

MINE HEALTH  
AND SAFETY  
INSPECTORATE



GUIDELINE FOR THE COMPILATION OF A  
MANDATORY CODE OF PRACTICE FOR THE

SAFE USE OF  
CONVEYOR BELT  
INSTALLATIONS FOR  
THE TRANSPORTATION  
OF MINERAL,  
MATERIAL OR  
PERSONNEL



**mineral resources**

Department:  
Mineral Resources  
REPUBLIC OF SOUTH AFRICA



**DEPARTMENT OF MINERAL RESOURCES**

**MINE HEALTH AND SAFETY INSPECTORATE**

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CHIEF INSPECTOR OF MINES



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## **PART A: THE GUIDELINE**

### **1. FOREWORD**

Over the past 20 years, 1 212 persons were involved in accidents relating to **conveyor belt installations**. Of these persons, 133 were fatally injured, 1 079 seriously injured and three disabled. Because of these accidents the Chief Inspector of Mines identified conveyor belt installation as an area requiring statutory regulation. A tripartite task group, with members chosen from the regions where **conveyor belt installation** are used, was established under the auspices of the Mining Regulation Advisory Committee (**MRAC**) to investigate the most appropriate means of regulating **conveyor belt installations**. After research was done on these accidents, on relevant South African and International Standards, on **SIMRAC** projects and having regard to the nature of the risks identified in a hazard identification and risk assessment process, it was decided that regulations and a guideline for a mandatory Code of Practice (**COP**) would be the most appropriate means of regulating **conveyor belt installations**.

### **2. LEGAL STATUS OF GUIDELINES AND CODES OF PRACTICE**

In accordance with Section 9(2) of the **MHSA** an employer must prepare and implement a **COP** on any matter affecting the health or safety of employees and other persons who may be directly affected by activities at the mines if the Chief Inspector of Mines requires it. These **COPs** must comply with any relevant guidelines issued by the Chief Inspector of Mines (Section 9(3)). Failure by the employer to prepare or implement a **COP** in compliance with this guideline is a breach of the **MHSA**.

### **3. THE OBJECTIVE OF THIS GUIDELINE**

The objective of this guideline is to enable the employer at every mine to compile a **COP**, which, if properly implemented and complied with, would improve health and safety in connection with the use of **conveyor belt installations** at a mine.

### **4. ACRONYMS AND DEFINITIONS**

In this guideline for a **COP** the following acronyms and definitions are used:

**COP** means a Code of Practice

**DMR** means Department of Mineral Resources

**ECSA** means Engineering Council of South Africa

**MHSA** means the Mine Health and Safety Act, 1996, Act 29 of 1996

**MRAC** means Mining Regulation Advisory Committee

**SABS** means South African Bureau of Standards

**SANS** means South African National Standards

**SIMRAC** means Safety in Mines Research Advisory Committee

**“Conveyor belt installation”** means a mechanical system used for the transportation of mineral, material or personnel on a belt over a distance

**“Power supply”** means any energy source feeding the drive motor of a **conveyor belt installation**

## 5. SCOPE

This guideline for a mandatory **COP** covers the significant health and safety risks relating to the use of **conveyor belt installations** for the transportation of minerals, material, or personnel. Consideration is given to the design, installation, operation, inspection and maintenance of conveyor belts.

## 6. MEMBERSHIP OF TASK GROUP

6.1 This document was prepared by the **MRAC** Task Group on **conveyor belt installations**.

6.2 The following persons were nominated to serve as members of this task group:

Messrs:	J Dodds	-	State (Project Leader)
	WC Botes	-	State
	J Smit	-	Employer
	CP Hughes	-	Employer
	R Bollen	-	Employer
	JP Pearson	-	Employer

No employee representatives were nominated by organised labour to serve on this task group, however various employee representatives at mines were consulted.

## **PART B: AUTHOR'S GUIDE**

1. The **COP** must, where possible, follow the sequence laid out in **Part C “Format and Content of the mandatory COP”**. The pages as well as the chapters and sections must be numbered to facilitate cross-reference. Wording must be unambiguous and concise.
2. It should be indicated in the **COP** and on each annexure to the **COP** whether:
  - (a) The annexure forms part of the guideline and must be complied with or incorporated in the **COP** or whether aspects thereof must be complied with or incorporated in the **COP**, or
  - (b) The annexure is merely attached as information for consideration in the preparation of the **COP** (i.e. compliance is discretionary).
3. When annexures are used the numbering should be preceded by the letter allocated to that particular annexure and the numbering should start at one (1) again. (eg. 1, 2, 3, ... A1, A2, A3,...).
4. Whenever possible illustrations, tables, graphs and the like, should be used to avoid long descriptions and/or explanations.
5. When reference has been made in the text to publications or reports, references to these sources must be included in the text as footnotes or sidenotes as well as in a separate bibliography.

## **PART C:    FORMAT AND CONTENT OF THE MANDATORY CODE OF PRACTICE**

### **1.    TITLE PAGE**

The title page must include the following:

- 1.1 Name of mine;
- 1.2 The heading: “**Mandatory COP for the safe use of conveyor belt installations for the transportation of minerals, material or personnel**”;
- 1.3 A statement to the effect that the **COP** was drawn up in accordance with this guideline **DMR 16/3/2/2-B1** issued by the Chief Inspector of Mines;
- 1.4 The mine’s reference number for the **COP**;
- 1.5 Effective date of the **COP**; and
- 1.6 Revision dates.

### **2.    TABLE OF CONTENTS**

The **COP** must have a comprehensive table of contents.

### **3.    STATUS OF MANDATORY CODE OF PRACTICE**

This section must contain statements to the effect that:

- 3.1 The mandatory **COP** was drawn up in accordance with Guideline **DMR 16/3/2/2-B1** issued by the Chief Inspector of Mines.
- 3.2 This is a mandatory **COP** in terms of Sections 9(2) and (3) of the **MHSA**.
- 3.3 The **COP** may be used in an incident/accident investigation/inquiry to ascertain compliance and also to establish whether the **COP** is effective and fit for purpose.
- 3.4 The **COP** supersedes all previous relevant **COP**’s.
- 3.5 All managerial instructions or recommended procedures (voluntary **COP**’s) and standards on the relevant topics must comply with the **COP** and must be reviewed to assure compliance.

### **4.    MEMBERS OF DRAFTING COMMITTEE**

- 4.1 In terms of Section 9(4) of the **MHSA** the employer must consult with the health and safety committee on the preparation, implementation or revision of any **COP**.
- 4.2 It is recommended that the employer should, after consultation with the employees in terms of the **MHSA**, appoint a committee responsible for the drafting of the **COP**.

- 4.3 The members of the drafting committee assisting the employer in drafting the **COP** should be listed giving their full names, designations, affiliations and experience. This committee should include competent persons sufficient in number to effectively draft the **COP**.

## 5. GENERAL INFORMATION

The general information relating to the mine must be stated in this paragraph.

The following minimum information must be provided:

- 5.1 A brief description of the mine and its location;
- 5.2 The commodities produced;
- 5.3 The mining methods/mineral excavation processes;
- 5.4 A description of the **conveyor belt installation(s)** used at the mine (including relevant information such as the application and technical specifications); and
- 5.5 Other relevant **COP's**.

## 6. TERMS AND DEFINITIONS

Any word, phrase or term of which the meaning is not absolutely clear or which will have a specific meaning assigned to it in the **COP**, must be clearly defined. Existing and/or known definitions should be used as far as possible. The drafting committee should avoid jargon and abbreviations that are not in common use or that have not been defined. The definitions section should also include acronyms and technical terms used.

## 7. RISK MANAGEMENT

- 7.1 Section 11 of the **MHSA** requires the employer to identify hazards, assess the health and safety risks to which employees may be exposed while they are at work, record the significant hazards identified and risk assessed. The **COP** must address how the significant risks identified in the risk assessment process must be dealt with, having regard to the requirements of Sections 11(2) and (3) that, as far as reasonably practicable, attempts should first be made to eliminate the risk, thereafter to control the risk at source, thereafter to minimise the risk and thereafter, insofar as the risk remains, to provide personal protective equipment and to institute a program to monitor the risk.
- 7.2 A proper hazard identification and risk assessment must be conducted on the complete conveyor belt installation. The information must be kept readily available at the mine. To assist the employer with the hazard identification and risk assessment all possible relevant information such as incident statistics, ergonomic studies, research reports, manufacturers specifications, international standards, design

criteria and performance figures for the **conveyor belt installation** should be obtained and considered.

- 7.3 In addition to the periodic review required by section 11(4) of the **MHSA**, the **COP** should be reviewed and updated after every serious incident/accident involving the **conveyor belt installation**, or if significant changes are introduced to procedures, mining and ventilation layouts, mining methods, plant or equipment and material.

## 8. ASPECTS TO BE ADDRESSED IN THE MANDATORY CODE OF PRACTICE

The **COP** must set out how the significant risks identified and assessed in terms of the risk assessment process referred to in paragraph 7.1 above will be addressed.

The **COP** must cover at least the aspects set out below unless there is no significant risk associated with that aspect at the mine.

Annexure B contains extracts from the Conveyor Manufacturers Association of SA Limited Guideline “Safety around Belt Conveyors” and must be consulted in preparation of the **COP**. Relevant minimum performance standards from Annexure B should be included in the **COP** unless other minimum performance standards can be justified in terms of the risk assessment.

### 8.1 Design

- 8.1.1 In order to prevent persons from being injured as a result of a **conveyor belt installation** collapsing, catching fire, a belt breaking or misalignment of the conveyor belt due to incorrect design, the **COP** must set out the design criteria for the belt conveyor installation, covering at least the following:

- Overall structural design;
- Environmental conditions that could affect the integrity of the **conveyor belt installation**;
- An appropriate drainage system along the **conveyor belt installation** to ensure efficient draining of water used for cleaning, dust suppression and prevent water seepage onto the **conveyor belt installation**;
- Appropriate **power supply** and braking systems;
- Conveyor belt extensions;
- Materials of which the conveyor belt is made of in order to minimise the risk of igniting flammable gas or dust during installation or operation;
- Materials of which the conveyor belt is made of in order to minimise the risk of any part of the conveyor belt catching fire; and
- Adequate lightning protection.

- 8.1.2 In order to prevent persons from being injured while crossing over or under any **conveyor belt installation** by means of a bridge, the **COP** must cover at least the following:

- Clearance requirements for persons and vehicles;
- Handrails and kickboard requirements;

- Prevention of slipping/sliding/falling;
- Sufficient number of cross over walkways;
- Method of access to walkway;
- Illumination; and
- Visibility (reflective paint tape etc).

8.1.3 In order to prevent persons from being injured due to inappropriate walkways while doing inspection, maintenance or repairs on the **conveyor belt installation**, the **COP** must cover at least the following:

- Safe clearances along and around **conveyor belt installations** or adjacent thereto; and
- Measures to prevent slipping, sliding and falling around and adjacent to **conveyor belt installations**.

## 8.2 Installation, extension, dismantling, transport and re-installation

In order to prevent persons from injury during installing, extension, dismantling, transportation and re-installing of **conveyor belt installations** due to the installation collapsing, the belt breaking or running away, the **COP** must at least address the following:

- Means of installing the conveyor belt safely;
- Means of cutting, joining and extending any belt safely;
- Means of clamping any belt safely;
- Means of pulling any belt in safely;
- The chemicals to be used during belt extensions and measures to address the risks associated with such chemicals;
- Means of transporting any belt and structure to its new site or position;
- Means to test the **conveyor belt installation** after installation and extension; and
- Supporting the roll of belting on tressles.

## 8.3 Maintenance and repairs

In order to prevent injury to persons as a result of inadequate maintenance, repairs and splicing of **conveyor belt installations** the **COP** must address the scheduling of maintenance, inspections and over inspections. This should include identification of components critical for the safe operation of the **conveyor belt installation** and the regular inspection of these components. Such components include the following:

- Belt Drive – all pulleys;
- Belt scrapers / Belt cleaning devices;
- Belt Drive motor / gearbox / fluid coupling / brakes / run-back and run-on device;
- Installation of guards / nip angles;
- Belt illumination;
- Conveyor belt;
- Take-up pulley and limits;
- Stop switches and trip wire;
- Pre start warning devices;

- Tail End – all pulleys;
- Belt slip devices;
- Sequence interlocking;
- Belt adhesives and mechanical fasteners;
- Belt cleaning chemicals;
- Rigging;
- Welding;
- Grinding;
- Exposure to toxic liquids or fumes;
- Dust;
- Emergency preparedness;
- The use of hazardous substances associated with operation and maintenance; and
- Belt cleaning devices.

#### 8.4 Fire prevention

In order to prevent persons from being exposed to fires, fumes and smoke arising from a **conveyor belt installation** catching fire, the **COP** must set out measures to prevent, detect and combat such fires. Such measures should include measures to prevent persons from being exposed to chemicals released when a **conveyor belt installation** is ignited. The **COP** should also set out:

- A description of the design and the selection criteria for the **conveyor belt installation** (SANS 971-2003, Edition 3 – “Fire-retardant textile-reinforced conveyor belting (for use in fiery mines)” may be referenced for guidance); and
- Criteria for determining the location and length of a belt.

Cognisance must be taken of frictional ignition for example  
limit switches and scrapers

#### **Side note:**

The regulations and guidelines under Fires and Explosions and the Mine Environmental Engineering and Occupational Hygiene must be consulted as well as the Guideline for a Mandatory Code of Practice for the prevention of Flammable Gas and Coal Dust Explosions in Collieries.

## **PART D: IMPLEMENTATION**

### **1. IMPLEMENTATION PLAN**

- 1.1 The employer must prepare an implementation plan for its **COP** that makes provision for issues such as organisational structures, responsibilities of functionaries and programs and schedules for this **COP** that will enable proper implementation of the **COP**.

A summary of/and a reference to, a comprehensive implementation plan may be included

- 1.2 Information may be graphically represented to facilitate easy interpretation of the data and to highlight trends for the purpose of risk assessment.

### **2. COMPLIANCE WITH THE CODE OF PRACTICE**

The employer must institute measures for monitoring and ensuring compliance with the **COP**.

### **3. ACCESS TO THE CODE OF PRACTICE AND RELATED DOCUMENTS**

- 3.1 The employer must ensure that a complete **COP** and related documents are kept readily available at the mine for examination by any affected person.
- 3.2 A registered trade union with members at the mine or where is no such union, a health and safety representative on the mine, or if there is no health and safety representative, an employee representing the employees on the mine, must be provided with a copy on written request to the manager. A register must be kept of such persons or institutions with copies to facilitate updating of such copies.
- 3.3 The employer must ensure that all employees are fully conversant with those sections of the **COP** relevant to their respective areas of responsibility.

## ANNEXURE A: References

1. The safe use, operation and inspection of man-riding belt conveyors in mines - SABS 0266:1995 (UDC 622.647, ICS 53.040.10, ISBN 0-626-10508-0).
2. Steel-cord reinforced conveyor belting - SABS 1366:1982 (UDC 622.647 : 678.066 : 621.778.4, ISBN 0-626-06202-0)
3. SANS 971-2003, Edition 3 – “Fire-retardant textile-reinforced conveyor belting (for use in fiery mines)”
4. General purpose textile-reinforced conveyor belting - SABS 1173:1977 (UDC 621.867.2, ISBN 0-626-04412-X).
5. Conveyor belts - Flame retardation - Specifications and test method - ISO 340:1988(E)
6. Steel Cord Conveyor Belting for Use within British Coal - Part 8: Methods of test for fire performance - British Coal Spec 730:1989 - Issue 1 – 1/11/89.
7. Degrees of protection provided by enclosures (IP Code) - CEI IEC 529:1989 (second edition).
8. On-site non-mechanical jointing of plied textile and steel reinforced conveyor belting (British Standard **COP**) - BS 6593:1985 (UDC 621.867.2.052-427.4-034.14: 678.06 : 62-762).
9. Steel Cord Conveyor Belts for Hoisting and Conveying (German Standard) - DIN 22 131 Part 4 (UDC 621.867.21: 622.647.21).
10. Steel Cord Conveyor Belts for Underground Coal Mining (German Standard) - DIN 22 129 Part 4, November 1991 (UDC 621.867.21.06: 622.647.21 : 622.333).
11. Testing Method for Conveyor Belt Splices (German Standard) - DIN 22 110 Part 3, September 1993.
12. Simrac Report – Gen 701
13. Lightning standard IEC 62305 parts 1 to 4
14. Standard for splicing of a conveyor belt

## **ANNEXURE B: Minimum Performance Standards**

This annexure forms part of the guideline and must be consulted in preparation of the **COP**.

This Annexure B contains extracts from the Conveyor Manufacturers Association of SA Limited Guideline “Safety around Belt Conveyors” and must be consulted in preparation of the **COP**. Relevant minimum performance standards from Annexure B should be included in the **COP** unless other minimum performance standards can be justified in terms of the risk assessment.

### **Safe operating procedures**

- Ensure that all personnel are equipped with the correct Personal Protection Equipment (PPE) relevant to the task and work area. Using PPE shall be strictly monitored by the appropriate safety officer.
- Ensure that all STOP/START and emergency controls are clearly marked and that maintenance staff are familiar with the location of these safety systems.
- Keep the area around the belt clean and tidy and apply good housekeeping practices to minimize potential hazards.
- Lock out, isolate and tag all areas before working on any part of the conveyor.
- Do not climb on, over or crawl under any conveyor.
- Do not ride on any conveyor unless the conveyor is approved and licensed for man-riding purposes.
- Ensure that the pre-start alarm is working correctly and if not, isolate the conveyor and request that it be repaired.

### **Basic check list prior to re-starting a conveyor**

Ensure that:

- Nobody is working on the belt;
- Guards have been re-fitted and that all the safety interlocks are operational;
- The area is clean and clear of equipment and /or debris or spillages;
- All the fire fighting and fire suppression devices and equipment are in place and operational;
- All clamps are removed or released;
- All other spragging devices have been removed; stem is operational.

### **CONVEYOR SYSTEM PROTECTION DEVICES**

The conveyor belt shall be provided with various devices and systems for protecting the system. These devices are used as run-permissive input commands to the general belt control system. The devices must be seen as safety-critical items and for that reason, deserve a high degree of attention and maintenance. The safety of personnel and the integrity of the conveyor system are largely dependent on the correct specification, installation and operation of these devices.

## **Belt control**

Belt control normally consists of the net sum of the belt permissives, the operator start/stop stations, the start warning system, interlock sequencing of individual conveyors and other process controls.

Belt control initiates a run command to the drive controller. Sometimes the belt control issues a running reference speed to the drive controller.

For stopping, the belt control simply removes the positive run signal to the drive controller or initiates a ramped stop command.

## **Stop/Start**

A belt conveyor system is usually provided with one or more control stations for operators. Start stations normally require a momentary operator input to initiate a start sequence. Stop stations monitor a maintained input for a run permissive. Many conveyors are started and stopped from a central control room.

Complex belts have many operator stations distributed at various physical locations.

A stop/start station is a control device and shall not be considered a lock out of the conveyor power source.

## **Belt overload**

The belt conveyor system is protected from overload via the overload of the electric drive motors. The motor overload indicator can be a simple bi-metallic or melting eutectic alloy or a complex computer-based motor thermal model.

Alternatively, the motor current can be monitored and any significant deviation from the standard operating signature for a pre-determined time will cause a power interruption.

A belt loading sail or paddle switch senses a belt overload at a specific point. However, such units must be designed to cater for the largest lump likely to be encountered in order to minimise spurious stops.

On the other hand, if a lump is large enough to activate the paddle switch, it makes operating sense to investigate the lump before it causes consequential damage downstream.

Complex belts are sometimes protected from overload by belt weigh scales that measure the belt loading at a given point.

Alternatively, a non-contact belt profile sensor, such as an ultrasonic, radar, laser or video device is used to measure the belt loading depth. Based on an assumed material density, the loading tonnes per hour can be projected. The actions regarding a single large lump apply in these cases as well.

Weigh meter controls are usually coupled to the belt feeding device, such as a belt, apron or vibrating feeder. The overload sensing signal is then relayed to the feeder controller and the feeder rate is reduced to comply with the requirements of the system.

Of course, unscrupulous operators may bridge any control and continuous spillage occurrences, despite any other protective measures that are in place. There is often evidence of such bridging or over-riding control of controls found during routine inspections.

Other methods of overload control are fusible plugs on fluid couplings and shear pins on flexible couplings. Electronic sensing has largely overtaken the use of mechanical devices and is less easily tampered with.

### **Belt slip protection**

Belt slip is the loss in transmission of tension from the drive pulley(s) to the belt cover and can destroy a belt or drive pulley, causing a fire hazard.

With the modern high-friction ceramic lagging of drive pulleys, the lagging itself may be destroyed depending on its type, or the belt cover completely stripped in localised areas.

Belt slip protection includes a belt drive speed sensor that compares the measured belt speed with the belt signature or specified design speed. Large conveyors with long ramp times require comparative slip detection during ramping similar to the slip protection applied to variable speed conveyors.

For constant speed belts this normally consists of a slip detection switch with a set point that trips the conveyor drive when the belt speed is below 80 percent of full speed. In order to prevent controller confusion, the belt slip switch is bypassed during starting and stopping and this is usually incorporated in the MCC, (motor control centre).

Belt slip in variable speed conveyors consists of a speed sensor that measures belt speed and compares it with the speed reference sent to the drive system. When the belt speed drops below 80 percent of the set speed, the drive is tripped. This type of belt slip is active during starting, running, and stopping.

In multiple pulley adjacent drives, tachometers are provided for each drive motor. The tachometer signals are compared to the normalised belt speed and sense slippage on any one of the multiple drive pulleys.

A method to adjust and test belt slip is normally an integral part of the belt control system. Slip detectors are often installed at other locations along the line of the belt, particularly at the tail pulley. In the event of the belt breaking for any reason, the tail pulley is usually the first to stop rotating.

### **Take-up over-travel**

Over-travel limit switches can be placed at the far extremes of the counterweight or take-up device travel.

**Comment:**

Use of over-travel limit switches is considered good practice even for section conveyors, but the use thereof for section conveyors may be omitted if justified in terms of the risk assessment.

In a gravity counterweight take-up, the top over-travel switch trip may suggest a jammed conveyor fabric condition.

A bottom over-travel switch may indicate belt stretch, or a broken belt fabric flight. Excessive take-up motion during starting and stopping indicates an inadequate or malfunctioning drive control.

Alternatively, excessive travel could indicate that one or more splices are failing or have failed.

**Bin level**

When conveyors discharge into bins or hoppers, bin level sensors provide protection to the belt in that they shut down the conveyor if the pre-determined level is exceeded.

**Comment:**

Use of bin level sensors is considered good practice, but the use thereof may be omitted if justified in terms of the risk assessment.

These can consist of simple hanging tilt switches or analogue measurement devices such as ultrasonic, radar or laser.

**Fire detection**

Some belts carrying combustible materials are fitted with fire detection protection systems. The belt material of construction can, however, also burn and give off noxious gasses and is protected in the same way.

These systems include point or distributed thermal trip switches located above the belt fabric, smoke sensors, carbon monoxide sensors, or fibre-optic temperature sensors.

The fire detection systems may be incorporated in the pull-wire switch systems, or may be installed as standalone systems.

**Lightning protection**

All conveyors are prone to lightning strikes and therefore the conveyor and the operating and maintenance staff will require protection from damage or injury.

Earthing and other applicable protection standards need to be installed and adhered to. The conveyor belt protection system shall be electrically isolated from the control system and all other control networks in accordance with the requirements of SANS 10313 or BS

6651. Any equipment or devices that are required to be directly connected to the control system shall be earthed to an acceptable minimum standard.

Underground conveyors are earthed and electrically supplied from cables normally installed in the shaft or through boreholes, allowing an electrical lightning path to the underground conveyor.

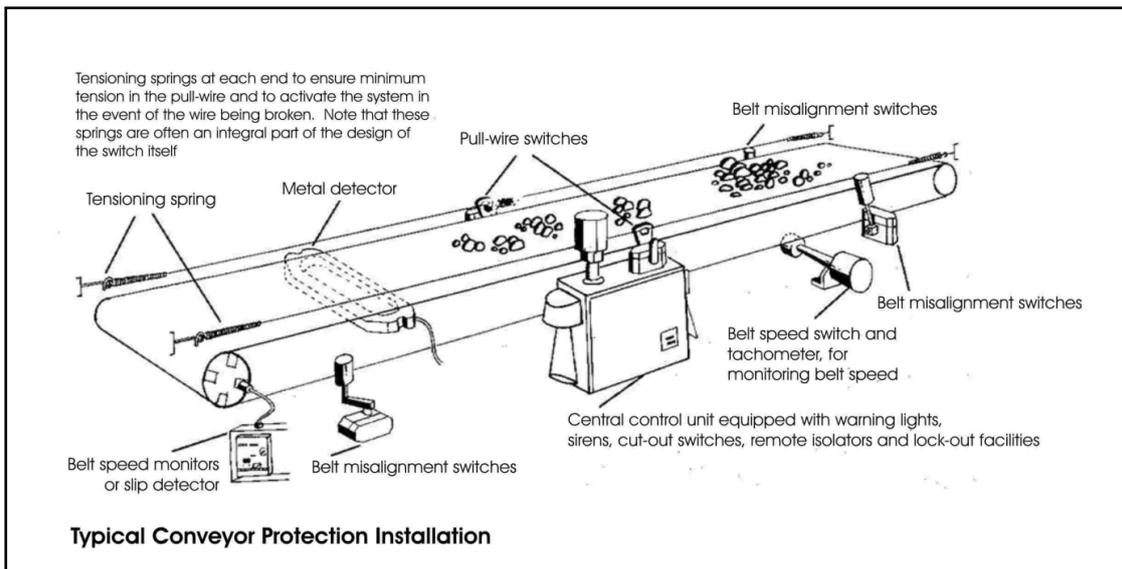
Lightning within the operational area needs to be monitored as such that systems can be shut down in the event of danger levels reaching pre-determined limits.

## Dust suppression

Belts transporting dusty material are equipped with water or chemical-based dust suppression systems. These systems spray the belt material at selected transfer and belt loading points. In some instances, dust suppression systems are coupled to ultrasonic spray nozzles.

Systems spray a constant amount of dust suppression per unit of time whilst the belt is running. The dust sprays are turned off when the belt is idle or unloaded to prevent puddling, waste and slippage.

The way in which dust suppression mechanisms work is to reduce the size of the water droplets, making them smaller than the dust particles. This enables the dust particles to break the water surface tension, adhering to the water droplet and forming larger drops.



Basics of conveyor guard design

## Guards and fences

A guard or fence is only effective if it is constructed to prevent a person from reaching the danger or nip point. A person is capable of reaching upwards, over, into, around or through a guard or fence, and all these aspects must be taken into account when considering the effectiveness of a guard or fence. For **conveyor belt installations** the so-called 'nip guard', examples of which are shown in the sketch below, extend over the whole width of

the pulley and are regarded as a reasonable solution to prevent access to the danger points. Installation of this type of guard is strongly recommended but unfortunately it is impossible to install it in such a way that a person is completely prevented from reaching around it. A nip guard alone cannot therefore be regarded as sufficient protection and it is essential that pulleys are further guarded or fenced off to meet the requirements of the regulations.

The following may be provisionally accepted as safe in the absence of facts to the contrary:

### **Upwards**

Any pulley or idler, which is 3,5 metres or more in height and therefore beyond an upward reach, may be regarded as being positionally safe and need not be guarded.

The possible reduction of this safe clearance by a build-up of spillage or discharge of material should, however, be borne in mind.

### **Over**

Head and tail pulleys must be guarded on at least the two sides and the top unless the guards or fences on the sides are extended to a height that makes it impossible to reach over and contact the nip point.

If side guards are only attached with a very small clearance between the edge of the belt and the side guard, this may perhaps be regarded as adequate to prevent reach over the guard to the nip point, but will not necessarily prevent tools or clothing from being caught in the nip point.

If a top guard is attached it must be high enough above the belt to ensure that the load on the belt will not damage it.

### **Into**

The distance that the guard or fence is placed from the side of the belt determines the distance that these extend away from the nip point along the length of the belt. An acceptable distance is at least 0,85 metres away from the nip point, preferably from the position of the nip guard.

### **Around**

This is similar to 'into' so far as the conveyor pulley guard is concerned, but may also be applied to determine the length of the top section of the guard. The same minimum distance of 0,85 metres applies.

When a V-belt or chain drive is associated with the conveyor installation, a common point of error is that while the V-belts or chains are perfectly guarded around the perimeter and on one side, the guard is installed in such a way that the nip points can easily be touched by reaching around the section forming the perimeter guard.

## Through

The protection afforded against injury by reaching through the guard is determined by the shape and size of openings in the material used for construction of the guard or fence.

### **Square Openings:**

It may be assumed that there is no reach through an opening of 10 mm × 10 mm or less, as it is too small for fingers. If the opening is such that it will admit one, two or three fingers, the reach is restricted by the roots of the fingers, a distance normally not exceeding 100 mm.

When the opening is sufficient to admit the whole arm and a small portion of the shoulder, the reasonable safe distance is based on the distance from the fingertips to the armpit, which is assumed to be 0,85 metres.

Screening materials with openings in excess of 80 mm × 80 mm shall not be used in the construction of guards or fences. Preference shall be given to materials with openings not exceeding 25 mm × 25 mm.

### **Elongated Openings (openings with parallel sides):**

Openings up to 6 mm wide are of no consequence. The guard or fence so constructed may virtually be regarded as a sheet, and a working clearance of approximately 25 mm is all that is required.

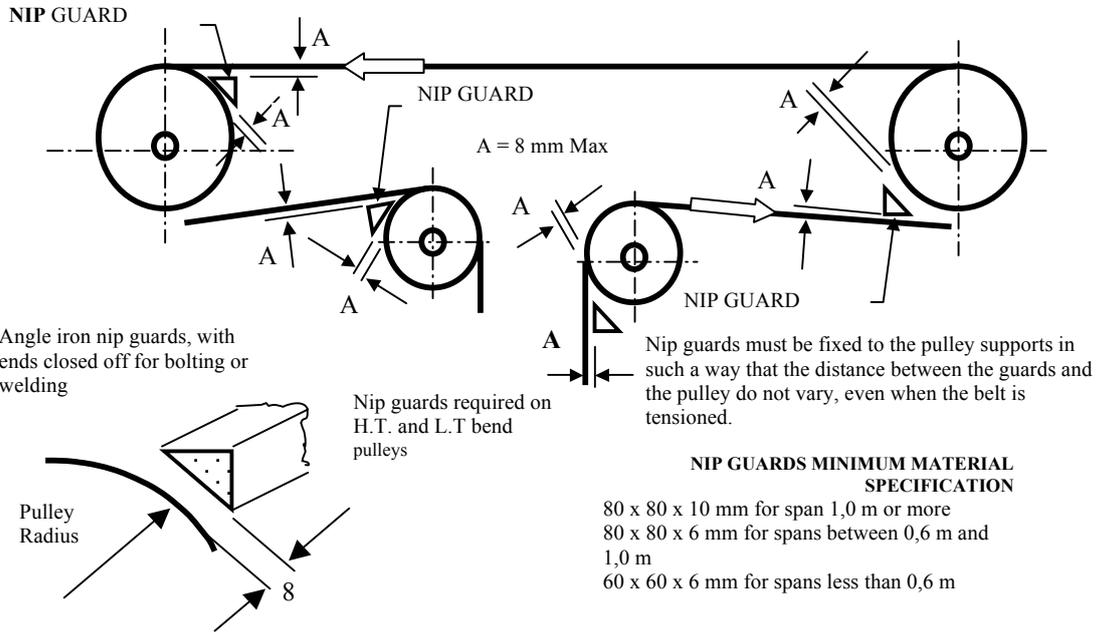
Openings greater than 6 mm but less than 13 mm will admit part of a finger and require at least 50 mm clearance from danger points.

Openings in excess of 13 mm but not greater than 80 mm are subject to the following formula:

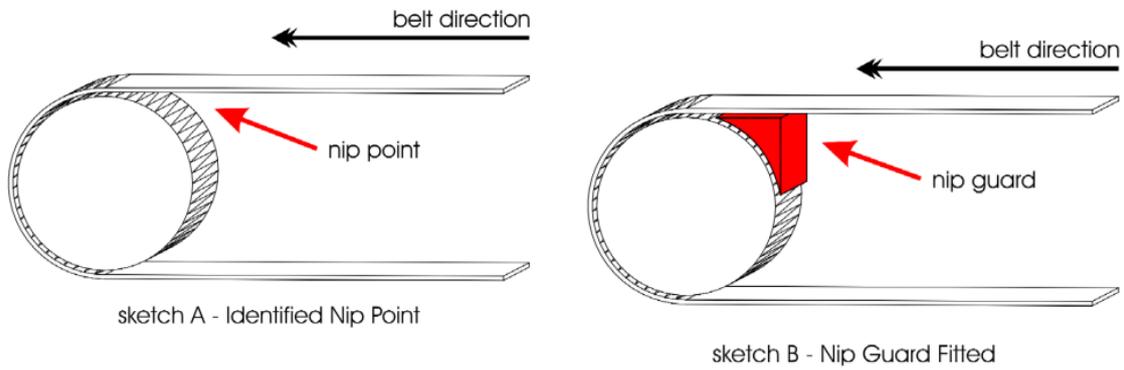
$X = 10Y$       where       $X =$  reasonable safe distance from danger point in millimetres.  
 $Y =$  width of opening in millimetres.

**Note:**  
The tail pulley guard shall be closed at the rear.

**Nip Points and Nip Guards**

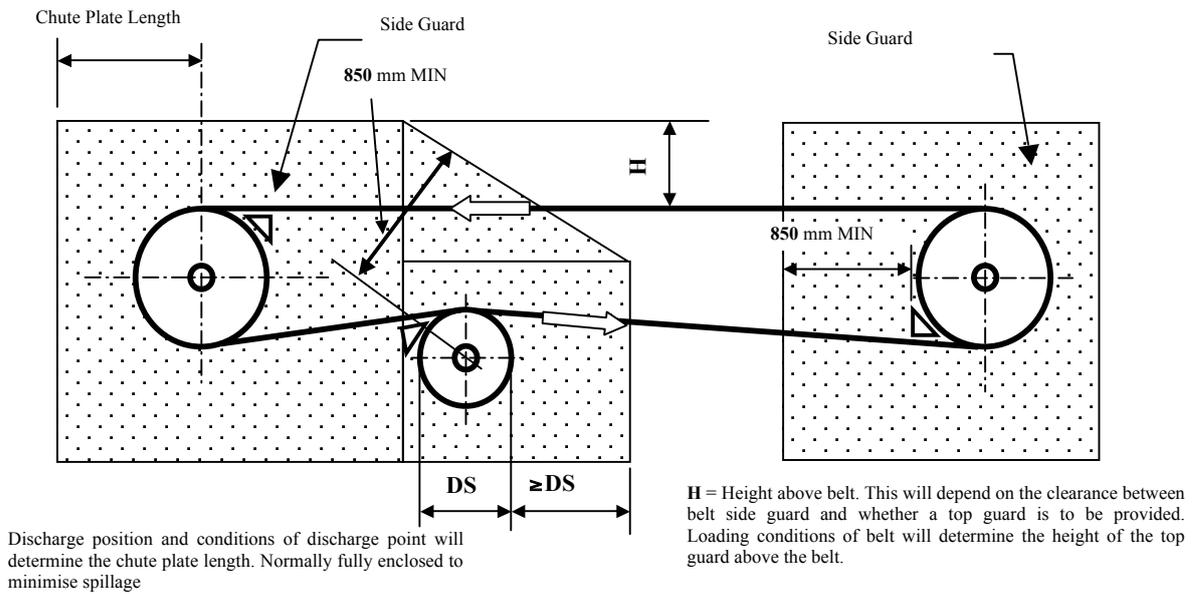


**Typical Conveyor Belt Protection Installation Showing Nip Guards**

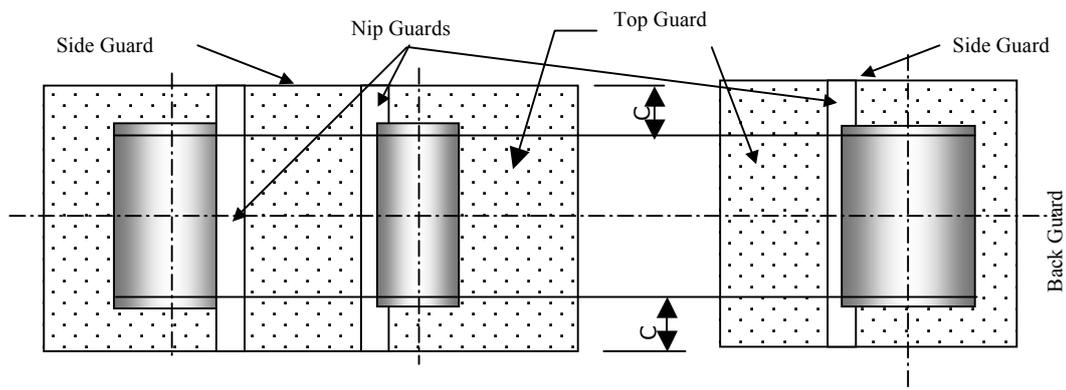


Identified nip point and fitted nip guard

## General Nip Guard Configurations – Side Elevation



## General Nip Guard Configuration – Plan View



Length of top guard will depend on length of chute plate and side guard

C = Clearance between side guard and pulley. Minimum clearance will depend on size of mesh or guard material

## Drive units

Driving belts, chains and couplings between driving motors and gear boxes or drive pulleys must be effectively guarded. Experience has shown that even when transmissions are apparently inaccessible they can still be a hazard. If the driving mechanism or any other part is fenced off completely in such a way that access thereto can only be gained through a gate or door forming part of the fencing, then this gate or door should be interlocked so that the conveyor stops when the gate or door is opened.

## Interlocked guards

In some applications guards are fitted in conjunction with limit switches interlocked with the safety system such that if a guard is removed, power to the conveyor is immediately cut and the conveyor will coast to a stop. Equally so, the conveyor will not start up if the guard has not been replaced or re-fitted correctly after maintenance has been done

E.g. should a pulley be fully fenced and guarded and in addition be equipped with an electric interlock which switches the system off and prevents it from starting when a gate is opened or any one of the guards is removed, the fitting of nip guards may be considered as optional.

To keep the pulleys clean, suitable mechanical devices must be installed.

The manual removal of build-up shall not be permitted whilst the belt conveyor is in motion. It is often necessary for an attendant to cross a conveyor at various points. It is dangerous to climb onto the moving belt. Where it is impossible to establish safe passageways underneath the belt, crossover bridges with handrails must be provided.

The position of these bridges will depend on conditions at the **conveyor belt installation**, but unless a sufficient number are installed, they will not always be used.

The crossover bridge must be accessed via stairs equipped with handrails and a toe-board (or kick-flat) as well as an intermediate or knee rail. Avoid vertical ladders.

In many cases where walkways are fitted on elevated conveyors, no adequate hand and knee rails are installed on the outer sides of the conveyor stringers. This presents a danger, as there is often a large opening between the inside of the walkway and conveyor stringer section at knee height. These areas shall be guarded off with knee rails and kick flats.

Safety at **conveyor belt installations** may be further enhanced by creating the optimum working environment including not only adequate ventilation, illumination and absence of undue noise, but also sufficient clearance around the installation and along walkways. Walkways should have an even, non-slip surface, be properly drained and free from obstructions.

## Ergonomics (human - machine interface)

To prevent accidents on conveyors it is vital to take engineering safety measures. It is possible to increase safety in existing installations at a very low cost. This document suggests ways of solving safety problems. Good engineering safety measures and an optimum working environment are not the only factors conducive to combating the high annual casualty rate associated with belt conveyors. One of the principal keys to success is an understanding of the human element.

Even a properly guarded **conveyor belt installation** is not in itself inherently safe but with adequate training and proper awareness of dangers, an operator may use it with perfect confidence.

Operator training is usually the personal responsibility of the staff member in charge of the correct operation and running of the machinery. Awareness of the fact that familiarity with the machine on his part and an over-estimation of the operators' skills and knowledge does not result in an under-estimation of the amount of instruction and degree of supervision necessary for the safe execution of tasks.

Comprehensive training schemes to ensure that operators have the required knowledge and skills to run the relevant equipment, including compulsory re-training opportunities are essential.

## **ANNEXURE C: Ergonomic Data - extracts from to AS1755-2000 (Normative)**

### **C1 GENERAL**

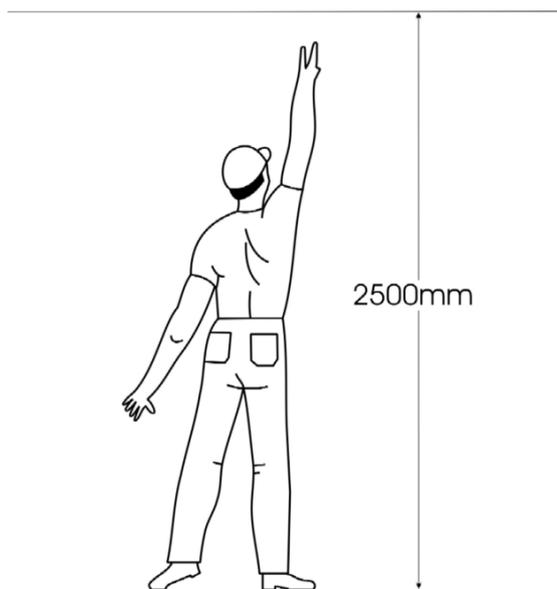
The data below are for users who need to design and build guards that prevent persons from encroaching into a danger zone associated with a machine.

They are taken from AS 4024.1—1996, and the most recently published version of that Standard shall be used, except for the specific variations detailed in Figure C4 herein. Users shall carefully consider whether the data are appropriate for use with the specific workforce which may be taller, shorter or thinner than the population from which the data were taken.

Where doubt exists, measurements of the workforce may be taken and careful trials made to ensure that the danger points are beyond reach. Where such trials are made, the machinery shall be in a safe condition during the trials.

### **C2 REACHING UP**

With the body upright and standing at full height, the minimum safety distance when reaching upward is 2500 mm (see Figure C1).



**FIGURE C1: Safety distance for reaching**

### **C3 UPPER LIMB REACH DISTANCE WITH FIXED FENCES**

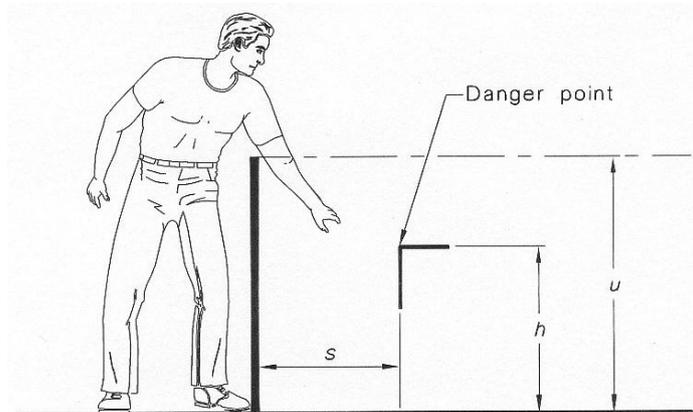
#### **C3.1 General**

Selection of the appropriate safety distance for reaching over a fixed fence shall depend on a risk assessment. The assessment shall be based on the probability of occurrence of injury and the likely severity of that injury.

### C3.2 Reaching down and over

When reaching down over an edge, e.g. on machine frames or barriers, the safety distance is found from Figure C2.

**NOTE:**  
Attention is drawn to the increased danger of overbalancing when reaching over a 1m high barrier.



LEGEND:

$h$  = Height of danger zone above floor  
 $s$  = Horizontal distance from edge of barrier to danger zone  
 $u$  = Height of edge of barrier above floor

Height of danger zone ( $h$ )	Horizontal distance to danger zone ( $s$ )								
	Height of protective structure ( $u$ )*								
	1 000†	1 200†	1 400†	1 600†	1 800	2 000	2 200	2 400	2 500
2 500	—	—	—	—	—	—	—	—	—
2 400	100	100	100	100	100	100	100	100	—
2 200	600	600	500	500	400	350	250	—	—
2 000	1 100	900	700	600	500	350	—	—	—
1 800	1 100	1 000	900	900	600	—	—	—	—
1 600	1 300	1 000	900	900	500	—	—	—	—
1 400	1 300	1 000	900	800	100	—	—	—	—
1 200	1 400	1 000	900	500	—	—	—	—	—
1 000	1 400	1 000	900	300	—	—	—	—	—
800	1 300	900	600	—	—	—	—	—	—
600	1 200	500	—	—	—	—	—	—	—
400	1 200	300	—	—	—	—	—	—	—
200	1 100	200	—	—	—	—	—	—	—
0	1 100	200	—	—	—	—	—	—	—

**FIGURE C2:** Guard distances

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

† Protective structures having a height of 1600 mm and less should only be used where a risk assessment indicates low probability and low severity of injury.

**NOTE:**

- 1) There shall be no interpolation of the values in the Table.
- 2) Barriers are not foolproof and they cannot prevent access to persons intent on gaining access. Therefore, as a person's intent on reaching a dangerous part increases, e.g. by climbing on chairs, ladders or the barrier itself, the protection provided by a barrier, decreases.

**C3.3 Reaching under**

Where clearance is provided under a guard for cleaning spillages, swarf and similar, the clearance shall not exceed 200 mm. (See also Figure C3.)

**C4 REACHING AROUND WITH UPPER LIMBS**

When reaching around edges in any position, the safety distance of freely articulating upper limbs is given in Figure C3.

The radius of the movement about a fixed edge is determined by the reach of given body parts. The safety distances assigned shall be respected as a minimum if the body part concerned is not to be allowed to reach a danger point.

Of special importance is the danger area which can be reached when these body parts are introduced through slots.

When applying safety distances, it is to be assumed that the basic joint component of the relevant body part is in fixed contact with the edge. The safety distances apply only if it is ensured that further advance or penetration of the body part towards the danger point is excluded.

Limitation of movement	Safety distance (sr)	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	

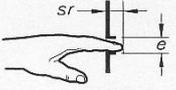
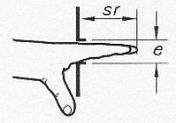
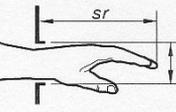
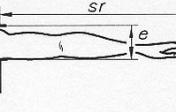
\* Either the diameter of a round opening, the side of a square opening or the width of a slot opening.

**FIGURE C3:** Safety distances for reach around

## C5 REACHING IN AND THROUGH REGULAR OPENINGS WITH UPPER LIMBS

Safety distances are  $s$  given in Figure C4. The dimension of openings ( $e$ ) corresponds to the side of a square opening, the diameter of a round opening or the narrowest dimension of an elongated opening or slot.

Should any opening allow access past the shoulder, safety distances shall be selected using Figure C2.

Part of body	Illustration	Opening	Safety distance ( $sr$ )		
			Slot	Square	Round
Fingertip		$e \leq 4$	$\geq 2$	$\geq 2$	$\geq 2$
		$4 < e \leq 6$	$\geq 10$	$\geq 5$	$\geq 5$
Finger up to knuckle joint or hand		$6 < e \leq 8$	$\geq 20$	$\geq 15$	$\geq 5$
		$8 < e \leq 10$	$\geq 80$	$\geq 25$	$\geq 20$
		$10 < e \leq 12$	$\geq 100$	$\geq 80$	$\geq 80$
		$12 < e \leq 20$	$\geq 120$	$\geq 120$	$\geq 120$
		$20 < e \leq 30$	$\geq 850$	$\geq 120$	$\geq 120$
Arm up to junction with shoulder		$30 < e \leq 40$	$\geq 850$	$\geq 200$	$\geq 120$
		$30 < e \leq 50^*$			
		$40 < e \leq 120$	$\geq 850$	$\geq 850$	$\geq 850$
		$50 < e \leq 120^*$			

\* For mining operations

**FIGURE C4:** Reaching in and through regular openings

## C6 OPENINGS OF IRREGULAR SHAPE

To choose a safety distance for upper limbs entering an opening of irregular shape, the following procedure shall be followed:

- (a) Determine:
  - (i) the diameter of the smallest round opening;
  - (ii) the side of the smallest square opening; and
  - (iii) the width of the narrowest slot opening into which the irregular opening can be inserted (see Figure C5).
- (b) Select the corresponding safety distances from Figure C4.

**NOTE:**

The shortest safety distance of the values selected may be used.

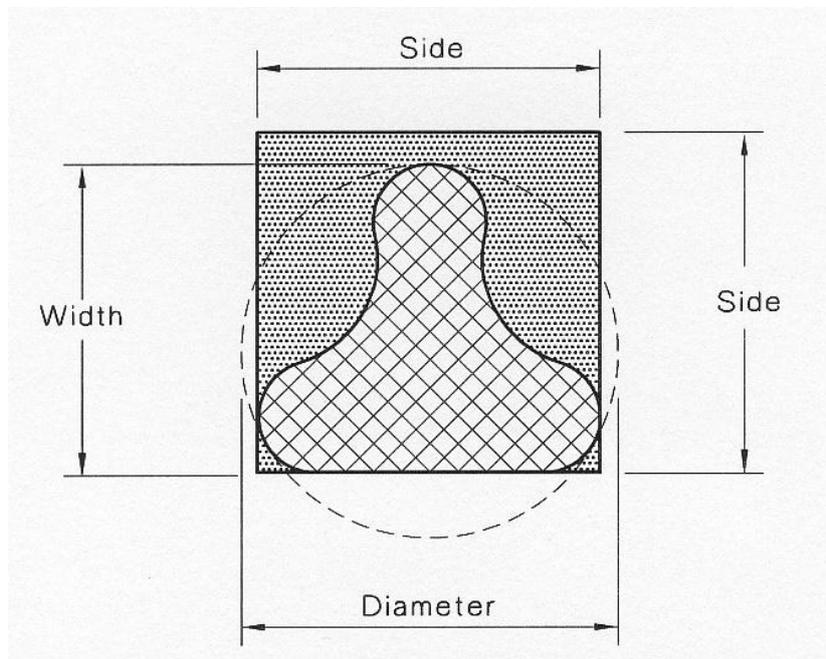
**C7 LOWER LIMB REACH DISTANCE**

**C7.1 General**

The data given in Figure C6 may be used where the risk assessment shows that there is a risk only to the lower limbs. Where there is a risk to both upper and lower limbs, then the longest safety distance appropriate to the aperture size and given in Figure C4 or Figure C6 shall be used.

**C7.2 Reaching in and through regular openings**

The dimension of openings (e), corresponds to the side of a square opening, the diameter of a round opening or the narrowest dimension of an elongated opening or slot.



**FIGURE C5: Irregular-shaped opening**

Part of lower limb	Illustration	Opening	Safety distance ( <i>sr</i> )	
			Slot	Square or round
Toe tip		$e \leq 5$	0	0
Toe		$5 < e \leq 15$	$\geq 10$	0
		$15 < e \leq 35$	$\geq 80^*$	$\geq 25$
Foot		$35 < e \leq 60$	$\geq 180$	$\geq 80$
		$60 < e \leq 80$	$\geq 650^\ddagger$	$\geq 180$
Leg up to knee		$80 < e \leq 95$	$\geq 1\ 100^\ddagger$	$\geq 650^\ddagger$
Leg up to crotch		$95 < e \leq 180$	$\geq 1\ 100^\ddagger$	$\geq 1\ 100^*$
		$180 < e \leq 240$	not admissible	$\geq 1\ 100^\ddagger$

\* If the length of the slot opening is  $\leq 75$  mm the distance can be reduced to  $\geq 50$  mm.  
 $^\ddagger$ The value corresponds to leg up to knee.  
 $^\ddagger$ The value corresponds to leg up to crotch.

**FIGURE C6:** Reaching in and through regular openings with the lower limbs

## C8 MINIMUM GAPS TO PREVENT CRUSHING

A crushing hazard will be generated if either two movable parts are moving towards one another, or one movable part is moving towards a fixed part.

The minimum gap dimensions to minimize the risk from a crushing hazard are given in Figure C7. Care must be taken to assess the risk of a person entering the crush zone in a different body orientation to those given. Where such a risk is considered to be unacceptable, additional measures will be required to minimize the risk, e.g. the use of fixed barriers to prevent access.

In addition, consideration shall be given to the increase in hand or body part dimensions as a result of holding tools or work pieces, or from the use of personal protective equipment such as gloves or helmets.







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