

Riga Technical University  
Institute of Industrial Electronics and Electrical Engineering  
Department of Electrical Engineering and Electronics

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# HIGH-VOLTAGE SAFETY PRECAUTIONS

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This material presents a summary of the organisational requirements for work with operating electrical installations. The summary includes basics of work organisation, types of work and the associated organisational measures. This study material is designed for in-depth training of qualified personnel in the field of organisational activities and can be used in qualification raising courses.

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Prepared by: Associate Professor Dr. sc. ing. A. Podgornovs  
Reviewed by: Associate Professor Dr. sc. ing. K. Bērziņa

Proofreading: Daina Ostrovska  
Design: Baiba Puriņa  
Cover Design: Paula Lore

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# 1. Introduction

It is almost impossible to imagine our everyday life without using electrical energy. The number of appliances and devices used in generating, transforming, transmission, distribution, and use of the electrical energy as well as the technological complexity of manufacturing and operating these appliances and devices are growing constantly. Operation of an electrical installation is closely connected with maintaining safe operational conditions. Electrical safety as a set of organisational measures and technical means that protects the staff from hazardous and dangerous impact of electric current, electric arc, electromagnetic field, and static electricity is still topical and requires specific measures.

There is a huge number of various internal regulations, national standards, European standards, national regulations (Cabinet Regulations and Laws of the Republic of Latvia) that regulate electrical safety related issues. This work is based on the following materials: Cabinet Regulation No. 1041 “Regulations Regarding Energy Standards of Mandatory Application Establishing Organisational and Technical Safety Requirements for the Operation of Energy Supply Objects” (adopted in Riga on 8 October 2013), and the applicable European Standard LVS EN 50110-1:2013 “Operation of Electrical Installations. Part 1: General Requirements”. LVS EN 50110 has two parts: the first one lays down minimum requirements that apply to all CENELEC countries and several informative annexes that are related to safe work on or with an electrical installation or in distance; the other part gives a summary of additional regulatory information that specifies or elaborates on the minimum requirements included in part one.

## 2. Terms and Definitions

This material uses the terms and definitions as included in the standard IEC 60050 and as available on [www.electropedia.org](http://www.electropedia.org). See also Electropedia or Glossary IEC on the website [www.iec.ch](http://www.iec.ch).

### 2.1. General

Electrical installation — assembly of electrical equipment, which is used for the generation, transmission, distribution and/or use of electric energy. Note. The electrical installation includes energy sources such as batteries, capacitors and all other sources of stored electric energy [IEC 60050-651:1999].

Operation — combination of activities including work activities necessary to permit an electrical installation to function. Note. The operation includes such matters as switching, controlling, monitoring and maintenance as well as both electrical work and non-electrical work [IEC 60050-651:1999; IEV 651-01-05, modified].

Risk — combination of probability and the degree of possible injury or damage to health of a person exposed to a hazard or to hazards [IEC 60050-651:1999; IEV 651-01-31, modified].

Electrical risk — source of possible injury or damage to health in presence of electrical energy from an electrical installation.

Electrical danger — risk of injury from an electrical origin.

Electrical injury — death or personal injury from electric shock, electric burn, arcing, or from fire or explosion initiated by electrical energy caused by any operation of an electrical installation [IEC 60050-651:1999, IEV 651-01-32, modified].

### 2.2. Personnel, organisation and communication

Person in control of operation of an electrical installation — person who has been designated to be the person with general management responsibility for safe operation of an electrical installation, compliance with technical and environmental regulations and operational conditions. Note 1. This person may be the owner, employer, entrepreneur, or a person designated to undertake this obligation. Note 2. Parts of this responsibility may be delegated to others as required. In the event of bulky or complex installations, these competences may be divided according to the separate parts of the installation (Fig. 3.1. a).

Person in control of work organisation — person who has been designated to be the person with direct management responsibility for safe operation of an electrical installation during work performance. Note. The person in control of work organisation performs risk assessment of the general impact of works on an electrical installation or a part thereof depending on the area of control, and evaluates the impact of an electrical installation on the work location and personnel. Parts of this responsibility may be delegated to others as required (Fig. 3.1. b).

Designated person in control of work performance — person who has been designated to be the person with direct responsibility for the work performance at the work location. Note. Parts of this responsibility may be delegated to others as required (Fig. 3.1. c).

Skilled person — person with relevant education and experience to enable him or her to perceive risks and to avoid hazards, which electricity can create [IEC 60050-826:2004; IEV 826-18-01, modified].

Instructed person — person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid danger, which electricity can create [IEC 60050-826:2004; IEV 826-18-02, modified].

Ordinary person — person who is neither a skilled person nor an instructed person [IEC 60050-826:2004; IEV 826-18-03, modified].

Notification— verbal orders or written instructions and assignments with information and activities that are related to all activities in an electrical installation.

Assignment — a document executed on a standard form and issued for the performance and organisation of work with a deadline of no more than 30 days.

Order — a task assigned verbally or in writing for the performance and organisation of work with a deadline of no more than one day.

### 2.3. Working zones

Work location — construction site, zone, or location where work will be performed, is being performed, or was performed [IEC 60050-651:1999; IEV 651-01-08, modified].

Live working zone — space around energized parts where the level of insulation required for avoidance of electrical risk cannot be ensured without special protective measures when accessed. Note. The outer boundary of a live working zone is designed as distance  $D_L$  [IEC 60050-651:1999; IEV 651-01-06, modified].

Vicinity zone — limited space outside the live working zone. Note. The outer boundary of a vicinity zone is designed as distance  $D_V$  [IEC 60050-651:1999; IEV 651-01-07, modified].

### 2.4. Activities

Work activity — all electrical work and non-electrical work where an electrical hazard is present.

Electrical work — work on or near an electrical installation, such as testing and measuring, repairing, replacing, modifying, extending, erection and inspection [IEC 60050-651:1999; IEV 651-01-12, modified].

Non-electrical work — work in direct proximity of electrical installations, such as construction and assembly works, earthworks, cleaning, painting, etc. [IEC 60050-651:1999; IEV 651-01-13, modified].

Live working — activity in which a worker makes contact with energized parts or encroaches inside the live working zone with either parts of his or her body or with tools, devices or equipment. Note. Live working in low-voltage installations is done if a worker complies with predefined requirements and makes contact with energized parts. Live working in high-voltage installations is done if a worker encroaches into the live working zone irrespective of whether or not he or she makes contact with energized parts [IEC 60050-651:1999; IEV 651-01-01, modified].

Working in the vicinity of live parts — activity in which a worker with part of his or her body, with a tool or with any other object enters into the vicinity zone without encroaching into the live working zone [IEC 60050-651:1999; IEV 651-01-02 modified].

Isolate — disconnect completely a device or an electric circuit from other devices or electric circuits by separation that would withstand the expected voltage difference between that device or electric circuit and other electric circuits [IEC 60050-151:200; IEV 151-15-37, modified].

Dead — at an electric potential equal to or not significantly different from that of earth at the worksite [IEC 60050 -651:1999; IEV 651-01-15, modified].

Dead working — work under conditions that are safe to avoid electrical hazard.

Work permit — a written or verbal unambiguous permission for the performance of scheduled works.

Permission to start work — instruction to workers to commence work when all the safety measures are fulfilled.

## 2.5. Protective equipment

Safety devices — any insulating or non-insulating device used to restrict access to energized parts of an installation or at a work location [IEC 60050-651:1999; IEV 651-01-29, modified].

Barrier — part providing protection against direct contact from any usual direction of access when moving and working [IEC 60050-826:2004; IEV 826-12-23, modified].

Insulating covering — a device made of hard or flexible insulating material used to cover energized and/or dead and/or near parts to prevent accidental direct contact.

Enclosure — protection of worksite against the impact of external factors and protection against direct contact in any direction.

Voltage detector — portable device used to provide clear evidence of the presence or absence of an operating voltage. Note. These diagnostic devices are generally described as either capacitive type or resistive type [IEC 60050-651:1999; IEV 651-10-04, modified].

Portable equipment for earthing or earthing and short-circuiting — equipment, which is portable and can be carried by one person and manually or mechanically connected with its insulating component to parts of an electrical installation for earthing or short-circuiting or earthing and short-circuiting purposes. Note. The portable equipment for earthing or earthing and short-circuiting comprises the earthing and short-circuiting device and one or more specific detachable or non-detachable insulating components such as earthing rods [IEC 60050-651:1999; IEV 651-14-01, modified].

## 2.6. Voltage nominal value

Extra-low voltage (ELV) — voltage not exceeding 50 V AC or 120 V DC without harmonics between conductors or between a conductor and earth (see HD 60364-4-41 Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock) [IEC 60050-826:2004; IEV 826-12-30, modified].

Low voltage (LV) — voltage not exceeding 1000 V AC or 1500 V DC between conductors or between a conductor and earth [IEC 60050-151:2001; IEC 60050-151:2001, modified].

High voltage (HV) — voltage exceeding 1000 V AC or 1500 V DC between conductors or between a conductor and earth.

## 3. Organisation of Works and Personnel

### 3.1. Safe work

Electrical hazards shall be assessed and measures for reducing or preventing working environment risks shall be established prior to inspection and any work in an electrical installation. The following aspects shall be considered within a risk assessment:

- operating voltage and frequency of an electrical installation;
- external factors, including meteorological conditions;
- impact of electromagnetic field;
- work in heights and peculiarities of steeplejack work;
- interaction of several working environment related factors.

If it is established as a result of assessing the working environment risks that exposure to electromagnetic fields cause risk to the safety and health of workers, the employer shall take measures to prevent or reduce the impact of electromagnetic field. Such assessment shall result in a decision on how an inspection or work shall be carried out or what safety measures and precautions shall be taken to ensure safety.

### 3.2. Personnel

Degree of responsibility for safety of persons that participate in work or are related to it must be set in line with the national regulations (Cabinet Regulation No. 1041 “Regulations Regarding Energy Standards of Mandatory Application Establishing Organisational and Technical Safety Requirements for the Operation of Energy Supply Objects”). All persons that work on or near an electrical installation must be instructed about the current safety requirements, regulations, instructions and the relevant internal requirements of the particular organisation. Such instructions shall be repeated if the work is to be performed over a longer period of time, if it is complicated or combined with other work. Workers shall be informed on the fact that they must comply with these safety requirements, regulations, instructions, and internal requirements of the organisation. Personnel shall wear clothing that is suitable for the work location and work conditions. Such clothing includes tight clothing or additional personal protective equipment. Before and during work, the person in control of work performance shall observe that all safety requirements, regulations, instructions, and internal requirements of the organisation are complied with. The person in control of work performance shall inform all the involved workers on the anticipated danger that may arise in the course of work performance. If any of workers involved in work lack the necessary experience or knowledge about electrical hazards and injuries, these workers may not perform the particular work. Work may be performed if monitoring is ensured. Independent work in an electrical installation is allowed for persons that have attained the age of 18 years and whose health has been examined according to regulatory enactments on the procedures for performance of mandatory health examinations and who have been awarded an electrical safety certificate. Persons performing independent work in an electrical installation must comply with the following criteria:

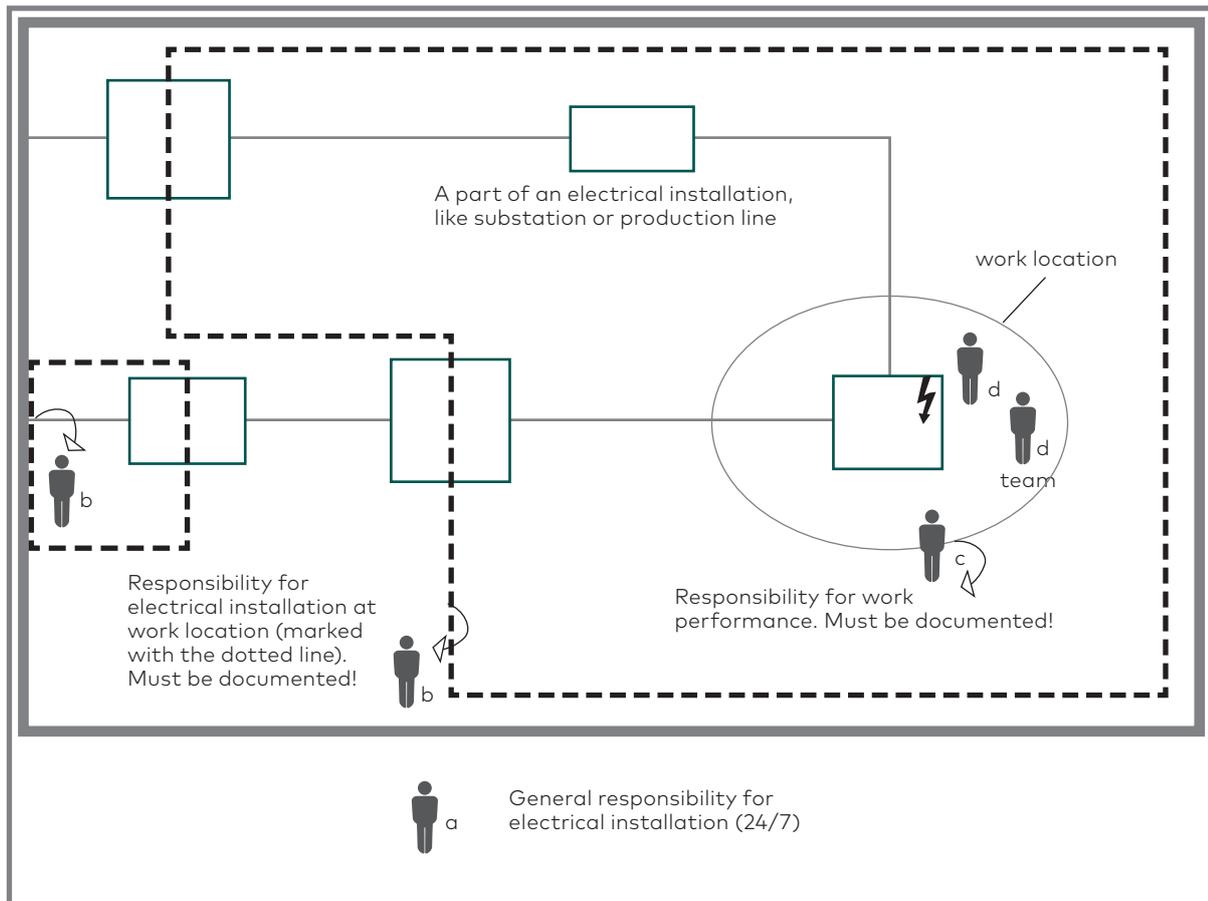
- knowledge of electrical engineering;
- experience in electrical engineering;
- knowledge of the electrical installation in which work shall be performed, and practical experience in performing the scheduled work;
- knowledge of hazards during the work and the necessary precautionary measures;
- ability to judge constantly if work is performed safely.

The type and complexity of works shall be assessed before commencement of these works to select the necessary personnel for the performance of the work from all skilled, instructed or ordinary persons.

### 3.3. Organisation

A person in control of operation of an electrical installation shall be designated for each electrical installation. This person may be either a natural person from the organisation itself or a third-party organisation. If another organisation is outsourced for these responsibilities, a document must be prepared that specifies the electrical installations for which the responsibility is taken and for what period of time. If necessary, parts of this responsibility may be delegated to others. However, it must be documented.

There must be a person in control of work organisation in every electrical installation in which works are being performed. The person in control of work organisation shall transfer part of work to the person in control of work performance. If necessary, the person in control of work organisation may delegate parts of this responsibility to others.



**Fig. 3.1.** Levels of responsibility in an electrical installation, where: a — a person in control of operation of an electrical installation (employer, or possessor, or a person designated as the person responsible for the general operation of that electrical installation); b — a person in control of work organisation (a person designated as the person responsible for the work organisation in that electrical installation); c — a person in control of work performance (team manager from within the company or from an outsourced company); d — team member.

Responsibilities of the person in control of operation of an electrical installation, of the person in control of work organisation, and of the person in control of work performance may be undertaken by one and the same person. If one or several electrical installations are interconnected, information exchange between the persons in control of work organisation shall be ensured to guarantee safety.

Access of ordinary persons to all locations where electrical danger exists shall be regulated appropriately. The person in control of operation of an electrical installation shall lay down the access requirements and ensure monitoring, and it must comply with the national regulations.

A person in control of work performance shall be designated for every work. If the work is split, a person responsible for safety shall be designated for each work group and a person coordinating all work groups shall be designated. The person in control of work performance and the person in control of work organisation shall prepare for work on, with or near an electrical installation, and coordinate if any changes to electrical installation are necessary prior to work commencement, for example if any switching operations must be done or if work may be commenced without any additional operations.

### **3.4. Communication (exchange of information)**

Communication includes any form of transfer of information or information exchange between persons, i.e. verbally (for example, by phone, by radiocommunication, in presence), in writing (telefax or e-mail), and optically (displays and monitors, warning displays, light signals). Before work commencement, the person in control of work organisation shall be informed. All information necessary for safe work in an electrical installation (configuration of electrical grid, position of switches (on, off, earthed)) shall be indicated in the directions (order, assignment). Other methods of information transfer, like radio signals, computers, light panels, may only be used if that method of information transfer is safe and unambiguous and if incorrect signals cannot be received. All directions must contain the name and if necessary location of the person providing information. To avoid mistakes when transferring information verbally, the receiver shall repeat the information to the transmitter and the transmitter of the information shall confirm that the information has been received and is understood correctly. When work is completed, the restrictions imposed in the work location may not be discarded immediately and an electrical installation may only be switched on using the signs and at the predetermined time. If workers speak different languages at the work location, the language of communication to convey important safety information to all involved workers shall be specified in prior.

### **3.5. Work location**

The work location shall be clearly defined and labelled using operational signs. Sufficient movement, free passages and sufficient lighting shall be provided in all work locations on or near an electrical installation. If necessary, safe access to work location must be clearly marked. The required safety precautions must be taken to protect workers from mechanical and other non-electrical injuries. Appropriate measures shall be taken to protect personnel also from non-electrical hazards in work location and during work, for example when using mechanisms connected with pressure systems or to avoid falling. Passages, backways, rooms used for the service of switchgears and equipment and work shall be free from any disturbing objects and inflammable materials. Inflammable materials that are stored near electrical installations must be stored separate from ignition sources.

## 4. Types of Works and Organisational Measures

Organisational measures for safe performance of work in electrical installations:

- designation of persons in control and workers in control of specific duties;
- giving of assignments or orders;
- organisation of works according to the internal regulations approved by the possessor;
- giving of permit for preparing work location and clearance;
- preparation of work location and provision of clearances for workers;
- monitoring during work;
- organised moving of workers to another work location and recording of this activity;
- recording of breaks and completion of works.

Works in an electrical installation shall be performed according to:

- an assignment;
- an order;
- internal regulations approved by the possessor.

### General requirements for types of works

Before work commencement, all risks must be assessed, and the necessary precautionary measures must be taken (see Chapter 3.1). Only the person in control of work organisation may issue a permit for scheduled works and receive it back. In case of a break this permit must be reissued, except for short breaks during which the work location is not left.

Prior to work commencement, the person in control of work performance shall provide the person in control of work organisation with information on the type and location of work and the impact of scheduled works on electrical installation. It is best to transfer this information in writing, especially in case of complex works. According to general principles, either the person in control of work organisation or the person in control of work performance must give instructions upon work commencement and completion.

Depending on the nature and electrical hazard of the work to be done there are several types of work:

- work under dead conditions;
- live working;
- working in the vicinity of energized parts.

Efficient safety precautions against electric shock, short-circuit, and arcing must be elaborated for all three types of work. The required levels of insulation must be ensured when working, for example by using dense insulation materials or by ensuring the necessary clearance.

### Requirements in case of induced voltage

Wires or other current-carrying parts that are near energized parts are subject to electric induction. When working in electrical installations with possible induced voltage, special safety measures must be taken (especially in overhead lines):

- additional earthing must be ensured at regular interval to reduce the induced voltage to safe level;
- measures for potential equalisation at work location to prevent workers from encroaching into induction zone.

### Weather-related requirements

If unfavourable weather conditions set in, like lightning, heavy rain, fog, blustering wind, etc., appropriate work restrictions shall be applied, and/or the work shall be suspended. If lightning is observed, thunder can be heard or if thunderstorm is approaching, work in overhead lines and in those parts and equipment of electrical installation that are directly connected to overhead lines must be suspended immediately and the person in

control of work organisation shall be informed thereon. In case of limited visibility at work location, work may not be commenced but the commenced work shall be suspended due to safety reasons.

#### **4.1. Work under dead conditions**

This chapter discusses the most important requirements (“five safety rules”) for preparing and ensuring constant dead conditions. For this, working zone must be clearly specified. When the necessary part of an electrical installation is selected, five important tasks must be carried out in specific order unless there are important grounds for declining them:

- disconnect completely;
- secure against re-connection;
- verify that the installation is dead;
- carry out earthing and short-circuiting;
- provide protection against adjacent live parts.

Permission for work organisation is given by persons in control of work organisation and it is received by a designated person or a person in control of work performance. All the persons involved in work must be skilled or instructed or must work under supervision of such person.

##### **4.1.1. Complete disconnection**

The part or electrical installation in which work is to be carried out shall be completely disconnected from all power sources. Disconnection is created by an air gap or similar insulation if it is safe against breakdown.

##### **4.1.2. Securing against re-connection**

All switching devices that are used to disconnect an electrical installation from voltage at work location must be secured against re-connection by blocking operational mechanisms and preventing switching on. If blocking is not possible, similar methods tested in practice shall be used to secure against re-connection. If an additional power source is needed for operating a switching device, it must be disconnected. To avoid accidental interference, appropriate measures shall be taken, for example placing of warning signs. Securing against remote re-connection shall be ensured, and on-site operation of a switching device shall also be discontinued. All control and blocking devices used for this purpose shall be reliable. The parts of a device that remain energized following disconnection and securing against re-connection, like condensers and cables shall be discharged using a special tool.

##### **4.1.3. Testing for the absence of voltage**

If operating voltage is disconnected, absence of voltage shall be tested in all terminal phases (poles) at the work location or as close to it as possible. Absence of voltage in an electrical installation is tested in accordance with the internal instructions of a company. Such instructions shall provide for terms of use of a voltage detector and use of a built-in voltage testing system and/or a portable voltage testing system. It is mandatory to test such voltage detectors and portable voltage testing systems prior and if possible after use thereof.

If a cable is disconnected, it is impossible to clearly establish at the work location if no additional precautionary measures are necessary. Therefore, cable cutting or cable punching tool may be used.

Absence of voltage shall be tested before each work. The used voltage detectors and voltage testing systems must comply with the valid standards EN 61243-1, EN 61243-2. If work is suspended at any time or if workers have left the work location and the disconnected

position of an electrical installation is not changed, absence of voltage shall be tested prior to work resumption. It is not necessary if earthing and short-circuit has already been made at the work location.

#### **Requirements for special devices**

If a remote earthing switch is used for ensuring absence of voltage, it must be appropriate for making and discharging short-circuit. In addition, an earthing switch must be operated using a remote control system. If an earthing switch is operated on site, the operation of earthing switch shall be visually tested, and all poles and terminals shall be checked. A high-voltage earthing switch shall correspond to the valid standards EN 62271-1 and EN 62271-102.

#### **4.1.4. Earthing and short-circuiting**

All current-carrying parts that are necessary for work in high-voltage electrical installations and in specific low-voltage electrical installations must be earthed and short-circuited at the work location. Earthing and short-circuiting devices must be first connected to earth loop (earth electrode) and then to parts that must be earthed. Removal of earthing is carried out in reverse. Earthing and short-circuit must be as visible from the work location as possible. In other cases they must be located as close to work location as possible.

If it is necessary to disconnect or connect a current-carrying part during work and if there is a risk due to difference between potentials, then appropriate measures, like earthing, shall be taken first at the work location. Earthing and short-circuiting equipment shall correspond to the valid standards EN 61219 and EN 61230. In any case, it must be clear that wires (cables) and feeders of earthing and short-circuiting equipment are safe and correspond to the short-circuit current at the place of connection. It must be established that earthing equipment and short-circuitors must be used throughout work time. If earthing equipment and short-circuitors are to be removed during measurements or testing, additional or other precautionary measures shall be taken. If a remote earthing switch is used for earthing and short-circuiting, it must be appropriate for making and discharging short-circuit. In addition, an earthing switch must be operated using a remote control system. If earthing and short-circuiting contacts of such earthing switch are visible at the work place, their position shall be checked after disconnection. If earthing and short-circuiting equipment in electrical installations are controlled remotely, it must be ensured that the status of this equipment is confirmed with a signal.

#### **Requirements for high-voltage electrical installations**

Non-insulated overhead lines and non-insulated current-carrying parts that are located in the work location zone must be earthed from all sides and all phases must be short-circuited. At least one earthing and short-circuiting equipment must be visible from work location. Exceptions may be applied in the following cases:

- if no wire is disconnected during work, earthing and short-circuit at the work location is enough;
- if no earthing and short-circuiting equipment is visible outside the work location, a screen with indications or another clear sign must be placed at the work location in addition to earthing and short-circuiting equipment;
- no short-circuit is necessary at the work location if special conditions are met when working on one wire of an overhead line only.

Insulated overhead lines, cables and other insulated conducting materials shall be earthed and short-circuited at disconnected places or in all directions as close to work location as possible.

#### 4.1.5. Covering or segregation of adjacent energized parts and placing of safety signs

Placing of safety signs is described in Chapter 5.

#### Work permit (order, assignment)

Work permit issued by the person in control of work organisation is a mandatory pre-condition for work performance. Permit for work commencement may only be issued by the person in control of work performance. To avoid any misunderstandings, the necessary disconnections and earthing shall be indicated in a detailed written confirmation (assignment) for work in high-voltage electrical installations.

#### Switching on of electrical installation after work completion

Following work completion and acceptance, persons whose presence is not necessary any more must be informed that the work is completed and no continuation of work is permitted. All persons not involved in further activities must be led out from the work zone. All the tools, equipment, and protective equipment used for work must be removed. Only then preparation for switching on electrical installations may be commenced.

All earthing and other safety equipment used must be removed. Then all the safety equipment, including earthing and short-circuiting equipment and safety equipment securing against re-connection used in work and removed must be removed from the work location. All the safety signs used in work must be removed. As soon as all safety equipment is removed, the particular part of electrical installation shall be regarded as energized.

When the person in control of work performance has assured himself or herself that voltage can be restored at the work location, he or she must inform the person in control of work organisation that the work is completed and voltage can be restored.

### 4.2. Live working

Live working is performed according to specific requirements, methods, and practice. It may happen that it is not possible to apply the requirements specified in Chapter 4.1, like testing for the absence of voltage, connecting of earthing and short-circuiting equipment in full for a particular work.

- In live working conditions, a worker makes contact with current-carrying parts or encroaches into the live working zone with his or her body, tools, or equipment. Values of the suggested minimum distance ( $D_V$ ) of the outer boundary of a live working zone are given in Table 4.1.
- Live working may only be performed if there is no fire and explosion hazard.
- Stable position of a worker must be ensured so that he or she can work with both hands.
- Workers shall wear appropriate personal protective equipment. Workers may not wear any metal-containing objects, like jewellery if they can cause any hazard.
- When performing live working, all the necessary measures shall be taken to ensure protection against electric shock and short-circuit. Measures for potential equalisation shall be taken close to the work location.

Depending on the method of the work, work may only be performed by skilled or instructed persons. These both groups of persons must receive appropriate special training.

Live working requires special techniques that are described in Chapter 4.2.1. Instructions on the maintenance of tools, equipment, and protective equipment to ensure proper condition thereof and on the testing of the tools and equipment prior to work commencement must be provided.

Such ambient conditions (see Chapter 4.2.5) as humidity and pressure may affect safe performance of works, therefore sufficient countermeasures shall be established.

#### 4.2.1. Special training for live working

To ensure that skills and training of personnel with regard to live working is up-to-date, a special training programme shall be developed. This programme shall include special requirements for personnel that carries out live working, as well as theoretical and practical classes. The knowledge gained during these classes shall be put in practice through work, but work that differs from the one discussed in classes shall be based on similar safety requirements. At the end of a successful special training course, participants shall be awarded a certificate of readiness to perform specific live work according to the provided training. This certificate shall attest the level of skills and readiness to perform live working. The ability of personnel to perform live working must be maintained either by practical work or by repeated training.

#### 4.2.2. Live working methods

There are three recognised working methods that are applied depending on the position of a worker to energized parts of an electrical installation and the equipment used for the protection against electric shock and short-circuit.

Work in a safe distance — a worker remains in a specified safe distance from the energized parts of an electrical installation during work and performs work using insulating rods.

Work with insulated (dielectric) gloves — work with this method implies that a worker makes direct contact with energized parts using dielectric gloves and insulated sleeves, if necessary in addition. If insulated or insulating tools are used when working in low-voltage electrical installations, dielectric gloves shall still be used and work location shall be insulated.

Direct contact with energized parts (the bare hand method) — when a worker is subject to the same potential as in the energized part, when working in contact with energized parts. Such method allows sufficient insulation of a worker from the surroundings.

#### 4.2.3. Conditions for live working

Depending on the type of work and the ambient medium, conditions for work must be defined that are fulfilled in line with Chapter 4.2.2. The work procedure shall be established considering the anticipated operations, and the special tools and equipment shall be used. Work conditions may include one or several of the following requirements:

- description of cooperation between the workers involved in live working, for example between the person in control of work organisation, person in control of work performance, and designated workers;
- measures for limiting switching overvoltages at the work location, for example, repeated switching on of power switches;
- definite distance between personnel and the current-carrying elements used; these distances are based with voltage against ground, but also voltages between phases must be observed (Table 4.1).

#### 4.2.4. Tools, equipment, and safety equipment for live working

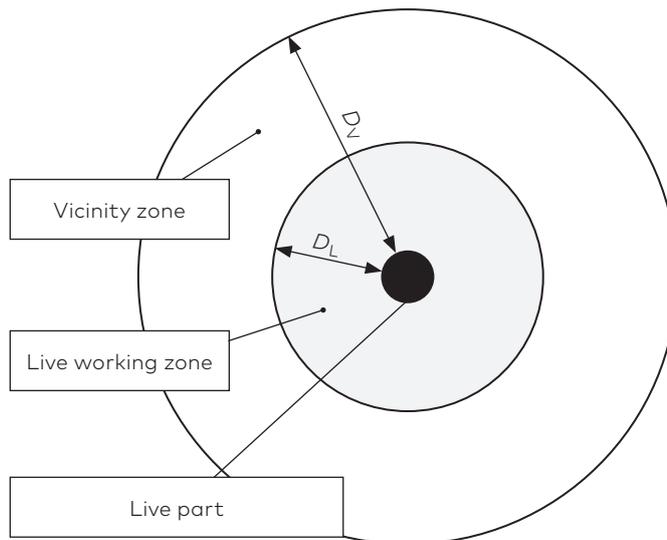
Additional special conditions for use, storage, maintenance, transport, and testing shall be laid down for tools, equipment, and protective equipment used in live working. Tools, equipment, and protective equipment shall be clearly identifiable. Manufacturer instructions must be at the disposal of users. Sometimes national regulations require that tools, equipment, and protective equipment is included in the so-called Technical Database in writing. Such database is used to ensure constant quality. All tools, equipment, and

protective equipment used in live working must be entered in such database even if it is not required by regulatory enactments.

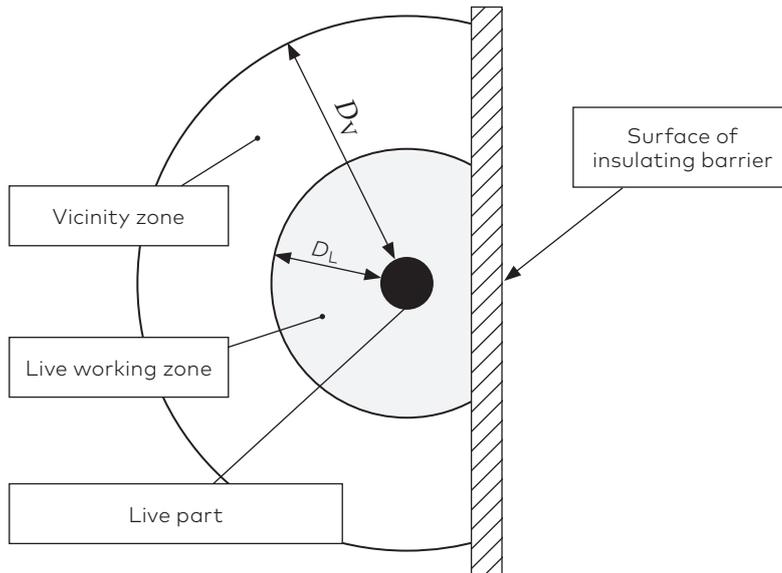
#### 4.2.5. Ambient conditions

When ambient conditions get worse, live working must be restricted. During the period of restrictions, it must be minded that level of insulation reduces and visibility and personnel movement is limited. If necessary, changes in weather conditions (precipitation, thick fog, thunderstorm, strong wind, extremely low temperature) must be considered when working outdoors. Live working must be prohibited or it must be suspended during heavy rain or in limited visibility or if it is impossible for workers to move their tools freely. Live working may not be commenced or it must be suspended in case of thunderstorm. It is possible not to take weather conditions in consideration when working indoors if the connected overhead lines cannot cause overvoltage and if there is sufficient lighting in the work location.

Other disturbing conditions like altitude, unfavourable surroundings, and air pollution must be specially considered when working in or near high-voltage electrical installations if such conditions have adverse effect on the insulation ability of tools, equipment, and protective equipment. If work must be suspended due to unfavourable ambient conditions, the electric installation and all the fixed insulating and insulated tools must be left in safe position. Then workers must leave the work location in line with safety requirements. If the suspended work is resumed later, it must be checked if the insulating parts are clean and free from damage. If any part must be cleaned, appropriate cleaning agent must be selected and used.



**Fig. 4.1.** Distance in air from live part and work zone, where  $D_L$  – distance marking the outer boundary of a live working zone;  $D_V$  – distance marking the outer boundary of the vicinity zone.



**Fig. 4.2.** Limiting of live working zone using an insulating barrier, where  $D_L$  – distance marking the outer boundary of a live working zone;  $D_V$  – distance marking the outer boundary of the vicinity zone.

Table 4.1

Advised values\* of  $D_L$  and  $D_V$

Rated voltage of the electrical grid $U_N$ , kV	Minimum admissible distance in air marking the outer boundary of a live working zone, $D_L$ , mm	Minimum admissible distance in air marking the outer boundary of the vicinity zone, $D_V$ , mm
≤ 1	no contact	300
3	60	1120
6	90	1120
10	120	1150
15	160	1160
20	220	1220
30	320	1320
36	380	1380
45	480	1480
60	630	1630
70	750	1750
110	1000	2000
132	1100	3000
150	1200	3000
220	1600	3000
275	1900	4000
380	2500	4000
480	3200	6100
700	5300	8400

\* The values of  $D_L$  and  $D_V$  indicate the minimum distance considering the distances used in European countries. Value of  $D_L$  matches the values calculated according to standard EN 61472.

There is a large number of  $D_L$  values for voltages up to 70 kV, as distances for ergonomic operation exceed the minimum distances for voltage.

## 5. Safety Signs

To draw attention to and to warn about the possible risks, safety signs are placed in accordance with regulatory enactments on labour protection requirements for use of safety signs. The following safety signs (Table 5.1) shall be placed when preparing work location for any kind of work.

1. Warning sign “DANGER, ELECTRICAL HAZARD!”.
2. Prohibition signs:
  - with symbol “Do not switch” (do not change the position of the switch);
  - with clarifying text or symbols “Do not open” and “Do not close”.

Table 5.1

Use of safety signs

Safety sign	Name and meaning	Usage
	Warning sign “DANGER, ELECTRICAL HAZARD!” (minimum length of a triangle side of portable sign placed on a white square — 120 mm)	<ol style="list-style-type: none"> <li>1. The warning sign “DANGER, ELECTRICAL HAZARD!” must always be placed on the outside of entrance doors and gates of electrical installations, on doors of power switches and transformer cases, doors of distribution cabinets, on the enclosures of energized parts located in manufacturing premises.</li> <li>2. This warning sign is used to mark off a work location. Work location must be marked off (leaving a place for entry) with a natural or synthetic rope, string, or tape and by placing warning signs “DANGER, ELECTRICAL HAZARD!” facing the inside of the marked off territory on it. When marking off a work location, the admissible distances to the energized parts of an electrical installation and the vertical projections thereof on ground, as indicated in Table 4.1, must be observed. Work location in secondary circuits of electrical installations and low-voltage panels need not to be marked off. Work location need not to be marked off when working in relay protection circuits and automatic and secondary circuits.</li> <li>3. For temporary marking off of energized parts, screens, barriers, and insulating shields may be used. Warning signs “DANGER, ELECTRICAL HAZARD!” must be placed on such temporary enclosures. In addition, warning signs “DANGER, ELECTRICAL HAZARD!” must be placed:                             <ul style="list-style-type: none"> <li>▪ on fencing of cases, cabinets, and panels that are adjacent to work location;</li> <li>▪ on electrical appliances that are next to the one being repaired and have similar looks or construction irrespective of whether they are in operation or disconnected;</li> <li>▪ on outdoor distribution installation structures using which one may arrive from a work location to a place that is adjacent to an energized electrical installation, or on structures that are forbidden to climb on;</li> <li>▪ when working in cabinets of a compact substation, on cabinet compartments in which energized parts have remained and whose shutters are locked;</li> <li>▪ near dug up cables and sleeves if they do not lay on ground;</li> <li>▪ near torn wires of 6–20 kV overhead lines or other damaged places where there may be earth fault. In such cases guarding must be ensured to prevent people and animals approaching the hazardous site.</li> </ul> </li> </ol>

Safety sign	Name and meaning	Usage
	Prohibition sign “DO NOT SWITCH” (portable)	<ol style="list-style-type: none"> <li>4. When testing electrical installations using increased voltage, the tested installation shall be marked off and a warning sign “DANGER, ELECTRICAL HAZARD!” facing outside shall be placed.</li> <li>5. When testing a cable line, a warning sign “DANGER, ELECTRICAL HAZARD!” must be placed on doors or fencing if the other end of that cable line is in a locked camera, compact substation bay or room.</li> </ol>
	Prohibition sign “DO NOT” supplemented with text or symbols: “DO NOT OPEN” (may be placed on one plate) or “DO NOT CLOSE” (portable)	<ol style="list-style-type: none"> <li>6. Prohibition sign with a symbol indicating that the position of switch shall not be changed “DO NOT SWITCH” is placed:                             <ul style="list-style-type: none"> <li>▪ on disconnecter, isolating and power switch drives, on remote control keys and buttons, on switching devices (automatons, load break switches, switches) incorrect switching of which may result in voltage being transmitted to the work location;</li> <li>▪ on the fencing of disconnectors that are operated using insulating rod, and on the drive of each single-pole disconnector;</li> <li>▪ on locked shutters or doors of compact substation cabinets drawn from overhead lines and cable lines;</li> <li>▪ on holders of removed fuses in low-voltage connections without switching devices.</li> </ul> </li> <li>7. Prohibition signs with text or symbols “DO NOT OPEN” and “DO NOT CLOSE” are placed on shutters and valves that cut off air supply to pneumatic drives of air switches and disconnectors incorrect switching on of which may result in voltage being transmitted to the work location.</li> </ol>

## 6. Procedure for Issuing Assignments

Assignment — a document executed on a standard form and issued for the performance and organisation of work with a deadline of no more than 30 days. Assignment contains mandatory information and specifies:

- 1) persons involved in work performance;
- 2) workers responsible for safe performance of work;
- 3) work to be done and measures for preparing the work place and clearance.

An assignment:

- 1) shall be issued for a period of time not exceeding 15 days from the beginning of works;
- 2) may be extended once for a period of time not exceeding 15 days from the moment of extending the assignment (if necessary);
- 3) shall be kept for minimum 30 days after completion of works, according to the procedure laid down by the person in control of operation of an electrical installation;
- 4) shall be executed in two copies; when preparing work location, executing clearance and during work, one copy of assignment shall be at the disposal of a worker who issues permit to prepare work location and give clearance to a team or to the person issuing clearance, and the other copy — at the work location;
- 5) shall be executed in three copies if it is transmitted using telecommunication means. In such case the person giving clearance shall execute one copy and the worker who receives the particular assignment text shall execute the assignment in two copies. The receiver of assignment text shall indicate the given name and surname of the issuing person in the field for signature of person issuing the assignment and shall confirm the correctness of the text with a signature.

### 6.1. Assignment form

Structural unit

Object

**Assignment No.** .....

**for work in an**

**..... electrical installation**

To the person responsible ..... to the person giving clearance .....

for work performance ..... supervisor .....

with team members: .....

.....

.....

.....

.....

assignment: .....

.....

.....

.....

Work to be commenced on: date ..... time .....

Work to be completed on: date ..... time .....

**Measures for preparing work location**

Table 1

Names of electrical installations in which disconnections shall be made and earthing shall be ensured	What must be disconnected and where earthing must be ensured	Completed
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

Special conditions: .....

.....

.....

.....

.....

Issued by: .....  
 (person in control (date and time, position, surname and signature of the person in control of work organisation) of work organisation)

Assignment  
 extended to: .....  
 (date and time, position, surname and signature of the person in control of work organisation)

Date when extended ..... time .....

**Permit for preparing work location and clearance**

Table 2

The following persons are instructed to prepare work location and eligible for clearance (position, given name and surname, signature)	Date, time	Signature of worker who received permit for preparing work location and clearance
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

Work locations have been prepared. The following are still energized: .....

.....

.....

Person giving clearance: .....  
 (signature)

Person in control of work performance (supervisor): .....  
 (signature)

**Daily clearance and completion of work**

**Table 3**

The team has been instructed and has been given clearance for work in a prepared work location			The work is completed, the team has been led away		
Names of work locations	Date, time	Signatures		Date, time	Signature of the person in control of work performance (supervisor)
		Person giving clearance	Person in control of work performance (supervisor)		
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

**Changes in team composition**

**Table 4**

Included in team (given name, surname, electrical safety qualification)	Removed from team (given name, surname, electrical safety qualification)	Date, time	Changes authorised by (position, signature)
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

The work is completed, team has been led away, the earthing placed by the team has been removed, the following person has been notified on it:

.....  
(position, given name, surname)

Date: ..... Time: .....

Person giving clearance: .....  
(signature)

Person in control of work performance (supervisor): .....  
(signature)

## 6.2. Instructions for filling in the assignment form

1. Entries in the assignment form must be made in the official language, legible and clear to workers. It is not allowed to fill in the form using a pencil or to make any corrections in the text.
2. The assignment form shall be printed on both sides of one sheet.
3. It is allowed to fill in the form by hand.
4. The procedure for numbering of assignments shall be laid down by the person in control of operation of an electrical installation.
5. When writing a date, the number of the day of the month shall be stated first, then the number of the month (may be stated in words), and then the four-digit number of the year.
6. The given name, surname, and electric safety certificate of a worker shall be indicated in the assignment.
7. Operational signs of electrical installations, equipment, and feeders must be indicated in the assignment.
8. If there is no place in the tables and text fields of the assignment form to enter all the necessary text, additional form with the same number may be appended to the assignment. In such case the phrase "see additional form" shall be written down in the last row of the main form or after the text. The designated persons shall sign both forms in such case. In the aforementioned case if pre-numbered forms are used, the person giving assignment shall strike out the number of additional form with one line, write the number of the main form above it and confirm it with a signature.

### 6.3. Filling in the front of the assignment form

1. In the upper part of an assignment form, the structural unit of the person giving the assignment and the object in which work will take place shall be indicated.
2. In the row “To the person responsible for work performance”, the given name, surname, and electrical safety qualification shall be indicated.
3. In the row “to the person giving clearance”, the given name, surname, and electrical safety qualification shall be indicated. With regard to electrical installations that are serviced by operational teams with clearance, “operational personnel” shall be indicated in the row “to the person giving clearance”.
4. In the rows “with team members”, members of the team shall be specified. In case of work using mechanisms, it must be specified in this row, which team member is responsible for the particular mechanism (indicating the brand of mechanism), who is slinger, or supervisor in case of work with fire hazard, or similar responsibilities, if such are necessary.
5. The following shall be indicated in the rows “assignment”:
  - names of electrical installation and feeders, the operational symbols;
  - operational symbols of power transmission lines and the boundaries of sections where work is to be done;
  - list of works to be done.
6. The date and time of beginning and end of the work shall be indicated in the rows “Work to be commenced on” and “Work to be completed on”.
7. In the first column of the first table, names of electrical installations in which operations with switching devices and earthing need to be done shall be stated.
8. In the second column of the first table, names and operational symbols of switching devices, feeders and equipment that will be involved in operations and places where earthing has to be made shall be indicated. Disconnections to be made in secondary, automatic, and control circuits shall not be indicated. If works are performed in 0.4–20 kV lines and 6–20 kV / 0.4 kV substations, the second column of the first table is used for switching operations (these operations must be executed according to the switching sequence). When an operation is completed, it must be marked in the form.
9. If it is not possible to determine the place for earthing in the work location at the moment, an assignment is issued, or if relocation of earthing is planned during the work, “earth at work location” shall be indicated in the column.
10. If the person giving clearance is instructed to give clearance at a work location that is already prepared, he or she shall indicate the disconnections and earthings that are necessary for preparing the work location stating the completed operations, in the second column of the first table.
11. If no preparation of work location is necessary during work performance, phrase “not necessary” shall be entered in the free place of the first table.
12. Time of preparing the work location shall be entered in the third column of the first table.
13. The following shall be indicated in the rows “Special conditions” of the first table:
  - additional measures that are necessary for safety of workers (fencing, testing of air composition, and fire safety measures);
  - stages of work or separate operations that are to be performed under direct guidance by the person in control of work organisation;
  - designated workers and/or team managers in cases when the assignment is issued to a supervisor;
  - permission to the person in control of work performance or the supervisor to move to another work location and to give a repeated clearance;
  - permission to switch on an electrical installation or a part thereof, or separate switching devices without an instruction by the operational personnel;
  - permission to the person in control of work performance to remove earthing temporarily;

- permission to use switching devices at the work location;
  - other instructions that are related to the work to be done.
14. Date, time, surname and signature shall be provided in the rows “Issued by” and “Assignment extended to” by the person giving the assignment.

#### **6.4. Filling in the back of assignment form**

1. The second table shall be filled in when permission for preparing the work location and first clearance is received.
2. The person who has allowed the preparation of work location and clearance shall indicate the given name, surname, and position of the worker in the first column of the second table. If the permission is given in person, the first column shall be filled in by the person giving the permission. Time and date of the permission shall be indicated in the second column. Workers who have received the permission to prepare the work location and first clearance shall sign in the third column. If several workers prepare the work location, all these workers shall sign the third column.
3. If permits for preparing work location and clearance were received at different times, two rows shall be filled in in the second table — one for the permission for preparing work location, and the other for the permission for clearance.
4. In the rows “Work locations have been prepared. The following are still energized”, the person giving clearance shall list the current-carrying parts that are energized in the feeder being repaired and in the feeders adjacent and next to the work location. If work is to be done in overhead lines, the current-carrying parts as indicated by the person issuing the assignment in the rows “Special conditions” and also other current-carrying parts if necessary shall be specified in these rows.
5. The person issuing clearance and the person in control of work performance shall sign below the rows “Work locations have been prepared. The following are still energized” only if it is the first clearance.
6. Everyday clearance and work completion shall be executed in the third table, as well as clearance in case of moving to another work location. If the person in control of work performance is also the person giving clearance, and if the person in control of work performance is allowed to give repeated clearance to the team, he or she shall sign the third and fourth column when giving clearance. If the person in control of work performance is allowed to give repeated clearance to a team, he or she shall sign the third column. Completion of work (at the end of a working day) shall be executed by the person in control of work performance or the supervisor in the fifth and sixth column.
7. Changes to team composition are presented in the fourth table. If any worker working with a mechanism, crane truck or car is included in or removed from a team, the name and type of this mechanism is indicated in the table.
8. After the completion of work, the person in control of work performance or the supervisor and person giving clearance shall sign the special rows specified in the assignment form and indicate the date and time of execution.
9. If the person giving clearance is absent at the time of recording the completion of work and in cases when the person in control of work performance is also the person giving clearances, the person in control of work performance or the supervisor shall record this only in his or her copy of assignment stating the person (given name, surname, position) to whom and date and time when the completion of work was declared.
10. If the team has not made any earthing during the work, then the phrase “the earthing placed by the team has been removed” shall be crossed out in the assignment form.

## 7. Literature

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10. EN 62271-102. *High-Voltage Switchgear and Controlgear. Part 102: Alternating Current Disconnectors and Earthing Switches (IEC 62271-102).* [LVS EN 62271-102. *Augstsprieguma komutācijas un vadības iekārtas. 102. daļa: augstsprieguma maiņstrāvas atdalītāji un zemētājslēdži*].
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