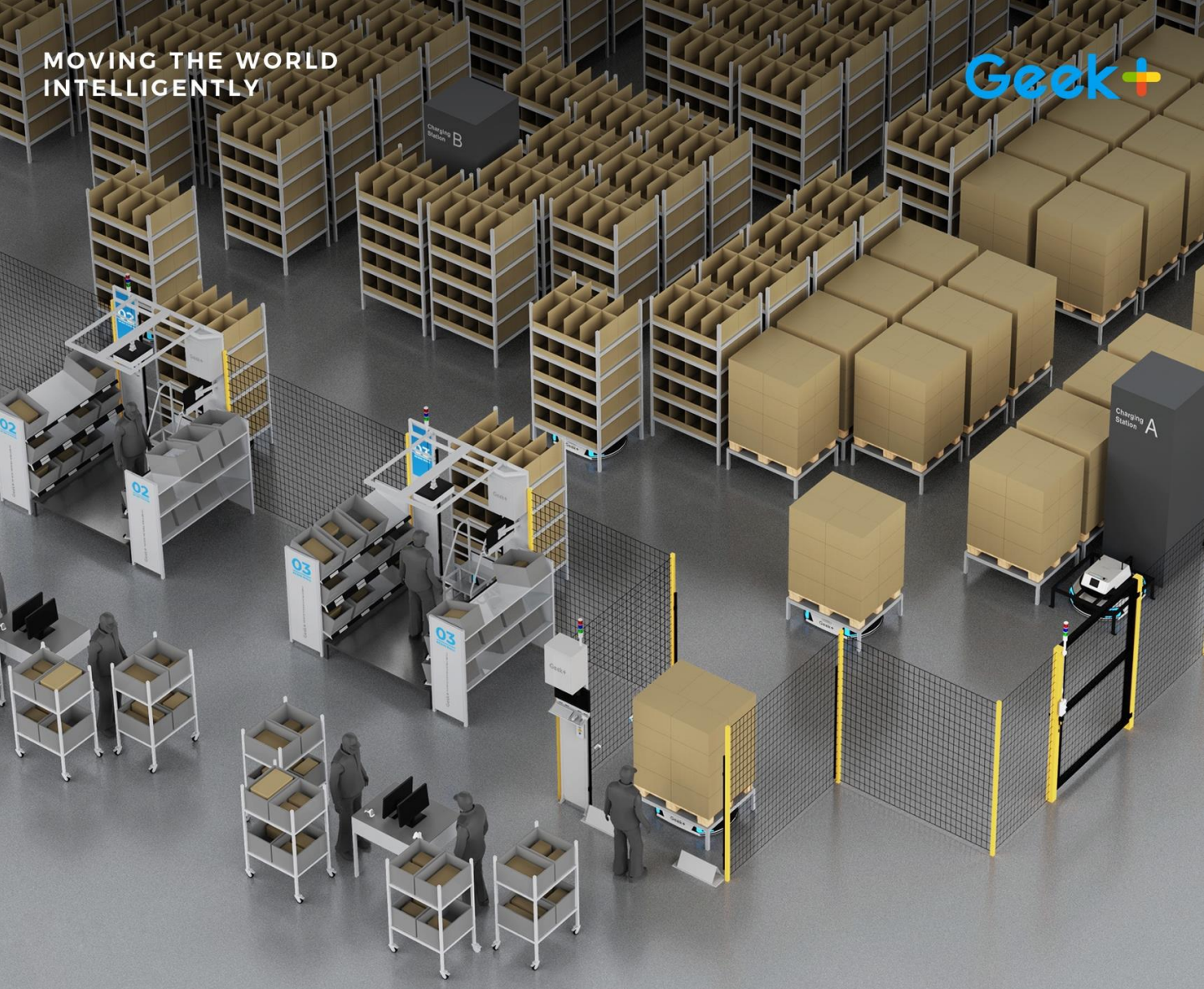
MOVING THE WORLD
INTELLIGENTLY



PRODUCT SAFETY

The Safety of Geek+ Robot Systems

Product | Mechanical | Electrical | Functional | Fire

This booklet aims to provide general information about product safety and enhance safety awareness. It must be noted that the information is not exhaustive and not bound to a project, but it goes some way towards a first overview of our efforts in the safety of our robots and robot systems. Beijing Geekplus Technology Co., Ltd. and its worldwide affiliates disclaim any and all liability and claims arising out of the use of the information included in this booklet.

Contents

Introduction

Human-robot interaction (HRI) can have a significant impact on safety in the warehouse and logistics settings. While robots can provide many benefits such as increased productivity, efficiency, and accuracy, the presence of human workers in the same environment introduces additional safety considerations. As a manufacturer, we know the need of dealing not only with the robot itself but with robot system safety.

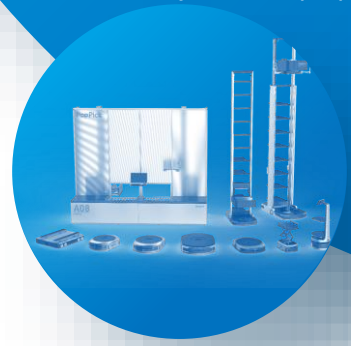
Robots are often used to move large and heavy objects, such as totes or pallets of goods, around warehouses and distribution centers. Safety considerations for robots differ from those of other industrial systems due to several reasons.

First, robots are typically more autonomous and can perform tasks without human intervention. This means that safety measures must be put in place to ensure that they do not cause harm to humans or damage property while performing their tasks.

Second, robots often have mechanical components that can move at high speeds and with great force, which poses an increased risk of injury to humans working in close proximity. As a result, safety features such as sensors and machine guarding are necessary to prevent accidental contact with moving parts.

Additionally, it often requires a number of robots to run on a site for good efficiency. When a robot is faulty, how to remove it among good robots and get it back safely is a problem to solve.

Another factor that sets robot system safety apart is the complexity of the software and control systems used to operate them. These systems require careful design and testing to ensure that they function properly and do not introduce any unintended safety hazards.



Our primary emphasis is on automating warehouse processes. However, it is crucial to ensure compliance with government regulations and seize ongoing opportunities for enhancement in an ever-evolving industry.

We appoint a team of specialists and leverage funds to investigate and develop safety solutions for our robot picking systems in accordance with the laws and standards in different countries and regions. Our professional safety design team consists of experienced safety engineers in China and abroad, and a safety expert with TÜV functional safety certificate.

We also have a global safety support team and project management team to monitor these systems and ensure continuous improvements to minimize the risk of failures, vulnerabilities, and security breaches.

Our standard and advanced safety solutions with high-level safety protection create an operating environment with ultra-low risks. From now on, safety solutions are not just afterthoughts added in order to meet regulations. The initiative helps us meet our customer's needs while making work safer and more productive for workers.

As robot systems become more advanced, new applications for them are emerging. New and improved safety strategies are becoming a way of improving productivity and competitiveness in the market.

Safety is a "must-answer" question for the development of automated warehouses. Geek+, the global AMR leader, strictly guards the "gate" of safety and explores every opportunity throughout the lifecycle of products from design, testing, implementation, and delivery in order to empower customers with sustainable and high-speed development.

Overall, the commitment to safety is an ongoing process that requires continuous improvement and integration into every aspect of the warehouse operation. This includes developing and implementing safety solutions and procedures that meet or exceed industry standards and regulations. Investing in safety equipment and technology and using them on the robots and the robot system is important. This also involves creating a safety culture where all employees are trained and knowledgeable about safety requirements, practices, and procedures.

Product Safety

Alert today, alive tomorrow.

Why Safety?

Despite the implementation of protective measures such as guards to prevent injuries and deaths, robots continue to present a considerable hazard in the workplace. Ensuring the safety of products is crucial for both manufacturers or integrators and consumers. There are many reasons why product safety is important. Here are some of the most significant ones:

To manufacturers or integrators:

- Protection of human health: Safe products help prevent injury or illness caused by defective or hazardous products.
- Legal compliance: In many countries, manufacturers or integrators are required by law to ensure that their products meet certain safety standards.
- Consumer trust: Consumers are likely to trust and continue to purchase products from companies that prioritize safety and quality.
- Reputation management: A company with a poor safety record will face criticism from consumers, investors, and regulators, which could harm its reputation and bottom line.
- Cost avoidance: Product recalls and lawsuits can be financially devastating. Ensuring product safety upfront can save manufacturers significant amounts of money in the long run.
- …

To customers:

- Health and well-being: A safe product ensures that it does not cause harm or injury to warehouse employees. It is essential for the customer's health and well-being that the product they use is safe.
- Production loss: The production will be interrupted and become unsustainable due to equipment shutdown or the absence of employees.
- Economic impact: A product repair or replacement due to safety issues can be costly for the customers. In addition, first aid, medical expenses, insurance claims, and higher premiums may be increased. Ensuring product safety can help prevent these issues and ultimately protect the customer's wallet.
- Legal implications: Compensation and legal litigation costs after accidents should not be underestimated.
- Other indirect losses: company reputation, management responsibilities, etc.
- …

Occurrence of Risk

Risk exists only when an operator is in the presence of a hazard. The purpose of safety is to protect people and the environment from accidents and risks caused by machines.

Only hazard present
No operator

No Risk

Both hazard and operator present

Risk of harm

Risk

Combination of the probability of occurrence of harm and the severity of that harm.

Source: ISO 12100:2010

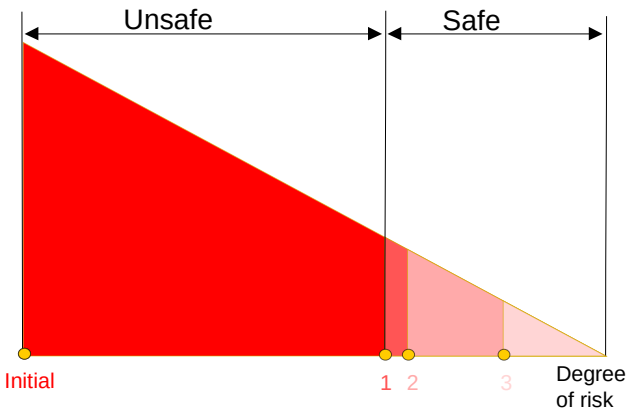
Safety

Safety is freedom from unacceptable risk.

Note: In standardization, the safety of products, processes, and services is generally considered with a view to achieving the optimum balance of a number of factors, including non-technical factors such as human behavior, that will eliminate avoidable risks of harm to persons and goods to an acceptable degree.

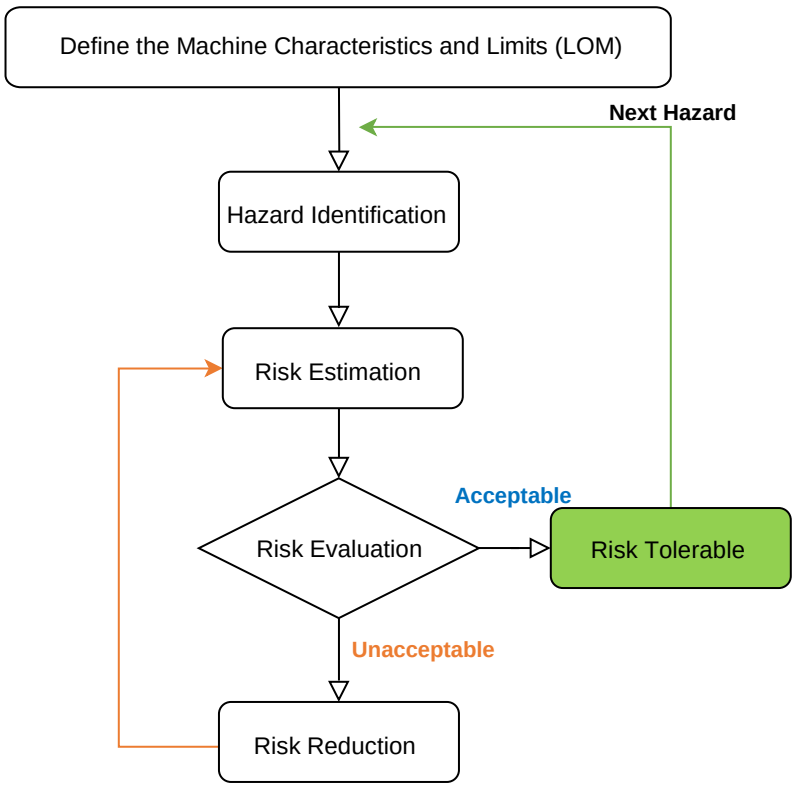
Source: ISO/IEC Guide 2:2004

Safety does not mean zero risk. We all know that absolute safety is almost impossible. So what exactly does "unacceptable risk" mean? There should be risk acceptance criteria. Once these criteria are met, we could say the risk is acceptable. The criteria can depend on various factors, including the country, culture, economy, and type of risk.



Risk Assessment

To achieve safety, principles of risk assessment and risk reduction specified in ISO 12100-2010 will be followed. Risk assessment consists of a series of logical steps to analyze and evaluate machinery-related risks.



To reduce risks, the 3-step method could be implemented by designers:

1. Inherently safe design measures
2. Safeguarding and complementary protective measures
3. Information for use

> **Protective measure**
>
> measure intended to achieve risk reduction, implemented
>
> – by the designer (inherently safe design, safeguarding and complementary protective measures, information for use) and/or
>
> – by the user (organization: safe working procedures, supervision, permit-to-work systems; provision and use of additional safeguards; use of personal protective equipment; training)
>
> Source: ISO 12100:2010

> **Inherently safe design measure**
>
> protective measure which either eliminates hazards or reduces the risks associated with hazards by changing the design or operating characteristics of the machine without the use of guards or protective devices
>
> Source: ISO 12100:2010

Safeguarding

protective measure using safeguards to protect persons from the hazards which cannot reasonably be eliminated or risks which cannot be sufficiently reduced by inherently safe design measures

Source: ISO 12100:2010

Complimentary protective measures

Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use, could have to be implemented as required by the intended use and the reasonably foreseeable misuse of the machine

Source: ISO 12100:2010

Information for use

protective measure consisting of communication links (for example, text, words, signs, signals, symbols, diagrams) used separately or in combination, to convey information to the user

Source: ISO 12100:2010

Based on the risk assessment, the most effective way to eliminate risks is to design machines to be inherently safe. But if risk reduction by design is not possible or practical, safeguarding through static guards or safety functions is often the best option.

In addition, measures implemented by users are also essential to reduce the risks. The following recommendations for the user are given:

- Incorporate manufacturer safety requirements into written company safety procedures for mobile robots.
- Train workers about the specific hazards and personal protective equipment safety requirements associated with mobile robots.
- Emphasize that workers are expected to follow required safety procedures every time, and ensure compliance through periodic refresher training and spot checks.
- Safety culture is really, really important. Most cases are because workers haven't followed the procedures.

Residual risk is the risk that remains when all risk reduction measures have been considered and implemented. Using technology, it is not possible to achieve a state of zero risk, since some residual risk always remains.

Tips

ISO 12100:2010 defines the protective measure as inherently safe design, safeguarding and complementary protective measures, and information for use when the measures are implemented by the designer. We will follow ISO 12100:2010 and call the combination of these measures "risk reduction measures".

Safety Regulations and Standards

National and international organizations establish safety laws and standards covering various aspects of safety. These laws and standards provide guidelines and requirements to ensure safe operations and prevent accidents and injuries in a variety of industries.

Code	Standardization authority (Abbreviation)	Country
ANSI	American National Standards Institute (ANSI)	USA
BS	British Standards Institution (BSI)	Great Britain
CEI	Comitato Elettrotecnico Italiano (Italian Electrotechnical Committee) (CEI)	Italy
DIN/VDE	Verband Deutscher Elektrotechniker (Association for Electrical, Electronic & Information Technologies) (VDE)	Germany
EN	Comité Européen de Normalisation Électrotechnique (European Committee for Electrotechnical Standardization) (CENELEC)	Europe
GB, GB/T	Standardization Administration of the P.R.C. (SAC)	China
GOST	Gosudarstvennyj Komitet Standartov (tate Committee for Standardization)	Russia
IEC	International Electrotechnical Commission (IEC)	Worldwide
JIS	Japanese Industrial Standard (JISC)	Japan
NF	Union Technique de l'Électricité (Technical Union of Electricity) (UTE)	France
SAA	Standards Association of Australia (SAA)	Australia
UNE	Asociación Española de Normalización y Certificación (Spanish Association for Standardization and Certification) (AENOR)	Spain

For example, to ensure the safe usage of the machine, the Machinery Directive and the associated standards must be taken into account when designing a machine.

Machinery Directive

The Machinery Directive is a European Union regulation. It consists of a comprehensive set of health and safety regulations that manufacturers must declare they have complied with to sell their products in the EU. There might also be other directives that apply, e.g., low voltage directive and EMC directive. On 29 June 2023, the European Commission published the new Machinery Regulation 2023/1230. This regulation replaces the Machinery Directive (2006/42/EC).

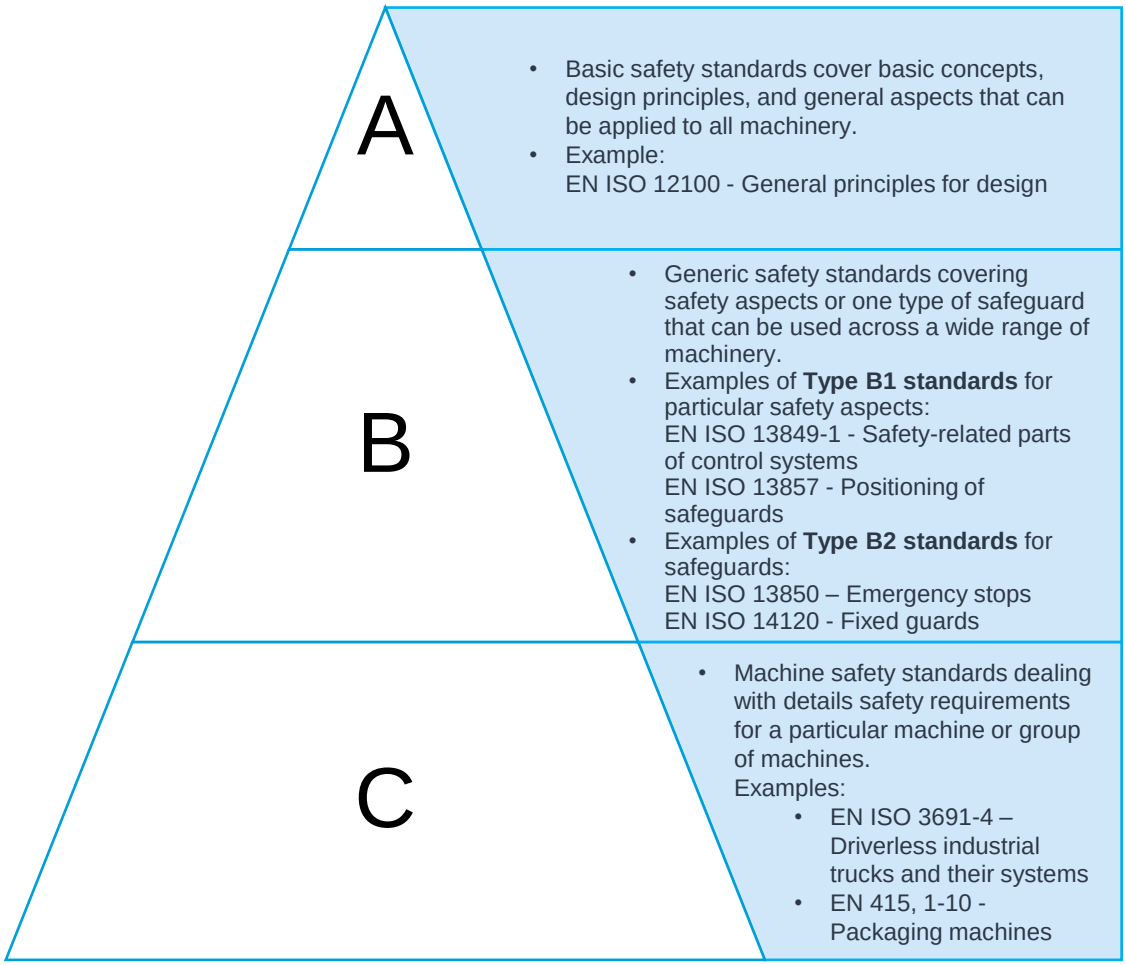
Tips

All countries use IEC and ISO standards or adapt them locally. IEC deals with electrical and electronic standards while ISO handles the rest.

Structure of the European standards

To show compliance with the Machine Directive, appropriate harmonized or non-harmonized standards shall be chosen. By designing machines according to these standards, manufacturers can demonstrate that they comply with the Machinery Directive.

The standards are classified as Type A, Type B, and Type C standards. Type C standard may deviate from the specifications of an A or B-type standard, the specifications of the C-type standard take precedence over the specifications of the A or B-type standard.



AGV/AMR Safety Standards

It is important to note that the following are just a few examples of the many safety regulations and standards that exist in each region. Regulations and standards are specific to their industry and location.

Country	Regulation	standard	Title of the standard
EU	MD	EN ISO 3691-4:2020	Industrial trucks - Safety requirements and verification - Part 4: Driverless industrial trucks and their systems
		EN 60204-1:2018	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
		EN 1175:2020	Safety of industrial trucks - Electrical/electronic requirements
		EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)
	EMC	EN 12895:2015+A1:2019	Industrial trucks - Electromagnetic compatibility
		EN 61000-6-2:2021	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
		EN 61000-6-4:2020	Electromagnetic compatibility (EMC) Part 6-4: Generic standards - Emission standard for industrial environments
US	OHSA	UL 583:2021	Standard for Electric-Battery-Powered Industrial Trucks
		Ul 3100:2021	Automated Mobile Platforms (AMPs)
		NFPA 79:2018	Electrical Standard for Industry Machinery
China	CR	GB/T 15706: 2012	Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)
		GB/T 5226.1:2008	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
		CR-1-0302TS:2018	Safety technical specifications for automated guided vehicle (AGV)
		GB 17799.2:2003	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
		GB 17799.4:2022	Electromagnetic compatibility (EMC) Part 6-4: Generic standards - Emission standard for industrial environments

Product Safety Certification

Putting the AGVs or AMRs to the market shall follow the regulations and standards about product safety. Good evidence for showing compliance is certificates issued by certified bodies. Here introduces the certification in EU and USA. It is recommended to consult with local authorities for the local regulatory requirements.

EU

CE certification

CE certification is the pass for products to enter the EU market. CE certification mode includes three types:

- Declaration of conformity issued by the company. This certificate is a self-declaration.
- Certificate of compliance. This is a declaration of conformity issued by a third party (intermediary or testing certification agency). It must be accompanied by technical information such as test reports, technical construction files (TCFs), and the company must also sign a Declaration of Conformity.
- EC Attestation of conformity. This is a certificate issued by the Notified Body (NB) of the European Union.

Declaration of Conformity (DoC) is a written statement and formulated by the manufacturer to certify that the product bears the CE mark and has produced a declaration in compliance with EU requirements including all Community Acts and harmonized standards that apply to the product.

Mark

In the EU market, the CE safety certification mark is compulsory to indicate that a manufacturer has declared that the product meets regulatory requirements in the EU that may or may not include product safety.

CE

Testing and certification bodies

Only NB is eligible to issue EC Type CE declarations in accordance with EU regulations. These bodies include TÜV, SGS, and so on.

USA

NRTL certification

NRTL is an abbreviation of the Nationally Recognized Testing Laboratory (NRTL). The Occupational Safety and Health Administration (OSHA) under the United States Department of Labor created the NRTL program to ensure that certain types of equipment be tested and certified for their safe use in the workplace. OSHA's authority is limited to employers; therefore, OSHA does not require manufacturers or suppliers to have their products certified by an NRTL.

An organization must have the necessary capability both as a product safety testing laboratory and as a product certification body to receive OSHA recognition as an NRTL.

Mark

OSHA does not mandate the use of, a specific "NRTL" mark, but must have the specific mark of one of the recognized NRTLs. Some NRTLs have voluntarily included the acronym "NRTL" with their regular certification marks. If the certification is done under the NRTL program, this mark signifies that the NRTL tested and certified the product and that the product complies with the requirements of one or more appropriate product safety test standards.

Testing and certification bodies

An NRTL is a private-sector organization that OSHA has recognized as meeting the legal requirements in 29 CFR 1910.7 to perform testing and certification of products using consensus-based test standards. These testing and certification bodies include ETL, UL, and so on.

Safety Aspects Involved

Safety includes but is not limited to the following aspects:

Mechanical

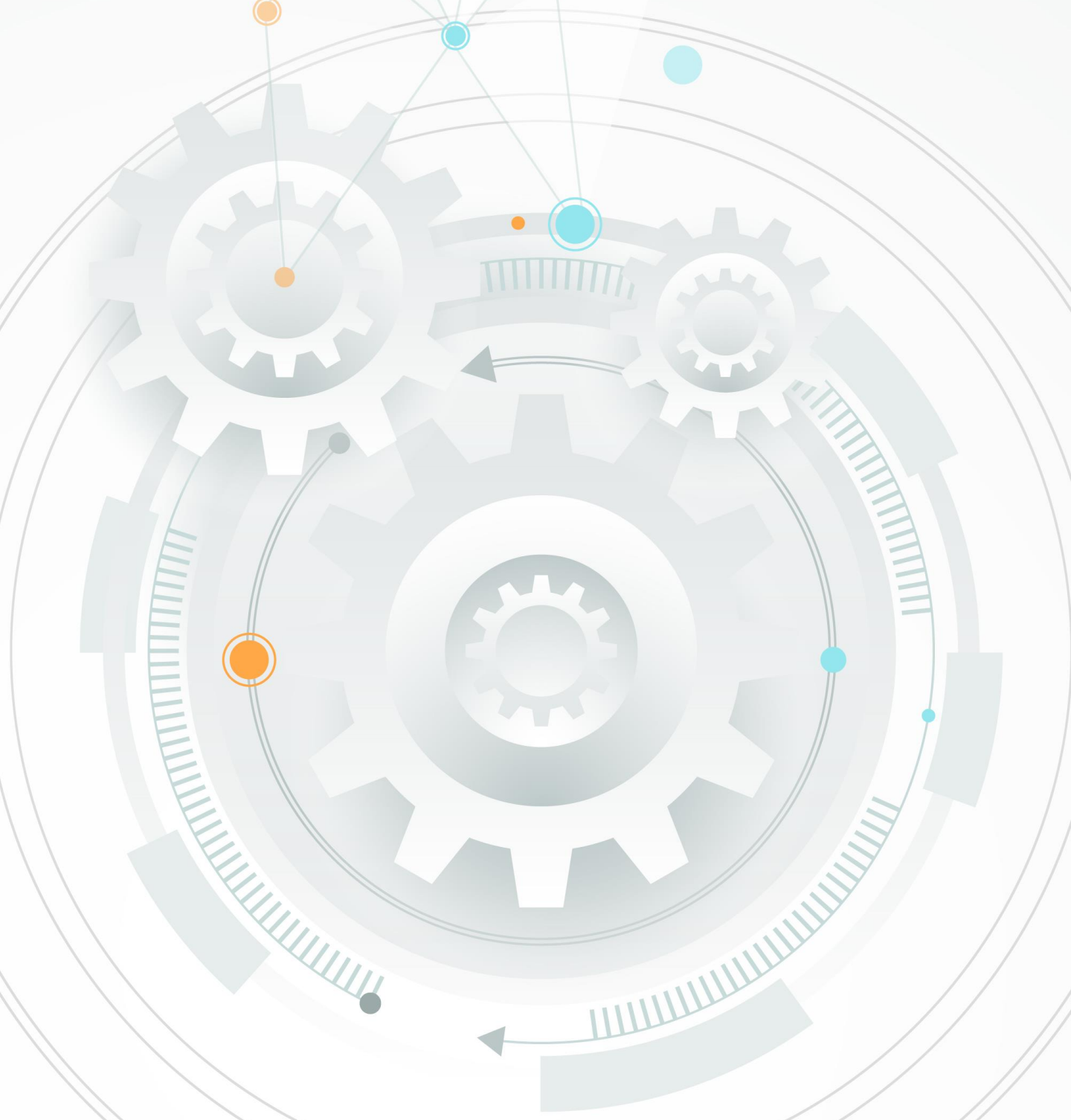
Electrical

Functional

Fire

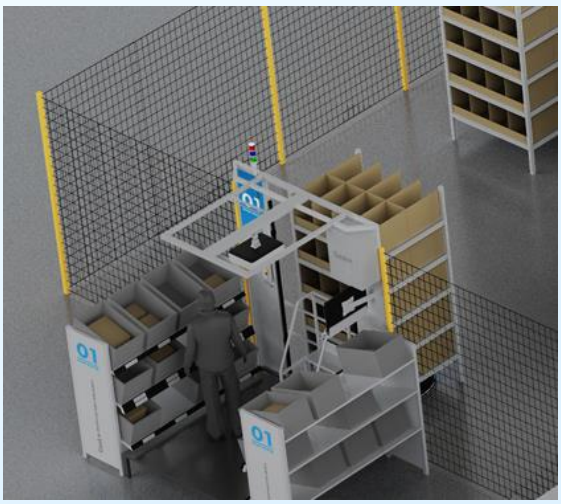
Mechanical Safety

Mechanical risks involve sharp edges or points of a product, gaps of a product or between the product and surroundings to squeeze, pinch, or entrap fingers, toes, and other parts.



Mechanical failures can result in user injuries and even death. The risk reduction measures may involve the following:

- Protection from exposure to moving parts of the machine
- Protection of sharp edges or points
- Clearance or space to prevent fingers, toes, and other appendages from squeezing, pinching, or entrapment during intended use
- Overall strength, durability, and load-bearing capacity under normal use conditions
- Critical components, such as screws and hinges



2500 mm-high fixed fences are installed to enclose the robot area. Space away from the moving robot meets the requirements of EN ISO 3691-4 and EN ISO 13857. For example, when the mesh size of the fence is 30×30 mm, the distance will be 120 mm to prevent people from reaching the hazard.

To prevent arms from being crushed in the space between the loaded robot and the workstation structure, enough space is reserved.

To ensure reliable installation and avoid removal by unauthorized personnel, security screws are applied to fix critical safety components including safety locks. A specialized tool is required to loosen these screws.

Electrical Safety

Electricity is often in the form of lighting, static electricity, and current flows. It has no shape, no color, no odor, and no sound, so it is hard for us to sense and prevent. However, the electrical heat energy can not only cause burns and scalds on the people, but also possibly result in a fire, and even an explosion.

The electric shock is very dangerous because it directly cause death in three ways: paralysis of the breathing center in the brain, paralysis of the heart, or ventricular fibrillation energy.

Current (mA)	Effects of electrical current on human body
0.5-3	Tingling sensation
3-10	Muscle contractions
10-40	Paralysis thresholds
30-75	Respiratory paralysis
50-200	Ventricular fibrillation
200-500	Heart contractions
1500+	Internal organ damage(1)

(1) The damage depends on the exposure time and frequency

Image by macrovector on Freepik

Electrical safety is to protect against potential electrical hazards. Modern machines are electrically made up of wires, switches, circuit breakers, power supplies, and motors, all of which are intricate and may have electrical risks such as arcing and electric shocks. Therefore, Electrical safety must be tested. It's crucial for businesses to obtain various certifications or sign a DoC to show it abides by many international directives and regulations regarding electrical equipment and components.

Low Voltage Directive (LVD) 2014/35/EU

The directive sets out requirements for electrical and electronic equipment that are intended to sell in the European Union. It applies to electrical equipment with an input or output voltage of between:

- 50 and 1000 V for AC, and
- 75 and 1500 V DC

These equipment include AC adapters, electric ovens, and cables, among others.

Electromagnetic Compatibility (EMC) Directive 2014/30/EU

This is an EU directive that regulates electrical interference between electrical and electronic equipment placed on the European market.

These equipment include alarm systems, household appliances, and lighting products, among others.

Radio Equipment Directive (RED) 2014/53/EU

The directive covers radio equipment placed on the EU market and makes requirements about safety, health, electromagnetic compatibility, efficient use of the radio spectrum, and protection of personal data and privacy. Radio equipment covered by the RED is not subjected to the LVD and EMC as it fully covers relevant aspects.

The RED applies to a wide range of electronic products that are Wi-Fi, Bluetooth, LTE, 5G, or GPS enabled, including wireless earphones, active RFID tags, and smartphones.

Certification Body (CB) Scheme

The CB Scheme of the IEC System for Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE) is a global system for product safety test reports and certificates for electrical and electronic equipment, devices, and components, which are mutually recognized in more than 50 member countries worldwide, including European Union (EU) Member States, the U.S., China, India, Korea, and Russia. Manufacturers using the CB Scheme can potentially gain access to every CB Scheme member country.

IEC 60204-1:2016

This is an international standard that specifies safety requirements for electrical, electronic, and programmable electronic equipment and systems to machines not portable by hand while working, including a group of machines working together in a coordinated manner. The standard outlines the necessary safety features and electrical requirements for the machinery to ensure that the operator remains safe from electrical hazards while operating the machine. It lays out safety considerations for electrical installations and machines, including maintenance, inspection, and protective measures to ensure compliance with international standards for safety.

UL NRTL certification

UL certification is known for its strict safety requirements and tests, which are highly authoritative in North America and other countries.

Regulation UN 38.3

The regulation imposes the requirements that must be fulfilled to safely transport batteries by air, sea, and land. The standard, which is recognized by regulators and customs authorities around the world, is also seen as an important gateway to access global markets.

CNAS Report

Any lithium batteries or products containing lithium batteries shipped from a Chinese airport or seaport must have a separate certificate called “Identification and Classification Report for Air / Sea Transport of Goods” which is accepted by the China National Accreditation Service for Conformity Assessment (CNAS)

Prevention is the key to safety

Safety Picking System

Geek+ safety picking system conforms to EN 60204-1:2018 and has achieved CE certification by TÜV Rheinland.

Overcurrent and overload protection

Appropriate circuit breakers and earthing conductors are installed in the safety PLC cabinet to prevent overcurrent and overload.

The safety PLC cabinet for the safety system receives an LVD certificate.

Robots and batteries

Our robots and charging stations have achieved certification in the European region, the UK, and North America, among others.

Classified as class-9 dangerous goods by the United Nations, batteries are governed by various international standards, including the CB scheme, UL NRTL certification, UN 38.3, and CNAS. The batteries for our robots have got all of the above certificates and reports.

Power up on electrical safety in the workplace

Compliance with local electrical regulations

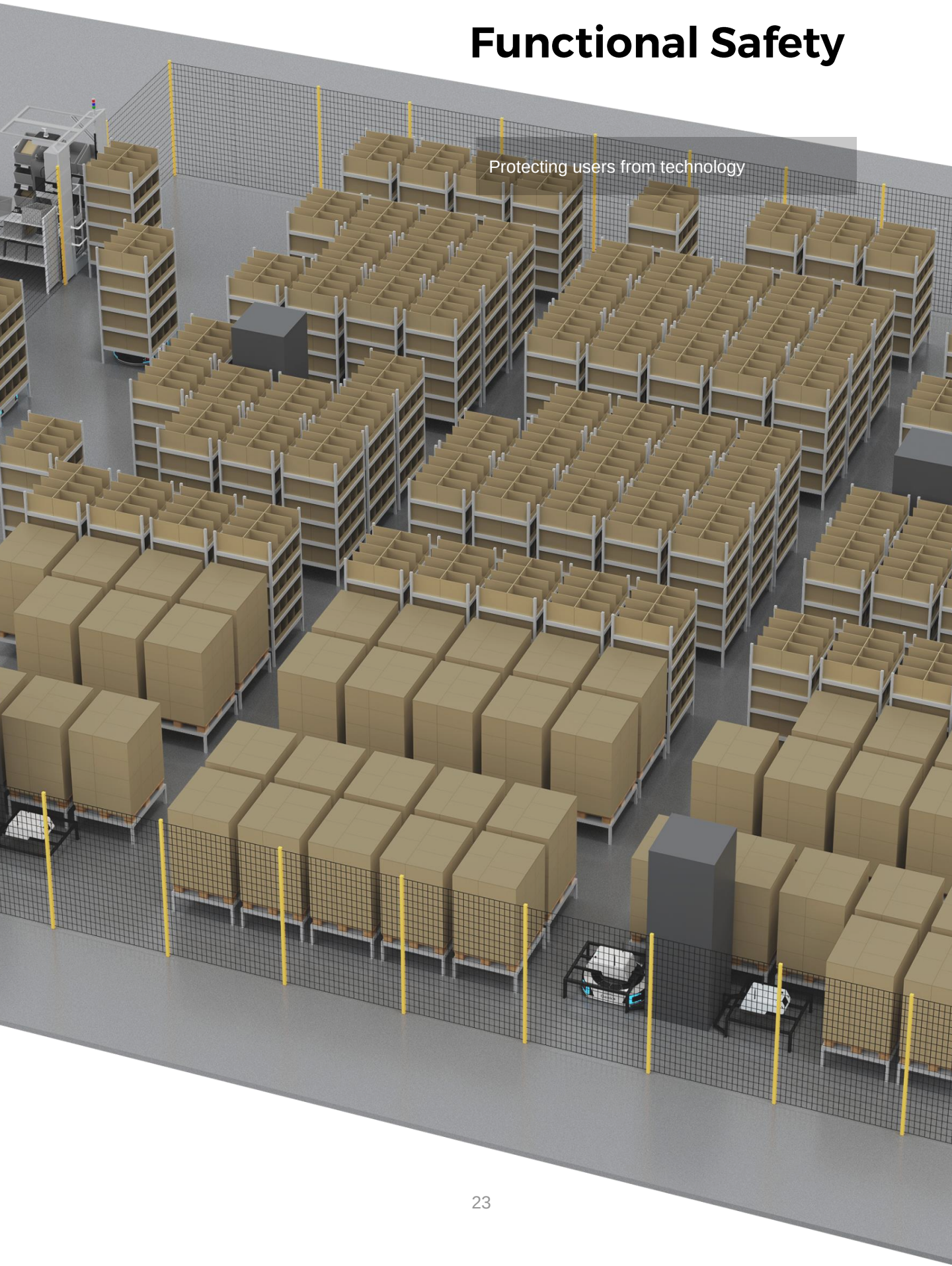
Insulated tools

Personal protective equipment (PPE)

LOTO procedures

Electrical safety practices

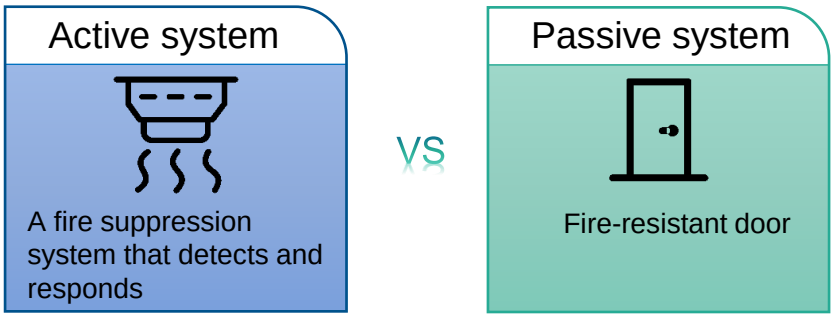
Functional Safety



> **Functional safety**
>
> Functional safety is part of the overall safety that depends on a system or equipment operating correctly in response to its inputs. Functional safety is achieved when every specified safety function is carried out and the level of performance required of each safety function is met.
>
> Source: ISO 12100:2010

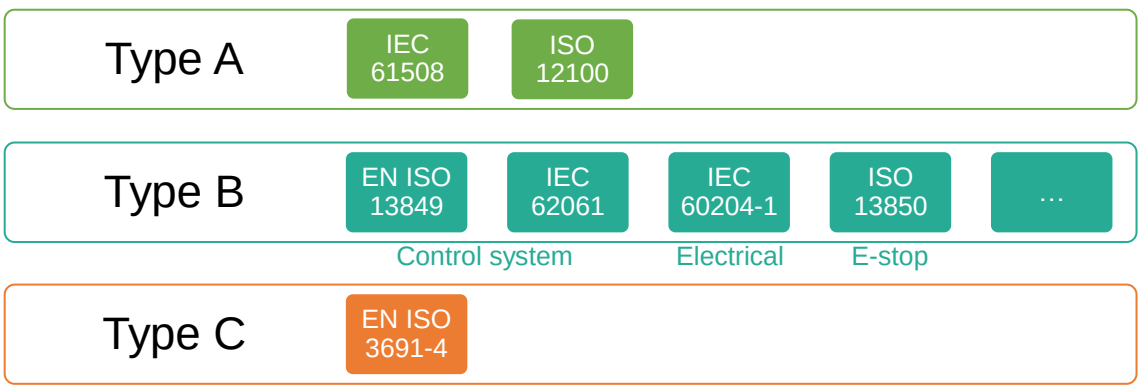
Functional safety is an aspect of safety management and is implemented by a safety system. A safety system includes all of the safety functions or fail-safes necessary to reduce risks of equipment damage, personal injury, property damage, and environmental damage. It takes account of any hazardous events that could be caused by human errors, systematic errors, hardware failures, the surrounding environment (e.g., birds or rats), and other factors.

Functional safety intends to prevent hazards caused by malfunctioning electrical, electronic, or programmable electronic systems. It depends on the continuous operation of an active system that detects and responds to a safety-related event.



This is just one way to deal with risks, while inherently safer design is the most important way to eliminate or reduce the risks. The emergency stop of a machine is a typical function that needs to be functionally safe. To be noted, if the safety function fails, the machine can operate normally, but there is a higher risk during use.

A well-defined safety process that complies with the standards ensures that the safety system is functionally safe and the machine operates safely and reliably. The following figure shows several standards that shall be complied with to achieve functional safety.



The functional safety system starts with the risk assessment, during which required safety functions and their safety characteristics are determined for the application. The higher the PL or SIL requirement, the greater the risk reduction required from the system.

The safety function is then designed according to relevant type B standards. A safety function must consist of PLr- or SIL-compliant devices. Working with the control system, these devices could contribute to a complete safety function that is PLr or SIL compliant.

Risk assessment

Safety system design

1

2

3

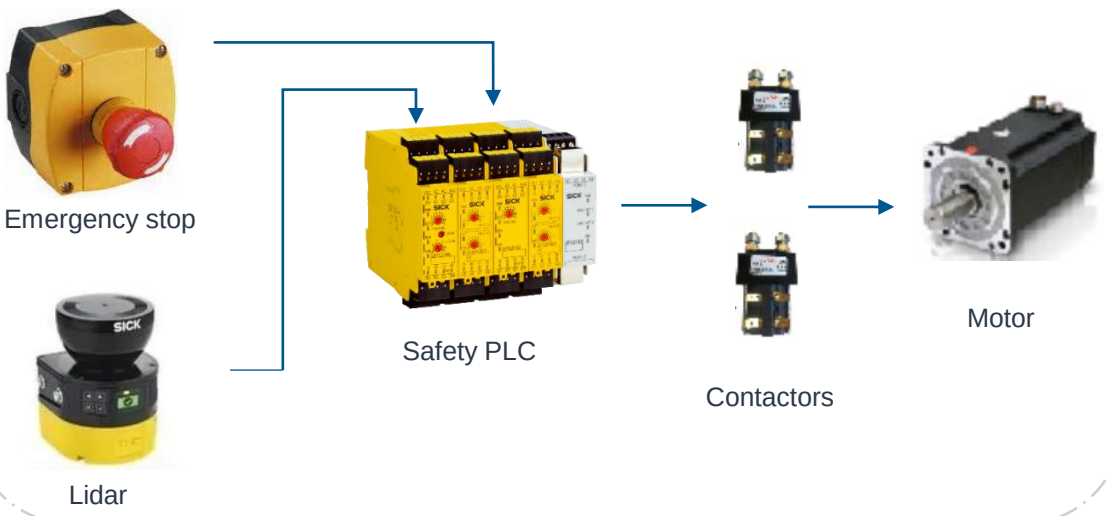
4

Safety requirement specification

Design verification

Safety function architecture

Components for a safety control system



In addition to the design, great importance must be given to the verification and validation of safety functions, which are carried out by persons independent of the design. Verification verifies that safety functions meet the safety requirements, while validation is performed to show that safety functions have been implemented properly and are suitable for their intended use. After delivery, the manufacturer also needs to provide training on the operating procedures and safety instructions so that the user could act accordingly.

During risk evaluation, one of the two standards will be chosen to define the safety-related control system.

- EN/ISO 13849-1, which defines Performance Level (PL)
- EN/IEC 62061, which defines Safety Integrity Level (SIL)

Here are the relations between them.

PL	a	b	c	d	e
SIL	-	1	1	2	3

EN ISO 13849-1

EN ISO 13849-1 specifies the safety requirements for all system technologies including mechanical, hydraulic, and pneumatic products. Where safety functions are to be performed by safety-related parts of the control system (SRP/CS), This standard can be evidence to show compliance with the Essential Requirements 1.2.1 of Annex I of the Machinery Directive 2006/42/EC.

IEC 62061

IEC 62061 considers the whole lifecycle of electrical, electronic, or programmable electronic (E/E/PE) systems and products. This is the machinery-specific implementation of IEC/EN 61508. To show compliance with the EHSRs of the Machinery Directive 2006/42/EC, this standard can be employed.

Our system is functionally safe

The goal of functional safety for Geek+ robots and safety systems is to minimize the risk of accidents and injuries and to ensure that the robot can be used safely in a variety of applications and environments.

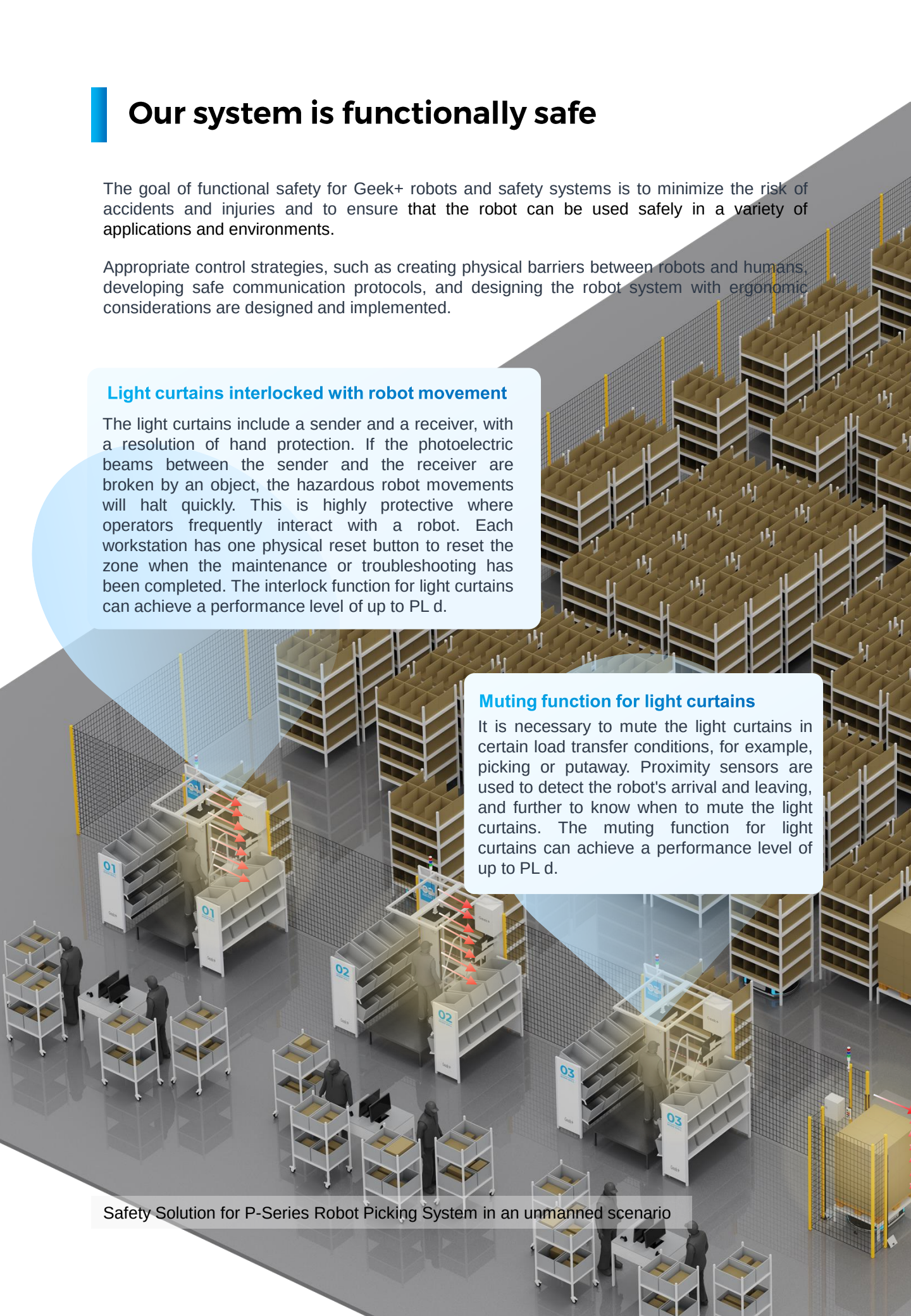
Appropriate control strategies, such as creating physical barriers between robots and humans, developing safe communication protocols, and designing the robot system with ergonomic considerations are designed and implemented.

Light curtains interlocked with robot movement

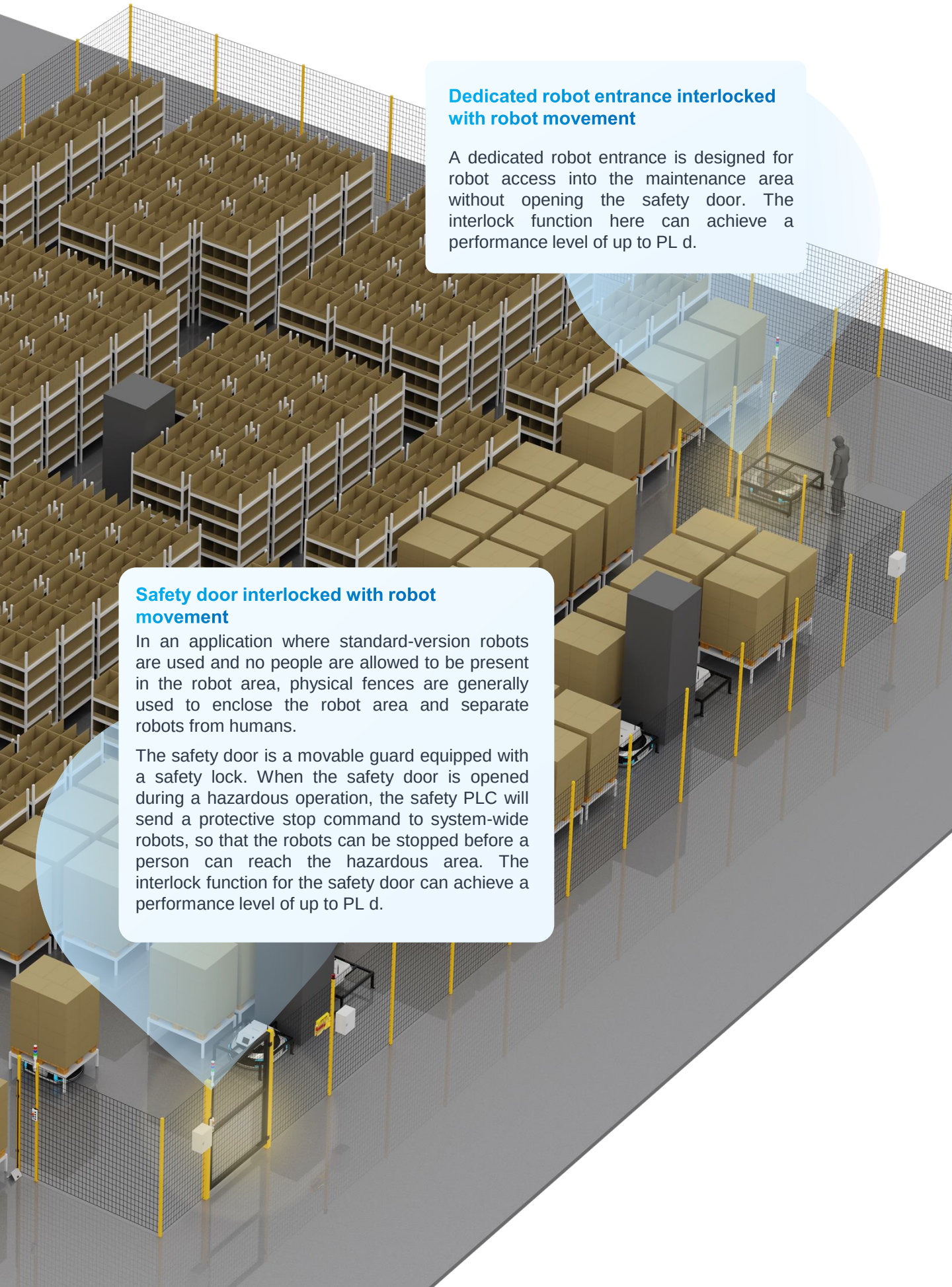
The light curtains include a sender and a receiver, with a resolution of hand protection. If the photoelectric beams between the sender and the receiver are broken by an object, the hazardous robot movements will halt quickly. This is highly protective where operators frequently interact with a robot. Each workstation has one physical reset button to reset the zone when the maintenance or troubleshooting has been completed. The interlock function for light curtains can achieve a performance level of up to PL d.

Muting function for light curtains

It is necessary to mute the light curtains in certain load transfer conditions, for example, picking or putaway. Proximity sensors are used to detect the robot's arrival and leaving, and further to know when to mute the light curtains. The muting function for light curtains can achieve a performance level of up to PL d.



Safety Solution for P-Series Robot Picking System in an unmanned scenario



Dedicated robot entrance interlocked with robot movement

A dedicated robot entrance is designed for robot access into the maintenance area without opening the safety door. The interlock function here can achieve a performance level of up to PL d.

Safety door interlocked with robot movement

In an application where standard-version robots are used and no people are allowed to be present in the robot area, physical fences are generally used to enclose the robot area and separate robots from humans.

The safety door is a movable guard equipped with a safety lock. When the safety door is opened during a hazardous operation, the safety PLC will send a protective stop command to system-wide robots, so that the robots can be stopped before a person can reach the hazardous area. The interlock function for the safety door can achieve a performance level of up to PL d.

System stop and e-stop buttons

The standard safety solution uses a yellow system stop button, while the advanced safety solution uses bright red mushroom-head stop buttons. In principle, such a button is present in the place where the human and the robot interact. Pushing it can make all robots stop in case of any emergency, which has been tested by TÜV Rheinland to comply with European standards and achieve a performance level of up to PL d. Robots will not be restarted until the personnel has left the zone and all triggered safe components have been reset.

Fail-safe mechanism

If something is fail-safe, it has been designed so that if one part of it does not work, the whole thing does not become dangerous, for example by stopping working. In order to make the safety system robust, the fail-safe mechanism applies to the system protective stop link. When the safety link between master safety PLC and robot (for advanced solution) or the network link between server and robot (for standard solution) is disconnected for more than a preset time, robots will stop with motor power-off and brake. Reconnection will make the robots recover operations automatically.

Safety communication system

In advanced system solution, communication system is specially designed between master safety PLC and all system-wide robots to meet the functional safety requirements of EN ISO 13849 and EN ISO 3691-4. When the advanced safety solution works, this safety communication connections are maintained at all time. When disrupted, the fail-safe mechanism of robots would be triggered to put robots into safety state. When any safety device is triggered, the system e-stop instruction is transmitted upon this safety communication connections to all system-wide robots. The robots would perform corresponding actions like stopping immediately and safely. This safety communication system is certificated by TÜV Rheinland to reach the performance level of PL d.

Verification and Validation

Geek+ safety solution for the robot picking system mainly includes three modules, that is workstation safe design, maintenance area safe design, and enclosed robot running area safe design. Geek+ safety solution passed safety risk assessment and CE certification by TÜV Rheinland, which obtained a system-level certification that can achieve PL b protection for the standard solution and PL d production for the advanced solution.

In addition, each system safety function is validated on-site after implementation to ensure a higher level of protection is really achieved.

Safety picking system meets:

- EN ISO 3691-4:2020
- EN 60204-1:2018
- EN ISO 12100:2010

In which, safety protective stop system

- EN ISO 3691-4:2020
- EN ISO 13849-1:2015

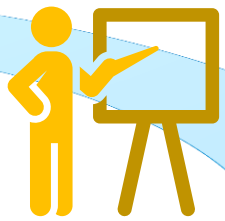
Protective measures by users

Users can play an important role in promoting product safety and protecting themselves and others from harm.

Make access control (authorized persons only, LOTO procedures, Work supervision, and so on)

Introduce safety signs and floor markings

Use personal protective equipment (PPE)



Train users

Read and follow instructions

Document and report safety concerns

Conduct regular inspection and maintenance

Fire Safety

Ensure fire safety, save life, save property.

Fire is one of the most important consideration in the workplace. According to the world fire statistics by CTIF (International Association of Fire and Rescue Services, “Comité Technique International de prevention et d'extinction de Feu” in French), in 48 countries surveyed, 20,600 people died during fires and 69,500 people were injured in 2020. During the year, there were 3,500 deaths and 15,200 injuries from 1,388,500 fires reported in the USA, 249 deaths and 24,798 injuries from 282,800 fires reported in France. There were 3.8 fire deaths and 16.1 fire injuries per 100 fires in Japan in 2020. Fire safety stats show that the US suffered $25.6 billion in property losses due to fire in 2018.

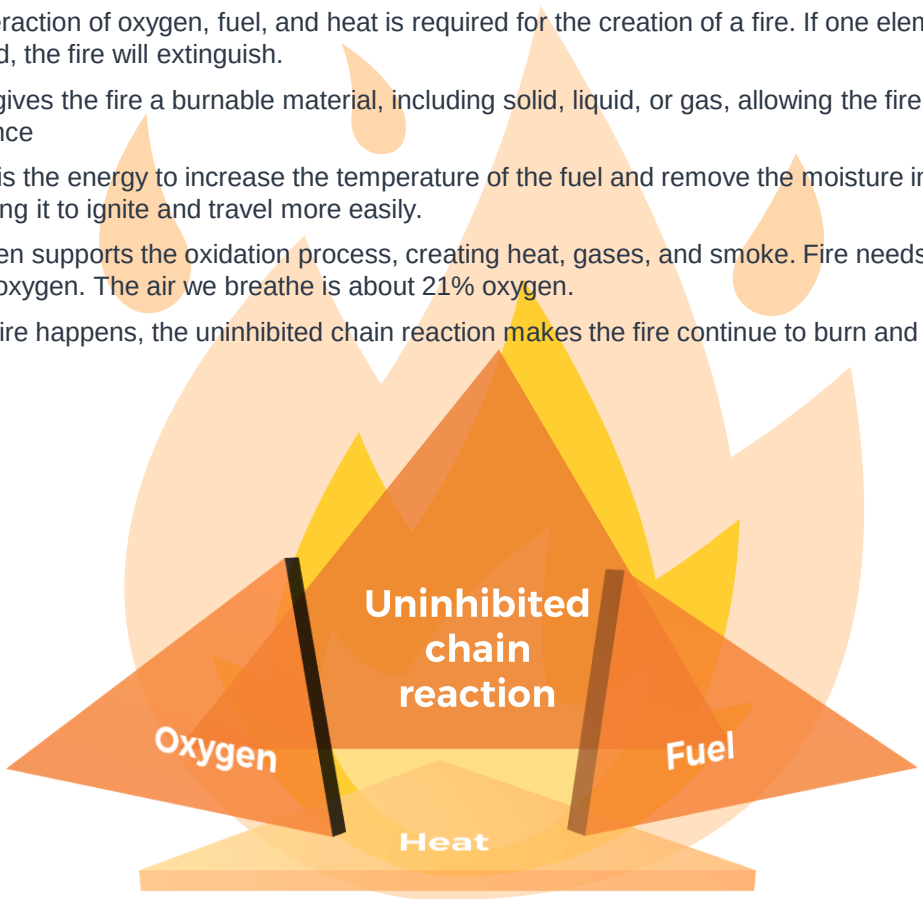
A fire is an unplanned burn that loses control. With the number of losses that result from a fire, it is evident that fire safety is important and mandatory.

Necessary ingredients to cause a fire

The interaction of oxygen, fuel, and heat is required for the creation of a fire. If one element is removed, the fire will extinguish.

- Fuel gives the fire a burnable material, including solid, liquid, or gas, allowing the fire to advance
- Heat is the energy to increase the temperature of the fuel and remove the moisture in it, allowing it to ignite and travel more easily.
- Oxygen supports the oxidation process, creating heat, gases, and smoke. Fire needs only 16% oxygen. The air we breathe is about 21% oxygen.

After a fire happens, the uninhibited chain reaction makes the fire continue to burn and spread.



Common sources of ignition

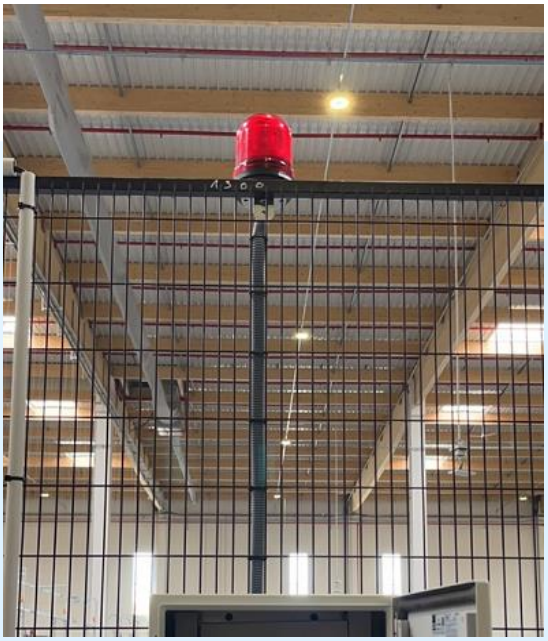
- Open flames
- Friction sparks
- Hot surfaces
- Overloading, Short circuits, & Electric sparks
- Electrostatic charging & Lightning
- Chemical reactions

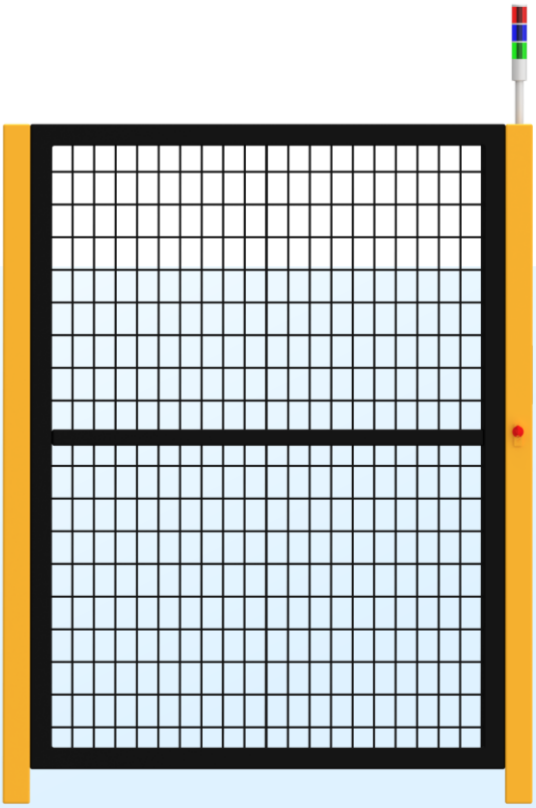
Fun fact

No one knows who invented the fire hydrant, because its patent was destroyed in a fire

Stay out and get out

The fire alarm signal can be connected to the safety PLC. When there is a fire, a sound and light alarm will work, alerting workers to leave the work area as soon as possible. Meanwhile, our robots will leave the fire access and stop automatically, which reduces collision risks and make room for evacuation.





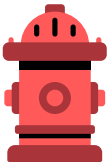
When physical guards are set up, an internal escape release is provided on the safety door for people to leave the robot area from the inside. No additional tool is required to open the safety door.

User's fire safety measures

From the perspective of users, implementing fire prevention measures can significantly reduce the risk of fire and protect people from harm.

These measures include but are not limited to the following.

Compliant building and fire access

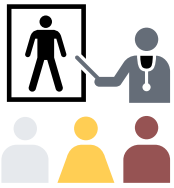


Complete fire protection equipment

Keep electrical equipment and wiring in good condition

Store flammable and combustible materials properly

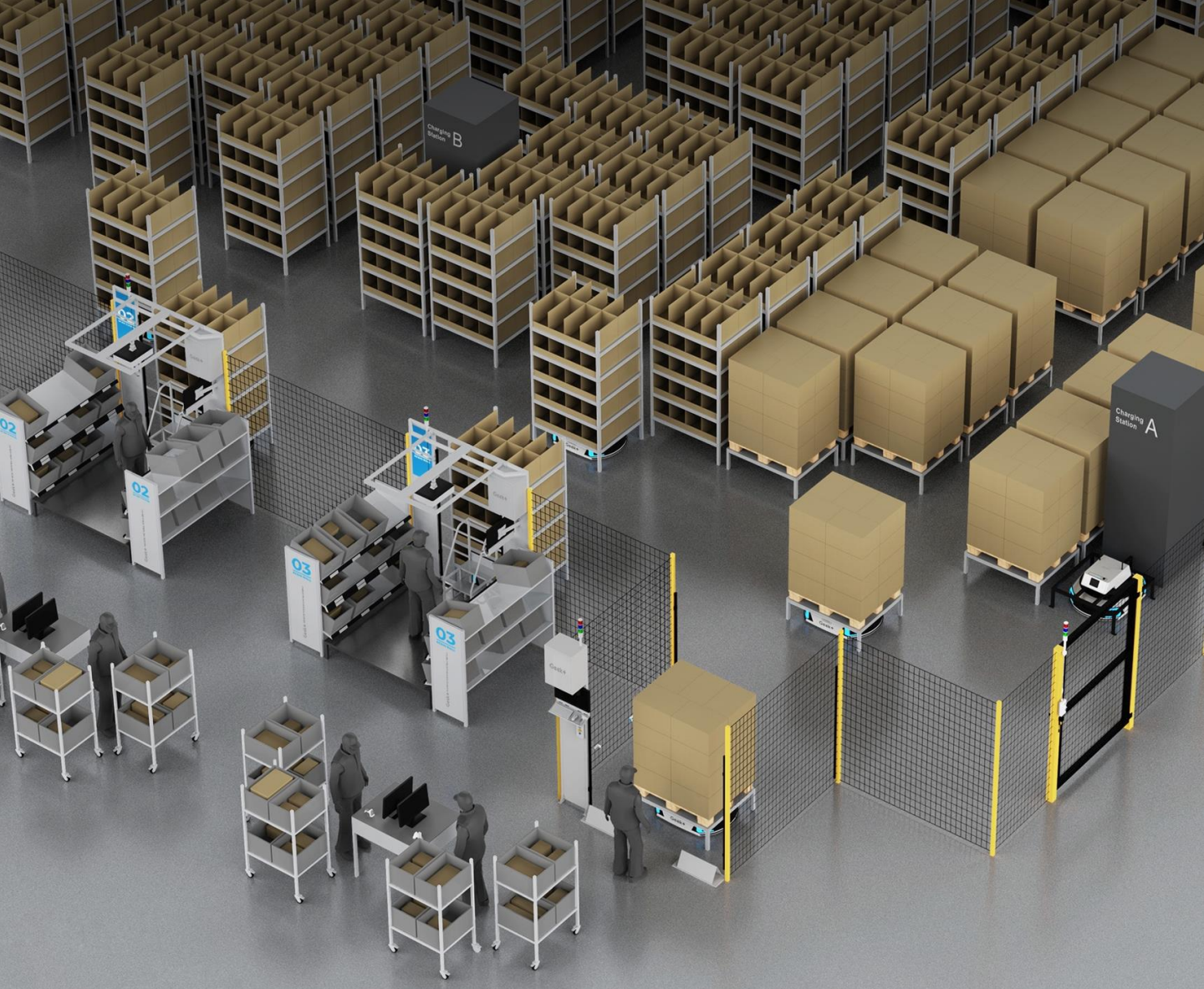
Clearly visible fire safety signs



Fire prevention plan and drills

Everyone needs fire safety awareness

No matter where you live or work, there is always a chance of a fire, therefore it's important to be prepared. It's crucial to understand the causes of fires. Using fire extinguishers correctly can help put out small fires before they grow out of control. You should only try to put out a fire if it's safe to do so. Evacuate right away if there is any uncertainty. When escaping an emergency situation, having a plan in place and knowing all possible exits can save precious seconds.



Geekplus Technology Co., Ltd.

www.geekplus.com

400-045-0010

sales@geekplus.com