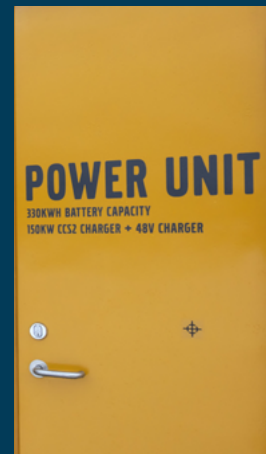
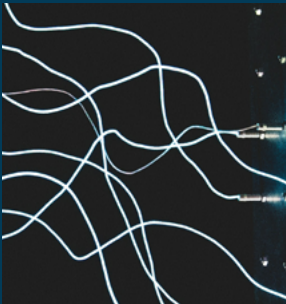


EDITION 2:2025

Industry Standard

Safe work on Electric Non-Road Mobile Machinery



Maskin
Leverantörerna

Industry Standard

Safe Work on Electric Non-Road Mobile Machinery

This industry standard has been developed by MaskinLeverantörerna (ML), the trade association for suppliers of mobile machinery in Sweden.

The industry standard has been prepared based on the “Industry Standard for Safe Handling of High Voltage Systems in Electric Vehicles,” developed by BIL Sweden (now Mobility Sweden), the Swedish National Association for the Motor Trade (MRF), and the Swedish Association of Vehicle Workshops (SFVF, now Svenska Fordonsbranschen), as well as applicable sections of the standard SS-EN 50110-1:2024 Operation of Electrical Installations, published by SEK Svensk Elstandard, which is the Swedish version of the European standard EN 50110-1:2024 developed by CENELEC.

The industry standard is also based on recommendations from machine manufacturers, importers, and other stakeholders within the machinery industry.

The standard is tailored to the machinery industry and regulates personal safety during maintenance, service, and repair of electric machinery.

In this industry standard, the term “**voltage class B**” is used for the voltage range that, in the vehicle/machinery industry, is commonly referred to as “high voltage.” Voltage class B (VCB) is the term used in the ISO standard ISO 6469-3.

This industry standard serves as recommended minimum requirements. If there are laws, regulations, manufacturer’s instructions, or other directives that set higher or different requirements than those specified in this industry standard, those take precedence.

If documents (such as ISO or EN standards) referenced by this industry standard have been updated since the publication of this industry standard, the latest version of those documents shall apply.

In the event of any discrepancy, the Swedish version of this Industry Standard shall prevail over the English version.

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Scope

This industry standard is intended to be applied during maintenance, service and repairs of electric non-road mobile machinery. The industry standard focuses solely on the electrical safety aspects of machines. This industry standard is intended to be used as a complement to the manufacturer's instructions for a specific machine.



1

Terms and Definitions

The following terms and definitions apply in this industry standard. For terms not defined below, please refer to IEC 60050 – International Electrotechnical Vocabulary, www.electropedia.org

Commissioning

Commissioning aims to change the electrical status of the electric machine by reconnecting the voltage class B system to its power sources.

Competence

Level of education, skill(s), or another acquired knowledge. Competence for a specific work task is acquired through specific training or experience with the task.

Decommissioning

Decommissioning aims to change the electrical status of the electric machine by completely disconnecting all power sources from other components in the voltage class B system and securing against unintentional reconnection.

Dead

Voltage equal to or close to zero. That is, without voltage and/or charge.

Electric Arc

An electric arc is a powerful electrical discharge transmitted through the air, for example, during a short circuit.

Electric Machinery

All types of machines powered by a voltage class B system.

Electrical Consequential Damage

Damage that has occurred to anything other than persons and has been initiated by electricity. For example, fire in machinery, property damage, or environmental damage.

Electrical Danger

Alla typer av arbetsmaskiner som drivs med ett Risk of electrical injury caused by electricity.

Electrical Energy Storage System

A component consisting of an electrochemical composition that stores electrical energy for later use, such as a voltage class B battery or a capacitor.

Electrical Hazard

A potential source of injury (to either a person or electric machinery) caused by electricity.

Electrical Injury

Personal injury or death due to electric shock, electrical burn, electric arc, or from fire or explosion caused by electricity.

Energized (Live) Part

A part of a voltage class B system that has not been confirmed as de-energized.

Incident

An event that could have led to, but did not result in, an electrical injury.

Isolated Part

A part of a voltage class B system that has been confirmed to be de-energized after decommissioning.

Isolating Material

Material that prevents electric current from passing. Used to cover live or not yet confirmed de-energized components to prevent accidental contact. Also used as a coating on tools to prevent electric current from reaching the user.

Isolation Device

A device used to reliably perform an insulation measurement between a voltage class B component and wiring to the chassis or enclosure.

Live Working Zone

An area where a person risks coming into contact with live parts with a body part, tool, or other equipment, and where the person risks electrical injury.

Machine / Machinery

In this document, “machine” or “machinery” refers to both tractors and other non-road mobile machinery (NRMM). See the Swedish Act (2001:559) on Road Traffic Definitions for the definitions of tractor and NRMM.

Protective Screening

An insulated or non-insulated device used to prevent approach to equipment or parts of a voltage class B system where there is an electrical hazard.

Protective Barrier

A physical marking that clearly prevents unauthorized persons from entering a certain place or area. Examples include bunting, plastic chains, posts, cones.

Responsibility

The obligation to be accountable for an activity or matter. Only one person may have responsibility for a specific area of responsibility at any given time. Responsibility cannot be delegated; however, the execution/task may be delegated.

Risk

The combination of the probability that injury (to either a person or an electric machine) will occur and the severity of the injury.

Risk Analysis

A documented, systematic assessment of the risks that may be present during a specific task. The employer is responsible for ensuring that a risk analysis has been carried out.

Risk Assessment

A simpler assessment of whether there is a risk of electrical hazard during a specific task. Risk assessment should be performed continuously and is based on the previously conducted risk analysis.

Roles

The responsibility and authority assigned to a person through a work task or a position.
The following roles are used in this industry standard:

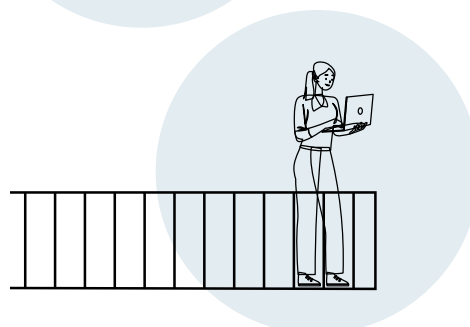
Safety Manager

Person responsible for ensuring that there are resources and procedures in place to conduct systematic electrical safety work.



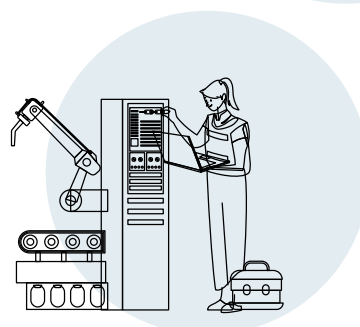
Supervisor

Person appointed by the safety manager and who is responsible for ensuring that anyone working on or is present near an electric machine is not exposed to electrical hazards.



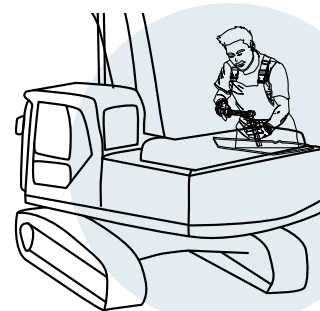
Skilled Technician

Technician with specific knowledge and experience to perform work on an electric machine.



Instructed Technician

Technician who has been instructed to avoid hazards that electricity may pose and can safely perform certain types of work on an electric machine.



Informed Person

Person who has been informed how to avoid hazards that electricity may pose and who can safely be present where work on electric machines may occur.



Voltage Class A (VCA)

Voltage that normally does not exceed 30 V alternating current (AC) or 60 V direct current (DC), either between conductors or to ground. For example, 12 or 24 V electrical systems in machinery.

Voltage Class B (VCB)

Voltage used for propulsion of electric machinery, including connected auxiliary systems, and which normally exceeds 30 V AC or 60 V DC and is less than 1000 V AC or 1500 V DC.

In addition to propulsion of electric machinery, voltage class B may also be used for, e.g. AC compressors or cabin heaters.

In the automotive/machinery industry, the term *high voltage (HV)* has been used for the same voltage range as voltage class B.

Voltage Class B System

Refers to all parts within electric machinery that are designed to use voltage levels corresponding

to voltage class B, as well as functions that affect these systems (including energy sources such as batteries, capacitors, and all other sources with stored electrical energy).

Voltage Detector

A device used to reliably determine the presence or absence of dangerous voltage.

Work in Voltage Class B

Work on or near a live voltage class B system, as well as work where there is uncertainty as to whether an electrical hazard may exist.

Work Zone

A work zone refers to a designated part of a workplace where electrical work is to be performed, is being performed, or has been performed.

Workplace/Operational Site

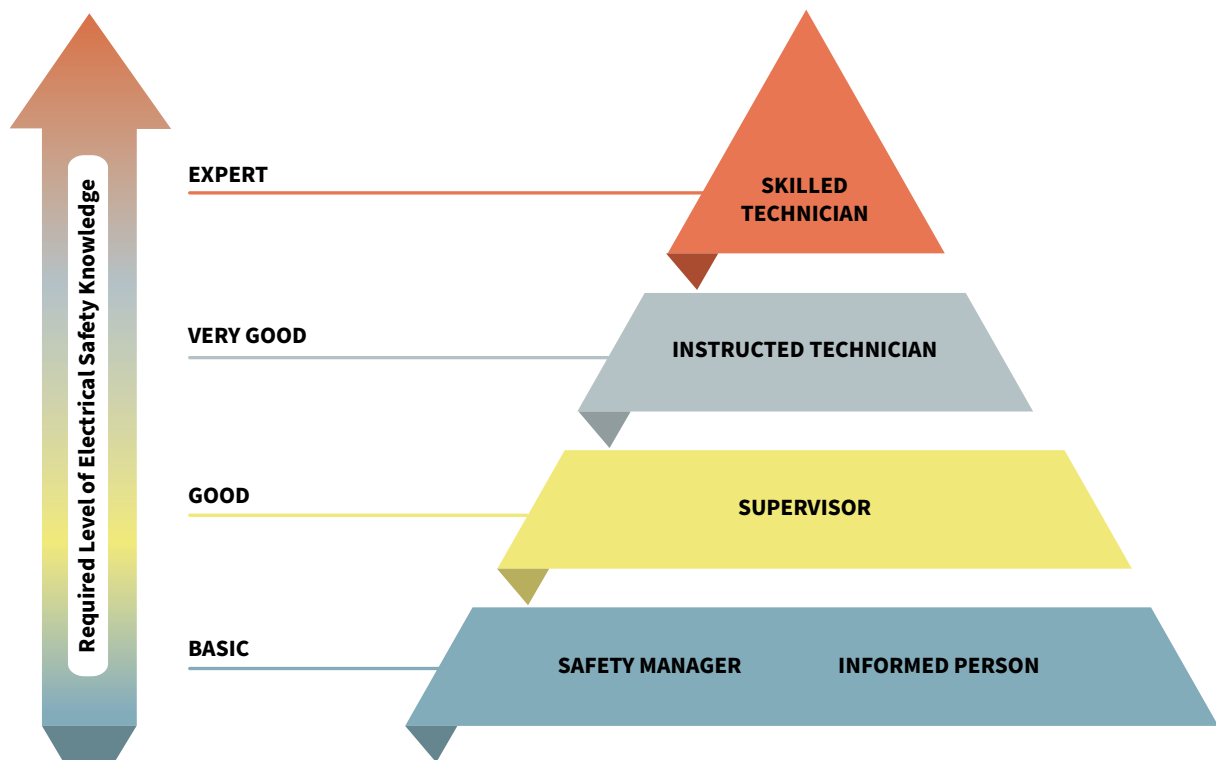
May be a facility, workshop, several workplaces within the same organisation, or out in the field.



2

Roles

Below, the responsibilities and competence requirements for all roles within the organisation are described. The need for the various roles may vary depending on the types of work performed on the electric machine or the nature of the operations conducted. The same person may hold several responsibility roles.



2.1 Safety Manager

The *safety manager* represents the organisation as the employer for its staff. This responsibility includes ensuring that operations are conducted in a manner that minimizes the risk of electrical hazards for all personnel. Clear allocation of responsibilities and tasks is a prerequisite for active, safe, and progressive electrical safety work.

For systematic electrical safety work to be implemented and for electrical safety to develop, the *safety manager* must initiate the electrical safety process by assigning tasks to appropriate individuals.

The safety manager is responsible for ensuring that:

- There are resources and procedures in place to conduct systematic electrical safety work (planning, execution, and follow-up of operations) so that legal requirements regarding safe electrical work are met.
- Tasks within the areas of responsibility specified by electrical safety legislation are allocated appropriately.
- The necessary decision-making authority, resources, and powers accompany the distribution of tasks and appointments.

The *safety manager* may, for example, be the CEO, country manager or regional manager.

2.2 Supervisor

The *supervisor* is appointed by the *safety manager* for each facility/site where work within voltage class B is to be performed. The *supervisor* is responsible for ensuring that anyone working on, or is present near, an electric machine is not exposed to electrical hazards, and that those working on the electric machine have the appropriate competence for the work to be carried out. The *supervisor's* duties and responsibilities may cover several facilities/sites.

Examples of duties:

- Responsible for the implementation of correct work instructions and processes.
- Plan and ensure that risk analyses are conducted.
- Ensure that all technicians working within voltage class B have suitable training for the work to be performed.
- Ensure that all other personnel who may be exposed to electrical hazards receive appropriate training to safely avoid electrical injury.
- Ensure access to suitable tools and protective equipment and that these are maintained in good condition.
- Update work steps, routines, inspections, and follow-ups as needed, for example, in the event of a reported electrical hazard or incident.
- Ensure that rules, work routines, and other safety regulations for handling electric machinery are followed.
- Lead and direct the work.



Competence requirements:

Basic knowledge in electric vehicle technology, electrical theory, and the risks associated with voltage class B systems, as well as basic knowledge of legislation, regulations, directives, and industry standards relevant to the handling of electric machinery. Furthermore, the person should have good knowledge of the work tasks for which they are responsible.

The *supervisor* may be a workshop manager, foreman, or another appointed person with clear authority.

2.3 Skilled Technician

A *skilled technician* is a technician with specific knowledge and experience required to perform work on an electric machine. The *skilled technician* must have completed in-depth training in the function and construction of electric machinery and possess sufficient knowledge and experience to analyse risks and avoid hazards associated with electricity.

Examples of work tasks:

- Participate in and perform risk analyses and, where necessary, risk assessments.
- Design and secure the workplace to minimize the risk of electrical injury.
- Perform inspections and measurements, such as voltage and insulation measurements.
- Perform decommissioning and commissioning of power sources in voltage class B.
- Secure against unintentional reconnection.
- Perform service and repair of de-energized voltage class B systems.

Work tasks requiring additional training:

To perform any of the following tasks, the *skilled technician* must have completed specific, tailored training with approved results:

- Work on or near connected voltage class B systems.
- Work on electrical energy storage systems.
- Risk analysis of damaged electric machines.

Competence requirements:

Must have completed in-depth training (both theoretical and practical) in electric vehicle technology, electrical theory, and the risks associated with voltage class B systems with approved results, as well as possess good knowledge of this industry standard. Furthermore, the person must have brand-specific training/knowledge related to the tasks they perform.



2.4 Instructed Technician

An *instructed technician* may perform extensive and complex work on electric machinery, provided that it does not involve a risk of electrical injury. To make this assessment, the *instructed technician* must possess the knowledge required to immediately recognise when a task cannot be performed safely and to immediately stop and report to the *supervisor*.

The *instructed technician* may also carry out work on or near voltage class B systems that have been disconnected, confirmed de-energized, and secured against unintentional reconnection by a *skilled technician*.

Examples of work tasks:

- Participate in and be able to carry out risk assessments.
- Service and repair work on or near de-energized voltage class B systems after the voltage class B system has been disconnected and secured against reconnection by a *skilled technician*.
- Perform extensive and complex work on electric machinery where the manufacturer has not specified decommissioning.

Competence requirements:

Must have completed basic training in electrical theory, electrical safety, and electric vehicle technology with approved results. This is to ensure sufficient knowledge and the ability to safely perform work on electric machinery.

An instructed technician must, at a minimum, possess the following competencies:

- Basic knowledge and training in electricity, electric machinery, and their associated risks.
- Awareness of the potential hazards that may arise during work and the safety measures that must be observed.
- The ability to determine at any time whether it is safe to continue working or not.

Recommendation:

All personnel performing service, maintenance, and repairs on electric machinery should, at a minimum, be *instructed technicians* or have an equivalent level of knowledge.

2.5 Informed Person

An *informed person* has received sufficient instructions to be able to avoid electrical hazards and can safely be present where work within voltage class B may be ongoing.

Competence requirements:

Has knowledge of the electrical hazards of an electric machine and how these should be avoided (for example, by paying attention to barriers, warning texts and warning signs). All personnel who are unsupervised in areas where work within voltage class B may be ongoing should, at a minimum, be an *informed person*.

3

Work on Electric Machinery

All work on electric machinery must be carried out safely. Necessary competence requirements and safety measures depend on the type of work that is to be performed. The conditions may also change during the course of the work, and in such cases, the competence requirements and necessary safety measures may also need to be adjusted accordingly.

Work on an electric machine is divided into general work (*section 3.2*) and work within voltage class B (*section 3.3*). Procedures, measures, etc., that apply to both of these types of work are addressed in *section 3.1*.

3.1 Procedures, Personnel and Locations

3.1.1 Risk Analysis

A risk analysis is a documented, systematic assessment of the risks that may occur during a specific task. A risk analysis is carried out using available information (for example, the manufacturer's instructions) so that the work can be performed in a manner that is safe for the person carrying out the work and for anyone approaching the electric machine. The risk analysis must be available to the technicians who will be working on the relevant machine.

The risk analysis should assess the risk of incidents, electrical injury, and electrical consequential damage that may arise from electric current, fire, or the consequences of an electric arc. If work within voltage class B is being carried out at the workplace, a risk analysis must be conducted for all aspects of the work.

For work tasks occurring more than once, the risk analysis only needs to be carried out initially; the tasks can then be repeated, provided that no new risks can be identified.

3.1.2 Risk Assessment

A risk assessment is an initial evaluation of whether there is a risk of electrical hazard. Before any specific work on an electric machine

begins, a risk assessment must be conducted. Risk assessments should be performed continuously, as conditions may change during the course of the work. To reliably assess risks during work, manuals or instructions from the manufacturer or equivalent should be used. If the risk assessment shows that there is a risk of electrical hazard that was not considered in the previously conducted risk analysis, the risk analysis must be supplemented.

3.1.3 Personnel

Personnel working with electric machinery are required to wear clothing suitable for the workplace and the prevailing conditions. This may, for example, include wearing close-fitting clothing, personal protective equipment (PPE), or refraining from wearing metal objects such as watches and jewellery if these may pose a risk. The employer is responsible for clearly informing personnel about the regulations regarding the use of protective clothing and/or other personal protective equipment.

Personnel who have electromedical devices (such as pacemakers, insulin pumps, or hearing implants) or who, for other health reasons, wish to object to working with electric machinery are responsible for informing the employer of this. The employer must then carry out a risk assessment and take measures to eliminate any potential risks. Personnel who, for safety reasons, consider the work to be risky are responsible for

informing the employer of this. The employer must then, after a risk assessment, take any necessary measures. When a task, for example during training, requires technical knowledge or experience to prevent electrical hazards or injury, the person performing the work must have this knowledge or experience, or be adequately supervised by a person with the appropriate competence.

3.1.4 Workplace/Operational Site

All personnel who will work on, with, or near a voltage class B system must receive training and information sufficient to provide appropriate first aid in the event of an electrical injury.

First aid equipment must be available at the workplace. The equipment should be adapted to the risks present in the operation. It is recommended that a defibrillator is available and that all employees have completed CPR training, with training kept up to date according to current recommendations. If individuals who lack training on the electrical risks of electric machinery may be present near ongoing work within voltage class B, appropriate safety measures must be taken.

3.1.5 Work Zone

The work zone must be clearly defined. There should be sufficient space for the work, necessary equipment, unobstructed access, and adequate lighting in the work zone. Flammable materials must not be stored near the work zone. The responsible technician working on an electric machine must ensure that any area where electrical hazards may be present is marked and cordoned off.

3.1.6 Handover/Interruption of Work

To avoid electrical hazards during interruptions in work as well as during the handover of responsibility and/or tasks, procedures must be in place and followed during the handover process. For example, when another technician takes over a responsibility area and/or work started by someone else, appropriate protective measures

must be taken to prevent electrical hazards. This includes, for instance, preventing uninsulated live parts from being accidentally touched. If there is any uncertainty, a new risk assessment must be conducted and disconnection must be confirmed before work can continue.

3.1.7 Emergency Measures

Appropriate procedures for emergency measures in the event of an incident, electrical injury, or electrical consequential damage must be in place. The *safety manager* should consider the risks associated with handling electric machinery and, if necessary, develop and implement suitable actions to take in an emergency. Based on a needs analysis and the size of the organisation, some or all of the following emergency measures may be included (the list is not exhaustive):

- The *safety manager* must ensure that information about the actions to be taken in the event of accidents or incidents involving electric machinery is prepared and immediately available.
- A procedure must be established for documenting and reporting electrical accidents and incidents to the Swedish Work Environment Authority (Arbetsmiljöverket) or the Swedish National Electrical Safety Board (Elsäkerhetsverket).
- Depending on the scope of operations, cooperation with the emergency services should be considered, for example, regarding the placement of damaged electric machinery.
- In the event of an accident, the person ultimately responsible for the operational site must be notified. If necessary, emergency services shall be notified.
- After an incident or electrical injury, appropriate measures must be taken to keep the workplace safe and, as far as possible, prevent further damage at the site. This is to enable an investigation of the accident site. The investigation may be carried out by internal staff or, under special circumstances, by the police, authorities, or insurance companies.

3.1.8 Adverse Weather Conditions

For work performed outdoors, appropriate protective measures or restrictions for starting/continuing work must be applied. This is to ensure safety during adverse weather conditions, such as thunderstorms, high humidity, or heavy precipitation.

3.1.9 Communication (Information Dissemination)

All necessary information about the electric machine and the nature of the work must be available to all involved roles in a language that each respective role understands.

To ensure understanding and clarity at a workplace where staff speak different languages, an agreement must be made in advance regarding a language that all relevant parties understand.



3.2 General Work

General work on electric machinery can be carried out where there is no electrical hazard.

Before any work is started, the level of difficulty must be determined to select appropriate personnel for the task.

3.2.1 Competence Requirements for General Work

Personnel performing work on electric machinery should, as a minimum, be *instructed technicians*. This is to ensure they can identify and assess whether a task involves electrical hazards (risk assessment) and avoid electrical risks.

Note also that work which, according to a manufacturer's instructions, should be possible to perform without risk of electrical hazard, may still involve hazardous elements due to human factors, external influences (such as damage to the electric machine), or incorrect actions previously performed on the electric machine.

General work on electric machinery includes:

**When a voltage class B system is
NOT decommissioned:**

- Easily supervised work that does not take place near the voltage class B system and where it is clear that no electrical hazard exists.
- Work that takes place near the voltage class B system and where the risk assessment shows that it is clear that no electrical hazard exists.

**When the voltage class B system
is decommissioned:**

- Work performed after decommissioning, which can therefore be carried out without risk of electrical hazard, for example, work on a decommissioned part of a voltage class B system or other mechanical work.

Clarification:

- Note that decommissioning and commissioning are classified as work within voltage class B and must be handled according to the requirements applicable to such work.
- In situations where decommissioning is not possible (for example, if the voltage class B system has been subjected to external damage or indicates a fault), the requirements for work within voltage class B apply.

3.3 Work Within Voltage Class B

In addition to the general requirements and guidelines for general work on electric machinery (section 3.2), additional requirements and guidelines apply to work within voltage class B as described below. Such work therefore places higher demands on the organisation, the level of training, and the safety measures that must be taken.

3.3.1 Competence Requirements for Work Within Voltage Class B

Work within voltage class B requires special competence and may only be performed by *skilled technicians*.

A company-specific training program must be in place to develop and maintain the competence required to perform work within voltage class B. This program should be tailored to the specific requirements and guidelines applicable to such work and should be based on both theoretical and practical exercises.

Work is considered to be within voltage class B when:

- it is performed on a voltage class B system that is not decommissioned,
- it is performed near a voltage class B system that is not decommissioned, where there is uncertainty about the presence of electrical hazards.

Work on electrical energy storage systems and live systems is also included in work within voltage class B. These are addressed in more detail in section 4.3.

3.3.2 Risks Associated with Work Within Voltage Class B

Technicians working on a commissioned voltage class B system may be exposed to hazards caused by electric current (electric shock) or electric arc. If the risk analysis shows that there is a risk of electric current passing through the body or consequences of an electric arc, and no other

safety measures can be taken to eliminate these risks, appropriate personal protective equipment must be used, see section 3.3.4.



3.3.3 Protective Measures and Planning of Work Within Voltage Class B

Based on the risk analysis, the supervisor must:

- Select the working method.
- Decide which protective measures will be taken, such as protective equipment, work clothing, tools, and barriers.
- Plan the execution regarding required knowledge levels.
- Ensure that a sufficient number of personnel on site are familiar with emergency procedures.
- Ensure that necessary instructions are given to the technician who will perform the work, before the work begins.
- Inform all participants about any reasonably foreseeable hazards that are not directly obvious to them.
- Before work begins, and while it is ongoing, ensure that all applicable rules and instructions are followed.

3.3.4 Tools, Equipment, and Protective Devices

Tools, equipment, and protective devices provided to ensure safe work with electric machinery must be suitable for their intended purpose, kept in a condition appropriate for their use, used as intended, and stored appropriately. Tools and equipment must also be maintained according to the manufacturer's instructions, for example through calibration or servicing.

Instructions/guidelines for the use, storage, maintenance, transport, and inspection of tools, equipment, and protective devices must be available.

Note:

"Kept in a condition appropriate for use" means periodic visual inspections and electrical testing when necessary, including after repairs and/or modifications, to check the electrical integrity and mechanical properties of the tools, equipment, and protective devices.

Tools/Equipment	Relevant Standards
Hand tools (insulated and insulating)	SS-EN IEC 60900
Voltage testers	SS-EN IEC 61010
Insulation meters, measuring instruments, and test probes	SS-EN IEC 61010, minimum CAT III and adapted for the machine's voltage level
Insulating mat	SS-EN 61111
Insulating cover sheet	SS-EN 61112
Eye/face protection	SS-EN ISO 16321-1,3
Insulating gloves/protective gloves	SS-EN 60903, SS-EN 388
Hearing protection	SS-EN 352
Safety helmets	SS-EN 13087, SS-EN 397
Protective clothing	SS-EN ISO 11611, SS-EN ISO 11612, SS-EN ISO 14116, and SS-EN 61482-2 (with cal/cm ² according to the manufacturer's recommendations, but at least one layer with a minimum of 8–12 cal/cm ²)

Equipment that prevents unintentional commissioning of the voltage class B system

Protective Devices

Protective devices must, at a minimum, meet the requirements of protection class IPXXB (according to SS-EN 60529), i.e., protection against contact with high-voltage live parts either through an electrical safety barrier or an enclosure. This is tested using a jointed test finger with dimensions Ø 12 mm, length 80 mm. Protective devices must be marked with the W012 symbol for dangerous electrical voltage and the W042 symbol for arc flash, both according to ISO 7010.



*symbol for dangerous
electrical voltage
(W012, ISO 7010)*



*symbol for
electric arc
(W042, ISO 7010)*

3.3.5 Manuals and Instructions

Current manuals, instructions, and diagrams relevant to each specific work within voltage class B must be available.

3.3.6 Signs and Barriers

Where work within voltage class B is being carried out, signs must be present to clearly indicate this. Work areas must always be marked with a physical barrier (such as plastic chains or barrier posts) and appropriate warning signs indicating that work involving electrical hazards is in progress. The signs must be designed in accordance with the ISO 7010 standard.

3.3.7 Decommissioning – Commissioning

Decommissioning and commissioning of voltage class B systems may only be performed by *skilled technicians* according to the manufacturer's instructions and with appropriate equipment (see 4.1).

The electric machine or its voltage class B component on which work is to be performed must, as preparation, be placed and maintained in a defined status (disconnected or connected) throughout the entire course of the work.

3.3.8 Measurement

When measurements are performed in a voltage class B system, appropriate and type-

approved measuring instruments and test probes must be used. The person performing the measurement must use the correct level of personal protective equipment and take protective measures against electric shock and the consequences of electric arc.

3.3.9 Inspection of Completed Work

The technician must carry out a self-inspection of the completed work before commissioning the voltage class B system.

For extensive work (for example, major repairs or installation of equipment) where the *skilled technician* cannot oversee the entire work process at once to perform an inspection after completion, ongoing inspections during the course of the work may be necessary. Documentation, photos, and similar materials may also serve as a basis for the inspection.

A self-inspection should include a visual check and measurement. The extent of the inspection should be adapted to the work performed. For example, an insulation measurement should be performed after replacing a component in the voltage class B system. The inspection should be carried out in accordance with the manufacturer's instructions. Deficiencies that pose an immediate danger must be rectified without delay. If this is not possible, faulty parts must be immediately decommissioned and protected against commissioning.

4

Work Within Voltage Class B

Work within voltage class B is divided as follows:

-
- Decommissioning and Commissioning (*see section 4.1*)
-
- Work on a commissioned voltage class B system (*see section 4.2*)
-
- Work near a commissioned voltage class B system where the risk assessment does not rule out electrical hazards and a risk analysis must therefore be carried out (*see section 4.2*)
-
- Work on electrical energy storage systems (*see section 4.3*)
-

4.1 Decommissioning and commissioning

The procedures for decommissioning and commissioning power sources in voltage class B must be carried out in accordance with the manufacturer's instructions. As a minimum requirement, the following steps must be performed in the specified order.

Decommissioning and commissioning may only be performed by *skilled technicians* and only with the intended personal protective equipment and approved tools.

4.1.1 Decommissioning

Decommissioning means that all power sources of the electric machine in voltage class B are disconnected from the rest of the voltage class B system, and that the system is secured against unintentional reconnection.

1***Disconnect from external power sources***

The electric machine must be disconnected from all external power sources (external charger, power grid connection, or similar) unless otherwise specified in the manufacturer's instructions.

2***Set the electric machine to the off position***

Just as the ignition is turned off on a conventional machine, the electric machine must also be set to the off position according to the manufacturer's instructions.

3***Verify that the system is de-energized (dead)***

Verification of de-energization must be performed by measurement, according to the manufacturer's instructions. The measuring equipment for voltage verification must be checked immediately before use and, if possible, after use. The equipment must be intended for this purpose.

This step is performed in order to verify that the electric machine has been set to the off position and to detect any faults in the voltage class B system.

4***Disconnect internal power sources in voltage class B***

The electric machine on which work is to be performed must be disconnected from all internal power sources, according to the manufacturer's instructions. The disconnection may consist of an air gap (service plug) or an equivalent disconnection system (for example, pilot line) which must ensure that the disconnection point cannot be electrically bridged. The disconnection must be visually or diagnostically verifiable.

5***Protect against reconnection (locking/blocking)***

The method for blocking the reconnection of the internal power sources must ensure that unintentional reconnection is not possible, for example, by using a lock. If a locking device is not available, another suitable method must be used. A warning sign must be posted to prevent unauthorised reconnection.



Example of warning sign

6***Verify once again that the system is de-energized (dead)***

Before starting work on the electric machine, check and confirm once again that the system is de-energized. This step is performed in order to ensure that the decommissioning procedure has been successful and to detect any faults in the voltage class B system.

4.1.2 Commissioning

Commissioning means that the voltage class B system of the electric machine is reconnected to its power sources after the work has been completed. After completion of the work, this must be inspected by a *skilled technician*. All involved persons must be informed that the work has been completed and that commissioning of the voltage class B system will take place.

The reconnection of power sources must be performed in accordance with the manufacturer's instructions.

As a minimum requirement, the following steps must be performed in the specified order:

1. Check that all connections are correct and insulated (if they have insulation).
2. Perform and document insulation measurement. The measured value must not deviate from the value specified by the manufacturer.
3. Remove the reconnection protection (blocking/lockout).
4. Reconnect internal power sources.
5. Clear any error codes and perform a new diagnostic check.

The complete commissioning procedure must be carried out by a skilled technician.

4.2 Work On or Near a Connected Voltage Class B System

Work on or near a connected voltage class B system involves tasks where contact with uninsulated live parts may occur or can be reached within the risk area.

Work on or near a connected voltage class B system may:

- Be performed when the nature of the work requires it, for example during measurement or testing of the system.
- **Only be performed by *skilled technicians*.**

- Only be performed using the intended personal protective equipment and approved tools.

Work on or near a connected voltage class B system may also be carried out if decommissioning is not possible, for example due to a technical fault in the electric machine.

Work on or near a connected voltage class B system is not permitted if decommissioning has not been performed due to, for example, lack of equipment or knowledge.

4.3 Work on Electrical Energy Storage Systems

Work on electrical energy storage systems involves working on or inside, for example, a battery in voltage class B and must be carried out in accordance with the manufacturer's instructions. The basic assumption for such work is that the electrical energy storage system is always energized, regardless of its charge status.

Working in electrical energy storage systems involves a high risk of contact with uninsulated live parts. The highest possible protective measures must be taken, such as shielding or insulating the live battery terminals.

Work on or in electrical energy storage systems may only be performed:

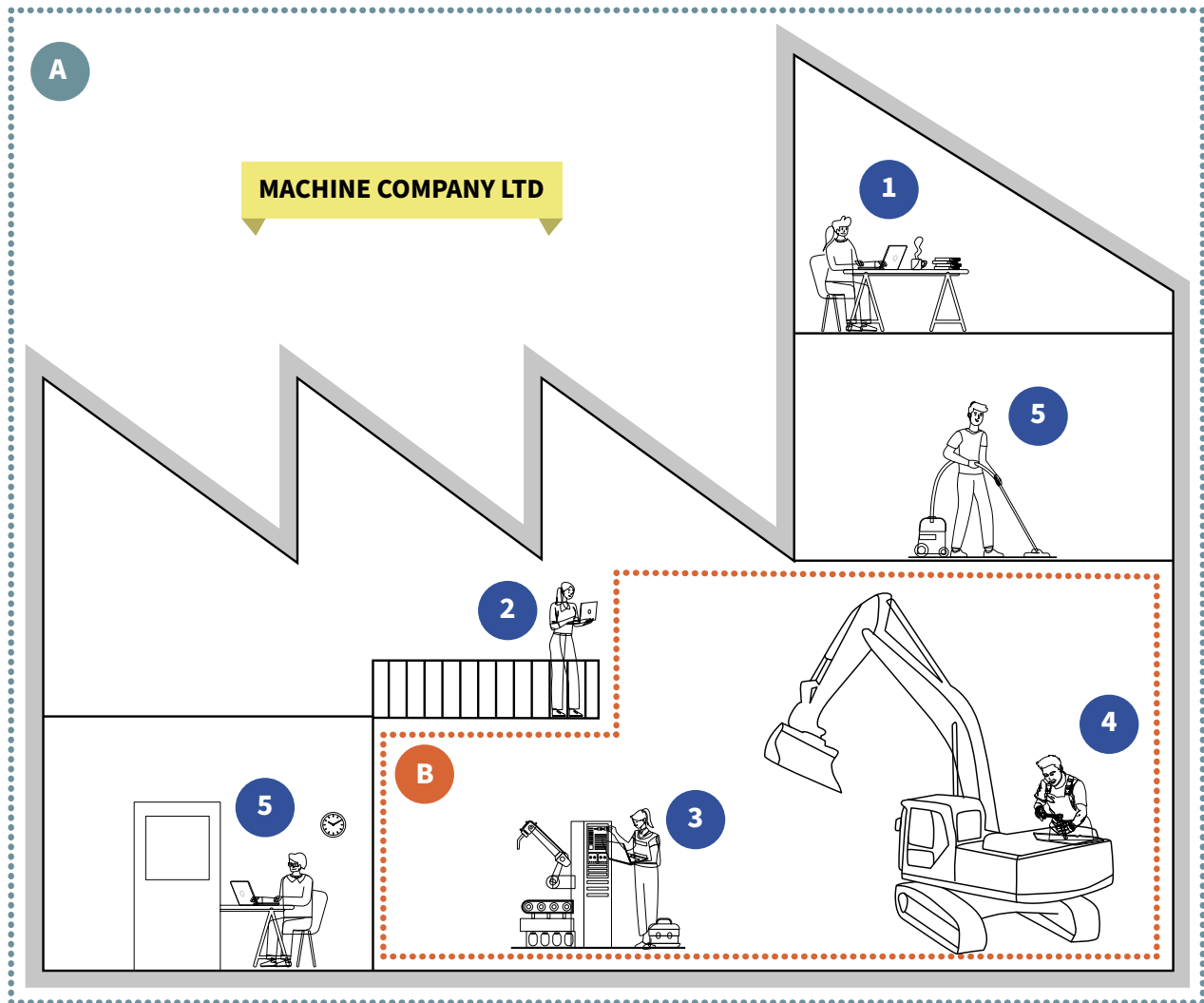
- **By a *skilled technician*.**
- With the intended personal protective equipment and approved tools.

Please note that the above requirements and guidelines apply both to electrical energy storage systems that are installed in an electric machine and to those that have been removed.

5

Appendices

Appendix 1



1 Safety Manager
e.g. CEO or country manager

2 Supervisor
e.g. workshop manager

3 Skilled technician

4 Instructed technician

5 Informed person
e.g. receptionist, cleaning staff, finance staff

A Workplace / Operational site

B Work zone



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