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Erection of electrical installations in underground mines

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National foreword

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Erection of electrical installations in underground mines

Construction des installations électriques dans les mines souterraines

Errichten elektrischer Anlagen im Bergbau unter Tage

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European foreword

This document (EN 50628:2016) has been prepared by CLC/TC 31 “Electrical apparatus for potentially explosive atmospheres”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-05-23
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2020-05-23

This document will be read in conjunction with the European Standards for the specific types of protection listed in the EN 60079 series of standards.

This document will also be read in conjunction with EN 1127-2.

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Introduction

When electrical equipment is to be installed in underground workings where an explosive atmosphere is likely to occur, protective measures are applied to avoid the ignition of firedamp either under normal operation of the electrical installation or under fault conditions.

Mines can be either gassy or non-gassy depending upon the mineral/material being extracted and whether or not firedamp can occur in the workings. It is usual practice to consider all coal mines as gassy mines. Non-coal mines can however, also be susceptible to the occurrence of firedamp e.g. if they are mining minerals/materials in the vicinity of oil bearing strata or unworked coal seams which are to be disturbed by the mining process, or are susceptible to outbursts of flammable gas.

Due to the fact that in underground workings firedamp is one of the major mining hazards that is to be considered all pieces of electrical equipment need to be selected with regard to this hazard. If there are other significant explosive atmospheres than firedamp the hazard occurring from these explosive atmospheres needs to be taken into account.

Directive 2014/34/EU extends the definition of potentially explosive atmosphere to include combustible dust as well as firedamp. Extensive research[1)] has shown that the minimum ignition energy (MIE) of coal dust/ air mixture is several hundred times higher than that of a firedamp/ air mixture and that the maximum experimental safe gap (MESG) for coal dust particles is more than double that for firedamp. It is therefore reasonable to assume that equipment, protective systems and components that are designed, constructed and maintained for use in firedamp/ air mixtures are also suitable for use in coal dust/ air mixtures.

Unlike Group II it will be assumed that in Group I industry nearly all underground workings need to be assessed where an explosive atmosphere is likely to occur and classified accordingly as hazardous areas. A zone classification for such underground workings is not possible because the degree of exposure of such an underground working does not depend on local parameters but on time parameters. In accordance with 2014/34/EU (ATEX-Directive) the exposure of the installed equipment may change from normally acceptable firedamp concentration in the mine air (hazardous condition 2; M2 equipment sufficient) to elevated methane concentration (hazardous condition 1; M1 equipment required, M2 equipment to be de-energized) and vice versa.

Areas of a coal mine could be non-hazardous according to national regulations. In such areas equipment that is not ATEX approved may be used, too subject to the risk assessment and specific local rules where national regulations require.

In non-gassy mines it can be possible that in certain regions in the underground workings explosive atmospheres can occur. In these cases national regulations will apply.

In mines where the atmosphere, in addition to firedamp, may contain significant proportions of other flammable gases than firedamp, the installed Group I equipment complies also with the subdivision of Group II corresponding to the other significant flammable gases.

In any underground working, irrespective of the size, there may be numerous sources of ignition apart from those associated with electrical equipment. Precautions will be necessary to ensure safety from other possible ignition sources, but guidance on this aspect is outside the scope of this standard.

Underground mining activities cause other special problems to the electrical installation as well as those arising from firedamp. Rough environmental conditions evoked by climate – temperature and humidity e.g. – rock pressure caused by depth, geometric dimensions of the underground workings, the winning process itself and other similar circumstances require therefore special specifications to the electrical installation in underground mines.

1) Survey on the use of flameproof enclosures in coal dust and methane atmospheres, G. A. Lunn, SM/97/01.

1 Scope

This European Standard specifies the safety requirements for the erection of new electrical installations.

This European Standard is supplementary to other relevant harmonized standards, for example HD 60364 series and the EN 61936 series as regards electrical installation requirements.

This European Standard also refers to EN 60079-0 and its associated standards for the construction, testing and marking requirements of suitable electrical equipment.

EN 60079-14 gives the specific requirements for design, selection and erection of electrical installations in explosive atmospheres.

NOTE EN 60079–14 can apply to electrical installations in mines where explosive gas atmospheres other than firedamp can be formed and to electrical installations in the surface installation of mines.

This European Standard applies to:

a) electrical installation in underground workings of mines;

b) electrical installations and parts of electrical installation above ground, which are directly connected with the underground workings in functional and safety relating matters because of being part of the underground working process:

   These are in particular:

   - safety and monitoring devices relating to the power distribution of the underground workings,
   - communication system of hoisting and inclined haulage plants,
   - intrinsically safe electrical installations of above ground installation being part of underground workings,
   - remote control systems if they shall fulfil increased requirements relating to functional safety,
   - electrical installation and electrical equipment of ventilation systems and shaft casings above ground being endangered by firedamp of the underground ventilation,
   - firedamp drainage systems;

c) electrical installation in underground workings outside mining if it is demanded of the competent national authorities.

National regulations of the mining authority shall remain unaffected.

This standard applies to installations at all voltages mentioned in Clause 10.

Requirements above both columns are requirements for all underground workings.

Gassy mines	**Other mines**
Requirements within left column are requirements for underground workings in the coal mining industry which could be endangered by firedamp.	Requirements within right column are requirements for underground workings of the coal mining industry not likely to be endangered by firedamp and for underground workings of non-coal mining industry.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

HD 631.1 S2, *Electric cables — Accessories — Material characterisation — Part 1: Fingerprinting and type tests for resinous compounds*

EN 50303, *Group I, Category M1 equipment intended to remain functional in atmospheres endangered by firedamp and/or coal dust*

EN 50393, *Test methods and requirements for accessories for use on distribution cables of rated voltage 0,6/1,0 (1,2) kV*

EN 60038, *CENELEC standard voltages (IEC 60038)*

EN 60079-0, *Explosive atmospheres - Part 0: Equipment - General requirements (IEC 60079-0)*

EN 60079-1, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d" (IEC 60079-1)*

EN 60079-7:2007, *Explosive atmospheres - Part 7: Equipment protection by increased safety "e" (IEC 60079-7:2006)*

EN 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres (IEC 60079-10-1)*

EN 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas — Explosive dust atmospheres (IEC 60079-10-2)*

EN 60079-11:2012, *Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i" (IEC 60079-11:2011)*

EN 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection (IEC 60079-14)*

EN 60079-25, *Explosive atmospheres - Part 25: Intrinsically safe electrical systems (IEC 60079-25)*

EN 60204-1, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1)*

EN 60296, *Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear (IEC 60296)*

EN 60309-1, *Plugs, socket-outlets and couplers for industrial purposes - Part 1: General requirements (IEC 60309-1)*

EN 60332-1-2, *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame (IEC 60332-1-2)*

HD 60364-4-41:2007, *Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock (IEC 60364-4-41:2005)*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

EN 60664-1, *Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests (IEC 60664-1)*

EN 60836, *Specifications for unused silicone insulating liquids for electrotechnical purposes (IEC 60836)*

EN 60865-1, *Short-circuit currents - Calculation of effects - Part 1: Definitions and calculation methods (IEC 60865-1)*

EN 60909 (all parts), *Short-circuit currents in three-phase a.c systems (IEC 60909 series)*

EN 61099, *Insulating liquids - Specifications for unused synthetic organic esters for electrical purposes (IEC 61099)*

EN 61557-6, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 6: Effectiveness of residual current devices (RCD) in TT, TN and IT systems (IEC 61557-6)*

EN 61557-8, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures — Part 8: Insulation monitoring devices for IT systems (IEC 61557-8)*

EN 61557-15, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 15: Functional safety requirements for insulation monitoring devices in IT systems and equipment for insulation fault location in IT systems (IEC 61557-15)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
mining operation / road heading

3.1.1
mining operation
a) in case of longwall mining: the face including the connected workings

Note 1 to entry: Connecting workings are up to 10 m on both sides of the face entrance. The face entrance is the area between the face and the latest complete row of the roof support.

b) in case of other mining methods: the production area including the connected workings

Note 2 to entry: Connecting workings are up to 10 m to the heading face.

Note 3 to entry: In case of greater mining operation areas, e.g. salt industry, the mining authority will decide.

3.1.2
roadheading
parts of the underground workings where road heading activities are taking part up to 50 m far from the roadhead

3.2
electrical installation

3.2.1
electrical power distribution
electrical installation with pieces of equipment used for such purposes as generation, conversion, storing, transmission, distribution or utilization of electric energy for mechanical work, for generation of heat and light or for electrochemical processes

3.2.2
switchgear
switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy

[SOURCE: IEV 441-11-02]

3.2.3
electrical interference
influence of an electric power installation on a communication system or between different communication systems depending on the coupling of capacitive, inductive or ohmic resistance

3.2.4
erection of electrical installation
new installation, redesign, extension, modification or reconstruction of an electrical installation

Note 1 to entry: Replacing of electrical equipment by similar one or reducing the electrical installation is not redesign if the electrical parameters will not change substantially.

3.2.5
electrostatic earthing
electrical equipment which is electrostatically earthed, i.e. for which the leakage resistance against earth is not bigger than a specific value

Note 1 to entry: The leakage resistance against earth should not be bigger than 10^6 Ω or bigger than 10^8 Ω if the capacity is less or equal than 100 pF.

3.2.6
potential equalization in the field of intrinsically safe electrical systems and electric power installations
elimination of potential differences between different protective conductors of electrical power installations and between exposed conductive parts of intrinsically safe electrical systems

3.2.7
protective bonding conductor
protective conductor provided for protective-equipotential-bonding

[SOURCE: IEV 826-13-24]

3.2.8
communication system
installation for transmitting and processing of messages and/or information (e.g. speech, tunes, pictures or characters) including remote control information (e.g. measuring values, messages or instructions)

Note 1 to entry: A communication system consists of broadcasting equipment, wireless or non-wireless transmission path, receive terminal devices and the supplying equipment.

3.2.9
initial inspection
inspection of all electrical apparatus, systems and installations before they are brought into service

[SOURCE: IEV 426-14-06]

3.3
electrical equipment

3.3.1
electrical equipment
item used for such purposes as generation, conversion, transmission, distribution or utilization of electric energy, such as electric machines, transformers, switchgear and controlgear, measuring instruments, protective devices, wiring systems, current-using equipment

[SOURCE: IEV 826-16-01]

3.3.2
mobile electrical equipment
electric equipment which is moved while in operation or which can easily be moved from one place to another while connected to the supply

[SOURCE: IEV 826-16-04]

3.3.3
current using equipment
electric equipment intended to convert electric energy into another form of energy, for example light, heat, mechanical energy

[SOURCE: IEV 826-16-02]

3.3.4
hand-held equipment
electric equipment intended to be held in the hand during normal use

[SOURCE: IEV 826-16-05]

3.3.5
switch
device for changing the electric connections among its terminals

[SOURCE: IEV 151-12-22]

3.3.6
switchgear and controlgear
electric equipment intended to be connected to an electric circuit for the purpose of carrying out one or more of the following functions: protection, control, isolation, switching

Note 1 to entry: The French and English terms can be considered as equivalent in most cases. However the French terms have a broader meaning than the English terms and include for example connecting devices, plugs and sockets outlets, etc. In English, these latter devices are known as accessories.

[SOURCE: IEV 826-16-03]

3.3.7
remote controlled switchgear
switchgear which is intended to switch on or off one or more electrical circuits by external activity, e.g. mechanically, electrically, electro-optically, pneumatically, acoustically, or on a thermal or magnetic way and where it is impossible to do it manually

3.3.8
convertor
set of equipment, static or rotating, to convert one type of electric current to another type different in nature, voltage and/or frequency

[SOURCE: IEV 811-19-01]

3.4
intrinsic safety

3.4.1
intrinsically safe electrical system
assembly of interconnected items of electrical apparatus, described in a descriptive system document, in which the circuits or parts of circuits, intended to be used in an explosive atmosphere, are intrinsically safe circuits

[SOURCE: IEV 426-11-08]

3.4.2
intrinsically safe circuit
circuit in which any spark or any thermal effect produced in the conditions specified in EN 60079-11, including normal operation and specified fault conditions, are not capable of causing ignition of a given explosive gas atmosphere

[SOURCE: IEV 426-11-01]

3.4.3
intrinsically safe electrical apparatus
electrical apparatus in which all the circuits are intrinsically safe circuits

[SOURCE: IEV 426-11-02]

3.4.4
associated apparatus
electrical apparatus which contains both intrinsically safe circuits and non-intrinsically safe circuits and is constructed so that the non-intrinsically safe circuits cannot adversely affect the intrinsically safe circuits

Note 1 to entry: Associated apparatus may be either:

a) electrical apparatus which has another type of protection listed in EN 60079–0 for use in the appropriate gas atmosphere, or

b) electrical apparatus not so protected and which, therefore, shall be not used within an explosive gas atmosphere.

[SOURCE: IEV 426-11-03]

3.4.5
accessory
device supplementing a main device or apparatus, but not forming part of it, that is needed for its operation or to confer on it specific characteristics

[SOURCE: IEV 151-11-24]

3.5
earthing

3.5.1
earthing system
arrangement of connections and devices necessary to earth equipment or a system separately or jointly

[SOURCE: IEV 604-04-02]

3.5.2
power system earthing
functional earthing and protective earthing of a point or points in an electric power system

[SOURCE: IEV 826-13-11]

3.5.3
earth
make an electric connection between a given point in a system or in an installation or in equipment and local earth

Note 1 to entry: The connection to local earth maybe:

- intentional, or
- unintentional or accidental,
- and may be permanent or temporary.

[SOURCE: IEV 826-13-03]

3.5.4
earth-free exposed-conductive-part
exposed-conductive part without any connection to earth or other earth bounded electrical equipment

3.5.5
earth fault
occurrence of an accidental conductive path between a live conductor and the earth

[SOURCE: IEV 826-14-13 modified]

3.5.6
earth fault current
current flowing to earth due to an insulation fault

[SOURCE: IEV 442-01-23]

3.5.7
double earth fault
insulation faults to earth occurring simultaneously at two different locations in one or several circuits originating from a common source

[SOURCE: IEV 604-02-22]

3.5.8
double earth fault current
current in case of a double earth fault

3.5.9
residual earth current
earth current at the point of fault after compensation

3.5.10
fault current
current which flows across a given point of fault resulting from an insulation fault

[SOURCE: IEV 826-11-11]

3.5.11
leakage current
electric current in an unwanted conductive path under normal operating conditions

[SOURCE: IEV 826-11-20]

3.5.12
functional earthing
earthing a point or points in a system or in an installation or in equipment for purposes other than electrical safety

[SOURCE: IEV 826-13-10]

3.5.13
insulation fault
defect in the insulation of an electrical installation or of an equipment which can create a resistive path to earth

Note 1 to entry: The insulation fault can appear as a single fault from one line conductor or as a symmetrical fault from all line conductors.

[SOURCE: IEV 604-02-02, modified]

3.5.14
Insulation Monitoring Device
IMD
device which permanently monitors the insulation resistance to earth of unearthed IT systems, independent from the method of measuring

3.5.15
earth fault locking device
electrical device to monitor the insulation resistance of a non-alive system in order to prohibit a restart as long as the insulation fault exists

3.5.16
exposed-conductive-part (of electrical equipment)
conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails

[SOURCE: IEV 826-12-10]

3.5.17
fault to frame
interconnection between exposed conductive parts and live parts of electrical equipment due to a fault

3.5.18
short-circuit
accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero

[SOURCE: IEV 826-14-10]

3.5.19
total fault to frame, short-circuit or earth fault
resistance at the point of fault is nearly zero

3.6
wiring

3.6.1
flexible cable
cable supplying mobile electrical equipment

3.6.2
stationary cable
cable supplying stationary electrical equipment which is suitably fixed at e.g. roadway wall, roadway support, conduits, platforms or constructional parts of machines

3.6.3
non-stationary cable
cable supplying electrical equipment which:

- are moved frequently or often,
- are moved as part of the mining or mineral winning process

3.7
conductors

3.7.1
line conductor
conductor which is energized in normal operation and capable of contributing to the transmission or distribution of electric energy but which is not a neutral or mid-point conductor

[SOURCE: IEV 826-14-09]

3.7.2
neutral conductor
conductor electrically connected to the neutral point and capable of contributing to the distribution of electric energy

[SOURCE: IEV 826-14-07]

3.7.3
protective conductor
conductor provided for purposes of safety, for example protection against electric shock

[SOURCE: IEV 826-13-22]

3.7.4
PEN conductor
conductor combining the functions of both a protective earthing conductor and a neutral conductor

[SOURCE: IEV 826-13-25]

3.8
switching

3.8.1
opening/tripping
opening of a circuit-breaker by either manual or automatic control of protective devices

Note 1 to entry: The expression tripping of a network item (line, transformer) in fact means tripping of the associated circuit-breakers.

[SOURCE: IEV 604-02-31]

3.8.2
disconnection
making a circuit non-alive (opening of all lines)

3.8.3
isolation
general separation of an electrical equipment or circuit from all not earth bounded lines

3.9
protection against electrical shock

3.9.1
live part
conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a PEN conductor

Note 1 to entry: This concept does not necessarily imply a risk of electric shock.

[SOURCE: IEV 826-12-08]

3.9.2
basic protection
protection against electric shock under fault-free conditions

Note 1 to entry: For low-voltage installations, systems and equipment, basic protection generally corresponds to protection against direct contact.

[SOURCE: IEV 826-12-05]

3.9.3
fault protection
protection against electric shock under single-fault conditions

Note 1 to entry: For low-voltage installations, systems and equipment, fault protection generally corresponds to protection against indirect contact, mainly with regard to failure of basic insulation.

[SOURCE: IEV 826-12-06]

3.9.4
basic insulation
insulation of hazardous-live-parts which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEV 826-12-14]

3.9.5
protection by using equipment of protection class II or by equivalent insulation
safety precaution which is made by:

- an additional insulation of the basic insulation, or
- by strengthening of basic insulation,

in such a way that in a case of malfunction of basic insulation no dangerous situation will occur

3.9.6
Extra-Low Voltage
ELV
voltage not exceeding the relevant voltage limit of band I specified in IEC 60449

[SOURCE: IEV 826-12-30]

3.9.7
SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

— under normal conditions, and

— under single fault conditions, including earth faults in other electric circuits

Note 1 to entry: SELV is the abbreviation for safety extra low voltage.

[SOURCE: IEV 826-12-31]

3.9.8
PELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

— under normal conditions, and

— under single fault conditions, except earth faults in other electric circuits

Note 1 to entry: PELV is the abbreviation for protective extra low voltage.

[SOURCE: IEV 826-12-32]

3.9.9
IT-system
systems with nominal voltages up to 1 000 V and those above 1 000 V where safety precautions are characterized as follows:

- there is no direct connection between live conductors and earth bonded parts; all exposed-conductive-part are bonded to earth via protective conductor;

- the protective conductor is routed underground through all voltage levels and is connected to the earthing system – see 12.3.3;

- arrangement and cross-section of the protective conductor within the cable are subjected to particular defined requirements not only because of too high touch-voltage; requirements of flame- and explosive protection are taken into account, too;

- each galvanically separated system is equipped with an insulation monitoring device to indicate and trip an insulation fault

3.9.10
TN-system
one point of a TN-system is directly bonded to earth

Note 1 to entry: The exposed conductive parts of the electrical installation are connected with this point by protective conductor.

Note 2 to entry: Three kinds of TN-Systems are existing depending on the arrangement of protective conductor and neutral conductor:

- TN-S system: in the whole system a separated protective conductor is used;
- TN-C-S system: in a part of the system the function of the neutral and protective conductor is combined in only one conductor;
- TN-C system: in the whole system the function of the neutral and protective conductor is combined in only one conductor.

3.10
voltages

3.10.1
operating voltage
value of the voltage under normal conditions, at a given instant and a given point in the system

Note 1 to entry: This value may be expected, estimated or measured.

[SOURCE: IEV 601-01-22]

3.10.2
touch voltage
voltage between conductive parts when touched simultaneously by a person or an animal

Note 1 to entry: The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

[SOURCE: IEV 826-11-05]

3.10.3
nominal voltage (of an electrical installation)
value of the voltage by which the electrical installation or part of the electrical installation is designated and identified

[SOURCE: IEV 826-11-01]

3.10.4
fault voltage
voltage between a given point of fault and reference earth resulting from an insulation fault

[SOURCE: IEV 826-11-02]

3.11
electrical circuits

3.11.1
(electric) circuit (of an electrical installation)
assembly of electric equipment of the electrical installation protected against overcurrent by the same protective device(s)

[SOURCE: IEV 826-14-01]

3.11.2
main electrical circuit
electrical circuits with items used for such purposes as generation, conversion, distribution switching or utilization of electric energy

3.11.3
auxiliary electrical circuits
electrical circuits with additional functions; e.g. remote circuits (command initiation locking), signal- and measurement circuits in electric power installations

3.11.4
remote circuits
control-, signal- and measurement circuits in communication system

3.12
overcurrent
electric current exceeding the rated electric current

Note 1 to entry: For conductors, the rated current is considered as equal to the current-carrying capacity.

[SOURCE: IEV 826-11-14]

3.12.1
overload current (of an electric circuit)
overcurrent occurring in an electric circuit, which is not caused by a short-circuit or an earth fault

[SOURCE: IEV 826-11-15]

3.12.2
short-circuit current
electric current in a given short-circuit

[SOURCE: IEV 826-11-16]

3.13
overcurrent device
equipment or device which will trip the current automatically when increasing above a set or selected value

3.13.1
overload current device
device which will protect electrical equipment against heating causing by overload

3.13.2
short-circuit current device
device which will trip in a definite and defined time rapidly and automatically on detection of short circuit currents

3.13.3
reclosing interlock
device which will prohibit the restart of electrical equipment in case of faults within the system

Note 1 to entry: The interlock can be neutralized by deliberate manual activity.

4 General

4.1 General requirements

4.1.1 Only electrical equipment shall be used for erection of electrical installations which are in accordance with the appropriate standards and for which a valid certification for intended use exists. In case of potentially explosive atmospheres due to firedamp in the coal mining industry or due to other explosive atmospheres in the non-coal mining industry the electrical equipment shall have a declaration of conformity or attestation of conformity according to ATEX – 2014/34/EU – Directive.

4.1.2 A certification is not necessary for cables and their accessories. Besides that a certification is not necessary for simple device in accordance with EN 60079–11.

4.1.3 Electrical installations shall be erected in such a way that they can be de-energized if firedamp concentration in air exceeds a maximum value stated by national regulation.

De-energizing is not necessary for:

- intrinsically safe systems of level of protection “ia”;
- electrical equipment of category M1. In case of intrinsically safe equipment with external circuits (input and/or output) they shall comply with Group I level of protection ia“.

4.1.4 Only such electrical equipment shall be used which are able to withstand the foreseeable electrical, mechanical and adverse or hazardous environmental influence (e.g. water, dust, chemical influence, electric and magnetic fields).

NOTE The required level of ingress protection is described in EN 60529.

4.1.5 Electrical equipment and electrical installation shall be erected with sufficient ability to withstand electrical short circuits.

4.1.6 Electrical equipment shall withstand the maximum short circuit current which can occur at the place of installation unless the short circuit occurs inside the electrical equipment itself.

4.1.7 Where current limitation devices and in particular fuses are fitted within switchgear on the line conductors, then careful consideration should be given, as the ability to withstand the short circuit depends on the forward current which can occur in the worst case scenario at the place of Installation.

4.1.8 The sufficient ability to withstand a short circuit of electrical installation shall be determined. In case of calculation of this ability EN 60865-1 shall be used.

4.1.9 To fulfil these requirements short circuit currents in electrical installations at the place of the electrical equipment shall be calculated in accordance with Clause 25 of this standard.

4.1.10 Electrical installations shall be erected in such a way that it is possible to have safe access and to be able to operate the electrical equipment from a safe place.

4.1.11 Electrical equipment shall be erected in such a way that dissipated heat generated during operation can be emitted sufficiently.

4.1.12 Electrical equipment which are tested only with the lowest impact energy in accordance with the

standards and therefore marked with an “X” in accordance with EN 60079–0 shall be erected, used and maintained only in accordance with the certificate and manufactures instruction manual.	
4.1.13 Communication equipment shall be in accordance with EN 60079 series even they are not installed in areas endangered or likely to be endangered by explosives atmospheres.	
4.1.14 Communication equipment for signal installations of hoisting plants shall be in accordance with EN 60079 series unless it is installed inside the hoisting room above ground.	Communication equipment shall be suitable to withstand mechanical stress, humidity and corrosion except those being installed above ground inside hoisting rooms. They shall be flame retardant according to EN 60332–1-2 and shall fulfil the following requirements: • ingress protection of at least IP54 • insulation coordination in accordance with EN 60664–1.

4.2 Initial inspections

4.2.1 Equipment shall be installed in accordance with their documentation. Initial inspections shall check that the selected type of protection and its installation are appropriate. These initial inspections shall be carried out before putting into operation and recorded at every new or modified electrical installation to guarantee a proper condition of the installation.

4.2.2 Detailed inspections shall be in accordance with national regulations and manufactures recommendations given in documentation and instruction manuals.

NOTE Useful information about inspection procedures for Group II equipment is provided in EN 60079–17.

4.3 Competence of personnel

4.3.1 The erection of electrical installation in underground workings shall be carried out only by competent persons. A competent person possesses sufficient technical knowledge, relevant practical skills and experienced for the task and is able to undertake it safely to prevent danger.

4.3.2 The technical knowledge may vary due to the complexity of the essential installation requirements. Due to that it shall be ensured that only competent persons are authorized to do the installation.

NOTE “Professional schooling”, “professional experience” and “occupational activities” are subject to the national member states.

4.3.3 People who are working in underground workings shall have sufficient knowledge of mining activities which are relevant for their own occupation. People who are working in underground workings which could be endangered by firedamp or in hazardous locations shall have the necessary relevant skill.

4.4 Documentation

4.4.1 It is necessary to ensure that any installation complies with the appropriate regulations and standards certificates as well as with this standard and any other requirements specific to the plant on which the installation takes place. To achieve this result, a verification dossier shall be prepared for every installation and shall be either kept on the premises or stored in another location. In the latter case, a document shall be left on the premises indicating who the owner or owners are and where that information is kept, so that if required, copies may be obtained.

4.4.2 At least the following documents are minimum required:

- Instruction and maintenance manuals of the used electrical equipment;
- Documentation of an intrinsically safe system;
- Overview-diagram of the whole installation.

4.4.3 The access to these documents shall be ensured all the time.

NOTE 1 Methods accepted by legislation in each country vary the form in which the documentation will be legally accepted.

NOTE 2 Further recommended requirements of documentation are listed in Annex A.

5 Means of protection against electric- and electrostatic charging

In underground workings endangered by firedamp electrical installations shall be erected in such a way that electrostatic discharging of electrical equipment will not ignite the atmosphere. This is met if the exposed conductive parts of those electrical equipment are at least electrostatically bonded to earth.

To provide the appearance of charging of air laid cables in systems above 1 kV nominal voltage the connections between protective conductor, armour and other earth bonded conductive parts shall be safe and approximately zero Ohms at the connection points.

6 Rooms and Locations

6.1 Electrical service rooms

Rooms extensively for erection and operation of electrical installation shall be demarcated from unintentionally entering by doors or chains or similar barriers.

NOTE Such rooms might be: pump rooms, hoist chambers, switch rooms, electrical-workshops.

6.2 Closed electrical service rooms

Rooms only for erection and operation of electrical installation shall be key-lockable. The doors shall only be opened outwards.

The locking devices shall be designed that unauthorized access is impossible but people inside are able to leave the room at any time.

6.3 Other rooms

Hazardous areas shall be indicated. For indication purpose EN 60079–10–1 in case of hazards due to gas-atmospheres or EN 60079–10–2 in case of hazards due to dust atmospheres shall apply. In the case of installation EN 60079–14 shall apply.

7 Protection against fire spreading

7.1 General requirements

7.1.1 Heaters, resistor devices and electrical machines shall be erected far away from objects which can be endangered by the heat so that there will be no fire hazard arising from the electrical installation.

7.1.2 For coalmining shall apply:

In case of an IT-system underground with nominal voltage above 1 kV and an earth fault current of more than 10 A an earth-fault neutralizing device shall be part of the electrical distribution network.

An earth-fault neutralizing device is not necessary if the earth fault current is lower than 100 A and if the faulty part of the system is switched off immediately, in case of selective detection a delay time of 1,5 s is permitted.

NOTE In that case coalmining means not only hardcoal.

7.1.2.1 The earth fault neutralizing device shall limit the earth fault current to 10 A.

7.1.2.2 The adjustment of the earth fault neutralizing device shall be automatically.

7.1.2.3 A bigger earth fault current is permitted in systems where a simple perfect earth fault leads to an undelayed switch off of the faulty part of the system; in case of selective detection the following times shall apply:

Earth fault current	Switch-off-time(max)
above 10 A to 20 A	3 s
above 20 A to 50 A	1,5 s

In case of an earth fault current of 10 A maximum the switch-off-time might be 6 s in accordance with 12.2 of this standard.

7.1.3 The covering and outer protective covers of cables shall be flame retardant. Cables where the insulating coating of the conductors are of non-flame retardant thermoplastic synthetic material there shall be a metallic screen, an armour or a non-metallic wrapping which is flame retardant between the outer coating of the conductors and the covering. That doesn't apply to non-electric conductors; e.g. optical fibres.

Cables are flame retardant if they are:

- in accordance with EN 60332-1-2.

8 Insulation, Insulation-resistance and its check

8.1 Insulation

8.1.1 In regard to material and design insulation shall withstand the stress in underground workings. This is approved using cable listed in the informative Annex E of this standard.

8.1.2 Cast resin cable joints shall be used which are in accordance with HD 631.1 S2.

8.1.3 If mineral oil is used in underground workings then it shall be in accordance with EN 60296, silicone liquids for electrical purpose shall be in accordance with EN 60836 and synthetic organic ester for electrical purpose shall be in accordance with EN 61099.

NOTE Member states may prohibit the use of such oil-filled equipment in underground workings.

8.2 Value of insulation resistance

The value of the insulation resistance of an electrical installation except for an intrinsically safe electrical installation shall be as follows:

8.2.1 In parts of systems without load the insulation resistance shall be measured. The resulting leakage current per every 1 000 m at rated voltage shall not exceed 1 mA. For calculation of the insulation resistance the following formula shall apply:

$$R = 1\,000 * U : I$$

where

R = resistance in Ω

U = voltage in V

I = length of the cable in km

1 000 = calculating factor in km/A

In the case of a cable length of less than 1 km, then the criteria associated with 1 km shall apply.

8.2.2 Using the IT-system the insulation resistance for a system including load shall be at least 50 Ω per V nominal voltage.

8.3 Insulation resistance check

Before putting an installation into use for the first time the installation should be commissioned. The commissioning should include visual inspection and testing of the insulation resistance in accordance with Subclause 8.2.1 of this standard.

8.3.1 The following shall be measured:

a) phase conductor – phase conductor,

b) each phase conductor – protection conductor and armour,

c) within TN-system additional,

   1) each phase conductor – neutral conductor,

   2) separated neutral conductor - protection conductor and armour.

Existing insulation monitoring devices in accordance with Subclause 12.4 of this standard shall be separated from the system before measuring.

8.3.2 Direct voltage shall be used for measurement.

Testing values shall be in accordance with manufactures guidelines.

8.3.3 The insulation resistance needs not to be measured in:

- intrinsically safe electrical installations,
- communication systems,
- auxiliary electric circuits.

9 Signboards, labels, wiring diagrams, inscriptions

9.1 General requirements

9.1.1 At the entrance to electrical operating locations or enclosed electrical operating locations signboards shall be placed to make clear that an unauthorized access is forbidden.

9.1.2 At the entrance to electrical operating locations or enclosed electrical operating locations signboards shall be placed to make people aware of a potentially fatal voltage inside the locations, or danger of death.

NOTE EN ISO 7010 could give information using the correct sign.

9.1.3 Overview-diagrams or similar kind of identification methods shall be available at all electrical installation locations. Modifications and extensions of the installations shall be marked immediately.

9.1.4 Boxes and associated covers shall be marked unambiguously to avoid interchanging.

9.1.5 Electric installations shall have unambiguous markings to let know what kind of load will be supplied.

9.1.5.1 The markings of cell designed switchgears shall be visible with cell door open as well as closed.

9.1.5.2 To avoid the potential for misidentification, where access to the rear of switchgear is available, then the duty of the circuit should also be displayed on the rear of the switchgear.

9.1.5.3 The information about the cross-section of the supplying power-cable shall be available on the label, too.

9.1.5.4 Duty labels shall provide details of the overload settings as well the rated current of the fuses.

9.1.6 The feeding cable of switchgears shall be marked at each joint unambiguously. At the installation location the feeding point of the feeding cables shall be identifiable.

9.1.7 Signboards and labels shall be readable all the time.

10 Nominal voltages

10.1 General requirements

The nominal voltage of the systems shall be at most:

10.1.1

11 kV	33 kV

The nominal voltage is only one indication for the distribution network. The maximum voltage U_{Max} should also be taken into account if electrical equipment and electrical cable are to be installed. See EN 60038.

10.1.2 6,6 kV in case of production areas or road headings.

10.1.3 In case of cables:

- directed in front of a production area,
- laid in workings where other workings are started from:

11 kV	33 kV

10.2 Voltage ranges

For the following equipment and installations the nominal voltages as below shall not be exceeded:

10.2.1 400 V AC nominal voltage for power tools, hand-held lamps, lighting installations. 1 000 V feeding nominal voltage is permitted for lamps within lighting installations which are galvanically separated by transformer from the feeding system.

10.2.2 230 V AC or 250 V DC for communication systems.

10.2.3 230 V AC or 250 V DC for auxiliary electric circuits.

10.2.4 50 V AC or 120 V DC for auxiliary electric circuits inside non stationary lines.

11 Protection against electrical shock

11.1 Requirements for basic protection

11.1.1 Protection by basic insulation of live parts

Live parts shall be completely covered with insulation which can only be removed by destruction.

NOTE 1 The insulation is intended to prevent contact with live parts.

NOTE 2 For equipment, the insulation complies with the relevant standard for the electrical equipment.

11.1.2 Protection by barriers or enclosures

11.1.2.1 Live parts shall be inside enclosures or behind barriers providing at least the degree of protection of IP2X according to EN 60529 except that, where larger openings occur during the replacement of parts, such as certain lamp holders or fuses:

- suitable precautions shall be taken to prevent persons from unintentionally touching live parts, and
- it shall be ensured that persons will be aware that live parts can be touched through the opening and should not be touched intentionally, and
- the opening shall be as small as is consistent with the requirements for proper functioning and for replacement of a part.

11.1.2.2 Barriers and enclosures shall be firmly secured in place and have sufficient stability and durability to maintain the required degrees of protection and appropriate separation from live parts in the known conditions of normal service, taking account of relevant external influences.

11.1.2.3 Where it is necessary to remove barriers or open enclosures or to remove parts of enclosures, this shall be possible only:

- by use of a special key or a special tool, or
- after disconnection of the supply to live parts against which the barriers or enclosures afford protection, restoration of the supply being possible only after replacement or reclosure of the barriers or enclosures, or

- where an intermediate barrier providing a degree of protection of at least IP4X prevents contact with live parts, by the use of a tool or a key to remove the intermediate barrier.

11.1.2.4 If, behind a barrier or in an enclosure, items of equipment are installed which may retain dangerous electrical charges after they have been switched off, a warning label is required.

11.1.3 Protection by obstacles and placing out of reach

11.1.3.1

Protection by obstacles and placing out of reach is not allowed.

11.1.3.2

The following is required:

The protective measures of obstacles and placing out of reach provide basic protection only. They are only for applications in installations with or without fault protection that are controlled or supervised by skilled or instructed persons.

NOTE Obstacles are intended to prevent unintentionally contact with live parts but not intentionally contact by deliberate circumvention of the obstacle.

Obstacles may be removed without using a key or tool but shall be secured so as to prevent unintentional removing.

11.2 Requirements for fault protection

Without exception one of the following precautions are applicable:

11.2.1 Protection in IT-systems in accordance with Clause 12, or

11.2.2 Protection in TN systems with an earth-fault current detection device (RCD) in accordance with EN 61557-6 and 13.1 of this standard, or

11.2.3 protection by using equipment of protection class II or equivalent insulation in accordance with Clause 14 of this standard, or

11.2.4 protection by using low voltage in accordance with Clause 14 of this standard.

12 Protection in IT-Systems

12.1 General

In IT- Systems the following monitoring devices and protective devices may be used:

- Insulation monitoring devices (IMD);
- Residual current monitoring devices (RCM);
- Insulation fault location systems (IFLS) according to EN 61557-9;
- Overcurrent protective devices;
- Residual current protective devices (RCD).

In case of an existing neutral point:

- Neutral point current monitoring device.

in case of a supervision conductor:

- Protection conductor monitoring device.

12.2 Earth fault detection in IT-systems

12.2.1 Systems not being IS shall be erected in such a way, that in case of a complete unresisting earth fault the faulty part of the system will be tripped automatically,

- undelayed in systems with a nominal voltage higher than 1 kV, within 6 s in case of selective tripping unless a shorter tripping time is required in accordance with 7.1.2;
- within 1,5 s in systems not being IS but less than 1 000 V.

12.2.2 Restart for the at least faulty part of the system shall be prevented as long as the earth fault exists.

12.2.3 In the case of mine winding systems the tripping following earth fault detection can be delayed until the completion of a winding cycle, if the systems overall safety is not compromised.

If an IT system is used, an IMD shall be provided to indicate the first insulation fault.

12.3Design of IT system

12.3.1 An IT-system is suitable for all kinds of nominal voltages.

12.3.2 In IT-systems live parts shall be insulated from earth or connected to earth through sufficiently high impedance. This connection may be made either at the neutral point or midpoint of the system or at an artificial neutral point.

12.3.3 All exposed conductive parts shall be connected to a continuous protective conductor which is bounded to earth at a suitable point. Under normal service conditions the protective conductor shall not be interrupted; no overcurrent devices are allowed.

12.3.4 Between the neutral point of the transformer and the protective conductor no overvoltage devices are allowed (e.g. overvoltage protector).

12.3.5 The following devices can be connected between live parts and protective conductor for measuring purposes:

a) Electrical impedances for earth leakage monitoring; e.g. in order to fulfil the requirements of Subclause 12.2 of this standard in all systems. In systems with nominal voltages of more than 1 kV in coal mining the impedance shall be dimensioned in such a way, that the earth leakage current is not more than 10 A. That doesn't apply to systems with earth current neutralizing devices in accordance with c). In systems with nominal voltages up to 1 000 V the value of the impedance shall not less than 15 kΩ.

b) Measuring devices or insulation monitoring devices or earth-fault tripping with an internal a.c. resistance of at least 250 Ω per V nominal voltage but at least 15 kΩ in system with a nominal voltage not more than 1 000 V.

c) In systems with nominal voltages above 1 kV:

earth-current neutralizing devices, special devices for limitation of over voltages and single pole insulated voltage transformers.

12.3.6 The installation shall be erected in such a way that the fault voltage caused by the build-up earth fault current of the system shall not exceed 50 V AC. This shall be ensured by measuring or calculating. Calculating according Annex D is sufficient. A calculation is not necessary in distribution networks with nominal voltage above 1 kV and a total length of cable up to 10 km and in distribution networks with nominal voltage up to 1 000 V.

12.3.7 In distribution networks without earth-fault tripping, double earth faults shall be taken into account. In distribution networks up to 1 000 V tripping times shall meet the requirements of HD 60364-4-41.

12.3.8	If it is guaranteed that there will not be any dangerous contact voltages in case of an earth fault- e.g. in salt mines due to dry conditions - it is allowed that the fault voltage can exceed 50 V AC. In these special cases where the contact voltage can exceed the limit of the fault voltage mentioned in 12.3.6 there shall be means of potential equalizing.

12.4 Insulation monitoring

12.4.1 An insulation monitoring device (IMD) shall be installed to measure the insulation resistant against earth for all kind of systems except intrinsically safe systems.

12.4.2 Insulation monitoring shall fulfil the requirements of 12.4.2.1 - 12.4.6.

12.4.2.1 In all systems where earth leakage/insulation monitoring is fitted the decrease of the insulation resistance of the monitored system of less than 50 Ω per V of nominal voltage shall be indicated.

12.4.2.2 The status indication shall be provided locally and visible or remotely to a permanently manned location or both.

12.4.2.2.1 In case of decrease of the insulation resistance of the monitored system on less than 20 Ω per V of nominal voltage the faulty network shall be switched off not later than in 1,5 s.

12.4.2.2.2 In this case the other part of monitored network (between transformer and next switchgear) shall be switched off with time delay of not more than 1,5 s.

12.4.2.2.3 If the insulation resistance of monitoring network is less than 25 Ω per V of nominal voltage network switching on shall be interlocked.

12.4.3 Only those deemed competent and authorized to do so, shall be permitted to adjust the threshold and tripping values of insulation monitoring devices.

NOTE Qualification: see 4.3.

12.4.4 The threshold values shall be recognizable directly on an integrated scale without any conversion factor.

12.4.5 The IMD shall have an integrated testing device which tests the function from outside of the equipment where the IMD is built-in. There is no need for such a testing device in cases where an IMD according to EN 61557-15 is used that meets SIL1 or higher levels by using an automatic test routine regarding functional safety.

12.4.6 An insulation monitoring device in accordance with EN 61557-8 shall be used in systems with nominal voltages of at most 1 000 V.

12.4.7 The measurement voltage of the insulation monitoring device which is interfered shall be at most 100 V.

Measuring circuits of earth fault tripping devices shall be intrinsically safe.

12.5 Protective conductor

12.5.1 Protective conductors inside cables shall be laid out as follows:

12.5.1.1 as an insulated conductor twisted with the phase conductors, or

12.5.1.2 as an insulated conductor uniformly distributed in the interstices,

12.5.1.3 as a non-insulated concentric conductor uniformly distributed around the insulation of the phase conductors, or

12.5.1.4 as a non-insulated conductor uniformly distributed in the interstices if the insulation of the phase conductors is covered with a non-metallic conducting material, or

12.5.1.5 as a non-insulated conductor between inner and outer covering concentrically to the centre line.

12.5.2 In hard coal mining the protective conductors shall be laid in accordance with 12.5.1.3, 12.5.1.4 or 12.5.1.5 in electrical power installations with a nominal voltage of more than 230 V supplied from a current generator with more than 20 kVA; in systems with a nominal voltage of more than 6,6 kV only protective conductors laid in accordance with 12.5.1.3 or 12.5.1.4 are permitted.

In mining operation or road heading areas the requirements of Clause 15 of this standard shall apply.

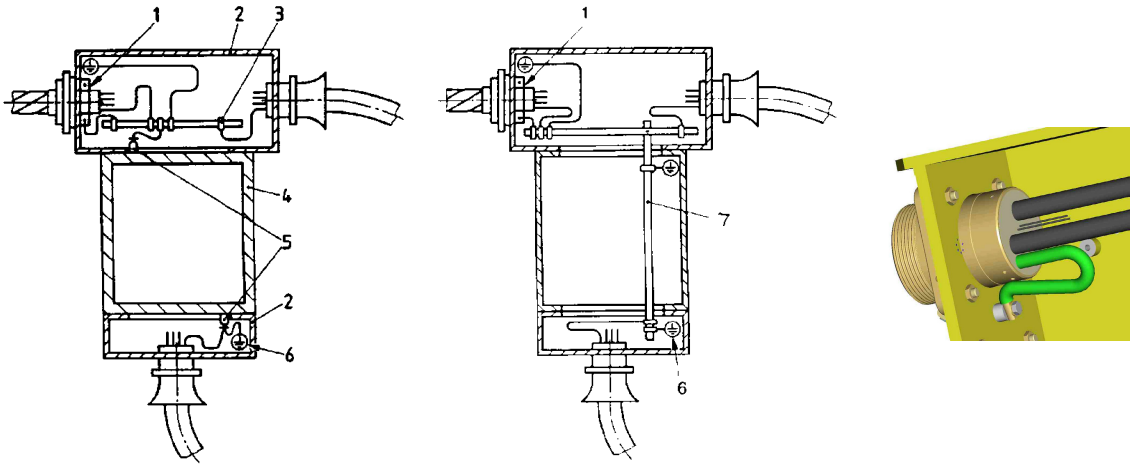
12.5.3 The insulation of the protective conductor shall be marked green/yellow.

The marking green/yellow is permitted as well for:

- Bonding conductors with protection functions,
- Earthing conductors with protection function.

For other conductors this kind of marking is not permitted.

12.5.4 The protective conductor of cables shall be connected to special marked terminals inside the equipment (see figures below).



a) Ex-proofed version **b) Non-Ex-proofed version** **c) Cable entry**

Key

1 metallic cover and/or armour
2 enclosure with type of protection “e”
3 protective conductor
4 enclosure with type of protection “d”
5 protective conductor terminal, non-insulated
6 protective conductor terminal
7 protective conductor configuration

Figure 1 — Examples for the connecting of the devices to the protective conductor, inside or outside from cables (From left to right: Ex-proofed version, non-Ex-proofed version, cable entry)

12.5.5 Inside cable of electrical power installations the cross-section of the protective conductor shall be at least:

Table 1 — Cross-section of the protective conductor inside cable

Cross-section of phase conductor in mm^2	Cross-section of the protective conductor in mm^2	Cross-section of phase conductor in mm^2	Cross-section of the protective conductor in mm^2
0,75	0,75	25	16
1,0	1,.0	35	16
1,5	1,5	50	25
2,5	2,5	70	35
4,0	4,0	95	50
6,0	6,0	120	70
10,0	10,0	150	70
16,0	16,0	185	95

12.5.6 The cross-section ratio of phase conductor and protective conductor is only valid for same material. The cross-section ratio of phase conductor and protective conductor shall be at least the same if different materials are used.

12.5.7 If there is only one protective conductor for more than one current circuit the cross-section of the protective conductor shall be appropriate to the cross-section of the bigger phase conductor (see Table 1).

12.5.8 In cables of communication systems the cross-section shall have at least the same size as the biggest live conductor under operation conditions.

12.5.9 For IT systems with rapid disconnect according to Subclause 7.1.2 2nd sentence, the cross section of protective conductor may be about as in table below:

Table 2 — Cross-section of the protective conductor inside cable in case of rapid disconnect

Cross section of phase conductor [mm^2]	Cross section of protective conductor [mm^2]	Cross section of phase conductor [mm^2]	Cross section of protective conductor [mm^2]
0,75	0,75	25	16
1,0	1,0	35	16
1,5	1,5	50	25
2,5	2,5	70	25
4,0	4,0	95	25
6,0	6,0	120	35
10,0	10,0	150	35
16,0	16,0	185	35

12.6 Electrical protection devices in IT-systems

Electrical protection devices shall only be used, if their effectiveness in connection with the design and the faults of the cable is shown by a type test report. This report shall be available for the user.

NOTE A protection device in the sense of this standard is not a safety device according to the ATEX-Directive.

12.6.1 Electrical protection devices shall protect the entire length of the cable and shall switch-off the cable in connection with a switch-gear in case of a fault.

Electrical protection devices shall prevent a restart after switching-off the faulty part of the system. Furthermore, the electrical protection devices shall be coupled electrically with the switchgear installed at the beginning of the protecting cable in such a way that it is impossible to energize the cable without an operating electrical protection device.

12.6.2 Electrical protection devices shall include at least the following devices depending on the nominal voltage:

12.6.2.1 In systems with nominal voltages up to 230 V, devices for prevent energizing of cable and switching-off in case of

- Short-circuit of supervision conductor/protection conductor,
- Break of the supervision conductor or the protection conductor,
- Short-circuit of live conductor/protection conductor.
- Earth fault, unless there is a switch off by an insulation monitoring device within 1,5 s.

12.6.2.2 In systems with nominal voltages from 230 V up to 1 000 V without convertors, devices for prevent energizing of cable and switching-off in case of:

- Short-circuit of supervision conductor/protection conductor,
- Break of the supervision conductor or the protection conductor,
- Short-circuit of live conductor/protection conductor.
- Earth fault, if the insulation resistance falls below a value of 20 Ω per V of nominal voltage or in case of unresistant earth fault the electrical protection device shall switch-off at least this part of the system within 1,5 s. This can be achieved by using an insulation monitoring device.
- In case of a complete earth fault this part of the system shall be switched-off within 0,2 s.
- Short circuit of phase conductor/supervision conductor if the supervision conductor is single concentric in accordance with 12.7.2.1.

12.6.2.3 In systems with nominal voltages from 230 V up to 1 000 V with converters, devices for prevent energizing of cable and switching-off in all cases of 12.6.2.2.

but if the insulation resistance falls below a value of 20 Ω per V of nominal voltage the electrical protection device shall switch-off at least this part of the system as quick as data acquisition will afford, but not later than in 15 s.

12.6.2.4 An automatically restart after earth fault tripping shall be prevented in systems with nominal voltages from 230 V up to 1 000 V.

This part of the system shall be energized only in case of an insulation resistance of more than 25 Ω per V of nominal voltage.

12.6.2.5 In systems with nominal voltages more than 1 kV for mobile equipment, devices for switching-off in case of:

- Short-circuit of supervision conductor/protection conductor,
- Break of the supervision conductor or the protection conductor,
- Short-circuit of live conductor/protection conductor.
- Earth fault. If the insulation resistance falls below a value of 50 Ω per V of nominal voltage the electrical protection device shall switch-off at least this part of the system within 1,5 s.
- In case of unresistant earth fault protection device shall switch off within 0,2 s.
- An automatic re-start after earth fault tripping shall be prevented.

12.6.2.6 In systems for feeding electrical equipment in production areas with nominal voltages of more than 1 kV, devices for switching-off in case of:

- Short-circuit of supervision conductor/protection conductor,
- Break of the supervision conductor or the protection conductor,
- Short-circuit of live conductor/protection conductor.
- Earth fault. If the insulation resistance falls below a value of 20 Ω per V of nominal voltage the electrical protection device shall switch-off at least this part of the system within 1,5 s.
- In case of unresisting earth faults electrical protection device shall switch-off at least this part of the system within 0,2 s.
- To prevent unnecessary activating of protection device by switching it on activating delay of at most 1 s is allowed.

12.6.3 For the supervision circuit (supervision conductor/protection conductor) the following applies, furthermore:

12.6.3.1 This circuit shall be laid out in such a way that the highest voltage by given capacity of the cable (3 x C_{10}) which will arise in this circuit while the system is not alive is lower than the lowest ignition voltage:

in accordance with EN 60079–11:2012, Annex A, Figure A.2 bottom curve.	In accordance to EN 60079–11:2012, Annex A, Figure A.3 using the curve of the relevant gas.

NOTE C_{10} is suggested to be the capacity between each main core and PE.

The compliance with this requirement shall be established by the manufacturer or an accredited test house.

In case on inductive coupling and electronic current limitation of the measuring circuit the non-ignitability shall be verified by using the spark test apparatus in accordance with EN 60079-11.

12.6.3.2 The connection arrangement shall be configured so that the supervision conductor makes last and breaks first, especially if the connections are subject to excessive tensile force.

12.6.3.3 Switches within the supervision circuits in systems of a nominal voltage higher than 230 V shall have opening contacts to disconnect the supervision circuit as well as a close contact to shorten the supervision and the protective conductor. Pushbuttons for remote control shall have a fixed position when being in “OFF”-position.

12.6.4 The tripping of this protection device shall be indicated optically.

12.6.5 The operational reliability of the protective device shall be established.

12.6.6 The testing equipment for the protective conductor monitoring is not necessary if the supervision circuit is used for remote control or signalling.

12.7 Design of cables being monitored by a protection device

12.7.1 Cables in accordance with 23.1.1 of this standard shall be selected.

12.7.2 To achieve the safety requirements in accordance with 12.6.1 the technical requirements of the cables shall be as follow:

12.7.2.1 Single concentric designed cable:

a) Protective conductor:

   1) as a non-insulated concentric conductor uniformly distributed around the insulation of the phase conductors, or

   2) as a non-insulated conductor uniformly distributed in the interstices if the insulation of the phase conductors is covered with a non-metallic conducting material.

b) Supervision conductor:

   1) as a metallic non insulated or non-metallic conducting covering between inner and outer covering concentrically to the centre line, or

   2) single line.

12.7.2.2 Overall concentric designed cable:

a) Protective conductor:

   1) as non-insulated conductor between inner and outer covering concentrically to the centre line.

b) Supervision conductor:

   1) as a non-insulated concentric conductor uniformly distributed around the insulation of the phase conductors, or

   2) single line, if the metallic non-insulated or non-metallic conducting covering around the insulation of the phase conductors is connected to the protective conductor.

12.7.2.3 In systems with a nominal voltage higher than 1 kV only cable designed in accordance with 12.7.2.1 is permitted.

12.7.3	Deviating from 12.7.2 it is allowed to use the following cables in workings endangered by fire hazards of non-hard coal mining • in system with a nominal voltage higher than 230 V cable with a single concentric protective conductor in accordance with 12.5.1.3 or 12.5.1.4 and a supervision conductor designed anyway, • in system with a nominal voltage of at most 230 V cable with protective and supervision conductor designed anyway. In other workings there are no requirements regarding the design of the protective and supervision conductor.

12.7.4 The conductors of the supervision circuit shall be arranged in a way that there is no bad influence on the operational reliability by induced voltage.

12.7.5 In cable with a non-metallic conductive covering there shall be a metallic conductor embedded to improve the longitudinal conductivity.

13 Protection in TN-systems

13.1 TN-S- systems with residual current devices (RCD)

TN-S Systems are not allowed.	TN-S systems are only permitted if the following requirements are fulfilled: **13.1.1** The partition between neutral conductor and protective conductor shall be before the point of interconnection to the consumer's installation. After the partition of the PEN-conductor neutral conductor and protective conductor shall not be connected together anymore. **13.1.2** At the point of interconnection the protective conductor shall be strictly bonded to earth. The earthing resistance shall not exceed 5 Ω. **13.1.3** A residual current device (RCD) or an AC / DC sensitive residual current monitor (RCM) in combination with a suitable switch gear shall be installed before feeding the workings. **13.1.4** The residual current device shall have a maximum rated fault current of 0,5 A. **13.1.5** Using RCM in combination with converter fed electrical drives the leakage currents of normal operation shall be taken into account. **13.1.6** All exposed conductive parts shall be connected to the earth bonded protective conductor. This protective conductor shall not be disconnected during operation; there shall be no overcurrent devices. **13.1.7** Regarding the layout of the protective

conductor Subclause 12.4 shall apply.

13.1.8 The protective conductor shall not keep operating current in any case.

13.1.9 The tripping of the residual current device (RCD) or the AC/DC sensitive residual current monitor (RCM) shall be within 0,2 s.

13.2 TN-S System without residual current devices (RCD)

TN-S Systems are not allowed.

All exposed conductive parts shall be connected to the protective conductor which shall be itself connected to the protective conductor of the feeding system. The protective conductor shall be laid out in accordance with 13.1.6, 13.1.7 and 13.1.8.

Further installation requirements are to be taken from HD 60364–4-41.

14 Other means of protection

The following other means of protection are applicable:

- Protection by using equipment of protection class II or equivalent insulation;
- Protection by using low voltage: SELV or PELV.

The corresponding installation requirements are to be taken from HD 60364–4-41.

15 Protection against danger caused by mechanical influence on non-intrinsically safe cables

15.1 General requirements

15.1.1 Effects caused by mechanical influence on cables shall be avoided. This can be achieved by using electrical protective devices in accordance with 12.6 in connection with cables of suitable design in accordance with 12.7 or by special mechanical protection in accordance with 15.1.2.

NOTE Face areas and areas up to 50 m to the heading face e.g. are areas where cables could be influenced by mechanical stress.

15.1.2 A special mechanical protection in accordance with 15.1.3 will be sufficient for cables:

- directed in front of a production area or
- laid in workings where other workings are spudded.

15.1.3 The mechanical protection devices shall be lead up as near as possible to the cable entry of the equipment and shall form part of the cable entry design. Metallic hoses are prohibited. Cables are considered to be especially mechanically protected if no damage is to be expected because of mechanical protection (e.g. spill plates, sectional steel, reinforced hose or cable protection chain) – see also EN 60204-1.

15.2 Cables to supply mobile electrical equipment

15.2.1 Cables to supply mobile electrical equipment shall be monitored by electrical protection devices in accordance with 12.6.

15.2.2 Subclause 15.2.1 does not apply to cables:

15.2.2.1	for low voltage circuits
15.2.2.2	supplying mobile electrical equipment with nominal voltage of at most 230 V in underground IT-systems and an earth leakage current of ≤ 0.03 A in case of an unresistant earth fault. If a hazard is to be expected through humidity (wetness) only one load shall be connected.
15.2.2.3	supplying mobile electrical equipment with nominal voltage of at most 500 V in TN-S systems if the equipment and the feeding cable are switched off undelayed by a residual current device in case of an unresistant earth fault.
15.2.2.4	supplying mobile electrical equipment with nominal voltage of at most 1 000 V in IT-systems if there is any device switching off the equipment and the feeding cable undelayed in case of an unresistant earth fault or if there is special potential equalizing system to reduce contact voltage in case of earth fault and break of the protection conductor.
15.2.2.5	to hand-held equipment, welding machines and equipment for vulcanizing switched off automatically and undelayed in case of an earth fault or fault to frame. RCD shall have a rated fault current of not more than 0,03 A with a tripping time of at most 0,1 s.
15.2.3	It shall be ensured that due to the dimension of the system according to 15.2.2.3 the tripping value of the RCD will be reached. This could be achieved by a capacity ratio against earth of at least 4:1 on line side and on load side of the RCD under all switch conditions if the earth fault current on line side of the RCD reaches the tripping value of the RCD. If necessary, the system-capacity of the pre-system is to be increased by fitting in capacitors.

15.3 Cable in areas of mining activities or road heading areas till 50 m far from the road heading face

15.3.1 Cables shall be monitored by an electrical protection device in accordance with Subclause 12.6.

15.3.2 Notwithstanding 15.3.1

- a particular mechanical protection in accordance with 15.1.3 will be sufficient
- a systematically laying of cables designed with single concentric protective conductor for supplying equipment following the winning or road heading process by flitting is sufficient.

15.3.3 In case of lighting installation an electrical protection device shall be provided anyway.

16 Intrinsically safe electrical systems

16.1 General requirements for selection

16.1.1 Intrinsically safe systems are made of:

- certified intrinsically safe apparatus and certified associated apparatus which may be connected together taking the descriptive system document according to Subclause 16.2 into account,

as well as

- all related cable according to Subclause 16.7 outside of enclosures leading only intrinsically safe circuits and which are specially marked,

as well as

- all simple apparatus according to EN 60079-11

16.1.2 All apparatus of the intrinsically safe system shall have an actual declaration of conformity when putting onto the market.

16.2 Descriptive system document

There shall be a descriptive system documentation for the whole intrinsically safe electrical system. The requirements shall be accordance with EN 60079-25.

16.3 Erection

16.3.1 Intrinsically safe electrical systems shall only be erected according to the descriptive system document in which is stated what kind of equipment including cable may be connected together in what kind of way, to ensure the intrinsic safety of the system. This document shall be available for the user.

16.3.2 Only those intrinsically safe electrical systems shall be installed where the intrinsically safe circuits will create neither a dangerous touch voltage nor a fire hazard. Associated apparatus shall be included in the fault protection of the feeding system.

16.3.3 Intrinsically safe electrical systems shall be installed so that the intrinsic safety will not be affected unduly by electrical and/or magnetic fields.

This may be achieved:

a) in the circuits which may be affected by

   1) twisting the conductors of the influenced cable (protection against magnetic fields),

   2) twisting the pair of conductors of earth balanced circuits (protection against electrical and magnetic fields),

   3) earthed screen (protection against electric and galvanic influence).

b) in the circuits being the source of influence by

   1) twisting and screening of the conductors,

   2) using earth balanced circuits.

c) observing a sufficient distance between influenced and affecting cables.

16.3.4 Plugs and sockets used for the connection of external intrinsically safe circuits shall be separate from, and non-interchangeable with those circuits which are not intrinsically safe.

16.4 Separation of intrinsically and non-intrinsically safe circuits

16.4.1

In case of associated apparatus not designed in other type of protection and being installed in control cabinets or equal the following requirements shall apply:

The terminals for outer circuits of intrinsically safe equipment and associated apparatus shall be arranged so that devices can't be damaged while mounting. The terminals of the intrinsically safe circuits shall be at least 50 mm far away from terminals of non-intrinsically safe circuits or blanked conductors unless they are separated by an insulation wall or an earthed metallic wall.

If such a separating wall is used it shall meet the requirements of EN 60079–11.

16.4.2 The clearance between terminals and bare conducting parts of each intrinsically safe circuit and earthed metallic parts shall meet the relevant chapters of EN 60079-11.

16.4.3 Intrinsically safe circuits shall not be within in the same cable with non-intrinsically safe circuits, otherwise it shall be certified by a notified body.

The same applies to bunched cables.

In cable channels, cabinets or apparatus racks intrinsically safe circuits and non-intrinsically safe circuits shall be separated by an insulated plate securely when using single core lines. This is not necessary when using sheathed or hose cable for the intrinsically safe circuits.

16.5 Separation of different intrinsically safe circuits

16.5.1 The interconnection of intrinsically safe circuits with different power supplies is not allowed unless the descriptive system document provides that. The requirements for interconnection shall be in accordance with EN 60079-25.

16.5.2 If there are more than one intrinsically safe circuit within one cable, the cable shall be in accordance with the requirements of EN 60079-25.

16.6 Earthing

16.6.1 Intrinsically safe circuits shall be erected unearthed and insulated unless it is stated within the certificate that it is allowed for functional reasons.

16.6.2 If there are earthed screenings or earthed metallic armouring in cable with intrinsically safe circuits and if they are bonded to earth at more than one point they shall be connected to the bonding conductor outside the cable. In that case the exposed conductive parts of the intrinsically safe equipment shall be connected to the screening or metallic armouring.

16.6.2.1 The bonding conductor shall be a single core copper line with a cross-section of at least 16 $mm^{2.}$. The bonding conductor shall be available in the whole area of the intrinsically safe system.

16.6.2.2 The protective conductor of an electrical power system may be a bonding conductor simultaneously if it is available in the whole area of the intrinsically safe system.

16.6.2.3 If the bonding conductor is a single core insulated line it shall be marked green-yellow.

16.6.2.4 Cores of the cable with intrinsically safe circuits which are potential free shall not be connected to the screen or the bonding conductor.

16.7 Cable for intrinsically safe systems

The requirements of EN 60079-25 and EN 50303 shall apply.

17 Installation of transformers

Transformers may be connected in parallel and may be protected with only one overload protection device, if

- they cannot operate alone,
- there are only two transformers connected in parallel,
- nominal power, transmission ratio and short-circuit voltage are within an acceptable tolerance and vector groups are equal, and
- the length of cable on the secondary winding side is similar.

18 Substations

Substations shall be easy to access for operation and maintenance purpose. Means of escape shall be kept all the time.

NOTE The above will be met if dimensions do not fall lower than values listed in Annex B.

19 Disconnecting devices in line of each switch-gears

Switchgears shall be provided with means to physically disconnect all phase conductors; the switching status shall be clearly visible. This does not apply to:

intrinsically safe systems.

systems with nominal voltage less than SELV level.

20 Switchgears

Only switchgear shall be used that is fitted with latching short circuit protection to prevent inadvertent reclosing.

21 Couplers and connectors

21.1 General requirements for use of couplers and connectors

21.1.1 Where plugs and sockets for differing duties are used and danger could arise due to misconnection, then means to avoid this should be provided, for example colour coding, padlocking or keyed plugs.

21.1.2 To avoid risk from exposed live parts interlocking circuits along with plug, socket and coupler design shall be arranged to ensure the exposed pins cannot become live unless fully assembled, this does not apply to intrinsically safe circuits.

It is allowed to differ from this configuration if couplers are interlocked electrically or mechanically so that contact pieces of all circuits except the interlocking circuit according to 21.2.4.2 can be connected or disconnected only when being dead. In case of connectors they shall apply to technical requirements of EN 60079-0.

21.1.3 To avoid risk where plugs, sockets and couplers contain a protective conductor the design shall ensure that this is made first and breaks last.

21.2 Additional requirements using couplers

21.2.1

For main power supply of electrical equipment only couplers according to EN 60309–1 shall be used.

21.2.2 Couplers shall be designed to restrain cables so that disconnection cannot occur under load, the design can include electrical interlocking or securing the joint by mechanical means, e.g. bolted.

This does not apply to interlocking circuits according to 21.2.4.2.

Sentence 1 does not apply if it is ensured that switching capacity of the coupler in accordance with EN 60309–1 is sufficient.

21.2.3 The requirements of 21.2.1 and 21.2.2 do not apply to couplers of intrinsically safe circuits

and not to installations with nominal voltage of at most 230 V when using

- couplers of auxiliary circuits,
- couplers in the conducting path of loads with nominal current of at most 16 A AC or 10 A DC and of loads with nominal current of more

	than 16 A but of at most 25 A if the load is equipped with a switch.

21.2.4 Electrical interlocking according to 21.2.2 using interlocking circuits shall fulfil the following requirements:

21.2.4.1 Couplers shall be designed to include interlocking so that if the plug is removed while the circuit is energized, the interlocking circuit causes the supplying switchgear to open before the phase connections are broken.

The tripping device for the switchgear shall be of the closed circuit configuration so that any break in the circuit will result in a failsafe condition.

21.2.4.2 The interlocking circuit shall be a circuit with increased requirements regarding functional safety or shall be part of a supervision circuit of an electrical protection device in accordance with Subclause 12.6 of this standard,

	or shall be monitored regarding short circuit. The effectiveness shall not be influenced in case of connection between phase conductor and interlocking circuit.
The interlocking circuit shall be designed that the highest voltage by given capacity of the cable ($3 \times C_{10}$) which will arise in the interlocking circuit is lower than the lowest ignition voltage in accordance with EN 60079–11:2012, Annex A, Figure A.2 bottom curve. NOTE C_{10} is suggested to be the capacity between each main core and PE. The compliance with this requirement shall be established by the manufacturer or an accredited test house. In case of inductive coupling and/or electronic current limitation of the measuring circuit the non-ignitability shall be verified by using the spark test apparatus in accordance with EN 60079–11.	

22 Luminaries and lighting installation

In non-hazardous workings of hard coal mining industry luminaries and the associated equipment for connecting of cable shall be explosion protected as well.

23 Cables

23.1 Design of cables

23.1.1 Only types of cables shall be used outside electrical equipment which are suitable taking environmental and electrical requirements into account.

NOTE Informative Annex E gives further information which kind of cables is suitable.

Other designs are permitted provided that they are similar on par with the appropriate design requirements taking into account the range of application and the laying system and that they are in accordance with the additional requirements in Subclause 23.4. Cable designs without protective conductor are permitted in extra low voltage systems or as feeding cable of protective insulated equipment.

23.1.2 The conductor insulation of cable for circuits of differential protection installation shall be chosen regarding the maximum voltage under operation conditions.

23.2 Conductor materials

23.2.1 The following materials for conductors shall be used:

Copper.

Steel, but only for

- screenings, protective and bonding conductor, steel strips only zinc coated,

other materials only for

- waveguides for radio installation.

Copper or aluminium.

23.2.2 For cable material in cables of intrinsically safe systems see EN 60079-25.

23.3 Current carrying capacity

23.3.1 Cables either multicore or single core shall be dimensioned or protected by current limiting devices so that they will not heat up impermissible neither under normal operation nor in case of a short circuit on the load side of the cable. Cumulating of laid out cables shall be taken into account.

NOTE 1 HD 60364–5-52:2011, Annex B will give information.

NOTE 2 EN 60865–1 applies.

NOTE 3 Annex F will give further information.

23.4 Coverings and outer protective covers

23.4.1 The outer coverings of cables shall be flame retardant and low smoke, and selected in accordance with the environmental factors.

23.4.2 Coverings or outer protective covers of cable shall be coloured continuously and permanently. It is recommended to use:

- red in systems with nominal voltage of more than 1 kV,
- yellow in systems with nominal voltage up to 1 000 V.

- other colours alternatively in non-coal mining industry in systems with nominal voltage up to 1 000 V.

- grey in communication systems.

- other colours alternatively in non-coal mining industry.

- light blue in systems with only intrinsically safe circuits.

NOTE 1 In case of intrinsically safe see also EN 60079–25.

For the purpose of safety at work it is strictly recommended to use different colours for different voltage levels.

NOTE 2 National regulations give advice regarding colour.

Coverings of cable with only optical fibre should be coloured preferentially orange. The colours red, yellow, grey and blue are not permitted. Cables with additional optical fibres inside shall be coloured in accordance with 1st sentence of this clause.

23.4.3 Cables shall have a marking on the covering which is permanently readable with at least the following information:

Complete design identification, number of conductors, cross-section of the phase and the protective conductor, if necessary with the addition of being single or whole concentric, name of manufacturer (short form) and the year of manufacturing (short form, too, e.g. “2014”).

23.5 Different circuits within one cable

23.5.1 Within the same cable only the phase conductors of the main circuit, the protective conductors and any auxiliary circuit shall be included.

23.5.2 In multicore cables phase conductors of at most 2 main circuits as well as the conductors of the associated auxiliary circuits may be combined.

23.5.3 Cables shall be designed according to the highest operating voltage if conductors of circuits with different voltages are leaded within the same covering.

The requirements of 23.1.2 shall apply to circuits of differential protection installation.

23.6 Laying out of cables

23.6.1 Cables shall be laid out so that:

- no kinks or impermissible loops will arise,
- it will not be crushed or damaged otherwise, and
- it will be accessibly on the whole length for inspection and maintenance all the time,
- adequately suspended,
- not bend beyond the minimum radius.

23.6.2 The accessibility of cables is not necessary, if:

- there is a special mechanical protection,
- the cable is laid out under water for supplying pumps,

- the cable is laid out inside drill holes if mobility and heat removal is ensured.

23.6.3 In electrical operating locations and enclosed electrical operating locations as well as in workshops cables may be laid out inside covered channels if it is ensured that they are accessible all the time.

23.6.4 Cables laid out through walls can be immured or set in concrete or similar due to protection means e.g. fire protection.

23.6.5 In workings with an inclination of at most 45 degrees cables shall be hung up at least every 5 m with suspension. The suspension depends on particular circumstances at the point of installation.

The 1st sentence does not apply to cable according to 23.6.2 as well as to trailing- and drum cables.

23.6.6 In workings with an inclination of more than 45°:

23.6.6.1 Cables shall be self-supporting with a safety factor of at least 3 relating to the tension length while hanging up and shall be fixed at least every 8 m unless it is self-supporting with a safety factor of at least 5 relating to the tension length.

23.6.6.2 Cables with copper conductors without any catenary wire, armouring or any devices for strain relief shall be designed so that the weight of the freely suspended part of the length will not result in a higher tension load relating to the whole cross-section than 20 N/mm^2 at the location of mounting.

23.6.6.3 Cables which will be coiled or uncoiled under normal operating conditions by winches shall be self-supporting including adherent devices with a safety factor of at least 5 relating to the tension length. Only extra heavy duty cable appropriate to the stress of coiling or uncoiling shall be used; e.g. NSSHöu or NTS (see Annex E).

23.6.6.4 Only communication-cables guaranteeing tensile strength shall be used as a trailing cable for remote control.

These trailing cables shall only contain intrinsically safe circuits.

23.6.7 The devices for hanging up and mounting shall be designed so that they do not damage the cables.

23.7 Glanding, terminating or making off

23.7.1 Only the appropriate accessories for glanding, terminating or making off shall be used.

NOTE Those are: e.g. sealing ends, cable entries, sleeves, terminal boxes, junction box.

23.7.2 Cables shall be leaded in the appropriate accessories so that the type of protection of terminal box will remain.

23.7.3 The armour of cables of electrical power installation shall be connected to the associated protective conductor of the terminal box depending on the approval of the terminal box and the cable entry. The same apply to non-metallic, conductive coatings if they are on earth potential.

In case of supervising non-metallic conductors they shall be earth free.

23.7.4 In systems with nominal voltage of more than 6,6 kV means shall be taken at the connecting parts to prevent partial discharge. The special means depends on the design of the cable.

23.7.5 If tensile- or torsion load may occur caused by the way of laying out of the cable the devices designed for leading in shall be provided with means of torsion protection and strain-reliefs, e.g. supplying cable for mobile machines.

There is no need for such means in case of cable with only one intrinsically safe circuit.

The bending radius given by the manufacturer of the cable shall be observed in any case.

23.7.6 All conductors shall be connected securely and permanently to the appropriate terminals.

This applies also to conductors which are not used. Insulated caps shall be put on the ends of any unused conductors, especially where they may come into contact with live terminals if there are no terminals to connect them with. Moreover the conductors shall be bundled and fixed in a sufficient distance to live parts.

23.7.7 The connecting of conductors shall only be done at built-in terminals or by insulated connectors. This applies to the protective conductor, too.

Disconnectable terminals shall remain accessible all the time.

NOTE Sealed connections are not considered to be disconnectable.

23.7.8 Cable-kits for jointing of cable are allowed, too. Those kits shall meet the requirements of EN 50393. Any kind of cable-kits shall meet the same requirements regarding flammability and electrostatics as cable itself.

23.7.9 Compounds shall be used in case of special joints. The “how to handle” instruction of the manufacturer shall be considered.

23.7.10 Depending on the terminals only a specified cross-section and numbers of conductors shall be connected to, according to the manual of the manufacturer.

The cross-section of the conductor shall not be reduced when the conductor is connected to the terminal.

23.7.11 Depending on the design of the terminal the whole conductor shall be prepared so that a correct connection is guaranteed and a separation of the strands will be avoided, e.g. by using cable lugs, core cable ends or other suitable techniques.

The values for the clearance and creeping distance according to the design approval shall not be reduced after connecting the cable to the equipment.

23.7.12 The glanding off and terminating arrangements should provide protection, so that in the event of the cable being pulled out of the enclosure, the protective conductor will be the last to disconnect. This does not apply to connections within potted sleeves.

23.7.13 The supervision conductor (pilot) in supplying-cables of equipment, which are provided with an electrical protecting device according to Subclause 12.6 of this standard, shall be connected to the terminals so that in the event of the cable being pulled out of the enclosure, it will be disconnected first. This does not apply to connections within potted sleeves.

23.7.14 The supervision conductor (pilot) according to Subclause 23.7.13 shall be marked for identifiable purpose.

23.8 Laying out of non-insulated conductors

Non-insulated conductors which are carried out without any insulating covering because of intended purpose may be laid out in case of:

- Protective or bonding conductors,

- special application of intrinsically safe circuits, if it is allowed by certificate.

- any conductors,
- bus bars within distribution installation,
- trolley lines.

23.9 Additional requirements for the use of single core cable

23.9.1 Single core cable may be laid out single or bundled together using only the three single cores supplying the same circuit. That bundled system of single core cables may be considered as to be one multicore cable when mounting.

To avoid heating of mounting material when using such single cores only mounting material without closed iron circles shall be used; e.g. Plastic clamps or non-magnetic metal clamps or similar.

23.9.2 All single core cables of the same AC or three-phase system shall be laid in common through closed steel-frames, apertures of steel constructions or steel pipes.

23.9.3 Single core cable shall be mounted securely due to the effect of asymmetric short-circuit-current.

23.9.4 The cross-section of the screening of a cable shall be dimensioned so that in case of a double earth fault the screening is able to run the occurring current without thermal stress till tripping.

23.9.5 The screenings of the single core cable shall be connected together in a certain interval. This interval shall be calculated individually with regard to an impermissible high touch voltage caused by a double earth fault.

24 Protection of electrical equipment or installation against overcurrent

24.1 Overcurrent protection devices

24.1.1 Electrical equipment and electrical cables shall be protected against impermissible heating causes by overload current and against the effect of short circuit current by over current protection devices.

24.1.2 The overcurrent protection shall be ensured even in the case of multi-feeding from different points.

24.1.3 Overcurrent protection devices shall be provided for all phase conductors in all systems above IS level.

24.1.4 In earth bonded circuits of communication systems only non-earthed phase conductor shall be protected by an overcurrent protection device.

24.1.5 in earth bonded auxiliary circuits only none earthed conductor shall be protected by an overcurrent protection device.

24.1.6 Each cable in parallel outside of electrical operating locations or enclosed electrical operating locations shall be protected.

Notwithstanding there may be only one overcurrent protection device for two parallel cables if they are laid out the same way, have the same length, are of the same material and cross-section, cannot operate alone and have no taps. This applies, too, for more than 2 cables in systems with nominal voltage of at most 1 000 V if they are used for connection of transformer and safety switch and/or associated distribution installation.

24.2 Overload protection

24.2.1 Electrical equipment shall be protected against impermissible heating caused by overload.

24.2.2 Associated overload current protection devices may not be necessary

24.2.2.1 if it is allowed due to certificate of conformity, to the type examination certificate or to the design approval.	if it is ensured that due to the nature or use of the equipment an overload may not occur or if an operation without overload protection is harmless. Precautions shall be taken to prevent operation of polyphase electrical equipment losing one or more phases which then may cause overheating.

24.2.2.2 in case of signal circuits of inclined haulage or hoisting plants.

24.2.3 Cables may not be protected by an overload current device if the cross-section is sufficient enough regarding the total sum of nominal current of the total loads and each load is protected against overload so that the cable will not be overloaded.

24.2.4 If switchgears with overcurrent tripping devices or relays are used as overload protection devices they shall be adjusted regarding the nominal current of the equipment and/or the cable which is to be protected.

24.2.5 The nominal current of cable is the current carrying capacity according to the data sheets of the manufacturer. If there are no such information available Annex F will give information.

If fuses used for overload protection, it shall be ensured that the relevant characteristics of the fuses and their nominal current is able to protect the equipment and/or the cable taking the permissible load current into account.

This may be done by special calculation programs or by using special data sheets of the manufacturer of the fuse.

24.2.6 If cables with the same cross-section are connected in parallel the overload protection devices may be adjusted to a value according to the sum of the permissible load of each cable.

24.2.7 In case of direct compensation of a single motor by capacitors the overload protection shall be adjusted lower regarding the decreasing current.

24.3 Short circuit protection

24.3.1 Electrical equipment and/or cables shall be protected against the effects of short circuits by over current protection devices (short circuit current protection devices), the use of phase sensitive short circuit protection is preferable.

24.3.2 Short circuit current protection devices shall be arranged at the beginning of the network which should be protected.

24.3.3 Short circuit current protection devices shall be arranged on the feeding side of transformers. The range of protection shall include even the load side of transformers comprising all cable through the next short circuit current protection device connected on load side. Short circuit current protection devices for the system on the load side of the transformer shall be arranged as close as possible to the transformer if you want to exercise the option of a longer tripping time according to 24.4.6.

In case of a common feeding of several transformers the short circuit current protection devices may be arranged in the common cable, if it is ensured that the short circuit protection of each transformer is guaranteed.

24.3.4 Short circuit current protection devices shall be selected and adjusted regarding tripping behaviour taking the minimum short circuit current into account.

24.4 Minimum short circuit current

24.4.1 The minimum short circuit current in IT-system is the lowest short circuit current which is to be expected in case of a metallic two pole short circuit at the end of the cable or a double earth fault which is to be protected without taking into account the current increasing influence of the load. The double earth fault shall only be considered where an earth fault tripping device is not present. The lowest short circuit current in TN-S or TN-C systems will be the single pole earth-fault current.

24.4.2 The lowest short circuit current shall be calculated in accordance with Clause 25 or shall be investigated by other equivalent means.

NOTE HD 60364–4-41:2007, 411.6 gives information regarding calculation in distribution networks up to 1 000 V.

24.4.3 The short circuit current protection devices shall only be adjusted to 80 % of the established minimum short circuit current. This does not apply to fuses.

24.4.4 If fuses are used for short circuit protection the nominal current of the fuses is depended on the minimum short circuit current to select so that the requirements of 24.4.5 are met.

24.4.5 Short circuit current shall be switched off at least after

- 0,2 s in system with nominal voltage of more than 1 kV,
- 0,13 s in systems with nominal voltage of at most 1 000 V,
- 0,1 s in case of fuses.

If it is impossible to do this within the stated time in case of switching off current converters in the range of low frequencies, this range of frequency shall not be used for operational purposes and shall be passed immediately.

a) In case of TN systems tripping times of HD 60364–4-41:2007, 411.3.2.2 and 411.3.2.3 shall apply.
b) In other systems:
   1) 1 s in coal mining and in other fire endangered workings of non-coal mining,
   2) 5 s in the other mining industry.

24.4.6 In case of selective short circuit switch-off with graduated tripping times a longer total switch-off time on condition that the shortest switch-off time does not exceed the stated values of 24.4.5 is permitted:

- 0,6 s for the load side of transformers according to 24.3.3 with a nominal voltage of at most 1 000 V on the load side,

- 1,5 s in coal mining and fire endangered workings of other mining industry,
- 5 s in other mining industry.

- 1,5 s in systems with nominal voltage of more than 1 kV. The time distance shall not exceed 0,3 s unless the arrangement of short circuit protection devices requires a longer time distance in places.

25 Calculation of short circuit currents

The EN 60909 series shall apply when calculating the short circuit current as well in the case of using simulated network.

26 Additional requirements for systems and equipment with nominal voltage of more than 1 kV up to 6,6 kV in production areas and road heading

26.1 General requirements

26.1.1 Systems with nominal voltage of more than 1 kV up to 6,6 kV in production areas and road headings shall be galvanically separated from the high voltage system under ground.

NOTE Examples for a galvanically separated system in production areas and road headings see Annex C.

26.1.2 Notwithstanding Subclause 7.1.2.1 the dimension of the galvanically separated systems shall be limited so that earth fault current will not exceed 5 A.

26.2 Switchgears

26.2.1 Only switchgears shall be used whose switches for earthing and shorting of cables on the load side are inside of enclosures of type of protection “d” or “p”.

26.2.2 An activity of the switches for earthing and shorting of cables on the load side shall only be carried out if type of protection is ensured.

26.3 Test of insulation resistance of non-alive cable in production areas and road headings

26.3.1 Insulation testing devices for testing the insulation resistance of cables laid in production areas and road headings shall be integrated.

26.3.2 The measuring shall be run with DC voltage. The measuring voltage shall be at least equal to the nominal voltage of the system.

The short circuit current of the insulation testing devices (maximum charge current) shall not exceed 0,015 A.

26.3.3 A fault during test cycle shall cause an interlock of the switchgear.

26.3.4 The use of the insulation testing device shall be ruled by operating instructions. Switch-on of the switchgear shall be interlocked while test cycle is running.

26.4 Insulation monitoring of alive systems

26.4.1 The insulation resistance of the system against earth shall be monitored by an insulation monitoring device (IMD) permanently.

26.4.2 The decrease of the insulation resistance of the monitored systems of less than 50 Ω per V nominal voltage shall be indicated by visual or acoustic information at the location of installation permanently. There is no need for such information if there is automatic information to a place where people are working continuously.

There is no need for such indication or information if the power of monitored system will be switched-off, when resistance is less than 40 Ω per V.

26.5 Earth fault protection in IT systems

Notwithstanding 12.2.1 the following requirements apply to the galvanically separated system:

26.5.1 The insulation monitoring device according to 26.4 of the system shall detect certainly an earth fault of ≤ 20 Ω per V nominal voltage of the system. The deactivation shall be within 1,5 s.

26.5.2 The power switch on line side of the transformer shall switch-off the part of the system between transformer and switchgear connected on load side of the transformer within a certain time delay if the insulation resistance of the system will be ≤ 20 Ω per V nominal voltage. The time delay shall not be greater than 1,5 s.

26.6 Monitoring of non-alive systems

26.6.1 The insulation resistance against earth of non-alive parts of a system shall be monitored by a locking earth fault monitoring device. Restart shall be prevented by this circuit as long as the insulation fault exists.

26.6.2 Restart shall be only possible after manual resetting at the associated switchgear.

26.6.3 This circuit shall be adjusted on an insulation value against earth of ≥ 25 Ω per V.

26.6.4 This circuit shall meet the requirements of Subclause 12.4.7.

26.7 Electrical protection devices for feeding cables of electrical equipment

26.7.1 The feeding cables of all electrical equipment in production areas and road headings shall be monitored by an electrical protection device in accordance to Subclause 12.6.

26.7.2 Notwithstanding Subclause 12.6.2.6 the following apply concerning switching off:

26.7.2.1 The feeding cable of equipment in production areas and road headings shall be switched off within 1.5 s if the value of the insulation resistance falls below 20 Ω per V nominal voltage. This may be done by an insulation monitoring device (IMD) in accordance with 26.4.

26.7.2.2 In case of an unresistant earth fault the monitored feeding cable of equipment in production areas and road headings shall be switched off within 0,2 s (fast earth fault detection based on residual voltage). To avoid fault tripping caused by circuit closing the connecting of the tripping device to the system may be time delayed but within 1 s.

26.8 Cable design

Only cables according to Annex E to this standard may be used with the following restriction:

- the protective conductor shall be in accordance with Subclause 12.5.1.3 or 12.5.1.4.
- the supervision conductor shall be designed as a conductive metallic covering around the inside sheath or a single core if the cable is additionally mechanically protected.

27 Additional requirements for cable entry selection

Where cables directly enter enclosures which contain none IS sparking contacts, careful selection of glands will be required to maintain explosion protection. The cable entries shall be in accordance to EN 60079-0 and EN 60079-1 and the cable shall be circular and compact.

Annex A
(informative)

Documentation

The following detailed information to an overview-diagram are recommended:

- The type of used electrical equipment should be mentioned to have a clear cross-reference to the appropriate instruction manuals of the equipment.

- The type, the length and cross-section of the used electrical cable and electrical flexible cable should be mentioned to make sure that the used cable and flexible cable are proper due to load and foreseeable malfunction within the distribution network.

- Either the minimum prospective short circuit current or the prospective double earth fault current for each power line depending on which is lower calculated in accordance to the EN 60909 series and multiplied by a safety factor in accordance with 24.4.3 of this standard should be written down near to the appropriate circuit breaker. This is to make sure that the tripping device within the circuit breaker could be adjusted rightly.

- The rated thermal current of each power line should be written down near to the appropriate circuit breaker. This is to make sure that the tripping device within the circuit breaker could be adjusted rightly for avoiding overload.

- The maximum prospective short circuit current for each power line calculated in accordance to the EN 60909 series should be written down at each junction point where electrical cable or flexible electrical cables with lower cross-sections are connected. This is to avoid thermal stress to the electrical cables or electrical flexible cable due to short circuit current. It could also be helpful for avoiding mechanical stress to electrical equipment especially to junction boxes.

- The value of the ambient temperature of the workings where electrical equipment is to be installed should be mentioned within the overview-diagram because the tripping value of rated thermal current depends on ambient temperature (see applicable table of Annex F of this standard).

- The line diagram should include any interlocking circuits.

- The line diagram should be periodically updated after extension or modification.

- The line diagram should show the operating status of bus sections and highlight ring main or parallel feeder circuits.

- The line diagram should show the maximum symmetrical fault current at each switchgear point.

For power lines disconnected automatically in case of firedamp the appropriate circuit breaker should be marked suitably.

Annex B
(normative)

Tables and figures regarding free space

Table B.1 — Minimum sizes of free space according to Figure B.1 for operating, testing and maintaining switchgears within substations

Purpose of free space	Minimum size *L* and *S* in m							Minimum height *H* in m
	Open switch-gears in enclosed electrical working places			capsuled switch-gears [a] in				
				enclosed electrical working places		Other workings		
	Nominal voltage			Nominal voltage				
	≤ 1 000 V	> 1 kV		> 230 V but ≤ 1 000 V	> 1 kV	> 230 V but ≤ 1 000 V	> 1 kV	
		One side	Two sides					
Operating	1	1 (L_3)	1.2 (L_4)	0.6	1 (L_3)	0.6	1.5 (L_3)	1.8
Testing and Maintenance	0.8	0.8 (L_1)	1 (L_2)	0.6	0.8 (L_5)	0.6	0.8 (L_5)	1.8
					0.6 (L_6)		0.6 (L_6)	–
Safety clearance	–	–	–	–	0.4 (S)	–	0.4 (S)	–

[a] One- or two sided installation.

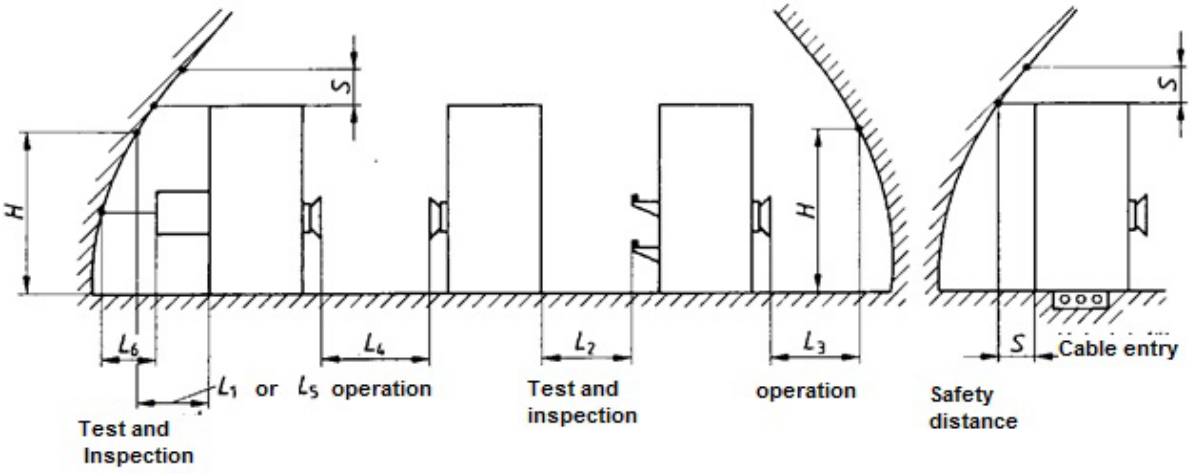
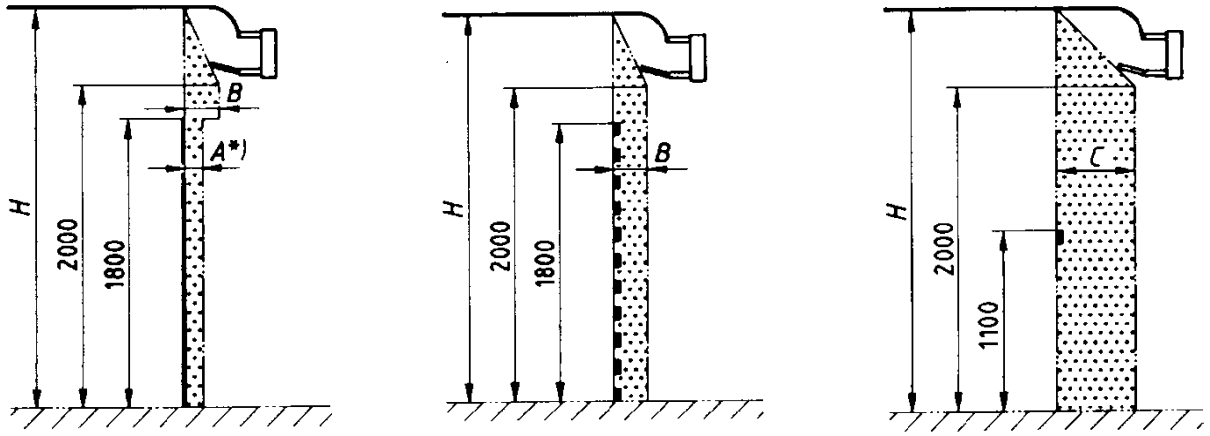


Figure B.1 — Free space of open and capsulated switch-gears

Table B.2 — Minimum clearance and minimum distances for protection

1	2	3	4	5	6	7	8
Nominal voltage **230 V** **400 V** **500 V** **690 V**	**clearance** **5 mm** **6 mm** **8 mm** **10 mm**	**Protection distance *A**)** **In case of** **Massive walls and bulky doors**		**Protection distance *B**)** **In case of lattices or lattice doors of at least 1 800 mm with a maximum mesh size of**		**Protection distance *C*** [a] **In case of lattices and lattice doors with less than 1 800 mm height, railings and protection strips of at least 1 000 mm height**	**Protection height *H**)** **Above walkable areas**
from EN 60079–7:2007, Table 1		**Non-conductive**	**Conductive and earthed**				
≤				**≤ 12 mm**	**≤ 50 mm**		
kV	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**
1	14	14	14	200	200	200	2 500
3	60	60	90	200	400	500	2 500
6	90	90	90	200	400	500	2 500
10	120	120	120	200	400	500	2 500
20	220	220	220	220	400	500	2 500

[a] See Figure B.2.



a) Massive walls and bulky doors

b) Lattices or lattice doors

c) Railings, protection strips, chains or ropes

Figure B.2 — Protection distances and height

Annex C
(informative)

Example for a galvanically separated system (in production areas or road headings)

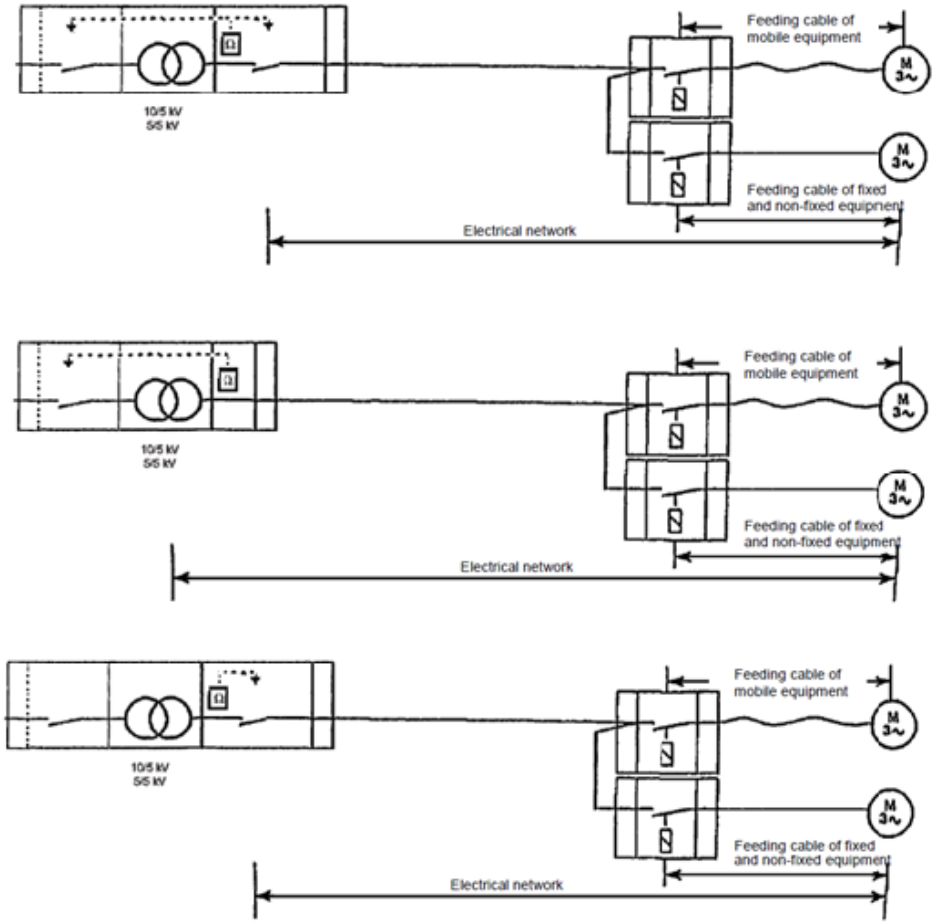


Figure C.1 — Example 1

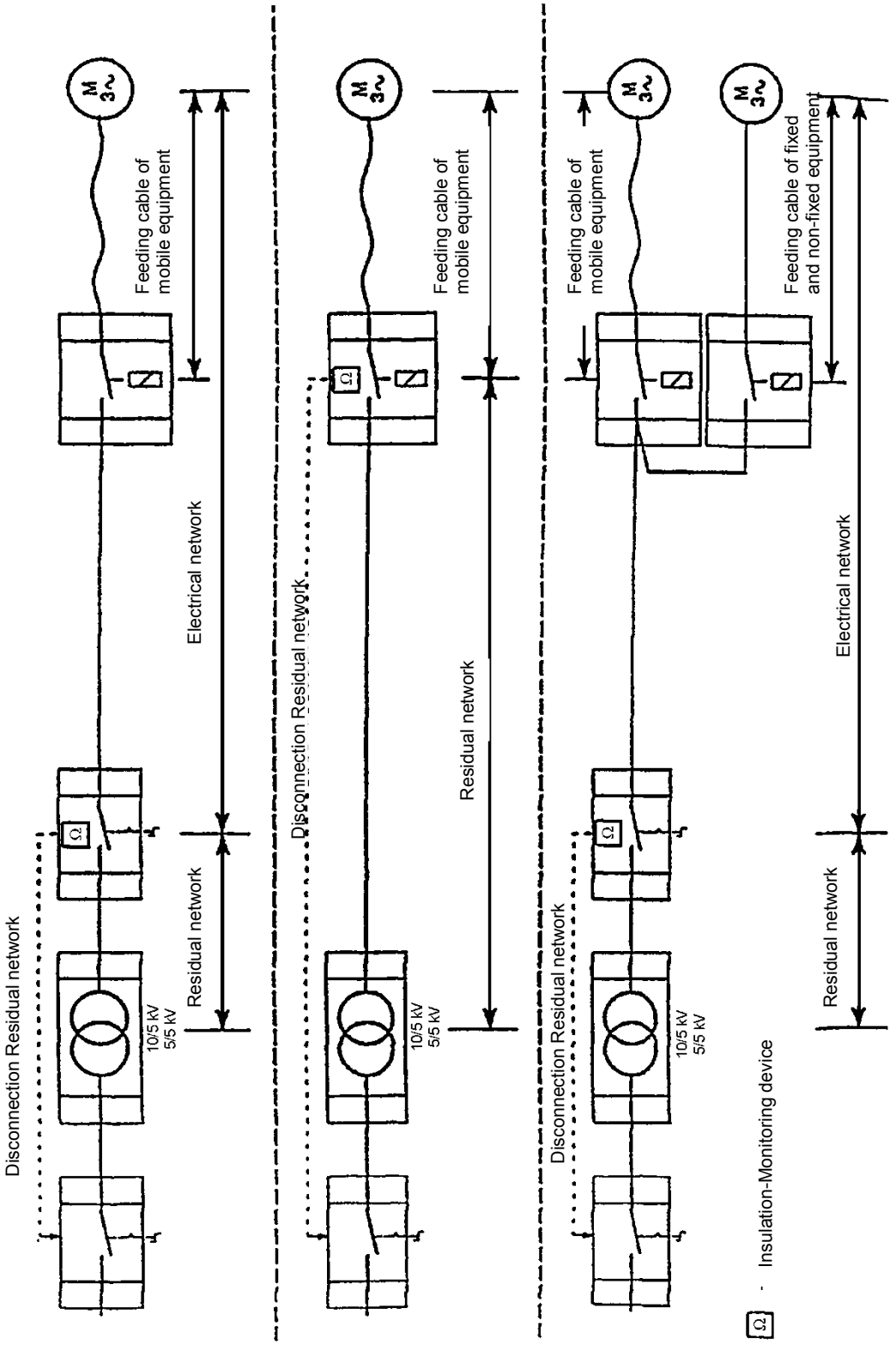


Figure C.2 — Example 2

Annex D
(informative)

Example for calculation (according to 12.3.6)

D.1 General

Calculation of the highest fault voltage U_F caused by an earth fault current.

D.2 Legend

U_F	Highest fault voltage	V
I_{eC}	Capacitive earth fault current	A
I_{eL}	Inductive earth fault current	A
I_{eB}	Wattles component of the earth fault current	A
I_{eR}	Active component of the earth fault current	A
I'_e	Length related earth fault current $I'_e = U \times \sqrt{3} \times \omega \times C'_{10}$	A/km
U_{vB}	Line voltage drop on the protective conductor caused by wattles current	V
U_{vR}	Line voltage drop on the protective conductor caused by active current	V
I_{aR}	Arithmetic median value of the current in one cable-section	A
R_{PE}	Ohmic resistance of the protective conductor	Ω
L	Cable length	km

D.3 Necessary system parameters

- Capacitive earth fault current in the whole system I_{eC},
- Inductive earth fault current of the tape degausser I_{eL},
- Length related earth fault current of each cable I'_e,
- Ohmic resistance of the protective conductor of each cable R_{PE},
- Active component of the earth fault current I_{eR}.

D.4 Determination of the reference points of the system

In case of an earth fault the highest fault voltage U_F will occur at this point of the system having the largest resistance of the protective conductor R_e.

In case of the following 5 kV system (see Figure D.1) this reference point (point E) will be at the end of cable-section V.

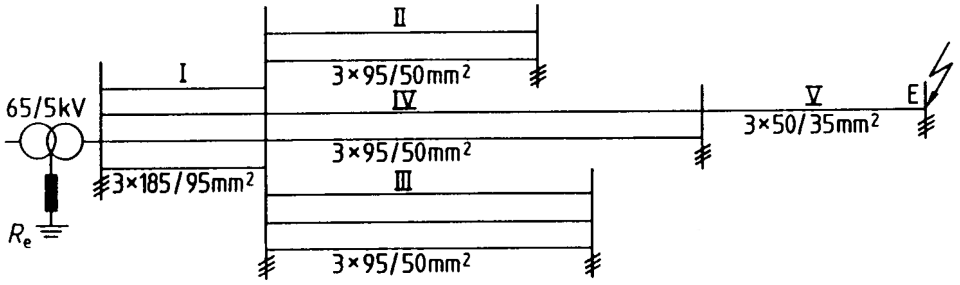


Figure D.1

D.5 Calculation of the capacitive earth fault current and displaying in a figure (see Figure D.2)

The data's from Table D.1 are used.

I_{eC} = 25,74 A

$$I_{eC} = U \times \sqrt{3} \times \omega \times C_{10}$$

Table D.1 — Cable-section

I	4 × 1,5	km		3 ×	185/95	mm^2		I_{eCI}	=	6,84 A
II	2 × 2,5	km		3 ×	95/50	mm^2		I_{eCII}	=	4,05 A
III	3 × 3	km		3 ×	95/50	mm^2		I_{eCIII}	=	7,29 A
IV	2 × 4	km		3 ×	95/50	mm^2		I_{eCIV}	=	6,48 A
V	1 × 2	km		3 ×	50/35	mm^2		I_{eCV}	=	1,08 A

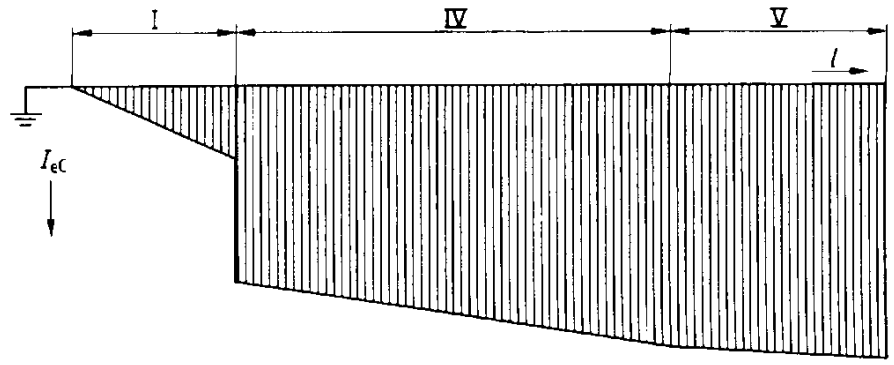


Figure D.2

D.6 Overlay of capacitive and inductive earth fault current $I_{eL} - I_{eC} = I_{eB}$.

The tape degausser in the chosen example is tuned in a way that there will remain an inductive earth fault current of I_{eL} = 20 A. You will get the resulting earth fault current (hatched marked) by adding the ordinates (see Figure D.3)

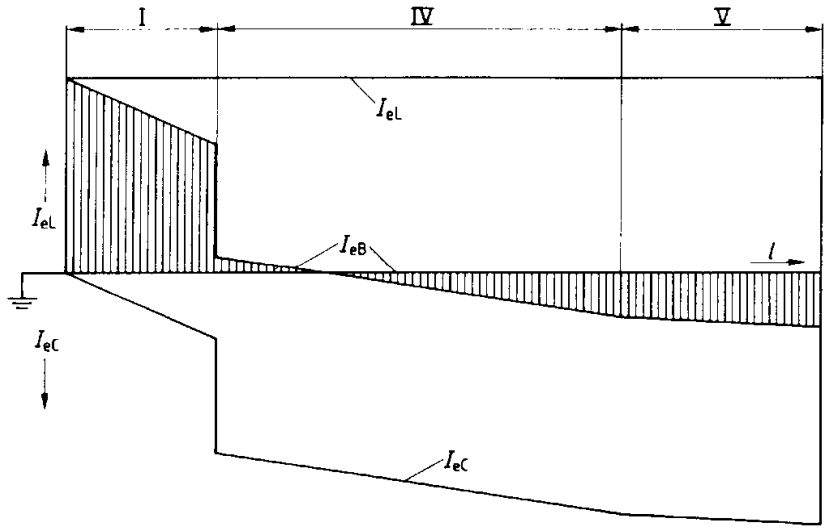


Figure D.3

D.7 Calculation of the voltage drop caused by the wattles component of the earth fault current

The voltage drop U_{vB} caused by the wattles component of the earth fault current is the product of the arithmetic median value of the current in the cable-section and the resistance of the protective conductor R_{PE}. The whole cross-section of the protective conductor within the cable-section shall apply.

You will get the arithmetic average value of the current I_{ar} of a cable-section by averaging over the current at the beginning and at the end of the cable.

Cable-section I

$$U_{vBI} = I_{arI} \times R_{PEI} = I_{arI} \times \frac{l}{\kappa \cdot A_{PE}}$$

$$\frac{13,16 + 20}{2}\,\text{A} \times \frac{1\,500}{56 \times 380}\,\Omega$$

$$= 16,58\,\text{A} \times 0,07\,\Omega = 1,16\,V$$

Cable-section IV

$$U_{vBIV} = I_{arIV} \times R_{PEIV}$$

$$\frac{-4,66 + 1,82}{2}\,\text{A} \times \frac{4\,000}{56 \times 100}\,\Omega$$

$$= -1,42\,\text{A} \times 0,71\,\Omega = -1,01\,V$$

Cable-section V

$$U_{vBV} = I_{arV} \times R_{PEV}$$

$$\frac{-5,74 - 4,66}{2}\,\text{A} \times \frac{2\,000}{56 \times 35}\,\Omega$$

$$= -5,20\,\text{A} \times 1,02\,\Omega = -5,31\,V$$

Whole drop voltage

$$U_{vB} = U_{vBI} + U_{vBIV} + U_{vBV}$$

$$= 1,16\,\text{V} - 1,01\,\text{V} - 5,31\,\text{V}$$

= – 5,16 V

D.8 Calculation of the voltage drop caused by the active component of the earth fault current

The active component of the earth fault current arises mainly from the tape degausser. The power loss of the cable by ohmic resistance can be neglected. In this example I_{eR} is assumed to be 10 % of the inductive earth fault current.

I_{eR} = 0,1 I_{eL}

$U_{vR} = I_{eR}\left(R_{PEI} + R_{PEIV} + R_{PEV}\right)$

= 2,0 A (0,076 Ω + 0,77 Ω + 1,1 Ω)

= 3,9 V

D.9 Resulting voltage drop U_F by geometrical addition

$U_F = \sqrt{U_{vB}^2 + U_{vR}^2}$

$= \sqrt{(-5{,}16)^2 + 3{,}9^2}$ V

U_F = 6,47 V

(Wattles resistance of cable is neglected.)

Table D.1 — Average value for earth capacity C'_{10} of cable – ambient temperature of 20 °C

Cross-section	5 kV[a]				10 kV[b]	
	Protective conductor concentric		Protective conductor Single-concentric		Protective conductor Single-concentric	
A mm^2	I'_e A/km	C'_{10} µF/km	I'_e A/km	C'_{10} µF/km	I'_e A/km	C'_{10} µF/km
16	0,33	0,12	0,81	0,30	1,09	0,20
25	0,41	0,15	1,09	0,40	1,09	0,20
35	0,49	0,18	1,22	0,45	1,20	0,22
50	0,54	0,20	1,49	0,55	1,31	0,24
70	0,68	0,25	1,63	0,60	1,52	0,28
95	0,81	0,30	1,77	0,65	1,69	0,31
120	0,92	0,34	1,90	0,70	1,80	0,33
150	1,03	0,38	2,04	0,75	1,96	0,36
185	1,14	0,42	2,17	0,80	2,12	0,39
240	1,30	0,48	2,44	0,90	2,39	0,44

a Core-insulation material PVC.

b Core-insulation material PE, VPE.

Annex E
(informative)

Table for cables suitable for underground workings

The following table should be read as being an example for a list of cables which are suitable for different kind of applications in underground workings referring to 23.1.1 of this standard.

Table E.1 — Suitable cables for power systems

1	2	3	4	5
No	**Cable type**	**Nominal voltage U_0/U**	**Scope**	**Methode of installation**
1	Cable acc. to IEC 60502–2 with – Insulation of VPE (2X) with inner and outer semi-conductive layer – Conductive inner covering for multicore cables with concentric protective conductor – Protective conductor of plain copper as concentric conductor • over conductive inner covering (C) or • evenly distributed over the individual wires (CE) or – without inner covering of PVC (Y) or – without armouring of galvanized flat (F) or round (R) steel wires or – without a counter helix of galvanized steel tape – outer sheath of PVC (Y)	6,6/10 kV	In coal mining – with armouring: in all mining workings, but not in mining operations and longwall – without armouring: only in electrical or in closed electrical operating areas Not in coalmining – in all mining workings, but not in mining operations and longwall	stationary
2	Cable with – Insulation of VPE (2X) with inner and outer semi-conductive layer – Copper screen over the outer semi-conductive layer (S) as protective conductor – Outer sheath of PVC (Y)	6,6/10 kV and 12/20 kV	For mines not in coal mines with an inclination up to 50 gon, but not in mining operations and longwall Respectively three single-core cables as route cable.	stationary
3	Trailing cable with (inductive symmetric protective conductor for IT systems	600/1 000 V	In all mining workings	

1	2	3	4	5
No	**Cable type**	**Nominal voltage U_0/U**	**Scope**	**Methode of installation**
	– Insulation of rubber compound, or – without a central cradle separator – Protective conductor of plain copper − applied as concentric conductor • between inner and outer sheath (KON) or	1,8/3 kV and 3,6/6,6 kV		
	• evenly distributed over the single insulation of the outer conductor (/3E) or − evenly distributed in the interstices as insulated conductor or as conductor covered with conductive rubber (/3) or	6,6/10 kV	In all mining workings, but not in mining operations and longwall	
	– without conductive metals (CE) or conductive non-metallic (CGE) sheath over the insulations of the outer conductor or – without control cores (ST) – inner sheath of rubber compound or – without armouring of round stranded wires of galvanized steel wires (RL)			semi flexible
	– outer sheath of rubber compound			flexible

1	2	3	4	5
No	**Cable type**	**Nominal voltage U_0/U**	**Scope**	**Methode of installation**

4	Rubber sheathed cable with
	− Insulation of EPR/HEPR IEC 60502–1 or
	− without a central cradle separator
	− Protective copper conductor
	  − as concentric conductor
	  • between inner and outer sheath (KON) or
	  • evenly distributed over the insulations of the outer conductor (/3E) or
	  − evenly distributed in the interstices as insulated conductor or as conductor covered with conductive rubber (/3) or
	  − as single core (-J)
	− with conducting metal casing (C) or conducting non-metallic casing (CG) over the stranded cores or between inner and outer sheath
	− conducting metal casing (CE) or conducting non-metallic casing (CGE) over the insulation of the outer conductors
	− Without control cores (ST)
	− without inner sheath
	− Rubber jacket
		600/1 000 V	In all mining workings	stationary
				semi flexible
				flexible

5	Rubber sheathed cable acc. EN 50525–2-21 − Fine stranded conductors (-F) − Rubber insulation (R) − single protective copper conductor (G) − without inner rubber sheath − outer sheath consisting of cross-linked compound AG2	450/750 V	In mining workings not being endangered by firedamp Up to 1 000 V ac in all mining works, only in enclosures	stationary non stationary flexible
6	welding cable acc. to EN 50525–2-81 with − extra fine stranded conductor type: D or E: H01N2-D or E	100/100 V	In mining workings not being endangered by firedamp	flexible

1	2	3	4	5
No	**Cable type**	**Nominal voltage U_0/U**	**Scope**	**Methode of installation**
7	PVC- non sheathed cable for internal wiring acc. to EN 50525–2-31 Single core non-sheathed cables H05V- − solid (-U) or fine stranded (-K) conductor − PVC insulation (V)	300/500 V	Only in enclosures	stationary
8	PVC- non sheathed cable for internal wiring acc. to EN 50525–2-31 Single core non-sheathed cables H07V- − solid (-U) or fine stranded (-K) conductor − PVC insulation (V)	450/750 V	Only in enclosures up to 1 000 V ac	stationary
9	Single core cables with cross-linked elastomeric insulation acc. to EN 50264–3-, Table 4 with − fine stranded conductor (F) − rubber compound (HX) insulation − outer sheath rubber compound	3,6/6,6 kV	In separate electrical equipment rooms (switchgear rooms)	stationary
10	Screened and controlled mining cable − EPR insulation acc. to IEC 60502–2 with inner and outer conductive layer; − protective copper conductor, evenly separated into concentric conductors over every conductor core insulation − pilot cores − concentric monitoring conductor over conductor insulation − inner sheath PVC acc. to EN 50363–1 − tinned steel braid armour − outer sheath PVC	6,6/10 kV	In all mining workings, not in mining operations. and longwall	stationary and non-stationary

Table E.2 — Suitable cables for communication systems

1	2	3	4	5
No.	**Cable type**	**Rated voltage up to ... V**	**Scope**	**Method of installation**
1	Mining cables with – insulated conductors or – pairs or – cores and paired – PE insulation acc. to EN 50290–2-23 – or without single protective conductor – PVC inner sheath acc. to EN 50290–2-21 – PVC jacket acc. to EN 50290–2-22 – ribbon of steel spiral binder – outer sheath PVC acc. to EN 50290–2-22, blue or grey	375 225 375/225	In all mining workings but not in mining operations and longwall	stationary
2	mining cables with – insulated conductors or – pairs or – insulated conductors and pairs – PE insulation acc. EN 50290–2-23 – or without single protective conductor – PVC inner sheath acc. EN 50290–2-22 – tensile strength braid consisting of flat formed tinned steel wires – PVC jacket acc. EN 50290–2-22, blue or grey	375 225 375/225	In all mining workings but not in mining operations and longwall	stationary
3	Data signal and control cables with – insulated conductors – PE insulation acc. to EN 50290–2-23 – or without single protective conductor – PVC inner sheath acc. to EN 50290–2-22 – inner sheath – corrosion –protected ribbon of steel armouring – outer sheath acc. to EN 50290–2-22, blue, grey or black	600	In non-coal mining in all mining workings but not in mining operations and longwall	stationary
4	tensile strength optimized cables with stranded conductors for increased mechanical stress – pairs	375	in all mining workings	stationary non stationary flexible

1	2	3	4	5
No.	**Cable type**	**Rated voltage up to ... V**	**Scope**	**Method of installation**
	– PVC insulation acc. to EN 50290–2-21 – or without single protective conductor – PVC inner sheath acc. to EN 50290–2-22 – glass yarn strain relief in PVC jacket acc. to EN 50290–2-22, blue or grey			
5	tensile strength optimized cables with stranded conductors for increased mechanical stress – pairs – PE insulation acc. to EN 50290–2-23 – or without protective conductor – copper braid screen over pair or copper braid screen over inner sheath – PVC inner sheath acc. to EN 50290–2-22 – glass yarn strain relief in PVC jacket acc. to EN 50290–2-22, blue or grey	375	in all mining workings	stationary non stationary flexible
6	armoured flexible cables with stranded conductors for higher mechanical performance – pairs – PE insulation acc. to EN 50290–2-23 – or without single protective conductor – PVC inner sheath acc. to EN 50290–2-22 – flat formed tinned steel wire braid as mechanical protection – PVC jacket acc. to EN 50290–2-22, blue or grey	375	In all mining works but not suspended in shafts and boreholes and not for self-supporting cable suspensions	stationary non stationary flexible
7	other Multi-element cables used in analogue and digital communication control acc. to EN 50288–1		For intrinsically-safe installations	stationary, if applicable flexible
8	Fibre optic cables based on EN 60794–1-1		in all mining workings	
9	tensile strength optimized cables with stranded conductors with inner sheath and PVC jacket (L-YTY or YYTII)	375	unlimited	stationary, flexible

1	2	3	4	5
No.	**Cable type**	**Rated voltage up to ... V**	**Scope**	**Method of installation**
10	flexible control- and communication cables with EPR insulation and jacket and rubber sheathed steel support element.	600	in all mining workings, in shafts unsupported up to 200 m	flexible

Annex F
(informative)

Table for current carrying capacity of cables suitable for underground workings

1	2	3	4	5.1	5.2	6.1	6.2	7.1	7.2	8.1	8.2	9	10	11
Cable type	rubber-sheathed flexible cables, trailing cables	screened PVC-sheathed flexible cables	PVC-sheathed flexible cables	Cable for fixed installation						flat rubbers-sheathed flexible cables	rubbers-sheathed flexible cables	welding cables [d]	PVC-single core cables [b, c]	special rubbers-sheathed flexible cables [c]
Nominal voltage U_0/U in kV	0,6/1 1,8/2 3,6/6 6/10	3,6/6	0,3/0,5	0,6/1	3,6/6	3,6/6	5,8/10	6/10		0,3/0,5	0,45/0,75 [a]	0,1	0,45/0,75 [a]	3,6/6
nominal cross section of copper conductor mm^2	current- carrying capacity [A]													
0,75	11									12				
1,5	21		19	19						19	19		15	
2,5	28		26	26						27	27		21	
4	38		35	35						35	35		28	
6	49		44	44						45	45		36	44
10	69		61	61						63	63		49	60
16	92		82	82						85	85	137	66	80
25	122	103	103	109	108	117	117	122		112	112	187	87	105
35	151	129	129	134	134	145	141	151	164	139	139	235	108	129

1	2	3	4	5.1	5.2	6.1	6.2	7.1	7.2	8.1	8.2	9	10	11
Cable type	rubber-sheathed flexible cables, trailing cables	screened PVC-sheathed flexible cables	PVC-sheathed flexible cables	Cable for fixed installation						flat rubbers-sheathed flexible cables	rubbers-sheathed flexible cables	welding cables d	PVC-single core cables b, c	special rubbers-sheathed flexible cables c
50	188	157		163	161	172	169	188	195	174	174	299	131	162
70	233	201		207	202	216	210	233	243	214	214	376	166	200
95	280	244		250	247	264	257	280	296	258	258	455	201	238
120	328			289	284	307	296	328	340		302	538	233	281
150	376			332	324	351	336		388		346			319
185	429			380	371	402	384		443		395			366
240				447	438	474	451		523		468			431
correction coefficients for other ambient temperatures than 28 °C													40 °C	
up to 25 °C	1,04	1,04				1,03	1,04			1,05		1,03	1,22	1,32
Higher than 25 °C up to 28 °C	1.0												3	1,26
higher than 28 °C up to 35 °C	0,91	0,91				0,93	0,91			0,88		0,93	1,08	1,12
higher than 35 °C up to 40 °C	0,85	0,85				0,88	0,85			0,79		0,88	1,0	
higher than 40 °C up to 45 °C	0,77	0,77				0,82	0,77			0,68		0,82	0,91	0,87
Higher than	0,69	0,69				0,76	0,69			0,56		0,76	0,82	0,71

1	2	3	4	5.1	5.2	6.1	6.2	7.1	7.2	8.1	8.2	9	10	11
Cable type	rubber-sheathed flexible cables, trailing cables	screened PVC-sheathed flexible cables	PVC-sheathed flexible cables	Cable for fixed installation						flat rubbers-sheathed flexible cables	rubbers-sheathed flexible cables	welding cables [d]	PVC-single core cables [b, c]	special rubbers-sheathed flexible cables [c]
45 °C up to 50 °C														
higher than 50 °C up to 55 °C	0,60	0,65				0,69	0,60			0,40		0,69	0,71	0,50

[a] In enclosures up to 1 000 V AC and 750 V DC.

[b] Correction coefficients for a group of lines.

[c] Ambient temperature 40 °C.

[d] 60 % ED, cycle time 5 min.

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