

Health and Safety Standard: Low Voltage Work

Code: NT.00054.GN-SP.ESS

Version: 2



The following text is a translation of the original document "Estándar de Seguridad y Salud: Trabajos en baja tensión" (NT.00054.GN-SP.ESS), Version 2 and is intended to allow all Gas Natural Fenosa employees to understand its content. In the event of any discrepancy in interpretation which may arise from the translation, the contents of the original Spanish version currently in force shall prevail for all relevant purposes.

Date approved: 07/03/2016

Date translated: 13/03/2016

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Revision Log

Version	Date	Reason for the version and/or summary of changes
1	23/02/2015	First edition of the document
2	19/02/2016	The Regulation is updated, including the obligation that all dead-line work that may be done on an existing installation or that may involve the connection of a new network to an existing one should be carried out using both personal protective equipment for live-line work and insulated tools.

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1. Purpose

The purpose of this Health and Safety Standard is to establish the general framework of criteria for performing work on low-voltage electrical installations.

2. Scope

It is applicable to all companies in which the Group holds responsibility for the operation and/or management thereof.

In any event, all applicable legislation in each territory and the aspects contemplated in this Health and Safety Standard must be complied with.

3. Reference documents

NT.00034.GN-SP.ESS Health and Safety Standard: Prior Control, Documented Inspections and Coordination Meetings

NT.00043.GN-SP.ESS Health and Safety Standard: Work Permits

NESC/ C2 – 2007/ National Electrical Safety Code

NFPA 70 E-2004 / National Fire Protection Association

IEC/TC 78 Live working

IEC 60079-17:2007 Explosive atmospheres. Inspection and maintenance of electrical installations

Technical guide for the evaluation and prevention of electrical risk. INSHT

General Instruction for low-voltage work. AMYS Vers.

4. Definitions

Authorised worker: a worker with sufficient training who is authorised by the operator to perform certain jobs with an electrical risk at low voltage, based on their ability to do so correctly according to procedures established in applicable regulations in force in the country. The Group could also require specific accreditation for such qualification.

Training must focus specifically on the job position or on the function of each worker, it must be adapted to the evolution of the risks and to the appearance of new risks, and it must be repeated periodically, if necessary.

The training (theoretical and practical) required for an "authorised worker" must qualify the worker to correctly perform the work they are going to do, within the following list:

- Electrical risk and first aid.
- Use and upkeep of individual and collective protective equipment on low-voltage installations.

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- The necessary operations and switching to leave low-voltage installations de-energised.
- The replacement of fuses in low-voltage installations in accordance with the provisions set forth in point 6.4.6 of this document.
- Measurements, testing and verifications on low voltage installations.
- Work on electrical installations at sites with a risk of fire in accordance with the provisions set forth in point 6.6.1 of this document.

Dead-line work: work on electrical installations that is performed after having taken all the necessary measures to keep the installation de-energised while the work is being performed and until it is completed.

Electrical risk: risk originating from electricity. The following risks are specifically included:

- Electric shock due to contact with live elements (direct electrical contact) or with an exposed conductive part that accidentally becomes live (indirect electrical contact).
- Burns caused by electric shock or electric arc.
- Falls or blows as a consequence of an electric shock or arc.
- Fires or explosions caused by electricity.

Elemental operations: they are operations such as connecting or disconnecting in installations with electrical material designed for the immediate use thereof and without risk to the public in general, as long as the installations comply with applicable legal provisions, they are in good condition and they are used in the proper manner and for the appropriate purpose.

Live-line danger zone or work zone: the space around live elements that are not protected, in which the presence of an unprotected worker represents a serious and eminent risk of an electric arc occurring or of direct contact with a live element, thereby considering the normal gestures and movements that the worker could make while remaining stationary. In general, a limit of 70 cm will be established, and it must be ensured that this limit is maintained while work is being performed. In any event, the values established in applicable local legislation must be considered, if it were more restrictive.

Live-line work: work during which a worker comes into contact with elements that are live or enters the danger zone, either with part of their body or with the tools, equipment, devices or materials that they handle. Switching, measurements, testing and verifications are not considered live-line work.

Low-voltage Electrical Installation: an installation in which the nominal voltage at alternating current is over 50 V but does not exceed 1000 V, and in direct current it is over 75 V but does not exceed 1500 V, as reference values. In any event, the values established in applicable local legislation must be considered.

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Measurements, testing and verifications: activities designed to check compliance with specifications or the necessary technical and safety conditions for the proper functioning of an electrical installation, including those designed to check the electrical, mechanical or thermal state, the effectiveness of protections, the safety or control circuits, etc.

Protected work zone: a zone of a de-energised electrical installation where the activities contemplated in point 6.3 of this document have been performed (commonly known as the 5 "golden rules") to ensure that the installation remains de-energised.

Qualified worker: an authorised worker who has specialised knowledge about low-voltage electrical installations due to their accredited, professional or university training or due to their proven experience of two years or more. The Group could also require specific accreditation for such qualification.

In this latter case, the certificate that proves the worker's experience must indicate the specific type of installation or installations on which the worker performs their activities.

In addition to the aforementioned training for authorised workers, they must have specific knowledge about low-voltage live-line work and, if necessary, knowledge about electrical work in areas with the presence of explosive atmospheres.

Safety voltage: a voltage below which there is no risk to people at the various installations and/or in various situations. Reference values of 50 V in dry zones and 24 V in wet zones are established for alternating current. In any event, the values established in applicable local legislation must be considered.

Switching: an operation designed to change the electrical state of an electrical installation, and it does not involve either the installation or removal of any element.

Work supervisor: the person designated by the operator to assume effective responsibility for the work.

5. Responsibilities

Those defined throughout the document.

Each Management Division will establish the necessary control mechanisms (specific audits, quality assurance, etc.) for the periodic verification of compliance with the requisites set forth in this Standard.

6. Development

In general, work on low-voltage installations (or work that could invade the danger zone while it is being performed) that involves electrical risk will be performed with the installations de-energised, unless the de-energisation thereof introduces additional risks or increases risks (loss of protection systems, etc.), or the operation to be performed requires that the installation be energised (load measurement, etc.).

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Prior to performing the work, special attention will be given to compliance with the provisions set forth in NT.00034.GN-SP.ESS, Health and Safety Standard: Prior Control, Documented Inspections and Coordination Meetings, as well as the provisions set forth in NT.00043.GN-SP.ESS, Health and Safety Standard: Work Permits.

Live-line work will be classified according to the following:

- Elemental operations
- Switching, measurements, testing or verifications
- Dead-line work
- Live-line work

All dead-line work (with the installation de-energised) that may be performed on elements for which it has not been possible to create a protected work zone must be considered as live-line work for purposes of the execution thereof, wherefore the protective equipment and methodology that are typical of such work must be used.

Depending on the activities to be performed on the various low-voltage elements, the tree shown in **Appendix 02** will be considered for determining the execution method of the activity to be performed, thereby considering the unique conditions existing in the environment of the various installations:

- Overhead distribution networks
- Underground distribution networks
- Distribution panels
- Line connection or switching boxes
- Transformation centres (overhead, surface, interior or underground)
- Centralisation of meters
- Motor control centres
- Motors and other loads (resistors, actuators, electro-deionisation units, light fixtures, etc.)
- Control/instrumentation/electronics systems closets and cabinets (excitation systems, generator voltage regulation, static start-up, dry transformers, etc.)
- Programmable controllers (power supplies, inputs/outputs, racks)
- Circuit breakers and disconnectors (interior)
- Busbars
- Cables and cylinders
- Electrostatic precipitator
- Cathodic protection systems
- Other low-voltage elements

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Depending on the complexity of the work to be performed, the following classification of workers is established (as they are defined in Section 4 of this document):

- Authorised worker
- Qualified worker

There must be an updated register of this classification of workers at each company, with the certifications corresponding to each type.

For executing the different types of work or phases of each job, the provisions set forth in the following sections of this Standard will be considered.

To perform the work, all other procedures and regulations that could be applicable will be considered, according to the activities to be performed in each job.

The basic characteristics of the aforementioned types of work are stated below.

6.1. Elemental operations or operations with safety voltages

Elemental operations must be performed according to the standard procedure of use provided for by the manufacturer and subject to verifying that the handled material is in good condition.

Work with safety voltages will only be permitted when there is no risk of confusion between the different circuits and on installations in which the currents of a possible short-circuit do not represent a risk for workers.

6.2. Switching, measurements, testing or verifications

Local switching and measurements, testing and verifications may only be performed by authorised workers.

The work method used and the work and protection equipment and materials used must protect the worker against the risk of electrical contact, electric arc, explosion or the projection of materials.

The aforementioned protective equipment and materials include the following:

- Insulating accessories (shields, covers, sheaths, etc.) for covering live parts or exposed conductive parts.
- Insulating or insulated tools (instruments, clips, test points, etc.).
- Hot sticks.
- Insulating or insulated devices (stools, rugs, work platforms, etc.).
- Personal protective equipment (shields, gloves, goggles, helmets, neck protection, etc.).

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The work or protective equipment and materials used to perform these operations will be used, maintained and checked following the manufacturer's instructions. In any event, they must comply with the specific legislation that is applicable to them.

Workers must have a solid and stable support that allows them to have their hands free, and they must have lighting that allows them to perform their work under adequate conditions of visibility.

The work zone must be adequately sign-posted and/or cordoned off whenever there is the possibility that other workers or unrelated persons might enter that zone and access live elements.

Whenever it may be necessary to use an exterior power supply for measurements, testing and verifications, precautions will be taken to ensure that the installation cannot be re-energised by a power supply source other than the one provided and that the shut-off points have sufficient insulation to resist the simultaneous application of the testing voltage on the one hand and the service voltage on the other.

Likewise, the prevention measures that are taken against the electrical, short-circuit or electric arc risk will be adapted to the voltage level that is used, with special attention to the ground connections of the testing equipment.

If, while performing the operations, it is possible that the danger zone may be invaded, the activity will be treated as live-line work.

6.3. Dead-line work

Before beginning work in the proximity of low-voltage elements, a qualified worker will determine the viability of the work and will direct the operations to create the protected work zone.

The operations and switching to leave a low-voltage installation de-energised before beginning dead-line work and the re-energisation operations after the work is completed will be performed by authorised **workers**.

Once the zone and the elements of the installation where the work is going to be performed have been identified, the process described below will be followed, unless there are essential reasons for doing it another way, and using the applicable protective equipment for each activity.

Until these stages have been completed, the beginning of dead-line work cannot be authorized, and the part of the affected installation will be considered to be energised.

All dead-line work that may be done on existing installations or that may involve the connection of a new network to an existing one will be carried out using both personal protective equipment and insulated tools, as if it were live-line work, just like voltage suppression and re-connection processes.

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6.3.1. Voltage suppression

1. Disconnect

The part of the installation on which the work is going to be performed must be isolated from all power supply sources, including electric generator units and the circuits they supply, if necessary.

Capacitors or other elements of the installation that retain voltage after disconnection must be discharged using appropriate devices.

Electrical elements will be disconnected using adequate devices according to the load level of those elements.

2. Prevent reconnection

The switching devices used to disconnect the installation must ensure that any reconnection is not possible, preferably by a switch blocking mechanism, and whenever necessary, signs that prohibit switching must be posted.

In default of a blocking mechanism, equivalent protection measures will be adopted.

3. Verify the absence of voltage

The absence of voltage must be verified on all live elements of the electrical installation that are in or closest to the work zone.

The choice of a no-voltage verifier must be made from among the models designed for such purpose according to the applicable standards. Moreover, they must be kept in good condition and be periodically checked.

The absence of voltage must be verified in each stage and on the neutral conductor, if it exists. The absence of voltage will also be verified on all exposed conductive parts that could potentially become energised.

4. Ground and short-circuit

Low-voltage installations that, by induction or for other reasons, could accidentally become energised must be grounded and short-circuited.

The equipment used to do so will be sized to support the foreseeable short-circuit currents under the considered conditions, and they will be installed considering the applicable safety measures.

Grounding and short-circuiting devices must first be connected to ground and then to the elements to be grounded, and they must be visible from the work zone. If this latter condition were not possible, the grounding connections must be placed as close as possible to the work zone.

If, during the course of the work, conductors must be cut or connected and there is the risk that potential differences might appear in the installation, protection measures must be taken, such as making bridges or grounding in the work zone, before proceeding to cut or connect such conductors.

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5. Protect against nearby live elements, and post safety signage to delimit the work zone.

If there are elements of an installation in the proximity of the work zone that have to remain under power, two possible solutions can be adopted:

- a) Consider the work as "live-line work", in which case it will be performed according to the provisions set forth in Section 6.4 of this document.
- b) Proceed to install protective elements such as shields, insulation or obstacles that allow considering the work zone to be outside of the danger zone.

In turn, if the installation of these elements involves live-line work due to positioning the protections in the danger zone, the activity will have to be performed as live-line work, such that no part of the body can access the danger zone without being protected.

This decision must be adopted before beginning the work, which means during evaluation and planning, by a **qualified worker**.

6.3.2. Reconnecting voltage

In general, the sequence of operations for reconnecting voltage is the inverse of the sequence required for disconnection, and the safety measures are also the same in each one of the stages.

Special attention must be paid to the following aspects:

- Prior notice to **all** workers involved regarding the fact that voltage is going to be reconnected.
- Verification that **all** workers have left the zone, except for those that must act to reconnect voltage, and verification that all work tools and instruments have been removed.
- Confirmation that all grounding and short-circuiting elements have been removed.
- Reporting, if applicable, to the manager of the installation that connection is going to be made.

Activation of the corresponding switching devices.

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6.3.3. Removal and replacement of fuses without voltage

For the removal and replacement of fuses without voltage, grounding and short-circuiting will not be necessary whenever there are disconnection devices on both sides of the fuse and within sight of the worker and accidental closure is not possible.

Before accessing a fuse after disconnection of the devices located on both sides of the fuse, the absence of voltage must be verified using the corresponding equipment.

If a protected work zone cannot be created and if the provisions set forth in the preceding paragraph cannot be met, the activity must be considered as live-line work, therefore taking into account the provisions set forth in point 6.4.6 of this document. Moreover, a worksheet / work procedure must be prepared, thereby describing the sequence of actions to be performed in each type of job and the protective measures to be used.

6.4. Live-line work

Live-line work will be performed by qualified workers.

In low-voltage live-line work, the object of this section, a prior study of the work procedures will be required, and whenever the complexity or the novelty of the work may make it necessary, those procedures must be tested without voltage or with safety voltages.

Work in places where communication is difficult, either due to the terrain, due to confinement or due to other circumstances, must be performed in the presence of at least two workers who have first-aid training.

6.4.1. Work method

The work method preferably used for performing live-line work at low voltage is the so-called contact method with insulating protection of the hands and feet.

In general, live-line work must not be performed on low-voltage installations or components that are discharged, burnt or deformed as a consequence of possible short-circuits, heating or other causes.

6.4.2. Creation of the live-line work zone

Workers will maintain a safety distance (in general, 70 cm) regarding both their body and the tools, equipment, devices or materials that they handle with respect to other points of a different potential that are not shielded or protected.

To create the live-line work zone, insulating elements that are suitable for each type of installation or element of the same will be used, such as profiles, vinyl cloths, hoods, shields or similar devices.

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6.4.3. Insulation of the worker with respect to ground and live elements

Workers will use insulating gloves and will position themselves on insulating devices that guarantee effective insulation with respect to ground, such as platforms, stools, rugs, ladders or other devices. To perform live-line work on low-voltage installations, insulated tools must always be used.

Workers must not wear bracelets, chains or other conductive elements.

6.4.4. Other personal protective equipment

In addition to the aforementioned, workers must use all or part of the following equipment, depending on the execution procedure:

- Fireproof gloves.
- Mechanical protection gloves.
- Hardhat with chin strap.
- Face shield equipped with protection against electric arc.
- Non-actinic glasses.
- Safety footwear.
- Fireproof and anti-static work clothing, without conductor elements and with protection against electric arc, completely covering the legs, arms, thorax and neck.

In all work to be performed, the personal protective equipment must be suited to the risks identified in the work.

6.4.5. Absence of electrical load

Whenever a live circuit is going to be divided or spliced, the necessary measures must be taken to guarantee that there is no electrical load on that circuit. This is done either by installing an alternative bridge or by guaranteeing that the derived circuit is previously open.

6.4.6. Removal and replacement of fuses with voltage

The specific activity of replacing low-voltage fuses may be done by an authorised worker when switching of the fuse holder device involves disconnection of the fuse and the material of the device offers complete protection against direct contacts and the effects of a possible electric arc.

In the event that this protection is not available, the operation will be done first without a load (or at a negligible level) and using, in any event, personal protective equipment that guarantees complete protection against the risk of

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electric arc (including face and neck protection) and suited to the level of risk existing in each installation.

The possible appearance of an electric arc will be kept in mind, and the possible evolution thereof to other phases or to metallic exposed conductive parts, wherefore the use of protective equipment against electric arcs is fundamental (shields, vinyl cloths, neck protection, etc.).

In this case, the work will be considered live-line work, given that there are live parts, and the handling thereof will be performed by a qualified worker.

In any event, the state of the installation will be verified beforehand, and the live-line work must not be executed if elements in bad condition are observed (discharged, deformed, etc.).

Likewise, in the presence of a short-circuit in the installation (including operations associated with maintenance and the location of breakdowns or similar operations) that could generate a high-energy arc, the job of removing and replacing fuses will be performed with the installation de-energised, unless equipment is available to allow the operation to be performed at a distance.

6.4.7. Connection and disconnection of elements in enclosures for switchgear and controlgear

Lacking any specific breaker or sectioning elements or fuses, the operation will first be performed without a load (or at a negligible level), in any event using personal protective equipment that guarantees the necessary protection.

This work will be performed by qualified workers.

The connection and disconnection of live equipment or installations will only be performed if the following conditions are all met at the same time:

- The power supply voltage is less than 250 V (AC or DC)
- The electrical circuit is fed by a single transformer of less than 125 kVA.

6.4.8. Worksheets / work procedures

Each type of live-line job that may be performed (or on jobs for which, having previously de-energised the installation, it is not possible to create a protected work zone) must have a detailed worksheet / work procedure that indicates the sequence of activities to be performed and the personal and collective protective equipment to be used in each phase.

Appendix 03 to this document includes a worksheet model.

Work teams must have these documents while performing the various activities.

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6.5. Protection equipment and materials

Personal and collective protective equipment must be kept clean, in dry locations and be protected from the elements and from sunlight, and it must be transported in bags, boxes or compartments designed for this purpose, according to the manufacturer's instructions.

Tools must be insulated, must be suited to the job to be performed and must be certified by an accredited body. Likewise, they must be subject to the periodic revisions that may be established, if necessary. They will be stored clean, and they will be transported in bags, boxes or compartments that are specific for them, according to the manufacturer's instructions.

Protection equipment, tools and all other materials must be visually checked before each job by the worker who is going to use them, and any flaw must be reported so that they can be replaced.

6.6. Work at special sites

For the different types of stated work, the existing conditions of the environment and the provisions set forth in the following points must be taken into account.

6.6.1. Work at sites with a risk of fire or explosion

Equipment must comply with the particular provisions for the installations of premises where there is a risk of fire or explosion that are indicated in applicable electrotechnical regulations.

Work on electrical installations with the risk of fire or explosion will be performed following a procedure that reduces such risks to the minimum. Therefore, to the extent possible, the presence of flammable substances in the work zone will be limited and controlled, and the appearance of sources of ignition will be prevented, particularly explosive atmospheres in case they could exist or could form. In such event, performing live-line work or operations (changing lamps, fuses, etc.) is prohibited, unless they are performed on installations and using equipment that are designed to operate under these conditions and that comply with applicable specific legislation.

Before performing the work, the availability of fire-extinguishing means and equipment will be verified, in addition to the good condition thereof and the suitability thereof to the foreseeable type of fire. If a fire occurs, the parts of the installation that could be affected will be disconnected, unless they should be left under power to fight the fire or if disconnection involves potentially more serious risks than those that could be derived from the fire itself.

Authorised workers will perform the work. When it must be performed in an explosive atmosphere, it will be performed by qualified workers, who must follow a previously studied procedure.

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6.6.2. Static electricity

In every location or process in which there could be an accumulation of electrostatic charges, the necessary preventive measures must be taken to avoid dangerous discharges and, particularly, to avoid causing sparks at sites where there is a risk of fire or explosion.

6.7. Weather conditions

The following weather conditions must be considered due to their possible influence on the commencement or continuation of low-voltage work, and they are especially relevant when live-line work is going to be performed:

- Atmospheric precipitation (rain, hail, snow)
- Electrical storms (a storm is deemed to be present when thunder can be heard or lightning can be seen)
- Fog
- Wind

In the event of atmospheric precipitation, fog or wind, work may begin, be interrupted or continue according to the judgement of the work supervisor, such that workers are protected at all times.

In the event of a storm, with respect to low-voltage live-line work, the work will not begin and will be interrupted if it had already begun.

7. List of appendixes

Appendix 02 Analysis tree for low-voltage work

Appendix 03 Low-voltage worksheet model

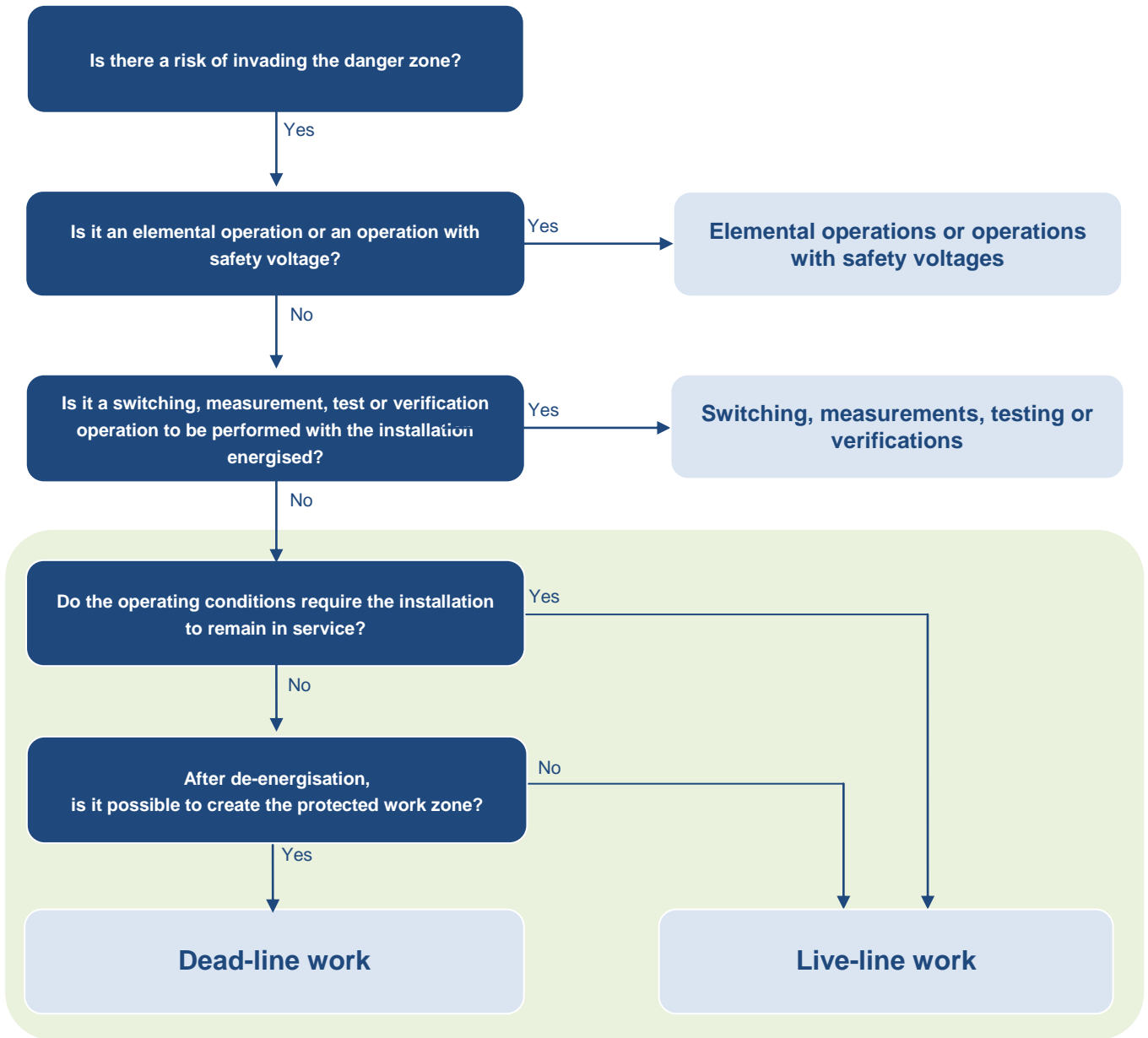
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Appendix 02. Analysis tree for low-voltage work



Note: in each type of work, all other considerations that could be established according to the surrounding environment must be taken into account: sites with the risk of fire, explosion, etc.

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Appendix 03. Low-voltage worksheet model

LOW-VOLTAGE WORKSHEET	
Underground input and output by-pass connection of a single conductor cable on a single conductor cable [Installation de-energised without feasibility of grounding]	page 1 of 1
Recommended work team: 1 work supervisor or qualified worker and 1 qualified or authorised worker.	
RISKS	PROTECTIONS FOR LIVE-LINE ACTIVITIES (S/A)
<ul style="list-style-type: none"> • Exposure to electrical contacts / electric arc • Falls to a different level • Falls at the same level • Impacts and blows • Falling objects • Cuts / Entrapments 	<ul style="list-style-type: none"> • Insulating gloves • Fireproof gloves • Mechanical protection gloves • Insulating rug/stool • Fireproof and anti-static work clothing, without conductor elements and with protection against electric arc, thereby allowing the legs, arms, thorax and neck to be completely covered • Safety footwear • Protective face shield against electric arc • Insulating tools, tool bag • LV insulating cloth • Insulating thimbles • "Operation prohibited" signage • No-voltage tester • Safety hardhat with chin-strap • Protective face shield against electric arc • Tape or chains to cordon off the work zone
	WORK EQUIPMENT
	<ul style="list-style-type: none"> • Volt-current sensing clip • Insulating clips and insulating chocks • Phase sequence tester
MANDATORY SAFETY MEASURES. BEGINNING OF WORK	
<ul style="list-style-type: none"> • Identify the installation on which the work is going to be performed • Verify that the weather conditions allow the work to be performed • Set up road signage if necessary • Inspect the installation where the work is going to be performed • Cordon off and signpost the work area • Check the condition of the equipment and tools that are going to be used • Remove all personal objects that are metallic • Evaluate the creation of the protected work zone according to the available elements in the low-voltage panel of the transformation centre [qualified worker]. Compliance with the applicable operating procedures. • Carry out activities to create a protected work zone using the necessary protective equipment for live-line activities [IF GROUNDING COULD NOT BE COMPLETED] <ul style="list-style-type: none"> • Disconnect • Prevent reconnection • Verify the absence of voltage • Ground and short-circuit [all cables reaching the work zone and those that can be isolated] • Protect the zone and signpost 	
MANDATORY SAFETY MEASURES. EXECUTION OF WORK	
<ul style="list-style-type: none"> • Check the main breaker box • Remove fuses from the main breaker box • Close the main breaker box if necessary • If necessary, signpost the main breaker box, either on the exterior or interior • Check the status of the excavation and of the conductors of the main line • Isolate the live-line work zone. Exposed conductive parts must be protected. • Identify and signpost the new input and output conductors. All ends of the conductors must be protected by insulating thimbles • Cut the most favourable conductor of the main line and verify that the cable to be connected can receive voltage • Connect the input and output cable to the isolated main cable, and replace the insulation. Whenever the configuration of the installation allows, the neutral conductor will be connected first • Repeat the process for the other conductors 	
MANDATORY SAFETY MEASURES, END OF WORK	
<ul style="list-style-type: none"> • Reverse the actions taken in the sequence to create the protected work zone, and connect voltage on the corresponding output • Check the voltages of the connection box and the phase sequences • Visually inspect the installation overall • Close the connection box • Check, clean and store the equipment, tools and materials used on the job • Remove the signage and perimeter markers of the work location • Remove waste materials • Remove road signs if any had to be set up 	

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