LECTURER HANDOUT

Course
“LIFT EQUIPMENT INSTALLER AND SERVICE TECHNICIAN”

PROJECT: LET'S COOPERATE!

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INTENDED OUTCOMES OF THE COURSE

1. COURSE AIM:

TO TRAIN QUALIFIED TECHNICIANS WHO UNDERSTAND THE FUNDAMENTAL PRINCIPLES, MECHANICAL, ELECTRICAL AND ELECTRONIC COMPONENTS OF LIFT SYSTEMS, ARE ABLE TO APPLY CURRENT MAINTENANCE AND REPAIR TECHNIQUES, AND HAVE THE SKILLS TO DIAGNOSE AND REPAIR FAULTS, MEETING INDUSTRY EXPECTATIONS.

UPON COMPLETING THIS COURSE, PARTICIPANTS WILL ACHIEVE THE FOLLOWING GOALS:

- Be able to identify different types of lifts and their basic components.
- Be able to interpret current European standards and legal regulations in the lift sector.
- Be able to explain the operating principles of mechanical lift systems.
- Be able to understand the functions of electric drive systems and electronic control units.
- Be able to apply basic tools and European Health and Safety procedures used during the installation and dismantling of lifts.
- Be able to correctly perform periodic maintenance procedures and use checklists.
- Be able to apply methods for diagnosing and safely removing common lift faults.
- Be able to understand the impact of innovative technologies (IoT, predictive maintenance, energy efficiency) on maintenance processes.
- Be able to read and interpret technical documentation (diagrams, instructions).
- Be able to work with awareness of health and safety and in accordance with regulations.

2. TARGET AUDIENCE AND EXPECTED OUTCOMES

This course is suitable for anyone pursuing a career in the lift sector or those who want to update their existing knowledge and skills to secure a more competent position in the industry.

Who should participate?

- Graduates of vocational and technical schools or individuals with basic knowledge in related fields.
- Aspiring technicians new to the lift sector or those who want to improve their skills.
- Current technicians working in lift maintenance companies who want to update their knowledge.
- People with basic knowledge of electrical engineering, electronics or mechanics who want to specialise in this field.

How can you benefit from the course?

- Versatile knowledge: You will gain in-depth insight into all the main components of a lift and how they work.
- Practical skills: You will develop practical skills in maintenance, repairs and fault diagnosis
- Current approach: You will learn about the latest technological developments and innovative maintenance methods in the industry.
- Safety awareness: You will learn to prioritise health and safety rules.
- Certification opportunity: Upon successful completion of the course, you will have the opportunity to obtain a certificate confirming your competence.
- Career benefits: You will increase your career opportunities as a skilled and in-demand lift maintenance technician in the industry.

3. Guidelines for using the booklet and references

This booklet is designed as a guide to the 70-hour course "Lift Equipment Installer and Service Technician". To maximise your learning experience, we recommend that you pay attention to the following points:

- **Structural flow:** The brochure is organised in such a way as to ensure a logical progression of topics. Following the sections will help you to better understand the information.
- **Key information:** Important definitions, formulas or critical information are highlighted in **bold** or *italics*.
- **Headings** such as**: "Consider:", "Remember:", "Tip:"** are used to encourage active thinking, draw attention to important points and offer practical advice.
- **Application and assessment:** Throughout the brochure, there are questions or short suggestions for application. These sections provide an opportunity to reinforce what you have learned.

Our references and current approach: The content of this brochure is based on general principles of lift engineering, as well as current technical instructions, service guides and the latest technological applications from leading European lift manufacturers (e.g. **Kone, Schindler, Orona, Otis, ThyssenKrupp, Mitsubishi Electric, Siemens**). By doing so, we aim to provide not only fundamental knowledge, but also **an innovative and future-oriented approach to this sector**. Safety and professional competence are our priorities.

Table of contents

I. SAFETY AND HEALTH AT WORKPLACE FOR THE ROLE OF LIFT EQUIPMENT INSTALLER AND SERVICE TECHNICIAN

1. JOB SPECIFICATIONS

A lift equipment installer and service technician deals with the installation, repair, maintenance and technical inspection of handling equipment such as lifts, hoisting platforms, cranes, freight lifts and passenger lifts.

The work is often carried out at height, in lift shafts or machine rooms, as well as in confined space and high risk conditions.

2. WORK ORGANISATION

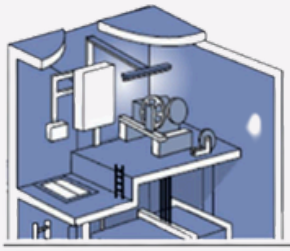
- **Maintenance work** should be carried out **in teams of** at least **two people.**
- When working in a lift shaft, **the use of belay systems** is required.
- Tools and equipment should be stored in **a safe and orderly manner.**
- **The worker must be in good physical and mental condition -** work must not be carried out under the influence of alcohol or other intoxicating substances.

3. HEALTH AND SAFETY REQUIREMENTS

- Regular health and safety training, including periodic training and job briefing.
- Knowledge of operating and maintenance instructions for lifting equipment.
- OTI (Office of Technical Inspection) authorisations appropriate to the type of equipment being maintained.
- Observance of power-off procedures before starting work.
- Constant monitoring of the technical condition of tools and equipment.
- Ensuring adequate lighting of the work area.
- Securing the workplace against unauthorised access.
- Obligation to report all irregularities and hazards to the supervisor.

4. OCCUPATIONAL RISKS OF THE JOB

- ⚠ **Working at height** - risk of falling when working in crane shafts or on structures
- ⚠ **Contact with electrical installations** - possibility of electrocution
- ⚠ **Mechanical hazards** - injuries caused by moving parts of machinery and equipment (e.g. ropes, gears)
- ⚠ **Confined work space** - risk of injury when working in shafts and machine rooms
- ⚠ **Noise and vibration** - prolonged work with electrical tools
- ⚠ **Chemical agents** - contact with oils, greases, cleaning agents
- ⚠ **Physical strain** - carrying heavy items, work in awkward positions



Risk of electric shock

Risk of being crushed by unsecured moving equipment

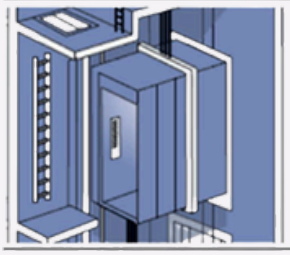
Risk of head injury from low ceilings

Asbestos

Risk of falling - access to machinery

Slipping hazards

Tripping hazards



Risk of electric shock

Risk of being crushed by unsecured moving equipment

Risk of crushing in the overhead area and drive system

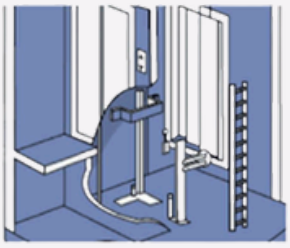
Falling objects

Risk of falling from the car roof

Slipping hazards

Tripping hazards

Asbestos



Risk of electric shock

Risk of being crushed by unsecured moving equipment

Risk of crushing by the cabin, counterweight, or neighboring lift

Falling objects

Risk of falling from a stop or ladder to the pit

Slipping hazards

Tripping hazards

5. INDIVIDUAL PROTECTION MEASURES

- Protective helmet
- Safety glasses
- Protective work clothing against dirt and mechanical factors
- Work gloves
- Ear protection
- Safety harness with safety rope
- Work footwear with steel toecap and anti-slip sole

PROTECTIVE HELMET:
IT IS NECESSARY WHEN THERE IS A RISK THAT SOMETHING COULD FALL ON YOUR HEAD.
IT IS COMPULSORY ON ALL CONSTRUCTION SITES.
CHECK THE HELMET FOLLOWING THE MANUFACTURER'S RECOMMENDATIONS!
PROTECTIVE HEADGEAR:
MUST ALWAYS BE WORN TO PROTECT AGAINST INJURY IN SMALL MACHINERY AND WHEN WORKING IN A LIFT SHAFT.

PROTECTIVE EYEWEAR:
MANDATORY WHEN HAZARDS ARE POSED BY EJECTED OBJECTS (E.G. WHEN DRILLING, GRINDING, ETC.).
RECOMMENDED WHEN WORKING WITH CHEMICAL PRODUCTS

EAR PROTECTION:
MANDATORY WHEN NOISE EXCEEDS 85 DB(A)

NECESSARY GLOVES:
STRONG WORK GLOVES FOR MANUAL HANDLING OF OBJECTS.
GLOVES TO PROTECT AGAINST INJURIES DURING REPAIRS, TOOL USE, ETC.
ELECTRO-INSULATING GLOVES FOR WORKING ON LIVE EQUIPMENT.
CHEMICAL GLOVES FOR WORKING WITH CHEMICAL PRODUCTS.

PROTECTIVE FOOTWEAR:
CONDUCTIVE, PUNCTURE RESISTANT.
TOE PROTECTION AGAINST FALLING OBJECTS.
HEEL TO GIVE BETTER SUPPORT WHEN CLIMBING A LADDER.
IT IS ADVISABLE THAT THE SHOE COVERS THE ANKLE.

WORKWEAR:
PROTECTING AGAINST CUTS, DIRT, ETC.
DENTIFYING THE COMPANY.

FALL PROTECTION EQUIPMENT IS MANDATORY WHEN THERE IS A RISK OF SUCH A FALL:
A BELAY SYSTEM TO STOP A FALL.
A SAFETY DEVICE TO PREVENT ACCESS TO THE DANGEROUS AREA.

WHAT NOT TO WEAR:
Metal watches, bracelets, necklaces, rings, etc. when working with live electrical equipment.
Loose-fitting clothing that could be caught in dangerous moving equipment.
Ties, scarves, etc. that could get caught in dangerous equipment.
ℹ️ **REMINDER:**
Local regulations may require the use of additional protective equipment, such as goggles, reflective vests, etc.

6. Emergency measures

- Knowledge of evacuation and emergency procedures.
- The ability to administer first aid.
- Obligation to notify the supervisor immediately of any accident or dangerous situation.
- Availability of a first aid kit at the workplace.

1.1. Characteristics of safety hazards when performing tasks related to the installation and maintenance of lifting equipment

ELECTRICAL HAZARDS

- Electrocution - working on electrical installations of lifts, often at operating voltage.
- Arcing and short circuits - risk of burns or explosion, especially with improperly protected installations.
- Improper grounding or insulation - risks serious accidents, including fatalities

FIRE HAZARDS AND EXPLOSION HAZARDS

- Electrical short circuits - can lead to fire.
- Use of flammable substances (e.g., lubricants, oils) - there is a risk of ignition at high temperatures or sparks.
- Working in confined spaces (e.g., lift shafts) - limited ventilation increases the risk of vapor explosion.

MECHANICAL HAZARDS

- Falling from height - work often takes place at height (e.g., elevator shafts, support structures), which poses a risk of falling.
- Crushing - crane components can be heavy and moving, there is a risk of being crushed by mechanisms or falling parts.
- Struck by a moving component - the possibility of contact with moving machine parts, such as cables, gears, counterweights.
- Fractures, injuries to limbs - during assembly or maintenance, such as by jamming hands in mechanisms.

ENVIRONMENTAL HAZARDS

- Electric shock - working on electrical installations of cranes, often at operating voltage.
- Arcing and short circuits - risk of burns or explosion, especially with improperly protected installations.
- Improper grounding or insulation - risks serious accidents, including fatalities

ERGONOMIC HAZARDS AND PSYCHOPHYSICAL HAZARDS

- Physical overload - carrying heavy items, working in forced positions.
- Stress and fatigue - working under time pressure, noise or limited visibility.
- Routine and distraction - can lead to skipping safety procedures.

RISKS FROM NON-COMPLIANCE WITH PROCEDURES AND IMPROPER USE OF TOOLS

- Failure to properly secure the workplace - lack of signage, inadequate fencing of the danger zone.
- Failure to use personal protective equipment (PPE) - such as helmets, harnesses, dielectric gloves.
- Improper maintenance or installation - can result in equipment failure and danger to people.

1.2. Safety rules at work

1. COMPLY WITH HEALTH AND SAFETY REGULATIONS

Have a knowledge of the health and safety instructions applicable to your position.
Participate in initial and periodic training courses

2. USE PERSONAL PROTECTIVE EQUIPMENT (PPE)

Wear helmet, gloves, safety glasses, reflective vests, masks, etc., if required.
Check the condition of PPE (personal protective equipment) and report wear or damage.

3. REPORT DANGERS AND ACCIDENTS

Don't ignore dangerous situations - even if nothing has happened.
Every incident (even minor ones) should be reported to your supervisor.

4. FOLLOW THE RULES FOR OPERATING MACHINERY AND EQUIPMENT

Only use equipment for which you are qualified.
Do not repair machinery yourself if you are not authorised to do so.

5. MAINTAIN ORDER IN THE WORKPLACE

Store tools and materials properly.
Remove obstacles from traffic routes.

6. DO NOT WORK UNDER THE INFLUENCE OF ALCOHOL OR DRUGS

This is not only dangerous but also punishable.
Report instances of suspicion to other employees.

7. KEEP YOURSELF AND OTHERS SAFE

Work in a manner consistent with procedures.
If necessary - warn others of hazards.

8. FOLLOW FIRE SAFETY RULES

Find the nearest emergency exits and fire extinguishers.
Do not block escape routes or fire appliances.

9. TAKE BREAKS - DO NOT OVERWORK YOURSELF

Fatigue increases the risk of mistakes and accidents.
Breaks help maintain focus and productivity.

10. AVOID DISTRACTIONS WHILE WORKING

Reduce the use of cell phones and other distractions

1.3. First aid in accidents related to, among other things, electrocution, falls from heights, crushing, etc.

1.3.1. ELECTRIC SHOCK

1. ENSURE YOUR OWN SAFETY

Do not touch the injured person until you are sure that the power source has been disconnected!

2. DISCONNECT THE POWER SOURCE

Switch off the fuses or pull the plug from the socket. If this is not possible, use a dry, insulating object (e.g. a wooden stick) to pull the casualty away from the source.

3. CHECK VITAL FUNCTIONS

Is he breathing? Does he have a pulse? If he is not breathing - start CPR (cardiopulmonary resuscitation).

4. CALL FOR HELP

Call the emergency number 112.

5. SECURE THE INJURED PERSON

If he is conscious, lay him down and observe him. Provide psychological support and cover with a blanket (if necessary).

1.3.2. FALL FROM HEIGHT

1. SECURE THE ACCIDENT AREA

Make sure you are not threatened by anything from above or around you.

2. DO NOT MOVE THE INJURED PERSON!

Suspect a spinal injury! Do not move it unless it is in further danger.

3. CHECK STATE OF CONSCIOUSNESS AND BREATHING

If there is no breathing - start CPR. If they are breathing, but unconscious - place in the lateral safe position, if there is no spinal injury.

4. CALL FOR HELP – 112

1.3.3.CRUSHING (E.G. BY A HEAVY OBJECT, MACHINE)

1. ENSURE SAFETY

Assess whether you can approach without risk.

2. DO NOT REMOVE THE OBJECT YOURSELF IF:

It is very heavy, crushing the chest or pelvis - this can worsen the victim's condition (e.g. cause internal bleeding).

3. CHECK VITAL FUNCTIONS

If there is no breathing or pulse - start CPR.

4. CALL FOR HELP

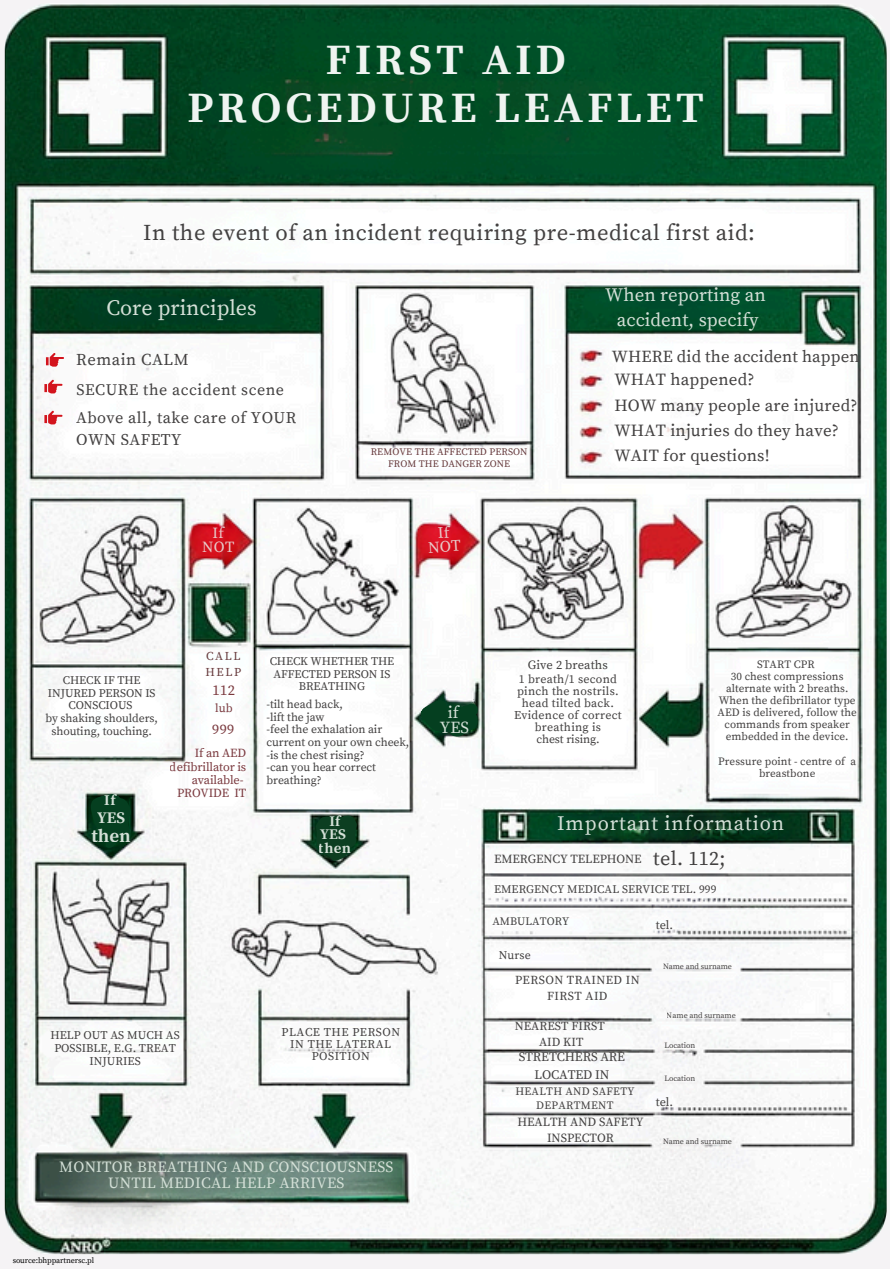
Call the emergency number 112.

5. PROVIDE SUPPORT

If the person is conscious - maintain contact with them.

GENERAL PRINCIPLES OF FIRST AID

1. Secure the scene - your safety first.
2. Assess the condition of the casualty - consciousness, breathing, bleeding.
3 Call for help – 112
4 Give first aid - according to your level of knowledge.
5. Do not leave the casualty alone - unless you have to call for help.



Note: The emergency numbers mentioned in the text are valid in Poland and may not be applicable in other countries!

II. CHARACTERISTIS OF LIFT EQUIPMENT

THE SAFE, EFFICIENT AND UNINTERRUPTED OPERATION OF LIFTS IS DIRECTLY LINKED TO **THE LIFE SAFETY, COMFORT AND TIME MANAGEMENT** OF USERS**.**

THEREFORE, REGULAR MAINTENANCE AND THE PROMPT, ACCURATE RECTIFICATION OF POTENTIAL FAULTS ARE CRUCIAL.

Safety: the main reason is the safety of human life. Regular maintenance proactively identifies potential hazards, preventing accidents.

Efficiency and effectiveness: A well-maintained lift uses less energy, runs quieter and has a longer service life.

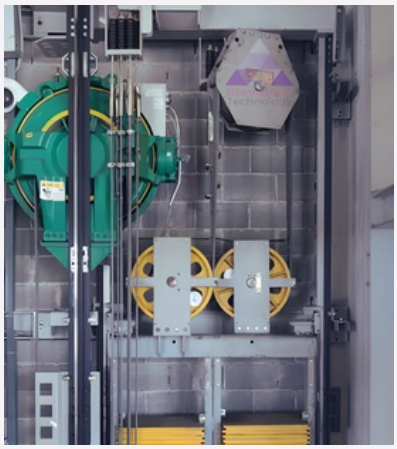
Legal obligations: In many countries (including the European Union), periodic maintenance and inspection of lifts is a legal requirement. It is the responsibility of both building managers and maintenance companies.

Cost-effectiveness: Fixing minor faults before they escalate prevents costly repairs in the future.

1. CLASSIFICATION AND DEFINITION OF LIFT EQUIPMENT

Lifts can be classified in various ways based on their design and operating principles. These classifications are made according to the purpose of the lift, the traction system or the location of the machine room. Each type has its own advantages and areas of application.

1.1. LIFTS ACCORDING TO DRIVE SYSTEM



TRACTION (ROPE) LIFTS:

Definition:

The most common type of lift. The car and counterweight move on a traction sheave by means of ropes. A motor rotates the traction sheave, causing the car to move up and down.

Operating principle:

The traction sheave, driven by the motor, pulls the ropes through friction. The counterweight balances part of the load on the trolley, reducing the energy recquired by the motor.

SUBCATEGORIES:

Geared traction machines: These traditionally used machines have a gearbox that transfers motion from the motor shaft to the traction sheave. They are suitable for slower speeds and higher capacities.

Gearless traction machines These use direct drive motors, eliminating the need for gears. This allows higher speeds, less noise and greater energy efficiency. They are preferred in modern buildings and high-speed lifts.

Tip: Gearless machines (especially those with PM - Permanent Magnet - motors) are now becoming the industry standard due to their compact design and high efficiency.

1.2. Lifts according to machine room location

MACHINE ROOM-LESS LIFTS (MRL):
Definition: The lift's traction machine and control panel are usually integrated into the shaft or at the top of the shaft, eliminating the need for a separate machine room – currently the more common solution.
Advantages: Saves space in the building, offers architectural flexibility, can reduce installation costs (no need to build a separate room).
Disadvantages: Access points for maintenance and repairs may be limited, and acoustic and thermal insulation may become more critical.

LIFTS WITH MACHINE ROOMS:
Definition: The lift traction machine, control panel and other critical equipment are located in a dedicated machine room.
Advantages: Better access and working space for maintenance and repairs, less noise and heat generated by the machine room spreading throughout the building.
Disadvantages: Requires additional space in the building, may limit architectural flexibility.

1.3. Lifts according to purpose of use

ESCALATORS AND MOVING WALKWAYS

Used for continuous mass transport in high-traffic areas such as shopping centres, airports and underground stations. Although their basic operating principles differ from those of lifts, their mechanical and electrical maintenance principles are similar.

FREIGHT LIFTS

Designed for transporting heavy loads in factories, warehouses, shopping centres, etc. Capacity and durability are the top priorities.

SERVICE LIFTS (DUMBWAITERS/FOOD LIFTS)

Used to transport small loads (food, documents, etc.) in restaurants, hotels, etc. The cabins are small and generally not designed for transporting people.

PASSENGER LIFTS

Used to transport people in residential, commercial, office buildings, etc. Comfort, speed and safety are the most important factors.

STRETCHER/BED LIFTS

Specially designed and equipped for transporting patients on stretchers in hospitals and healthcare facilities. A large cabin and smooth movement are prioritized.

LIFTS FOR DISABLED PEOPLE

Designed to ensure accessibility for people with physical disabilities. They operate at low speeds and with special precautions.

2. PARAMETERS OF LIFTING EQUIPMENT

The performance and suitability of lifts are determined by specific technical parameters. These parameters help us understand which building and purpose a lift is suitable for, and provide key information during maintenance processes.

Speed (m/s): The vertical distance that a lift travels in one second. This varies depending on the intended use and the height of the building. For example, residential lifts typically operate at a speed of around 1 m/s, while in tall buildings they can reach speeds of 6-10 m/s or higher.

Range (m): Vertical distance between the lowest and highest floors served by the lift.

Capacity (kg) and number of persons: The maximum load (kilograms) and maximum number of persons that the lift can safely carry. This is directly related to the size of the cabin and the power of the motor. The specified load capacity must never be exceeded.

Number of stops: Number of floors served by the lift.

Motor power (kW): The power of the motor that moves the lift car and its load. It is directly proportional to capacity and speed.

Diameter (mm) and number of ropes: The diameter and number of steel ropes used in traction lifts are crucial for the lift's performance and safety.

Supply voltage (V) and frequency (Hz): The power values that the lift receives from the electrical network (e.g. 380-400 V/50 Hz in Europe).

Rail types: Profile and size of steel rails that guide the cabin and counterweight in vertical movement (e.g. T70, T90, T125).

Tip: These parameters are like the lift's technical data sheet. In the event of any maintenance or breakdown, the correct identification of spare parts and performance assessment are carried out on the basis of these parameters. This information is usually included in the lift's operating permit and maintenance log.

3. STANDARDS FOR LIFTING EQUIPMENT

The design, manufacture, installation, maintenance and operation of lifts are subject to strict standards and regulations established at European level. These standards were created to ensure user safety and guarantee that lifts meet specific quality and performance criteria.

CORE EUROPEAN AND NATIONAL STANDARDS:

EN 81 series standards: Primary safety rules for lifts established by the European Union and harmonised with national regulations by national standardisation bodies (e.g. PN-EN 81 in Poland, DIN EN 81 in Germany, BS EN 81 in the United Kingdom, TS EN 81 in Turkey).

EN 81-20 (Safety rules for construction and installation): Covers safety rules for lifts intended for the transport of persons and/or goods. Contains detailed information on modern lift safety requirements (e.g. pit and overhead clearances, cabin dimensions, door resistance).

EN 81-50 (Design principles, calculations, examinations and tests): Specifies the design principles, calculations, examinations and testing methods for lift components.

Remember: Older standards (EN 81-1, EN 81-2) have been replaced by newer generation standards. It is vital for maintenance technicians to be proficient in the current standards in order to perform their work correctly and safely.

CE marking: A mark indicating that products comply with health, safety, environmental and consumer protection requirements for free movement within the European Economic Area (EEA). This marking is mandatory for lift components and complete lifts.

LIFT DIRECTIVE (2014/33/EU):

This European directive sets out the essential health and safety requirements that lifts and safety components must meet before being placed on the market or put into service. It specifies the obligations of manufacturers, installers, importers and distributors. It regulates CE marking and conformity assessment processes for lifts.

Tip: It is important to regularly check the websites of the European Commission and national standardisation bodies (e.g. CEN/CENELEC) to access the Lift Directive and related standards.

MAINTENANCE AND OPERATION REGULATIONS:

Regulations concerning maintenance and operation:
Across Europe, there are various national regulations governing the safe and proper operation of lifts, mandatory periodic maintenance and periodic inspections.

KEY PROVISIONS:

- Mandatory maintenance contracts.
- Mandatory periodic inspection (annual inspection) and authorised inspection bodies.
- Responsibilities of the building owner/manager and the lift maintenance company.
- Maintenance documentation.

Remember: As a lift technician, technical knowledge alone is not enough; you must also be aware of the standards according to which the lifts you work on were manufactured, the regulations they are subject to, and your legal obligations. This is essential for your own safety and that of users.

4. TECHNICAL DOCUMENTATION

Technical documentation is the cornerstone for lift maintenance and repair processes. It is a comprehensive set of documents provided by the manufacturer throughout the entire lift life cycle (design, manufacture, installation, maintenance, repair, modernisation) containing detailed information. The ability to correctly read and interpret this documentation is crucial for diagnosing faults or performing maintenance correctly.

MANUALS FOR INSTALLATION AND MOUNTING:

They contain step-by-step instructions for assembling lift components.
They contain detailed technical drawings, such as the dimensions of the shaft, machine room and car, as well as assembly tolerances.

Tip: In modern lifts, installation instructions often include tips on "quick installation" and "safety".

ELECTRICAL AND MECHANICAL SCHEMATICS:

ELECTRICAL SCHEMATICS:
Diagrams showing all electrical circuits, cable connections, fuses, contactors, relays, sensors and control panels of the lift. They are one of the most important tools for diagnosing faults.
MECHANICAL SCHEMATICS:
Drawings showing the location, connections and moving parts of the lift's mechanical components (motor, pulley, brake, door mechanisms, etc.).

Tip: The ability to read electrical and mechanical diagrams is one of the most basic skills for a lift maintenance technician. Understanding symbols and connections will help you quickly locate faults.

SPARE PARTS LISTS AND DEFINITIONS:

They contain information such as codes, serial numbers and sometimes dimensions of all components used in the lift (motor, board, button, sensor, etc.).
They enable quick identification of the correct spare part in the event of a failure.

MAINTENANCE AND SERVICE MANUALS (MANUFACTURER'S HANDBOOKS):

They describe in detail the frequency of periodic maintenance procedures, what to check in each procedure and how to perform them.
They contain specific information such as lubrication points, adjustment procedures and torque values.

Remember: Maintenance instructions may vary depending on the manufacturer and even the model. The most accurate information can always be found in the manufacturer's manual for the specific lift.

DIGITAL DOCUMENTATION AND CLOUD RESOURCE MANAGEMENT:

Current approach: Many lift manufacturers now make their technical documentation available on digital platforms (PDF files, specialised software). Some companies use cloud-based document management systems that allow maintenance technicians to access information immediately on site via tablets or smartphones. This ensures quick access to up-to-date information and efficient work.

Future prospects: Applications supporting virtual reality (VR) or augmented reality (AR) are designed to enable technicians to access technical diagrams or installation steps in real time while working directly on the lift.

MECHANICAL COMPONENTS AND THEIR FUNCTIONS

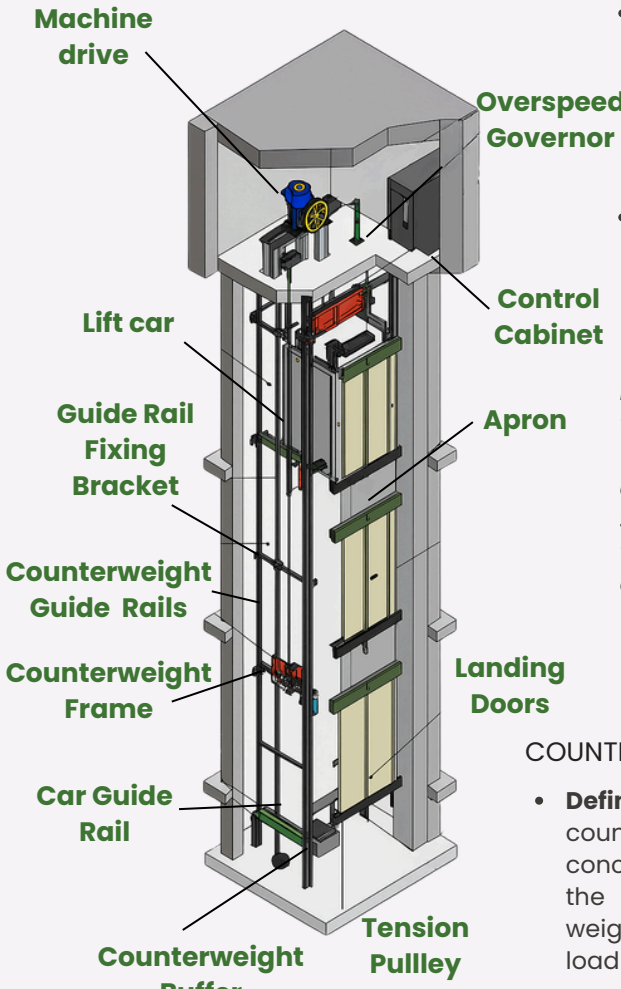
Elevators consist of many mechanical parts that ensure safe and comfortable movement. Each of these parts is crucial to the integrity and functionality of the system.

5.1. MAIN SUPPORT SYSTEMS

CAR (LIFT CABIN)

- **Definition:** An enclosed compartment in which passengers or goods are transported. It is constructed of a steel frame covered with cladding materials (sheet metal, wood, glass, etc.).
- **Function:** Safe transport of users or loads between floors. It includes a control panel, lighting, alarm and emergency equipment.

Maintenance note: The interior lighting, ventilation and emergency buttons should be checked regularly to ensure they are working properly. The door mechanism is crucial for smooth door opening and closing and shock-free movement.



ROPES

- **Definition:** Flexible connecting elements, usually made of twisted, multi-layer steel wire, which support the car and counterweight. Elevators typically use multiple ropes.
- **Function:** To ensure the movement of the car and counterweight via the traction sheave and to transfer the load.

Maintenance note: Regularly check the tension of the rope, its wear (broken wires, reduced diameter), corrosion and correct seating in the sheave grooves. Correct rope tension is crucial for the efficient operation of the traction system.

HOISTWAY GUIDE RAILS

- **Definition:** Steel T-shaped bars extending vertically along the lift shaft. The car and counterweight move along these rails using sliders (guide rollers).
- **Function:** Ensuring smooth and shake-free vertical movement of the cabin and counterweight and preventing horizontal swaying.

Maintenance note: Check the lubrication of the rails, the tightness of the rail mounting screws, and the absence of bends, wear or rust on the rails. Adjusting the rails is important for a comfortable lift ride.

COUNTERWEIGHT

- **Definition:** In traction lifts, a set of counterweights (usually cast iron or concrete blocks) used to balance part of the weight of the cabin (usually the weight of the empty cabin + 50% of the load capacity).
- **Function:** Reducing the energy required by the motor to move the car, increasing system efficiency and optimising the braking distance.

Maintenance note: Ensure that the counterweight blocks are not displaced, their frame is solid and they move smoothly along the guide rails.

5.3. DRIVE SYSTEMS

TRACTION MACHINE (MOTOR AND GEARBOX/TRANSMISSION UNIT):

Definition: The main power source that drives the lift. It consists of an electric motor and a gearbox connected to it (in gearbox systems) or a gearless motor with direct drive.
Function: Pulls the ropes through the pulley, causing the vertical movement of the cabin and counterweight.

Maintenance note: Check the oil level in the engine and gearbox (if applicable), the condition of the bearings, noise and vibration levels, brake system adjustment and temperature.

TRACTION SHEAVE:

Definition: A grooved wheel rotated by a traction machine, above which ropes are located and which pulls the ropes through friction.
Function: Transfers the movement of the motor to the ropes, causing the cabin and counterweight to move.

Maintenance note: Check the condition of the pulley grooves (groove depth and profile), surface cleanliness, and correct seating of the ropes in the pulley. A worn pulley can lead to rope slippage and system failure.

BRAKE SYSTEMS:

Definition: An electromechanical system that safely stops the traction sheave (and thus the car) in the event of a power failure or motor shutdown.
Function: To ensure that the lift stops and remains stationary at the stopping point, and also to activate in the event of a potential overspeed to increase safety.

Maintenance note: Brake shoe wear, brake coil operation, brake gap adjustment and braking force should be checked regularly. A reliable brake is essential for lift safety.

5.4. SAFETY SYSTEMS

OVERSPEED GOVERNOR:

- **Definition:** A mechanical safety device that activates when the lift exceeds a specified maximum speed.
- **Function:** In the event of excessive speed of the cabin, it first attempts to stop the lift by cutting off the electrical circuit; if this fails, it activates the rope to activate the safety gear system (parachute brake).

Maintenance note: The overspeed governor should be checked periodically for cleanliness, rope tension and speed settings. Annual testing is mandatory.

SAFETY EQUIPMENT (PARACHUTE BRAKE):

- **Definition**: A mechanical safety device mounted under the vehicle that clamps onto the guide rails, stopping the vehicle in the event of activation of the overspeed governor or rope breakage.
- **Function:** Prevents uncontrolled descent of the vehicle and ensures passenger safety.

Maintenance note: Check the mobility of the safety gear mechanism, the condition of the brake linings, the release mechanism and the contact surfaces with the rails. Safety gear tests are carried out very rarely and in special circumstances by teams of experts.

DOOR LOCKS AND SAFETY SWITCHES:

- **Definition:** Mechanical and electrical safety devices that confirm that the access doors and cabin doors are completely closed and locked.
- **Function:** To ensure that all doors are closed and locked before the lift can move. If any door is open or unlocked, this prevents the lift from operating.

Maintenance note: Check the proper functioning of the door locking mechanisms, the cleanliness of the electrical contacts and their adjustment. It is important that the doors move freely and do not jam when closing.

BUFFERS:

- **Definition:** Spring or hydraulic devices located at the bottom of a shaft hoist that absorb and cushion impacts if the car or counterweight moves below its normal lower limit.
- **Function:** To absorb impacts as a final safety measure if the car or counterweight moves below the lowest limit, minimising potential damage.

Maintenance note: Check the physical condition of the buffers, the oil level in the hydraulic buffers and that they are securely fastened to the shaft floor.

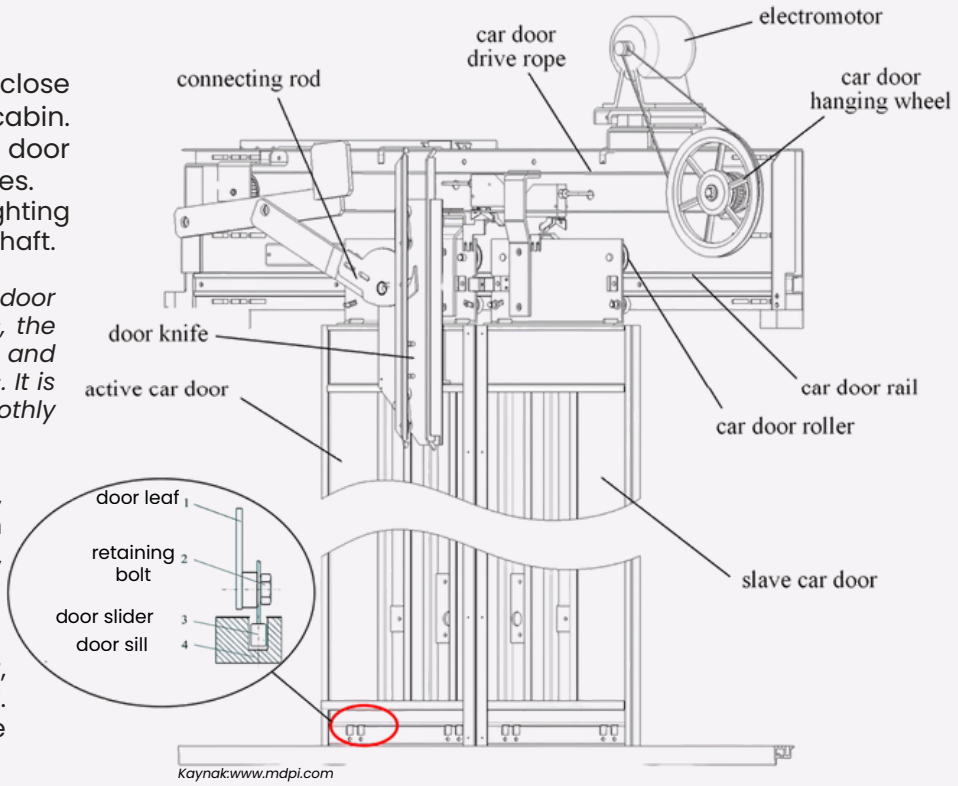
5.5. DOOR MECHANISMS

AUTOMATIC ACCESS AND CABIN DOORS:
Definition: Door systems that open and close automatically at the stop level and in the cabin. They usually consist of a door motor, door panels, sensors and door mechanism guides.
Function: To ensure safe boarding and alighting of passengers and to prevent access to the shaft.

Maintenance note: Check the operation of the door motor, the tension of the door belts or cables, the cleanliness and lubrication of the door guides, and the operation of the photocells or light curtains. It is important that the doors open and close smoothly and quietly.

Application: In the lift you are working on, carry out a visual inspection of the main load-bearing systems (cabin, counterweight, ropes, rails).

Pay attention to the physical condition (wear, corrosion, damage) of each component. Follow health and safety rules during the inspection.



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6. COMPONENTS OF LIFTING EQUIPMENT

IN ADDITION TO BASIC MECHANICAL COMPONENTS, LIFTS HAVE VARIOUS ACCESSORIES THAT INCREASE USER COMFORT, SAFETY AND SYSTEM FUNCTIONALITY.

EQUIPMENT INSIDE THE CABIN:

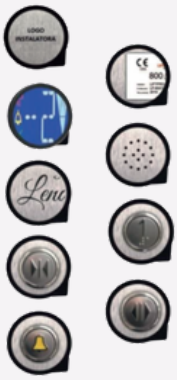
CONTROL PANEL (COP - CAR OPERATING PANEL):
A panel located inside the cabin, containing call buttons, door open/close buttons, an alarm button, an emergency telephone and floor indicators.

FLOOR INDICATORS:
Digital or analogue displays showing the current floor of the vehicle or direction of travel.

EMERGENCY COMMUNICATION SYSTEMS:
Usually activated by an alarm button, these systems provide two-way voice communication from the cabin to an external entity (service company or emergency services).

VENTILATION:
Fans or air conditioning systems that ensure air circulation inside the cabin.

LIGHTING:
Lighting fixtures in the cabin and emergency lighting.



LCP (LANDING CALL PANELS)

CALL BUTTONS:
Directional up/down buttons located on each floor for calling the lift.

FLOOR INDICATORS:
Displays on the landing panel showing the current floor and the direction of travel of the lift.

EMERGENCY EQUIPMENT

EMERGENCY STOP BUTTON:
A button located inside the cabin or on some landing panels that immediately stops the lift in emergency situations.

ALARM BUTTON:
A button that activates an emergency siren if passengers are trapped in the cabin.

FIRE SENSORS/SYSTEMS:
In some buildings, integrated fire protection systems ensure that the lift travels to the designated floor (usually the evacuation floor) and opens the doors before shutting down in the event of a fire.

SMART BUILDING INTEGRATIONS AND CONTACTLESS ACCESS SYSTEMS

Intelligent destination control systems:
Systems that analyse passenger density to optimise lift allocation (e.g. Schindler PORT Technology, Kone Destination Control).

CONTACTLESS ACCESS:

Card readers, fingerprint or facial recognition systems for lift paging and floor selection.

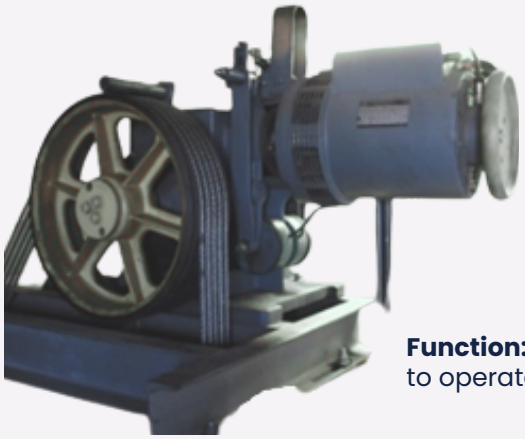
SMARTPHONE INTEGRATION:

Enabling users to call up the lift and select floors using their smartphones.

Note on maintenance: These smart systems allow maintainers to remotely monitor and diagnose faults, but also require software updates and cyber security checks.

7. ELEMENTS OF ELECTRICALLY POWERED LIFTS

THE PRIMARY DRIVING FORCE FOR THE MOVEMENT OF THE LIFT CAR AND ITS LOAD IS THE ELECTRIC DRIVE SYSTEMS. THESE SYSTEMS ARE THE HEART OF MODERN LIFT TECHNOLOGY IN TERMS OF EFFICIENCY AND COMFORT.



ASYNCHRONOUS AND SYNCHRONOUS MOTORS (WITHOUT GEARS)

Asynchronous motors: Induction motors typically used in older machines with gearboxes. They are robust and simpler, but require frequency converters for speed control.

Synchronous motors (especially PM motors with permanent magnets): Motors mainly used in gearless lifts, offering high efficiency, precise speed control, quiet operation and small size.

Function: To convert electrical energy into mechanical movement, enabling the pulley to operate.

FREQUENCY INVERTERS AND REGENERATIVE FUNCTIONS

Definition: electronic devices that control the speed and torque of a motor. They adjust the speed and power of the motor by varying the voltage and frequency of the network.

Function:
Ensure smooth acceleration/deceleration of the crane when starting and stopping, without jerking. Maintaining constant speed and precise levelling under varying load conditions. Dynamic control of engine speed and direction**.**

Regenerative functions: An important feature of modern frequency converters. When the lift car moves upwards with a light load or downwards with a heavy load (situations where the motor acts as a generator), they supply the generated electricity back to the grid.

Energy efficiency: regenerative drives significantly reduce the lift's energy consumption, offering an environmentally friendly and cost-effective solution**.**

Maintenance note: Drives tend to operate at high temperatures, so cooling fans and heat sinks should be cleaned regularly and electrical connections checked for leaks. Error codes can be read from the drive display.

ENGINE BRAKE SYSTEMS

Definition: An electromechanical system that stops or slows down the engine.

Function: To ensure that the lift remains stationary on a stopped floor and to hold the drive wheel securely in the event of a power failure or emergency.

Maintenance note: Periodically check the wear condition of the brake linings, the correct operation of the brake coil, the brake gap and the brake torque adjustment. A reliable brake is essential for the safety of the lift.

8. ELECTRICAL COMPONENTS OF LIFTING EQUIPMENT

Lifts contain many electrical components that control their movement and ensure safety. These components work in harmony to guarantee the smooth operation of the lift.

POWER SOURCE AND CONTROL CABINET

Definition: the main assembly that supplies mains power to the lift system and distributes it to all components.

Function: To provide a safe and continuous power supply to the lift. Includes main switches, fuses and safety devices.

Maintenance note: Periodically check the continuity of the main power connections, the condition of the fuses and the general cleanliness of the panel.

CABLES, CABLE TRAYS AND FITTINGS

Definition: Cables that carry electrical signals and power between the various lift components. Cables for individual lifts and hoists must be flexible and durable.

Function: To ensure reliable electrical communication and power transfer between all electrical and electronic components.

Maintenance note: Check that cables are not worn, damaged, crushed or cracked. Ensure that cable trays are tidy and open and that connections are tight and free from corrosion.

LIMIT SWITCHES, MAGNETIC SWITCHES

Definition: Switches to detect specific positions in the shaft and on the floors or to define safety levels for the lift.

Limit switches: Mechanical switches that interrupt the safety circuit to prevent the cab from exceeding predetermined highest or lowest points.

Magnetic sensors (counters/coders): These are used to detect floor level, transmit speed information and for precise levelling. The magnets are usually mounted on the trolley and the sensors are fixed in the glass.

Function: Control of the safe area of the lift, detection of the floor position and transmission of information to the control system.

Maintenance note: Check the physical condition of the switches, continuity of connections, adjustment range and correct triggering.

PHOTOCELL SENSORS, OPTICAL SENSORS AND LASER SCANNERS

Definition: Safety sensors mainly used in automatic doors to prevent passengers from being trapped when the door closes.

Photocell sensors: They emit a light beam and, when interrupted by an object, stop the door closing or cause it to open again.

Laser scanners (light curtains): More advanced systems that use multiple beams of light to scan a wider area, providing greater security.

Function: Ensure that the door reopens when passengers or obstacles are detected, thus preventing potential accidents.

Maintenance note: Check the cleanliness, position and correct response of the sensors. Today's lifts are increasingly using more advanced and reliable light curtain sensors.

INDUSTRIAL ETHERNET AND FIELDBUS-BASED COMMUNICATION PROTOCOLS:

Current approach: In modern lift systems, communication between the control panel and the cabin, floors and other equipment is often via faster and more reliable digital communication protocols (e.g. CANbus, Modbus, EtherCAT or proprietary protocols). This reduces wiring and simplifies fault diagnosis.

A note on maintenance: In such systems, the integrity of communication cables and connectors, the integrity of the signal and software settings are extremely important.

9. ELECTRICAL POWER UNITS

MOTOR CONTROL CARDS

Definition: electronic boards that manage the operating parameters of an elevator motor (acceleration, deceleration, speed, stop). They can work with frequency converters.

Function: To provide precise motor control to regulate the smooth and efficient movement of the lift.

Maintenance note: Check LED indicators on the board, error codes and tightness of connections. A software update may be required.

SAFETY CIRCUIT BOARDS

Definition: Special electronic boards that monitor the correct operation of all lift safety components (door interlocks, limit switches, safety gear switch, etc.) and stop the lift in the event of any safety violation.

Function: To ensure the safe operation of the lift in accordance with national and international standards.

Maintenance note: The operation of each safety circuit element (switches), the state of the contacts and the operation of the safety relays on the board must be tested regularly.

NEXT-GENERATION INTEGRATED CONTROL UNITS (PLC-BASED SYSTEMS):

Current approach: PLC (Programmable Logic Controller) based systems, which replace traditional relay-contact systems or operate integrated with microprocessor boards, offer greater flexibility, programmability and advanced diagnostic capabilities in lift control.

Function: Management of all lift movement algorithms, connection management, fault diagnostics and security protocols.

Maintenance note: These systems allow software updates, parameter adjustments and remote access for fault diagnosis.

10. POWER SUPPLY AND PROTECTION SYSTEMS FOR LIFTING EQUIPMENT

FUSES, THERMAL RELAYS, RESIDUAL CURRENT DEVICES (RCDS).

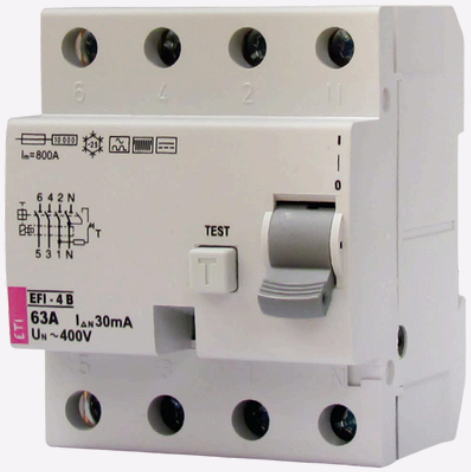
Fuses and circuit breakers: Passive and active protection elements that protect electrical circuits against overcurrents and short circuits.

Thermal relays: Thermal protective devices connected to the motor circuit that protect motors against overheating and overloading.

Residual current circuit breakers (RCCB/RCD): Protective devices that protect people from electric shock by detecting leakage currents and switching off the circuit.

Function: To protect the lift system and users from electrical faults, overloads and electric shock.

Maintenance note: The correct ratings of these safety components, their physical condition and their operation must be checked regularly using test buttons.



LIGHTNING AND SURGE PROTECTION SYSTEMS

Definition: Equipment that protects sensitive electronic equipment from sudden and high voltage fluctuations in the electrical grid (e.g. lightning strikes, grid failures).

Function: To prevent damage to expensive and sensitive lift components such as electronic control boards and motor drives.

Note on maintenance: Visual inspection and occasionally testing of these systems should be carried out. Damaged safety devices should be replaced.

SMART GRID INTEGRATIONS AND MICROGRID-SUPPORTED SYSTEMS:

Future prospects: Especially in large buildings, lifts can be integrated into intelligent energy management systems to optimise energy consumption or use local sources such as solar energy.

A note on maintenance: These systems may require more complex software and network management skills.

UPS (UNINTERRUPTIBLE POWER SUPPLY) AND EMERGENCY RESCUE SYSTEMS

Definition: Battery-powered systems that can continue lift operation for a specified period of time or bring the lift to the nearest floor and open its doors in the event of a power failure.

Function: To prevent passengers becoming trapped in the lift during a power failure and to ensure their safe evacuation.

Maintenance note: UPS battery status, charge level, system activation time and automatic rescue scenario functionality should be tested periodically.

11. CONTACTOR-RELAY CONTROL SYSTEMS

BASIC FUNCTIONS AND OPERATION OF CONTACTORS AND RELAYS

Definition: electromechanical switches used to control large currents or switch signal currents in electrical circuits.

Function: To control multiple electrical operations, such as starting/stopping the engine, controlling the door motor and activating the lighting.

Maintenance note: Check contactor and relay contacts for cleanliness, wear condition, coil operation and absence of mechanical jamming.

FAULT DIAGNOSIS METHODS

Diagnosing faults in classic systems is usually done by measuring voltage and current with a multimeter, checking contact continuity and systematically following the schematic diagram.

Visual (burnt cables, loose connections) and auditory (unusual sounds) checks are also important.

12. MICROPROCESSOR-BASED CONTROL SYSTEMS

SYSTEMS BASED ON PLCS (PROGRAMMABLE LOGIC CONTROLLERS)

Definition: Sophisticated electronic controllers that manage the entire logic of lift operation (call management, floor position, speed control, fault detection) via software.

Function: To process more complex algorithms, provide more precise control, facilitate fault diagnosis and offer remote access capabilities.

Note on maintenance: Software reliability, parameter settings and fault code interpretation are important in these systems.

LIFT CONTROL BOARDS AND SOFTWARE

Definition: The main control boards, which are the central brain of the lift, contain microprocessors, memory units and input/output (I/O) ports.

Functions: Processing floor calls, deciding which direction and floor the vehicle should travel, sending commands to the motor drive and monitoring all safety systems.

REMOTE ACCESS AND MONITORING MODULES

Definition: Hardware and software systems that transmit lift performance data, fault statuses and operational information remotely (via the Internet or GSM network) to the maintenance company's centre.

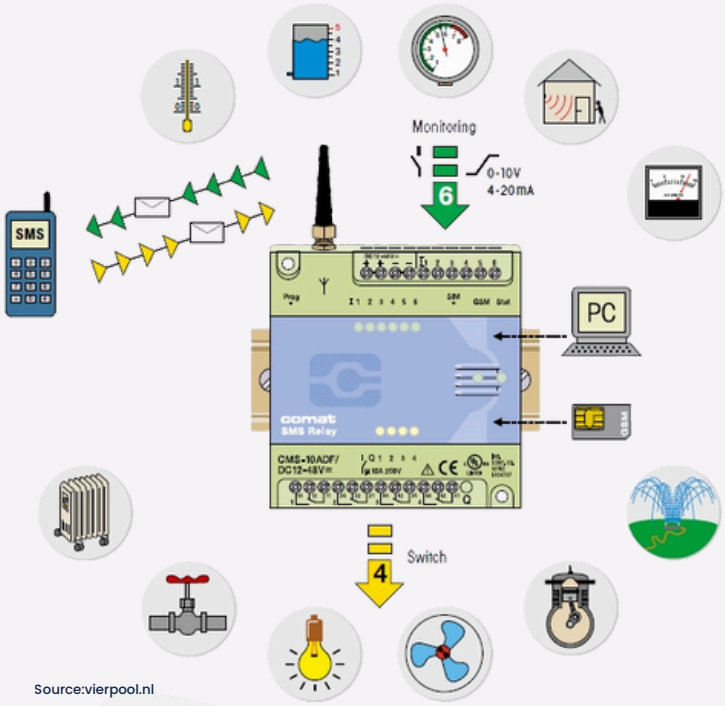
Function: Receive instant fault notifications, pre-assess the condition of the lift before periodic maintenance, perform software updates remotely and support predictive maintenance applications.

CLASSICAL CONTROL SCHEMES AND LOGIC STRUCTURES

Definition: In conventional lifts, the entire control logic (floor calls, cab movements, safety chain) is physically built through wiring between contactors and relays.

Function: To manage all operational stages and the safety chain of the lift using electrical logic.

Maintenance note: Fault diagnosis on these systems requires the ability to read schematics and knowledge of the function of each relay/contactor. Fault location is identified by circuit tracing and measurements.



Maintenance note: LED indicators on control boards, diagnostic displays (LCDs), test points and remote access ports are important tools for fault diagnosis. Software updates and parameter backups should be performed regularly.

Current approach (IoT-based control and management systems): By connecting lifts to "Internet of Things" (IoT) platforms, sensor data (Big Data) can be analysed using artificial intelligence algorithms to predict potential faults before they occur. This means proactive maintenance and less unplanned downtime

13. ELECTRICAL CIRCUITS FOR LIFTING EQUIPMENT

Main control circuits

Definition: Critical circuits where all lift safety components (door interlocks, limit switches, overspeed governor switch, buffer switch, emergency stop button, etc.) are open. If any of the components are open, this prevents the lift from operating.

Function: Programming and control of lift movements according to user commands.

Maintenance note: Faults in these circuits usually lead to irregular lift operation or inability to access certain floors.

Safety circuits

Definition: Circuits that manage the normal operating functions of a lift (starting, stopping, changing direction, floor selection).

Function: Ensures that all safety conditions are met for the lift to operate. Any violation of the safety conditions breaks the circuit and immediately stops the cabin.

Important: The safety circuit must never be bridged or bypassed. This creates a serious safety risk.

Current approach: In the new generation of lifts, the safety perimeter is further strengthened by "redundant" or "dual channel" systems that prevent a single fault from affecting the entire safety system.

Lighting and auxiliary circuits

Definition: Electrical circuits that are outside the main lift movement, such as cabin interior lighting, shaft lighting, engine room lighting, alarms and ventilation

Function: Providing comfort and safety in emergency situations.

Maintenance note: Check the operation of the light fittings, the functionality of the cabin fans and the condition of the emergency lighting batteries.

Reading electrical diagrams and troubleshooting:

Electrical circuit diagrams show the electrical structure of a lift using symbols and circuit diagrams. Following the schematic step by step, taking voltage and continuity measurements is an essential skill to find a fault.

Tip: Familiarising yourself with the meaning of the individual symbols on the diagram will greatly speed up the process of diagnosing faults.

14. ELECTRONIC CIRCUITS FOR LIFTING EQUIPMENT

DOOR CONTROL PANELS

Definition: Special electronic boards that manage the operation, speed, closing/opening control and safety sensors of automatic door motors.

Function: To ensure smooth, safe and correct opening and closing of doors.

Maintenance note: Check jumper settings, potentiometers, LED indicators and fault codes on the board.

COMMUNICATION PROTOCOLS (CANBUS, RS485, ETC.)

Definition: Special communication protocols enabling data exchange between the various electronic units of the lift (main control room, floor level board, cab board, drive).

Function: To provide fast and reliable transmission of digital data signals, reducing cabling.

Maintenance note: Check the integrity of the communication cables and connectors, signal integrity and the status of the communication LEDs. Communication errors can lead to many lift faults.

KEYPAD AND INDICATOR PANEL

Definition: Electronic boards that process the signals from the cab and access panel buttons and control the floor indicators.

Function: Detect user input (calls) and provide visual feedback (floor number, direction).

Maintenance note: Check the operation of the buttons, the backlighting of the LEDs, the readability of the displays and the tightness of the board connections.

ADVANCED TECHNOLOGIES AND SENSOR INTEGRATION:

Current approach: Advanced sensors such as vibration sensors, temperature sensors and accelerometers collect data about the lift's operation in real time. This data is used for predictive maintenance to detect faults before they occur.

Note: Data from these sensors can usually be read out via the interface on the control panel or a remote monitoring system.

Use: Trace the main safety circuit on the electrical diagram of the lift and identify which components are connected in series with this circuit. Then, using a multimeter, measure the voltage at the contacts of the components in question and check the integrity of the circuit (when taking measurements on the actual lift, always observe safety precautions and work under the supervision of a qualified expert).

15. THE INSTALLATION OF POWER, PROTECTION, CONTROL AND REGULATION SYSTEMS FOR LIFTING EQUIPMENT

The installation of all lift components is a meticulously planned and sequenced process. In particular, the installation of the electrical systems is crucial for the safe and functional operation of the lift.

CABLE ROUTING AND SECURE CONNECTIONS:

Definition: the process of laying all electrical cables (power, control, safety, communication) between the lift machine room, the shaft interior, the cabin and the stops.

Function: Ensuring the safe and continuous flow of energy and signals between all electrical and electronic components of the lift.

INSTALLATION STEPS:

- **CABLE TRAYS AND CONDUITS:**
  Appropriate sizes and types of cable ducts or trays are used for orderly and protected cable routing.
- **FLEXIBLE RUNNING CABLES:**
  The correct suspension of the special lift cables that move with the cabin in the shaft, ensuring freedom of movement.
- **FIXED CABLES:**
  Protection of the main power cables and control cables in the engine room, shaft and floors.
- **CLAMP CONNECTIONS:**
  Connecting all cable ends to the appropriate terminal blocks with correct polarity and tightness.
- **LABELLING:**
  Marking each cable and terminal according to the diagrams is crucial for future maintenance and fault diagnosis.

Safety note: Care must be taken not to damage the cables when routing them, avoiding sharp edges and excessive tension. All connections must be fully insulated.

POSITIONING OF PANELS AND ELECTRICAL CONNECTIONS:

Definition: The correct arrangement of electrical equipment, such as the main lift control panel, operating panel and motor drives, and their connection to the mains and other lift components.

Function: To provide a safe and accessible location for the central lift control unit and integration of the entire electrical system.

INSTALLATION STEPS:

- **LAYOUT PLAN:**
  Determination of panel installation locations (engine room, shaft interior, etc.) in accordance with manufacturer's instructions.
- **SECURING:**
  The panels must be securely fixed to the floor or wall to prevent vibration and the risk of falling.
- **GROUNDING:**
  Effective earthing of all metal parts and panels is the most basic safety requirement to eliminate the risk of electrocution.
- **POWER AND CONTROL CONNECTIONS:**
  Connect the main power supply, motor connections, brake connections, sensor and switch connections and cab and access panel connections according to the diagrams.

Tip: Particularly in modern systems, the wiring layout and labelling of panels ensures ease of quick intervention in the event of a fault. Industry leaders (Otis, Kone) use modular panels and plug-and-play connectors to reduce wiring complexity.

ADJUSTMENT OF SENSORS AND SWITCHES:

Definition: Installation and adjustment of all sensing elements such as limit switches, magnetic switches (floor sensors), photocell sensors and light curtains in the shaft and door at the correct distances and angles.

Function: To ensure precise detection of lift floor levels, correct definition of safety zones and safe operation of doors.

Adjustment principle: Each sensor or switch has a specific trip distance or position set by the manufacturer. Adjustments are made using precision measuring tools (measuring tape, laser positioning device) and sometimes using specialised calibration software. For example, photocell sensors in doors are checked to ensure that they are correctly positioned and able to detect obstacles within a certain distance. Limit switches are checked for safe detection of the highest and lowest vehicle stops.

Important: An incorrectly adjusted sensor or switch can lead to faulty operation of the lift, deterioration of stopping accuracy or safety risks.

AUTOMATION AND ROBOTIC SYSTEMS IN INSTALLATIONS:

Future prospects: major lift manufacturers are exploring robotics and automation technologies to speed up installation processes and reduce human error.

Note on maintenance: Although these systems can lead to faster initial installation, they may require specialised diagnostic hardware and software for troubleshooting.

16. TERMS AND CONDITIONS FOR THE INSTALLATION AND DISMANTLING OF LIFTING EQUIPMENT

Lift assembly and disassembly are high-risk activities. Health and safety (H&S) must therefore be prioritised and all operations carried out in a planned and disciplined manner.

WORK SAFETY PROCEDURES AND RISK ANALYSIS (ASSEMBLY AND DISMANTLING PHASES)

Definition: Before installation or dismantling begins, potential hazards are identified, assessed and measures are planned to minimise these risks. This must be done within the framework of the European Union directives on health and safety at work.

Basic safety steps:

Personal Protective Equipment (PPE): Full and correct use of all PPE is mandatory, from safety helmets to safety footwear, gloves and safety glasses. A safety harness is essential for working at height.

Lockout/Tagout (LOTO): Disconnect and lock out electrical power sources in the work area and attach warning tags such as 'Work in progress, do not operate!'. This prevents uncontrolled re-energising.

Workplace safety: Ensuring adequate safe distances in the hoisting shaft overhead and in the shaft, using handrails or barriers to prevent falls. Ensuring safety of working platforms at height.

Warning signs: Placement of warning signs "Construction site", "Elevator installation", "Danger" in prominent locations.

Training: Ensuring that all employees are fully trained and aware of the safety rules at work.

Remember: Any mistake made during lift installation and removal can have serious consequences, potentially costing lives. Safety must always be the highest priority.

Safe use of lifting equipment

Definition: Equipment such as cranes, hoists, lifts and pallet jacks used to lift, transport and position heavy lift components (motor, panel, rails, cab frame)

Principles of safe use:

Lifting capacity: ensure that the lifting capacity of the equipment used exceeds that of the load to be lifted.

Lashing points: Loads must be secured at the safe lifting points specified by the manufacturer.

Periodic inspections: ensure that lifting equipment is regularly inspected by authorised personnel and that its certificates are valid.

Communication: team members should maintain clear and continuous communication (hand signals, two-way radio) during lifting operations.

Tip: For confined spaces or areas with restricted access, specialised compact lifting solutions and robot assistants can be used.

CORRECT SEQUENCE AND STEP-BY-STEP APPLICATION OF THE PROCEDURE

Definition: Perform assembly and disassembly operations carefully, step by step, following the sequence specified by the manufacturer and engineering principles.

Example order of assembly (simplified):

1. PREPARATION AND CLEANING OF THE LIFT.
2. INSTALLATION AND ALIGNMENT OF RAILS.
3. PLACEMENT OF BUFFERS.
4. INSTALLATION OF MACHINE ROOM OR CORRIDOR MACHINE.
5. INSTALLATION OF ROPE AND COUNTERWEIGHT.
6. INSTALLATION OF CABIN FRAME AND CABIN.
7. INSTALLATION AND ADJUSTMENT OF BUS STOP DOORS.
8. INSTALLATION OF WIRING AND ELECTRICAL PANEL.
9. INSTALLATION AND ADJUSTMENT OF SAFETY COMPONENTS (OVERSPEED GOVERNOR, SAFETY FITTINGS).
10. INITIAL LAUNCH, TESTING AND COMMISSIONING.

Disassembly: the reverse sequence is usually followed, but security and structural integrity must be maintained at each stage.

Important: Using checklists at each stage ensures that no detail is overlooked.

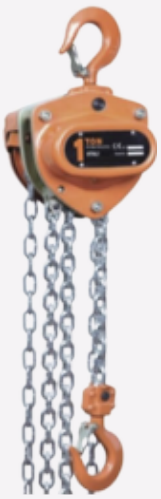
MODULE-BASED INSTALLATION TECHNIQUES AND QUICK INSTALLATION SOLUTIONS:

Current approach: The industry is increasingly using modularisation and pre-assembled units (e.g. pre-wired cabs or integrated machine units) to reduce lift installation time on site. This reduces installation errors and increases productivity.

Note on maintenance: Modular systems allow for faster intervention in the event of part replacement or failure, but may require more sophisticated diagnostic tools.

17. TOOLS AND MEASURING INSTRUMENTS FOR ASSEMBLING AND DISASSEMBLING THE LIFTING DEVICE

LIFTING AND CARRYING EQUIPMENT:



Crane: Large-scale lifting equipment used to move heavy loads vertically and horizontally.
Ceraskal (chain hoist): A compact manually or electrically operated lifting device used to raise and lower heavy loads.
Pallet truck/forklift: Vehicles used for horizontal transport of heavy equipment.
Special cabin trolley: For moving a platform or cabin frame.
Hand winch: For lifting and positioning heavy cab parts.
Slings: High strength synthetic rope, chain or straps used to secure the load to be lifted to a crane or hoist.
Rope/strap stands: Anti-tangle equipment that allows new ropes or straps to be safely unwound from pulleys.
Rope/strap grips/clamps: Gripping devices used to temporarily secure ropes/belts during assembly or pulling operations.
Lifting eyes/screws: Specially designed lifting points on equipment.
Pulling devices: Manual or motorised pulling devices used to pull ropes/belts through the system or to pre-tension.

MEASURING, ALIGNING AND TENSIONING INSTRUMENTS:

Plumb bob/laser alignment tool: For vertical alignment.
Tape measure: For checking rope/strap lengths, distances and clearances.
Shims: Thin sheets of metal that are placed underneath equipment for precise levelling or spacing adjustments.
Rope/belt tension meter: A special tool used to accurately measure the tension of each rope or belt and ensure that all load-bearing elements are evenly tensioned.

Tools for clamping and fixing:

Torque spanner: For tightening screw connections to a specific torque. Essential for applying the correct force to rope locks, belt clamps.
Spanner sets (open, ring, allen): For various nuts and bolts.
Cordless drill/driver: For drilling holes and tightening screws.
Rivet gun: For riveted joints (if required).
Rope cutters: Heavy-duty cutting tools designed to cleanly and carefully cut wire ropes.
Clamping strips/grip switches: Special spanners for the correct tightening of rope clamps.

Basic hand tools:

Spanners: Open end, ring, socket spanner sets (various sizes).
Screwdrivers: Flat, Phillips, torque screwdrivers, with different tips and sizes.
Pliers and side cutters: For stripping insulation, cutting and bending cables.
Hammer, chisel, axe: For some installation and fixing tasks.
Pliers/adjustable spanner: For joints of various sizes.
Measuring tape, spirit level, protractor: For measuring and alignment.
Cutting tools: Cable cutters, pipe cutters, etc.
Protective supports/clamps: For temporary protection of parts during assembly.
Drill: For drilling mounting holes.
Cleaners: For removing dirt or oil from pulley grooves and cable/belt surfaces (to increase supplication efficiency).
Insulation tape: For insulating electrical connections.

Electrical measuring instruments:

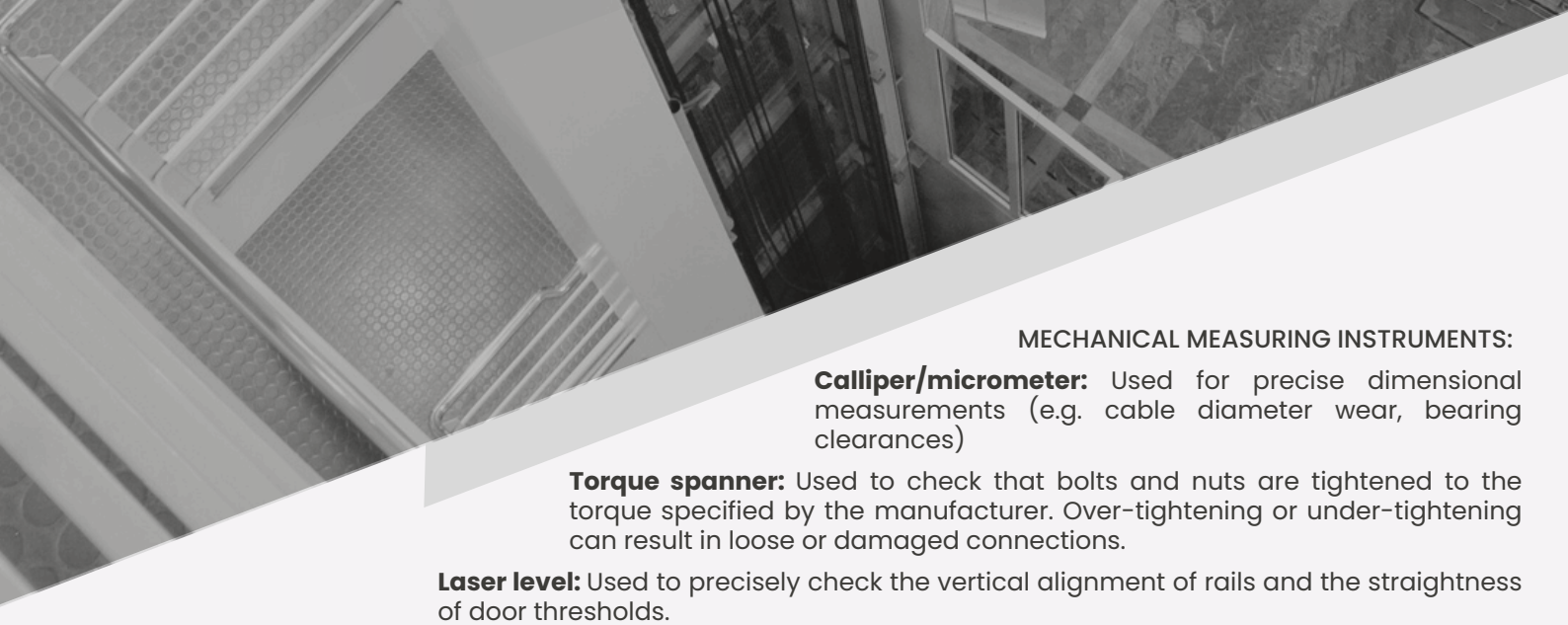
Multimeter: A basic electronic test instrument for measuring voltage (Volt), current (Ampere), resistance (Ohm) and continuity. It is the most commonly used tool for diagnosing faults in lift circuits.

Clamp meter: a safe and practical measuring tool that can measure current without breaking the circuit. It is used to check the current of a motor or an entire system.

Mega-meter (insulation resistance tester): Used to measure the insulation resistance of electrical cables and motor windings to detect discontinuities or insulation problems. This is extremely important, especially in damp or old installations.

Phase sequence relay/phase rotation tester: Used to check the phase sequence to ensure that three-phase electric motors rotate in the correct direction. An incorrect phase sequence can cause the motor to rotate backwards or damage the motor.

Voltage tester.



MECHANICAL MEASURING INSTRUMENTS:

Calliper/micrometer: Used for precise dimensional measurements (e.g. cable diameter wear, bearing clearances)

Torque spanner: Used to check that bolts and nuts are tightened to the torque specified by the manufacturer. Over-tightening or under-tightening can result in loose or damaged connections.

Laser level: Used to precisely check the vertical alignment of rails and the straightness of door thresholds.

Rope tension meter: Used to check the uniform tension of each rope in multi-rope lifts. Uneven tension accelerates rope wear and can damage the traction system.

SPECIAL TOOLS FOR LIFT INSTALLATION:

Rail alignment tools: Special clamps ensuring correct and smooth rail connection.

Rope tensioning devices: Tools that ensure that ropes are installed and adjusted with the correct tension.

Cabin/counterweight lifting equipment: Specialised equipment designed for the safe movement of lift components within the shaft.

Application: Identify basic hand tools and measuring instruments. Explain the purpose of each tool and the rules for its safe use. For example, practise performing a cable continuity test using a multimeter.

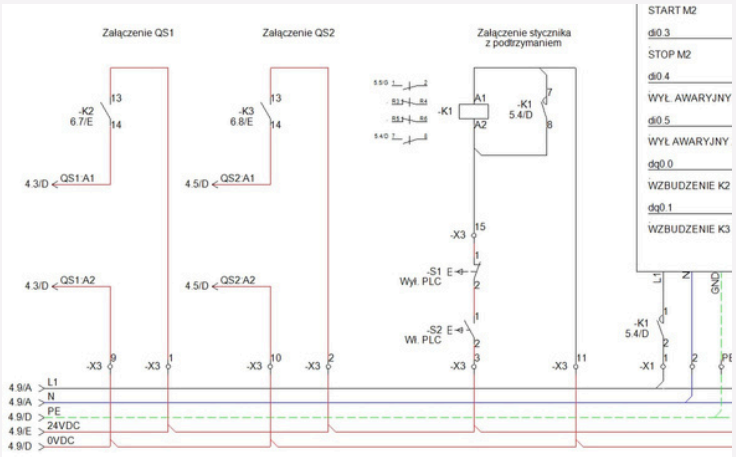
18. WORK WITH TECHNICAL DOCUMENTATION, ASSEMBLY INSTRUCTIONS AND OPERATING INSTRUCTIONS

ABILITY TO READ AND APPLY DIAGRAMS:

Definition: The ability to understand technical drawings, such as electrical circuit diagrams, mechanical assembly diagrams, and to apply this information to an actual lift.

Function: To provide guidance on fault diagnosis (which cable goes where, which component is faulty), installation (where to install which part) and maintenance (which point to lubricate).

Learning Tip: Find out what each symbol means, the cable numbering system and the logic of the circuit. Try to match the component on the schematic to its counterpart in the actual jack.



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STRICT COMPLIANCE WITH INSTALLATION INSTRUCTIONS

Definition: Strict adherence to the step-by-step instructions, measurements and safety warnings contained in the manufacturer's installation manuals.

Function: To ensure that the lift has been installed in accordance with the manufacturer's specifications and European safety standards, minimising potential errors and safety hazards.

Remember: The manufacturer's instructions reflect years of engineering experience and testing. Failure to follow these instructions compromises both the performance and safety of the lift and may void the warranty.

INITIAL LAUNCH AND COMMISSIONING PROCEDURES:

Definition: Once the installation of the cabin has been completed, the procedure involves connecting the electrical supply, performing safety tests, making parameter settings and putting the lift into operation for the first time.

CRITICAL STEPS:

CONTROL OF SAFETY CIRCUITS:

Ensuring that all safety switches (limit, safety, door interlocks) are working correctly and the circuit is closed.

MOTOR DIRECTION TESTS AND BRAKE:

Check that the motor is rotating in the correct direction and that the brake is working effectively.

FLOOR LEVELLING AND ADJUSTMENT:

Precise adjustment of the floor sensors and making sure the cab stops exactly at floor level.

OVERLOAD TEST:

Testing whether the lift operates safely with a load exceeding its nominal load capacity (specified percentage).

TEST OF THE OVERSPEED REGULATOR:

Testing that the over-speed regulator and safety gearbox activate if a certain speed is exceeded (carried out by authorised inspection bodies).

Important: The commissioning process must be carried out by authorised and experienced technicians, taking all precautions and in compliance with the relevant European regulations.

CREATION AND DELIVERY OF A USER MANUAL:

Definition: To prepare and present to building managers or users, simple and understandable instructions containing information on the correct and safe use of the lift.

Content: Basic lift operation, actions to be taken in emergency situations (alarm, communication), contact information for the maintenance company, initial steps to be taken in case of an emergency.

Tip: The operating instructions can help prevent unnecessary failures by guiding users to operate the lift correctly.

Consider: think about how a minor error during the installation or dismantling of a lift can lead to significant safety risks or costly failures in the future. Why is attention to detail so important in this area?

19. INSPECTION OF THE TECHNICAL CONDITION OF THE LIFTING EQUIPMENT

The first and most critical step in lift maintenance is to assess the overall condition of the system. This includes both a visual inspection and basic checks. The aim is to identify potential problems before they develop into major faults.

VISUAL INSPECTION AND DETECTION OF UNUSUAL NOISE/VIBRATION

Definition: A meticulous inspection of all visible lift components, from the engine room to the shaft, cab and stops, and an assessment of the noise/vibration generated during operation.

Usage:

Engine room/machine area in shaft: Cleanliness, oil leaks, unusual odours (burning), signs of overheating in electrical panel, loose cables.

Motor and gearbox: Engine fan operation, bearing noises (buzzing, grinding), vibration levels, overheating. Oil level and leaks in the gearbox.

Pulley and cables: Wear in pulley grooves, broken wires in cables, rust, wear or looseness. Correct seating of ropes in pulley grooves.

Braking system: Worn brake shoes, audible brake coil action, unusual noise when braking.
Rails: State of lubrication of the rails (in some traction systems lubrication takes place at specific points), wear, rust spots or bending. Tightness of rail fastening screws.
Doors: Smooth opening and closing of stop and cab doors, jamming of tracks or rollers, unusual noises such as creaking. Accumulation of dirt on door thresholds.

Cabin interior: Check lighting, ventilation, operation of buttons, indicators, alarm and emergency communication system.
Unusual sounds: Beeping, grinding, clicking, buzzing, knocking may indicate potential mechanical wear, play or bearing faults.
Vibration: Excessive vibration may indicate unbalance, motor faults, cable problems or rail alignment issues.

Tip: Visual and audible assessment can pick up early signs of many faults.

CHECK FOR WEAR, CORROSION AND DAMAGE (CABLES, RAILS, ROLLERS)

Ropes: Check the rope surface for visible broken wires, wear, rust, loss of brightness or reduced diameter. Even tensioning of the ropes is also important.

Rails: Check the surface of the rail for deep scratches, signs of wear, rust spots or play at the connection points.

Rollers/guides: check the guide rollers (sliders) on the cab and counterweight for wear, deterioration, play or flat spots on the wheels. Smooth rotation or sliding of these parts is important for shock-free movement.

General equipment: Check all metal components for corrosion, especially in lifts operating in humid environments. Look for structural damage (cracks, bends).

Important: Excessive wear or damage to parts has a direct impact on the safety and performance of the lift and may require urgent replacement.

CHECKING ELECTRICAL CONNECTION POINTS (USING A THERMAL IMAGING CAMERA)

Definition: Check all electrical connection points in electrical panels, motor terminals, drive connections and other areas for looseness or overheating.

Methods:
- **Visual inspection:** Looking for signs of burned, melted or discoloured cables.
- **Manual touch (careful and safe):** After disconnecting the system from the power supply, manually check connection points for loose components.
- **Thermal imaging camera:** used to detect overheating (hot spots) at connection points in live panels and motors. A loose or corroded connection increases electrical resistance, causing heat build-up. This creates a risk of fire and damage

Current approach (sensor data analysis for predictive maintenance): Modern lifts are equipped with various sensors such as vibration sensors, temperature sensors and current/voltage sensors. Data from these sensors is analysed using software in the control panel or cloud-based platforms (IoT) to predict when a component is likely to fail (e.g. motor bearing overheating, brake lining wear) before it actually fails. This aims to minimise unplanned downtime and optimise maintenance.

Note on maintenance: Predictive maintenance systems give technicians the ability to intervene proactively, but require the ability to correctly interpret data from these systems.

Use: On the lift you are working on, visually check the main connection points in the power panel. Check for any signs of overheating or burning. If you have access to a thermal imaging camera, observe the temperature distribution in the live panel and identify any abnormally hot spots.

20. Periodic inspection and technical testing of lifting equipment

Regular periodic inspections and technical tests are mandatory to ensure that lifts operate safely and in accordance with legal requirements.

MONTHLY, QUARTERLY AND ANNUAL MAINTENANCE CHECKLISTS

Definition: Standardised lists, defined by maintenance companies and manufacturers, of items that must be checked at specific intervals (monthly, quarterly, annually).

Function: To ensure that specific components are systematically checked during each maintenance visit, ensuring that no detail is missed and standardising the quality of maintenance.

EXAMPLE CONTENT:

- **Monthly maintenance:** Visual checks, lubrication point checks, functionality of door mechanisms, checks on vehicle interior lighting and alarms, emergency stop button test.
- **Quarterly inspections:** Cable tension check, brake lining wear check, shaft cleaning, shaft lighting, visual inspection of all (limit) switches.
- **Annual maintenance:** more comprehensive. Cleaning and lubrication of rails, leakage check of all electrical connections, general cleaning of motor and control panel, full load test, brake tests, safety gearbox test (with authorised inspection service).

Note: Different models and types of lifts may have different checklists. Always refer to the maintenance instructions provided by the manufacturer of the lift in question.

PERIODIC INSPECTIONS (AUTHORISED INSPECTION BODIES)

Definition: In EU Member States, every lift must be comprehensively inspected at least once a year by authorised inspection bodies (accredited organisations). This is supported by the Lift Directive 2014/33/EU and relevant national legislation.

Function: Independent assessment of the lift's compliance with relevant life safety standards and regulations and property.

Application: The inspection body subjects the mechanical, electrical, electronic and safety components of the lift to detailed tests (e.g. safety gear test, full load tests, tests).

Result: As a result of the inspection, the lift usually receives a coloured label or similar classification (Red: Dangerous, Yellow: Seriously damaged, Blue: Minor defects, Green: Safe/Compliant). Lifts with a red label are immediately taken out of service.

Important: It is the responsibility of the maintainer to rectify defects identified during these periodic inspections and to ensure that the lift achieves "safe" status (green label).

TESTS OF SAFETY COMPONENTS (SAFETY GEAR, BRAKE, LIMIT SWITCH)

Safety gearbox test: A test of the operation of the safety gear that stops the lift in the event of over-speeding or rope breakage. It is usually carried out on a loaded wagon under controlled conditions and only by authorised inspection bodies. This test is one of the most important safety tests of the lift.

Brake tests: Tests carried out to confirm that the traction machine's braking system can safely and accurately stop the lift and does not slip under load.

Limit switch tests: Checks that the limit switches (final limit switches) used to prevent the vehicle from crossing the highest and lowest floors are in the correct position and operational.

Note: These tests are extremely important to confirm the functionality of the lift's basic safety systems. The test procedures are detailed in the manufacturer's instructions and relevant standards.

CAB LEVELLING ACCURACY TESTS

Definition: Verification that the difference between the lift cab floor and the landing level (levelling accuracy) is within the specified tolerance limits when the cab stops at a given floor.

Function: To ensure that passengers can safely and smoothly enter and exit the lift without the risk of tripping. This accuracy is crucial, especially for the elderly, disabled and wheelchair users.

Maintenance note: The levelling accuracy is corrected by adjusting the motor drive or adjusting the magnetic switch.

REMOTE MONITORING AND DIAGNOSTIC SYSTEMS WITH AUTOMATIC REPORTING:

Current approach: Many modern lifts are equipped with sensors and communication modules that remotely transmit performance data and fault statuses to the maintenance company's centre.

Advantages: faults are detected immediately and in some cases can even be remedied remotely. Maintenance visits are scheduled more efficiently. Maintenance reports can be generated automatically.

Tip: These systems provide maintenance technicians with information about potential problems prior to a site visit, enabling them to provide the appropriate equipment and spare parts.

2.1 MAINTENANCE CHECKS ON LIFTING EQUIPMENT

LIFT MAINTENANCE IS NOT JUST ABOUT TECHNICAL PROCEDURES; RECORDING AND MANAGING THESE PROCEDURES IS ALSO KEY.

MAINTENANCE RECORD KEEPING AND REPORTING

Definition: Detailed record of all procedures performed during each maintenance visit (checks, lubrication, adjustments, replacement of parts, identified faults and their solutions).

Function:

- Meeting legal requirements.
- Tracking of lift history and identification of chronic problems.
- Planning future maintenance and estimating necessary spare parts.
- Serves as evidence in legal proceedings in the event of a potential accident.

Logging methods: Manual maintenance logs, digital maintenance applications, web-based maintenance management systems.

Tip: Detailed and regular record-keeping is one of the most important duties of a professional lift service technician.

SPARE PARTS MANAGEMENT AND STOCK CONTROL

Definition: Management of spare parts needed for maintenance and repair processes (contactors, relays, buttons, lamps, oil, fuses, etc.), ensuring sufficient stock availability and quick procurement of the right parts.

Function: Enabling rapid troubleshooting, preventing prolonged lift downtime and increasing operational efficiency.

Current approach: Some large companies are using artificial intelligence and data analytics to optimise their inventory management, predicting which parts are most likely to fail and adjusting their stock accordingly.

SERVICE QUALITY STANDARDS AND CUSTOMER SATISFACTION.

Definition: Providing service at a defined level of quality, communicating effectively with customers and managing customer complaints.

Function: Protect the reputation of the service company, increase customer loyalty and create new business opportunities.

Tip: Professional appearance, timely service, clear communication about faults and cleanliness after work have a direct impact on customer satisfaction.

BLOCKCHAIN-SUPPORTED SERVICE DOCUMENTATION AND SECURE DATA STORAGE:

Future prospects: next-generation data storage methods, such as blockchain technology, are currently being explored to ensure the security, transparency and immutability of service records. This provides a reliable database for audits.

Note on maintenance: While these technologies ensure data integrity, they also require consideration of authorised access and privacy issues.

22. Diagnosing and repairing the most common failures and defects

TYPICAL LIFT DEFECTS

Lift stalling (stopping): Safety circuit open, power supply interruption, main contactor fault, motor drive fault, control board fault.

Door faults: Door jamming, photocell/light curtain fault, door motor fault, door plate fault, door lock problem.

Inaccuracy of levelling: The cab does not stop exactly at floor level. Motor drive adjustment, magnetic switch adjustment, cable slip (traction).

Noisy operation: Wear/loosening of motor, brake, cables, guides or door mechanism.

Buttons not working: Button fault, faulty cable, button panel board fault, communication error with main control board.

Lighting problems: Inoperable cabin interior or shaft lighting lamps, ballast fault.

Emergency communication problem: Intercom or telephone line fault.

FAULT CODES AND THEIR MEANING

Definition: Modern lift control systems, in the event of a fault, display specific “fault codes” (error codes) on the control panel screen or via a diagnostic device.

Function: Quick identification of the source and nature of the fault. Each code represents a specific system fault or sensor fault.

Note: Each lift manufacturer has its own unique list of fault codes and a manual explaining the meaning of these codes. A good knowledge of these manuals will greatly increase the speed and accuracy of fault diagnosis.

USING BASIC TEST EQUIPMENT SUCH AS A MULTIMETER AND CLAMP METER

Multimeter: For measuring voltage (AC/DC), current (AC/DC), resistance and continuity to detect open circuits, short circuits, power shortages or component failures in electrical circuits.

Clamp meter: For measuring the current drawn by the lift motor or main power cables without breaking the circuit to detect overload or motor problems.

Thermal imaging camera: For identifying overheated areas in electrical panels, revealing loose connections or faulty components.

SYSTEMATIC FAULT DIAGNOSIS (OBSERVING, LISTENING, TESTING)

→ STEP 1: OBSERVATION AND INFORMATION GATHERING:

Obtain detailed information about the fault from the client or building manager. Ask when and how the fault occurred and whether there were any unusual conditions (noise, smell, vibration) beforehand. Visually check the condition of the faulty lift (where it stopped, whether the doors are open/closed, etc.).

→ STEP 2: SECURE THE LIFT:

Always switch off the main power supply and use the Lockout/Tagout (LOTO) procedure before interfering with the lift. Secure the work area.

→ STEP 3: FAULT DIAGNOSIS (SYSTEMATIC APPROACH):

Precise adjustment of the floor sensors and making sure the cab stops exactly at floor level.

- Check the fault code: if available, read the fault code on the control panel and find its meaning in the manufacturer's manual.
- Check the safety circuit: Identify the cause of the opening of the safety circuit (door lock, limit switch, emergency stop, etc.) Measure the voltage on the safety circuit with a multimeter.
- Check system components: Isolate and test the relevant component (motor, drive, control board, sensor, contactor) using the diagrams.
- Visual/hearing/thermal inspection: Re-check for abnormal conditions.
- Method of elimination: Confirm the source of the problem by testing the suspect part with another working part in the system or a replacement part (if possible and safe).

→ STEP 4: FAULT RECTIFICATION:

Replace the identified faulty part or make the necessary adjustment (e.g. tighten a loose connection, adjust alignment).

→ STEP 5: TEST AND LAUNCH:

Once the fault has been rectified, safely restart the lift and carry out functional tests (cabin movement, door opening/closing, emergency systems). Make sure that everything is working properly.

→ STEP 6: REPORTING:

Record in detail all procedures performed and the fault rectified in the maintenance log or digital system. Inform the customer.

CASE STUDIES AND PRACTICAL APPLICATIONS:

Example case: 'The lift has a levelling inaccuracy and the cab vibrates at the stop.'

Possible causes: Motor drive adjustment is faulty, magnetic switch adjustment is offset, cable tension is unbalanced, rail feet are worn, hydraulic valve adjustment is faulty.

Diagnostic steps: Check error code on the motor drive display, check position and operation of floor switches, measure cable tension, check footwear.

Solution: Carry out an appropriate adjustment or replace the part according to the identified problem.

Purpose recyklinguight recyklingu: Work on different fault scenarios, including including the exercise of identifying possible causes, planning diagnostic steps and discussing solutions.

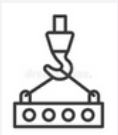
III. MECHANICAL ASSEMBLY OF LIFT EQUIPMENT

1. Health and safety rules during the assembly of the mechanical part of a lifting device

MECHANICAL ASSEMBLY PROCESSES AND ASSOCIATED RISKS

HEAVY LIFTING AND TRANSPORT OPERATIONS:

- **Hazards:** Serious situations such as **muscle injuries**, **crushing**, **falling** or **tipping over** can occur due to improper lifting techniques, use of inadequate or faulty lifting equipment, overloading and unbalanced loads.
- **Precautions: Before all lifting operations, prepare and implement a detailed lifting plan.** The lifting capacity of lifting equipment such as cranes, hoists, pallet trucks should always be checked and not exceeded.



Loads must be properly connected and balanced using suitable slings or securing devices. The lifting area must be clearly marked and unauthorised persons must not enter it. Appropriate personal protective equipment (PPE) must be worn during these operations, in particular **protective footwear with steel toes** and **impact-resistant gloves**. In situations involving teamwork, there must be clear and continuous **coordination and communication** between all team members.

ENTRAPMENT AND CRUSHING HAZARDS:

- **Hazards:** Entrapment of the hands or limbs of the body between moving lift parts (e.g. carriage, counterweight, rails), overturning of heavy components or overhanging during installation can result in serious injury.

- **Precautions:** The work area must always be tidy and secured. Before working on live or mobile systems, fully observe the **LOTO (Lockout/Tagout)** procedure and check that the power has been cut off. When securing components, use fixings, spacers and brackets correctly to prevent tipping or slipping. Avoid identified danger zones and moving parts.

RISK OF FALLING FROM HEIGHT:

- **Risks: Falls** during installation in the lift shaft, on high working platforms in the machine room or on stairs are one of the most serious risks during lift installation.

- **Precautions:** Safe, certified work platforms, scaffolding or ladders should be used. Appropriate fall protection systems (safety belts, lifelines, retractable fall protection devices) should always be used, and the attachment points and stability of these devices should be checked regularly. Shaft entrances, openings and edges of working platforms should be guarded by **handrails** or **barriers**. Workers must be trained and authorised to work at height.

SHARP EDGES AND PROJECTIONS:

- **Hazards: Cuts** and **scratches** may occur due to **sharp edges of lift rails**, **cabin panels**, **sheet metal** in engine room equipment or other mechanical parts.
- **Precautions: Thick work gloves** and other appropriate **personal protective equipment** (e.g. long-sleeved clothing) should be used **at all times**. Clutter in the work area should be avoided, sharp edges should be visible or appropriate protective coatings should be used.

ELECTRICAL HAZARDS:

- **Hazards:** There is a risk of **electric shock** due to incorrect or uninsulated electrical connections, damaged cables or unauthorised intervention.
- **Precautions:** Before interfering with or connecting any electrical components, ensure that the main power supply is disconnected and **LOTO** procedure is followed. Electrical work should only be carried out by authorised, trained and certified electricians or technicians qualified in this field. **Insulated hand tools** should be used and all open electrical connections should be properly insulated to prevent short circuits.

2. Evaluation of conformity of the installation site with the technical documentation

2.1. Importance and scope of technical documentation

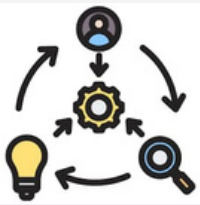
The technical documentation includes all written and drawing information used throughout the lifetime of the lifting system. Proper management and tracking of these documents is essential for the following reasons:

- **Safety:** Proper installation must comply with national and international safety standards (e.g. EN 81 series)**.**
- **Quality:** Ensures that manufacturer specifications and performance expectations are met.
- **Legal compliance:** Confirms full compliance with relevant laws and regulations.
- **Troubleshooting and maintenance:** Greatly facilitates future maintenance, repair and troubleshooting.
- **Efficiency:** Saves time and costs by reducing installation errors and the need for rework.

2.2 Main types of technical documentation:

- **Assembly drawings:** These are detailed technical drawings that show how the elevator components will be assembled, their positions, dimensions and connection details.
- **Electrical diagrams:** These are diagrams showing the elevator's electrical circuits, component connections, wiring routes and current flow.
- **Operating instructions:** These are written instructions describing step-by-step procedures for assembly, testing, commissioning, operation and maintenance.
- **Performance specifications:** These are documents that define the performance criteria of the lift, such as expected speed, lifting capacity and stop sensitivity.
- **Safety Data Sheets (SDS):** These are documents containing safety information on the chemicals used (e.g. lubricants, cleaners).
- **Version control records:** These are records that track different versions of documents and document the changes made.

2.3 Compliance and control of field investigations with documentation



The following principles should be applied to ensure that the fieldwork fully complies with the technical documentation:

1. Understand and recognise the documents: All relevant technical documents must be carefully studied, read and fully understood before installation. Observe the cross-references between the documents and understand the overall functioning of the system. Always use the most up-to-date versions and avoid working with old or invalid documents.

2. Document comparison with the object (as-built inspection): During and after installation, verify that each component, measurement or connection made exactly corresponds to the technical drawings and specifications. In particular, confirm that critical points such as **shaft dimensions, rail clearances, power connections, drilling equipment layouts and end switch levels** conform to the drawings. In the event of any deviation (e.g. an unexpected obstacle on site or the need to change the design), the project manager or engineer should be contacted immediately and an approved solution developed. It is imperative to avoid making changes on your own.

3 Change management and as-built documentation: any changes that occur on site and become mandatory must be approved by the engineering team and meticulously processed into **as-built drawings**. Accurate documentation of these changes is essential for future service, maintenance, repair and formal inspection processes. All updates must be recorded in the relevant version control records.

4. Quality control and test procedures: All tests (e.g. electrical tests, braking tests, load tests) and quality control (QC) procedures specified in the technical documentation must be fully implemented. Test results and checklists must be completed and documented accurately and completely. This documentation confirms the performance and safety of the crane.

3. Installation of mechanical elements of the shaft equipment

3.1 Basic shaft equipment

- Lift rails
- Rail brackets
- Buffers
- Shaft limit switches
- Shaft lighting

3.2 Principles of installation and use of shaft equipment

1. Preparation and cleaning of the shaft: The shaft must be cleaned before installation begins. Adequate lighting and ventilation must be provided inside the shaft. Throughout the installation process, the riser must be accurately and precisely installed and maintained as the primary reference point for vertical rail alignment. Entrances and exits to the shaft must follow established safe procedures,
and entrances to the shaft must always be protected by barriers or covers.

2. Installation of the rail brackets: the locations of the rail brackets are marked on the shaft wall according to with the distances and positions specified on the technical drawings. Anchor holes are drilled at the marked points and the brackets are securely fastened to the shaft wall using suitable anchoring elements (dowels, bolts). Ensure that all screw connections are tightened in accordance with the specified torque values.

3. Installation and alignment of the lift rails: The lift rails, as they are heavy components, must be carefully lowered into the shaft according to the appropriate lifting equipment (crane, hoist) and lifting plan. The rails are attached to the consoles and precisely aligned vertically according to the plumb lines. Ensure that each rail is in the correct vertical position and within the rail tolerances specified on the technical drawings. The rail joints (connecting plates) must be fitted correctly and the connecting bolts must be tightened to the specified torque. Check that the rail surfaces are clean, undamaged and smooth.

4. Mounting of buffers: The cabin buffers and counterweights that settle to the bottom of the shaft must be securely fastened according to their position on the technical drawings. Confirm that the base of the bumpers is stable, flat and at the correct level.

5. Installation of shaft end switches: The upper and lower shaft end switches (limit switches) are accurately installed at the levels specified on the technical drawings. It is necessary to check that the switches are working properly and that they interact correctly with the mechanical activators (cam) on the carriage or counterweight.

4. Installation of mechanical equipment in the engine room

4.1. BASIC EQUIPMENT OF THE ENGINE ROOM

- Drive unit
- Control panel
- Main disconnector
- Speed controller
- Brake mechanism
- Safety circuit components

4.2 PRINCIPLES OF INSTALLATION AND USE OF ENGINE ROOM EQUIPMENT

1. Preparation of the engine room: Before installation, the engine room must be cleaned, dry and adequately lit. In order to reduce the transmission of noise and vibration, it is important to provide suitable floor insulation materials (e.g. vibration isolators).

2. Positioning and levelling the drive unit: The drive unit is one of the heaviest components of the crane. Precise levelling should be done using adjustable feet or shims. Ensure that the alignment of the pulley and cables in the shaft is correct. Misalignment can lead to rope wear, vibration and energy loss. Use torque spanners to ensure that the connecting bolts are tightened to the correct torque.

3. Installation of the control cabinet (control panel): The control panel must be securely fixed in the location specified on the technical drawings (usually on the wall or floor). Suitable anchoring elements must be used to prevent the panel from falling or tipping over (e.g. chemical pins, steel pins). Sufficient space and access to electrical connections must be provided. The internal components of the panel must be protected from dust and moisture. The vertical and horizontal alignment of the panel is checked using plumbing or laser tools.

4. Installation of the main disconnector: The main disconnect switch must be installed in an easily accessible and clearly marked location. This switch is used to cut off the power supply to the entire system in emergency situations or during maintenance. It must be ensured that the capacity of the switch corresponds to the power requirements of the lift. Insulated screwdriver sets and voltage testers are used during installation.

5. Installation of the speed controller: The speed governor must be securely installed in the location specified in the technical drawings (usually on the engine room floor or on a special plinth). Ensure that the regulator rope passes correctly through the pulleys and is sufficiently tensioned. The friction surfaces of the rope must be clean. Test switches must be easily accessible and securely fitted. Basic measuring instruments such as a spirit level and a meter are used during installation.

6. Check and adjust the brake mechanisms: Check that the brakes integrated into the drive unit are working properly. The condition of the brake pads and the clearances between the pads must be precisely adjusted in accordance with the technical specifications. Ensure that the brake release and clutch mechanisms operate smoothly. These adjustments may require special spanners and precision measuring instruments.

7. Connection of safety circuit components: All safety circuit wiring to the control panel (e.g. door interlock switches, limit switches, buffer switches) must be connected to the appropriate terminal blocks. Ensure that each connection is tight and secure and carefully follow the wiring diagrams. Electrical test instruments, such as multimeters or voltage detectors, must verify that each component in the safety circuit has the correct polarity (if any) and functionality. Verify that cables are routed in cable channels in an orderly manner and that there is no risk of pinching.

8. Cable routing and termination: All electrical cables (power, control, signal) must be routed neatly in suitable cable ducts or pipes. This is important for both safety and tidiness reasons. All connections to terminal strips must be correctly labelled and insulated. It must be ensured that the cables do not pass through sharp edges and are not subjected to mechanical damage. At this stage, cable stripping pliers, cable crimping pliers and insulating tape are used.

5. INSTALLATION OF CABIN COMPONENTS

5.1 BASIC CABIN COMPONENTS

- Cabin frame
- Cabin floor
- Cab walls and roof
- Cabin door
- Door mechanism
- Cabin top control panel
- Cabin control panel
- Communication systems
- Lighting and ventilation

Source :muratorplus.pl

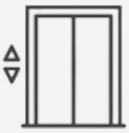
5.2 PRINCIPLES OF CABIN ASSEMBLY

Cabin frame assembly: The lower beam (Safety Plank) and the upper beam (Crosshead) of the cabin frame are assembled according to the technical drawings. These parts are usually moved from above or below in the shaft to the correct position. Safety components, such as the parachute system and guide rollers, must be correctly attached to the frame and adjusted. Ensure that the frame is upright and correctly aligned. All bolted connections must be tightened to the specified torque . Use lifting equipment (e.g. ceraskal, special cabin jacks), plumbing or laser tools and torque spanners during assembly.

2 Cabin floor placement: The cabin floor platform is placed on the lower beams of the cabin frame. The level and strength of the platform must be checked. The necessary vibration isolators or pads must be correctly placed to ensure vibration isolation. The platform must be securely fastened to the frame. A spirit level and shims are used for precise levelling at this stage.

3. Installation of the cabinet walls and roof: The cabinet wall panels and ceiling are installed sequentially according to the manufacturer's instructions. Ensure that the panels fit tightly to each other and to the frame. Ceiling components, such as the cabin lighting and fan, are installed and preparations for electrical connections are completed. Basic hand tools such as drills, various sets of spanners and wire stripping/clamping pliers are used at this stage.

4. Cabin door and door mechanism installation: The door drive and door rails are mounted on top of the vehicle frame. The door panels are hung on the rails and correctly adjusted. Ensure that the doors move freely and quietly. The door drive motor and control unit are connected. Safety devices such as door stops and safety edges must be installed and their operation checked. Screwdrivers, spanner sets and electrical testers are used at this stage.



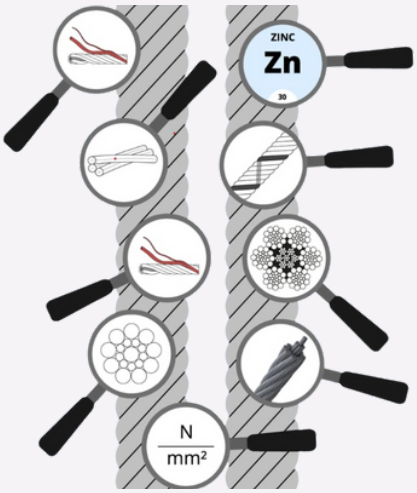
5. Installation of the cab top control panel: the cab roof control panel is fixed to the roof of the vehicle in an easily accessible location. The electrical connections (control signals, safety circuit) of this panel are made. Components such as the emergency stop button, the inspection switch and the socket are checked for correct operation.

6. Installation of the control panel in the cab (COP): The COP is mounted on the cab wall at an ergonomic height and in the position specified in the technical drawings. Ensure that call buttons, floor indicators and other interface components are correctly connected. Emergency call button and intercom systems are connected and tested.

7. Cabin lighting and ventilation: cabin light fittings and fans are mounted on the ceiling panel. Electrical connections are made and their correct operation is checked.

8. Installation of other interior equipment: Other interior accessories such as mirrors, handrails and decorative panels are installed. Make sure these items are firmly and securely attached. The floor covering inside the cabin is laid.

6. INSTALLATION OF CRANE CABLES AND STRAPS



6.1 TYPES OF LOAD-BEARING ELEMENTS

Wire ropes: These are flexible steel cables, usually multi-stranded, with high tensile strength, carrying the lift cab and counterweight. They are used in conventional systems.

Flat belts: These are thinner, flexible and high-strength synthetic or steel-reinforced composite belts that are used instead of steel cables, especially in some modern gearless systems (MRL).

6.2 PRINCIPLES AND APPLICATIONS OF ROPE AND WEBBING INSTALLATION

1. rope/strap selection and inspection: Check the accuracy of the rope or belt type and diameter according to the project specifications before installation. Careful visual inspection should be made for any damage such as cuts, crushing, corrosion, warping or fraying. Damaged materials should never be used.

2. Retraction: the ropes or belts must be carefully lowered into the shaft via the **drive wheel** in the engine room and the deflection pulleys, **if present**. This process must be carried out in a controlled manner, taking care that the ropes do not bend or knot. The method of transmission varies depending on the lift drive system (e.g. 2:1, 1:1) and shaft layout; the relevant technical drawings must be carefully followed. Racks and rope/strap couplers are used in this process.

3. Making rope/strap connections: Ropes or straps must be securely fastened to the cab frame and counterweight frame using the methods specified on the technical drawings. If rope locks (rope grips/clips) or special belt fasteners are used, they must be installed in the correct number and spacing according to the manufacturer's instructions, ensuring that all connections are sufficiently tight and secure.

4. Tensioning and even distribution: After installing the lift system, check that all ropes or belts are evenly tensioned. Uneven tension can lead to different rope wear, vibration and uneven ride. Using special tension measuring tools, the tension of each rope should be precisely adjusted according to the technical specifications. This adjustment is usually made using spring mechanisms or special tensioning screws under the ropes.

5. Final safety checks: A final visual inspection should be carried out to ensure that all ropes are properly seated in the pulley grooves and show no signs of damage or wear. A full range of motion should also be checked to ensure that the ropes are not caught or rubbing against any obstructions in the shaft.

IV. ELECTRICAL INSTALLATION OF LIFT EQUIPMENT

1. Health and safety rules during the assembly of electrical components

When installing electrical equipment, it is important to observe health and safety rules, such as disconnecting the power supply before work, using appropriate tools and personal protective equipment checking the installation for damage, and following the operating instructions and the **LOTO** principle.

Basic health and safety principles in the installation of electrical equipment:

1. Unplugging and disconnecting electricity: Before working on electrical equipment, completely disconnect it from the power supply and check that no voltage is present.

2. Use of appropriate tools and equipment: Use tools suitable for electrical work, such as insulated tools, and appropriate personal protective equipment, e.g. gloves, safety shoes, safety goggles.

3. Securing the work site: The work site should be adequately secured and any openings (e.g. in the floor, walls) should be fenced off or marked.

4. Checking the installation: Check the condition of the electrical installation, including wires, plugs and sockets for damage.

5. Operating instructions: The operating instructions and technical documentation for the equipment to be installed must be carefully observed.

6. Personal protective equipment (PPE): Appropriate PPE should be used, such as insulating gloves, safety shoes, safety goggles, and appropriate work attire.

7. Protection against accidental energisation: When the power supply is disconnected, the work site must be protected against accidental energisation, e.g. by lockout/tagout procedures.

8. Work at height: When carrying out work at height, stable ladders or hoists must be used and suitable fall protection must be provided.

9. Communication: Workplaces should be properly signposted, adequate lighting should be provided, and adequate communication between workers should be ensured.

10. Rules for working in confined spaces: Working on electrical equipment in confined spaces requires that adequate ventilation is provided and that an adequate temperature is maintained.

11. Fire prevention: Fire prevention rules should be observed, such as not using damaged cables, not overloading sockets, not using electrical appliances near flammable materials.

Additional guidance:

- **Working in dry conditions:** Avoid working on electrical equipment in damp conditions.
- **Physical fitness:** Workers should be in good physical condition to carry out the work safely.
- **Noticing irregularities:** Note any irregularities in the operation of electrical equipment and report them to your supervisor.
- **Earthing:** Ensure that electrical equipment is properly earthed.
- **Fall protection:** Appropriate fall protection, such as safety nets or safety belts, should be used when working at height.
- **Childproofing the installation:** The electrical installation must be childproof.

2. Analysis of the wiring diagrams for connecting the lifting equipment

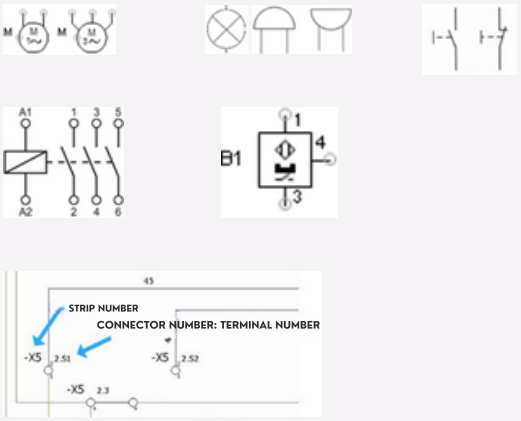
The hoist's electrical diagram is a piece of documentation that is necessary both during the installation (assembly) of the equipment and during its operation. It should be kept in the machine room or, for lifts without a machine room, in **the control cabinet or on the car.**

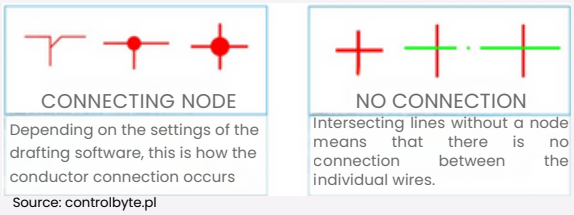
It is an essential document for analysing and rectifying faults and failures of the equipment occurring during operation.

In addition, in microprocessor controls, wiring diagrams are often accompanied by lists of installation parameters and lists of assignments or addresses of individual inputs/outputs of peripheral components.
Analysing the wiring diagram of a lift equipment connection is the process of identifying and understanding all the electrical components and connections that are necessary for its proper functioning. This diagram includes connections, controls, motors, and other electrical equipment.

2.1. Diagram elements:

- **Motor:** The component responsible for the movement of the crane.
- **Contactors:** Components that control the motor, turning it on and off.
- **Relays:** Elements that are used to control contactors and other devices.
- **Signalling:** Elements that indicate the status of the lift (e.g. direction of movement, open door).
- **Safety components:** Elements that protect the lift from failures.
- **Sensors:** Elements that monitor the condition of the crane (e.g. level sensors, doors).
- **Control elements:** Elements that allow the operator to control the crane.





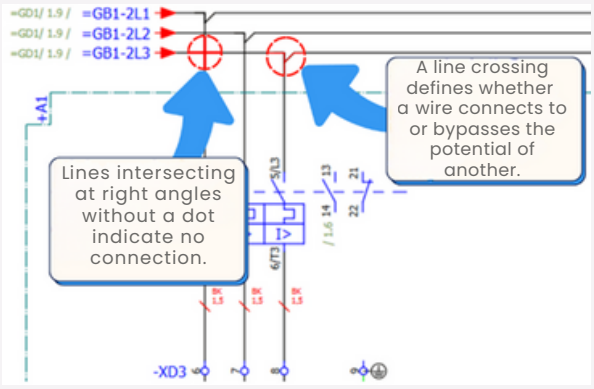
Source: controlbyte.pl

2.2 .Types of schemes:

- **Single-period diagrams:** Usually represent the main current flow.
- **Assembly diagrams:** Detail the location and connections of individual components.
- **Block diagrams**: Represent the system as a whole, with the main components and their interactions.
- **Idea diagrams:** Usually used for design, they contain symbolic elements.

2.3. Scheme analysis:

- **Identification of elements:** Find and identify all elements of the diagram.
- **Understanding connections:** Understand how the elements are connected to each other.
- **Analyse operation:** Understand how the different elements work together to control the crane.
- **Identify control points:** Find and identify all the control points that are used to monitor the performance of the crane.
- **Identify safety points:** Find and identify all safety points that protect the crane from failures.



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2.4. Supporting tools:

- **Diagram:** This can be found in the crane's technical documentation or on the manufacturer's website.
- **Documentation:** Additional material describing the operation of the scheme and its components.
- **Understanding the principles of operation:** Knowledge of the operating principles of the electrical components is key to understanding the schematic.

Remember. It is worth remembering that a thorough analysis of the diagram and documentation facilitates the assembly and commissioning of the crane, planning and carrying out inspections and maintenance, and is essential when upgrading the crane.

Important!: The diagram analysis must be carried out taking into account the specifics of the crane model in question and its technical documentation.

2.5 Typical errors in diagram analysis:

- Failure to include all safety circuits.
- Incorrect connection of limit switches (e.g. not breaking the circuit when reaching the final position).
- Lack of feedback from sensors.
- Omission of motor protection (thermals, overloads).

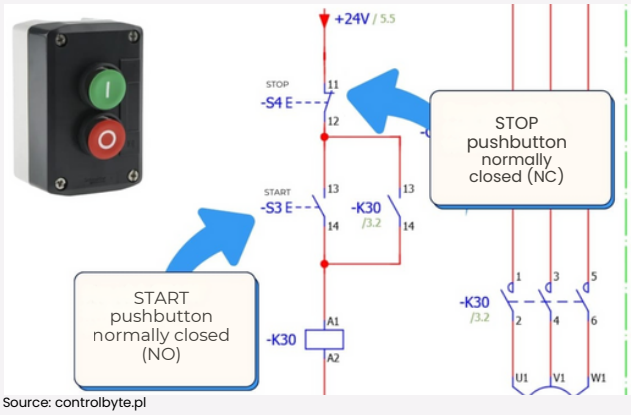
2.6. What to look for when analysing a scheme:

1. WILL THE UNIT STOP IN THE EVENT OF DOOR OPENING OR OVERLOAD?
2. ARE ALL DIRECTIONS OF MOVEMENT PROTECTED BY LIMIT SWITCHES?
3. DO THE CONTACTORS HAVE MUTUAL ELECTRICAL/MECHANICAL INTERLOCKING (E.G. UP-DOWN)?
4. DOES A POWER FAILURE AUTOMATICALLY STOP THE UNIT?
5. DOES THE SCHEME INCLUDE A PHASE SEQUENCE CONTROL RELAY?

Use: Check the correct operation of the lift after assembling the main and safety circuit wiring diagram by following the simplified logic diagram:

1. START! Press upward travel button:
- Checking the conditions (door closed, no overload, curbside inactive).
- Activation of the upward travel motor contactor.
- Brake applied.
- Lift movement.

2. STOP! Stop:
- Limit switch activation or release.
- Disengagement of the contactor.
- Brake activates.
- Stopping the lift.



Source: controlbyte.pl

3. Installation of power supply and protection systems for lifting equipment

The power supply from the local power grid in the building is fed to the main switch, which is located in the lift machine room, and in lifts without a machine room in the control panel, usually located next to the shaft door of the top landing. It is assumed that the main switch is the first component of the lift's electrical installation. In the past, short-circuit protection in the form of fuses and overload protection in the form of a thermal breaker and a line contactor were installed directly behind the main switch. Limit switch contacts were also placed in the power circuit of the line contactor coil.
The main circuit breakers used today are so-called compact circuit breakers, incorporating short-circuit and overload protection.

The power circuits provide electricity to drive and control the hoisting mechanisms.

3.1 Main components of the power system:

- **Main power source –** 3-phase power line 400V/50Hz.
- **Additional power source**

- independent single-phase line 230V
- one for the cabin lighting and signalling circuit,
- the other for the shaft lighting circuit.

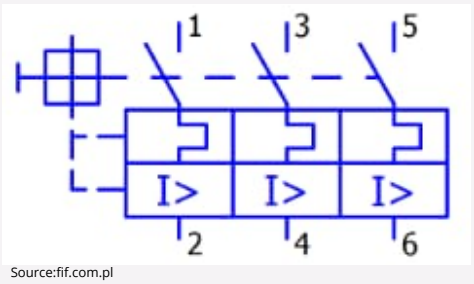
- **Switchboard –** contains safety and switching apparatus.
- **Power cables –** suitably sized for the load and length of the route.
- **Transformer –** if low voltage supply or galvanic separation is required.
- **Inverters/soft starters –** for infinitely variable speed control of motors.

3.2 Security systems

Safeguards are designed to protect people, equipment and installations from the effects of short circuits, overloads or faults.

TYPICAL SAFETY FEATURES:

- Overcurrent circuit breakers - protect against overload and short circuit.
- Residual current circuit breakers - protects against electric shock.
- Phase control system - protects against phase sequence/direction change.
- Thermal relays - protect motors from overheating.
- Safety controller(PLC Safety) - often used in modern systems.
- Position sensors and limit switches - prevent exceeding movement ranges.
- Electromagnetic brake - safety in the event of power failure
- Safety contacts - e.g. in lift cabin doors.



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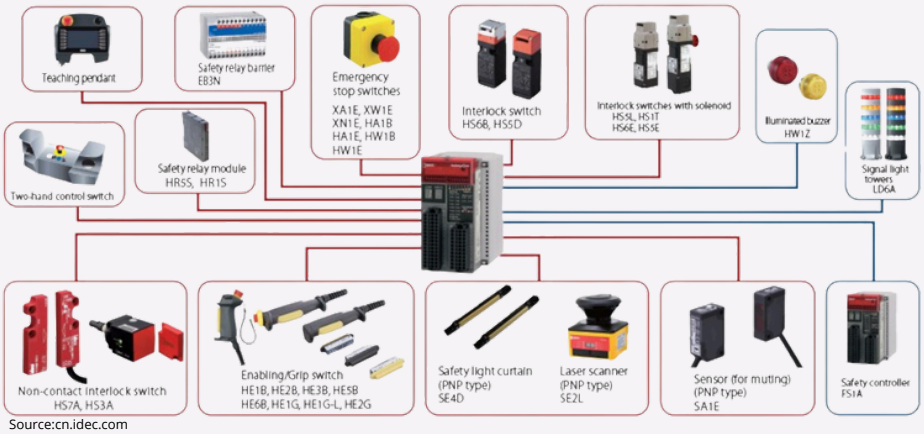


Source:cn.idec.com

3.3. Installation of power and protection systems in lifting equipment

The installation of power and protection systems in lifting equipment is a key step in ensuring its safe and reliable operation. The following is a general description of this process:

1. Preparation for installation

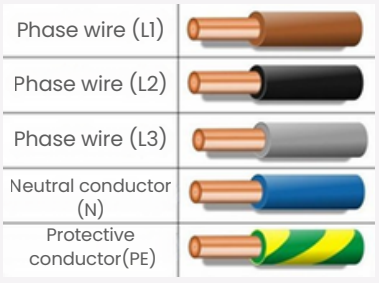
- **Analysis of technical documentation:** Familiarisation with electrical diagrams, power plan, manufacturer's requirements.
- **Selection of appropriate components:** Conductors, circuit breakers, fuses, contactors, relays, power supplies, residual current protection, surge arresters.
- **Assessment of local conditions:** Inspection of the installation site (e.g. engine room, lift shafts, distribution rooms).

2. Installation of power supply systems

- **Installation of supply lines:**
  - Laying of cables in accordance with standards (PN-HD 60364).
  - Construction of cable routes, routing of cables in trays, pipes or conduits.
- **Connection of crane drive (e.g. inverter):**
  - Connection of power supply to motor, braking system, control.
- **Connection of the power distribution board:**
  - Installation of main power switch.
  - Installation of overcurrent and residual current circuit breakers and overvoltage protection.

3. Installation of security systems

- **Electrical protections:**
  - Overload and short-circuit protection.
  - Residual current protection (against electric shock).
  - Overvoltage protection.
- **Mechanical and functional safety features:**
  - Limit switches (top and bottom).
  - Safety switches in shaft and cab doors.
  - Speed and position control systems (e.g. encoders, sensors).
  - Emergency power or rescue systems.
- **Emergency stop systems:**
  - Safety mushrooms, overload sensors, braking devices.
- **Power supply for auxiliary equipment:**
  - Cabin lighting, sensors, ventilation, alarm systems.



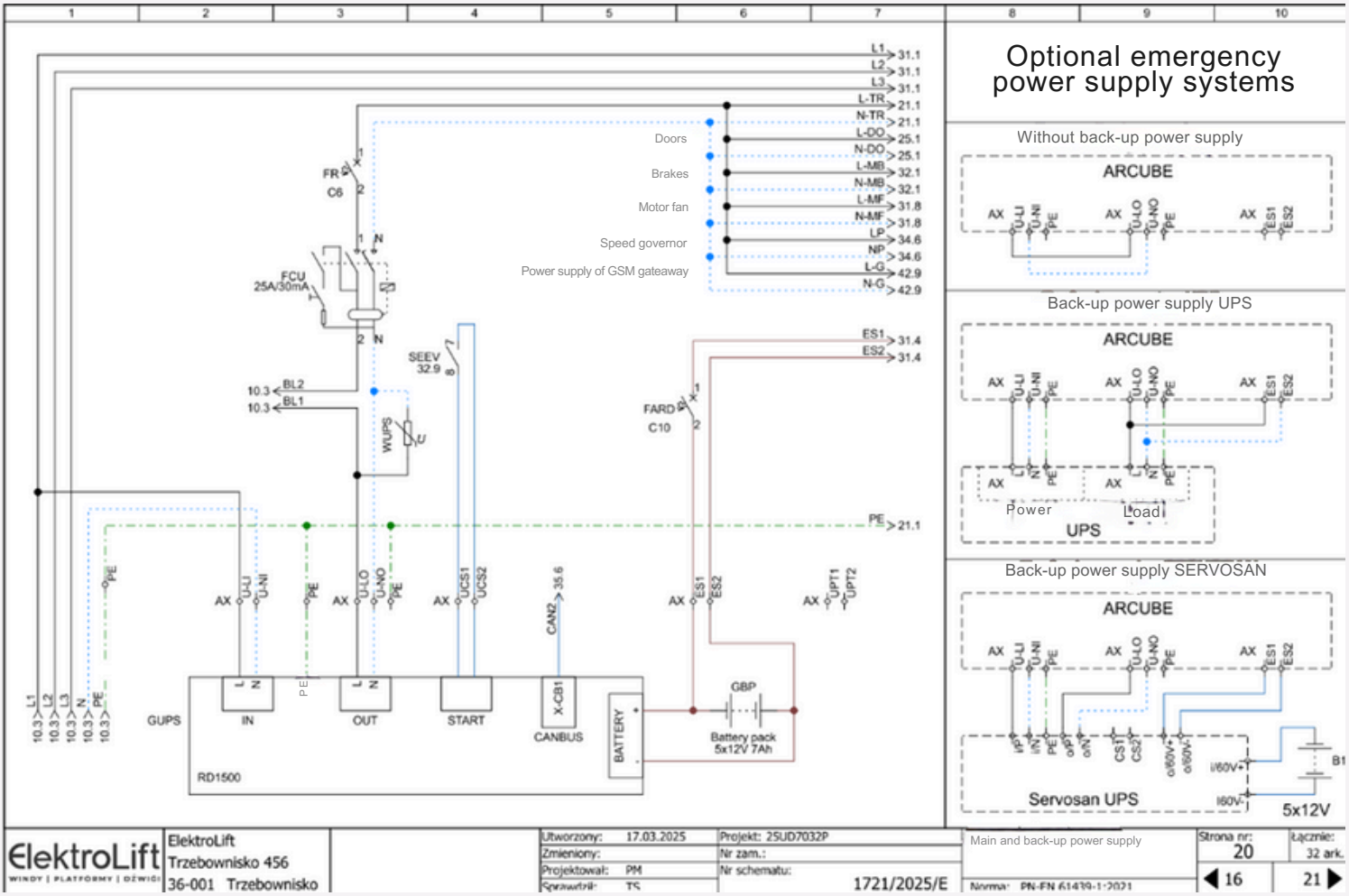
4. Testing and commissioning

- Functional tests of power supply and protection systems.
- Checking the continuity of protective conductors and insulation resistance.
- Functional tests of all protections.
- Trial commissioning with and without load.
- Preparation of measurement and acceptance protocols.

NOTE: WHEN CARRYING OUT A WIRE CONTINUITY CHECK WITH A UNIVERSAL METER, SWITCH OFF THE POWER SOURCES.

NOTE: CARRY OUT CONTROL TESTS ON ALL SECURITY FEATURES, WITHOUT OMITTING ANY.

Use: According to the diagram, perform a continuity check of the power supply and protection circuits with a multimeter with the power supply switched off in accordance. Record the results and compare with the data in the technical documentation.



5. Standards and regulations

- **The installations must meet the requirements of the standards:**
  - PN-EN 81 - for passenger and goods lifts.
  - PN-HD 60364 - for low voltage electrical installations.
  - Decrees of the Office of Technical Inspection (UDT).
  - Health, safety and accident prevention regulations.
  - Machinery directives

4. Installation of control and regulation systems for lifting equipment

The installation of control and regulation systems for lifting equipment is an important part of the process of installing and commissioning lifting equipment such as lifts. It includes a series of steps to ensure the safe and efficient operation of these devices in accordance with applicable standards and regulations.

4.1. Preparation for mounting

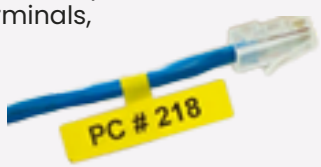
1. Technical documentation:
- Reading of electrical and hydraulic diagrams (if applicable),
- Analysis of the equipment manufacturer's instructions,
- Checking the design of the control installation.

2. Tools and equipment:
- Multimeter, voltage tester, insulation resistance meter,
- Assembly tools: screwdrivers, spanners, drills, etc.,
- Health and safety equipment (gloves, goggles, harness, helmet).

4.2 Physical installation of the control system

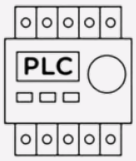
1 Installation of components:
- Assembly of the control cabinet at a suitable location,
- Installation of inverters, PLCs, relays, contactors, power supplies, limit switches, sensors (e.g. position)
- Arrangement of cables according to the cable route plan.

2. Wiring:
- Correct connection of signal and power cables,
- Labelling of cables and terminals,
- Grounding the system.



Note: Currently all control components are contained in the control cabinet as a whole

4.3 Programming and configuration



1. Programmable devices:
- PLC programming according to functional requirements (e.g. lift operation logic, floor priorities),
- Inverter configuration (e.g. lift speed, acceleration, braking),
- Sensor set-up (levels, loads, doors, etc.).

4.4. Launching and testing

1. Performance tests:
- Validation of input and output signals,
- Simulation of system operation under no-load conditions,
- Calibration of position, load, level sensors.

2. Safety tests:
- Test of operation of limit switches,
- Test of operation of emergency brake,
- Test of emergency stop and redundant systems.

4.5 .Technical approval and documentation

- Preparation of launch protocol,
- Handover of as-built documentation,
- Operating instructions for operators,
- Notification to UDT (Office of Technical Inspection) for acceptance.

5. Installation of safety circuits for lifting equipment

The installation of safety circuits for lift equipment is one of the key elements in ensuring the safe operation of lifts (e.g. passenger lifts, goods lifts, disabled platforms). It involves the installation and connection of components that prevent emergency situations and protect users and the equipment. Below, I provide general information on the installation of such circuits.

5.1. Purpose of safety circuits

Safety circuits are intended to:
- **Prevent the crane from starting under hazardous conditions**
- **Automatically stop the crane from operating in the event of a fault**
- **Protect people from falling, getting stuck, electrocution, etc.**

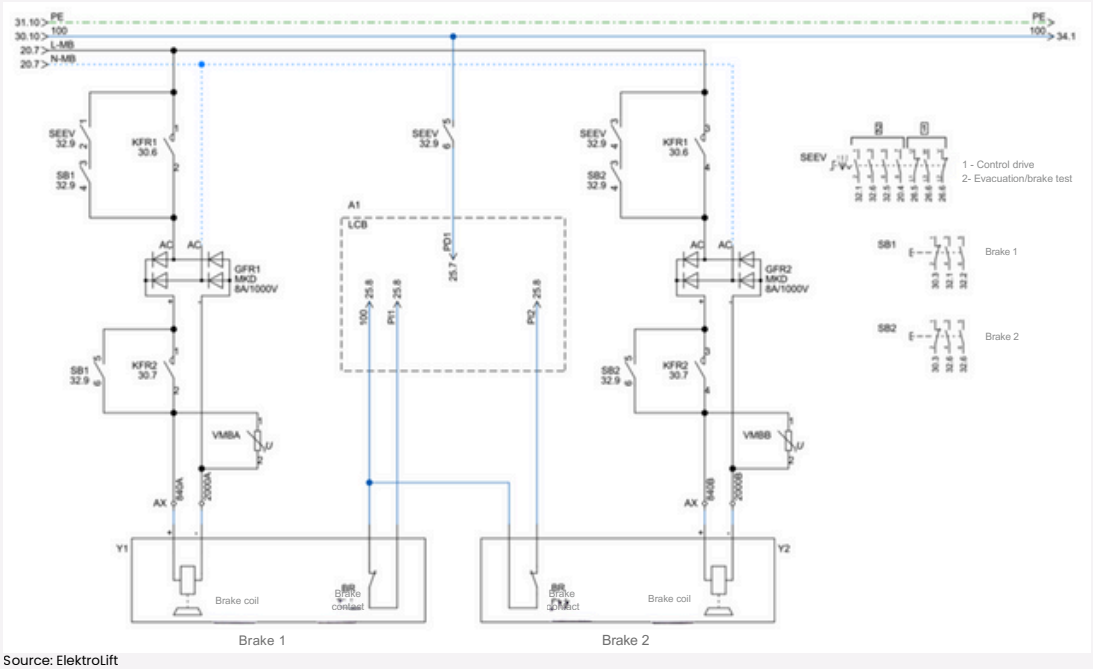
5.2. Elements of the lift safety circuits

- Rods: Shaft and cabin door limit switches
- Rope safety switch (rope break or slack sensor)
- Top/bottom limit switch
- Gripper: Cabin safety brake
- Speed control circuit and grabbers
- Emergency power and rescue system (e.g. UPS, batteries, emergency descent)
- Stop door lock with lock control
- STOP button in the cabin and landing
- Cabin and landing door surveillance sensors

5.3 Steps in the installation of safety circuits

1. Design and selection of components
- In accordance with EN 81-20, EN 81-50, EN ISO 13849
- Consideration of UDT requirements

2. Physical installation of components
- Installation of switches, sensors and cables in accordance with the technical documentation
- Installation in the control cabinet (e.g. safety relays, PLCs)



Source: ElektroLift

3 Connection to the control system
- Connections in the safety circuit must be made in the so-called **NC (normally closed) logic,** so that a break indicates an error.

4. Functional tests
- Functional tests of each safety device (e.g. door opening, wire breakage, over-speeding)
- Tests in accordance with the UDT acceptance procedure.

Practical notes on installation: It is advisable to use safety relays with a self-test function (TEST).

Important: No bridging or bypassing is allowed in the safety circuit (except in service mode with supervision).
Important: The installation and test documentation must be complete - this is required for acceptance by the OTI.

6. Installation of contactor-relay control for lifting equipment

6.1 What is contactor-relay control?

Contactor-transistor control is the classical method of realising control logic in electrical systems, using:

- **contactors** - to switch electrical consumers (e.g. motors) on and off,
- **relays** - to perform logical functions (e.g. time delays, latches, change of direction of movement),
- **safety elements -** such as limit switches, thermal switches, fuses,
- **control buttons and switches -** for manual start/stop**.**

6.2. Typical components of the system:

Component	Function
Motor contactor	Engaging the drive
Directional relay	Choice of movement direction (up/down)
Timing relay	Delay or securing
Limiters	Restriction of movement
STOP button	Emergency stop
Thermistor	Motor overheating prevention

6.3 Installation of contactor-relay control in lifting equipment:

1. Design of the control system

- Development of the concept and implementation diagram.
- Determination of the sequence of operations (lift operating sequence).
- Selection of components: contactors, relays, push buttons, sensors, limit switches, PLC (if the system is hybrid).

2. Preparation of the control panel

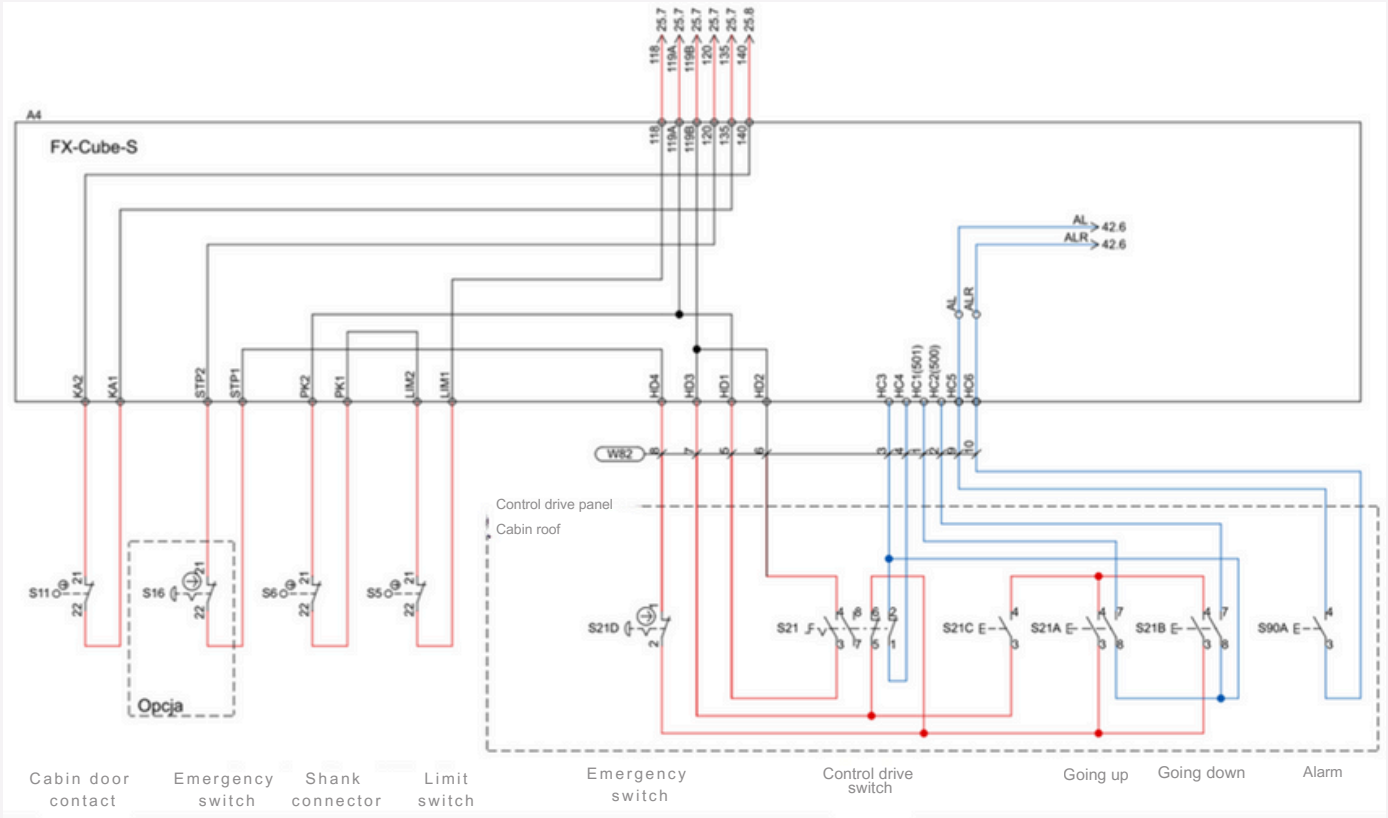
- Mounting the mounting plate.
- Positioning of DIN rails and cable ducts.
- Arranging and fixing the components in accordance with the diagram.

3. System wiring

- Power supply connections.
- Connections between relays, contactors and other controls.
- Marking of wires according to the technical documentation.
- Use of conductors with appropriate cross sections and insulation.

4. installation of components in a lifting device

- Installation of control buttons on the operator panel (up/down, STOP, alarm).
- Installation of limit switches (e.g. stop on extreme floors).
- Connection of lift drive motor and actuators.



Source: ElektroLift

5. Testing and launching

- Verification of correct connections.
- Test run (manual override).
- Test of safety devices: thermals, emergency stop, limit switches.
- Adjustment of parameters (e.g. time relay times).

Use: Carry out the assembly of the contactor-relay control system according to the schematic and assembly diagram . Using a multimeter, check the continuity of the circuit with the power off. Start up the system and check its correct operation. If necessary, correct the settings of limit sensors and time relays.

6.4. Safety

In the case of lifting equipment, the following are of particular importance:

- **dual protection –** redundant safety systems,
- **certified components –** e.g. emergency stop switches, safety relays,
- **compliance with standards –** e.g. PN-EN 81, PN-EN 60204-1, Machinery Directive 2006/42/EC.

7. Installation of speed control systems for lifting equipment

The installation of equipment speed control systems is an essential part of ensuring the smooth, safe and energy-efficient operation of this equipment.

Lifting equipment requires precise speed control to ensure:

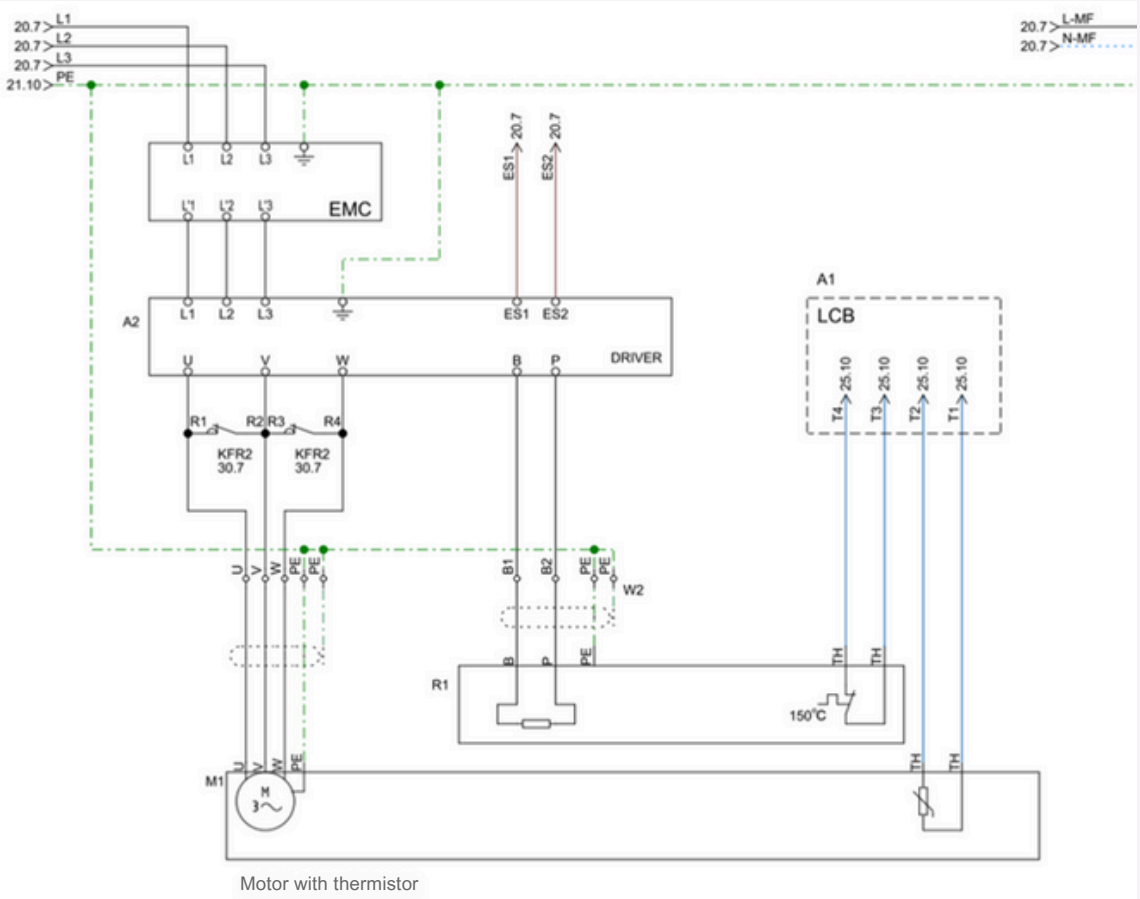
- comfort (smooth starting and braking),
- protection of the load and mechanical structure,
- compliance with safety standards (e.g. EN 81 for passenger lifts),
- energy efficiency.

7.1 Speed control systems are typically:

- frequency converters (inverters),
- PID controllers,
- position and speed sensors (e.g. encoders).

7.2. Speed control system components

1. Electric motor - usually asynchronous or permanent magnet synchronous.
2. Inverter - provides stepless speed control by varying the frequency and voltage supplied to the motor.
3. Sensors (encoders, tachometers) - provide speed and position information.
4. PLC / microprocessor controller - manages the entire process.
5. Electromagnetic brake - a safety element.



Source: ElektroLift

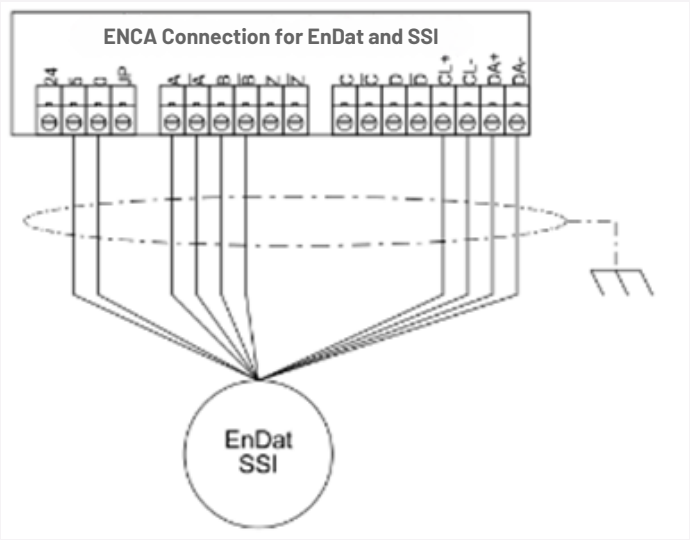
7.3. Installation stages

1. Preparation of the installation

- Checking the manufacturer's technical documentation.
- Selection of appropriate components (matched to motor power and crane type).
- Switching off the power supply, securing the workstation.

2. Mechanical mounting

- Fixing the inverter and controllers in the control cabinet.
- Mounting of sensors (encoders) on the motor shaft or drive mechanism.



3. Electrical mounting

- Connection of inverter to power supply and motor.
- Connection of sensors to inverter or PLC.
- Grounding of all components according to standards.

4. Configuration and launch

Inverter programming: setting parameters such as:
- acceleration/deceleration ramp,
- maximum and minimum speed,
- operating modes (vector control, U/f, etc.).

Calibration of sensors.
Driving tests without load and then with load.

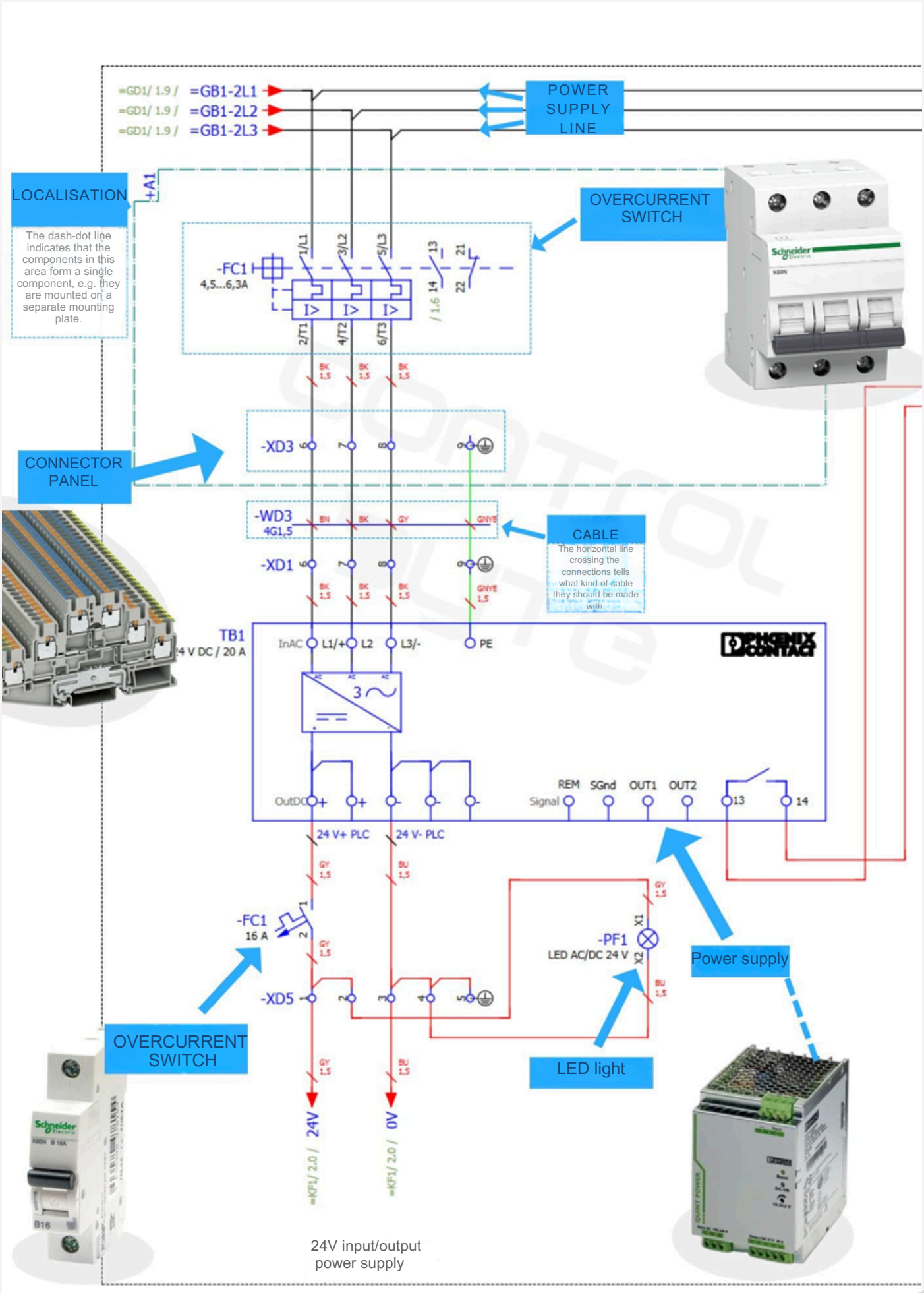
7.4. Safety

The systems must comply with safety standards (e.g. EN 81-20, EN 60204-1).
Protection against:
- overload,
- overheating,
- sensor failure,
- loss of power supply.

Emergency stop systems are required.

7.5 Documentation and technical acceptance

After the installation is completed the following should be done:
- prepare as-built documentation,
- carry out technical inspections and measurements,
- train staff.



Source:controlbyte.pl

1. References in use

1.Buczek K., Obsługa dźwigów, Wydawnictwo i Handel Książkami KaBe s.c., Krosno, 2007.
2.Chimiak M., Konserwacja dźwigów elektrycznych, Wydawnictwo i Handel Książkami KaBe s.c., Krosno, 2008.
3.Kwaśniewski J., Dźwigi osobowe i towarowe, budowa i eksploatacja, wyd. AGH, Kraków 2006.
4.Praca zbiorowa pod redakcją M. Szymańskiego, Dźwigi elektryczne. Podstawy budowy, zasada działania, wyd. PSPD, Warszawa 2020
5.Dorobińska E., Bujański M., Bezpieczna konserwacja i naprawa dźwigów, Wydawnictwo UDT, Warszawa 2016
6.Podstawowe zasady bezpieczeństwa przy pracach dźwigowych, European Lift Association, Brussels, Belgia 2015, polska wersja opracowana przez PSPD
7.Bezpieczeństwo użytkowanania dźwigów. Wstęp do zastosowania SNEL (EN 81-80), European Lift Association, Brussels, Belgia 2013, polska wersja opracowana przez PSPD

2.Online resources

1.https://iautomatyka.pl
2.https://www.controlbyte.pl
3.https://kursyautomatyki.pl
4.https://www.elektroda.pl
5.https://egis.com.pl
6.https://dzwignice.info
7.https://dzwig-portal.pl
8.https://infozawodowe.men.gov.pl
9.https://www.tanieapteczki.pl
10.https://www.windy.rzeszow.pl
11.https://www.controlbyte.pl/blog/jak-czytac-schematy-elektryczne
12.https://pl.dreamstime.com
13.https://www.vierpool.nl
14.https://www.elektrykapradnietyka.com
15.https://www.fif.com.pl
16.https://cn.idec.com
17.https://www.mdpi.com
18.https://www.scribd.com
19.https://www.bhppartnersc.pl
20.AI Chat GPT
21.https://meslek.meb.gov.tr/upload/dersmateryali/pdf/EET2024AMA1110.pdf
22.https://www.otis.com/tr/tr/tools-resources/resource-library
23.https://www.aysad.org.tr/standartlar/

3.Industry magazines

1.”Dźwig” magazine, wyd. EWIT, Radom