Machine Guarding as per BIS & ISO standard

ISSA - Functional Safety and Validation

tec.nicum
Schmersal Group

Trainer
Gaurav Gore
26th Sep 2023

tec.nicum
Schmersal Group

Name: - **Gaurav Gore**
Designation: - **Safety Consultant – tec.nicum**
Education: - **Mechanical Engineering**
Machinery Safety Experience: - 6 years

Mr. Gore is working in Machinery safety from last 6 years. Mr. Gore has conducted Risk Assessment as per EN ISO 12100:2010 on machines from various sector like Food, Pharma , Automotive, Automobile, Oil and Gas industry, Process Industry and provided safety consulting services to customer from India & APAC countries. Mr. Gore has conducted more than 670 machines assessment and CE marking projects.

He has experience in design of machine guarding, develop safety circuits considering relevant Safety Standards like EN ISO 14120 , EN ISO 13849-1. He is trainer for Key Customers.

He has certified from the United Kingdom in **NEBOSH, OSHA, Fire Safety** and Risk Assessment.
Mr. Gore is certified by TUV Nord as **Certified Machinery Safety Experts (CMSE)** in 2019 CMSE(CERT-P13VA101) and **MCEExpert®**(TUV Rheinland)

Goal : Together with Customers & Partners, We are Turning workplaces into safer places

tec.nicum
Schmersal Group

tec.nicum
Schmersal Group

"The tec.nicum team powered by the Schmersal Group works to assure our clients receive the highest quality engineered safety service. Leveraging our extensive industry knowledge and application experience our goal is to help in the optimizing of production processes through efficient safety following the latest local and international standards. By utilizing our global network of safety engineers, tec.nicum is able to meet the safety requirements of our customers by providing a *neutral approach every time, everywhere*."

Vision & Mission

Goal : Together with Customers & Partners, We are Turning workplaces into safer places

tec.nicum
Schmersal Group

WHY tec.nicum

Services

tec.nicum
Schmersal Group

academy

- Seminars
- Customer-specific training
- Inhouse-training
- Presentations

Training centre

consulting

- Risk assessment
- Risk assessment (HSE)
- Lockout / Tagout
- CE conformity assessment
- Evaluation of machines and production lines
- Reports
- ATEX and hygiene

Consultancy

engineering

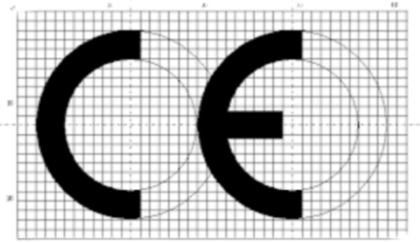
- Technical planning and project management
- Validation
- PLC programming
- CAD and CAE
- Design of safety equipment and fences
- Laboratory tests and measurements
- Modernisation of machines

Technical planning

integration

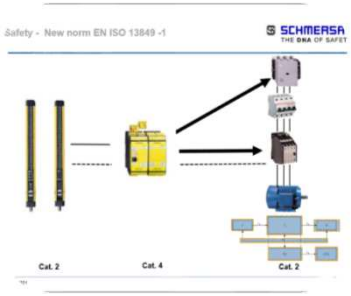
- Installation
- Conversion / Retrofit
- Machine safety maintenance

Design



[CE Services]

[Machine Guarding]



[Safety Implementation]

INTERNATIONAL LEGISLATION

BIS – ISO Association

tec.nicum Schmersal Group

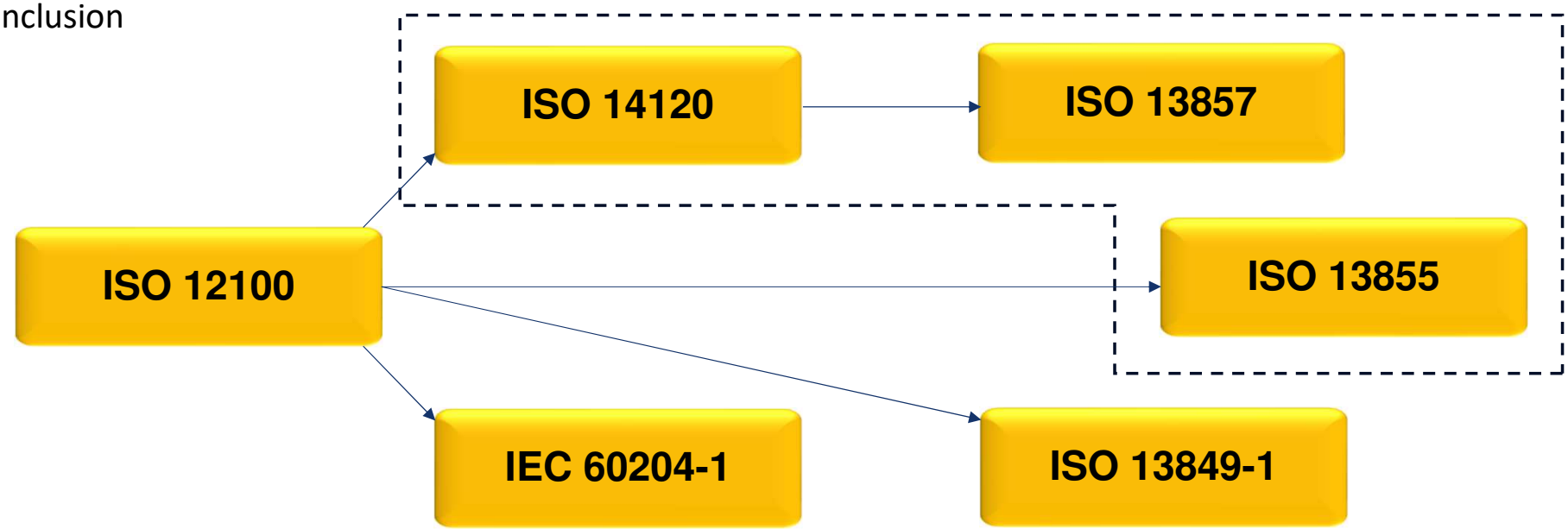
Bureau Of Indian Standards

ISO Standard	BIS Standard
ISO 12100:2010	IS 16819 : 2018
ISO 13849-1:2015	IS 16810-1 : 2018
ISO 13849-2:2012	IS 16810-2 : 2018
ISO 13850:2015	IS 16818 : 2018
ISO 13851:2002	IS 16817 : 2018
ISO 13854:2017	IS 16816 : 2019
ISO 13855:2010	IS 16815 : 2018
ISO 13856-1:2013	IS 16835-1 : 2018
ISO 13856-2:2013	IS 16835-2 : 2018
ISO 13856-3:2013	IS 16835-3 : 2018
ISO 13857:2008	IS 16814 : 2018
ISO 14118:2017	IS 16813 : 2019
ISO 14119:2013	IS 16812 : 2019
ISO 14120:2015	IS 16811 : 2018

ISO Standard	BIS Standard
ISO 14122-1:2016	IS 16809-1 : 2018
ISO 14122-2:2016	IS 16809-2 : 2018
ISO 14122-3:2016	IS 16809-3 : 2018
ISO 14122-4:2016	IS 16809-4 : 2018
ISO 14123-1:2015	IS 16834-1 : 2018
ISO 14123-2:2015	IS 16834-2 : 2018
ISO 14159:2002	IS 16808 : 2018
ISO 19353:2015	IS 16819 : 2018
ISO 21469:2006	IS 16912 : 2018
ISO 29042-1:2008	IS 16806-1 : 2018
ISO 29042-2:2009	IS 16806-2 : 2018
ISO 29042-3:2009	IS 16806-3 : 2018
ISO 29042-4:2009	IS 16806-4 : 2018
ISO 29042-5:2010	IS 16806-5 : 2018

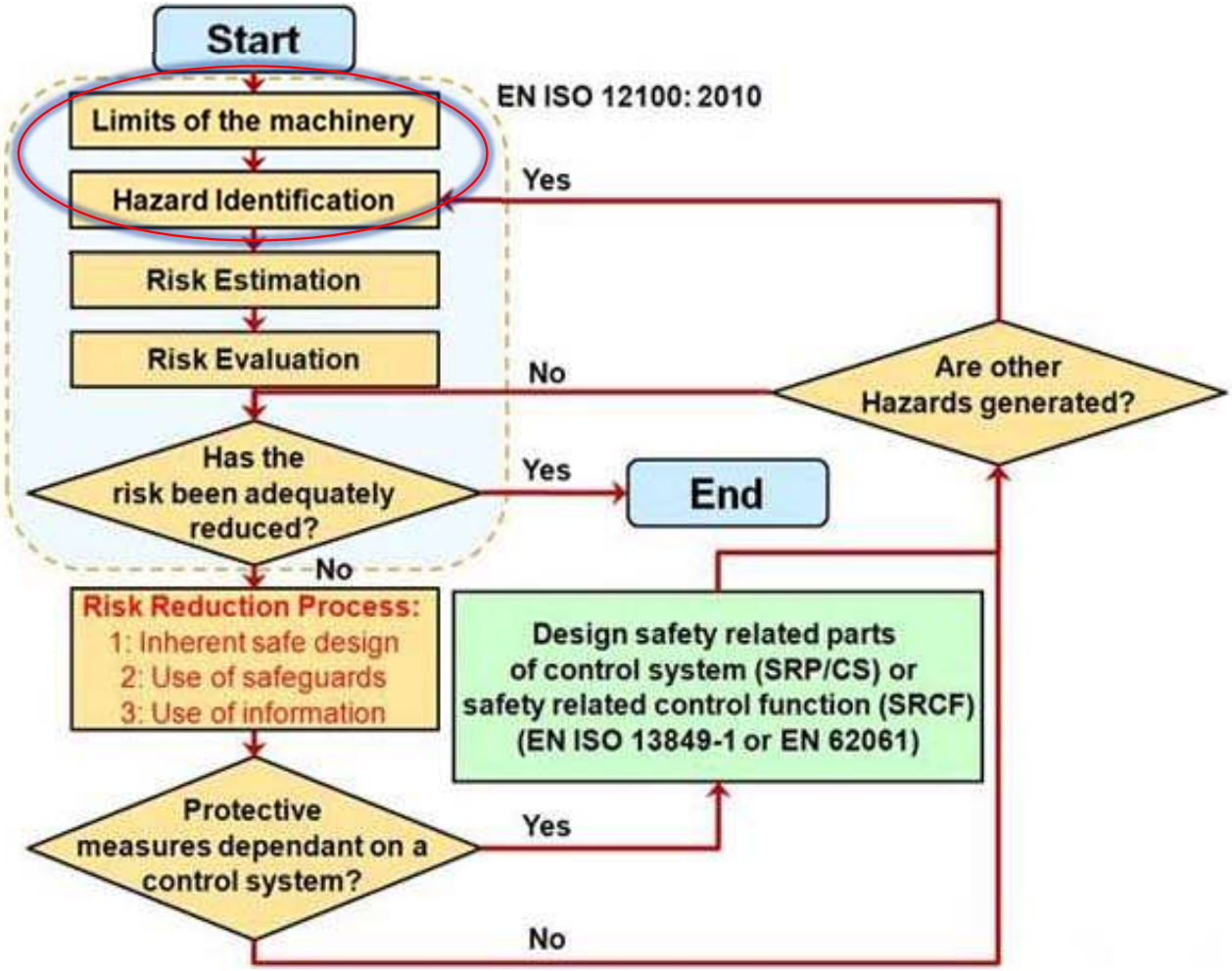
Agenda

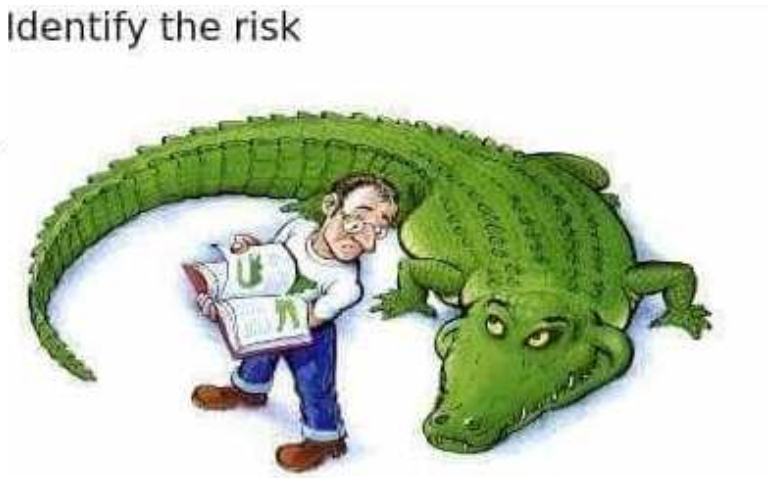
- Introduction
- Risk Reduction Process
- Machine Guarding
- Design Requirements – Fixed Guards
- Design Requirements – Safety Distance w.r.t Guard Design
- Design Requirements – Safety Components w.r.t Safe Distance
- Conclusion



Safe Design & Risk Reduction

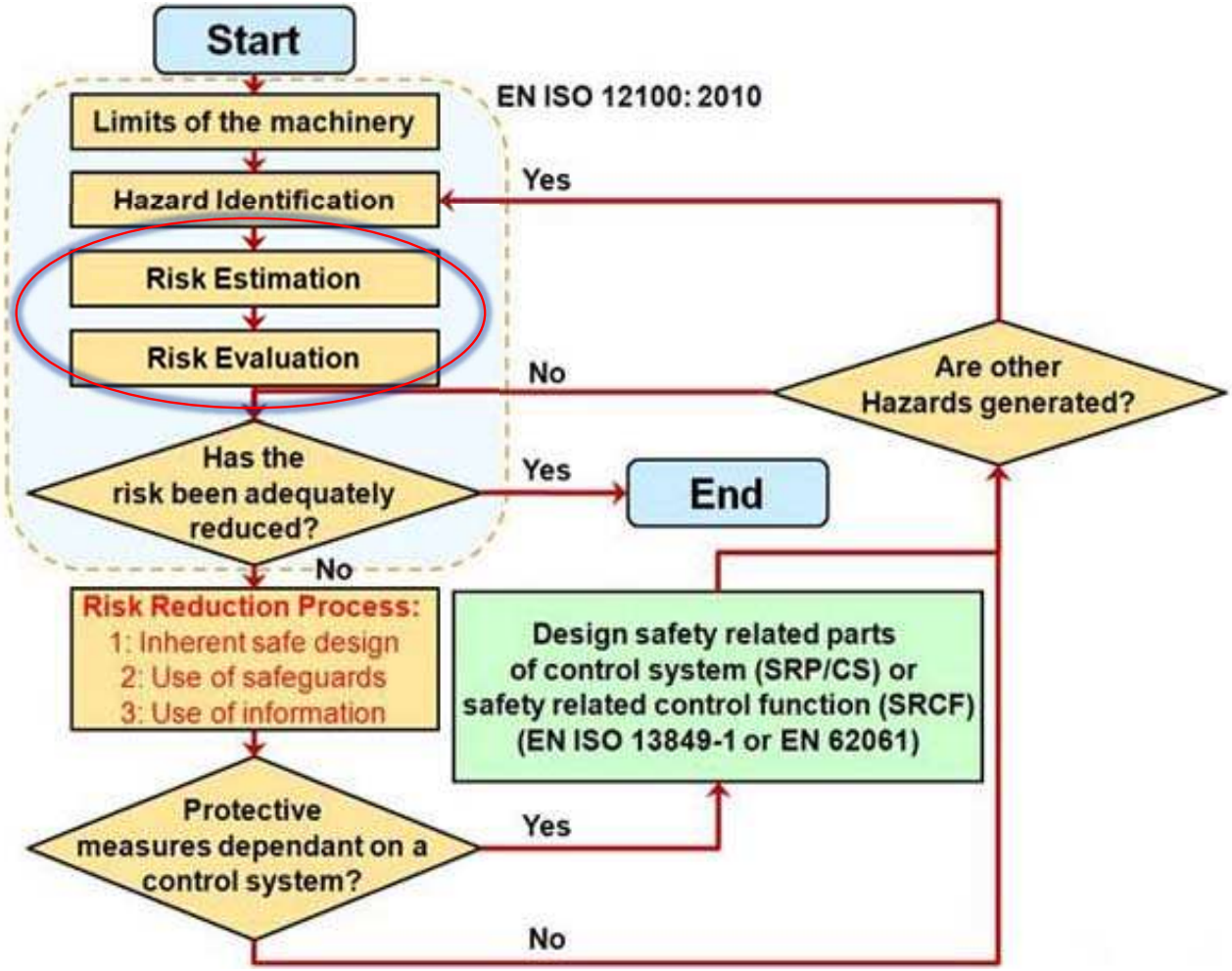
tec.nicum
Schmersal Group



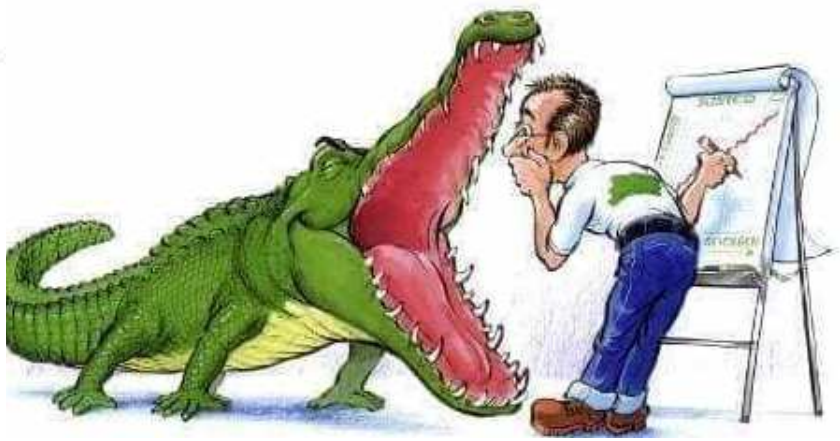


Safe Design & Risk Reduction

tec.nicum
Schmersal Group



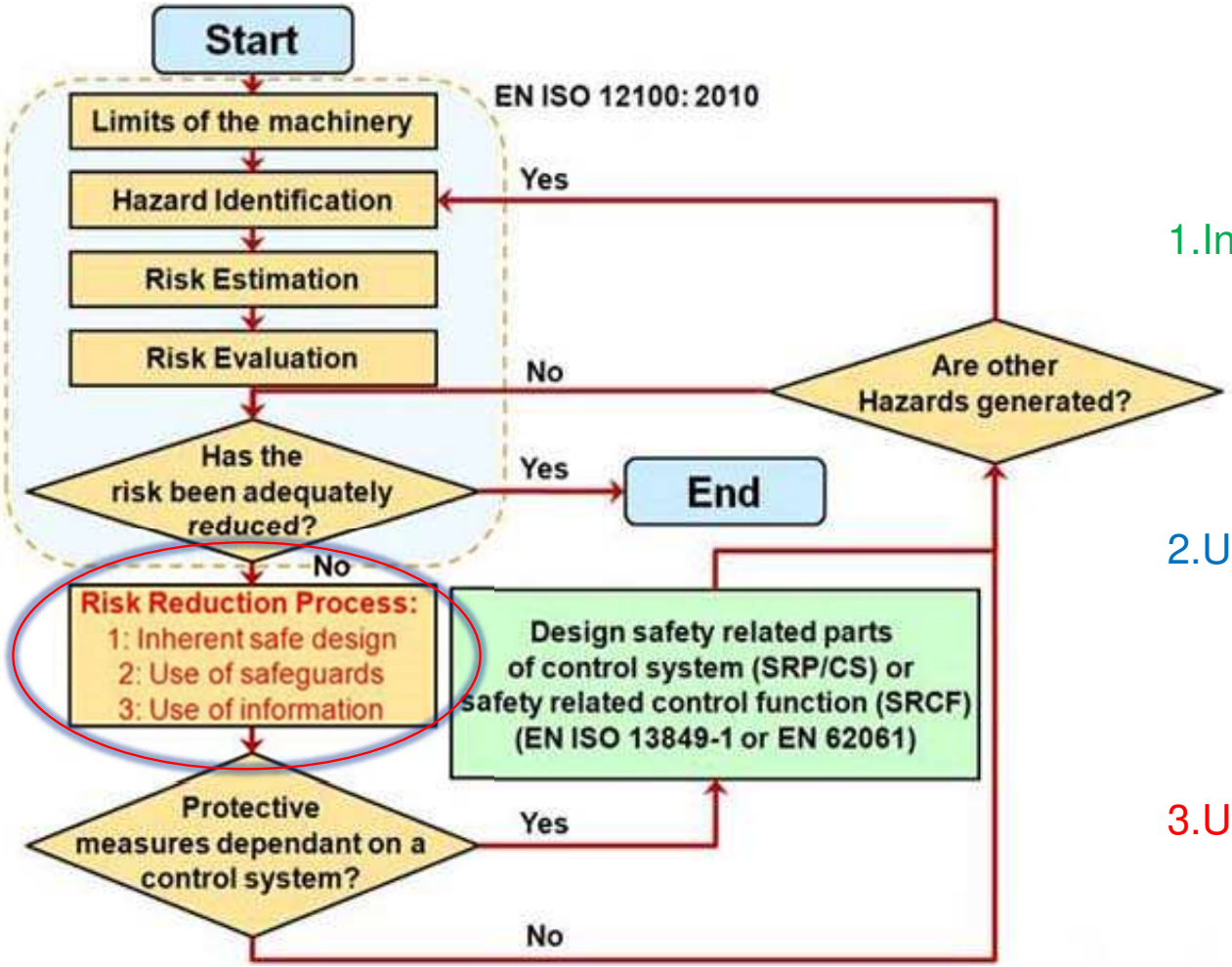
- Evaluate the risk



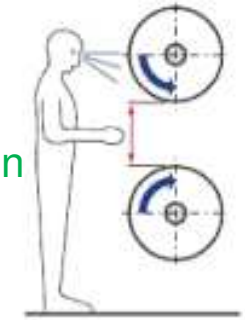
High Risk

Safe Design & Risk Reduction

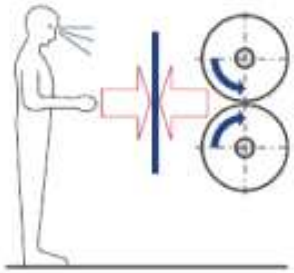
tec.nicum
Schmersal Group



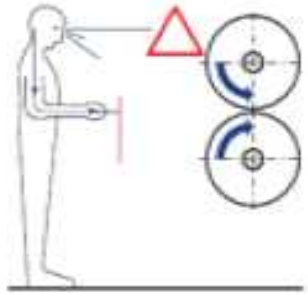
1.Inherently Safe Design



2.Use of Safeguards

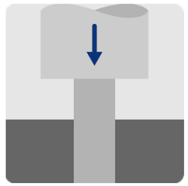


3.Use of Information

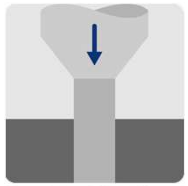


tec.nicum
Schmersal Group

Minimization of risks according to the 3-step method

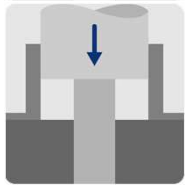


The “crushing point”



Direct (Inherent Safe Design)

Conical shoulder prevents closing of the form, limited course (minimum distance) prevents dangerous narrowing.



Indirect (Safety protective Measure)

- A well-secured protection covers the **crushing point** between the shoulder and the housing on all sides.

Signage (Information for use)

Warning against injuries to hand.

Avoid the hazards

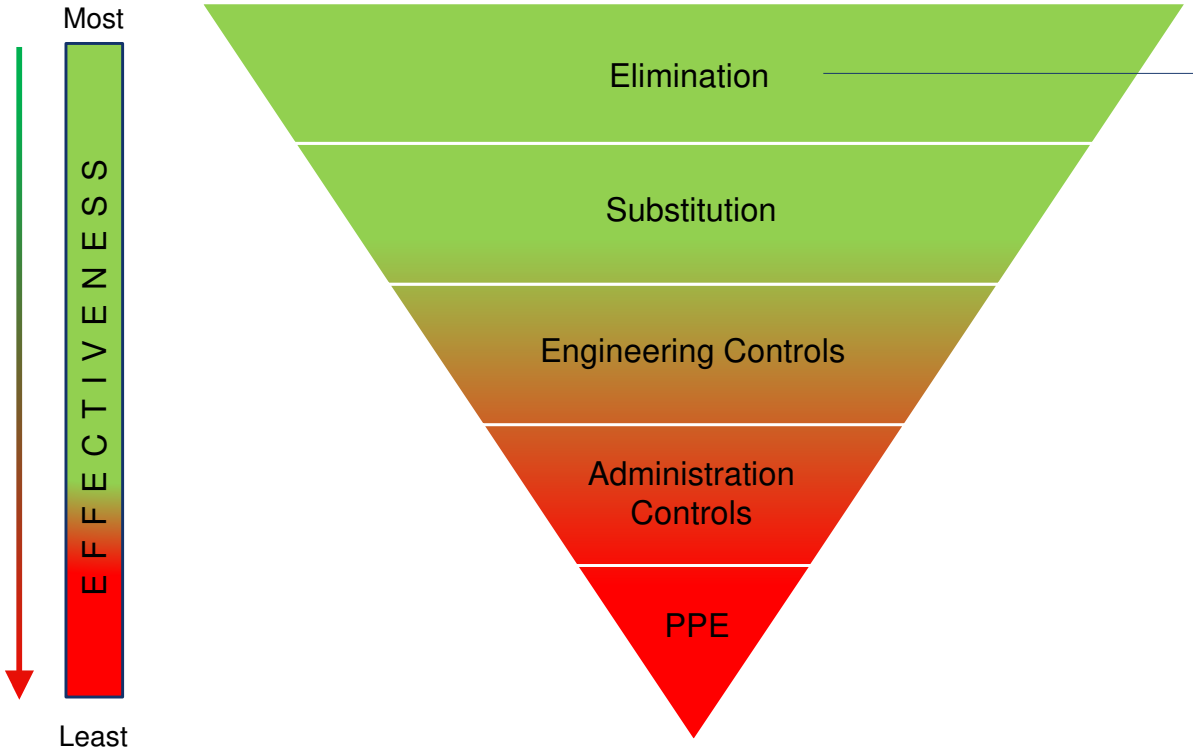
Protect hazards

Indicating hazards

Principles of effective mitigation of hazard

Hierarchy of Controls

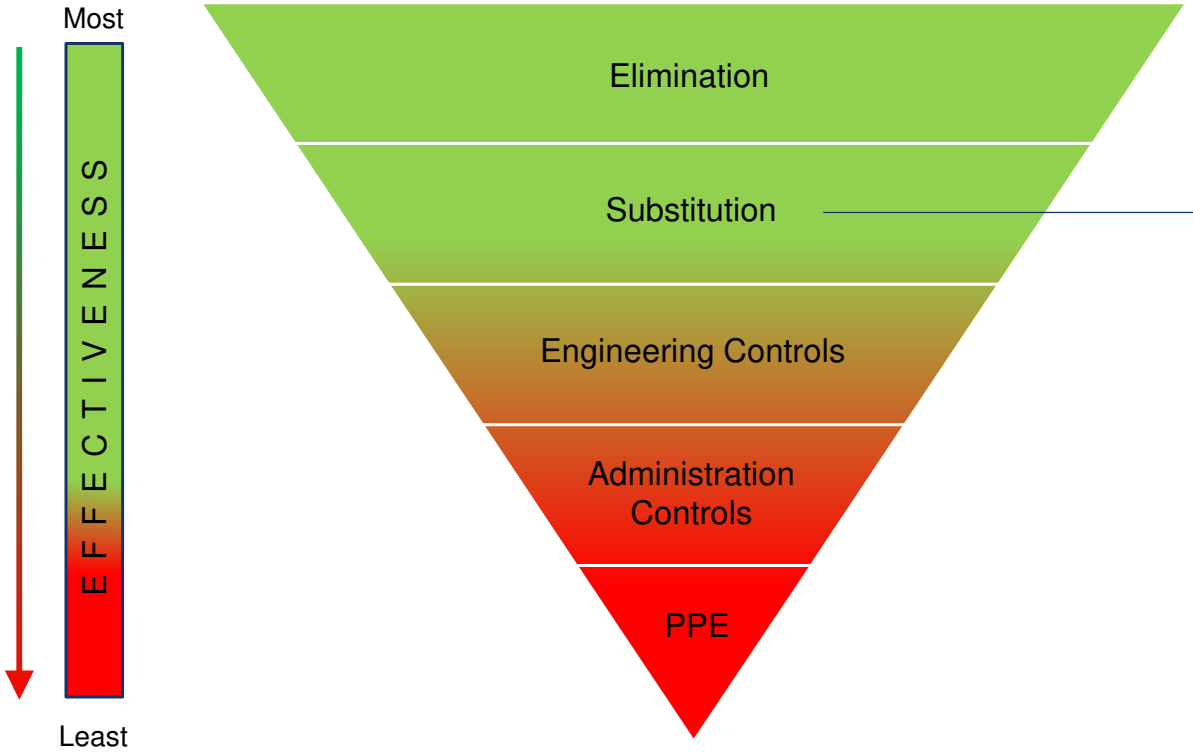
tec.nicum
Schmersal Group

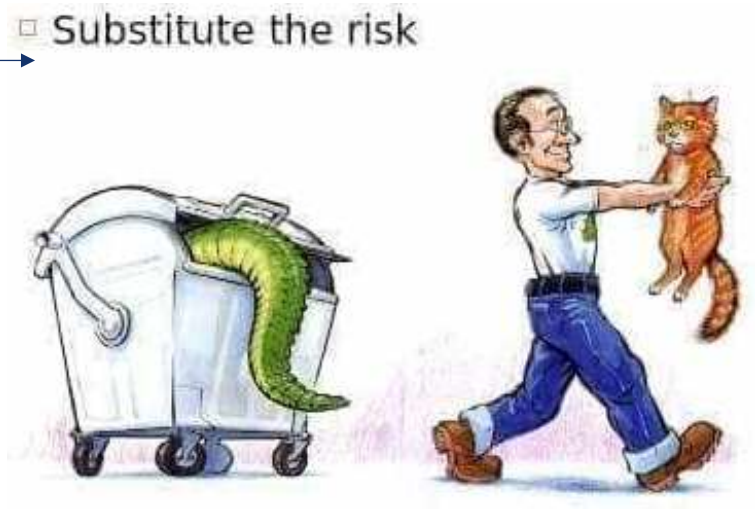


Principles of effective mitigation of hazard

Hierarchy of Controls

tec.nicum
Schmersal Group

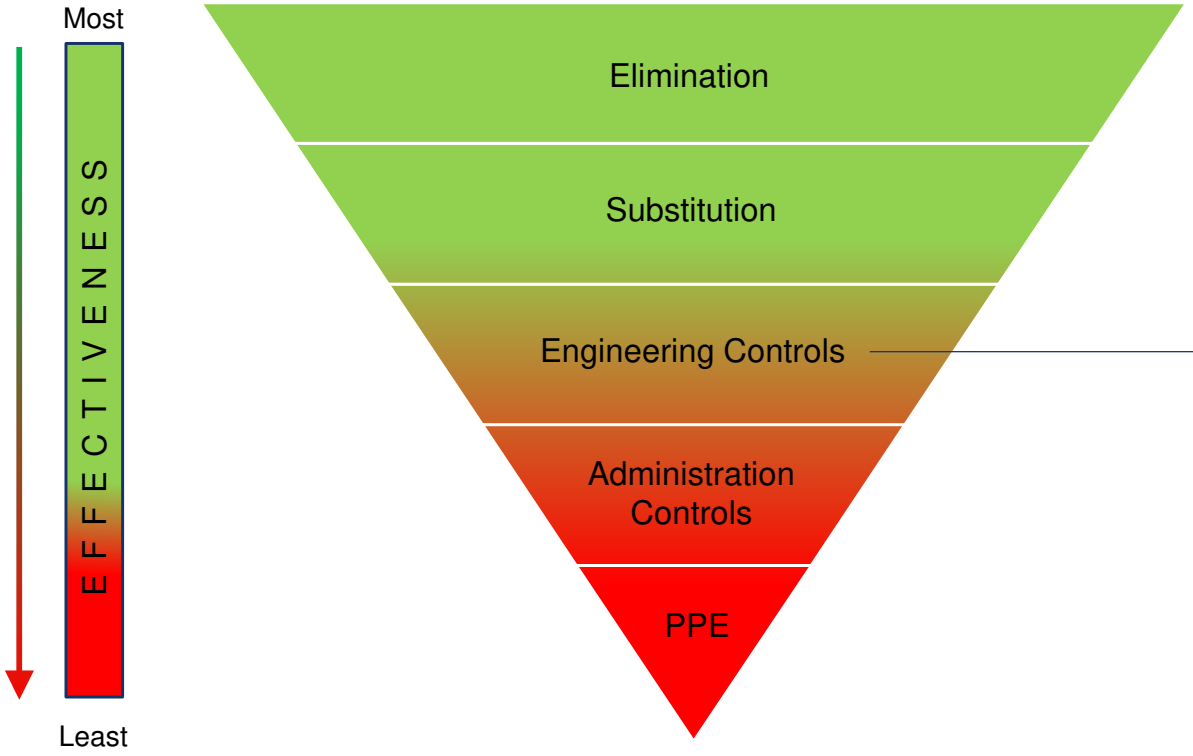




Principles of effective mitigation of hazard

Hierarchy of Controls

tec.nicum
Schmersal Group

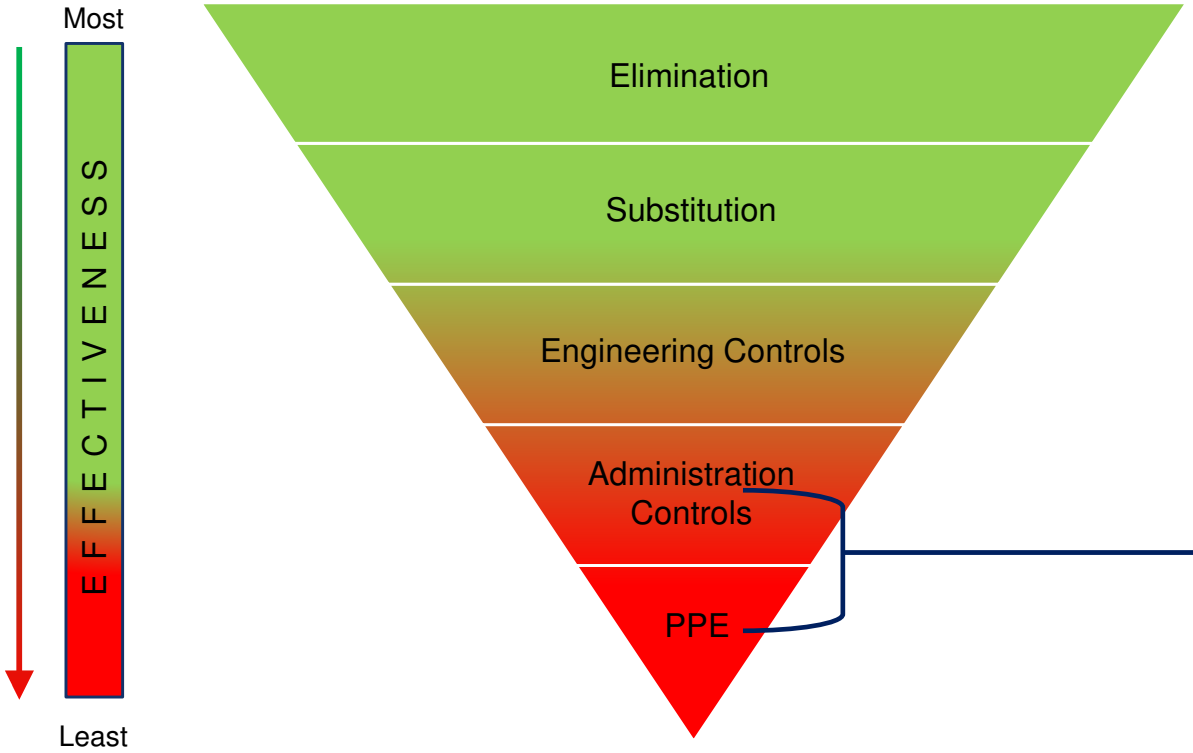


Isolate the risk

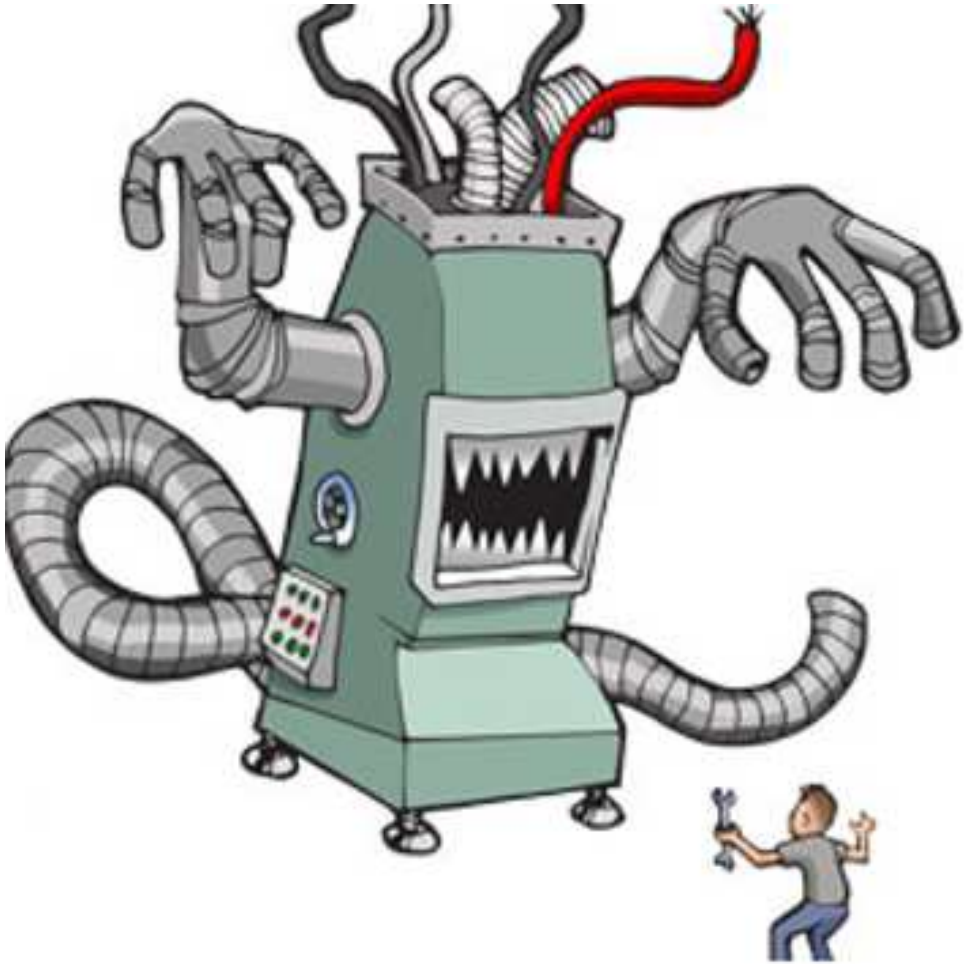
Principles of effective mitigation of hazard

Hierarchy of Controls

tec.nicum
Schmersal Group



Machine Guarding

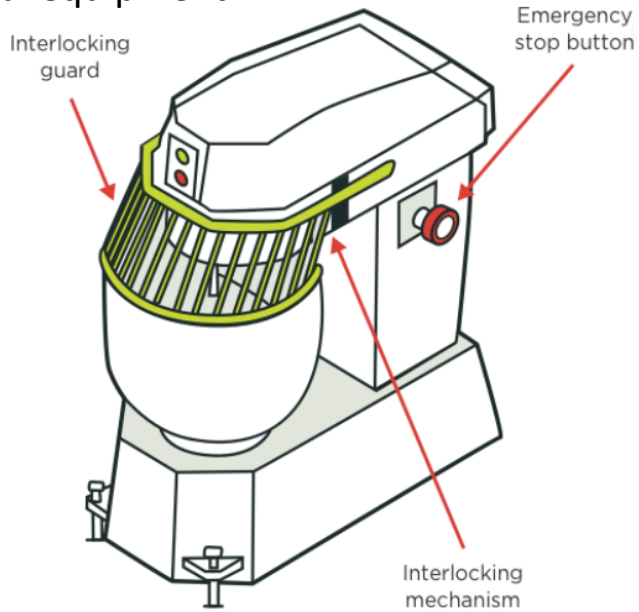


Machine guarding is a **safety feature** on or around **manufacturing** or **engineering equipment** consisting of a **shield** or **device covering hazardous areas** of machine to prevent contact with body parts or to control hazards.

Why Machine Guarding is Required?

tec.nicum
Schmersal Group

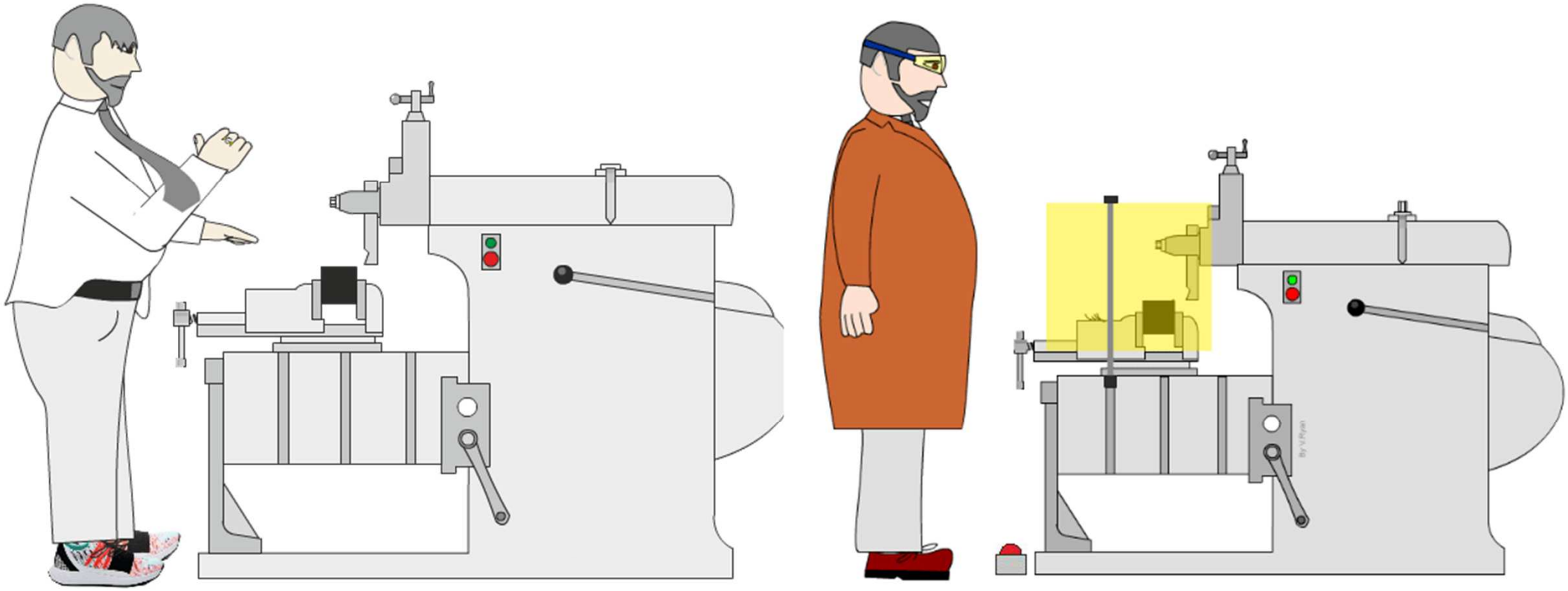
- Any Machine is equipped with linear or rotation motion parts powered by electrical source of supply.
- There is possibility for the operator or maintenance person to get harm with the source of hazard available or generated by any electrical or mechanical equipment.



Machine Guarding

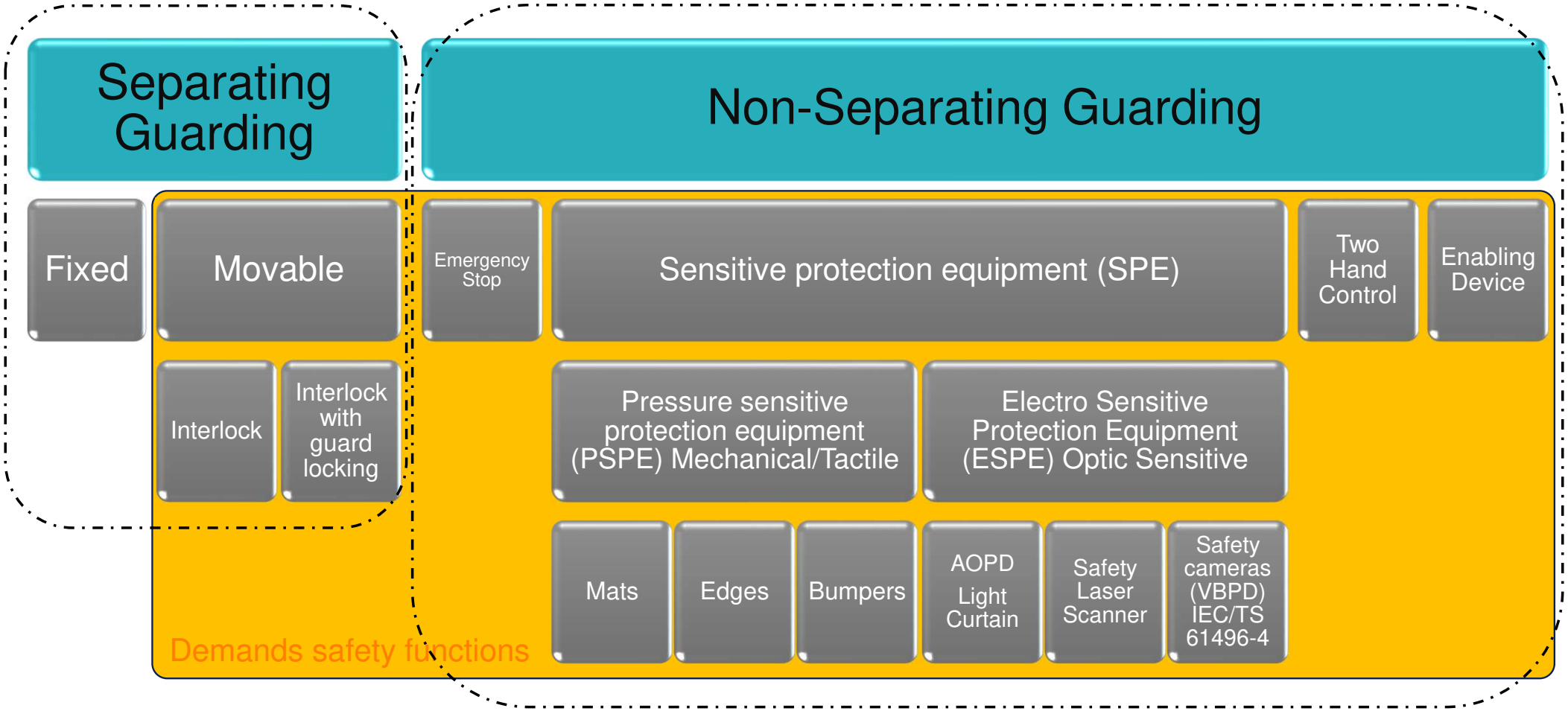
Before & After

tec.nicum
Schmersal Group



Machine Guarding Types

tec.nicum
Schmersal Group

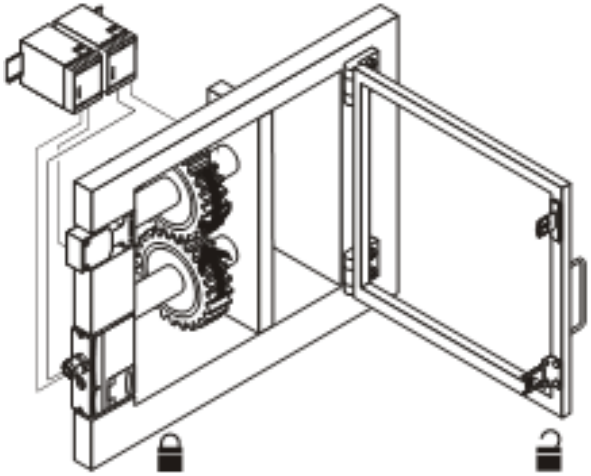


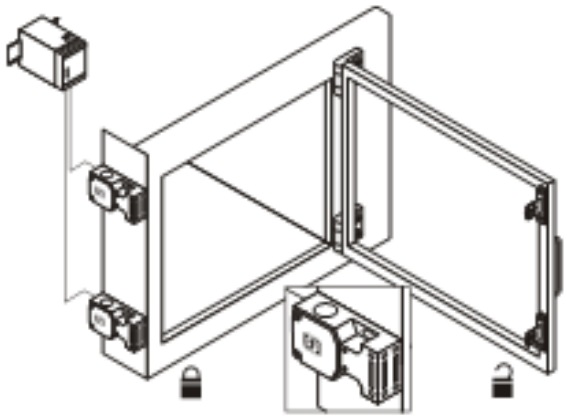
Separating guarding

tec.nicum
Schmersal Group

Separating Guarding

- Fixed
- Movable
- Interlock
- Interlock with guard locking





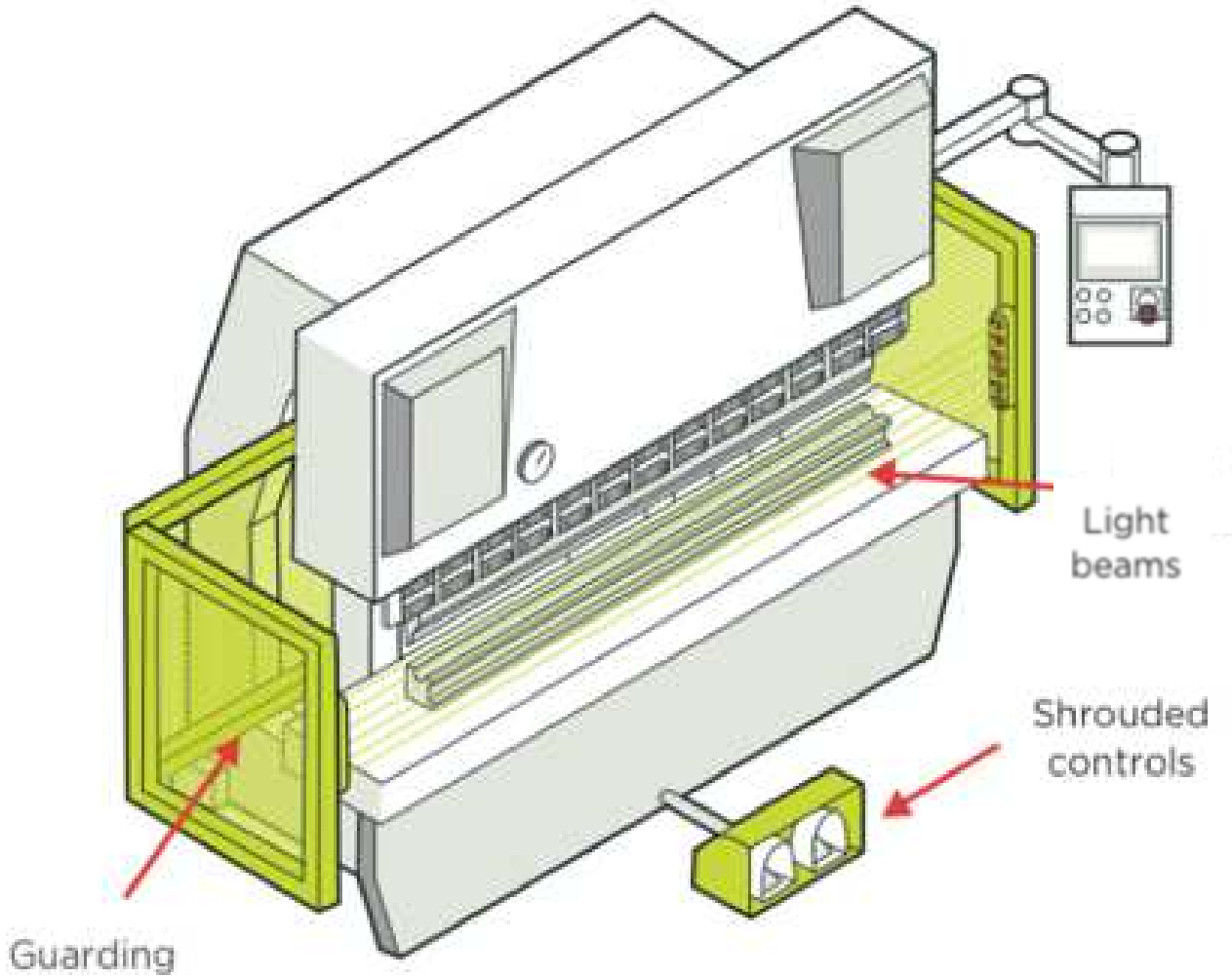
Non-Separating guarding

tec.nicum
Schmersal Group

Non-Separating Guarding

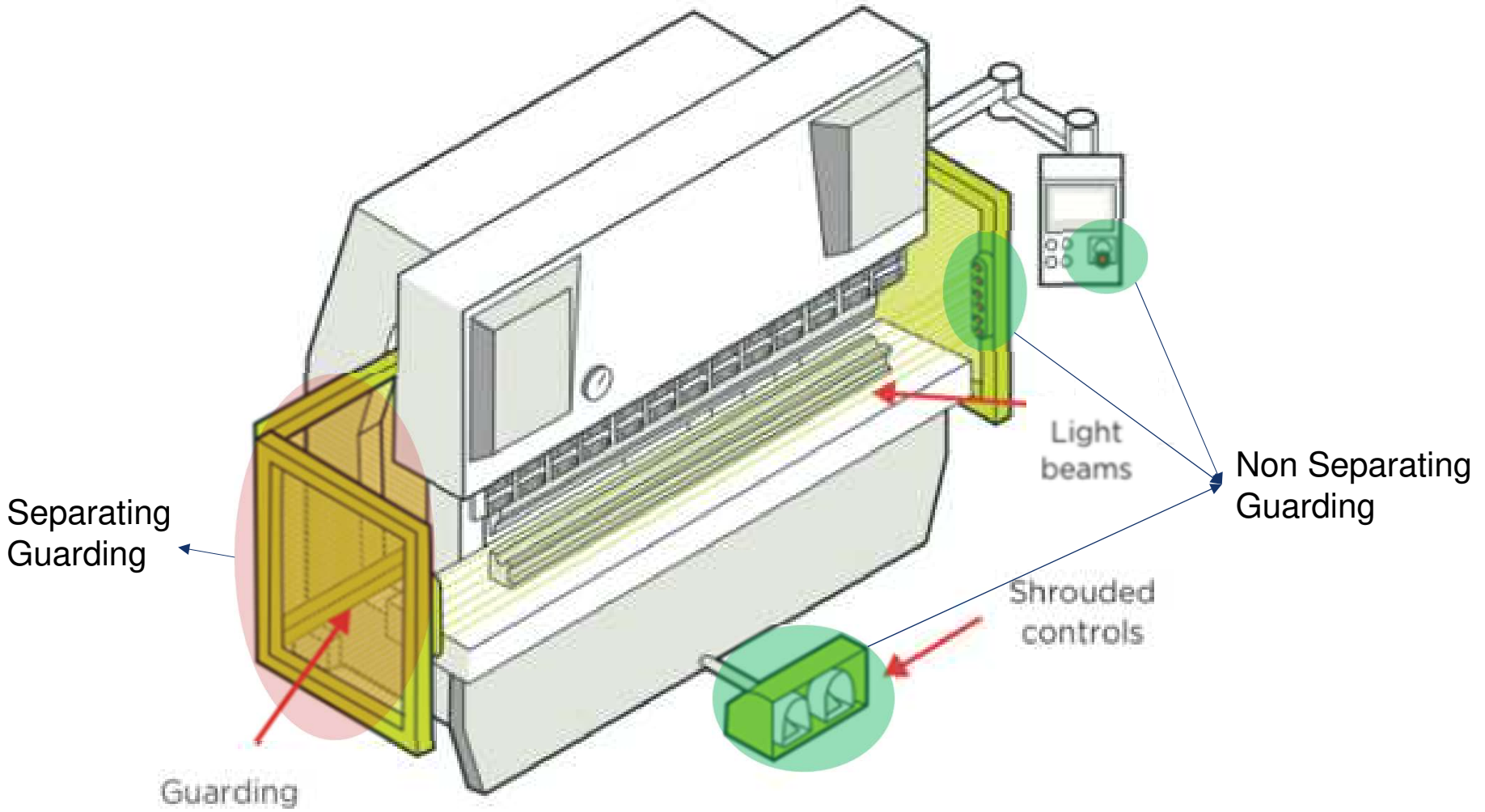
- Emergency Stop
- Sensitive protection equipment (SPE)
  - Pressure sensitive protection equipment (PSPE) Mechanical/Tactile
    - Mats
    - Edges
    - Bumpers
  - Electro Sensitive Protection Equipment (ESPE) Optic Sensitive
    - AOPD Light Curtain
    - Safety Laser Scanner
    - Safety cameras (VBPD) IEC/TS 61496-4
- Two Hand Control
- Enabling Device

Separating and Non-Separating guarding



Separating and Non-Separating guarding

tec.nicum
Schmersal Group



tec.nicum
Schmersal Group

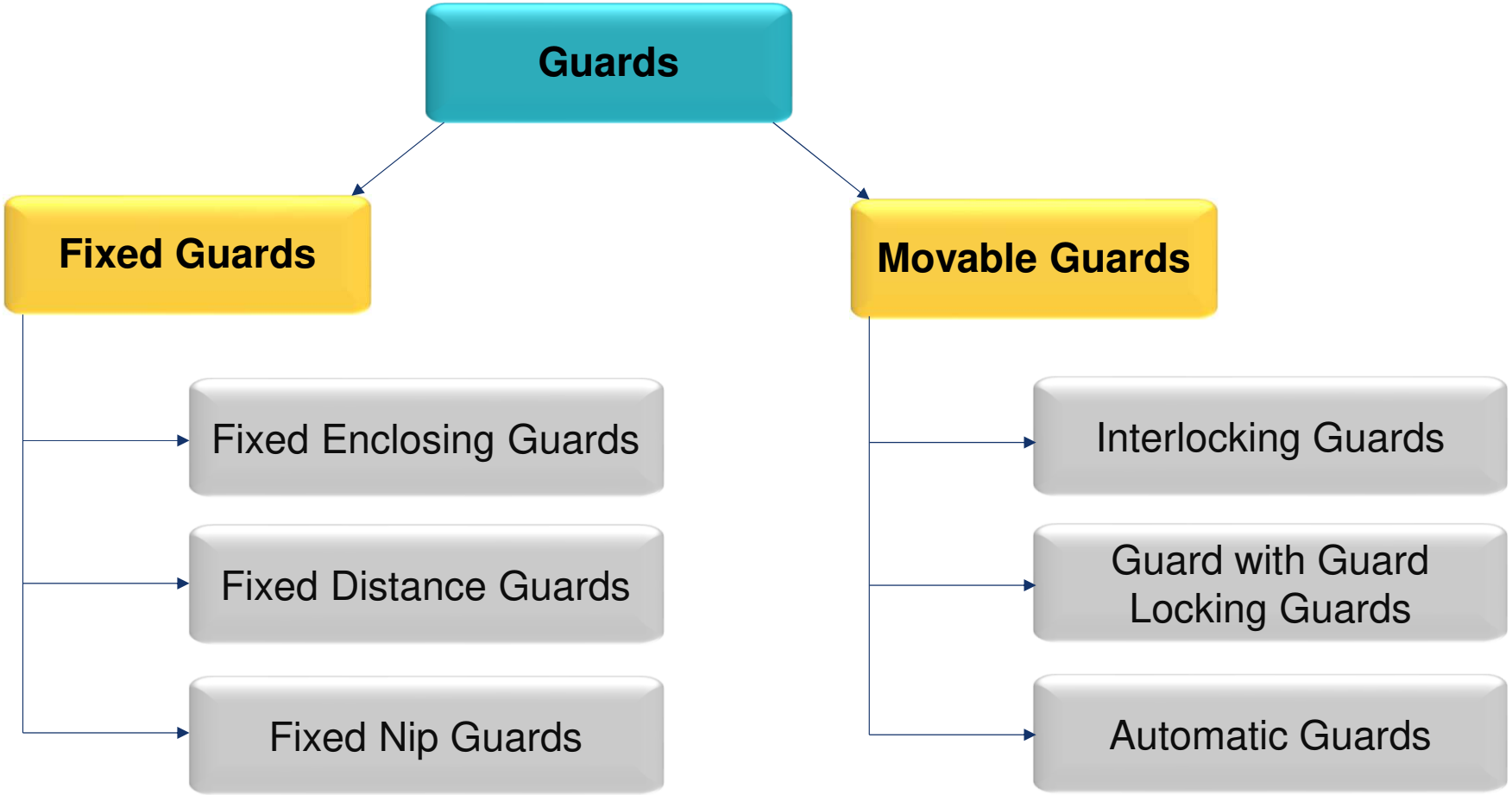
ISO 14120

General requirements for the design, construction, and selection of guards provided to protect persons from mechanical hazards.

Machine Guarding – ISO 14120

General requirements for the design and construction of fixed and movable guards

tec.nicum
Schmersal Group



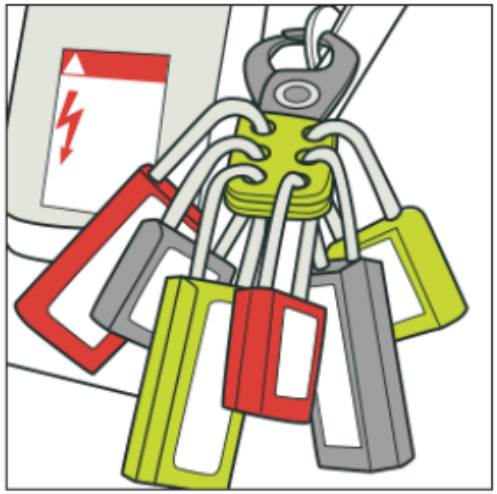
General requirements for the design and construction of fixed and movable guards

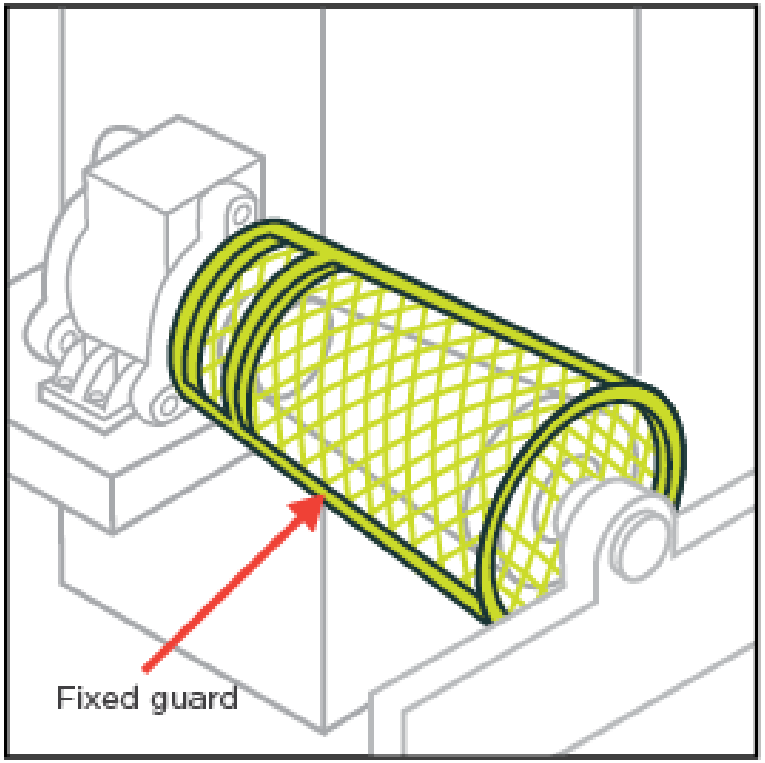
tec.nicum Schmersal Group

Fixed guard :

Guard affixed in such a manner by screws, nuts or welding that it can only be opened or removed by the use of tools or by destruction of the means by which the guard is affixed.

The frequency of access to the fixed guard should be less and the guard must be easy to remove during maintenance.



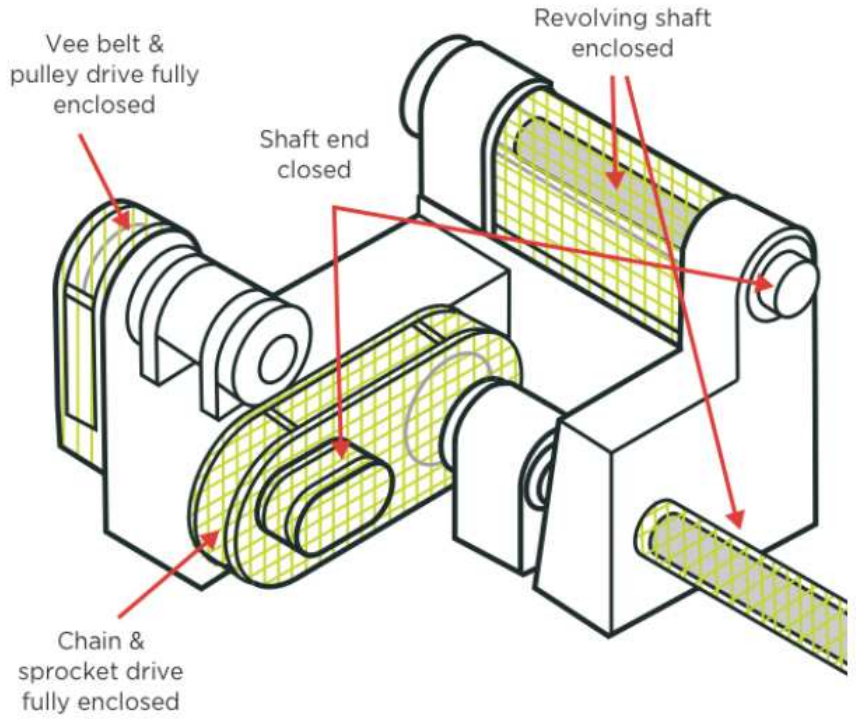


General requirements for the design and construction of fixed and movable guards

tec.nicum Schmersal Group

Fixed Guards

- Fixed Enclosing Guards
- Fixed Distance Guards
- Fixed Nip Guards

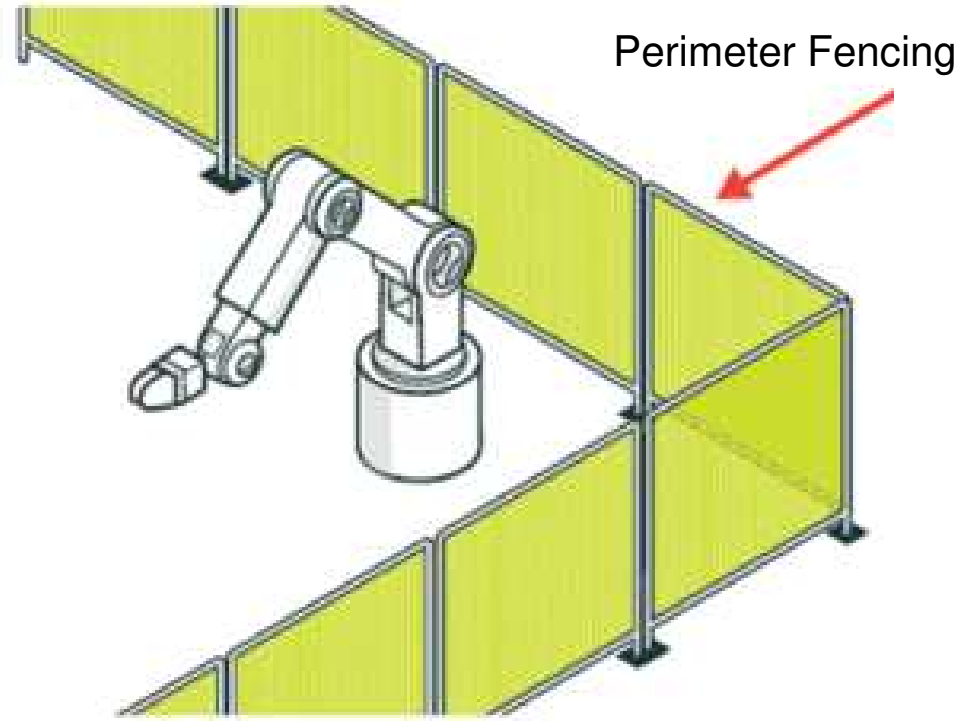


General requirements for the design and construction of fixed and movable guards

tec.nicum
Schmersal Group

Fixed Guards

- Fixed Enclosing Guards
- Fixed Distance Guards
- Fixed Nip Guards

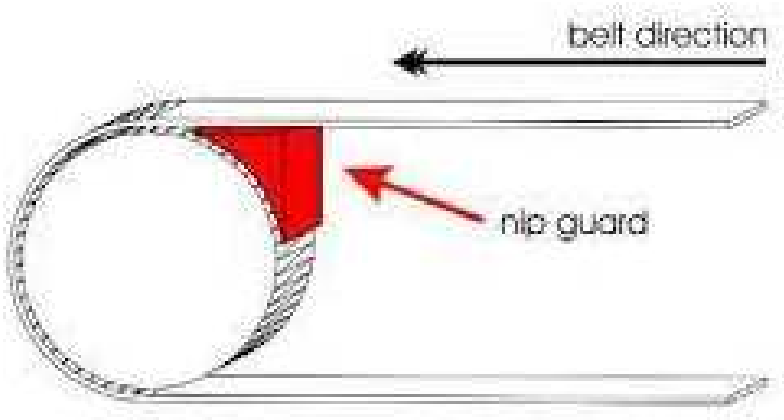


General requirements for the design and construction of fixed and movable guards

tec.nicum Schmersal Group

Fixed Guards

- Fixed Enclosing Guards
- Fixed Distance Guards
- Fixed Nip Guards



General requirements for the design and construction of fixed and movable guards

tec.nicum Schmersal Group

Movable guard :

Guard which can be opened without the use of tools.

Movable guard shall be considered, if removal or replacement of a fixed guard would be difficult.

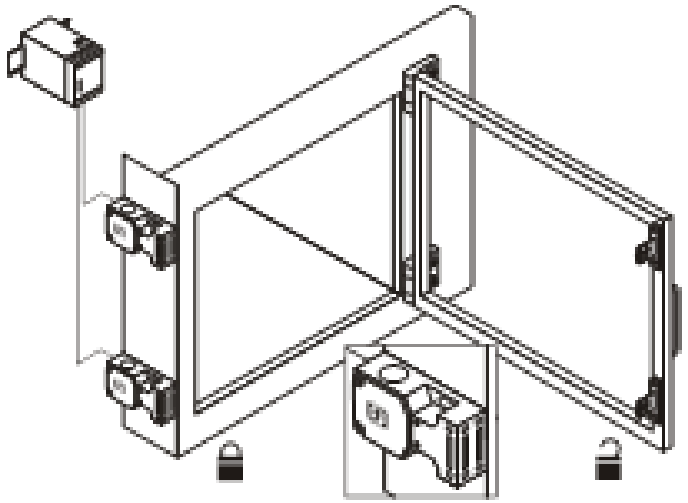
Movable guards shall be associated with an interlock or an interlock with guard locking.

General requirements for the design and construction of fixed and movable guards

tec.nicum Schmersal Group

Operable Guards

- Interlocking Guards
- Guard with Guard Locking Guards
- Automatic Guards



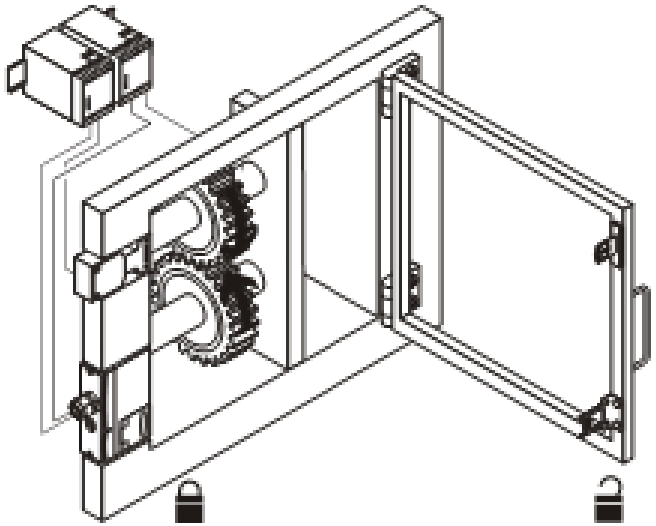
- **Machine Stopping Time:** Immediate
- **Machine Operation Starts:** Reset Function followed by the **Door Completely Closed**
- **Door Open Access:** At any moment as there is no moment of inertia

General requirements for the design and construction of fixed and movable guards

tec.nicum Schmersal Group

Operable Guards

- Interlocking Guards
- Guard with Guard Locking Guards
- Automatic Guards



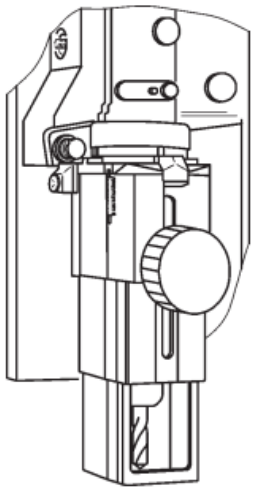
- **Machine Stopping Time:** Not Immediate
- **Machine Operation Starts:** Reset Function followed by the Door Completely Closed & Locked by **Solenoid Control**
- **Door Open Access:** After Moment of Inertia reached Standstill Condition

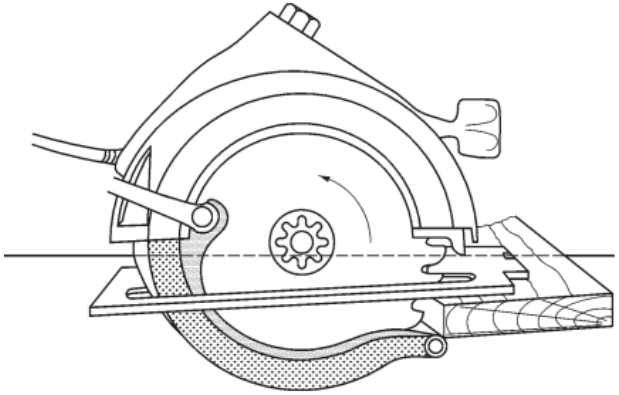
General requirements for the design and construction of fixed and movable guards

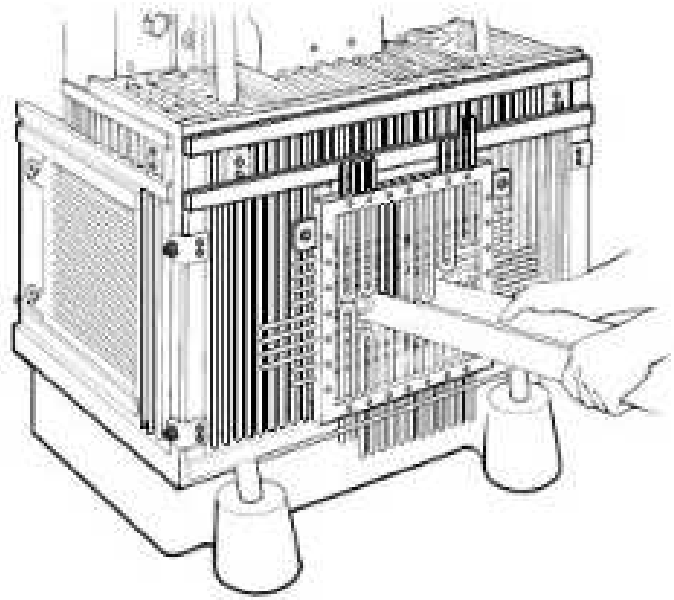
tec.nicum Schmersal Group

Operable Guards

- Interlocking Guards
- Guard with Guard Locking Guards
- Automatic Guards
  - Power-Operated Guards
  - Self-closing Guards
  - Adjustable Guards



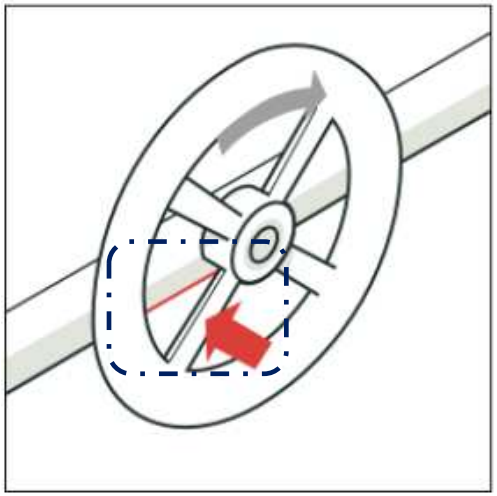


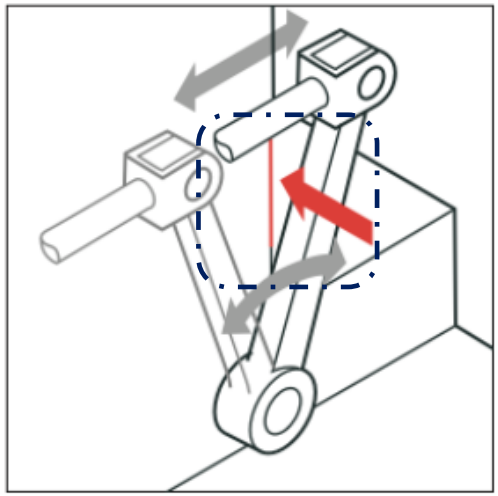


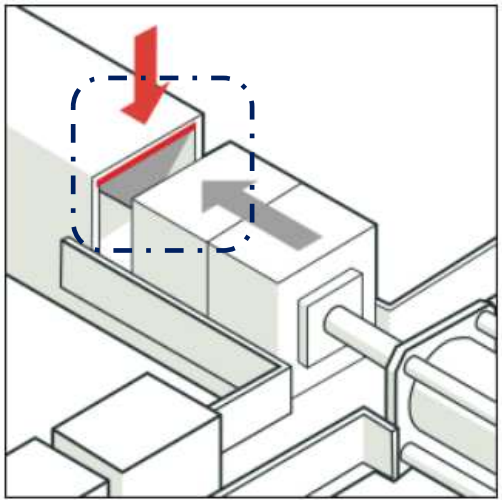
Machine Guarding – ISO 14120

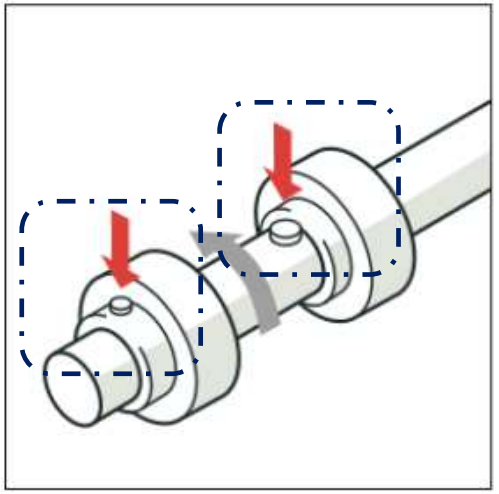
General requirements for the design and construction of fixed and movable guards

tec.nicum
Schmersal Group

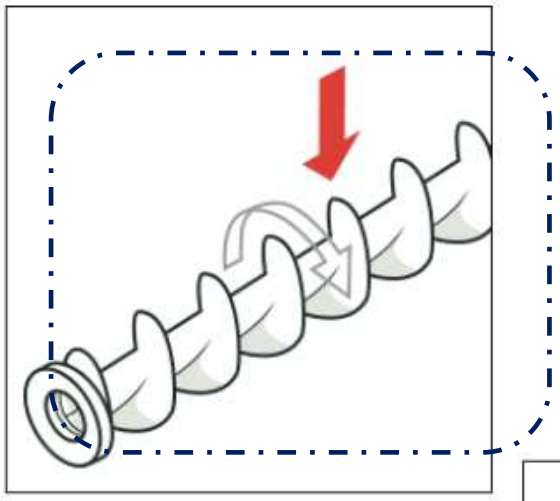


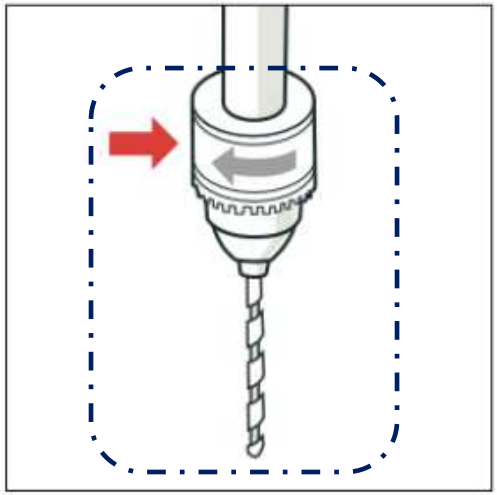


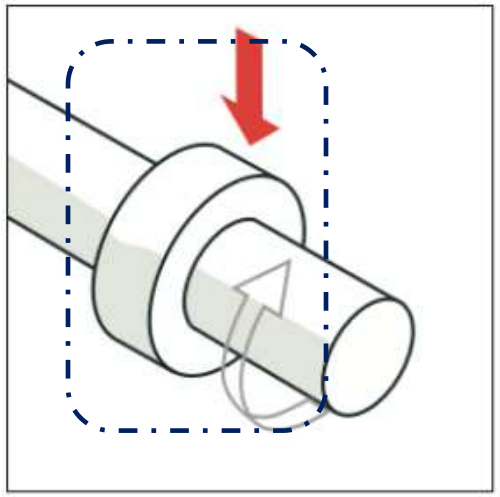


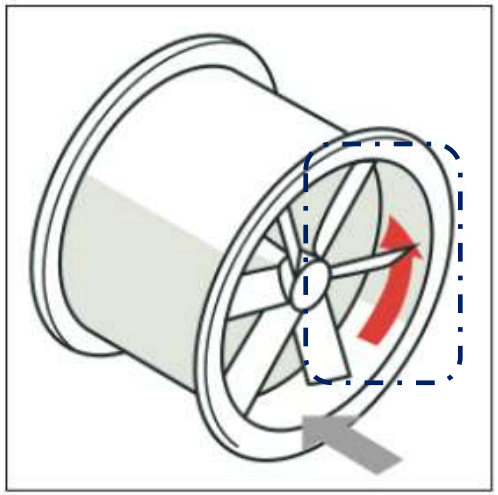


General requirements for the design and construction of fixed and movable guards



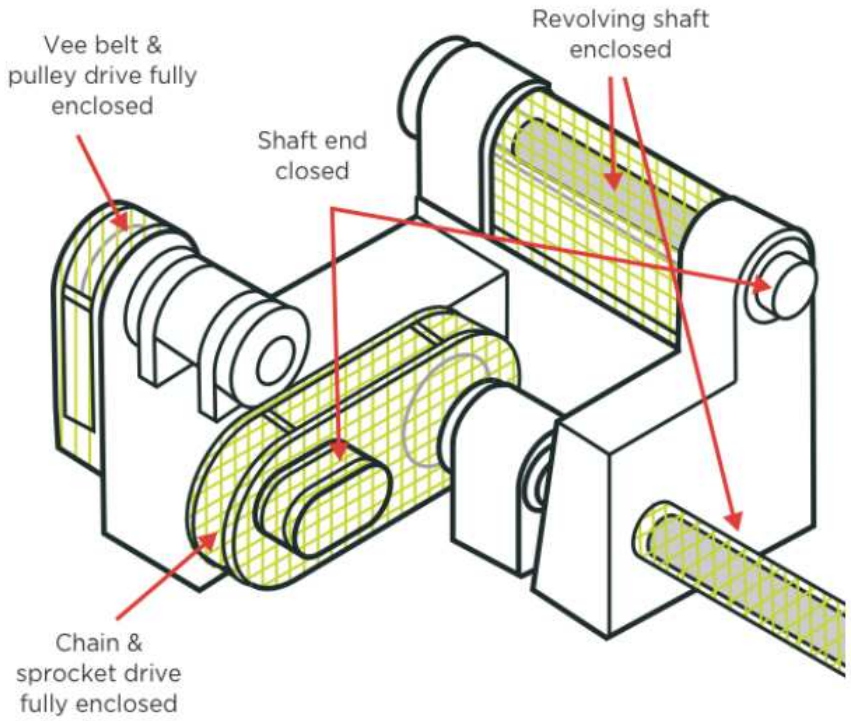






General requirements for the design and construction of fixed and movable guards

- During the maintenance, calibration, loading/unloading, filling & draining, removal of waste/scrape, the installation of fixed guard should not create access hindrance or introduce any new hazard.



General requirements for the design and construction of fixed and movable guards

- During the maintenance, calibration, loading/unloading, filling & draining, removal of waste/scrape, the installation of fixed guard should not create access hindrance or introduce any new hazard.

- The Fixed or movable guards should withstand the impact of ejected components from machine.

Machine Guarding – ISO 14120

General requirements for the design and construction of fixed and movable guards

tec.nicum
Schmersal Group

- During the maintenance, calibration, loading/unloading, filling & draining, removal of waste/scrape, the installation of fixed guard should not create access hindrance or introduce any new hazard.
- The Fixed or movable guards should withstand the impact of ejected components from machine.
- Clear visibility for the machine process observation.

General requirements for the design and construction of fixed and movable guards

- During the maintenance, calibration, loading/unloading, filling & draining, removal of waste/scrape, the installation of fixed guard should not create access hindrance or introduce any new hazard.
- The Fixed or movable guards should withstand the impact of ejected components from machine.
- Clear visibility for the machine process observation.
- Resistant to Contamination

General requirements for the design and construction of fixed and movable guards

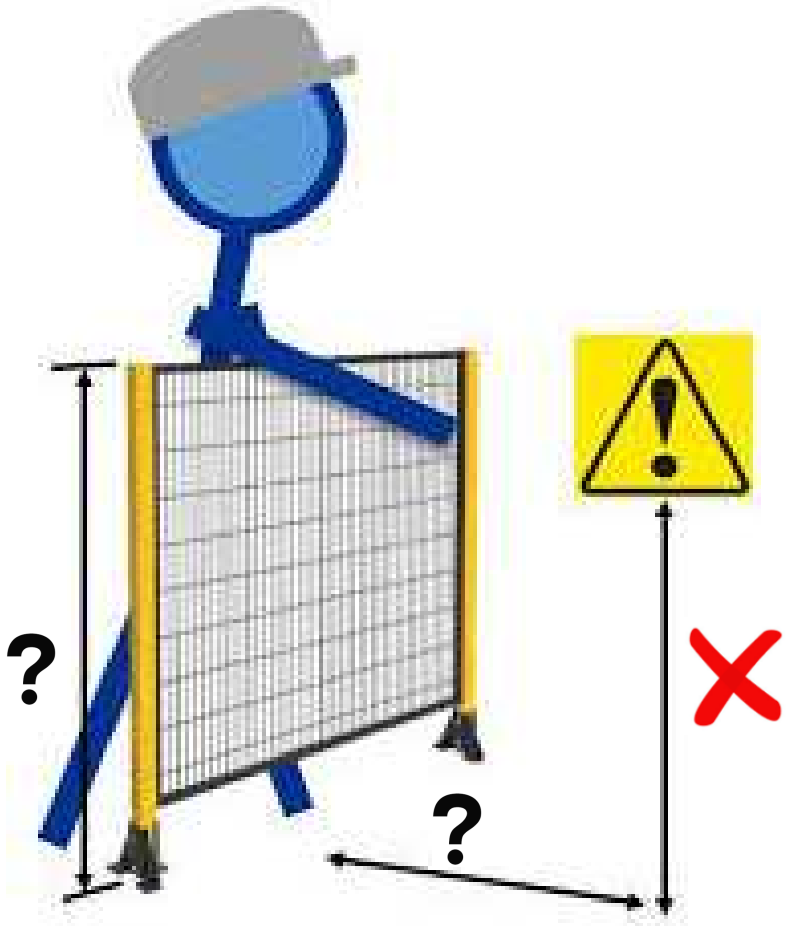
tec.nicum Schmersal Group

- During the maintenance, calibration, loading/unloading, filling & draining, removal of waste/scrape, the installation of fixed guard should not create access hindrance or introduce any new hazard.
- The Fixed or movable guards should withstand the impact of ejected components from machine.
- Clear visibility for the machine process observation
- Resistant to Contamination
- Proper design and Selection for the applications when ATEX and Radiations involved.

tec.nicum
Schmersal Group

ISO 13857

Establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached.



Machine Guarding – ISO 13857

Establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached

tec.nicum
Schmersal Group

Definition :

Establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached.

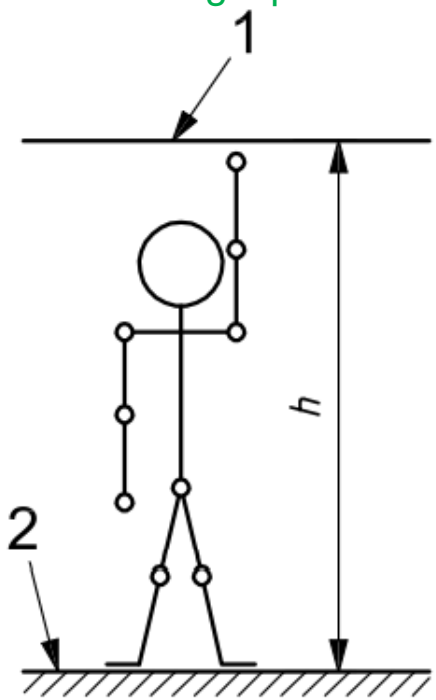
- Safety distances are measured from the surface restricting the body or the relevant part of the body.
- Persons may force parts of the body over protective structures or through openings in an attempt to reach the hazard zone.
- The reference plane is a level at which persons would normally stand, but is not necessarily the floor (e.g. a working platform could be the reference plane)

Machine Guarding – ISO 13857

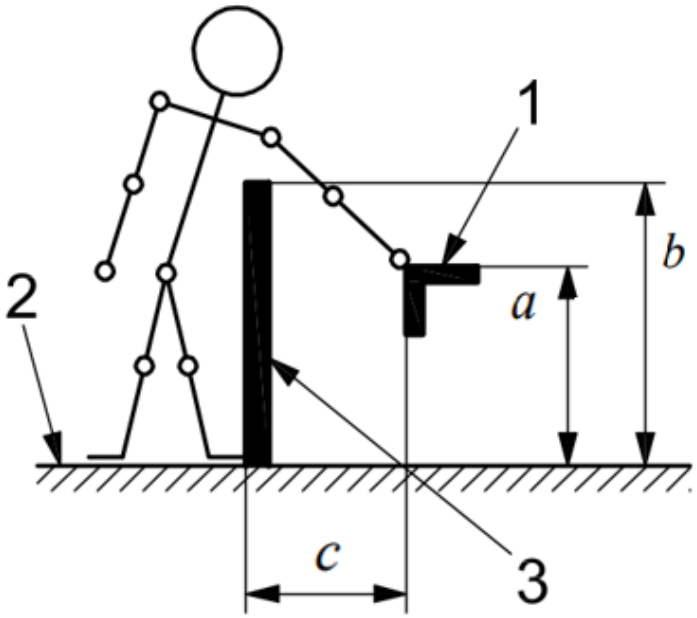
Establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached

tec.nicum
Schmersal Group

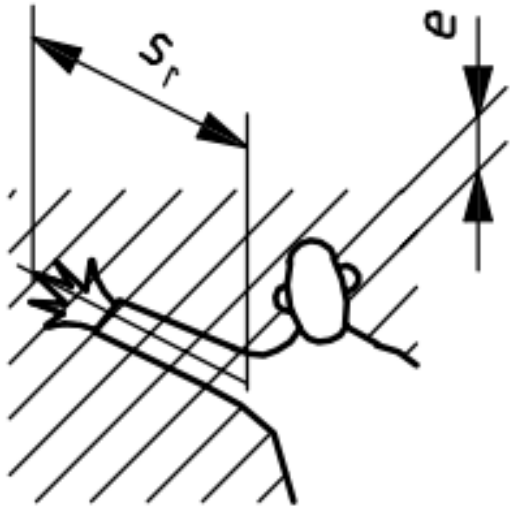
Reaching Upward



Reaching over Protective Structures

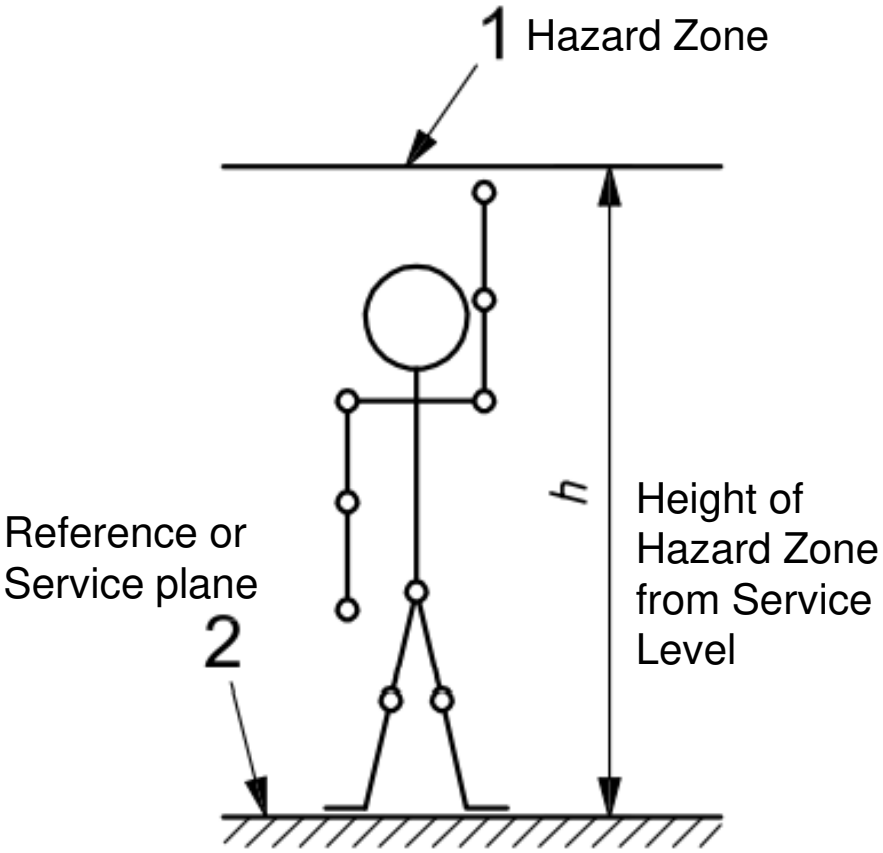


Reaching through Openings



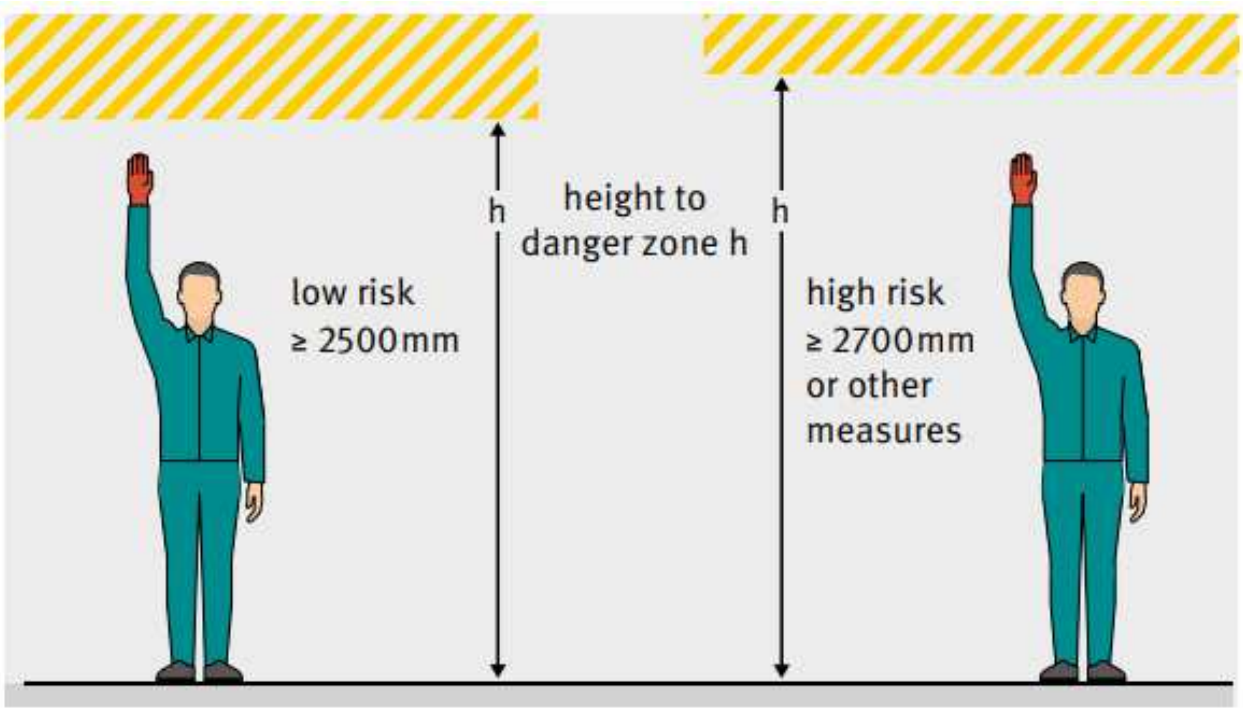
Reaching Upward - Safety Distance

tec.nicum
Schmersal Group

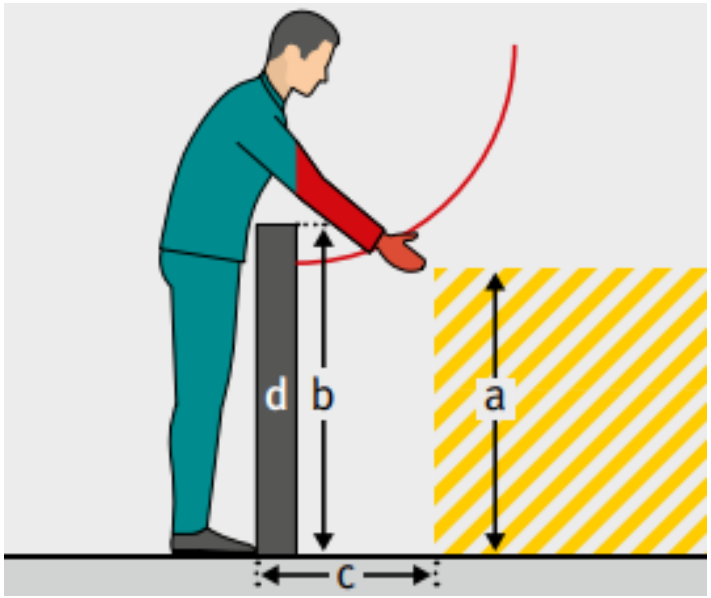


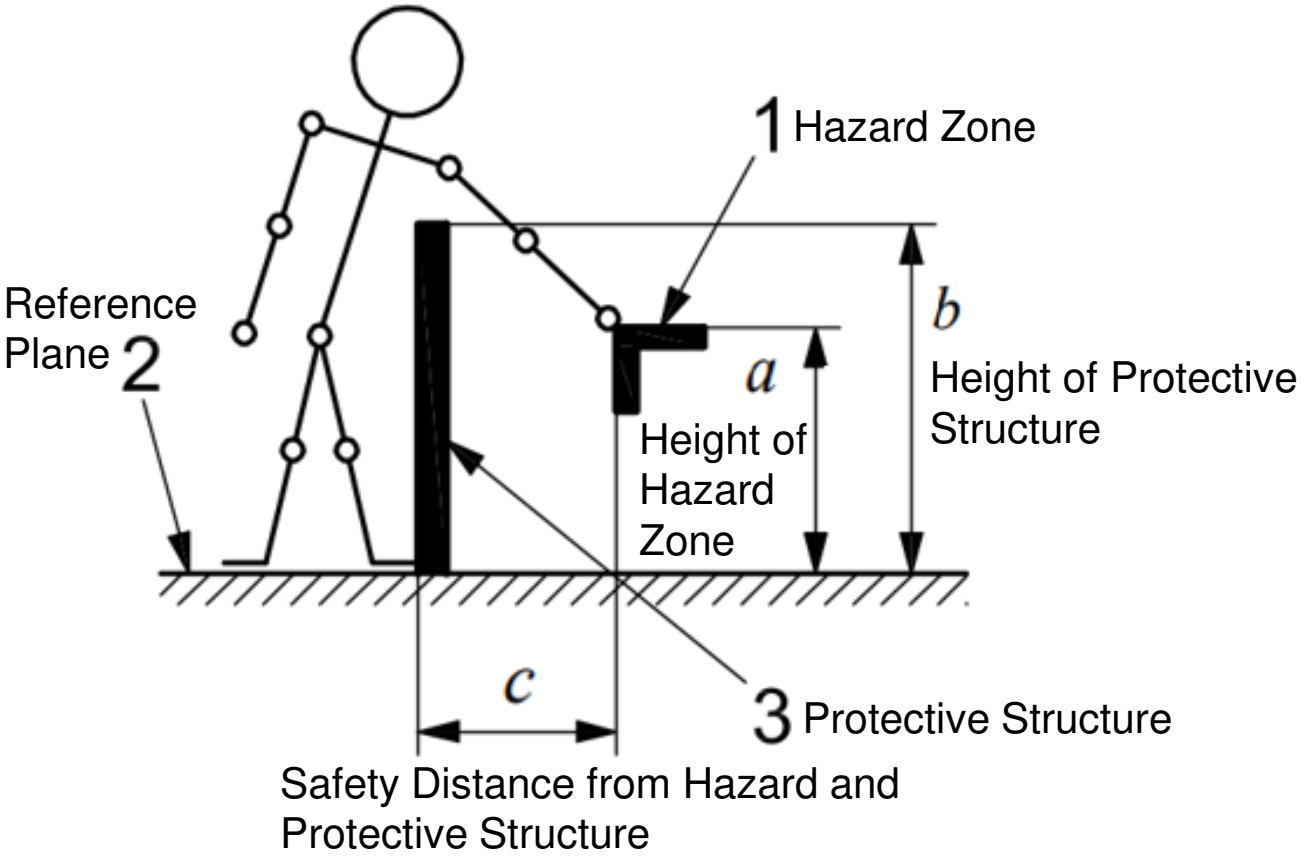
If hazardous zone is Low risk, then
height of the hazard zone (h) = minimum **2500mm**

If hazardous zone is High Risk, then
height of the hazard zone (h) = minimum **2700mm**



Reaching Over Protective Structures - Safety Distance





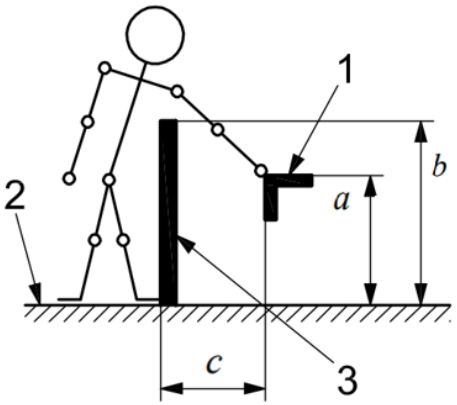
Reaching Over Protective Structures - Safety Distance for Low Risk

tec.nicum Schmersal Group

Dimensions in millimetres

Height of hazard zone [b] *a*	Height of protective structure [a] *b*								
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500
	Horizontal safety distance to hazard zone, *c*								
2 500	0	0	0	0	0	0	0	0	0
2 400	100	100	100	100	100	100	100	100	0
2 200	600	600	500	500	400	350	250	0	0
2 000	1 100	900	700	600	500	350	0	0	0
1 800	1 100	1 000	900	900	600	0	0	0	0
1 600	1 300	1 000	900	900	500	0	0	0	0
1 400	1 300	1 000	900	800	100	0	0	0	0
1 200	1 400	1 000	900	500	0	0	0	0	0
1 000	1 400	1 000	900	300	0	0	0	0	0
800	1 300	900	600	0	0	0	0	0	0
600	1 200	500	0	0	0	0	0	0	0
400	1 200	300	0	0	0	0	0	0	0
200	1 100	200	0	0	0	0	0	0	0
0	1 100	200	0	0	0	0	0	0	0

- **Protective structures** less than 1000 mm in height are not included because they do not sufficiently restrict movement of the body.



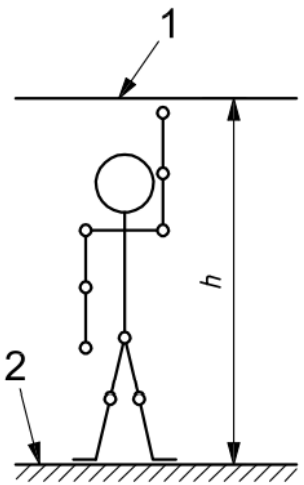
Reaching Over Protective Structures - Safety Distance for Low Risk

tec.nicum Schmersal Group

Dimensions in millimetres

Height of hazard zone [b] *a*	Height of protective structure [a] *b*								
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500
	Horizontal safety distance to hazard zone, *c*								
2 500	0	0	0	0	0	0	0	0	0
2 400	100	100	100	100	100	100	100	100	0
2 200	600	600	500	500	400	350	250	0	0
2 000	1 100	900	700	600	500	350	0	0	0
1 800	1 100	1 000	900	900	600	0	0	0	0
1 600	1 300	1 000	900	900	500	0	0	0	0
1 400	1 300	1 000	900	800	100	0	0	0	0
1 200	1 400	1 000	900	500	0	0	0	0	0
1 000	1 400	1 000	900	300	0	0	0	0	0
800	1 300	900	600	0	0	0	0	0	0
600	1 200	500	0	0	0	0	0	0	0
400	1 200	300	0	0	0	0	0	0	0
200	1 100	200	0	0	0	0	0	0	0
0	1 100	200	0	0	0	0	0	0	0

- **Protective structures** less than 1000 mm in height are not included because they do not sufficiently restrict movement of the body.
- **For hazard zones above 2500 mm**, we need to refer the data related to Reaching Upward



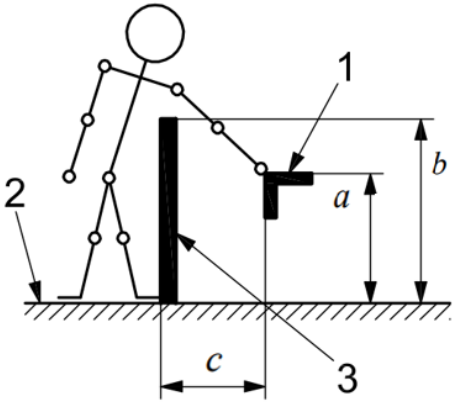
Reaching Over Protective Structures - Safety Distance for High Risk

tec.nicum Schmersal Group

Dimensions in millimetres

Height of hazard zone [c] *a*	Height of protective structure [a, b] *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
0	1 100	500	0	0	0	0	0	0	0	0

- **Protective structures** less than 1000 mm in height are not included because they do not sufficiently restrict movement of the body.



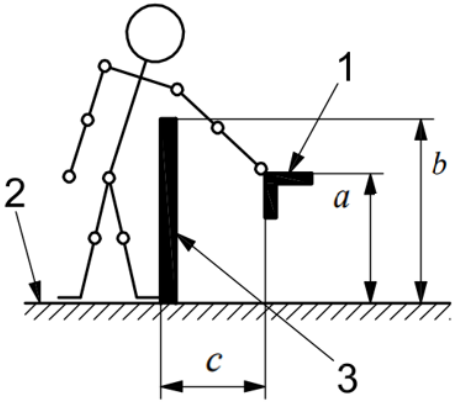
Reaching Over Protective Structures - Safety Distance for High Risk

tec.nicum Schmersal Group

Dimensions in millimetres

Height of hazard zone [c] *a*	Height of protective structure [a, b] *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
0	1 100	500	0	0	0	0	0	0	0	0

- **Protective structures** less than 1000 mm in height are not included because they do not sufficiently restrict movement of the body.
- Protective structures lower than 1400 mm should not be used without additional safety measures.



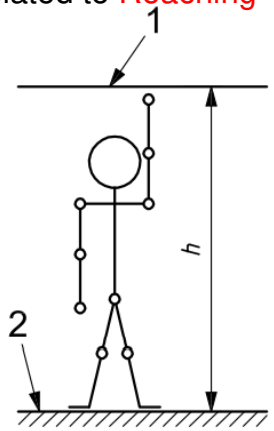
Reaching Over Protective Structures - Safety Distance for High Risk

tec.nicum Schmersal Group

Dimensions in millimetres

Height of hazard zone [c] *a*	Height of protective structure [a, b] *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
0	1 100	500	0	0	0	0	0	0	0	0

- **Protective structures** less than 1000 mm in height are not included because they do not sufficiently restrict movement of the body.
- Protective structures lower than 1400 mm should not be used without additional safety measures.
- **For hazard zones** above 2700 mm, we need to refer the data related to Reaching Upward

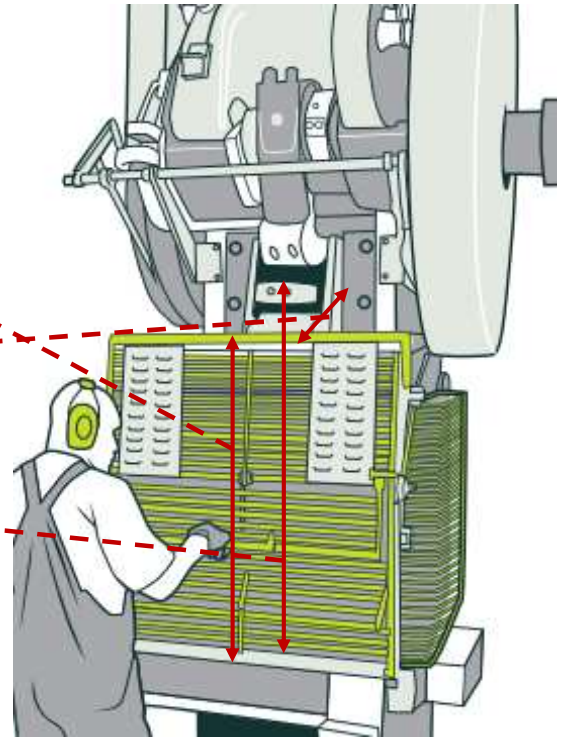


Reaching Over Protective Structures - Safety Distance for High Risk

tec.nicum Schmersal Group

Dimensions in millimetres

Height of hazard zone [c] *a*	Height of protective structure [a, b] *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
0	1 100	500	0	0	0	0	0	0	0	0

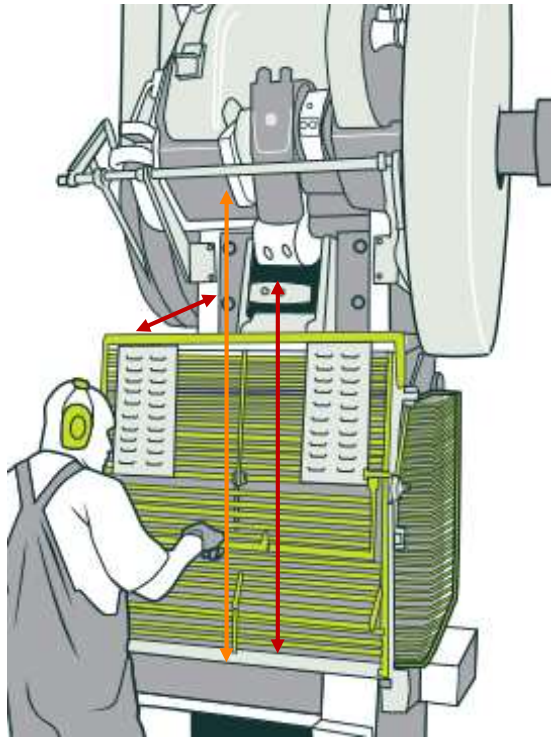


Reaching Over Protective Structures - Safety Distance for High Risk

tec.nicum Schmersal Group

Dimensions in millimetres

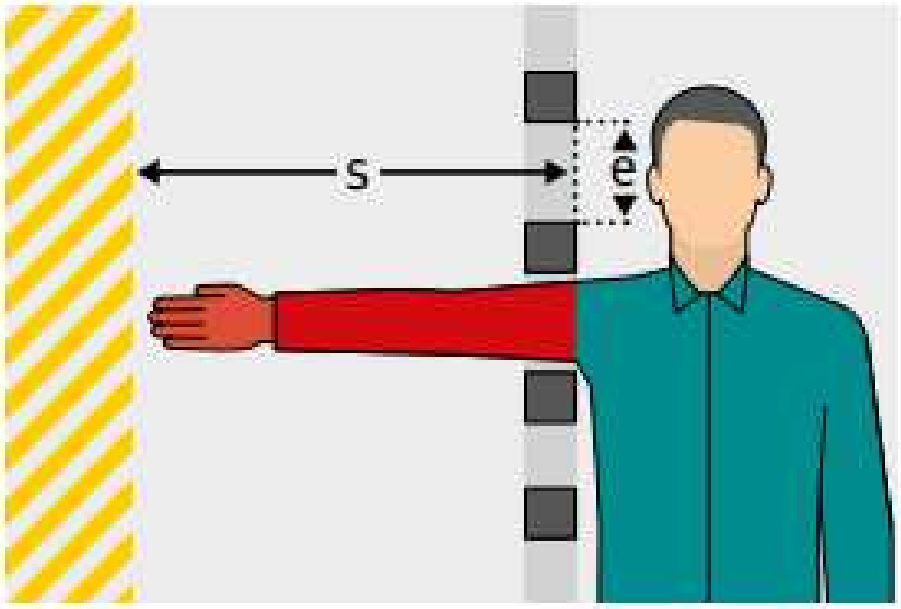
Height of hazard zone [c] *a*	Height of protective structure [a, b] *b*									
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500	2 700
	Horizontal safety distance to hazard zone, *c*									
2 700	0	0	0	0	0	0	0	0	0	0
2 600	900	800	700	600	600	500	400	300	100	0
2 400	1 100	1 000	900	800	700	600	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
0	1 100	500	0	0	0	0	0	0	0	0

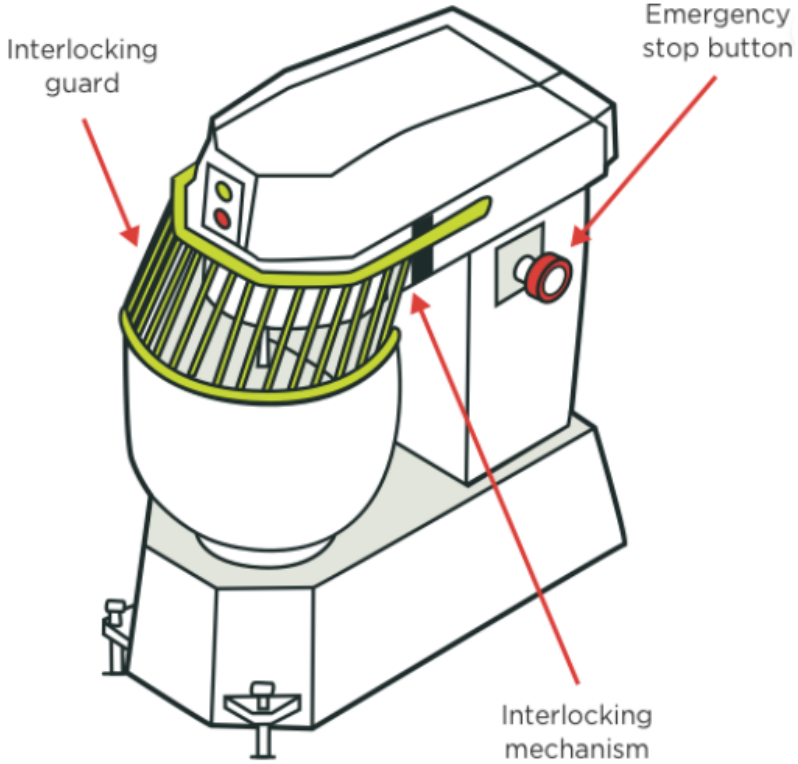


Reaching Through Opening

tec.nicum
Schmersal Group

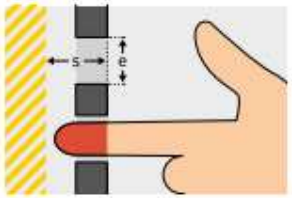
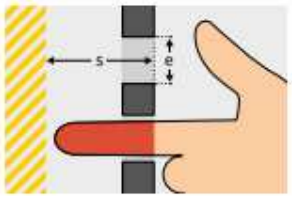
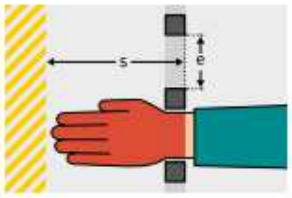
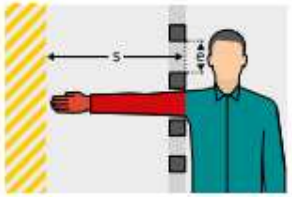
Reaching through Openings



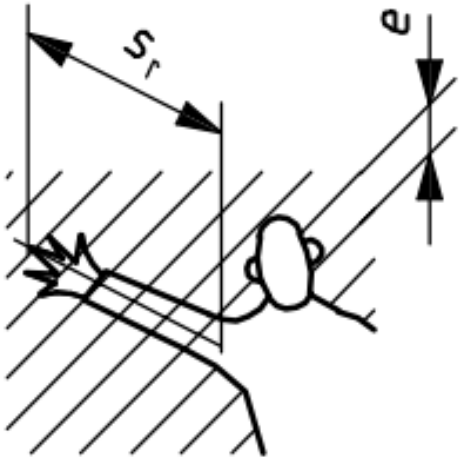


tec.nicum
Schmersal Group

Reaching Through Opening – Safety Distance

Part of body	Illustration	Opening[2] e	Safety distance s slot	square	circle
Finger tip		e ≤ 4	s ≥ 2	s ≥ 2	s ≥ 2
		4 < e ≤ 6	s ≥ 10	s ≥ 5	s ≥ 5
Finger up to knuckle joint		6 < e ≤ 8	s ≥ 20	s ≥ 15	s ≥ 5
		8 < e ≤ 10	s ≥ 80	s ≥ 25	s ≥ 20
		10 < e ≤ 12	s ≥ 100	s ≥ 80	s ≥ 80
		12 < e ≤ 20	s ≥ 120	s ≥ 120	s ≥ 120
		20 < e ≤ 30	s ≥ 850[1)]	s ≥ 120	s ≥ 120
Arm up to shoulder joint		30 < e ≤ 40	s ≥ 850	s ≥ 200	s ≥ 120
		40 < e ≤ 120	s ≥ 850	s ≥ 850	s ≥ 850

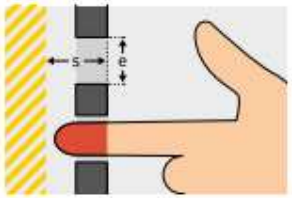
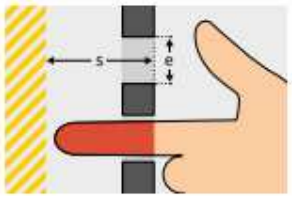
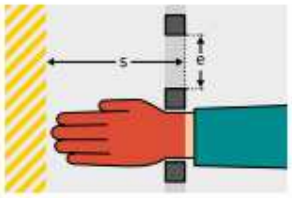
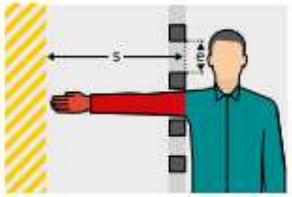
For openings > 120 mm, the safety distances for reaching over protective structures must be applied.

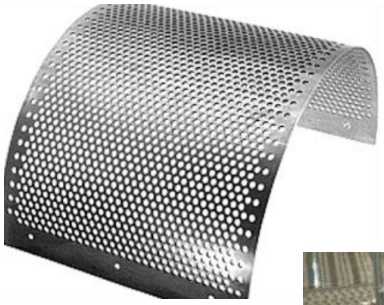


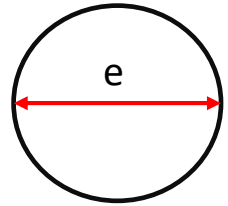
Dimensions in millimetres

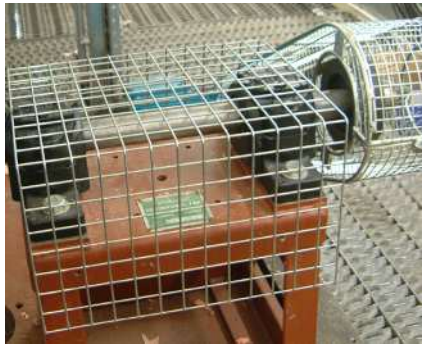
Machine Guarding – ISO 13857

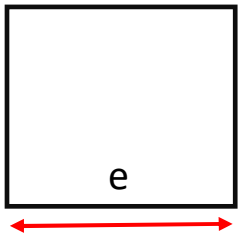
Reaching Through Opening – Safety Distance

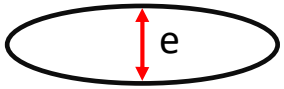
Part of body	Illustration	Opening[2] e	Safety distance s slot	square	circle
Finger tip		e ≤ 4	s ≥ 2	s ≥ 2	s ≥ 2
		4 < e ≤ 6	s ≥ 10	s ≥ 5	s ≥ 5
Finger up to knuckle joint		6 < e ≤ 8	s ≥ 20	s ≥ 15	s ≥ 5
		8 < e ≤ 10	s ≥ 80	s ≥ 25	s ≥ 20
		10 < e ≤ 12	s ≥ 100	s ≥ 80	s ≥ 80
		12 < e ≤ 20	s ≥ 120	s ≥ 120	s ≥ 120
		20 < e ≤ 30	s ≥ 850[1)]	s ≥ 120	s ≥ 120
Arm up to shoulder joint		30 < e ≤ 40	s ≥ 850	s ≥ 200	s ≥ 120
		40 < e ≤ 120	s ≥ 850	s ≥ 850	s ≥ 850

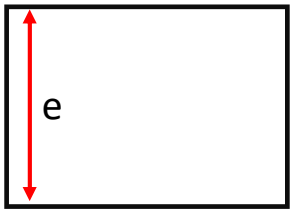


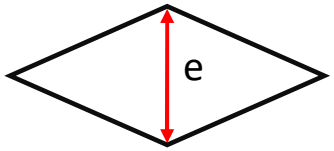






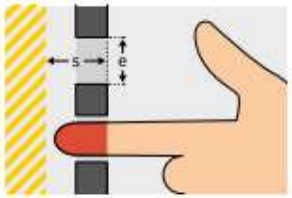
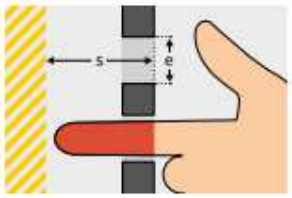
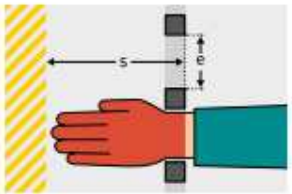
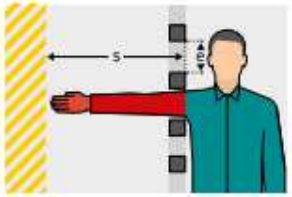


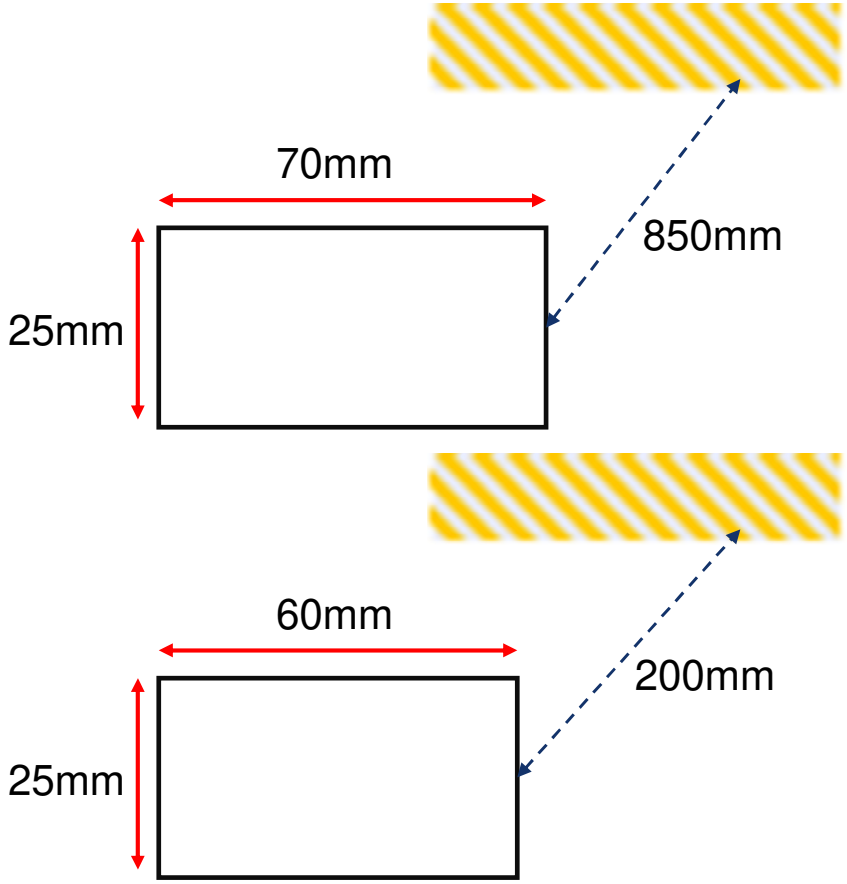




Dimensions in millimetres

Reaching Through Opening – Safety Distance

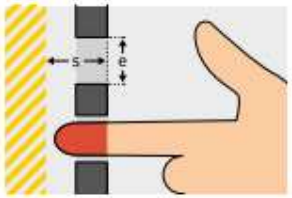
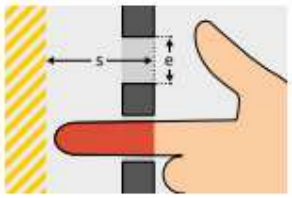
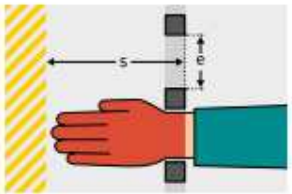
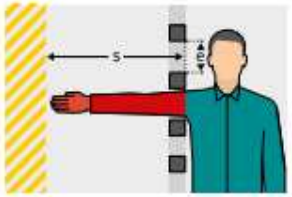
Part of body	Illustration	Opening[2] e	Safety distance s slot	square	circle
Finger tip		e ≤ 4	s ≥ 2	s ≥ 2	s ≥ 2
		4 < e ≤ 6	s ≥ 10	s ≥ 5	s ≥ 5
Finger up to knuckle joint		6 < e ≤ 8	s ≥ 20	s ≥ 15	s ≥ 5
		8 < e ≤ 10	s ≥ 80	s ≥ 25	s ≥ 20
		10 < e ≤ 12	s ≥ 100	s ≥ 80	s ≥ 80
		12 < e ≤ 20	s ≥ 120	s ≥ 120	s ≥ 120
		20 < e ≤ 30	s ≥ 850[1)]	s ≥ 120	s ≥ 120
Arm up to shoulder joint		30 < e ≤ 40	s ≥ 850	s ≥ 200	s ≥ 120
		40 < e ≤ 120	s ≥ 850	s ≥ 850	s ≥ 850

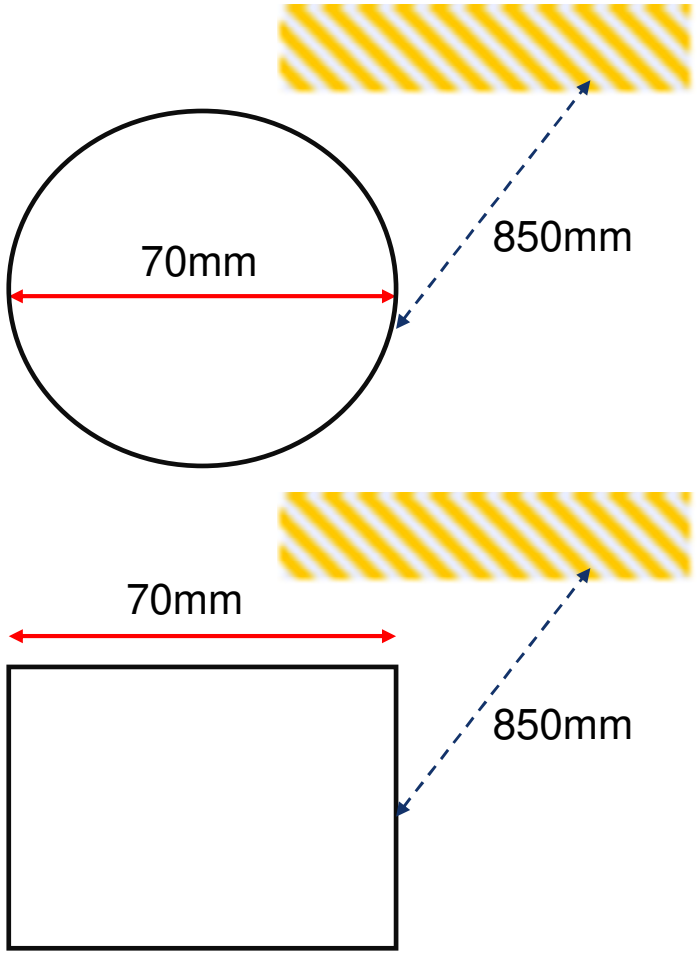


If the length of slot opening is less than 65 mm, the thumb will act as a stop and the safety distance can be reduced to 200 mm

Dimensions in millimetres

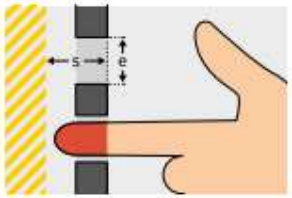
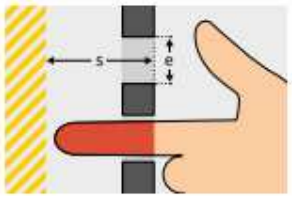
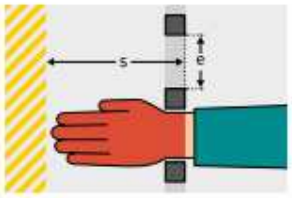
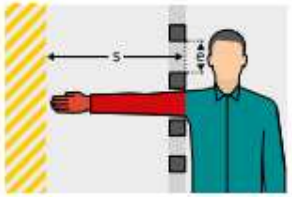
Reaching Through Opening – Safety Distance

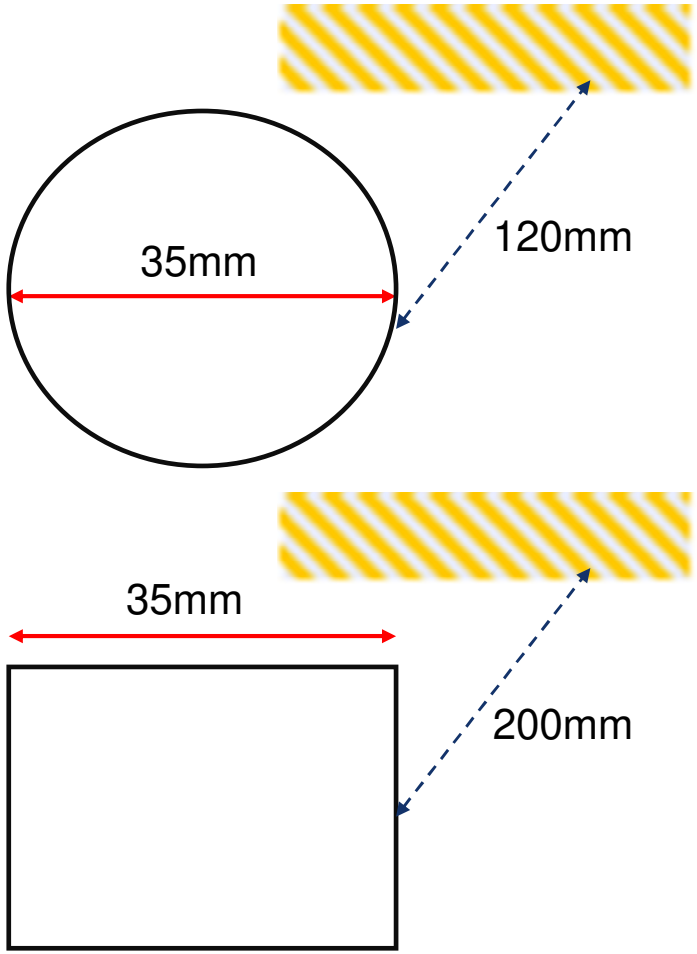
Part of body	Illustration	Opening[2] e	Safety distance s slot	square	circle
Finger tip		e ≤ 4	s ≥ 2	s ≥ 2	s ≥ 2
		4 < e ≤ 6	s ≥ 10	s ≥ 5	s ≥ 5
Finger up to knuckle joint		6 < e ≤ 8	s ≥ 20	s ≥ 15	s ≥ 5
		8 < e ≤ 10	s ≥ 80	s ≥ 25	s ≥ 20
		10 < e ≤ 12	s ≥ 100	s ≥ 80	s ≥ 80
		12 < e ≤ 20	s ≥ 120	s ≥ 120	s ≥ 120
		20 < e ≤ 30	s ≥ 850[1)]	s ≥ 120	s ≥ 120
Arm up to shoulder joint		30 < e ≤ 40	s ≥ 850	s ≥ 200	s ≥ 120
		40 < e ≤ 120	s ≥ 850	s ≥ 850	s ≥ 850



Dimensions in millimetres

Reaching Through Opening – Safety Distance

Part of body	Illustration	Opening[2] e	Safety distance s slot	square	circle
Finger tip		e ≤ 4	s ≥ 2	s ≥ 2	s ≥ 2
		4 < e ≤ 6	s ≥ 10	s ≥ 5	s ≥ 5
Finger up to knuckle joint		6 < e ≤ 8	s ≥ 20	s ≥ 15	s ≥ 5
		8 < e ≤ 10	s ≥ 80	s ≥ 25	s ≥ 20
		10 < e ≤ 12	s ≥ 100	s ≥ 80	s ≥ 80
		12 < e ≤ 20	s ≥ 120	s ≥ 120	s ≥ 120
		20 < e ≤ 30	s ≥ 850[1)]	s ≥ 120	s ≥ 120
Arm up to shoulder joint		30 < e ≤ 40	s ≥ 850	s ≥ 200	s ≥ 120
		40 < e ≤ 120	s ≥ 850	s ≥ 850	s ≥ 850

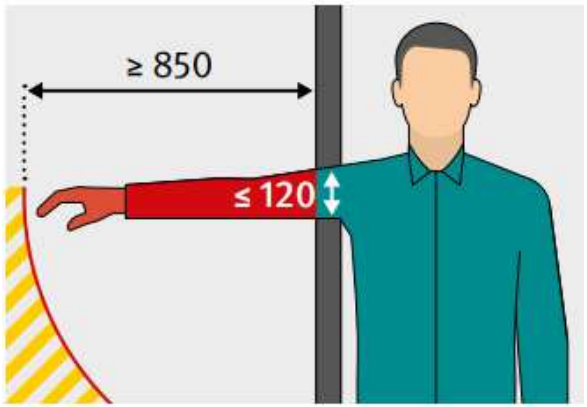


Dimensions in millimetres

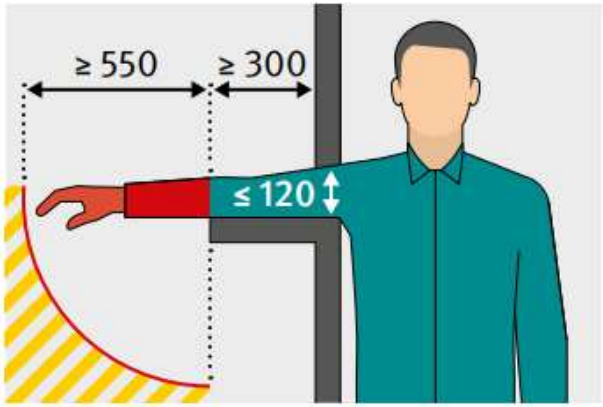
Reaching Around Opening – Safety Distance

tec.nicum
Schmersal Group

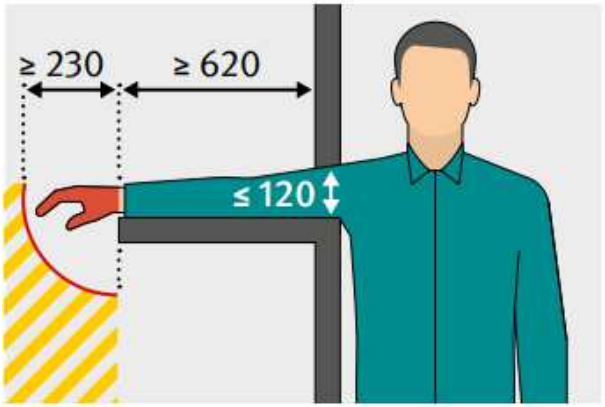
Limitation of movement Shoulder



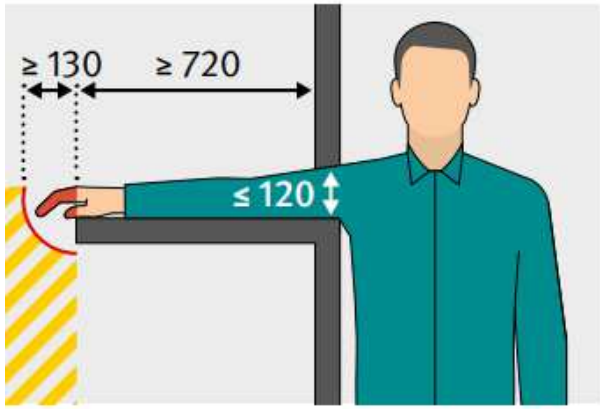
Limitation of movement - Arm supported upto Elbow



Limitation of movement - Arm supported upto Wrist

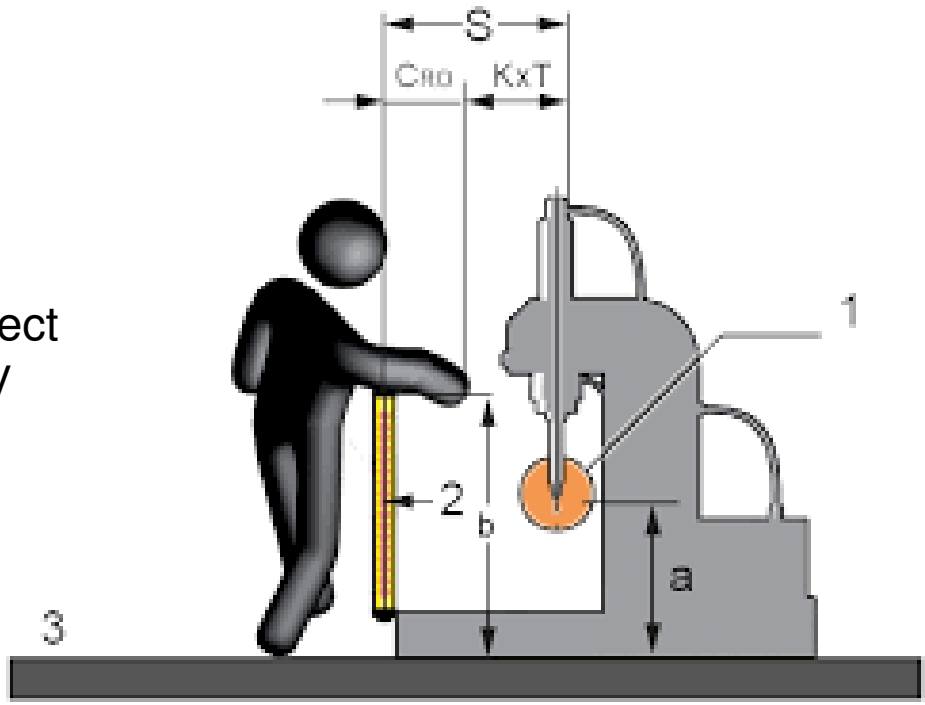


Limitation of movement - Arm supported upto Knuckle Joint



ISO 13855

Establishes the positioning of safeguards with respect to the approach speeds of parts of the human body



Machine Guarding – ISO 13855

Positioning of safeguards with respect to the approach speeds of parts of the human body

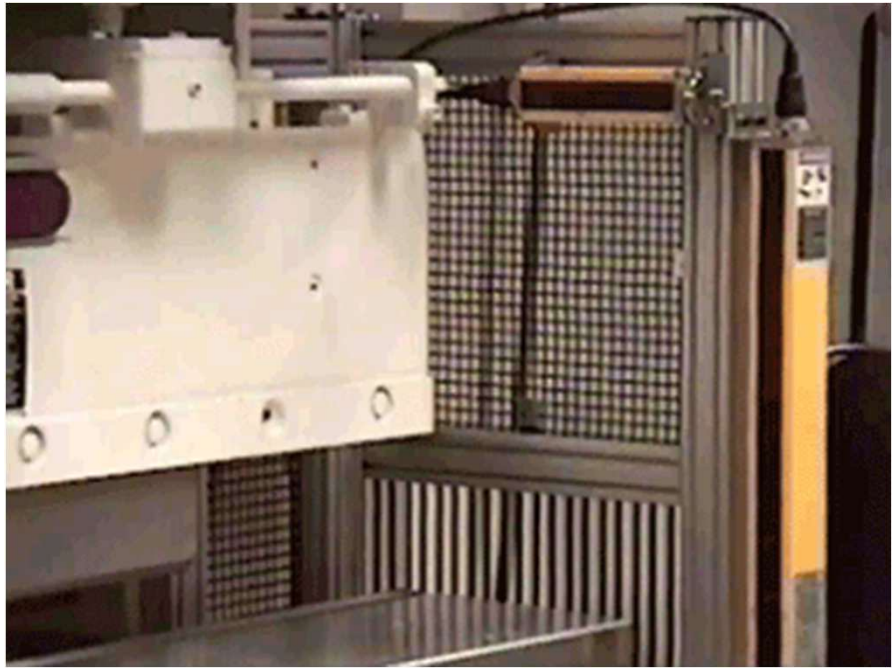
tec.nicum
Schmersal Group

Definition :

Establishes the positioning of safeguards with respect to the approach speeds of parts of the human body.

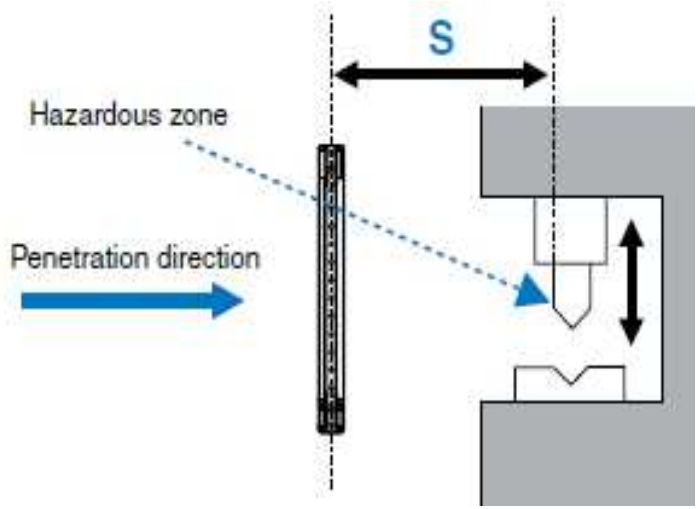
The minimum safety distance need to be maintained during the installation of the following devices,

- Electrosensitive protective equipment (Light Curtain, Safety Scanners)
- pressure-sensitive protective equipment (Safety Mat)
- two-hand control devices
- interlocking guards without guard locking



Light Curtain - Safety Distance Calculation – Vertical Installation

tec.nicum Schmersal Group



S = (K x T) + C

Where:

- **S = minimum safe distance [mm]:**
- **K = Approach speed [mm/s]:**
  - **K = 2000mm/s(for s≤*500mm*)**
  - **K = 1600mm/s(for s≥*500mm*)**
- **T = total reaction time of the system (curtain + relay + machine) [s]**
- **C = Complementary additional distance (mm). (Depends on the device)**

Ex. : For light curtains,

C = 8 x (Resolution – 14) [mm]

Different equations for horizontal and vertical applications of equipment influencing the final safe distance

Light Curtain - Safety Distance Calculation – Vertical Installation

tec.nicum Schmersal Group

S = (K x T) + C

Where:

- **S = safe distance [mm]**
- **K = 2000mm/s (distance considering ≤ 500mm)**
- **T = 0.2s**
- **C = Additional reaching capability**

For light curtains with a resolution **= 30mm** (hand)

C = 8 x (Resolution – 14) [mm]

S = (K x T) + C
S = (2000 x 0.2) + 8 x (30 – 14)
S = (400) + 8 x (16)
S = 400 + 128
S = 528mm

S = (K x T) + C
S = (1600 x 0.2) + 8 x (30 – 14)
S = (320) + 8 x (16)
S = 320 + 128
S = 448mm

Minimum distance in this case is 500mm

Smin ≥ 500mm for normal operation.

Cycle initiation by Light Curtain
For cyclic or stroke operation use –
Smin > 150 mm if R ≤ 30 mm.
Smin > 100 mm if R ≤ 14 mm.

Safety Distance Calculation – Horizontal Scanning Devices

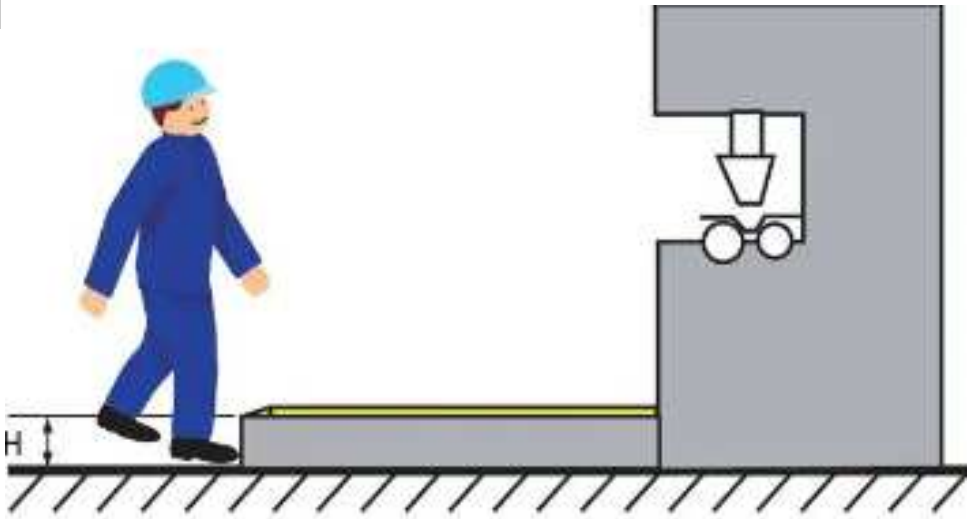
tec.nicum Schmersal Group

Horizontal Scanner or Light Curtain

S = (1600 x T) + (1200 – 0.4H)

For a safeguard where the direction of approach is parallel to the detection zone,

- The **height (H)**, of the detection zone **shall not be greater than 1000 mm.**
- However, if H is greater than 300 mm there is a risk of inadvertent **undetected access beneath the detection zone**.
- This shall be considered in the risk assessment and additional protective measures applied, if necessary.



Guard Interlock Without Guard-locking - Safety Distance Calculation

tec.nicum Schmersal Group

S = (K x T) + C

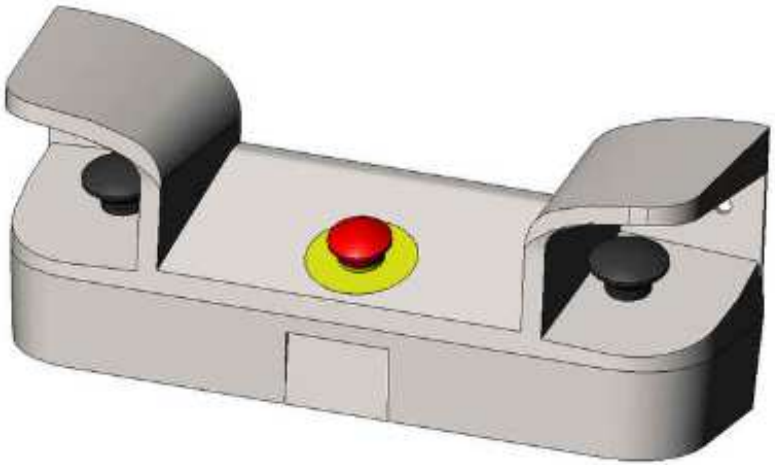
S = (1600 x T) + C

Where:

- **S = minimum safe distance [mm]:**
- **K = Approach speed [mm/s]: K = 1600mm/s**
- **T = total reaction time of the system (interlock switch + relay + machine) [s]. The response time T may be reduced by considering the opening time of the operable door. The opening time shall be determined by calculation or onsite test.**
- **C = Additonal safety distance, if there any opening in the operable guard in which the hazardous zone shall be accessed before the machines stop signal is initited. (ISO 13857 safety reach distance need to be considered (Table 4 or 5))**

Two Hand Control Device - Safety Distance Calculation

tec.nicum
Schmersal Group



S = (K x T) + C

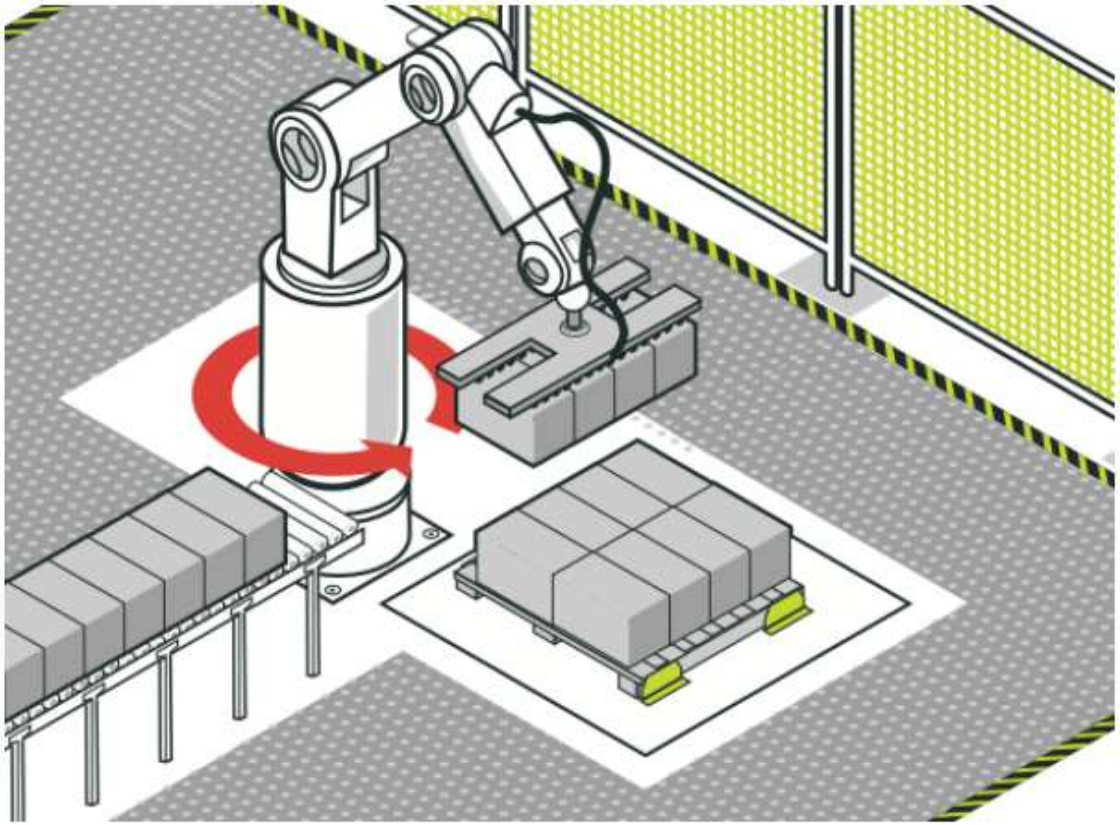
S = (1600 x T) + 250

Where:

- S = minimum safe distance [mm]:
- K = Approach speed [mm/s]: K = 1600mm/s
- T = total reaction time of the system (relay + machine) [s]
- C = 250mm
  (If the risk of encroachment of the hands or part of the hands towards the hazard zone is eliminated while the actuator is being operated, for example by adequate shrouding, then
  C may be zero, with a minimum allowable distance for S of 100 mm.)

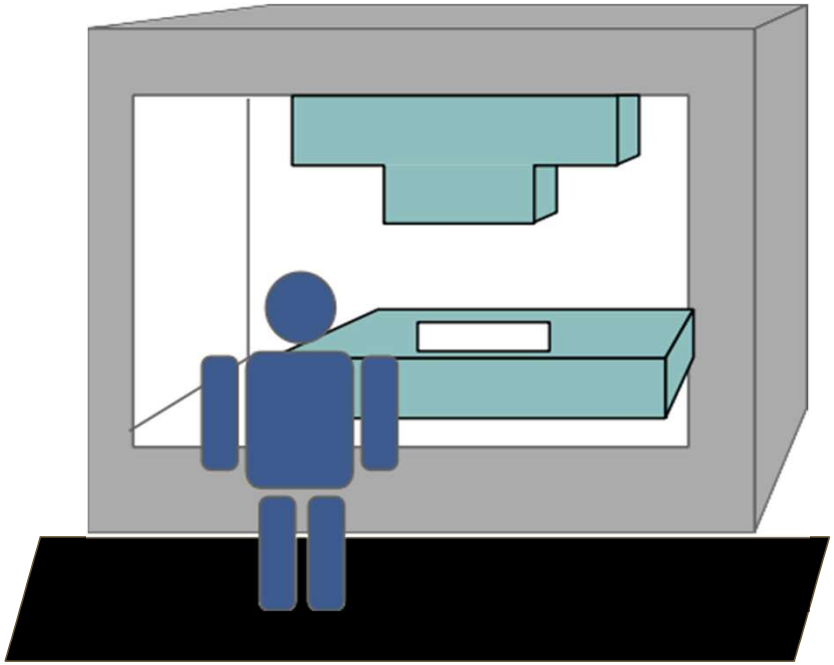
Safety Mat - Safety Distance Calculation

tec.nicum
Schmersal Group

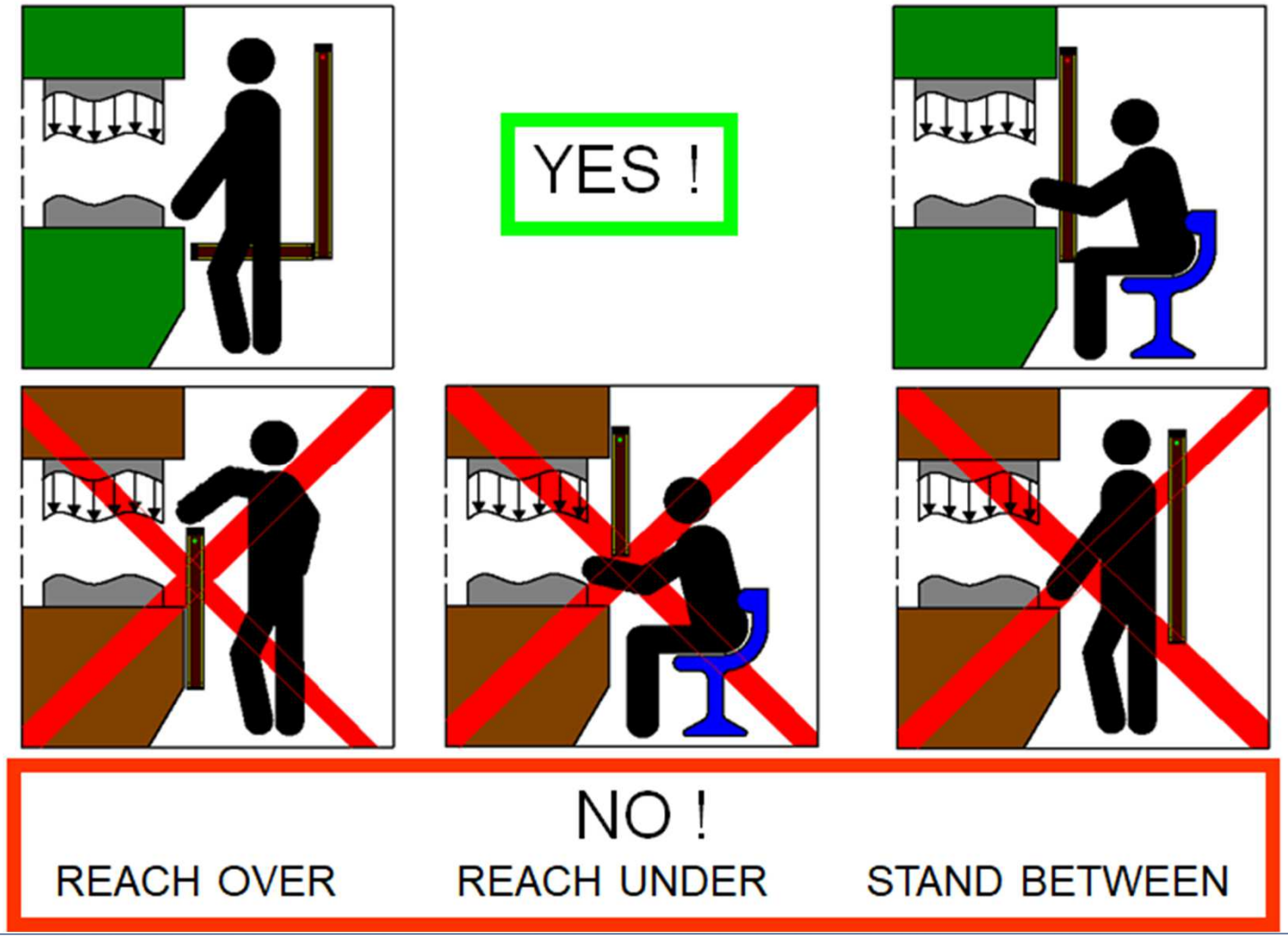


Safety Mat

S = (1600 x T) + 1200



Proper installation of Light Curtain



Thank you

www.tecnicum.com