Vedanta Resources Plc

Sustainability Governance System

Guidance Note GN18

Machinery Guarding

Guidance Note – Machinery Guarding

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DATE	**REVISION NUMBER**	**CHANGE SUMMARY**
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Signature		**Signature**	
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1. INTRODUCTION

1.1. Who is this Guidance Note aimed at?

This Guidance Note is aimed at all Vedanta subsidiaries, operations and managed sites, including new acquisitions, corporate offices and research facilities and to all new and existing employees and contractor employees. This Guidance Note is applicable to the entire operation lifecycle (including exploration and planning, evaluation, operation and closure).

This Guidance Note is for those operations and individuals with machinery-related responsibilities at a Vedanta operation including the sourcing, the installation, the setting, the use and maintenance of machinery.The Guidance Note may also form the basis for training and communications in relation to machine guarding. The Guidance Note should be used in conjunction with the Guidance Note on Risk Assessment and also associated Standards as listed in the back of this Guidance Note.

1.2 What is the aim of this Guidance Note?

This aim of this Guidance Note is to outline the company requirements with regards to machine guarding which Vedanta implements in order to prevent access to dangerous parts of machinery or stop their movement before any part of a person enters a danger zone.This is in line with Vedanta's HSE policy aim of preventing injury and ill-health to employees and contractors by providing a safe and healthy working environment and by minimising risks associated with occupational hazards.

1.3 What issues does this Guidance Note address?

This Guidance Note presents the framework to be used by Vedanta operations for preventing access to dangerous parts of machinery or stop their movement before any part of a person enters a danger zone by the use of machine guarding.

This Guidance Document focuses on the mechanical hazards associated with the use of machinery within Vedanta operations and how to control these hazards by using machine guarding. Vedanta operations must also consider other hazards associated with machinery that are not specifically covered by this Guidance document such as: electrical; thermal; noise; vibration; radiation; hazardous materials and substances; slipping, tripping and falling; environmental hazards or a combination of these hazards.

The focus of the Guidance Noteis on the provision of preferred methods and outcomes rather than prescriptions whilst at the same time representing a practical "how to" guide for all Vedanta operators. It is intended that the Guidance Note will represent a standard baseline guidance for all Vedanta staff within all the operations whilst recognising the need for flexibility at a site depending upon specific circumstances or regulatory specific requirements. In this sense, Guidance Notesarenot designed to be definitive text, nor are they designed to provide prescriptive methods and procedures for undertaking tasks.

1.4 How should this Guidance Note be used?

This Guidance Note is not mandatory and is intended to reflect good practice and provide the basis for continual improvement of sustainability issues across the Vedanta business.However, preventing access to dangerous parts of machinery or stopping the movement of machinery before

any part of a person enters a danger zone is often a regulatory requirement, or at a minimum, best practice in all jurisdictions where Vedanta operations are located. Therefore, where this Guidance

Note is not used, operations will need to demonstrate (and document) how an equivalent process is in placeand how the operation achieves compliance in relation to machine guarding.

When using this guidance, the limitations summarised below should be appreciated:

- The guidance has been designed to be applicable for all Vedanta operations;
- Guidance provided in the present document should be considered with reference to relevant jurisdictional based regulations and/or guidance. Adherence to this Guidance does not necessarily represent adherence to the requirements of relevant jurisdictions or regulatory policy.

All operations must ensure that they have reviewed and incorporated any relevant regulatory requirements that apply to their operation. Where no regulatory requirements exist, this document and appropriate additional guidance as stipulated in other jurisdictions (e.g. by the European Union or Occupational Safety and Health Administration (OSHA)) should be used.

The remainder of this Guidance Note is structured as follows:

Section 2: What are the occupational hazards associated with rotating and moving machinery;
Section 3: Approach to the management of occupational hazards relating to rotating and moving machinery;
Section 4: Options for machinery risk reduction- removing the hazard by design;
Section 5: Use of risk assessment;
Section 6: Guarding types
Section 7: General features of guards and protection devices;
Section 8: Calculation of safe working distances
Section 9: Color coding
Section 10: Maintenance of guards & protection devices;
Section11: Provision of information, instruction and training;
Section12: Management controls.

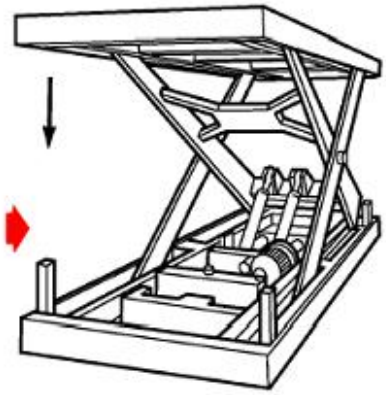
AnnexA: Additional information in relation to the design and construction of safeguards

2. WHAT ARE THE OCCUPATIONAL HAZARDS ASSOCIATED WITH ROTATING AND MOVING MACHINERY

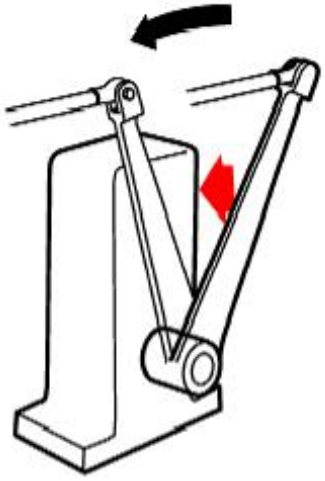
Rotating and moving machine parts have the potential to cause severe workplace injuries, such as crushed fingers or hands, amputations, burns, blindness, or evendeath. Injuries or death can occur from being trapped, entangled, or struck by machinery parts due to the unexpected starting of equipment or unobvious movements during operations, maintenance or cleaning.

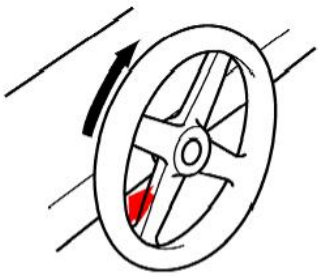
Typical hazards associated with rotating and moving machinery may include:

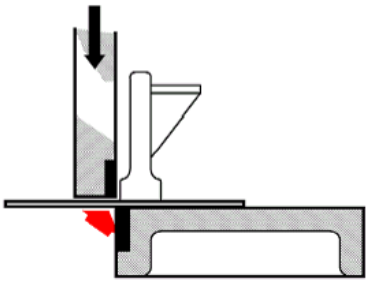
- **Crushing**: Occurs when part of the body is caught between a moving part of a machine and a fixed object, e.g. underneath scissor lift or between the tools of a press;



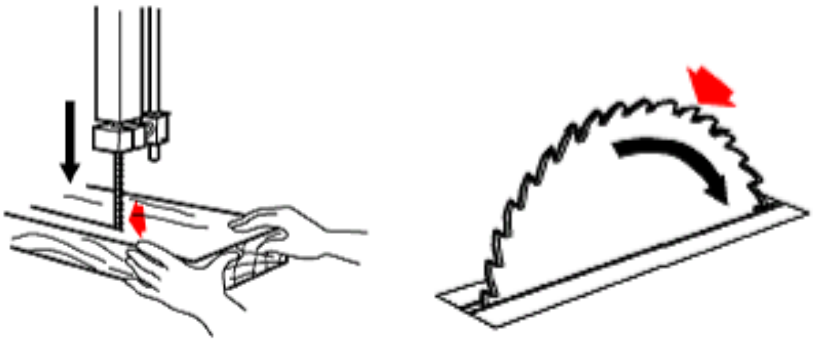
- **Shearing**: Parts of the body may be sheared by scissor action caused by parts of the machine (e.g. mechanism of scissor lift or platform or oscillating pendulum);



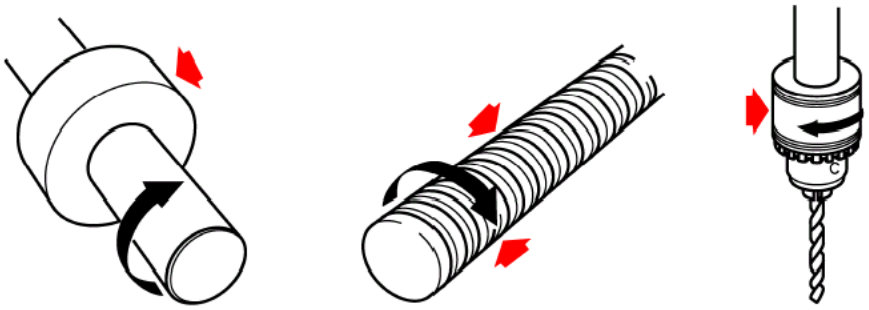




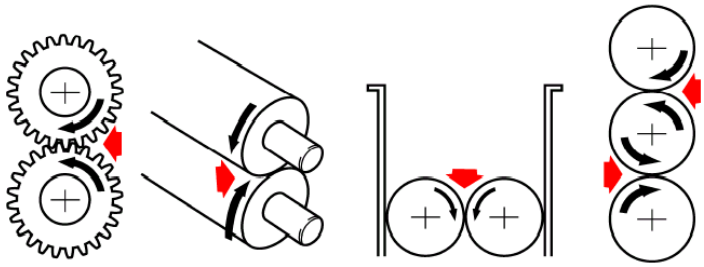
- **Cutting and severing**: Cutting hazards include contact with circular saws, guillotine knife, rotary knives or moving sheet metal;



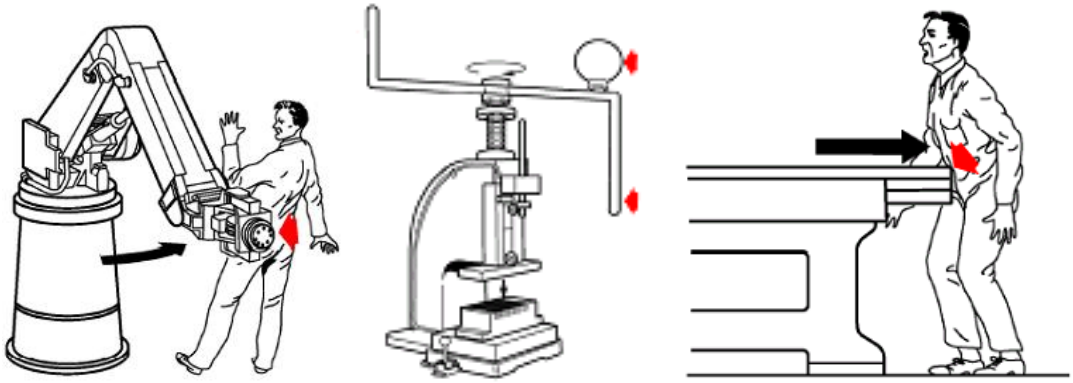
- **Entanglement**: Occurs as a result of clothing or hair contact with rotating objects or catching on projections or in gaps, e.g.; revolving beaters, cylinders and drums; revolving shafts, spindles, mandrels and bars etc.;



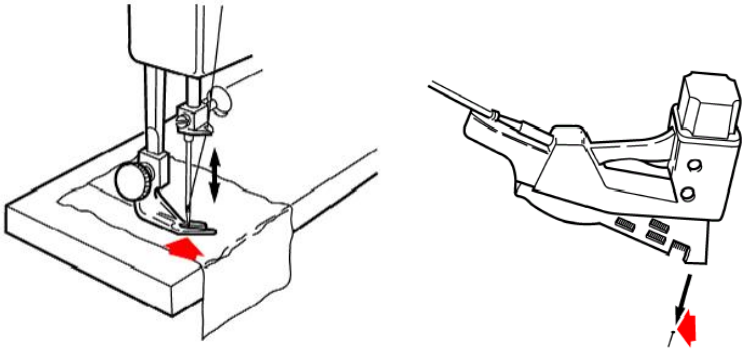
- **Drawing-in or trapping**: Occurs when part of the body is caught between two counter-rotating parts, e.g. gears, mixing mills or between belt and pulley or chain and chain wheel;



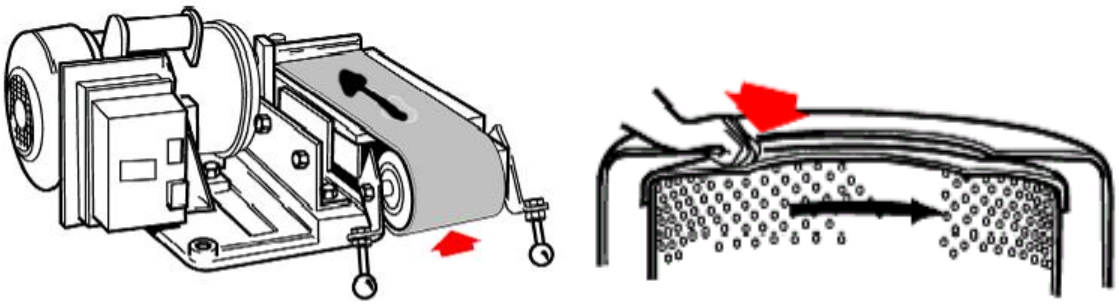
- **Impact**: Impact hazards are caused by a moving object striking the body without penetrating it, e.g. being hit by a robot arm or moving parts of a conveyor belt;



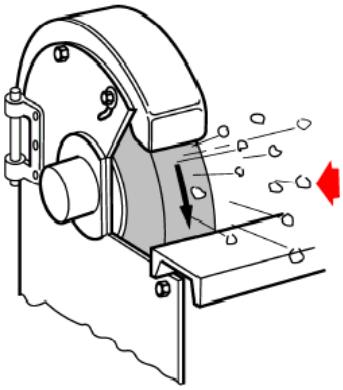
- **Stabbing and puncture**: Occurs when flying objects, swarf or rapid moving parts make contact with the body;



- **Friction and abrasion**: Occurs when the body makes contact with moving rough or abrasive surfaces e.g. abrasive wheels; conveyor belts;



- **Projectile hazards**: Breakage of high-speed cutting tools; disintegration of abrasive wheels; disintegration of conveyor belts; robot arm gripper (or clamp) failure;



- **High pressure fluid injection**: Sudden release of fluid under pressure can cause tissue damage similar to crushing; and

- **Other hazards**: exposure to electricity; hot surfaces; ionising and/or non-ionising (microwaves, ultraviolet light, laser beams and radio waves) radiations; noise; work activity hazards (e.g. highly repetitive actions, stressful posture, lifting/ handling, poor workplace designetc.).

3. APPROACH TO THE MANAGEMENT OF OCCUPATIONAL HAZARDS RELATING TO ROTATING AND MOVING MACHINERY

Vedanta is committed to preventing injury and ill-health to employees and contractors by providing a safe and healthy working environment and by minimising risks associated with occupational hazards (such as the hazards listed in section 2 associated with rotating and moving equipment).

Preventing access to dangerous parts of machinery or stopping the movement of machinery before any part of a person enters a danger zone is either a regulatory requirement, or at a minimum, best practice in all jurisdictions in which Vedanta operations are located.

Vedanta Technical Standard TS 10 on Safety Management directs Operations to implement all reasonable precautions to protect the health & safety of Vedanta employees, contract employees and third parties affected by the work activities and introduce preventative and protective measures (with a preference for the avoidance of risks and impacts over minimisation) according to the following order of priority:

- Hazard elimination by removing the activity from the work process;
- Hazard control at the source through the use of engineering control mechanism;
- Hazard minimization through the design of safe systems of work, and administered control measures; and
- Provision of appropriate Personal Protective Equipment (PPE) in conjunction with training, use and continual maintenance.

Furthermore, Section 4.3 of the Technical Standard TS 10 on Safety Management states that operations have to identify, assess and minimise the hazards and risks relating to rotating and moving equipment through the application of controls which follow the hierarchy of control set above.

This means that, in practice, there is a need, in the first instance,to aim to remove hazards associated with machinery by removing the activity from the work process or, changing the work process. For work activities that remain present on Vedanta Operations, a priority is to prevent exposure to the hazards associated with machineryby identifying and substituting a work activity by a non-hazardous or less hazardous alternative. This should be a thorough and comprehensive process which considers and evaluates the hazards posed by alternative work processes and the machinery that can be used with a view to selecting for use the machinery that produces the least risk for the circumstances of the work.

The remaining sections of this guidance note assume that aprocess has been undertaken to identify and then remove, where possible, any activity requiring the use of dangerous machinery.

Options for machinery risk reduction- Removing the hazard by design

In order to reduce the occupational hazards associated with rotating and moving machinery, consideration must be given to substituting existing dangerous machinery for the less dangerous; and/ or identifying the least dangerous machinery when making new purchases.

The most effective risk control measures are those implemented at the machine/ work equipment design stage. It is a legal requirement in parts of the world such as Europe that all machinery supplied after a certain date (January 1995) carries a CE markto demonstrate that the machine complies will all relevant EU machinery legislation, including the“essential health and safety

requirements" that must be met by a specific piece of machinery. In effect, under EU machinery legislation, manufacturers and suppliers need to carry out a risk assessment and demonstrate that all risks are adequately controlled by design rather than by procedures. This means that the machinery is inherently safer as the manufacturers/ suppliers have designed out the hazards. It must be recognised, however, that the presence of a CE mark does not in itself provide a guarantee of safety – the user must ensure through risk assessment that the equipment is safe for use.

All over the world, there are different laws that apply to the designing of machinery/ work equipment with a similar aim to European legislation on machinery safety. In India as per Factories act -1948 &ISO 13857:2008

Vedanta operations are required to identify the requirements which are relevant to the locations in which they operate, and ensure compliance with these requirements prior to sourcing new machinery or refurbishing existing machinery in order to make machinery safer before it is put into use at Vedanta's operations. (This also includes self-manufacture of equipment).

5. USE OF RISK ASSESSMENT

The level of risk presented by rotating and moving machinery should be established at each operation through an on-going and formalised (i.e. documented) risk assessment process as per established Vedanta Standards[1].

The nature of the potential injuries resulting from contact with rotating and moving machine parts should be evaluated in line with section 2 above to establish the severity and likelihood of occurrence for each type of hazard identified. This will enable a decision to be made on whether the level of risk is acceptable or if risk reduction measures are needed. In most cases, the objective of risk reduction measures is to prevent contact of part of the body or clothing with any dangerous part of the machine, by the use of, for example, guarding.

The hierarchy of control specific to machine guarding is based on the use of *(in order of priority):*

1. Fixed and enclosed guards;
2. Other guards or protection devices such as interlocked guards and pressure mats;
3. Protection appliances such as jigs, holders and push sticks etc.; and
4. The provision of information, instruction, training and supervision throughout all levels of the hierarchy of controls.

Where protective measures (such as guards) have been fitted, it is important to ensure these are designed and installed in conformance with the legal machine safety standards applicable to a specific Vedanta Operation.

When selecting reduction measures, consideration should be given to each level of protection from the first level of the scale above (i.e. consider the use of fixed guards in the first instance) and use reduction measures from that level so far as it is practicable to do so and then move to the next level down the hierarchy. It is necessary to continue the selection process down the scale until the combined measures are effective in reducing the risks to an acceptable level.

[1]Operations should refer to GN 07 on 'Risk Assessment'.

Note: most machinery will present more than one mechanical hazard, and it may be necessaryto select a combination of measures to control the risks associated with all these. For example, at belt conveyors there is a risk of entanglement with the rotating shafts and of being trapped by the intake between drum and moving belt.

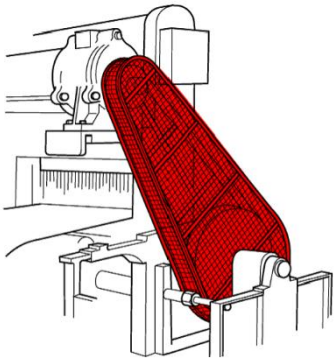
Any risk assessment should not just deal with the machine when it is operating normally, but also must cover activities such as setting, maintenance, cleaning, repair, clearing of jams/blockages etc. – it is often these situations in which many incidents occur.

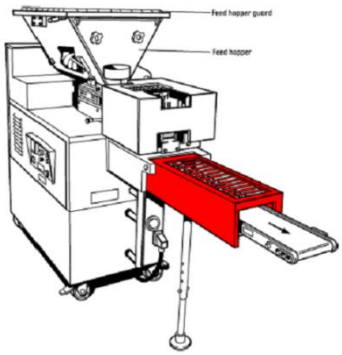
6 GUARDING TYPES

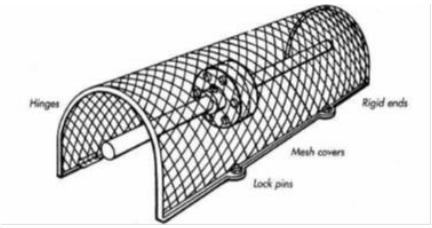
The main types of safeguards and safety devices can be classified as follows:

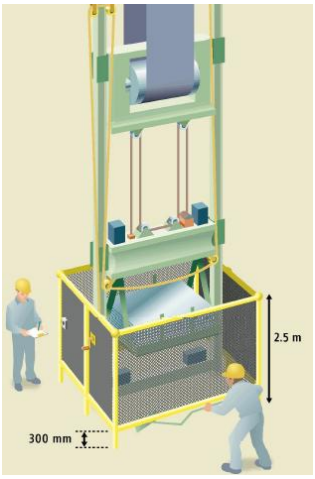
- **Fixed Guards**: These guards have no moving parts and are fastened in a constant position relative to the danger zone. They are kept in place either permanently, by welding for example, or by means of fasteners (screws, nuts etc.) making removal/opening impossible without using tools. If by themselves, or in conjunction with the structure of the equipment, they enclose the dangerous parts, fixed guards meet the requirements of the first level of the hierarchy. Note that, in most countries, fixed enclosing guards, and other types of guard can have openings, provided that they comply with appropriate safe reach distances as set by the relevant in-country regulations. **Note the use of clips, wing nuts, etc. which can be removed without tools is not permittedfor a fixed guard.**

  Examples of fixed guards:



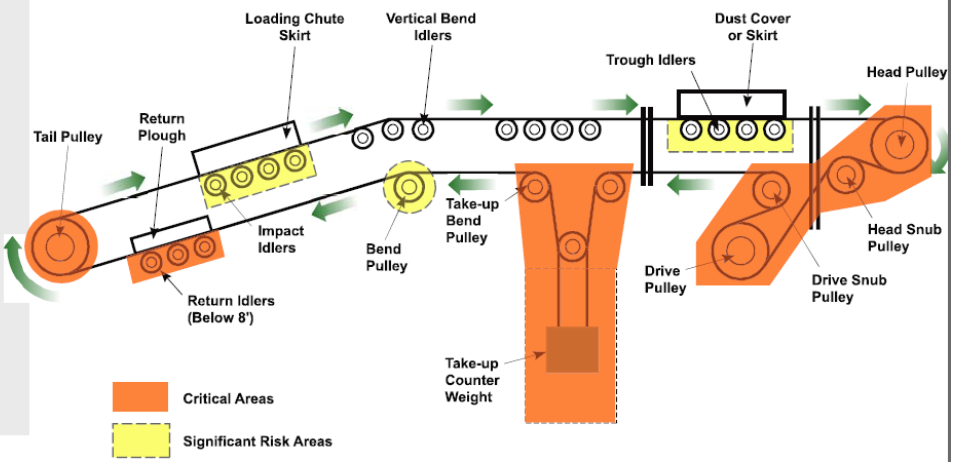




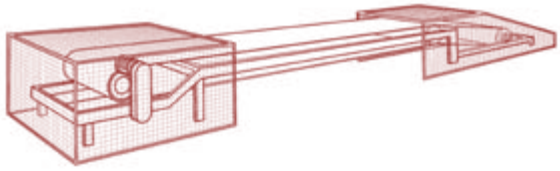


Operations should, in particular, ensure that dangerous zones on conveyors are guarded appropriately. Conveyors are an efficient method of transportation. However, they can also be one of the most dangerous items of plant in a workplace as illustrated by Figure 1 below.

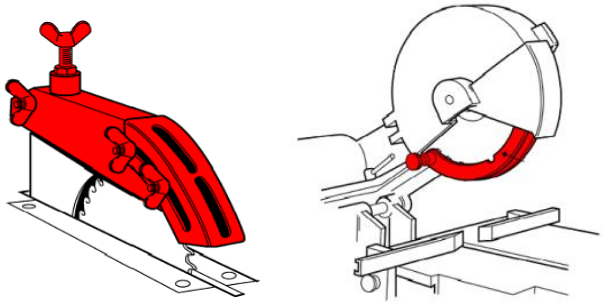
Figure 1: Numerous Danger Points on a Standard Conveyor



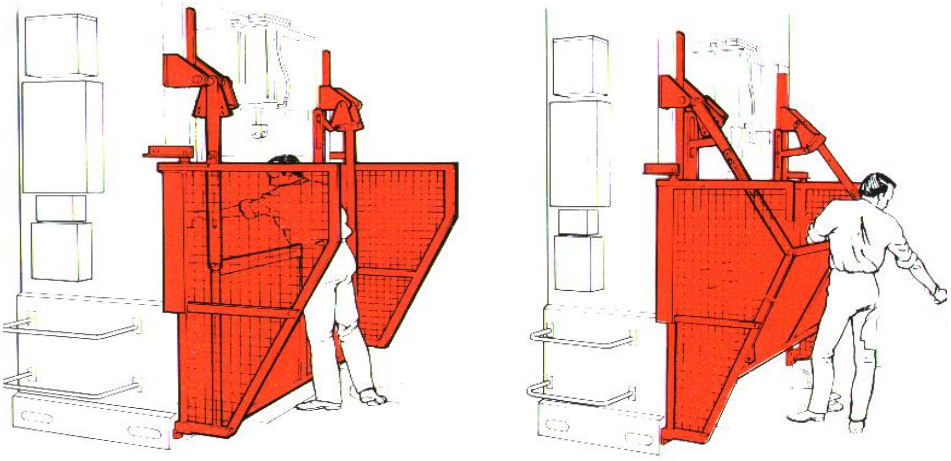
This may include, for example, the use of fixed guards for the head and tail sections of conveyors- see picture below.



- **Other Guards**: These include, for example, fixed guards with an adjustable element, automatic guards or interlocked guards.
    - *Adjustable guards*: comprise a fixed guard with adjustable elements that are either self-adjusting or which the setter or operator has to position to suit the job being worked on. They are widely used for tool-room machines and woodworking. These guards can usually be adjusted without the use of tools. These allow limited access through openings, gates etc. for feeding materials, making adjustments, cleaning etc.;



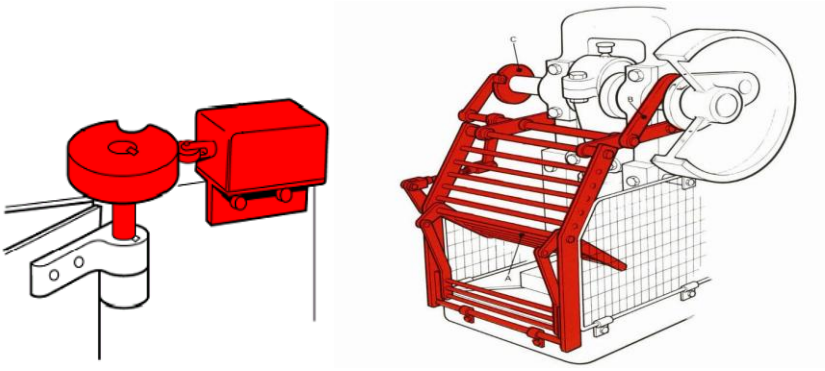
- *Automatic guards*: these are guards, which are moved into position automatically by the machine, thereby removing any part of a person from the hazardous area of the machine. They are often called ‘sweep away’ guards;



- *Interlocked guards*: these guards are usually movable, e.g. they can be hinged, sliding or removable. These guards are used when frequent access to hazardous parts of a machine may be needed, and are connected to the machine controls by means of ‘position sensors’. Interlocked guards may operate mechanically, electrically, magnetically, hydraulically or pneumatically (or a combination of these ways). The position sensors interlock the guard with the power source of the hazard. When the guard is open, the power is isolated, therefore allowing safe access into the relevant part of the machine.

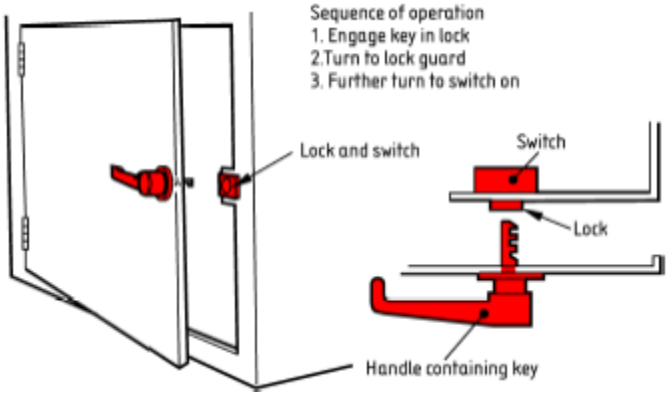
  Interlocked guards commonly use the following types of interlocking elements:

  - *Cam-operated limit switch interlocks*: these are one of the most popular types of interlocks used as they areusually versatile, effective and easy to install.



  - *Trapped key interlocks:* A master key, which controls the power supply to the machine at the master key box has to be turned OFF before the keys for individual guards can be released. The master key cannot be turned back ON until all the individuals keys are replaced in the master key box. This type of interlock is usually used in electrical isolation;

- *Captive-key interlocks:* This involves a combination of an electrical switch and an mechanical lock in a single assembly;



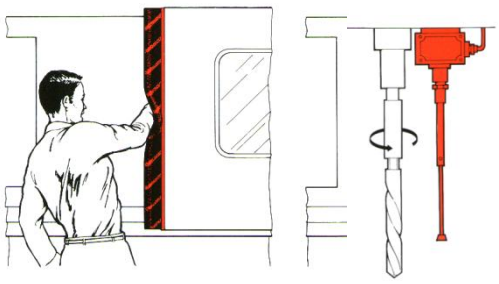
- *Direct manual switch or valve interlocks:* This is a system where a switch or valve controlling the power source cannot be operated until a guard is closed; and the guard cannot be opened at any time the switch is in the ON position;

- *Mechanical interlocks:* These interlocks directly link the guards to power or transmission control of a machine This means that, in practice, the power/ transmission switch cannot be reached when the guard is open;

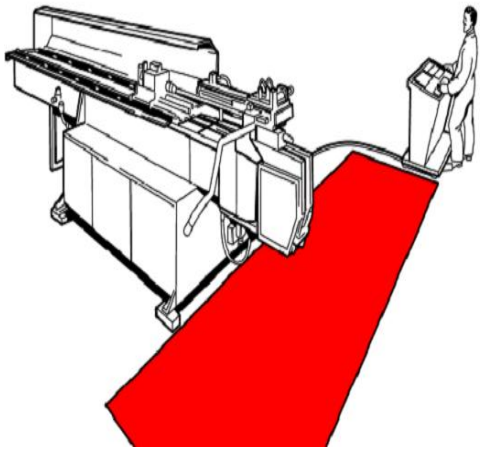
- *Magnetic switches:* These interlocks use a 'coded' magnet attached to the guard. As the guard is removed, the magnetic field is broken and the machine comes to a stop or fail safe mode;

- *Electro-mechanical interlocks:* These interlocks use a mixture of electro-magnetic and mechanical devices. For example, the removal of bolts on a guard may immediately trip the machine. The bolt has then to be removed a considerable distance for the guard to be completely removed.

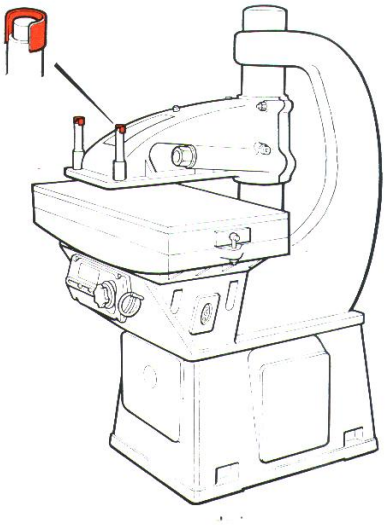
- **Safety Devices**: A safety device is a protective appliance, other than a guard, which eliminates or reduces risk on its own or associated with a guard. There are many forms of safety device available. These devices do not prevent access to the danger zone but stop the movement of the dangerous part before contact is made. Typical examples are mechanical trip devices, active opto-electronic devices such as light curtains, pressure-sensitive mats, two-hand controls and dead man switches.



Examples above of mechanical trip devices



Example of a pressure-sensitive mat



Example of two-hand control

Operators make use of protection appliances to hold or manipulate materials/ products in a way which allows them to control and feed a loose workpiece at a machine while keeping their body clear of the danger zone. They are commonly used in conjunction with manually fed woodworking machines and some other machines such as bandsaws. These appliances will normally be used in addition to guards.

7 GENERAL FEATURES OF GUARDS AND PROTECTION DEVICES

All guards and protection devices provided must be suitable for their purpose. In deciding what is suitable, first establish the foreseeable risks associated with the machine (see risk assessment section above) and then follow guidance contained in national and international standards (such as ISO 13857:2008 on the safety of machinery. which sets outsafety distances to prevent hazard zones being reached by upper and lower limbs) guidance from the relevant national health & safety regulatory bodies relevant to the jurisdiction(s) in which they operate; guidance from industry associations; and their own knowledge of the particular circumstances in which the machine is to be used.See Annex A for further information.

At a minimum,it should be ensured that safeguards and safety devices:

- Are of robust construction to prevent ejected parts of the machine/ components or material penetrating the guard;
- Do not give rise to additional hazards;
- Are not easy to bypass or render non-operational;
- Are located at an adequate distance from the danger zone;
- Cause minimum obstruction of view for machine operators; and
- Enable essential work to be done without guard removal.

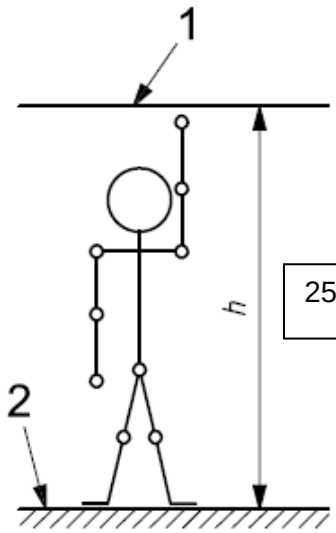
8 CALCULATION OF SAFE WORKING DISTANCES

- **Reaching upwards**

  Theillustrationbelow shows the safety distance for reaching upwards, If there is a low risk from the hazard zone, then the height of the hazard zone, *h*, shall be2500 mm or more.

  If there is a high risk from the hazard zone, then the height of the hazard zone, *h*, shall be 2700 mm or more.

  Refer Annex – A tables for type of guard and for the placement.

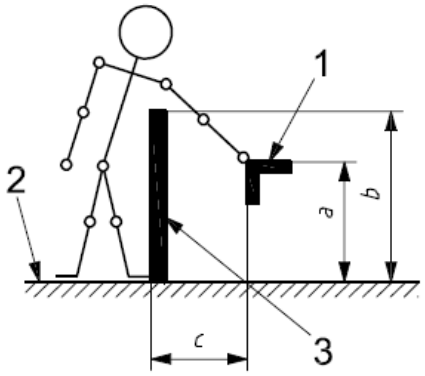


Key

1 hazard zone
2 reference plane
h height of hazard zone

- **Reaching over protective structures**:

  The following illustration will help to assess whatsort of guarding is required and where it should be located (inorder to keep a danger point on a machine safely out of reach). Where doubt exists in relation to the distances shown,measurements should be taken of the actual work place toensure danger points are beyond reach.



Key

a	height of hazard zone	1	hazard zone (nearest point)
b	height of protective structure	2	reference plane
c	horizontal safety distance to hazard zone	3	protective structure

9 COLOUR CODING

Colour coding should be considered for all guarding. It is considered good practice for all safety guards to be painted the same colour. For example, use highvisibility yellow (provided it is different to the general machinery colour). It is also good practiceto paint the surfaces behind the guard a different colour (e.g. blue or red), so that when the guardhas been removed, the exposed colour is clearly visible. It is then easy to identify that the guardhas been removed and workers are alerted to possible danger.

10 MAINTENANCE OF GUARDS & PROTECTION DEVICES

Guards and protection devices must be maintained in an efficient state, in efficient working order and in good repair. This is an important requirement as many accidents occur when guards have not been maintained. Operations are required to develop and document inspection, maintenance and testing procedures to ensure that guards and protection devices are maintained in an efficient state, in efficient working order and in good repair. These procedures should be included in any Standard Operating Procedures.

Guards and protection devices should be installed so that they are not easily defeated or by-passed. Where people have to work inside guarded areas LOCK OUT & TAG OUT (**LO/TO)** procedures should be in place to ensure that all energy sources are isolated.

Rotating/moving parts should not be within reach of any limbs or hands. No loose clothing should be worn around moving machinery, regardless of moving speed or rotation speed as kinetic/potential energies involved can never be underestimated. Guards should be easily removable (for cleaning purposes) but also sufficiently attached so they cannot fall off. Tools and equipment used around moving machinery must be of a design to ensure they can be easily released if caught by the machinery.

An effective programme of record keeping should be developed to demonstrate the implementation of the above procedures.

11 PROVISION OF INFORMATION, INSTRUCTION AND TRAINING

The provision of information instruction and training is the requirement for operators and maintenance teams. The extent of the information, instruction and training provided to employees (and contractors) will vary with the complexity of the hazards, risks, processes and controls identified in the risk assessments, and legal requirements. Operations should aim to strike a balance between providing sufficient information for an employee, and / or contractor to carry out work safely, and providing too much information that may result in overburdening and confusing the employee. Training should be included for all existing employees, new starters and contractors that may have to undertake machinery related activity. Training should be documented and include refresher training.

Procedures should ensure that no person installs, sets, operates or maintains a machine unless they have been instructed in the actual and potential hazards associated with that machine and the precautions to be taken in relation to these hazards. Training on the use of machinery should include information on:

- Actual and potential hazards and appropriate controls associated with a specific piece of machinery;
- Purpose of guards and other safety devices;
- Correct use and adjustment of guards.

If a trainee machine operator does not have the skills to operate the machine safely, then he/she will need to be closely supervised by a person who does have the skills or he/ she is not allowed to use the machine.

Providing information, instruction and training is not a one-off exercise. Information, instruction and training should be reviewed and updated whenever significant changes are made to the type of work carried out or to the work methods used.Significant changes might include the amount of materials used or produced, new machinery brought into the workplace; new control measures, new materials brought into the workplace, and automation of certain processes. Additional information and training following anupdate of arisk assessment should explain why the risk assessment was reviewed, any changes to the way the work is to be done and any changes the precautions the employees should take to protect themselves and others.

See also Vedanta Management Standard MS06 Competency, Training and Awareness.

12 MANAGEMENT CONTROLS

Management controls (procedures, inspections, communications, training and drills) should be used to address residual risks that have not been prevented or controlled through the use of machine guarding.

DEFINITIONS

Definitions of key terms used in this document are shown in the following table.

Term	Definition
Contractor	Any third party organisation which is engaged or commissioned by Vedanta to undertake work or provide services.
Contractor Employee	An employee of a contracted company engaged or commissioned by Vedanta to undertake work or provide services, but who are not directly employed by Vedanta. For example, contractor employees working on Vedanta operations, persons working for Vedanta through staff/employment agencies, contract cleaners etc.
Employee	An individual who is engaged to work directly for Vedanta on either a part-time or full-time basis and for a fixed period or on permanent basis and is salaried. By virtue of the individual's contract of employment, the employee is obliged to adhere to Vedanta's terms and conditions of employment (specific to Group or the subsidiary employing the individual), and is protected by national (where it exists) and international laws concerning labour and working conditions.
Fail-safe mode	In the event of failure, the machine is designed to return to a safe condition in the event of a failure or malfunction and will respond in a way that will cause no harm, or at least a minimum of harm, to other devices or danger to personnel. Usually the machine comes to rest in the standby position.
Guards	Guards are barriers which prevent access to danger areas. There are four general types of guards: fixed, interlocked, adjustable and self-adjusting.
Hazard	An object, property or an activity that can cause adverse effects e.g. a high voltage electricity supply or a toxic chemical may present a hazard, meaning that they present the potential for harm.
Hazard identification	Identification of the inherent capability of a substance to cause adverse effects.
Operation(s)	A location or activity that is operated by a Vedanta Company and is part of the Vedanta Group. Locations could include mines, refineries, ports or transportation activities, wind farms, oil and gas development sites, offices including corporate head offices, and research and development facilities.
Risk	Combination of probability or frequency of certain hazardous occurrences and severity of impacts resulting from an occurrence. The ISO13001 Standard on Risk Management -- Principles and Guidelines defines risk as the effect of uncertainty on objectives, uncertainties including events (which may or not happen) and uncertainties caused by a lack of information or ambiguity.
Risk assessment	The identification, evaluation and estimation of the levels of risks involved in a situation, their comparison against benchmarks or standards, and determination of an acceptable level of risk.
Vedanta Company	A subsidiary of Vedanta Group either fully or majority owned that has its own management structure (e.g. Hindustan Zinc Limited, Vedanta Aluminium Limited, Sterlite Industries Limited, etc.)

RELATED DOCUMENTATION

A summary of the references and supporting documents relevant to this document is provided in the following table.

Doc. Ref.	Document name
POL 06	HSE Policy
MS 06	Competency, Training and Awareness
TS10	Safety Management
GN 07	Risk Assessment

Annex A – Additional information in relation to the design and construction of safeguards

ISO 13857:2007 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 year olds 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 year olds is approximately 900 mm) where reaching through openings needs to be addressed.

Operations should, when designing and/ or constructing guards (either themselves or via a specialist contractor), aim to comply with the following guidance:

Reach Dimensions The design and construction of guards and their subsequent location shall be such that the distance of any nip point or shear hazard and the nearest point of access is restricted as follows:

(a) Arm reach . . . . . 1000 mm from under arm to fingertips
(b) Elbow reach . . . . . 500 mm from the inside elbow to fingertips
(c) Wrist reach . . . . . 280 mm from wrist to tip of middle finger
(d) Finger reach . . . . 150 mm
(e) Vertical reach . . . . 2500 mm maximum when standing on toes

The above dimensions include an allowance made to obtain clearance from the hazardous areas.

Ergonomic considerations

No admittance

Reach restricted to root of finger

Reach restricted to root of thumb

Reach restricted to hand thickness

Guard Placement:

The size of mesh or other openings in the guard and the distance of the guard from the hazardous point shall be as follows:

(a) Size of mesh of opening up to and including 9 mm, distance of guard from the hazardous point virtually same as sheet metal, working clearance only required.

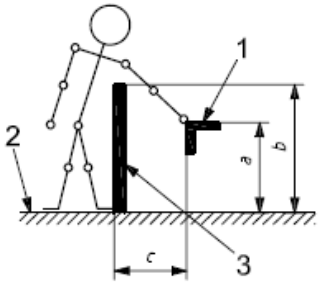
(b) Above 9 mm up to 50 mm square, guard at least 150 mm from hazardous point.

(c) All types of guards, distance between the underside of the guard and the floor not to exceed 250 mm.

Where complete enclosure with a guard is not provided, distance/fence type guards need to be used and the height of the guard and the distance of the guard from the hazardous point shall be in accordance with. The size of mesh or other openings shall be not greater than 9 mm where the nip point is up to and including 150 mm from the guard, and not greater than 50 mm square where the nip point is in excess of 150 mm from the guard. The table below provides an example of the various height and distance requirements.

Height of nip point from floor or working surface (a)	millimetres								
	Distance from nip point to Guard (c)								
	Height of Guard from floor or working surface (b)								
	2290	**2130**	**1980**	**1830**	**1680**	**1520**	**1380**	**1220**	**1000**
2500	-	-	-	-	-	-	-	-	-
2360	75	150	230	230	230	230	230	230	230
2290	75	150	230	300	380	380	380	380	-
2210	-	200	300	300	450	530	530	530	600
2130	-	200	300	450	530	600	600	600	-
2050	-	150	300	450	600	600	600	680	1100
1980	-	150	300	450	600	680	680	750	-
1900	-	-	230	450	600	680	680	840	-
1830	-	-	-	450	600	680	750	840	1200
1750	-	-	-	450	600	750	840	900	-
1680	-	-	-	300	600	750	840	900	-
1600	-	-	-	300	530	750	840	900	1300
1520	-	-	-	230	530	750	840	900	-
1450	-	-	-	-	530	750	840	900	-
1380	-	-	-	-	450	750	840	900	-
1300	-	-	-	-	380	750	840	900	1350
1220	-	-	-	-	-	750	840	900	-
1150	-	-	-	-	-	680	840	900	-
1050	-	-	-	-	-	680	750	840	-
1000	-	-	-	-	-	680	680	840	1400
920	-	-	-	-	-	300	680	940	-
840	-	-	-	-	-	-	600	840	-
750	-	-	-	-	-	-	380	750	-
680	-	-	-	-	-	-	300	600	1200
600	-	-	-	-	-	-	-	530	-
530	-	-	-	-	-	-	-	380	-

Reaching over protective structures



Key

a	height of hazard zone	1	hazard zone (nearest point)
b	height of protective structure	2	reference plane
c	horizontal safety distance to hazard zone	3	protective structure

Table 1: Reaching over protective structures – High Risk (from ISO 13857:2008)

Dimension in millimetres

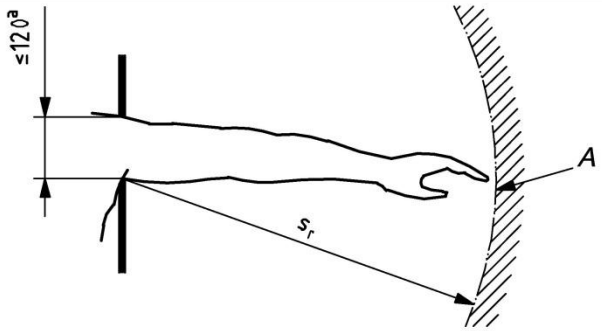
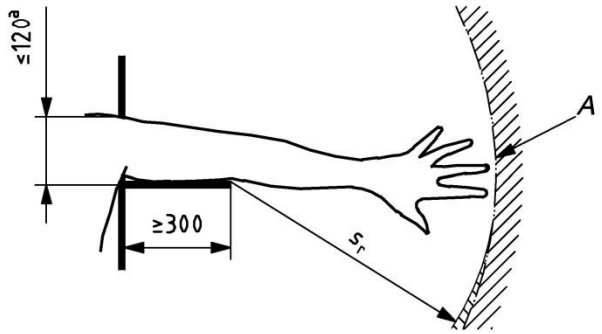
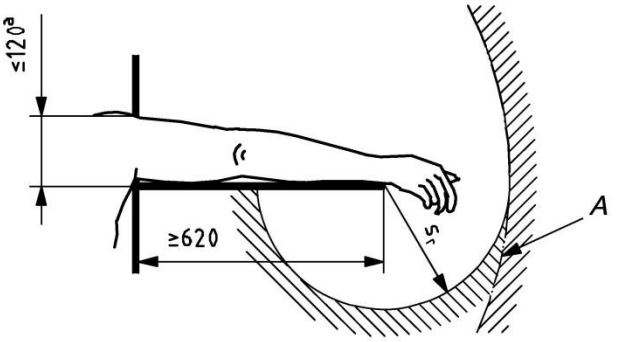
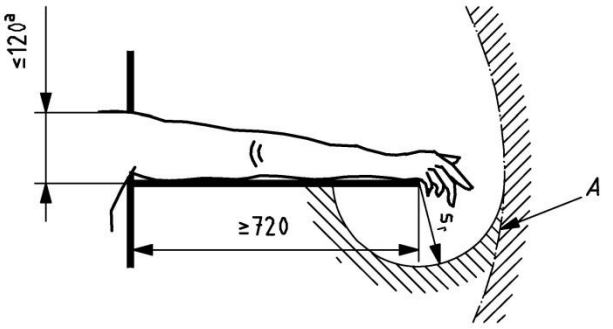
Height of hazard zone *a*	Height of protective structure [a, b] *b*									
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500	2 700
	Horizontal safety distance to hazard zone, *c*									
2 700	0	0	0	0	0	0	0	0	0	0
2 600	900	800	700	600	600	500	400	300	100	0
2 400	1 100	1 000	900	800	700	600	400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

[a] Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

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

Table 2: Reaching around with limitation of movement (from ISO 13857:2008)

Dimensions in millimetres

Limitation of movement	Safety distance, s_r	Illustration
Limitation of movement only at shoulder and armpit	⩾ 850	
Arm supported up to elbow	⩾ 550	
Arm supported up to wrist	⩾ 230	
Arm and hand supported up to knuckle joint	⩾ 130	

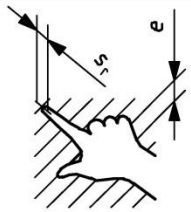
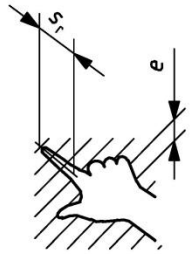
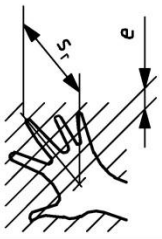
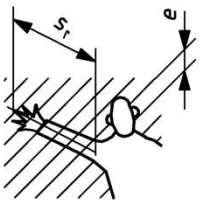
A range of movement of arm

s_r 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.

Table 3: Reaching through regular openings – Persons of 14 years of age and above (from ISO 13857:2008)

Dimensions in millimetres

Part of body	Illustration	Opening	Safety distance, s_r		
			Slot	Square	Round
Fingertip		$e \leqslant 4$	$\geqslant 2$	$\geqslant 2$	$\geqslant 2$
		$4 < e \leqslant 6$	$\geqslant 10$	$\geqslant 5$	$\geqslant 5$
Finger up to knuckle joint		$6 < e \leqslant 8$	$\geqslant 20$	$\geqslant 15$	$\geqslant 5$
		$8 < e \leqslant 10$	$\geqslant 80$	$\geqslant 25$	$\geqslant 20$
Hand		$10 < e \leqslant 12$	$\geqslant 100$	$\geqslant 80$	$\geqslant 80$
		$12 < e \leqslant 20$	$\geqslant 120$	$\geqslant 120$	$\geqslant 120$
		$20 < e \leqslant 30$	$\geqslant 850$ [a]	$\geqslant 120$	$\geqslant 120$
Arm up to junction with shoulder		$30 < e \leqslant 40$	$\geqslant 850$	$\geqslant 200$	$\geqslant 120$
		$40 < e \leqslant 120$	$\geqslant 850$	$\geqslant 850$	$\geqslant 850$

The bold lines within the table delineate that part of the body restricted by the opening size.

[a] If the length of the slot opening is $\leqslant$ 65 mm, the thumb will act as a stop and the safety distance can be reduced to 200 mm.