shall be agreed with the network operator. The following data may be used as reference values:

Single length of the measuring transformer secondary line **[m]**	**Conductor cross-section (Cu) [mm²]**		
	Current transformer 1 A	**Current transformer 5 A**	**Voltage transformer 100 V**
up to 25	2.5	4.0	2.5
25 to 40	4.0	6.0	4.0
40 to 65	6.0	10.0	6.0
65 to 120		16.0	6.0
120 to 200		25.0	10.0

The different conductors need to be laid and labelled according to the network operator's specifications. Secondary lines of current and voltage transformers are routed in separate sheathings.

It is not allowed to connect operating devices at the current transformers' meter core; their connection to the voltage transformers' meter winding is permissible only after approval of the network operator. The transformers' wiring is specified by the network operator.

4.3 Voltage level of measurement

The network operator determines whether measurements on the customer facility connected to the medium-voltage network are carried out on the medium-voltage or low-voltage side.

If measurements are carried out on the low-voltage side, the measuring voltage shall be measured off (tapped) in the energy direction ahead of the current transformers.

4.4 Comparative measurements

Each contracting party is entitled to operate its own measuring device for comparative measurements according to the „MeteringCode" /58/. The structure and design are to be agreed between the contracting parties.

4.5 Data tele-transmission

According to the „MeteringCode" /58/, tele-metering is required for the query of metered values on a day-to-day basis from measuring devices with load-profile meters. Under Section 19, paragraph 1, clause 1 of the Ordinance on electricity network access (German abbreviation: StromNZV /73/, the meter operator has to make sure that correct electricity metering and data transmission be guaranteed.

Data recorded by the network operator shall be treated confidentially and made available only to authorized persons.

5 Operation

5.1 General

The operation of electric facilities comprises all technical and organizational activities required to ensure the functional efficiency and security of plants. These activities include all operating measures as well as electrical and non-electrical operations as described in the applicable rules and regulations, particularly in DIN VDE 0105-100 /8/. For the operation of the transfer station, the network operator's provisions and guidelines shall be observed in addition to applicable legal and official regulations, in particular with regard to switching operations and work on the network point of connection.

Responsibility for the operation of the transfer station rests with the plant operator.

The plant operator shall name a person to the network operator responsible for the proper operation of the transfer station. This person must be a qualified electrical specialist having switching authority, and shall be available any time to the network operator. Relevant information shall be deposited with the network operator and mutually updated immediately in the case of changes. If the plant operator has the necessary qualifications, he may himself carry out the function of the person responsible for the operation of the transfer station.

The property boundary and the boundaries of the area at disposal have to be agreed between the network operator and the plant operator.

If work is carried out on the transfer station which is within the network operator's area of disposal, the plant operator shall nominate to the network operator a plant-responsible person that, according to DIN VDE 0105-100 /8/ is responsible for the plant components at the working premises.

In the case of contingency, disturbances or risk to network security, the network operator is entitled to immediately disconnect the customer facility from the network or to reduce active power supply.

Should the network operator identify serious faults in terms of personal and plant safety within the transfer station, he is entitled to disconnect these plant components from the network until these faults have been remedied.

The plant operator is required to disconnect the switching bays of the transfer station located in his area of disposal on demand of the network operator. Scheduled disconnections of network equipment and changes of the switching status due to maintenance may require a temporary disconnection of the customer facility from the network and a reduction of its output. The implementation of this work shall be announced by an adequate advance notice.

The plant operator shall agree with the network operator in due time proposed changes carried out in the transfer station to the extent that they have an impact on the network connection and the transfer station's operation, such as increase or reduction of power demand, replacement of protection equipment, utilization of generating plants, modifications to the compensation equipment.

Different points of connection on the network of the network operator(s) must not be operated in an interconnected manner through customer facilities.

5.2 Access

The transfer station must always be kept locked. Access to the station shall only be granted to qualified electrical personnel and persons trained in electrical terms, or to other persons if they are accompanied by qualified electrical personnel or by electrically trained persons (cf. DIN VDE 0105-100 /8/).

The network operator and the persons acting on his behalf shall be granted safe access at any time (even outside normal working hours) to his facilities and to the plant components within the area at his disposal within the transfer station (e.g. by means of a double closing device; see also Chapter 3.1.2). Where applicable, the same applies to separate rooms for measuring, protection and control equipment. Access to the station must be possible at any time to the network operator's vehicles. A direct access road and a paved transport route have to be provided to this end.

If there are any modifications in terms of the access to the transfer station, e.g. changes to the locking system, the network operator shall be immediately informed and unimpeded access has to be guaranteed.

The network operator may grant access to his facilities to the plant operator and qualified personnel of the latter.

5.3 Area of disposal / Operation

Instructions for switching operations shall be given by the network operator for plant components within the area exclusively at his disposal. Where switching devices are within the area at the common disposal of the network operator and the plant operator, the latter or the persons acting on their behalf shall agree on the switching operations to be carried out within these switching bays, and determine on a case-by-case basis who is to give the switching instruction. Switching operations for the remaining plant components are ordered by the plant operator or by the persons acting on his behalf.

Operator control actions shall only be carried out by order of the person with authority over

the area at disposal (network operator and/or plant operator). Operator control actions may only be implemented by qualified electrical personnel or persons trained in electrical terms.

5.4 Maintenance

Responsibility for the proper maintenance of plants and equipment rests with the respective owner. This applies as well to plant components within the area at the network operator's disposal.

According to the accident prevention provisions in force and VDE Guidelines, the plant operator has to take care that inspections of the proper condition of electrical installations and operating equipment are carried out at regular intervals. The results of the inspections shall be documented and submitted to the network operator on demand. This requirement is satisfied under normal operating and environmental conditions if the inspection deadlines mentioned in BGV A3, Table 1 /75/ are observed.

Disconnections carried out within the area at the disposal of the network operator shall be agreed in due time between the plant operator and the network operator.

5.5 Operation in the event of disturbances

Even in the event of a forced zero voltage condition at the network connection point, modifications to the switching status shall be implemented only in accordance with the disposal area boundaries between the network operator and the plant operator.

Irrespective of the disposal area boundaries, the network operator may immediately disconnect the customer facility from the network in the event of disturbances in the medium-voltage network. If possible, the network operator shall inform the plant operator in due time about this measure. Reconnection is implemented in accordance with the disposal area boundaries.

Due to the possibility of voltage recovery at any time after an interruption of supply, the network is to be considered as permanently energized. The plant operator is usually not informed by the network operator prior to the reconnection.

Fault clearance may require extraordinary investigations and measurements which the network operator and the plant operator shall carry out on their operating equipment.

For fault clearance and remedy, the network operator and the plant operator shall provide mutual support. All information required for fault clearance are to be exchanged between the network operator and the plant operator.

The plant operator shall immediately inform the network operator about any disturbances or

irregularities in the transfer station that may have an impact on the network operator's network. In this case, a reconnection must be carried out only after appropriate clarification of the fault reason and on consultation with the network operator.

5.6 Reactive power compensation

The displacement factor cos φ of the customer facility must be between 0.9 inductive and 0.9 capacitive. The network operator may determine closer limits for its network.

The equipment to be installed for reactive power compensation shall either be controlled as a function of cos φ or switched on and off together with the assigned consumption devices.

Load-independent fixed compensation is not admissible.

Possibly required choking of the compensation installation shall be agreed between the customer and the network operator.

6 Modifications, decommissioning and disassembly

If any modifications, decommissioning or disassembly of the transfer station are envisaged by the customer, the network operator shall be timely informed in writing of this intention. The same applies to a modification planned in terms of the operating regime of his plant which has an impact on the network operator's network.

If an increase of the network short-circuit capacity or a change of the network voltage give rise to serious effects on the customer facility, the network operator shall inform the customer in due time. The connection owner shall defray the cost of follow-up measures carried out on its network connection.

With a view to maintaining the reliability of operation of the customer facility, an adjustment to the state of the art or to modified network conditions, e.g. higher short-circuit capacity, must be carried out by the customer.

Disassembly and disposal of transfer stations or of its components must only be entrusted to authorized firms which guarantee correct implementation of this work and the required disposal of possible residual materials. Relevant laws and regulations in force shall be observed.

7 Generating plants

Concerning generating plants to be connected to and operated in the medium-voltage network, planners, installers, connection owners and plant operators shall agree with the network operator on the technical design of the connection and operation according to the Guidelines on „Generating plants connected to the medium-voltage network " /54/ and the network-operator-specific connection requirements for generating plants.

Annexe

A Glossary

Area of disposal	Area which defines the responsibility for giving switching operation instructions. *Note: Some network operators designate this area as switching order area.*
Attendance	Attendance of electrical equipment comprises observation and positioning (switching, setting, controlling).
Commissioning	First energizing of the customer facility.
Connection owner	Any natural or legal person whose electrical installation is immediately connected through a supply connection to the network of the network operator. The connection owner has a legal relationship with the network operator.
Connection user	The connection user is a natural or legal person utilizing a facility connected to the network operator's network.
Current, Rated current I_r	Current of a device or installation for which the device or the installation has been designed for permanent operation by the manufacturer or on the basis of a standard.
Current Short-circuit current I''_k	Initial symmetrical short-circuit current according to /17/.
Customer facility	A customer facility comprises all electrical equipment behind the transfer point, except for the measuring device, and serves the supply of the connection user.
Displacement factor cos φ	In the present guidelines, the displacement factor cos φ is the cosine of the phase angle between the fundamental oscillations of a voltage to neutral and a current.
Earthing, Control earth electrode	Earth electrode which due to its form and assembly is rather used for potential grading than for attaining a certain earth-electrode resistance. (DIN VDE 0101 Chapter 2.7.9.5 /7/)
Earthing, Depth earth electrode	Earth electrode which is normally laid or driven in greater depths. It may consist e.g. of a tube, rod or other shaped material. (DIN VDE 0101 Chapter 2.7.9.2 /7/)
Earthing, Foundation earth electrode	Part of a building with conducting features embedded in concrete which is in a conductive contact with the earth over a wide area. (DIN VDE 0101 Chapter 2.7.9.4 /7/)
Earthing, Protection earthing	Earthing of a conductive component which does not belong to the live parts in order to protect individuals against dangerous fault currents. (DIN VDE 0101 Chapter 2.7.11.1 /7/)

Earthing, Surface electrode	Earth electrode laid in low depth, generally to about 1 m. It may consist of tape, round material or rope and can be designed as crow-foot, ring-shaped or grid-type earth electrode or as a combination of these types. (DIN VDE 0101 Chapter 2.7.9.1 /7/)
Earthing switch	An earthing switch is a mechanical switching device for earthing of parts of a circuit withstanding for a certain time electric currents under abnormal conditions, such as in the event of a short circuit; in normal operation, an earthing switch must not carry electric current.
Earthing, System earth electrode	Earthing of a point of the working circuit required for the proper operation of devices or installations. (DIN VDE 0101 Kapitel 2.7.11.2 /7/)
Fault clearance time	Period from the beginning of a fault to its elimination.
Flicker	Voltage fluctuations producing the subjective impression of fluctuations in the lighting density (of lighted objects) via the chain of electric lamp – eye – brain.
Generating plant	Plant comprising one or several electricity generating units and all electrical installations required for operation of the plant.
Harmonics	Sine-shaped oscillations whose frequency is an integral multiple of the fundamental frequency (50 Hz).
Initial start-up	Initial start-up is the initial energizing of an electrical installation up to the transfer point or to a component of an electrical installation for the purpose of instantaneous or subsequent surrender to the operator of the installation.
Inter-harmonics	Sine-shaped oscillations whose frequency is no integral multiple of the fundamental frequency (50 Hz). Inter-harmonics may also occur in the frequency range between 0 Hz and 50 Hz.
Interruption of supply	A condition in which the voltage at the transfer point is lower than 1 % of the agreed service voltage U_c.
Junction point	The point in the public network closest to the customer facility to which further customer facilities are connected or can be connected. It is normally identical with the network connection point. The junction point is used as a basis for the assessment of network disturbances.
Measuring device	Measuring devices comprise meters, additional equipment, instrument transformers, communication systems and control devices.
Metered value	A metered value is a value (such as meter indication, energy quantity or load profile) determined by means of a calibrated measuring device. Metered values can be available as primary or secondary values. Metered values are always transmitted with additional data.
Medium-voltage network	Within the meaning of these guidelines, a medium-voltage network is a network with a rated voltage of from > 1 kV to < 60 kV.

Meter	A meter is a measuring instrument which is used alone or in conjunction with other measuring devices for the determination and indication of one or several metered values. Meters used for energy accounting must comply with legal requirements.
Meter operation, Meter operator	Meter operation, i.e. installation, operation and maintenance of all components of measuring devices, describes the field of activity of the meter operator.
Meter point	The meter point comprises all measuring devices working together including the necessary connections and data links.
Network connection point	Network point at which the customer facility is connected to the network operator's network. The network connection point is mainly important in the context of network planning. It is not necessary in any case to make a distinction between the network connection point and the junction point.
Network disturbances	Network disturbances are repercussions in distribution networks caused by consumption devices with or without electronic control units, and which may possibly lead to disturbances to the supply of other electricity customers. Such disturbances may occur in the form of harmonics or voltage fluctuations.
Network operator	Operator of a network of public electricity supply.
Notification of initial start-up	Information of the plant installer to the network operator about the implemented installation of the transfer station according to official regulations or decrees in force and in consideration of the acknowledged rules of technology, particularly in conformity with currently valid DIN-, DIN-VDE-standards, the accident-prevention rule BGV A3 and the technical connection requirements of the responsible network operator. The results of the necessary inspections have to be documented.
Operating current	The operating current (of a circuit) is the current to be conducted by the circuit under normal operating conditions. The operating current (of a circuit) is usually indicated as I_b (DIN VDE 0100-200).
Operation	Operation comprises all technical and organizational activities required to enable the electric facility to function. This includes switching, controlling, monitoring and maintenance as well as electrotechnical and non-electrotechnical work.
Operation responsible person	A qualified electrical specialist with switching authority named by the plant operator to the network operator as the person responsible for proper operation of the transfer station. *Note: The plant operator himself may assume the function of operation responsible person on condition that he has the necessary qualifications.*

Plant installer	The installer of an electric facility within the meaning of these Technical Connection Conditions is both the one who erects, extends, modifies or maintains an electric facility, and the one who, though not having erected, extended modified or maintained the plant, inspects the work carried out as an expert and assumes responsibility for its proper implementation.
Plant operator	Within the meaning of these guidelines, the entrepreneur or a natural or legal person acting on his behalf that undertakes the entrepreneurial obligation to ensure the secure operation and proper condition of the customer facility.
Plant responsible person	A person charged to assume during the implementation of work the direct responsibility for the operation of the electric facility or of components belonging to the working premises.
Power, Apparent power S	Product of the rms values of the operating voltage, current and the factor $\sqrt{3}$.
Power demand	Power demand is the maximum electric power simultaneously required within a customer facility. Power demand is the product of installed capacity (sum of connected loads) and coincidence factor.
Power factor λ	The ratio of the magnitude of the active power P to the apparent power S: $\lambda = \frac{\lvert P \rvert}{S}$ Like P and S, λ relates to the rms values of the total alternating quantity, i.e. to the sum of their fundamental oscillations and all harmonics.
Power, Reactive power Q	Usually, the reactive power Q is the product of the apparent power and sine of the phase displacement angle φ between the fundamental oscillations of the voltage to neutral U and the current I.
Protection equipment	Equipment comprising one or several protection relays and, where necessary, logic devices to carry out one or several predetermined protection functions. *Note: Protection equipment is part of a protection system.*
Short-circuit current I''k	Initial symmetrical short-circuit current according to DIN EN 60909-0 (VDE 0102) /17/.
Short-circuit power S''_k	Initial symmetrical short-circuit power decisive for the calculation of the short-circuit strength according to /17/. $S''_k = \sqrt{3} * U_n * I''_k$
Transfer point	Network point which represents the boundary between the network operator's area of responsibility and that of the operator of the connection facility. The transfer point is mainly of importance in the context of operation management. It is not in any case identical with the property boundary.

Transformers, Instrument transformers, current and voltage transformers, transformer factor	Measuring transformers are additionally used in the case of higher currents and voltages. Only voltage transformers are used in the low-voltage network, whereas both current and voltage transformers are used in the medium and high-voltage networks. Current and voltage transformers have the function to map the primary values „current" and „voltage" according to their magnitude and angle onto the secondary values. The ratio between *primary* and secondary values is expressed by the transformer factor.
Voltage, Agreed service voltage U_c	Normally, the agreed service voltage is equal to the rated network voltage U_n. If the network operator and the customer agree on a voltage at the transfer point which is at variance with the rated voltage, this voltage is the agreed service voltage U_c.
Voltage change ΔU_{max}	Slow voltage change: A voltage increase or decrease usually attributable to changes of the overall load on the network or a network part. Rapid voltage change: A single rapid change of the rms value of a voltage between two successive voltage values of certain but not specified durations. When indicating a relative voltage change, the voltage change of the line-to-line voltage is related to the ➔ voltage, operating voltage of the network: $\Delta u = \frac{\Delta U_{max}}{U_b}$ Instead of the operating voltage, the agreed service voltage U_c is used as a basis for the connection inspection.
Voltage, Nominal voltage U_n	Voltage by which a network or an installation is defined or identified.
Voltage, Operating voltage U_b	Voltages occurring during normal operation at a certain time and at a certain point of the network. In the present guidelines, this is the rms value (10-minute mean value) of the line-to-line voltage.
Voltage, Rated voltage U_r	Voltage of a device or installation for which the device or installation has been designed for permanent operation on the basis of a given standard or by the manufacturer.

B References

The most important technical and administrative provisions and rules which have to be taken into consideration for planning, installation, operation and de-commissioning of transfer stations are listed hereinafter. Separate agreements need to be concluded, where necessary, between the planner or the plant operator and the network operator for the clarification of rarely occurring specific problems.

DIN VDE Provisions and standards with VDE Classification

/1/	DIN VDE 0100	Bestimmungen für das Errichten von Starkstromanlagen mit Nennspannungen bis 1000 V
/2/	DIN VDE 0100-442	Elektrische Anlagen von Gebäuden Schutzmaßnahmen - Schutz bei Überspannungen - Schutz von Niederspannungsanlagen bei Erdschlüssen in Netzen mit höherer Spannung
/3/	DIN VDE 0100-520	Errichten von Niederspannungsanlagen Teil 5: Auswahl und Errichtung von elektrischen Betriebsmitteln - Kapitel 52: Kabel- und Leitungsanlagen
/4/	DIN VDE 0100-557	Errichten von Niederspannungsanlagen Teil 5: Auswahl und Errichtung elektrischer Betriebsmittel - Kapitel 557: Hilfsstromkreise
/5/	DIN VDE 0100-710	Errichten von Niederspannungsanlagen – Anforderungen für Betriebsstätten, Räume und Anlagen besonderer Art Teil 710: Medizinisch genutzte Bereiche
/6/	DIN VDE 0100-718	Errichten von Niederspannungsanlagen – Anforderungen für Betriebsstätten, Räume und Anlagen besonderer Art Teil 718: Bauliche Anlagen für Menschenansammlungen
/7/	DIN VDE 0101	Starkstromanlagen mit Nennwechselspannungen über 1 kV
/8/	DIN VDE 0105-100	Betrieb von elektrischen Anlagen Teil 100: Allgemeine Festlegungen
/9/	DIN EN 50065 VDE 0808	Signalübertragung auf elektrischen Niederspannungsnetzen Frequenzbereich 3 kHz bis 148,5 kHz
/10/	DIN EN 50160	Merkmale der Spannung in öffentlichen Elektrizitätsversorgungsnetzen
/11/	DIN EN 60044 VDE 0414-44-1	Messwandler
/12/	DIN EN 60071 VDE 0111	Isolationskoordination
/13/	DIN EN 60265-1 VDE 0670 Teil 301	Hochspannungs-Lastschalter, Teil 1 Hochspannungslastschalter für Bemessungsspannungen über 1 kV und unter 52 kV
/14/	DIN EN 60446 VDE 0198	Grund- und Sicherheitsregeln für die Mensch-Maschine-Schnittstelle; Kennzeichnung von Leitern durch Farben und numerische Zeichen
/15/	DIN EN 60529 VDE 0470 Teil 1	Schutzarten durch Gehäuse (IP-Code)

/16/	DIN EN 60865-1 VDE 0103	Kurzschlussströme – Berechnung der Wirkung Teil 1: Begriffe und Berechnungsverfahren
/17/	DIN EN 60909-0 VDE 0102	Kurzschlussströme in Drehstromnetzen
/18/	DIN EN 61000-3-2 VDE 0838 Teil 2	Elektromagnetische Verträglichkeit (EMV) Teil 3-2: Grenzwerte – Grenzwerte für Oberschwingungsströme (Geräte-Eingangsstrom ≤ 16 A je Leiter)
/19/	DIN EN 61000-3-3 (VDE 0838 Teil 3)	Elektromagnetische Verträglichkeit (EMV) Teil 3-3: Grenzwerte – Begrenzung von Spannungsänderungen, Spannungsschwankungen und Flicker in öffentlichen Niederspannungs-Versorgungsnetzen für Geräte mit einem Bemessungsstrom ≤ 16 A je Leiter, die keiner Sonder-anschlussbedingung unterliegen
/20/	DIN EN 61000-2-2 VDE 0839 Teil 2-2	Elektromagnetische Verträglichkeit (EMV) Umgebungsbedingungen; Hauptabschnitt 2: Verträglichkeits-pegel für niederfrequente leitungsgeführte Störgrößen und Signalübertragung in öffentlichen Niederspannungsnetzen
/21/	DIN EN 61243-5 VDE 0682 Teil 415	Arbeiten unter Spannung; Spannungsprüfer Teil 5: Spannungsprüfsysteme (VDS)
/22/	DIN EN 61230 VDE 0683 Teil 100	Arbeiten unter Spannung Ortsveränderliche Geräte zum Erden oder Erden und Kurzschließen
/23/	DIN EN 62271-105 VDE 0671 Teil 105	Hochspannungs-Schaltgeräte und Schaltanlagen – Teil 105,
/24/	DIN EN 62271-200 VDE 0671 Teil 200	Hochspannungs-Schaltgeräte und Schaltanlagen – Teil 200, Metallgekapselte Wechselstrom-Schaltanlagen für Bemes-sungsspannungen über 1 kV bis einschließlich 52 kV
/25/	DIN EN 62271-202 Teil 202: Fabrikfertige Stationen für Hochspannung/Niederspannung VDE 0671-202	Hochspannungs-Schaltgeräte– und -Schaltanlagen
/26/	DIN VDE 0132	Brandbekämpfung und Hilfeleistung im Bereich elektrischer An-lagen
/27/	DIN VDE 0141	Erdungen für spezielle Starkstromanlagen mit Nennspannungen über 1 kV
/28/	VDE 0373	Bestimmung für Schwefelhexafluorid (SF_6) von technischem Reinheitsgrad zur Verwendung in elektrischen Betriebsmitteln
/29/	DIN VDE 0510	VDE Bestimmungen für Akkumulatoren und Batterieanlagen
/30/	VDE 0532-216-1	Zubehör für Transformatoren und Drosselspulen Teil 1: Allgemeines
/31/	DIN VDE 0670-402	Wechselstromschaltgeräte für Spannungen über 1 kV Auswahl von strombegrenzenden Sicherungseinsätzen für Transformatorstromkreise
/32/	DIN VDE 0670-1000	Wechselstromschaltgeräte für Spannungen über 1 kV
/33/	DIN VDE 0675	Überspannungsableiter
/34/	DIN VDE 0681	Geräte zum Betätigen, Prüfen und Abschranken unter Spannung stehender Teile mit Nennspannungen über 1 kV
/35/	DIN VDE 0838-1	Rückwirkungen in Stromversorgungsnetzen, die durch Haus-haltsgeräte und durch ähnliche elektrische Einrichtungen verur-sacht werden, Teil 1 Begriffe

DIN Standards

/36/	DIN 4102	Brandverhalten von Baustoffen und Bauteilen
/37/	DIN 18014	Fundamenterder – Allgemeine Planungsgrundlagen
/38/	DIN 4844	Graphische Symbole – Sicherheitsfarben und Sicherheitszeichen Teil1: Gestaltung für Sicherheitszeichen zur Anwendung in Arbeitsstätten und in öffentlichen Bereichen Teil2: Darstellung von Sicherheitszeichen Teil3: Flucht- und Rettungspläne
/39/	DIN EN 61082-1 VDE 0400-1	Dokumente der Elektrotechnik
/40/	DIN EN 60464-1 VDE 0532-221	Ölgefüllte Drehstrom-Verteilungstransformatoren 50 Hz; 50 bis 2500 kVA
/41/	DIN 42523-1/A1	Trockentransformatoren 50 Hz; 100 bis 2500 kVA
/42/	DIN 43455	Bildzeichen für die Betätigung von Hochspannungsschaltgeräten unter 52 kV
/43/	DIN 43625	Hochspannungs-Sicherungen; Nennspannung 3,6 bis 36 kV; Maße für Sicherungseinsätze
/44/	DIN 43870	Zählerplätze - Funktionsplätze
/45/	DIN 47636	Starkstromkabel-Steckgarnituren für Außenkonus-Geräteanschlussteile; U_m bis 36 kV, Einbaumaße
/46/	DIN EN 50181	Steckbare Durchführungen über 1 kV bis 36 kV und von 250 A bis 1,25 kA für Anlagen anders als flüssigkeitsgefühlte Transformatoren
/47/	DIN 18252	Profilzylinder für Türschlösser – Begriffe, Maße, Anforderungen, Kennzeichnung
/48/	DIN 49440	Zweipolige Steckdosen mit Schutzkontakt, AC 16A 250V
/49/	DIN EN 60255 DIN VDE 0435	Elektrische Relais

VDEW / VDN / BDEW – Guidelines and Brochures

/50/	VDN	DistributionCode 2007 – Rules on Access to Distribution Networks
/51/	VDEW	Richtlinien für den Anschluss ortsfester Schalt- und Steuerschränke im Freien an das Niederspannungsnetz des VNB
/52/	VDEW	Gasisolierte metallgekapselte Lasttrennschalteranlagen bis 36 kV; Betriebliche Anforderungen für Projektierung, Bau und Betrieb im EVU
/53/	VDEW	Gasisolierte metallgekapselte Leistungsschalteranlagen bis 36 kV; Betriebliche Anforderungen für Projektierung, Bau und Betrieb im EVU
/54/	BDEW	Technische Regel - Erzeugungsanlagen am Mittelspannungsnetz
/55/	VEÖ, VSE, CSRES, VDN	Technische Regeln zur Beurteilung von Netzrückwirkungen; 2. Ausgabe 2007
/56/	VDN	Richtlinie Notstromaggregate - Richtlinie für Planung, Errichtung und Betrieb von Anlagen mit Notstromaggregaten

/57/	VDEW	Tonfrequenz-Rundsteuerung; Empfehlungen für die Vermeidung unzulässiger Rückwirkungen
/58/	BDEW	MeteringCode 2006, 2008 Edition
/59/	VDN	Technische Richtlinie für digitale Schutzsysteme

Laws and Regulations

/60/	KrW-/AbfG	Kreislaufwirtschafts- und Abfallgesetz
/61/	WHG	Wasserhaushaltsgesetz
/62/	AltölV	Altölverordnung
/63/	EltBauVO	Verordnung über den Bau von Betriebsräumen für elektrische Anlagen
/64/	EMVG	Gesetz über die elektromagnetische Verträglichkeit von Geräten
/65/	FGSV 939	Merkblatt über Baumstandorte und unterirdische Ver- und Entsorgungsanlagen
/66/	GefStoffV	Verordnung zum Schutz vor Gefahrstoffen (Gefahrstoffverordnung)
/67/	ChemVerbotsV	Verordnung über Verbote und Beschränkungen des Inverkehrbringens gefährlicher Stoffe, Zubereitungen und Erzeugnisse nach dem Chemikaliengesetz (Chemikalien-Verbotsverordnung)
/68/	TRGS 518	Technische Regeln Gefahrstoffe: Elektroisolierflüssigkeiten, die mit PCDD oder PCDF verunreinigt sind
/69/	TRGS 519	Technische Regeln Gefahrstoffe: Asbest; Abbruch-, Sanierungs- oder Instandhaltungsarbeiten
/70/	VAwS	Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen und über Fachbetriebe sowie evtl. dazugehörende Verwaltungsvorschriften des jeweiligen Bundeslandes (z.B. VV-VAwS, VVAwS, AV-VawS)
/71/	26. BImSchV	Verordnung über elektromagnetische Felder; 26. Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (sowie länderspezifische Hinweise zur Durchführung der Verordnung über elektromagnetische Felder)
/72/	TA Lärm	Technische Anleitung zum Schutz gegen Lärm Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz
/73/	StromNZV	Verordnung über den Zugang zu Elektrizitätsversorgungsnetzen (Stromnetzzugangsverordnung) vom 25. Juli 2005

Accident-prevention rules of the Accident Prevention and Insurance Association for the electrical, textile and precision mechanics industry

/74/	BGV A1	Grundsätze der Prävention
/75/	BGV A3	Elektrische Anlagen und Betriebsmittel

C Examples of basic circuit diagrams of transfer stations

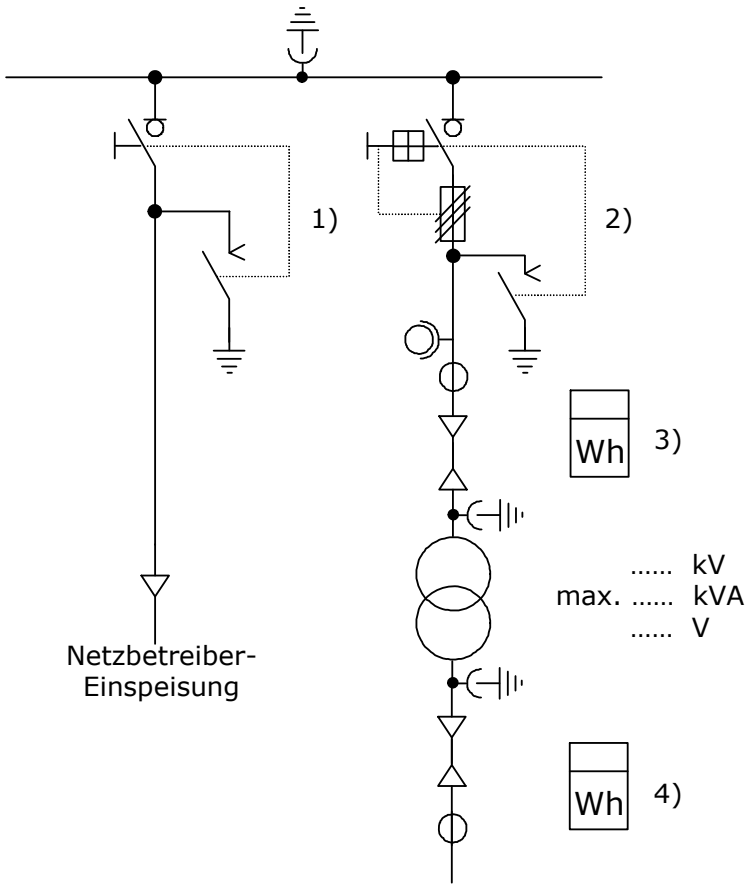
The following basic circuit diagrams represent examples of possible connection solutions. The practical implementation is an integral part of the technical connection requirements of the network operator concerned.

Figure 1: Example of a transfer station with one transformer and one incoming network operator feeder

Figure 2: Example of a transfer station with one transformer and two incoming network operator feeders

Figure 3: Example of a transfer station with one or several transformers and medium-voltage side metering

Figure 1: Example of a transfer station with one transformer and one incoming network operator feeder



Erdungsfestpunkt (wenn technisch möglich)

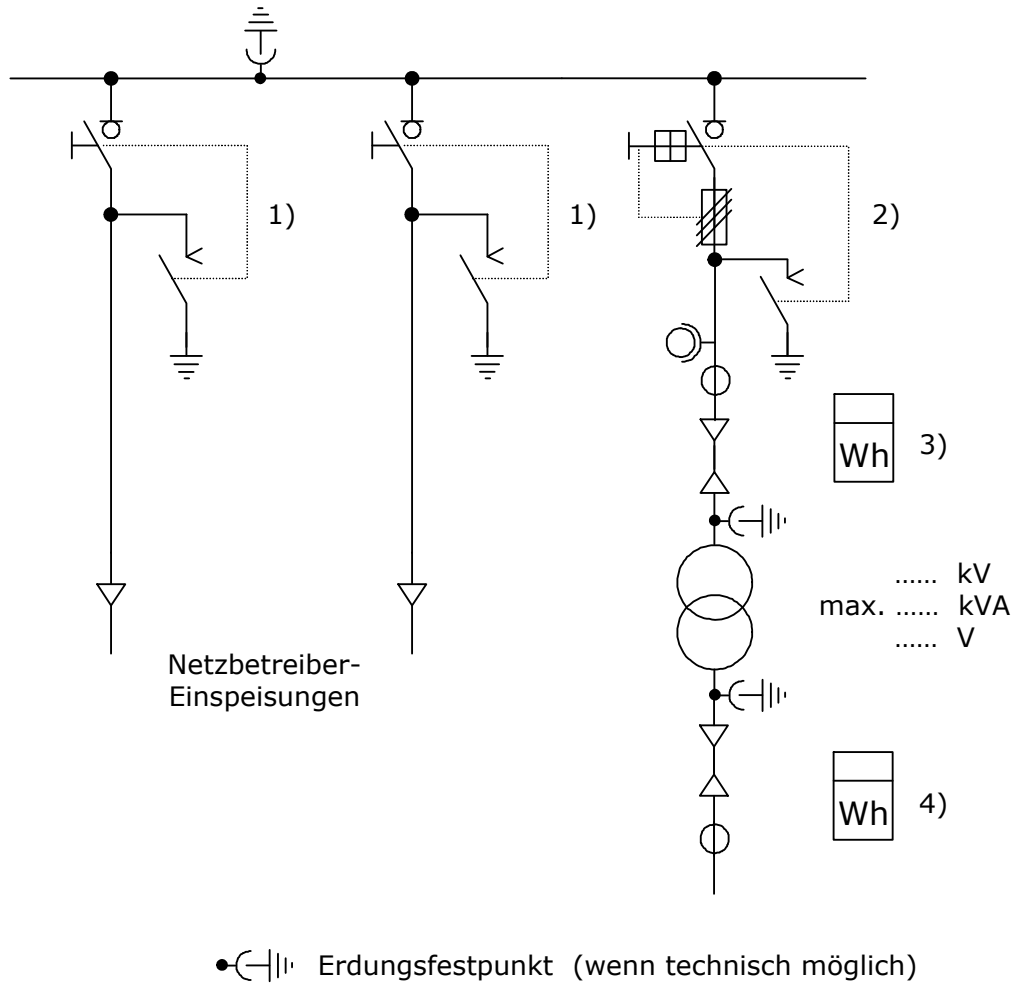
Legend:

Netzbetreiber-Einspeisung: incoming feeder of network operator
Erdungsfestpunkt: fixed earthing point (where technically feasible)

1) Instead of a load disconnector it is also possible to install a circuit breaker with definite time-delay over-current protection.
2) Instead of the load disconnector with HV HRC fuses, a circuit breaker with definite time-delay over-current protection may be used.
3) Metering on the medium-voltage side
4) Metering on the low-voltage side

Agreed service voltage		..... kV
Highest voltage for operating equipment		..... kV
Rated lightning impulse withstand voltage (according to DIN EN 60071)		..... kV
Rated short-time current (rated short-circuit duration 1 s)		≥ ..... kA
Rated surge current or rated short-circuit making current		≥ ..... kA
Rated operating current	bus-bar	..... A
	network operator switching bays	..... A

Figure 2: Example of a transfer station with one transformer and two incoming feeders of the network operator

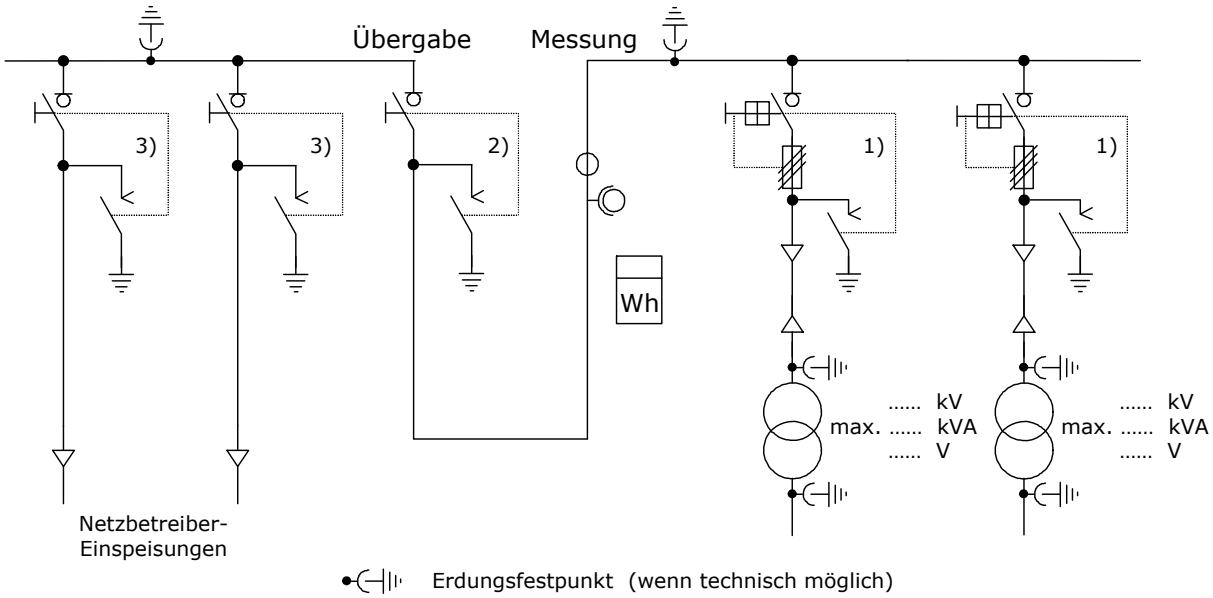


(Legend see Figure 1)

1) Instead of a load disconnector it is also possible to install a circuit breaker with protective equipment.
2) Instead of the load disconnector with HV HRC fuses, a circuit breaker with definite time-delay over-current protection may be used.
3) Metering on the medium-voltage side
4) Metering on the low-voltage side

Agreed service voltage		..... kV
Highest voltage for operating equipment		..... kV
Rated lightning impulse withstand voltage (according to DIN EN 60071)		..... kV
Rated short-time current (rated short-circuit duration 1 s)		≥ ..... kA
Rated surge current or rated short-circuit making current		≥ ..... kA
Rated operating current	bus-bar	..... A
	network operator switching bays	..... A

Figure 3: Example of a transfer station with one or several transformers, metering on the medium-voltage side



Legend:

Übergabe: transfer Messung: metering
Netzbetreiber-Einspeisungen: incoming feeders of the network operator
Erdungsfestpunkt: fixed earthing point (where technically feasible)

1) Instead of the disconnector with HV HRC fuses, a circuit breaker with definite time delay over-current protection may be used.

2) A transfer circuit-breaker switch with protection equipment may also be required.

3) It may be necessary to use circuit breakers with protection equipment on incoming feeders of the network operator if the reliability of supply of the connected customer or the network constellation require to do so.

Agreed service voltage		..... kV
Highest voltage for operating equipment		..... kV
Rated lightning impulse withstand voltage (according to DIN EN 60071)		..... kV
Rated short-time current (rated short-circuit duration 1 s)		≥ ..... kA
Rated surge current or rated short-circuit making current		≥ ..... kA
Rated operating current	bus-bar	..... A
	network operator switching bays	..... A

D Forms

The network operator shall determine the contents of the forms on his own responsibility.

D.1: Application

D.2: Data sheet for the assessment of network disturbances

D.3: Network connection planning

D.4: Construction planning

D.5: Order of initial start-up

D.6: Earthing records

D.7: Inspection records for transfer protection

D.8: Initial start-up records

D.1 Application

Application for network connections (medium voltage) (to be completed by the customer)			
Plant address	street no and name _____ postal code, place _____		
Connection owner	name, surname _____ street no and name _____ postal code, place _____ phone, e-mail _____		
Plant installer (specialist electrical firm)	company, place _____ phone, e-mail _____		
Type of plant	☐ new installation	☐ extension	☐ dismantling
Location of the premises to be supplied (map on the scale of at least 1:1,000) with proposals on possible station places?			☐ yes ☐ no
Expected power demand			_____ kVA
Need for building-site power supply	☐ no	if so: capacity _____ kVA	from when _____
Data sheet for the assessment of network disturbances completed (see Annex D.2)			☐ yes ☐ no
Schedule of construction progress available (if so, please attach)			☐ yes ☐ no
Planned date of initial start-up			_____

_____ place, date	_____ signature of the connection owner

D.2 Data sheet for the assessment of network disturbances

Data sheet for the assessment of network disturbances (medium voltage) 1 / 2 (to be completed by the customer)			
Plant address	street no and name _____ postal code, place _____		
Transformers	rated power S_{rT}		_____ kVA
	relative short-circuit voltage u_k		_____ %
	connection symbol		_____
Reactive power compensation	range of adjustable reactive power		_____ kVAr
	reactive power per tap _____ kVAr	number of taps _____	
	choking degree / resonant frequency		_____
Welding machines	maximum welding capacity _____	power factor _____	
	number of welding operations		_____ 1/min
	duration of a welding operation		_____
Motors	asynchronous motor ☐	synchronous motor ☐	motor with converter-fed drive ☐
	rated voltage		_____ V
	rated current		_____ A
	rated capacity		_____ kVA
	power factor		_____
	efficiency		_____
	ratio starting current / rated current I_a / I_r		_____
	starting connection:	directly ☐	star / delta ☐	other ☐
	number of starts per hour or day		_____
	starting with or without load:	with load ☐	without load ☐
	number of load or rotation direction alternations		_____ 1/min

Data sheet for the assessment of network disturbances (medium voltage) 2 / 2

(to be completed by the customer)

Converter	rated capacity		_____ kVA
	rectifier ☐	frequency converter ☐	AC power controller ☐
(Input) rectifier	pulse number or switching frequency		_____
	connection (bridge, …)		_____
	control:	controlled ☐	uncontrolled ☐
	intermediate circuit exists ☐	inductive ☐	capacitive ☐
Converter transformer	connection symbol		_____
	rated capacity		_____ kVA
	relative short-circuit voltage u_k		_____ %
Commutating inductances			_____ mH

Manufacturer's information on network-side harmonic currents

Ordinal number	3	5	7	9	11	13	17	19	23	25
I_μ [A]										

Remarks

_____

_____

_____

_____

D.3 Network connection planning

Network connection planning (medium voltage) (Check list for the network operator concerning the determination of the network connection)		
Address of facility	station name/bay no _____ street no and name _____ postal code, place _____	
Location of the transfer station and network operator's line route clarified?		☐ yes ☐ no
Structure of the medium-voltage switching station clarified?		☐ yes ☐ no
Necessary protection equipment for feed-in and transfer bay clarified?		☐ yes ☐ no
Remote control/remote monitoring and necessary automatic change-over equipment clarified?		☐ yes ☐ no
Type and layout of measuring device clarified?		☐ yes ☐ no
Property borderlines clarified?		☐ yes ☐ no
Customer's and network operator's scope of supply and performance clarified?		☐ yes ☐ no

D.4 Construction planning

Construction planning (medium voltage) (at least two copies to be handed over by the customer to the network operator not later than 6 weeks prior to the commencement of construction)	
Plant address	station name/bay no _____ street no and name _____ postal code, place _____
Plant operator	name, surname _____ street no and name _____ postal code, place _____ phone, e-mail _____

Scale plan of the site showing the location of the transfer station, the network operator's line route and existing and scheduled structures attached?	☐ yes ☐ no
Basic circuit diagram of the entire medium-voltage installation including transformers, measuring, protection and control equipment (data of the auxiliary power source, if available) including the borderlines of the site and of the area at disposal attached ? (please also indicate technical parameters)	☐ yes ☐ no
Drawings of all medium-voltage bays showing the arrangement of appliances attached ? (assembly drawings)	☐ yes ☐ no
Scheme of the layout of the measuring device (including data telecommunication) attached ?	☐ yes ☐ no
Ground plans and sectional drawings (on the scale of 1:50, if possible) of the electrical operating rooms for the medium-voltage switchgear and transformers attached ? (These drawings must also show the route of the lines and the switching station entrance.)	☐ yes ☐ no
Has an arrangement by mutual consent concerning the location and operation of the transfer station and the network operator's line route been concluded between the house and land owner and the installer or operator of the transfer station (in case that they are different persons) ?	☐ yes ☐ no
Is there any proof available to the network operator showing that his technical requirements according to Chapter 3 of the technical conditions for connection to the medium-voltage network are satisfied ? (evidence of the short-circuit strength for the entire transfer station, …)	☐ yes ☐ no
Is there any evidence available concerning the short-circuit strength of the medium-voltage switchgear ?	☐ yes ☐ no

D.5 Order of initial start-up

Order of initial start-up (medium voltage)

(to be completed by the plant installer)

Plant address	station name/bay no _____		
	street no and name _____		
	postal code, place _____		
Meter operation	The measuring device is made available by the network operator or by another meter operator (if so, please give the meter operator ID as specified in the meter operator framework agreement): _____		
work to be realized:	☐ installation	☐ extension	☐ change of metering for the aforementioned meter point
requested measuring device:	☐ three-phase meter	☐ load-profile meter	☐ 2 energy directions
transformer owner	☐ network operator	☐ connection owner	☐ meter operator
Plant data	☐ new plant	☐ re-commissioning	☐ plant modification
	☐ renewables-based	☐ cogeneration	☐ other _____
type of demand:	☐ trade	☐ agriculture	☐ industry
	☐ building-site power	☐ other short-time connection _____	
power / energy:	maximum simultaneous power _____ kW		
	expected annual consumption _____ kWh		
Network feed-in from:	☐ wind power	☐ hydro power	☐ block-type heat and power plant
	☐ photovoltaics	☐ other _____	
Note concerning electricity supply	Prior to the commencement of connection use, a power supply agreement has to be concluded by the connection user with the power supplier.		
	_____ place, date	_____ signature of connection user (customer)	
Remarks:	_____		
Initial start-up	I/We confirm that the installation of the transfer station has been implemented, inspected and completed by me/us in observance of the statutory provisions in force and official decrees and according to the generally acknowledged rules of technology, particularly on the basis of DIN VDE standards, according to the requirements of the BDEW Guidelines „Technical conditions for connection to the medium-voltage network“ and the technical connection requirements defined by the network operator. The inspection results have been documented.		
	_____ place, date	_____ signature of plant installer (certified company)	

D.6 Earthing records

Earthing records (medium voltage)

(to be completed by the customer)

Plant address	station name/bay no _____ street no and name _____ postal code, place _____

Sketch-map of the implemented earthing system (please enter a north arrow)

constructed by (company): _____			**date:** _____
soil texture: ☐ **loam** ☐ **humus** ☐ **sand** ☐ **gravel** ☐ **rocky**			
soil: ☐ **moist** ☐ **dry**			
depth earth electrode ? ☐ yes ☐ no	**surface electrode ?** ☐ yes ☐ no	**control earth electrode?** ☐ yes ☐ no	**foundation earth electrode?** ☐ yes ☐ no
earth electrode material: _____			
total length of depth earth electrode ___ m		**total length of surface electrode** _____ m	
high-voltage protective earthing _____ Ω		**low-voltage station earthing** _____ Ω	
total earthing impedance value after connection of the high-voltage protection and the low-voltage earthing system : ____ Ω			
faults: ☐ no ☐ yes (which?) _____			

D.7 Inspection records for transfer protection

Inspection records for transfer protection (medium voltage)				**1 / 2**
(to be completed by the customer; example: definite time-lag overcurrent protection)				
Plant Address	station name/bay no _____			
	street no and name _____			
	postal code, place _____			
Plant installer (certified electrical company)	company, place _____			
	phone, e-mail _____			
Transformer				
product (current): _____	product (voltage): _____		earthing towards* ☐ KA ☐ netw.	
current Ü = ____ : _____	S = _____ VA		class _____	
voltage Ü = ____ : _____	S = _____ VA		class _____	
Protective relay				
type of relay: _____	software version no: _____			
product: _____	type: _____		serial no _____	
operating voltage: _____ V		transformer secondary rated current: ☐ 1 A ☐ 5 A		
I >	setting: _____ (prim _____) A _____ s			
I >>	setting: _____ (prim _____) A _____ s			
Fittings				
actual setting: **	I > _____ A	I >> _____ A	t1 _____ s	t1 _____ s

Remarks:

* *KA (Kundenanlage – Customer facility): earthed towards customer facility*

Network: earthed towards the network operator's network

** *Only required in the case of analogous protection*

Inspection records for transfer protection (medium voltage) 2 / 2

(to be completed by the customer; example: definite time-lag overcurrent protection)

Conductors	L1 (terminal no ___/___)	L2 (terminal no ___/___)	L3 (terminal no ___/___)
response value I > A			
drop-off value I > A			
response value I >> A			
drop-off value I >> A			
test value in I sec. A			
$I >_{response}$ _____ A	**release time in s**		
$I >_{drop-off}$ _____ A			
$I >>_{response}$ _____ A			
$I >>_{drop-of}$ _____ A			
actual I [A]			
measurement (s)			
degree °			
current K [mA]			
U [V]			
voltage			
degree °			

release and signal checked: ☐		release activated by MCB: ☐	
terminal number for releases:	MCB: _____	SOE recorder: _____	telecontrol: _____

Wattmeter E-relay	
type of relay: _____	relay no: _____
type of transformer: _____	transformer ratio: _____
setting: primary: _____	secondary: _____
response value I_e: _____ mA	response value U_{en} : _____ V
drop-off value I_e: _____ mA	drop-off value U_{en} : _____ V
measured performance values U_{en}: _____ mA	I_f = _____ mA

_____	_____	_____
place, date	plant installer	plant operator

D.8 Initial start-up records

Initial start-up records (medium voltage) (to be completed by the plant installer)				
Plant address	station name/bay no	_____		
Connection owner	first name, last name phone, e-mail	_____ _____		
Plant operator	first name, last name phone, e-mail	_____ _____		
Person responsible for operation	first name, last name street no and name postal code, place phone, e-mail	_____ _____ _____ _____		
Plant installer (certified company)	company, place phone, e-mail	_____ _____		
Network configuration	☐ resonant-earthed	☐ insulated-neutral	☐ low-resistance	
Documentation (delivery to distribution network operator at least one week prior to initial start-up of the network connection)	Updated project documents of the transfer station available			☐
	Initial start-up order available (D.5)			☐
	Earthing records available (D.6)			☐
	Verification certificates of transformers available			☐
System control agreement	required ☐ yes ☐ no	if so: available		☐
Protection inspection records (D.7)	required ☐ yes ☐ no	if so: available		☐
Remote control	required ☐ yes ☐ no	if so: tested (incl. remote OFF)		☐
Transmission of metered values	required ☐ yes ☐ no	if so: tested		☐
Measurement for accounting purposes	pre-inspection + commissioning test implemented			☐

Remarks: _____

Within the meaning of the currently applicable DIN VDE provisions and the accident-prevention rule BGV A3, the station is considered to be a closed electrical plant. Access may only be granted to qualified electrical personnel or persons trained in electrical terms. Laymen may enter into the plant only if they are accompanied by the aforementioned persons.

The station has been constructed in accordance with the requirements of the BDEW Guidelines on „Technical conditions for connection to the medium-voltage network“ and the network operator’s technical connection requirements. The plant installer has instructed the plant operator during hand-over and declared the station to be operational according to BGV A3 Section 3 and Section 5.

_____	_____	_____
place, date	plant operator	plant installer

The customer facility was connected to the medium-voltage network on: _____

_____	_____	_____
place, date	plant operator	network operator

E Check lists for acceptance tests, initial start-up and documentation

List 1	General information	☐
List 2	Building / casing	☐
List 3	Medium-voltage switchgear	☐
List 4	Accessories and bulletin-board notices	☐
List 5	Documentation	☐
List 6	DC voltage equipment	☐

The lists are an integral part of acceptance tests, initial start-up and documentation.

Project name:

_____

Station name:

_____

Place: _____

Cadastral district / cadastral unit:

_____

Date: _____

Plant installer:

_____

Connection owner

_____

For the network operator's concerns:

_____

Participants

in acceptance tests / initial start-up:

Customer:

_____

Plant installer:

_____

Network operator:

_____

Other:

_____

_____

_____

Signature:

_____

Signature:

_____

Signature:

_____

List 1	Sheet: 1/3
General information	
Building:	
Type of construction:	Owner:
Manufacturer / Type:	Installer:
Year of construction:	Operator:
Remarks:	

List 1 Sheet: 2/3 **General information**	
Medium-voltage switching station:	
Bays ..... to	
Manufacturer:	Ownership structure:
Type:	
Insulating medium: air ☐ gas ☐ other ☐	Installer:
Year of construction:	Operator:
	Basic circuit diagram no:
	Proof of arcing fault resistance:
Bays ..... to	
Manufacturer:	Ownership structure:
Type:	
Insulating medium: air ☐ gas ☐ other ☐	Installer:
Year of construction:	Operator:
	Basic circuit diagram no:
	Proof of arcing fault resistance:
Remarks:	

List 1 Sheet: 3/3

General Information

Transformer:			
	Transformer...	Transformer...	Transformer...
Manufacturer:			
Type:			
Year of construction:			
Insulating medium:			
Rated power:			
Rated voltage:			
Impedance voltage in %:			
Connection symbol:			
Remarks:			

Metering:	
Medium voltage ☐	Low voltage ☐
Remarks:	

List 2 Sheet: 1/2

Building / Casing

serial no.		yes	no	n/a
2.1	The construction work (as far as required for operation) has been finalized.			
2.2	Cable connection work is feasible.			
2.3	The building and the roof are undamaged.			
2.4	All the doors can be properly opened, closed and locked; door hinge/escape direction correct (doors to open outward)			
2.5	Doorstops have been installed.			
2.6	Access door can be opened only with a key from outside.			
2.7	The lock has an anti-panic function.			
2.8	Doors with double locks are designed in a way so as to enable a network-operator closure (e.g. profile half-cylinder lock) to be added.			
2.9	Signage as required.			
2.10	Cable entry according to specifications exists; bushings currently not used are provided with water-proof dummy covers (or sealing of the cable entry as required). Necessary depth of cable laying is ensured.			
2.11	Exhaust and ventilation equipment exists and is poking-proof.			
2.12	Pressure discharge apertures exist.			
2.13	Operation corridors according to DIN VDE			
2.14	Double floor locked			
2.15	Cable basement as required			
2.16	Vent uptakes and access opening to the cable basement exist and are secured.			
2.17	Lighting installation exists.			
2.18	A sufficiently dimensioned collecting basin exists and has been implemented according to the requirements.			

List 2 Sheet: 2/2

Building / Casing

serial no.		yes	no	n/a
2.19	There are no pipes and lines in the station which are not required for its operation			
2.20	Accessibility to the station is ensured any time.			
2.21	Design of the meter location corresponds to the network operator's specifications.			

as to serial no.	Remarks

List 3 Sheet: 1/2

Medium-voltage switching station

serial no.		yes	no	n/a
3.1	Switchgear assembled according to specifications (basic circuit diagram)			
3.2	Bay numbering and identification implemented according to basic circuit diagram			
3.3	Visible external damages do not exist.			
3.4	The switchgear is connected to the substructure (support frame) in accordance with the manufacturer's instructions.			
3.5	Rating plates of the switchgear are in German; the contents correspond to the ordering designations; they are permanently fixed.			
3.6	Mimic connection diagram is available according to specifications			
3.7	Possibilities for verifying the off-voltage condition and implementation of the phase comparison exist.			
3.8	Voltage test systems			
	Capacitive metering points are unmistakeably assigned to outgoing feeders and labelled according to standards.			
	The protective covers of measuring bushes are undetachably fixed.			
	The location of capacity taps in the switchgear is represented on the mimic connection diagram.			
3.9	Short-circuit current indicators:			
	built in as required			
	Response value and reset time adjusted as required.			
3.10	Switching devices:			
	All switching devices can be switched on and off			
	Required locking devices are operational.			
	Switch-position indications clearly correspond with the respective switch position.			
	Measures have been taken to prevent unauthorized operation of switching devices and opening of doors for bays within the network operator's area of disposal.			

List 3 Sheet: 2/2

Medium-voltage switching station

serial no.		yes	no	n/a
3.11	Outer conductors have been marked within all bays (L1, L2, L3).			
3.12	Gas leakage indications (e.g. green / red signal) exist; gas pressure is sufficient.			
3.13	The protection scheme for the transfer station including secondary technical equipment and messages comply with the network operator's specifications. Protection inspection records are available !			
3.14	Settings of protective equipment (transformer and line protection) comply with the requirements of the network operator. Protection inspection records are available !			
3.15	Electric shock protection is ensured.			
3.16	Implementation and configuration of fixed earthing points as required.			
3.17	Bay and recess doors close in the escape direction.			
3.18	Remote control has been tested in accordance with the network operator's specifications. Inspection records are available !			
3.19	Earth-fault indicator systems comply with the network operator's requirements.			

as to serial no.	Remarks

List 4 Sheet: 1/1

Accessories and bulletin-board notices

serial no.		yes	no	n/a
4.1	Indicating devices for capacitive metering points exist.			
4.2	Control rods are available.			
4.3	Required control levers exist.			
4.4	Earthing and short-circuiting device with earthing rod exist (number ad cross-section according to the network operator's specification).			
4.5	Insulating protection plates for the medium-voltage switchgear exist (number according to the network operator's requirements).			
4.6	Bay-door key available.			
4.7	Additional signs (e.g. caution: do not switch, etc.) complying with the network operator's requirements exist.			
4.8	Bulletin-board notices (e.g. social insurance leaflets) according to the network operator's specifications are available.			

as to serial no.	Remarks

List 5 Sheet: 1/2

Documentation

serial no.		yes	no	n/a
5.1	Technical documentation of the switchgear used is available (maintenance and operation instructions).			
5.2	Installer confirmation according to BGV A2 available			
5.3	Valid medium-voltage / low-voltage basic circuit diagram of the transfer station available			
5.4	Protocol of protection setting and protection inspection records available			
5.5	Earth-resistance metering protocol available			
5.6	Documents about network disturbances available			
5.7	Installation plan of electrical equipment, location within the building, available			
5.8	Metering for accounting purposes: Inspection records and certification of instrument transformer as required.			

as to serial no.	Remarks

List 6 Sheet: 1/1

D.C. voltage supply system

Rectifier	Battery system
Manufacturer:	Manufacturer:
Type:	Type:
Rated voltage:	Rated voltage:
Rated current:	Capacity:
Supervisory equipment:	Battery terminals not earthed: yes / no
	Supervisory equipment:
Remarks:	