GUIDE TO BETTER SAFE GUARDING

ISO STANDARDS AND THE MACHINERY DIRECTIVE 2006/42/EC

PROTECTING PEOPLE, PROPERTY, AND PROCESSES.

CONTENTS

Troax is a global developer and manufacturer of steel mesh panels for Machine Guarding, Warehouse Partitioning and Property Protection. Our business concept is to develop innovative steel mesh panel solutions to protect people, property and processes. Our lightweight but strong mesh panels can be combined into unique solutions and are built to withstand the toughest tests and environments. Read more about our systems at **www.troax.com**

YOUR GUIDE TO BETTER SAFE GUARDING

Modern and future industrial processes are safe when no unauthorised person can access the machinery. Troax mesh panels provide safe machine guarding for your personnel and machine safety in accordance with ISO standards and the Machinery Regulation.

Troax is a well-known name in machine guarding and machine safety for the industry worldwide. The key is intelligent details, which can be combined with new and old modules in well-tested systems.

In this guide, we have collected the relevant paragraphs from the Machinery Directive regarding machine guarding and have highlighted the sections in the ISO standards that will assist you in implementing safeguarding!

WITH PROVEN STRENGTH
We are constructing the foundation of our systems – our mesh panels – step by step. Theoretical calculations are tested in our own test center.

The panels are tested using energies of up to 2,500 joules, which is a very respectable level (feel free to compare this with other manufacturers' panels).

If an accident occurs, you can be confident that the panels are strong enough to protect people and machinery. Every weld can withstand a heavy impact, which is crucial.

COMPLY WITH THE MACHINERY DIRECTIVE
Troax machine guarding and machine safety products meet all the requirements set in The European Machinery Directive, 2006/42/EC, and European Machinery Regulation EU 2023/1230 require that your installation meet these requirements today and, in the future, when you supplement or extend your machine guarding system with new mesh panels, doors and locks.

In this Guide for Better Safe guarding, we have gathered paragraphs on machine guarding from ISO standards and the Machinery Directive/regulation.

MAXIMUM SAFETY

BACKGROUND AND HISTORY
The Machinery Directive 2006/42/EC has been in force since December 29th, 2009 and will be replaced by Machinery Regulation EU/2023/1230 on January 20th, 2027.

The Machinery Directive has undergone several changes and was originally known as 89/392/EEC. The latest Directive (2006/42/EC) is the last directive. The Machinery Regulation was officially published on June 14, 2023, and shall be used as a reference from January 20, 2027. Member Countries of the European Union shall not legalise the change to a regulation, as it becomes a legal document in all member states.

The Machinery Directive/regulation harmonises the essential health and safety requirements for machinery by combining mandatory health and safety requirements with voluntary harmonised standards. The regulations apply to machinery, interchangeable equipment, safety components, lifting accessories, chains, ropes, webbing, removable mechanical transmission devices and partly completed machinery. The Member States of the EU, Norway, Iceland, Switzerland, Liechtenstein, the UK, and Turkey may choose to incorporate the regulation into their legislation.

MARKET SURVEILLANCE
The term "market surveillance" refers to the activities and measures conducted by public authorities of the Member States to ensure the correct application of the provisions of the Machinery Directive for machinery and partly completed machinery (in the new 12100:2025 component machine) and to ensure the safety of machinery placed on the market and put into service. The Regulation has been directly applicable since the 1st of January, 2010. The Machinery regulation law from the 20th of January 2027 establishes a stronger legal basis for market surveillance and enforcement actions. Also, it provides for necessary cooperation between Member States and the Commission in this area.

The practical application is carried out in the framework of the Machinery Administrative Cooperation Group (Machinery ADCO), which exchange information at meetings usually twice a year.

REGULATIONS FOR PUTTING MACHINERY INTO SERVICE OR PLACING IT ON THE MARKET
Before the manufacturer or his representative may put machinery into service or release it to market, the following conditions must be met:

- *The machinery must comply with the applicable sections of the essential Health and Safety requirements in Annex 1. For Machine regulation, Annex 3.*
- *The technical documentation as set out in Annex 7, chapter A, must be accessible. Machine Regulation Annex 4 Part A.*
- *Provide all necessary information, for example, the machinery's operating Manual.*
- *Conduct a suitable procedure for the assessment of conformity in accordance with Articles 10–13. Machine regulation chapter 2, article 10–19.*
- *Issue an EC Declaration of Conformity in accordance with Annex 2, part 1, chapter A. Machine regulation Chapter 3 Article 20–22. Ensure that the Declaration is supplied together with the machinery.*
- *Affix the CE marking in accordance with vc Annex 3. Machine Regulation Chapter 3 articles 23–24.*

RISK ASSESSMENT
The most widely accepted method for designing machinery or safety measures today is to use a risk assessment as a foundation. Conducting an early risk assessment results in a safer and more user-friendly machine. Various methods are available for conducting a risk assessment. The ISO 12100:2010 standard offers the required guidelines for carrying out a risk assessment.

RISK ASSESSMENTS ARE NORMALLY DIVIDED INTO DIFFERENT STEPS:

- *Status Report: This report describes the current status of the machinery and determines its viability.*
- *Identification of Risks: This involves identifying risks based on the Health and Safety requirements of the Machinery Directive.*
- *Risk Assessment is a crucial step as it guides the necessary measures by assessing and evaluating the identified risks.*
- *Risk Reduction: This section describes the recommended actions, the timeline for implementation, and the person responsible for executing them.*
- *Methodology: This section is crucial as it explains the method used for analysis and how the results are to be interpreted.*

A 'step' model is often utilised for risk reduction. The 'step' model consists of the following:

- *First, a risk is eliminated through design.*
- *Second, a risk is eliminated through protection.*
- *Third, the risk can be addressed through warning or informing about it.*

EXCERPT FROM THE MACHINERY DIRECTIVE 2006/42/EC

PARAGRAPH 1.3.7
PREVENTION OF RISKS RELATED TO MOVING PARTS
The moving parts of machinery must be designed and constructed in such a way as to prevent risks of contact which could lead to accidents or must, where risks persist, be fitted with guards or protective devices.

All necessary steps must be taken to prevent accidental blockage of moving parts involved in the work. In cases where, despite the precautions taken, a blockage is likely to occur, the necessary specific protective devices and tools must, when appropriate, be provided to enable the equipment to be safely unblocked.

The instructions and, where possible, a sign on the machinery shall identify these specific protective devices and how they are to be used.

The moving parts of the machinery or related product shall be designed and constructed in such a way as to prevent risks of contact which could lead to accidents or shall, where risks persist, be fitted with guards or protective devices. The moving parts of machinery must be designed and constructed in such a way as to prevent risks of contact which could lead to accidents or must, where risks persist, be fitted with guards or protective devices.

All necessary steps shall be taken to prevent accidental blockage of moving parts. In cases where, despite the precautions taken, a blockage is likely to occur, the necessary specific protective devices and tools shall, when appropriate, be provided to enable the equipment to be safely unblocked.

The instructions for use and, where possible, a sign on the machinery or related product shall identify these specific protective devices and how they are to be used.

The instructions and, where possible, a sign on the machinery shall identify these specific protective devices and how they are to be used.

The prevention of risks of contact leading to hazardous situations and the psychological stress that may be caused by the interaction with the machine shall be adapted to:
(a) human-machine coexistence in a shared space without direct collaboration;
(b) human-machine interaction.

PARAGRAPH 1.3.8
CHOICE OF PROTECTION AGAINST RISKS RELATED TO MOVING PARTS
Guards or protective devices designed to protect against risks arising from moving parts must be selected on the basis of the type of risk. The following guidelines must be used to help to make the choice.

PARAGRAPH 1.3.8.1
MOVING TRANSMISSION PARTS
Guards designed to protect persons against the hazards generated by moving transmission parts must be:
» either fixed guards as referred to in section 1.4.2.1, or
» interlocking movable guards as referred to in section 1.4.2.2.

Interlocking movable guards should be used where frequent access is envisaged.

PARAGRAPH 1.4.1
GENERAL REQUIREMENTS
Guards and protective devices must:
» be of robust construction,
» be securely held in place,
» not give rise to any additional hazard,
» not be easy to by-pass or render non-operational,
» be located at an adequate distance from the danger zone,
» cause minimum obstruction to the view of the production process, and
» enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled.

In addition, guards must, where possible, protect against the ejection or falling of materials or objects and against emissions generated by the machinery or related product.

PARAGRAPH 1.4.2
SPECIAL REQUIREMENTS FOR GUARDS
PARAGRAPH 1.4.2.1
FIXED GUARDS
Fixed guards shall be fixed by systems that can be opened or removed only with tools. Their fixing systems shall remain attached to the guards or to the machinery or related product when the guards are removed. Where possible, guards shall be incapable of remaining in place without their fixings.

PARAGRAPH 1.4.2.2
INTERLOCKING MOVABLE GUARDS
Interlocking movable guards shall:
(a) as far as possible remain attached to the machinery or related product when open,
(b) be designed and constructed in such a way that they can be adjusted only by means of an intentional action.

Interlocking movable guards shall be associated with an interlocking device that:
(a) prevents the start of hazardous machinery or related product functions until those guards are closed; and
(b) gives a stop command whenever those guards they are no longer closed.

Where it is possible for an operator to reach the danger zone before the risk due to the hazardous machinery or related product functions has ceased, movable guards shall be associated with a guard locking device in addition to an interlocking device that:
(a) prevents the start of hazardous machinery or related product functions until the guard is closed and locked, and
(b) keeps the guard closed and locked until the risk of injury from the hazardous machinery or related product functions has ceased.

Interlocking movable guards shall be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery or related product functions.

EN AND ISO STANDARDS

WORKING WITH STANDARDS
Standards can be compared to specifications for designing a machine to meet the requirements of the Machinery Directive, a legal document with rules and regulations that must be followed. Standards provide guidelines for designing and constructing machinery, and following these standards can help reduce documentation.

A standard:

» *Is a recommendation for the design of a product in a certain manner.*
» *Provides examples of solutions for a recurrent problem.*
» *Is developed by representatives from manufacturers, users and authorities.*

Standardisation leads to simplification, safety, profitability, and improved communication. Technical committees and working groups draft the standards.

HARMONISED STANDARDS
A harmonised standard means that all Member States of the European Union have approved the contents of the standard in question. Once the standard has been approved, it is published in the "Official Journal of the European Communities", and is then designated as an EN standard. Once a standard fulfils the requirements of a directive/regulation, it becomes 'presumed'. An example of such a standard is EN 60204-1 (Safety of Machinery – Electrical Equipment or ISO 13849-1:2015 Safety of machinery – Safety-related parts of control systems – Part 1: General principles for desi). The machine directive/regulation requirements are automatically met if the standard's recommendations are fulfilled.

DIFFERENT TYPES OF STANDARDS
There are several levels of standards. They are type A, B and C. The type A standard contains comprehensive content, while the type C standard is tailored for specific machines, such as press tool die sets.

The scope of safety standards in the field of machinery is as follows:

a) **TYPE-A STANDARDS**
Basic safety standards outline essential design concepts and principles applicable to all machinery.

b) **TYPE-B STANDARDS**
Generic safety standards address specific safety aspects or safeguards applicable across various types of machinery.

» *Type-B1 standards regarding specific safety aspects, such as safety distances, surface temperature, and noise levels.*
» *Type-B2 safety measures standards include items such as two-hand controls, interlock devices, pressure-sensitive devices, and guards.*

c) **TYPE-C STANDARDS**
Machine safety standards address specific safety requirements for machines for groups of machines. The C standards are typically EN standards within the EU or national standards.

STANDARDS RELATED TO MACHINE SAFETY
Utilising applicable harmonised standards in machinery development, protection, and safety applications is an effective way to ensure that the final product meets the Machinery Directive/regulation requirements.

Since 2007, Troax has been involved in various national and international standard committees, striving to enhance and clarify the recommendations of standards and norms. The EN and ISO standards serve as our guides for the design and construction of safe products. The following pages include a table that outlines the most common standards within the Machine Safety category.

STANDARD	TYPE	DESCRIPTION	CONTENT*
ISO 12100:2010	**A**	Safety of machinery – General principles for design – Risk assessment and risk reduction.	Specifies basic terminology, principles and a methodology for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction to help designers in achieving this objective.
SS-EN 614-1:2006 +A1:2009	**C**	Safety of machinery – Ergonomic Design Principles – Terminology and General Principles.	Design of the machinery and ergonomic design of the workspace.
EN 614-2:2006 A+A1:2008	**C**	Safety of machinery – Ergonomic design principles – Interactions between the design of machinery and work tasks.	Design of the machinery and ergonomic design of the workspace.
ISO 13857:2019	**B**	Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs.	Establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached. The safety distances are appropriate for protective structures.
EN 1005-4:2005 +A1:2008	**B**	Safety of machinery – Human physical performance – Part 4: Evaluation of working postures and movements in relation to machinery.	Presents guidance when designing machinery or its component parts in assessing and affecting health risks due only to machine-related postures and movements, i.e. during assembly, installation, operation, adjustment, maintenance, cleaning, repair, transport, and dismantling.
EN 60204-1:2018	**B**	Safety of machinery – Electrical equipment of machines – General requirements.	Gives safety guidance and recommendations on electrical equipment for machinery. This includes safety requirements for electrical, electronic and computer controlled equipment and systems for machines – but excludes power circuits where electricity is used directly as a working tool.
ISO 13854:2019	**B1**	Safety of machinery – Minimum gaps to avoid crushing of parts of the human body.	Purpose is to enable the user (e.g. standard makers, designers of machinery) to avoid hazards from crushing zones. Specifies minimum gaps relative to parts of the human body. Applicable when adequate safety can be achieved by this method.
ISO 13855:2010	**B1**	Safety of machinery – Positioning of safeguards with respect to the approach speeds of parts of the human body.	It specifies parameters based on values for approach speeds of parts of the human body and provides a methodology to determine the minimum distances to a hazard zone from the detection zone or from actuating devices of safeguards.
ISO 11161:2007/ AMD 1:2010	**B1**	Safety of machinery – Integrated manufacturing systems – Basic requirements.	Specifies the safety requirements for integrated manufacturing systems (IMS) that incorporate two or more interconnected machines for specific applications, such as component manufacturing or assembly.

*Text not taken from the standards.

STANDARD	TYPE	DESCRIPTION	CONTENT*
ISO 13849-1:2015	**B1**	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design.	Provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software.
ISO 14120:2015	**B2**	Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards.	This International Standard specifies general principles for the design and construction of guards, both fixed and movable. It is intended for use by manufacturers, designers, standards makers and other interested parties.
ISO 14119:2025	**B2**	Safety of machinery – Interlocking devices associated with guards – Principles for design and selection.	Specifies principles for the design and selection independent of the nature of the energy source of interlocking devices associated with guards. It covers the parts of guards which actuate interlocking devices. It provide specific requirements for trapped key systems.
ISO 10215-1:2025	**C**	Robots and robotic devices. Safety requirements for industrial robots – Part 1: Robots.	Describes basic hazards associated with robots and requirements to eliminate/reduce the risks.
ISO 10218-2:2025	**C**	Robots and robotic devices. Safety requirements for industrial robots – Part 2: Robot systems and integration.	This covers how to integrate all equipment into a robot system.
EN 62061:2005/ A1:2013		Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.	Specifies requirements and makes recommendations for the design, integration and validation of safety-related electrical, electronic and programmable electronic control systems (**SRECs**) for machines.
EN 619:2022	**C**	Continuous handling equipment and systems – Safety and EMC requirements for equipment for mechanical handling of unit loads.	This European Standard deals with the technical requirements for electromagnetic compatibility (EMC).

*Text not taken from the standards.

THE IMPORTANCE OF SAFETY DEVICES

The Machinery Directive outlines guidelines for designing and constructing machines to ensure their safety. While some view the CE marking requirement as burdensome, costly, and challenging, there are significant benefits beyond mere compliance. These advantages include creating a safer working environment, enhancing the reliability of machine operations, and improving overall production efficiency.

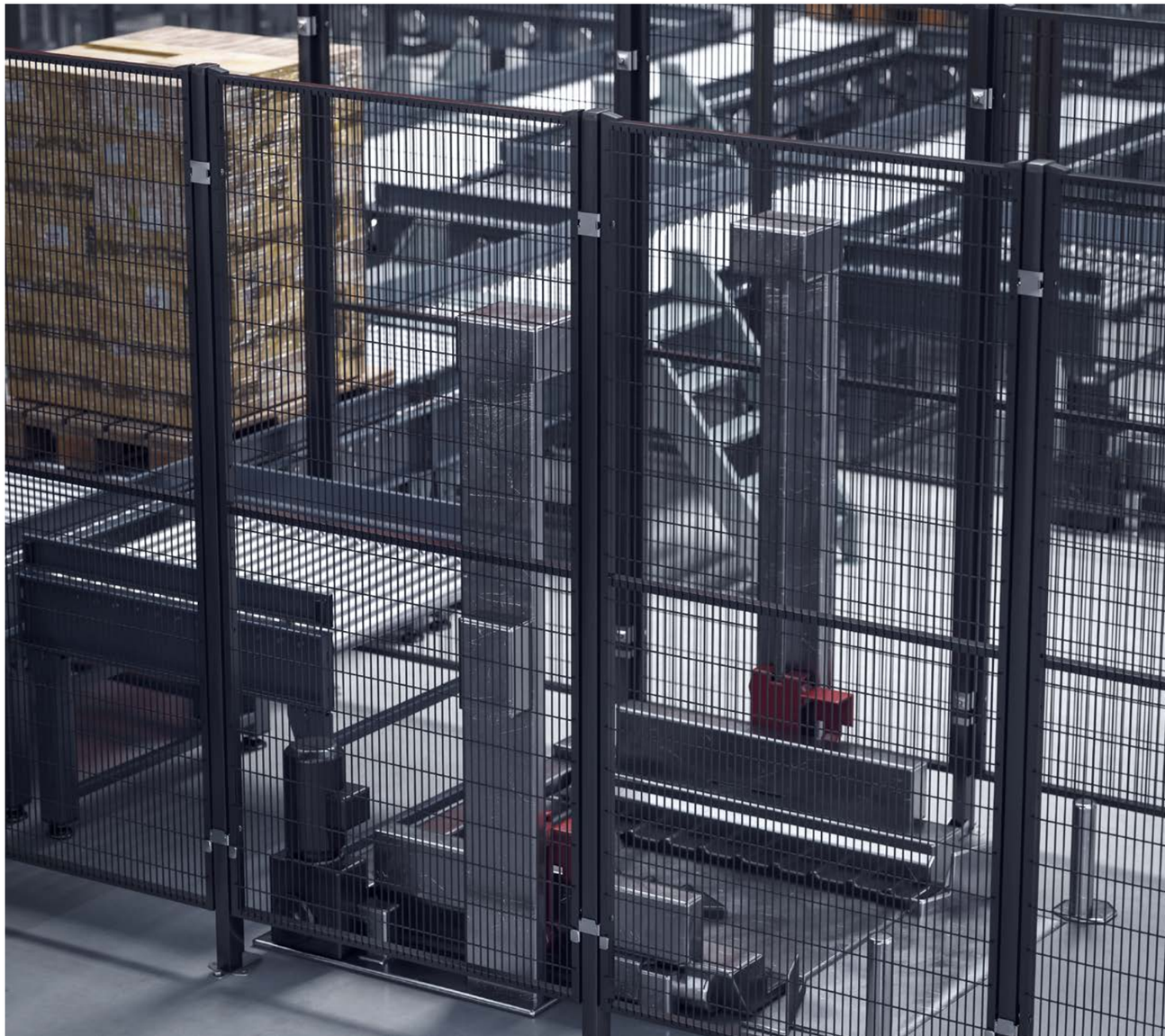
GUIDELINES FOR THE SELECTION OF SAFETY DEVICES

The manufacturing of safety devices for machines requires careful consideration. While it is generally feasible to eliminate all risks through protective measures, the challenge lies in ensuring safety while maintaining the machine's ease of use and accessibility. When selecting safety devices, four key concepts should be taken into account:

- The machinery directivere quirements
- Accessibility
- Safety
- Cost

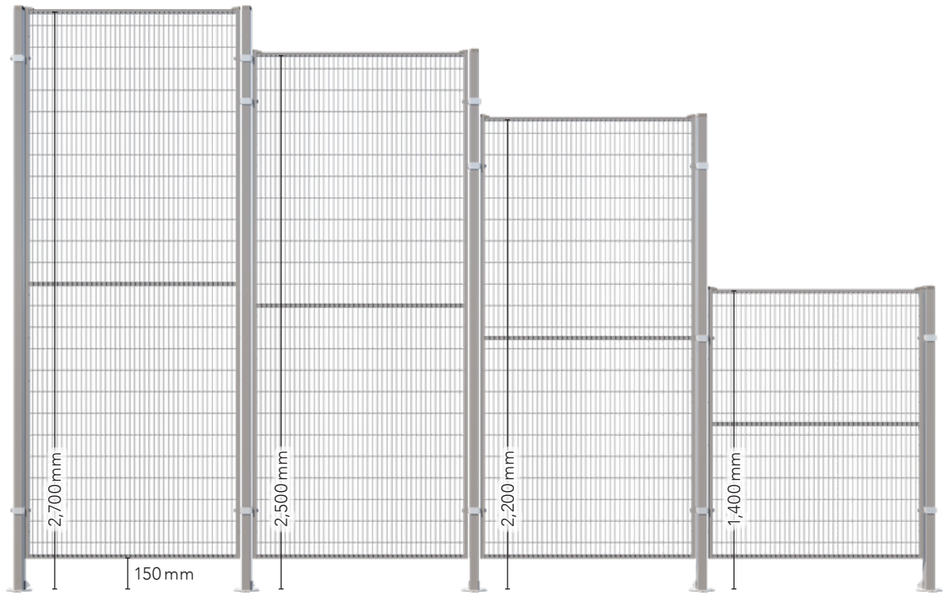
THE FOLLOWING STANDARDS OFFER GOOD GUIDANCE FOR THE MANUFACTURE OF SAFETY DEVICES:

- *ISO 11161, Safety of machinery – Integrated manufacturing systems – Basic requirements (ISO 11161:2007).*
- *ISO 13855, Safety of machinery – Positioning of safeguards with respect to the approach of the human body (ISO 13855:2024).*
- *EN ISO 13857, Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs.*
- *ISO 14120, Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards (ISO 14120:2015).*
- *ISO 14119, Safety of machinery – Interlocking devices associated with guards – Principles for design and selection (ISO 14120:2024).*



ISO 13857:2019

SAFETY OF MACHINERY – SAFETY DISTANCES TO PREVENT HAZARD ZONES BEING REACHED BY UPPER AND LOWER LIMBS



SCOPE

This document establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached. The safety distances are appropriate for protective structures. It also gives information about distances to impede free access by the lower limbs. It covers people of 14 years and older (the 5th percentile stature of 14 years and older is approximately 1,400 mm). In addition, for upper limbs only, it provides information for children older than 3 years (5th percentile stature of 3 years and older is approximately 900 mm) where reaching through openings needs to be addressed.

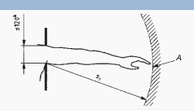
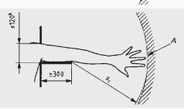
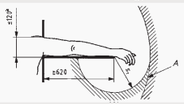
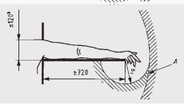
4.2.2.2 REACHING OVER PROTECTIVE STRUCTURES

Table 2 – Dimension in millimeters.

HEIGHT OF HAZARD ZONE, A	HEIGHT OF PROTECTIVE STRUCTURE, B									
	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,500	2,700
	HORIZONTAL SAFETY DISTANCE TO HAZARD ZONE, C									
2,700	0	0	0	0	0	0	0	0	0	0
2,600	900	800	700	600	600	500	400	300	100	0
2,400	1,100	1,000	900	800	700	600	400	300	100	0
2,200	1,300	1,200	1,000	900	800	600	400	300	0	0
2,000	1,400	1,300	1,100	900	800	600	400	0	0	0
1,800	1,500	1,400	1,100	900	800	600	0	0	0	0
1,600	1,500	1,400	1,100	900	800	500	0	0	0	0
1,400	1,500	1,400	1,100	900	800	0	0	0	0	0
1,200	1,500	1,400	1,100	900	700	0	0	0	0	0
1,000	1,500	1,400	1,000	800	0	0	0	0	0	0
800	1,500	1,300	900	600	0	0	0	0	0	0
600	1,400	1,300	800	0	0	0	0	0	0	0
400	1,400	1,200	400	0	0	0	0	0	0	0
200	1,200	900	0	0	0	0	0	0	0	0

4.2.3 REACHING AROUND WITH LIMITATION OF MOVEMENT

Table 3 – shows examples of fundamental movements covering people of 14 years and older. Dimension in millimeters.

LIMITATION OF MOVEMENT	SAFETY DISTANCE, Sr	ILLUSTRATION
Limitation of movement only at shoulder and armpit	≥ 850	
Arm supported up to elbow	≥ 550	
Arm supported out to wrist	≥ 230	
Arm and hand supported up to knuckle joint	≥ 130	

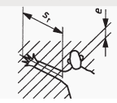
Protective structures lower than 1,400 mm should not be used without additional safety measures.

A = The range of movement of the arm.
Sr = The radial safety distance.

a = This is either the diameter of a round opening, or the side of a square opening, or the width of a slot opening.

4.2.4.1 REACHING THROUGH REGULAR OPENINGS

Table 4 – The values in the table below apply solely to persons aged 14 years and over. Dimension in millimeters.

PART OF BODY	ILLUSTRATION	SAFETY DISTANCE, Sr			
		OPENING	SLOT	SQUARE	ROUND
Fingertip		e ≤ 4	≥ 2	≥ 2	≥ 2
		4 < e ≤ 6	≥ 10	≥ 5	≥ 5
Finger up to knuckle joint		6 < e ≤ 8	20	≥ 15	≥ 5
		8 < e ≤ 10	≥ 80	≥ 25	≥ 20
		10 < e ≤ 12	≥ 100	≥ 80	≥ 80
or hand		12 < e ≤ 20	≥ 120	≥ 120	≥ 120
		20 < e ≤ 30	≥ 850 [1]	≥ 120	≥ 120
Arm up to junction with shoulder		30 < e ≤ 40	≥ 850	≥ 200	≥ 120
		40 < e ≤ 120	≥ 850	≥ 850	≥ 850

The shaded areas within the table delineate that part of the body restricted by the opening size.
[1] If the length of the slot opening is ≤ 65 mm, the thumb will act as a stop and the safety distance can be reduced to 200 mm.

4.3 DISTANCE TO IMPEDE FREE ACCESS BY LOWER LIMBS

Table 7 – The values in the table below are independent of whether clothes or footwear are being worn and are applicable for persons of 14 years of age and above. Dimension in millimeters.

PART OF LOWER LIMB	ILLUSTRATION	SAFETY DISTANCE, Sr		
		OPENING	SLOT	SQUARE OR ROUND
Toe tip		e ≤ 5	0	
		5 < e ≤ 15	≥ 10	0
Toe		15 < e ≤ 35	≥ 80	≥ 25
Foot		35 < e ≤ 60	≥ 180	≥ 80
		60 < e ≤ 80	≥ 650	≥ 180
Leg (toe tip to knee)		80 < e ≤ 95	≥ 1,100	≥ 650
Leg (toe tip to crotch)		95 < e ≤ 180	≥ 1,100	≥ 1,100
		180 < e ≤ 240	Not applicable	≥ 1,100

The shaded areas within the table delineate that part of the body restricted by the opening size. If the length of a slot opening is ≤ 75 mm, the safety distance can be reduced to ≥ 50 mm. Slot openings e > 180 mm, square and round openings e > 240 mm permit full body access. Additional safety measures must be taken.

4.4 CONSIDERATION OF WHOLE BODY ACCESS

Protective structures with slot opening with e > 180 mm and square or round opening with e > 240 mm shall not be used without additional protective measures since they can allow whole body access. Protective structures less than 1,400 mm in height, shall not be used without additional protective measures. The consideration of the whole body access either by climbing over or by crouching under protective structures is indispensable for the application. Appendix B of EN ISO 13857 details special cases for safety devices that solely prevent access for persons in a standing position. As there is a risk of slipping or sliding through – something that cannot be ruled out in a normal industrial environment – the specified values are deemed to be of little use. We have therefore not included these.

ISO 14120:2015

SAFETY OF MACHINERY – GENERAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION OF FIXED AND MOVABLE GUARDS

An updated version of ISO 14120 was published in 2015, and it replaced the old standard EN 953. Requirements for safety has been updated and tightened to comply with the Machinery Directive, the definitions and terms has been updated, validation and verification has a new table and the information of use is very clear with who can remove guards and what the manual shall include.

TYPE OF STANDARD
ISO 14120 is a type-B2 standard as stated in ISO 12100. Guards provide a risk reduction for both protection against unintended access and against ejected parts and substances. The guarding can also give protection against others hazards e.g. noise, fire, biological hazards, radiation.

SCOPE
ISO 14120 is an International Standard that specifies general requirements for the design, construction and selection of guards provided to protect persons from mechanical hazards. It indicates other hazards that can influence the design and construction of guards and it applies to guards for machinery which will be manufactured after it is published. The requirements are applicable if fixed and movable guards are used. This International Standard does not cover interlocking devices, these are covered in ISO 14119.

ISO 14120 does not provide requirements for special systems relating specifically to mobility or to the ability to lift loads such as ROPS (Rollover Protective Structures), FOPS (Falling-Object Protective Structures) and TOPS (Tip over Protective Structures) are outside the scope of this standard.

IMPORTANT CLAUSES IN THE STANDARD
3.1 GUARD
Physical barrier, designed as part of the machine, to provide protection

» *alone, in which case it is only effective when "closed" (for a movable guard) or "securely held in place" (for a fixed guard), or*

» *in conjunction with an interlocking device with or without guard locking, in which case protection is ensured whatever the position of the guard.*

3.2 FIXED GUARD
Guard affixed in such a manner (for example by screws, nuts, and welding) that it can only be opened or removed by the use of tools or by destruction of the means by which the guards are affixed.

3.3 MOVABLE GUARD
Guard, which can be opened without the use of tools.

3.7 TOOL
Implement such as a key or wrench designed to open and close a fastener. Note to entry: An improvised implement such as a coin or a nail-file cannot be considered as a tool.

3.8 USE OF A TOOL
Action by a person under known and predetermined circumstances as part of a safe working procedure.

4 RISK ASSESSMENT
In order to select and design types of guards appropriate to particular machinery, it is important to assess the risk arising from the various hazards present at that machinery and the foreseeable categories of persons who can be exposed to the hazard(s) (see ISO 12100:2010, Clause 5).

5.1.3 CONTAINMENT OF EJECTED PARTS AND OTHER IMPACTS
Where there is a foreseeable risk of

» *ejection of parts (for example workpiece or broken tooling) from the machine,*

» *impacts from parts of machinery, or*

» *impacts from the operator,*
the guard shall, as far as practicable, be designed and constructed so as to contain and withstand such ejections and impacts. See Annexes B and C for options.

5.2.4 VIEWING
Where viewing of the process is required guards shall be designed and constructed to offer adequate viewing. This can eliminate the need for defeating them. See also 5.9.

5.3.9 REMOVAL OF FIXED GUARDS
Demountable fixed parts of guards shall only be removable with the use of a tool (see 3.8). See also 8.5 and 8.6.

» *Fixed guards shall be designed to prevent easy removal.*

NOTE 1 This is because operators may prefer to use an easily removable fixed guard instead of using an interlocked movable guard.

» *Quick release fasteners such as quarter turn screws shall not be used to secure fixed guards from outside the safeguarded space.*

NOTE 2 The use of fastenings that can be released quickly from the inside of the guarded area should not be regarded as an alternative to providing an emergency exit. The emergency release of guards with interlocking/guard locking is dealt with in ISO 14119. See also Clause 6, Selection of types of guards.

» *Quick release fasteners are not allowed to be used from the outside of the safeguarded space.*

5.3.10 MOUNTING OF REMOVABLE FIXED GUARDS
Fixed guards which are removable shall, where practicable, be unable to remain in place without their fixings.

5.3.12 MOVABLE GUARDS
The opening of movable guards shall require deliberate action. Where possible movable guards shall be attached to the machine or adjacent fixed elements so that they are retained, for example by hinges or slides, even when open. Such attachments shall only be removable with the use of a tool (see 3.8). Interlocked moveable guards shall be positioned relative to the hazard zone in accordance with ISO 13855.

REAL IMPACT TEST

using an ABB robot with magnetic gripper that ejects a steel tube of 52 kg into the Smart Fix machine guard.

5.4.2 IMPACT AND EJECTION RESISTANCE
Guards shall, as far as practicable, be designed and material selected to withstand and contain reasonably foreseeable impacts and ejections according to 5.1.3. Materials for viewing panels shall be selected with properties suited to resist the mass and velocity of the ejected object or material. Where guards are fitted with viewing panels, special consideration shall be given to the selection of materials and method of fixing them. Guards shall resist static and dynamic forces (pressure, impacts) according to the risk assessment.

NOTE The impact resistance depends e.g. on the properties of the material being used, its strength, the fixing and its aging.

» *The risk assessment shall provide information on how much impact resistance the machine guard shall withstand.*

5.4.3 RIGIDITY
Support posts, guard frames, mountings, and infill materials shall be selected and arranged to provide a rigid and stable structure and to resist deformation. This is especially important where deformation of material could be detrimental to maintaining safety distances.

5.4.4 SECURE FIXING
Guards or parts of guards shall be secured by fixing points of adequate strength, spacing and number to remain secure under any foreseeable loading or impact. Fixing can be by means of mechanical fasteners or clamps, welded or bonded joints or other means suited to the application. See also 5.3.8.

5.12 ELECTROSTATIC PROPERTIES
Materials of the guard that enclose or is placed in an environment containing dust, fibres or particles shall be selected to prevent accumulation.
If there is a risk of static charge to a hazardous level, guards shall be designed in material with an electrical conductance high enough to avoid build-up of static charge or by other measures to prevent hazardous static charge. For consideration of ignition sources, see 5.1.7.

NOTE IEC/TR 61340-1 gives guidance on electrostatic problems and hazards.

EARTHING For Smart Fix system, the kit functional bonding creates an electrical bonding between panels and posts, solving problems with leakage current.

5.13 GUARDS WITH ELECTRICALLY CONDUCTIVE PARTS
Where guards are made of electrically conductive material and used in electrically powered machines, they may need to be considered as "extraneous conductive parts of the machine" according to IEC 60204-1:2005, clause 8.

5.18 CLIMBING
Climbing on guards shall, as far as practicable, be inhibited by design. Consideration shall be given to this possibility in their construction and the selection of materials and shapes. For example, by eliminating horizontal structural members and the horizontal component of mesh fabric from the outside surface of the guard, climbing is made more difficult.

CAPTIVE BOLTS The bolt that attaches the panel to the post in the Smart Fix system is held captive even when the system is disassembled, fulfilling the standards and rules for machine guarding.

5.19 RETAINED FASTENINGS
When it is foreseen (for example maintenance) that the fixed guard will be removed, then the fastenings shall remain attached to the guard or to the machinery. The requirement does not necessarily apply to fixed guards that are only liable to be removed, for example, when the machinery is completely overhauled, is subject to major repairs or is dismantled for transfer to another site. For the same reason, it may not be necessary to apply the requirement for retained fastenings to the casings of machinery if,

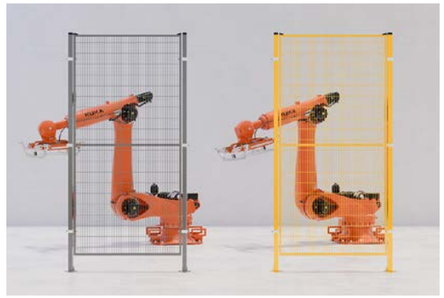
» *the manufacturer's instructions specify that the repairs requiring removal of these casings are only to be carried out in a specialist repair workshop, and*

» *fastenings, as far as practicable, shall only be removable by the use of a tool.*
See Annex A for examples of retained fastenings.

NOTE This requirement aims to reduce risks due to loss of one or more of the fixings when guards are removed, for example, for maintenance purposes. This can lead to the guards not being replaced, being only partially fixed in place or fixed with replacement fixings that do not have adequate strength, so that the guard cannot adequately perform its protective function, for example, where containment of ejected parts is necessary.

5.22 COLOUR
Attention can be drawn to the hazard while the guard is opened or left off by highlighting the hazard by the use of suitable colours. For example if a guard is painted the same colour as the machine then the hazardous parts is painted a contrasting bright colour. Care should be taken in the selection and combination of colours to avoid confusion, for example red and yellow in combination is normally used for emergency stop. When observation of the process is required, guards of perforate material should not be painted in bright colours, e.g. yellow, that might interfere with the viewing of the process.

NOTE For further information see EN 614-1.



6.2 COMBINATION OF DIFFERENT GUARDS OR OF GUARDS WITH OTHER DEVICES
It can be appropriate to use a combination of different types of guards. For example:

» *if a machine has several hazard zones and access is required to one of them during the operating phase, the guards can consist of a fixed guard combined with an interlocking movable guard;*

» *if a perimeter fence is used to prevent access to the hazard zones of a machine, an interlocked gate would normally be required to provide safe access.*

In a similar way, a combination of protective devices and guards can sometimes be required.

EXAMPLE Where a mechanical feed device is used in conjunction with a fixed guard to feed workpieces into a machine (thereby removing the need for access to the hazard zone), a sensing protective device (see ISO 12100:2010, 3.28.5) can be required to protect against a secondary trapping or shearing hazard between the mechanical feed device and the fixed guard.

6.3 SELECTION OF GUARDS ACCORDING TO THE NUMBER AND SIZE OF THE HAZARDS
Where practicable hazards shall be guarded by enclosing guards. When enclosing guards are not practicable guards of the most appropriate type must be selected e.g. fixed guards (distance or perimeter), movable guards, adjustable guards (automatic or manual) (see 6.4). It is possible for a guard to protect multiple hazards and/or hazardous zones e.g. perimeter guarding with an interlocked access gate around an assembly of machines.
If a guard protects multiple hazards then the guarding shall be appropriate for all the hazards.

NOTE 1 When a hazardous area is separated into different zones to allow access to stationary machinery in one zone when machinery is operating on other zones, access to a zone still in operation by accessing a safe zone should be prevented by the use of appropriate safe guarding.

NOTE 2 Other safe guarding measures outside of the scope of this standard might be more suited to the hazard(s) identified and the intended operation of the machine.

It can be beneficial to the production process to divide a guarded area into different zones, to enable actions (for example checking, adjustment) in one zone to be carried out without affecting machine operation in another zone. In this case, the guarding for each zone shall be in accordance with all the requirements of this International Standard.

6.4.4.1 WHERE ACCESS IS REQUIRED ONLY FOR MACHINE SETTING, PROCESS CORRECTION OR MAINTENANCE
The following types of guard should be used:

a) **MOVABLE GUARD** if the foreseeable frequency of access is high (e.g. more than once per week) or if removal or replacement of a fixed guard would be difficult. Movable guards shall be associated with an interlock or an interlock with guard locking (see ISO 14119);

b) **FIXED GUARD** only If the foreseeable frequency of access is low (e.g. less than once per week), its replacement is easy and its removal and replacement are carried out under a safe system of work.

» *If access is requested more than once per week, a movable guard (a door) shall be installed.*

7.2 VERIFICATION AND VALIDATION METHODS
Verification and validation can be satisfied by methods including but not limited to:

» *Visual inspection (A);*

» *Practical tests (B);*

» *Measurement (C);*

» *Observation during operation (D);*

» *Review of task-based risk assessment (E);*

» *Review of specifications, layout and documentation (F).*

8.1 GENERAL (INFORMATION FOR USE)
The instructions for use shall contain the required information about guards, their safety parameters and their functions (e.g. vertical or horizontal orientation), including installation and maintenance (see ISO 12100:2010, 6.4).

8.2 GUARD HAZARDS
Information shall be provided for any hazards associated with the guards themselves, for example mechanical hazards or flammability of materials and relevant test results. We provide third party test results.

8.3 INSTALLATION
Instructions shall be supplied for the correct installation of guards and associated equipment. When guards are to be attached to a structure, the instructions shall include requirements for fixing. This includes but is not limited to:

» *fixing to a floor;*

» *assembling of movable guards;*

» *number and types of fixings;*

» *compliance with other relevant standards, e.g. ISO 13857 and ISO 14119.*

NOTE When guards are designed to be fixed to a concrete floor, instructions for installation can refer to concrete classification. See for example EN 206-1 with classes C20/25 to C50/60 for compressive strength.

8.5 REMOVAL OF GUARDS
Information shall be provided indicating actions to be taken before guards are removed, for example machine power isolation, dissipation of stored energy and procedures for the removal of guards. The information shall also prescribe requirements on procedures for the removal of guards, including

» *the appropriate use of a tool (see 3.9) and*

» *the safe working procedure.*

NOTE See also ISO 14118 and IEC 60204-1:2005, 5.3 and 5.4.

8.6 INSPECTION AND MAINTENANCE
Details shall be provided of inspections to be carried out and maintenance required for, including:

» *loss of or damage to any part of the guard, especially where this leads to deterioration of safety performance, for example reduction of impact resistance from scratches to glazing materials;*

» *deformed or damaged part shall be repaired or replaced if the damage has negative influence on safety;*

» *replacement of wearing parts;*

» *correct operation of interlocks;*

» *degradation of jointing or fixing points;*

» *degradation by corrosion, temperature change, embrittlement or chemical attack;*

» *satisfactory operation and lubrication, if necessary, of moving parts;*

» *modification of safety distances and aperture sizes;*

» *degradation of acoustic performance, if applicable.*

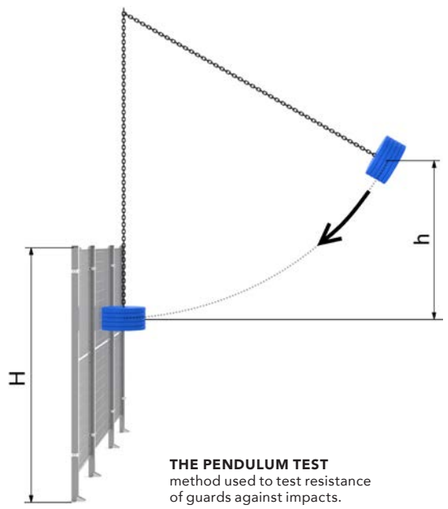
The information for use shall include requirements on the use of a tool (see 3.9).

ANNEX A, ANNEX B
Annex A shows example of retained fastening and Annex B shows example of projectile test method for mechanically testing guards.

ANNEX C
Annex C gives example of the pendulum test method for mechanically testing guards. The pendulum test method can be used to test the resistance of guards against impacts from outside the protected hazard zone and from inside the hazard zone.

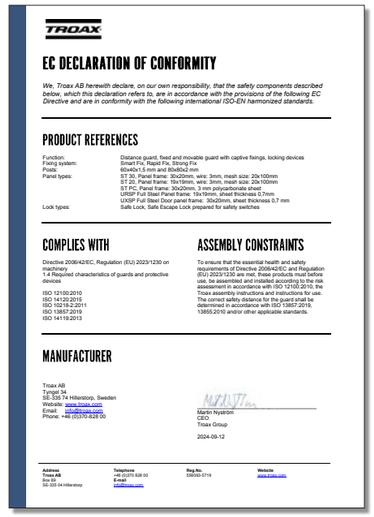
The test method is based upon the impact of a “body”, which might be a human body (soft body) or a part of a machine (hard body) falling under the effect of gravity and simulating the contact by the human body with the guard or by part of the machine with guard.

Annex C describes test equipment, test object, test impact energies, resistance of guards against impacts from outside the hazard zone and resistance of guards against impacts from inside the hazard zone and what type of results and test reports that are required.



THE PENDULUM TEST
method used to test resistance of guards against impacts.

EC DECLARATION OF CONFORMITY



TROAX

EC DECLARATION OF CONFORMITY

We, Troax AB herewith declare, on our own responsibility, that the safety components described below, which this declaration refers to, are in accordance with the provisions of the following EC Directive and are in conformity with the following international ISO-EN harmonized standards.

PRODUCT REFERENCES

Function: Distance guard, fixed and movable guard with captive fixings, locking devices
Fixing system: Smart Fix, Rapid Fix, Strong Fix
Posts: 60x40x1,5 mm and 80x80x2 mm
Panel types: ST 20, Panel frame: 30x20mm, wire: 3mm, mesh size: 20x100mm
ST 25, Panel frame: 30x20mm, wire: 3mm, mesh size: 25x100mm
ST PC, Panel frame: 30x20mm, 3 mm polycarbonate sheet
UXSP Full Steel Panel frame: 10x10mm, sheet thickness 0,7mm
UXSP Full Steel Door panel frame: 30x20mm, sheet thickness 0,7 mm
Lock types: Safe Lock, Safe Escape Lock prepared for safety switches

COMPLIES WITH

Directive 2006/42/EC, Regulation (EU) 2023/1230 on machinery
1.4 Required characteristics of guards and protective devices

ISO 12100:2010
ISO 14120:2015
ISO 19218-2:2011
ISO 13857:2019
ISO 14119:2013

ASSEMBLY CONSTRAINTS

To ensure that the essential health and safety requirements of Directive 2006/42/EC and Regulation (EU) 2023/1230 are met, these products must before use, be assembled and installed according to the risk assessment and instructions in the Troax CAD tool, Troax assembly instructions and instructions for use. The correct safety distance for the guard shall be determined in accordance with ISO 13857:2019, 13855:2010 and/or other applicable standards.

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A Declaration of Conformity is a statement made by the manufacturer, or their representative, confirming that the product meets all relevant safety requirements outlined in the Machinery Directive 2006/42/EC. This declaration is a self-certification that the product has been designed and constructed in compliance with the Machinery Directive. It is important to note that a Declaration of Conformity is not a quality certificate or a safety certificate.

The Declaration of Conformity is an integral part of the CE marking process for integrators and end users. Market surveillance authorities assume that CE-marked products are accompanied by a Declaration of Conformity unless they have evidence to the contrary, such as through examination or testing of the product.

When multiple directives apply to a piece of machinery, the conformity assessment procedures required by each directive may differ. In such cases, the conformity assessment conducted for each directive will focus only on the specific aspects addressed by that directive.

ATEX Directive (Directive 2014EC34 on equipment and protective systems intended for use in potentially explosive atmospheres).

R&TTED (Directive 1999/5/EC45 on radio and telecommunications terminal equipment).

ROHS (Directive 2002/95/EC49 on the restriction of the use of certain hazardous substances in electrical and electronic equipment).

EMCD (Directive 2014/30/EU on electromagnetic compatibility).

LVD (Directive 2014/35/EC on lifts).

RISK ASSESSMENT

WHAT IS A RISK ASSESSMENT?
According to ISO 12100, a risk assessment is a systematic process for identifying and evaluating potential hazards associated with machinery. These standard outlines a structured approach to ensuring machinery safety.

A risk assessment is a crucial component of health and safety management. It primarily aims to identify the necessary measures to comply with regulations set by authorities.

WHY CONDUCT A RISK ASSESSMENT?
Conducting a risk assessment is essential for safeguarding your workers and business and ensuring compliance with local rules and regulations. It is especially important to conduct a risk assessment before you or any other employees engage in work that poses a risk of injury or ill health.

HOW TO DO A RISK ASSESSMENT?
There are no fixed rules for conducting a risk assessment, but a few general principles should be followed. Five steps can ensure that your risk assessment is conducted correctly. These five steps are:

- → IDENTIFY THE HAZARDS
- → DECIDE WHO CAN BE HARMED AND HOW
- → EVALUATE THE RISKS AND TAKE ACTION
- → RECORD THE RISKS AND ELIMINATE THEM
- → REVIEW THE ASSESSMENT AND UPDATE IT WHEN NECESSARY

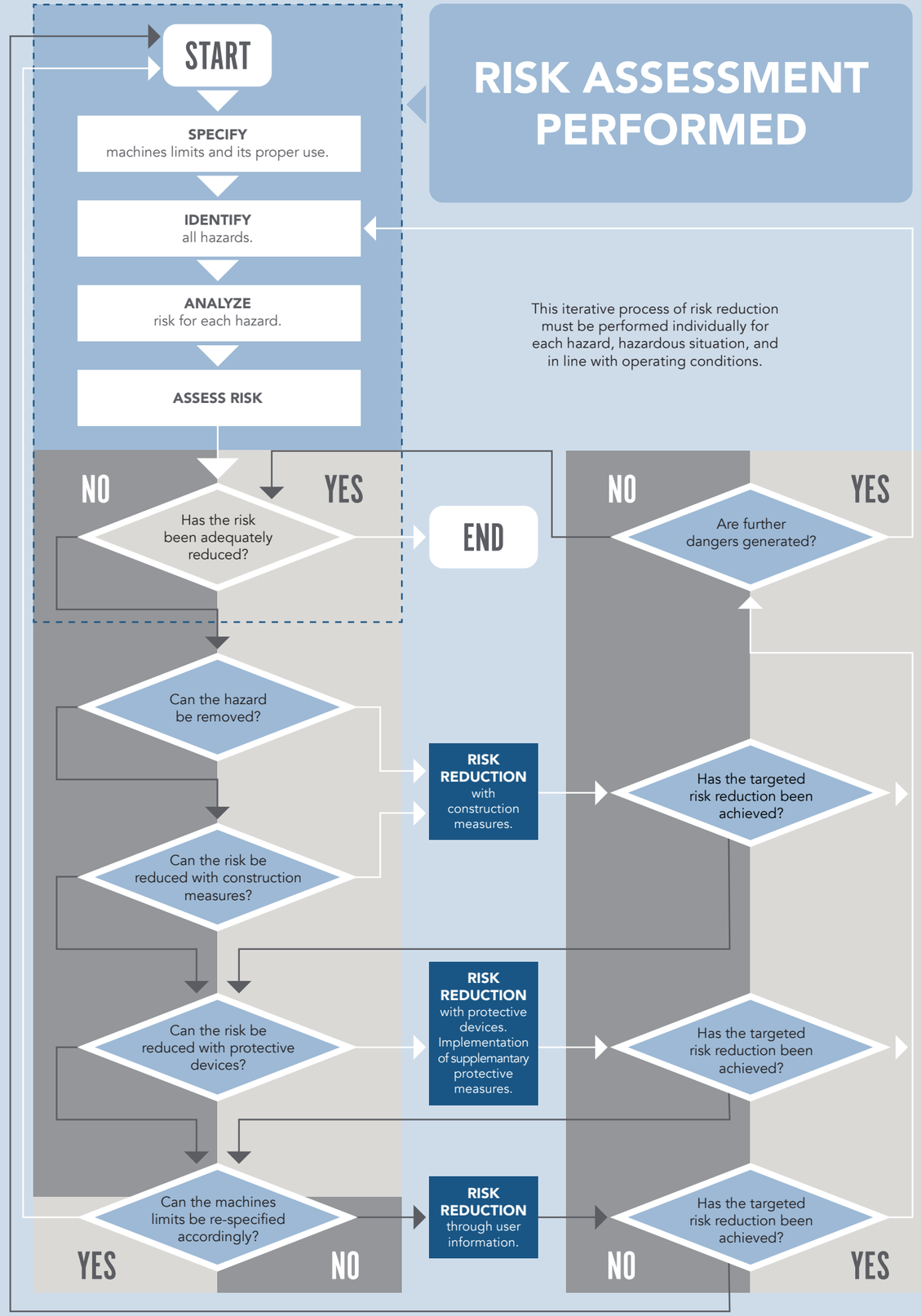
STEP 1: IDENTIFY THE HAZARDS
To identify hazards, it's important to understand the distinction between a "hazard" and "risk." A hazard refers to something that has the potential to cause harm, while the risk is the likelihood that the potential harm will occur. You can identify hazards using various techniques, such as walking around the workplace and asking your employees for input.

STEP 2: DECIDE WHO CAN BE HARMED AND HOW
After identifying hazards, it is important to know who is at risk and how, such as 'warehouse employees' or 'members of the public.'

STEP 3: EVALUATE THE RISKS AND TAKE ACTION
After identifying hazards, we must determine who might be harmed and how to safeguard those individuals. Hazards shall be eliminated, or risk reduction measures should be implemented. The risks shall be thoroughly verified and validated.

STEP 4: RECORD THE RISKS AND ELIMINATE THEM
It is a legal requirement to document risks. Doing so demonstrates that you have identified potential hazards, assessed who may be harmed and how, and outlined your plans for eliminating these risks and hazards.

STEP 5: REVIEW THE ASSESSMENT AND UPDATE IT WHEN NECESSARY
Always remember that workplaces are constantly evolving. It is essential to ensure that established safety procedures are consistently followed (for example, supervisors and line managers should adhere to management's safety instructions). Additionally, consider new working practices, emerging technologies, and increased work targets that may impact safety.



TÜV TYPE APPROVED

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Regular Production Surveillance
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TESTED QUALITY IMPROVES SAFETY
Troax machine guarding systems ensure safety for both people and machines. It is important to us that you feel secure using our products. At our Test Centre, we conduct impact tests on our product systems, including panels, brackets, and accessories, to verify their functionality and maintain our internationally recognised high quality. TÜV Rhineland certifies both our products and our testing methods. This independent testing institute assesses the safety of various products and services to protect people and the environment from potential hazards.

TROAX TEST CENTER
Our Research & Development department continuously optimises products and system solutions.

Over the past decades, more than eight hundred tests have been performed in our Test Center. All our machine guarding systems are tested in accordance with the test method stated in Annex C, ISO 14120. The tests are conducted by dropping weights onto the protection, weights equivalent to forces of 309 joules up to 2,500 joules. For example, an impact of 1,600 joules is equivalent to 100 kg hitting the protection at 20 km/h.

TEST REPORTS
All systems and panels have been tested. Test reports detailing the type of panel, post, and bracket tested are available for download on our website. Watch the impact test videos and read more at **www.troax.com**.

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