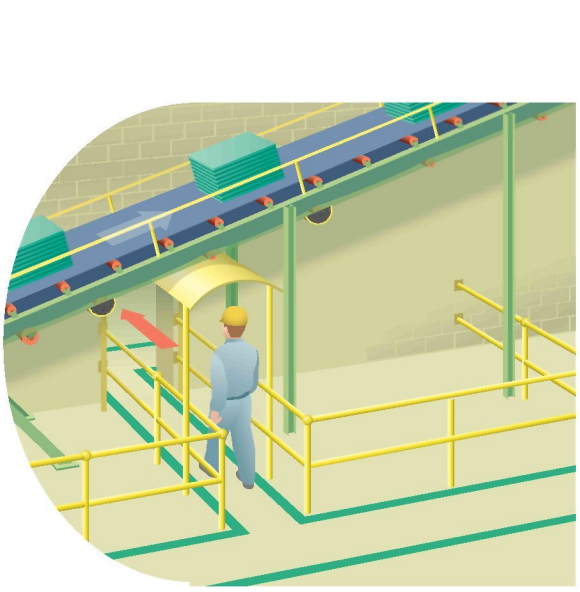
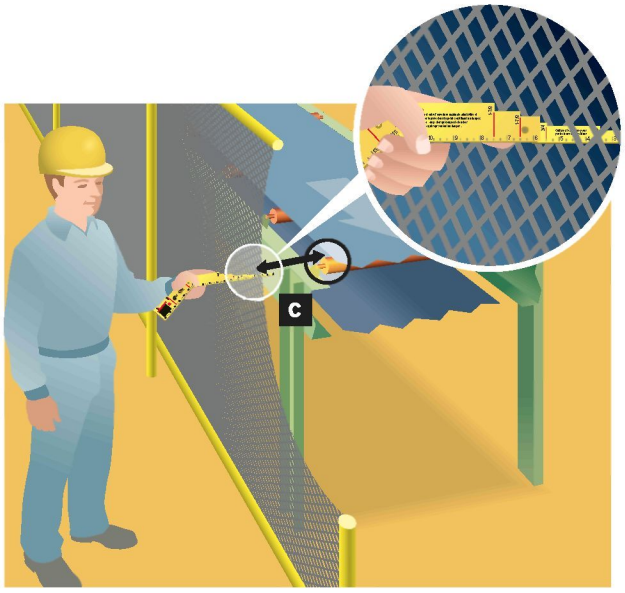
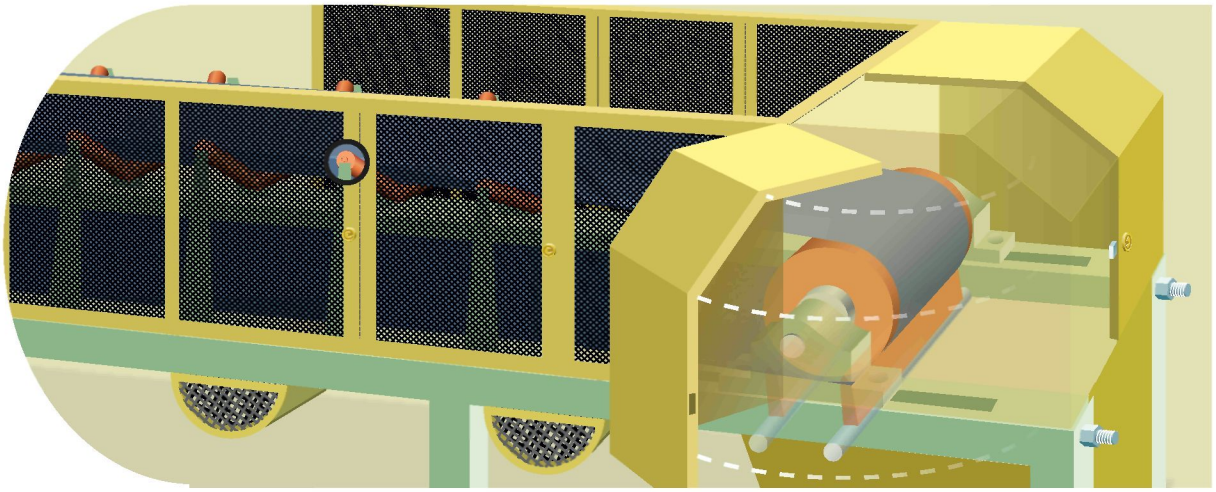
# A User's Guide to Conveyor Belt Safety

## Protection from Danger Zones





irsst

CSST

IAPA
It's About Making A Difference.

RESEARCH AND EDITING
Laurent Giraud, Ph.D., Trainee Engineer, Researcher, IRSST
Serge Massé, Engineer, Scientifi c Professional, IRSST
Julie Dubé, Trainee Engineer, Scientifi c Professional, IRSST
Luc Schreiber, Engineer, M.Sc., Direction régionale de la Mauricie et du Centre-du-Québec, CSST
André Turcot, Engineer, Direction de la prévention-inspection, CSST

"CONVEYOR SAFETY COMMITTEE" VALIDATION
Laurent Giraud, Ph.D., Trainee Engineer, Researcher, IRSST
Serge Massé, Engineer, Scientifi c Professional, IRSST
Julie Dubé, Trainee Engineer, Scientifi c Professional, IRSST
Gilles Brouard, Inspector, Direction régionale de l'Outaouais, CSST
Yves Desrochers, Inspector, Direction régionale de l'Abitibi-Témiscamingue, CSST
Donald Duchesne, Engineer, Prevention-Inspection Consultant, Direction de la prévention-inspection, CSST
Gilles Gagnon, Engineer, Prevention-Inspection Consultant, Direction de la prévention-inspection, CSST
Louise Gravel, Engineer, Prevention-Inspection Consultant, Direction de la prévention-inspection, CSST
Daniel Macleod, Engineer, Inspector, Direction régionale de la Chaudière-Appalaches, CSST
André Marchand, Inspector, Direction régionale de la Mauricie et du Centre-du-Québec, CSST
Yvon Papin, Prevention-Inspection Consultant, Direction de la prévention-inspection, CSST
Luc Schreiber, Engineer, M.Sc., Inspector, Direction régionale de la Mauricie et du Centre-du-Québec, CSST
André Turcot, Engineer, Prevention-Inspection Consultant, Direction de la prévention-inspection, CSST
Joseph Wigorski, Inspector, Direction régionale de l'Abitibi-Témiscamingue, CSST
Lyne Beaulé, Communications Consultant, Direction des communications, CSST

PROJECT MANAGER
Donald Duchesne, Engineer, Prevention-Inspection Consultant, Direction de la prévention-inspection, CSST

PROJECT PRODUCTION AND DESIGN SUPERVISOR AND COORDINATOR
Lyne Beaulé, Communications Consultant, Direction des communications, CSST

TRANSLATION
Goodwill Vezina

PROOFREADING
Claudette Lefebvre, Direction des communications, CSST

GRAPHIC DESIGN AND COMPUTER GRAPHICS
Eykel Design and David Gillis

ILLUSTRATIONS
Steve Bergeron

ORIGINAL TITLE
Sécurité des convoyeurs à courroie : guide de l'utilisateur

2e édition revue et corrigée

Copyright Deposit - Bibliothèque nationale du Québec, 2003
ISBN 2-550-42283-X

DC 200-16227-1 (04-01)

ACKNOWLEDGEMENTS
We wish to thank all company and union representatives from the following establishments and organizations: Les gravières de Beauce, Abitibi-Consolidated (Belgo Division and Laurentides Division), Produits forestiers Domtar (Val-d'Or Division), Uniboard Canada (Val-d'Or Division), Mine Jeffrey, ASSIFQ-ASSPPQ, CIFQ and AMQ.

# TABLE OF CONTENTS

## APPENDICES



## LIST OF TABLES



## LIST OF FIGURES

## INTRODUCTION

A number of accidents involving conveyor belts can be attributed to accessibility to danger zones. The majority of these occur during maintenance activities with conveyors still in operation and danger zones unprotected.

Preventative measures must be implemented in order that work on or near conveyors can be performed safely. Right from the design stage, worker exposure to hazards must be controlled by reducing the frequency of under-conveyor clean-ups, conveyor maintenance, removing jams, etc. This guide suggests possible preventative measures but they are by no means exhaustive. In many situations, the risk must be analyzed before any preventative measures are implemented.

This guide is composed of two sections. Section 1 provides definitions, information on conveyor belt accidents, an overview of mechanical hazards and applicable legal requirements. Section 2 discusses risk assessment and hazard control procedures, specific safeguards against mechanical and other hazards, safeguards against hazards encountered during maintenance, and training for operators and maintenance personnel.

This guide is directed mainly to workers, technicians, supervisors, joint health and safety committee members, and other interested parties.

Conveyor design and modification for enhanced safety are discussed in *Sécurité des convoyeurs à courroie : guide du concepteur* (*A Designer's Guide to Conveyor Belt Safety)*. An entire chapter is devoted to operational problems and diagnostics and includes suggested solutions for consideration in the problem solving process. In another chapter, a fault tree illustrates links between conveyor defects and accidents. *Sécurité des convoyeurs à courroie : guide du concepteur* (*A Designer's Guide to Conveyor Belt Safety)* targets engineers, designers, conveyor belt manufacturers and maintenance managers.

## APPLICATION

This guide applies to conveyor belts designed to transport continuous bulk or individual loads along a predetermined path between loading and unloading points. Movable conveyors are also discussed, for example, conveyors that swing around a hopper, on wheels, or used on semi-trailers (or fl oat).

# SECTION 1
# GENERAL INFORMATION

## 1 Context Analysis and Definitions

### 1.1 Context Analysis

From a safety standpoint, the following characteristics of conveyor belts are:

> A belt which may vary greatly in length - conveyors may be from a few meters to several kilometers long and split into smaller lengths or sections

> The fact that the majority of accidents occur in the areas of head drums, tail drums and drive mechanisms

> The fact that the majority of accidents occur during cleaning or other maintenance activities

> The existence of hazards related to:

- Power transmission moving parts (motor parts, transmission parts, gears, etc.)
- Moving loads
- Moving sub-assemblies (switch mechanisms, pushers, etc.)
- Proximity to unrestricted access throughways and throughways passing over or under equipment
- Conflicts between repeated stoppages (to clear jams) and production requirements
- Stoppages from causes unknown to operators and other workers not located near the conveyor, resulting in situations that may lead to dangerous actions
- Falling loads

> The existence of varying degrees of risk depending upon the conveyor belt's dimensions and the load size (e.g., large conveyors in mines)

> Hazards posed by a particular mechanism or by an entire conveyor zone

## 1.2 Definitions

Equipment safety must be designed from the standpoint of workers who are carrying out their tasks in the workplace.

### 1.2.1 Tasks

These are associated with two distinct activities:

- PRODUCTION OPERATIONS: Start-up, shut-down, and other operations such as loading and unloading, assembly, fastening, labelling, coding, monitoring, etc.
- MAINTENANCE: Inspection, cleaning, unclogging, load unjamming, greasing, adjustments, repairs or other maintenance

### 1.2.2 Workers

- OPERATORS: Persons operating the machinery or equipment used in the production process and generally posted at the control station
- MAINTENANCE CREW: Persons trained and authorized to maintain equipment

**NOTE:** Properly trained operators can perform maintenance tasks such as unclogging, unjamming and cleaning.

### 1.2.3 Areas

INTERVENTION AREA: The area in and around equipment and the moving load, including access points and integrated access ways. This includes:

- DANGER ZONE: any area inside or around equipment that presents a risk to worker's health, safety or physical integrity
- WORK STATION: an operating area specifically set up for one or more workers (the work station may also be the control station)
- SERVICE WAY: an area reserved for conveyor or other equipment operations and maintenance
- THROUGHWAY: a passage way for all persons. It is not part of the equipment area and may run along or cross over or under the equipment
- LOADING AND UNLOADING ZONES: areas where loads are picked up for and deposited after conveyance, either manually or automatically

### 1.2.4 Conveyor Components

The principal conveyor components are defined below and illustrated in figures 1-1 to 1-3. The numbers in the figures correspond to the numbers in the legend and in the following definitions. More detailed definitions can be found in *Sécurité des convoyeurs à courroie : guide du concepteur* (*A Designer's Guide to Conveyor Belt Safety)*.

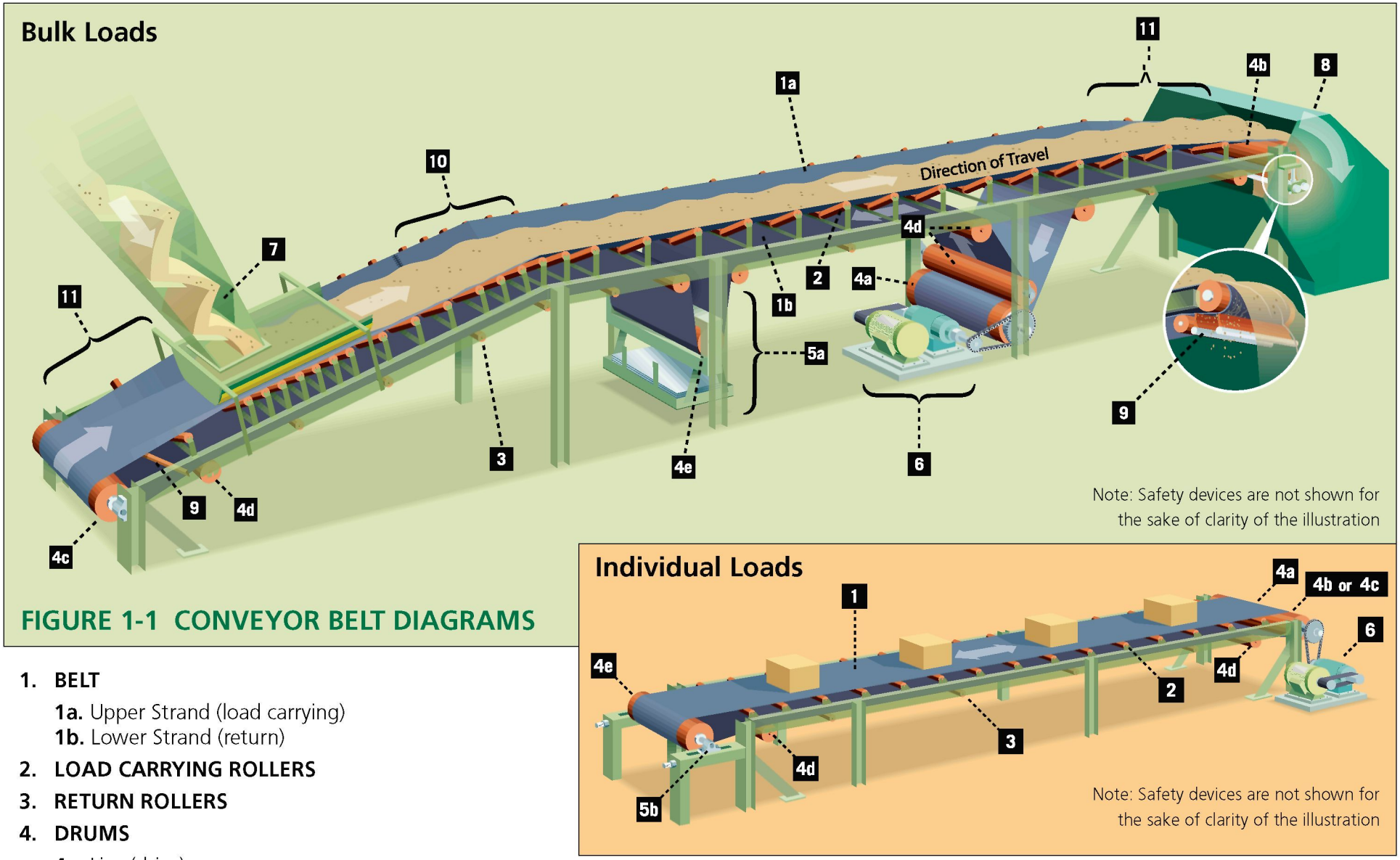



**FIGURE 1-1 CONVEYOR BELT DIAGRAMS**

1. **BELT**
   - **1a.** Upper Strand (load carrying)
   - **1b.** Lower Strand (return)
2. **LOAD CARRYING ROLLERS**
3. **RETURN ROLLERS**
4. **DRUMS**
   - **4a.** Live (drive)
   - **4b**. Head
   - **4c.** Tail
   - **4d.** Snub
   - **4e.** Take-up
5. **TAKE-UP SYSTEM**
   - **5a**. By force of gravity
   - **5b.** Manual or self-adjusting
6. **POWER TRANSMISSION MOVING PARTS**
7. **LOADING SYSTEM**
8. **UNLOADING MECHANISM**
9. **BELT AND DRUM CLEANING SYSTEM**
10. **CURVED ZONE**
11. **TRANSITION ZONE**

## 1. Belt

**Function:** To convey or transport material.

**1a.** Upper strand (generally the load carrying strand).

**1b.** Lower strand (generally the return strand).

## 2. Load Carrying Rollers

**Function:** To support the belt and reduce its resistance to movement of the load. Some load carrying rollers may also be impact reducing, self-aligning, trough forming (figure 1-2) or be able to change the inclination of the belt.

## 3. Return Rollers

**Function:** To support the belt and reduce resistance to movement. Some return rollers may also be self-aligning or be able to change the inclination of the belt.

## 4. Drums

**Function:** To drive a belt or re-orient the direction of travel. Types of drums:

**4a**. Live drum - drives the belt by being itself driven by a motor.

**4b.** Head drum - returns the belt to the lower strand (and may also serve as a live drum).

**4c.** Tail drum - returns the belt to the upper strand.

**4d.** Snub drum - aligns the entering or exiting strand with the lower strand or ensures the required arc of contact with the live drum.

**4e**. Tensioning drum - maintains proper belt tension by way of a take-up system.

1. **BELT**
   - **1a.** Upper Strand
   - **1b.** Lower Strand
2. **LOAD CARRYING ROLLERS**
3. **RETURN ROLLERS**

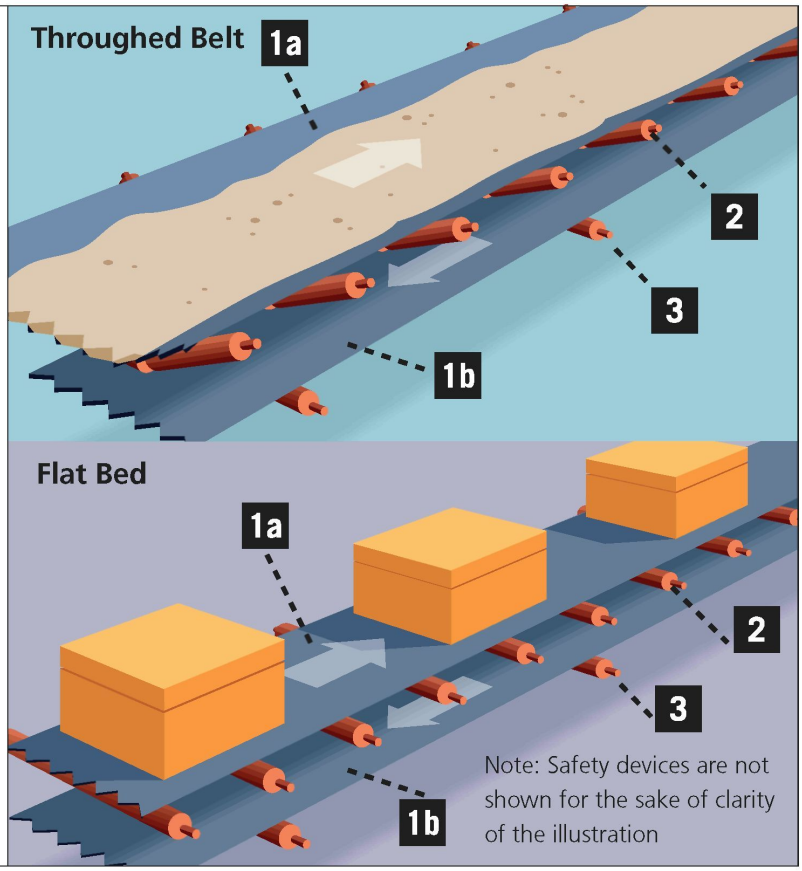



**FIGURE 1-2**
**TYPES OF BELT SUPPORTS**

## 5. Take-Up System

**Function:** To ensure proper belt tension. Types of systems:

**5a.** Gravity system - a guided weight pulls the tensioning drum (figure 1-1, 4e) to provide the required tension.

**5b.** Manual or self-adjusting system - adjustment screws or automatic control systems provide the required tension.

## 6. Power Transmission Moving Parts

**Function:** To produce and transmit the required energy to the live drum for moving or restraining the belt. Many combinations are possible:

> A geared motor is mounted directly to the live drum shaft or is integrated into the live drum.

> The motor and speed reducing units are connected by couplings.

> Chains or belts are used between the motor and the live drum shaft.

## 7. Loading System

**Function:** To guide and control the load feed on the belt (figure 1-3). There are many possible systems: hoppers, chutes, automatic loaders, pushers, etc. Hoppers usually contain the following parts:

**7a.** Hopper assembly - Guides, contains and sometimes controls the bulk load feed.

**7b**. Skirtboard - Centers the load on the belt or redirects the load. The skirt (7c) is bolted on to it.

**7c.** Skirt - Stops loose material from leaking off the belt and holds fine material that can be fairly good-sized grain.

**7. LOADING SYSTEM**

**7a.** Hooper Assembly

**7b.** Skirtboard

**7c.** Skirt

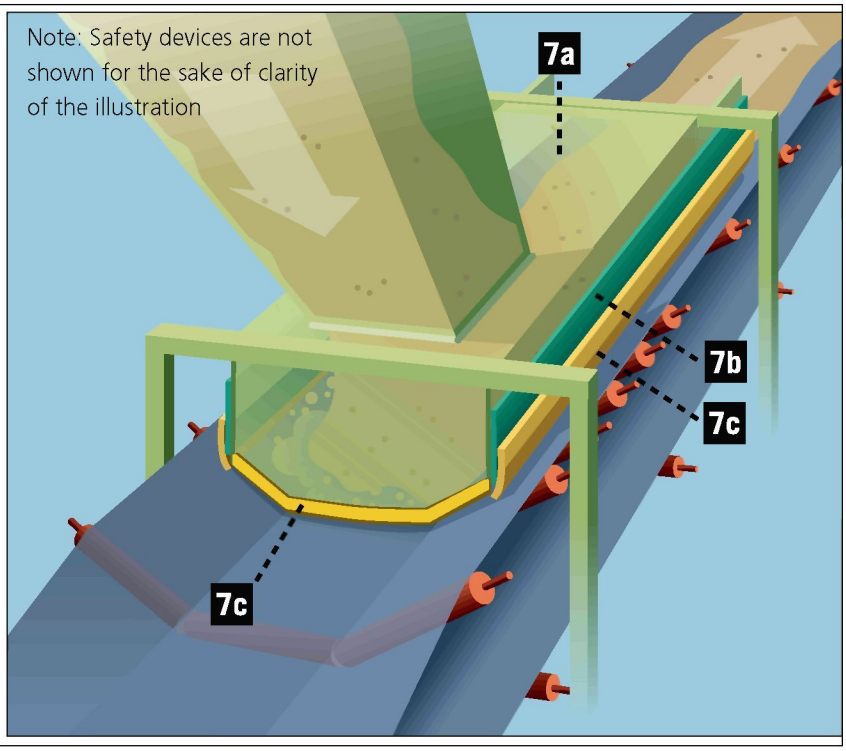



**FIGURE 1-3 TYPICAL BULK LOADING SYSTEM**

## 8. Unloading Mechanism

**Function:** To guide the load exiting the conveyor system. Various devices may be used: chutes, slides, automated systems, ejectors, packagers, etc.

## 9. Belt and Drum Cleaner

**Function:** To remove material accumulation from belts and drums. These are often scrapers and brushes.

## 10. Curved Zone

This is the area of the conveyor where the belt is vertically curved.

## 11. Transition Zone

Conveyor area where the profile (cross) of the belt changes from troughed to flattened and vice versa.

## 12. Shunting Mechanism

**Function:** To change load direction. Various devices may be used: bumpers, pushers, ejectors, etc. (figure 1-7).

# 2 Accident Information

Based on information collected from 85 serious or fatal accidents* involving conveyor belts, the majority of accidents (55%) involved head or tail drums or drive mechanisms (table 1-1).

**Table 1-1 Serious or Fatal Accidents by Areas of Occurrence**

| Conveyor belt area where accident occurred | % |
|---|---|
| Between the live drum, head drum or tail drum and the belt, inside one of these drums, or between one drum and another | 48 |
| Between a load carrying or return roller and the belt | 13 |
| Other areas (for example, between electromagnets and other parts) | 13 |
| Motor-to-drum drive mechanism | 7 |
| Between a take-up drum and the belt | 5 |
| Between a jammed tool and the belt or the conveyor chassis | 2 |
| Not indicated or explanations too vague | 12 |

A large number of these accidents occurred during cleaning (30%) or during the maintenance of or near a conveyor belt in motion (26%). Accidents occurring during normal production activities (sorting, packaging, etc.) were less frequent (12%) (table 1-2).

**Table 1-2 Serious or Fatal Accidents by Worker Activity**

| Work activity when accident occurred | % |
|---|---|
| Cleaning a drum, applying adhesive to the drum or cleaning another part of the conveyor (load carrying or return rollers, etc.) | 23 |
| Conveyor maintenance (other than cleaning) | 20 |
| Normal activities (for example, sorting, packaging) on or around a conveyor | 12 |
| Recovery of a jammed item from an unguarded in-running nip (7/8 between a drum and the belt; 1/8 between a magnetic roller and the belt) | 9 |
| Cleaning around or under the conveyor | 7 |
| Maintenance (other than cleaning) near a conveyor | 6 |
| Unjamming a conveyor or removing accumulated debris | 5 |
| Adjusting tension or centering the belt | 4 |
| Other activities (for example, worker being transported by conveyor) | 4 |
| Freeing a frozen conveyor | 1 |
| Not indicated | 9 |

These statistics illustrate the diversity and scope of hazards associated with conveyor belts, regardless of the nature of worker activities.

*Eleven investigations by the CSST from 1981 to 2000, 42 by the INRS (France) from 1993 to 2000, and 32 by OSHA from 1984 to 1996.

# 3 Hazards

Hazards associated with conveyors are principally mechanical in nature. They are discussed briefly below.

Other hazards are covered in Section 2 of this guide. They are the hazards generated by neglecting ergonomic principles in machine design, breakdown-related or security-related control system malfunctions, electricity, heat, fire and explosions.

For more information on hazards, refer to the CSST document DC 900-337 *Sécurité des machines : phénomènes dangereux – situations dangereuses – événements dangereux – dommages (Machine Safety; Hazards – Hazardous Situations – Hazardous Events – Damages)*.[1]

- **Power transmission moving part hazards (figures 1-4 and 1-5):** These hazards are associated mainly with the power transmission parts between the motor and the live drum. They include: shafts, couplings, pulley belts, chain and sprockets. Dragging, crushing or entanglement on contact with rotating parts or pinch points can result in serious injuries.

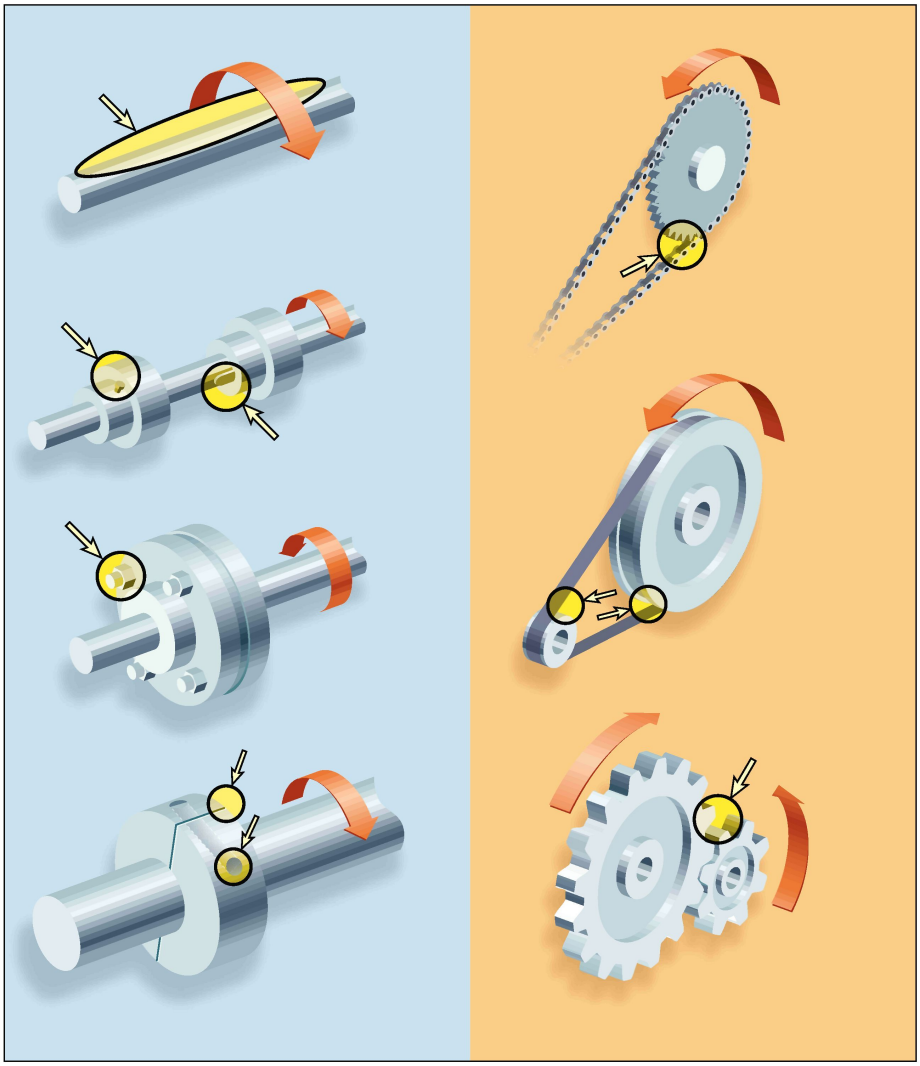


**FIGURE 1-4 TYPICAL POWER TRANSMISSION MOVING PART HAZARDS**

- **Other conveyor moving part hazards** (figure 1-5): These are associated with the moving conveyor belt and in-running nips when in contact with rollers and drums, and to falling return rollers dislodged from worn fasteners. These hazards can result in injuries from being dragged into in-running nips, in abrasion and friction burns from rubbing against the belt, and injuries from being struck by a ruptured belt or a falling roller.
- **Confinement zone hazards** (those related, for example, to hoppers, skirtboards, skirt): Injuries result from shearing and crushing between the load and a fixed object (figure 1-5).
- **Moving load hazards** (figure 1-6): Injuries result from shearing and crushing between the load and a fixed object. Injuries can also be caused by falling loads or impact with loads.
- **Moving sub-assembly hazards** (figure 1-7): Injuries result from shearing and crushing between the load and a fixed object, occurring mainly with equipment that re-orients the load.

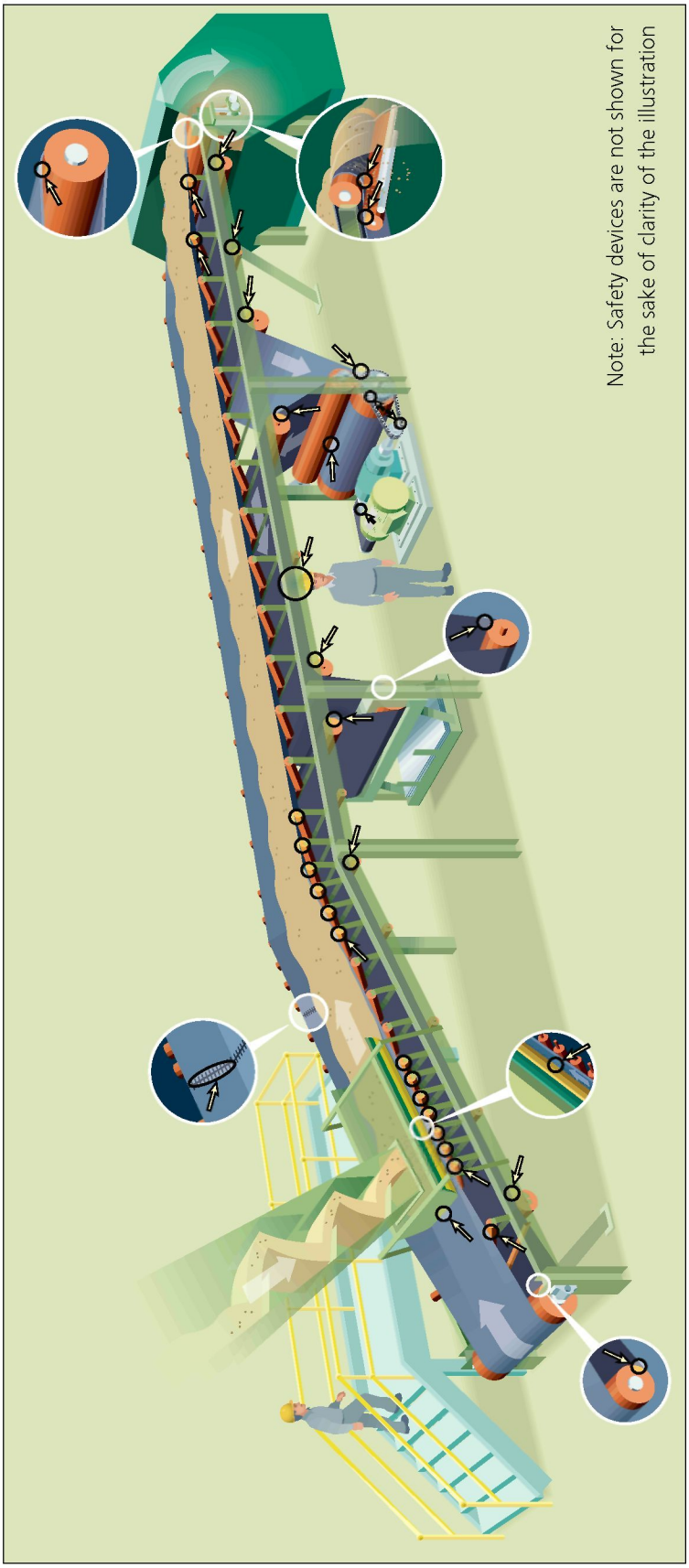



**FIGURE 1-5 TYPICAL MECHANICAL HAZARDS**

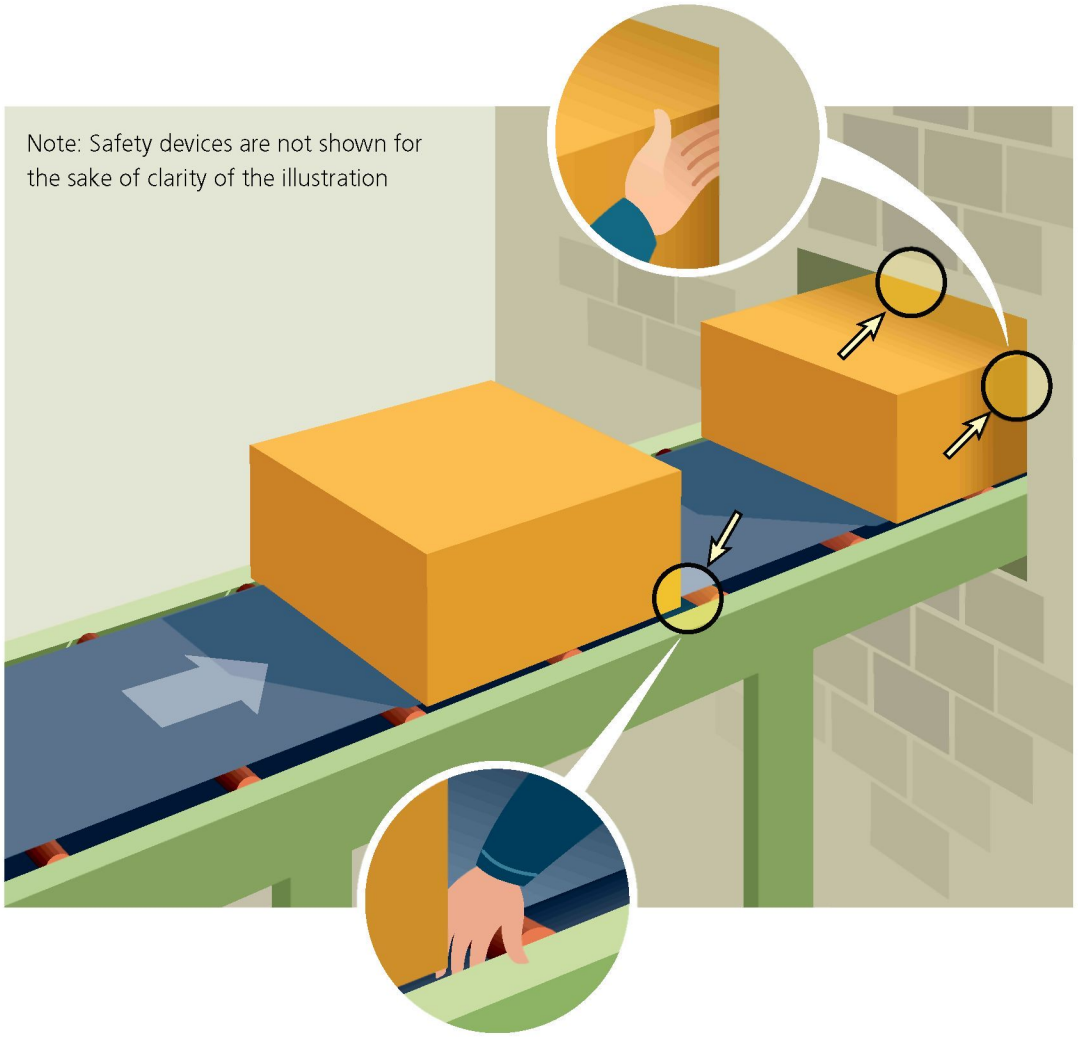



FIGURE 1-6 TYPICAL HAZARDS OF INDIVIDUAL LOADS AND FIXED OBSTACLES

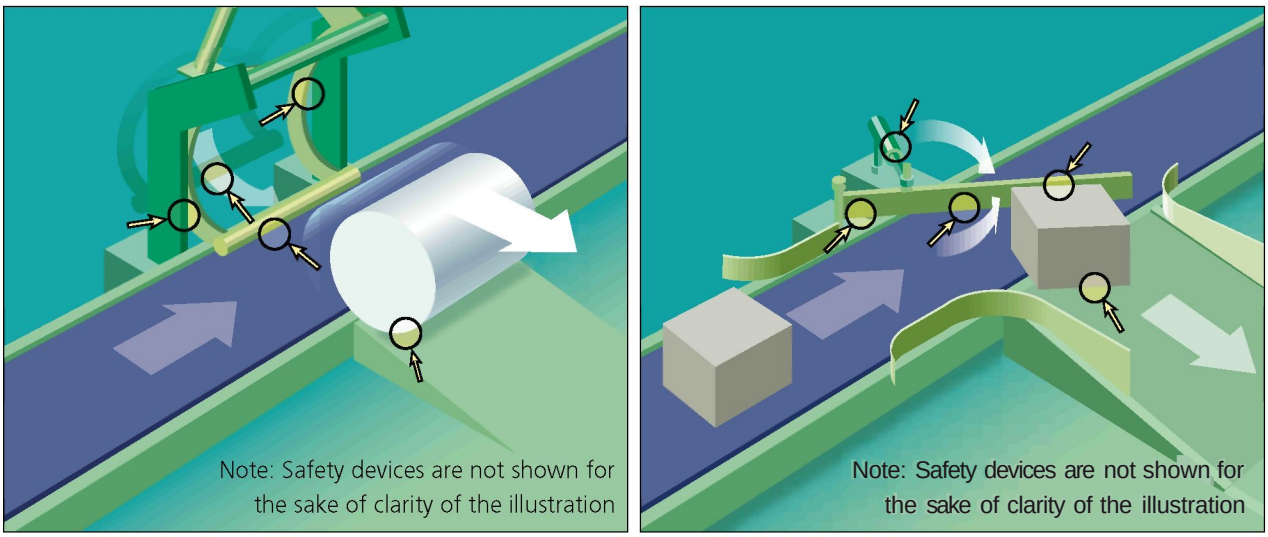



FIGURE 1-7 TYPICAL HAZARDS OF MOVING SUB-ASSEMBLIES

# 4 Applicable Acts and Regulations

The table below lists the principal sections applying to conveyor belts, by statute.

**Table 1-3 Applicable Acts and Regulations**

| Statutes | Sections Applicable to Conveyor Belts, with Title | |
|---|---|---|
| An Act Respecting Occupational Health and Safety (R.S.Q., c. S-2.1) | 2 | Law Object, Participation of Workers and Employers |
| | 51 | Employer's Obligations |
| | 63 | Dangerous Substance (Supplier) |
| Regulation Respecting Occupational Health and Safety (D. 885-2001) | 20 | Machine Guidance Tracks |
| | 172 | (Danger Zone) |
| | 173 | Applicable Provisions |
| | 174 | Permanent Protector |
| | 175 | Interlocking Protector |
| | 176 | Interlocked Protector |
| | 177 | Automatic Closing Protector |
| | 178 | Adjustable Protector |
| | 179 | Sensor Device |
| | 180 | Two-Hand Controls |
| | 181 | Multiple Two-Hand Controls |
| | 182 | Controlling the Danger Zone |
| | 183 | Equivalent Safety Precautions |
| | 184 | Installation |
| | 185 | Making Secure |
| | 186 | Adjustment, Repair, Unjamming, Maintenance, and Apprenticeship |
| | 187 | Characteristics of a Protector |
| | 188 | Spare Parts |
| | 189 | Control Devices and Switches |
| | 190 | Start and Stop Switches |
| | 191 | Warning Devices |
| | 192 | Emergency Stop |
| | 193 | Groups of Machines |
| | 265 | Carrying Elements |
| | 266 | Transmission Devices |
| | 267 | Protection from Falling Objects |
| | 268 | Arial Conveyors |
| | 269 | Safety Precaution |
| | 270 | Emergency Stop |
| | 323 | Tasks Involving Maintenance or Repairs |
| Safety Code for the construction industry (R.S.Q., c. S-2.1) | 371 | (Climbing on Conveyors Prohibited) |
| | 372 | (Cleaning While all Movement has Ceased) |
| | 373 | (Conveyor Protector) |
| | 374 | (Underground Mine Conveyors) |
| Regulation Respecting Occupational Health and Safety in Mines. (c. S-2.1, r. 19.1) | 3.10.13 | Safety and Protective Devices |
| | 3.16.9 | Conveyors |
| Enginners Act (R.S.Q., c.1-9) | | |

More recent versions of the statutes in French are available from the following site: www.csst.qc.ca. The French and English versions can be purchased from Publications du Québec.

There are as well many standards relating to conveyor belts and machine safety. Refer to the list at the end of the Guide in the REFERENCES and BIBLIOGRAPHY Sections.

# 5 Risk Assessment and Reduction

Once hazards have been identified, they must be eliminated or controlled by applying and implementing the appropriate safeguards and other control measures. It is necessary to carry out a risk assessment to determine which hazards to address first and the most effective methods to control them, so that the risk at each work station is systematically controlled. A method for doing this is outlined in Section 2 of this guide and explained in detail in the document *Sécurité des machines : phénomènes dangereux – situations dangereuses – événements dangereux – dommages* (*Machine Safety; Hazards – Hazardous Situations – Dangerous Events – Damages)*.[1]

For more on preventative measures, refer to the document *Guide de prévention en milieu de travail : à l'intention de la petite et de la moyenne entreprise, Publication Number DC 200-16082-2, 2000 (A Guide to Prevention in the Workplace for Small and Medium-Sized Businesses)*.[2]

# 6 Maintenance Information

Maintenance must be carried out according to the conditions set forth in sections 185 and 186 of the *Regulation Respecting Occupational Health and Safety*. These sections stipulate that safety measures must be in effect before attempting any maintenance in a machine's danger zone. These measures are addressed in point 5 in the second section of this guide.

Maintenance can be performed only by workers assigned to that type of task and designated to carry out the task.

# SECTION 2
# SAFEGUARDS AGAINST HAZARDS

## 1 Risk Assessment and Reduction

The diagram in figure 2-1 describes an ongoing process for risk assessment and reduction[1]. The guidelines will be helpful in selecting the appropriate controls.

First, assess the risks. Then systematically eliminate or reduce the risks by implementing the following control measures:

**1)** Eliminate or reduce the hazard through design methods.

**2)** Install safeguards or protective devices for each hazard that cannot be eliminated or reduced through design methods. Evaluate the need for additional controls (warnings, signs, work procedures, personal protective equipment, etc.).

**3)** Inform workers of all hazards.

Safeguards implemented at the design stage are preferred over safeguards implemented by the user. The principles of safe conveyor belt design are addressed in *Sécurité des convoyeurs à courroie : guide du concepteur* (*A Designer's Guide to Conveyor Belt Safety)*.

The planning of control measures and recommendations should be part of the prevention program or of the action plan of the company.[2]

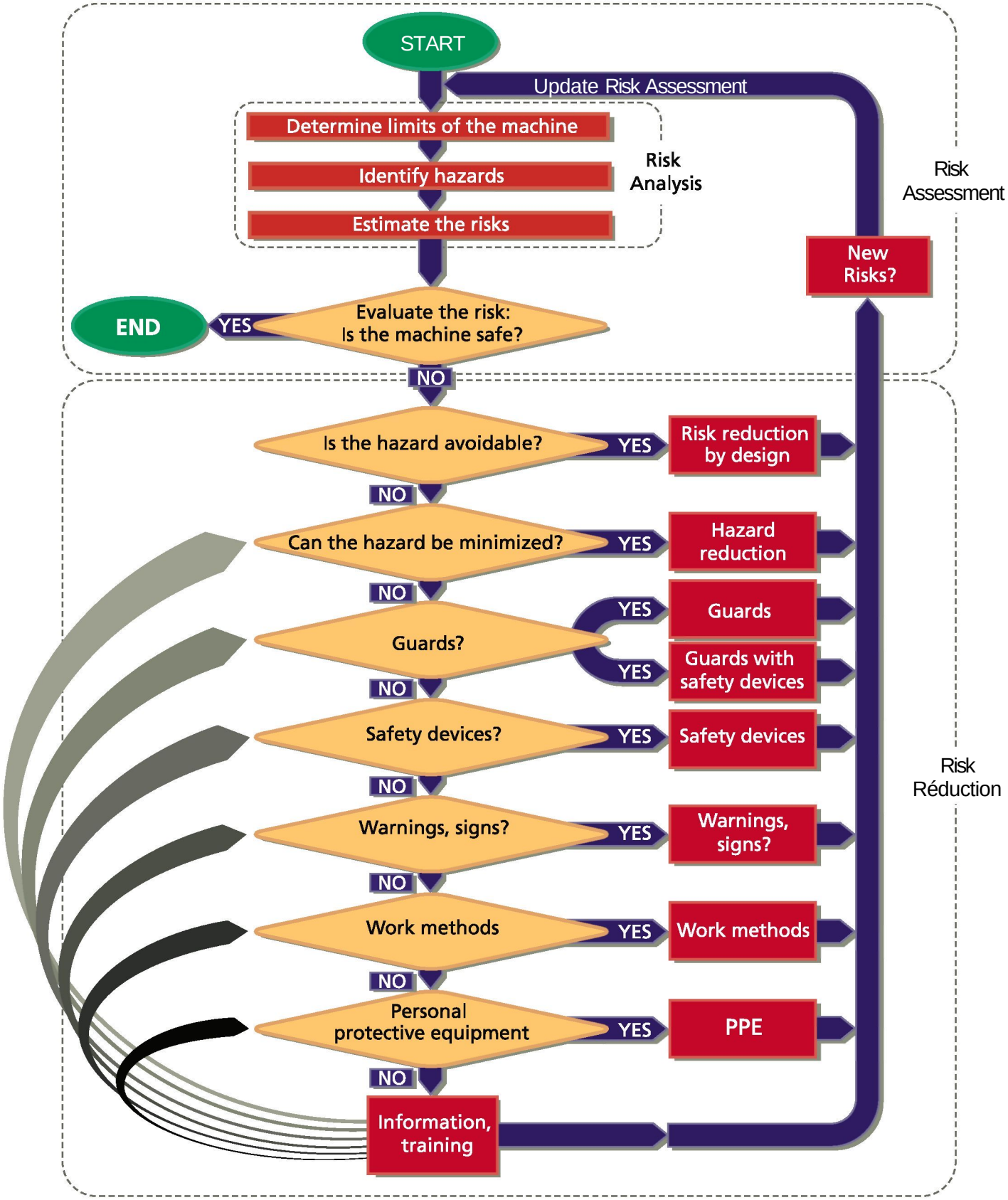



FIGURE 2-1 RISK ASSESSMENT AND REDUCTION FLOWCHART

# 2 Safeguards against Mechanical Hazards

## 2.1 General Principles

In and around conveyor belts there are many danger zones as defined in section 172 of the Regulation Respecting Occupational Health and Safety. Hazards are located in danger zones.

Sections 182 to 184 of the regulation stated above describe provisions relating to the installation of guards and protective devices on machines. Section 373 of Regulation Respecting Occupational Health and Safety in Mines,[4] describes the various safety devices that must be installed on a conveyor belt. Section 3.10.13 of the *Safety Code for the construction industry*,[5] specifies the general features of safety devices and guards. According to the regulations, a conveyor must be constructed in such a way as to not allow access to danger zones or, by default, must be equipped with guards and protective devices (section 182 of the Regulation Respecting Occupational Health and Safety). It is also possible to use deterrent devices.

Various types of protectors and deterrent devices on a conveyor belt are described below. Safety requirements for conveyor sub-assemblies are also described.

Preventative measures for hazards related to conveyor operation must be implemented when the hazard is 2.5 m or less from the floor or working platform.[6]

## 2.2 Guards

A guard is a machine element that makes the danger zone inaccessible, by isolating it (section 172 of the Regulation Respecting Occupational Health and Safety).

Guards on conveyor belts must be designed with operating conditions in mind. They must be capable of resisting the loads to which they will be subjected. These devices must not create additional hazards or tempt workers to bypass their use. The dimensions and weight of movable guard components must be designed to allow for easy handling. To this end, it is preferable to have articulated or hinged guards. Guard removal and reinstallation must be quick and easy. Ideally, guards should be self-locking when closed. For more information on user-related characteristics (colour, ease of manipulation, etc.) and guard construction, see Appendix A of this guide.

There are three types of guards:

**1)** Fixed guards:

- Surrounding fixed guards
- Barrier guards (fixed distance)
- Fixed in-running nip guards

**2)** Interlocking guards

**3)** Interlocked guards with guard locking

## 2.2.1 Allowable Dimensions for Guard Openings

A guard can have openings. The specifications for allowable dimensions for guard openings in Table 2-1 are taken from CSA Standard Z432-1994.[6]

Guard opening dimensions can be verified with a tool called a Safety Ruler (Table 2-1). This tool makes it possible to check if the hazard can be reached through the guard. The safety ruler instruction manual is published by CSST (DC 500-191).

## 2.2.2 Fixed Guard

A fixed guard is a guard that can be removed only by using a tool or that is permanently set in place, for instance, by welding (Regulation Respecting Occupational Health and Safety, section 174).

Guards may be easily opened with tools or keys, for instance, when equipped with quarter-turn latches. When keyed latches are used, responsibility for controlling and distributing socket keys or tools must be assigned. For more information on types of tools and fixtures, see Appendix A.

### 2.2.2.1 Surrounding Fixed Guard

This is a fixed guard that either completely or partially surrounds the danger zone.

Because of openings required for belt and load passage, surrounding fixed guards only partially surround the danger zone.[7]

In conveyor belts, fixed guards that only partially surround the danger zone take on two principal shapes:

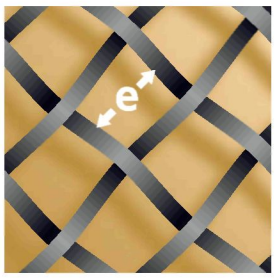
- Partial cages as illustrated in figure 2-2 and used mainly for head and return drums;
- Side screens as illustrated in figure 2-3.

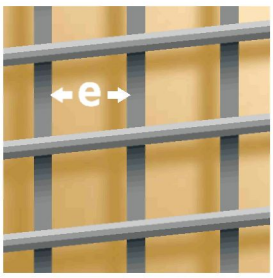
Guards must extend beyond the in-running nips between belts and rollers so as to make them inaccessible from above, below and from the ends.

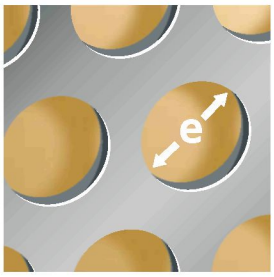
#### To Prevent Access from Guard Ends

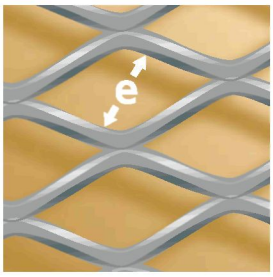
- For partial cages like the one illustrated in figure 2-2, the guard must extend 1,000 mm from a drum center.[8]
- Side screens must extend 1,000 mm from the center of the first roller (load carrying or return) or drum, at the entrant side of the belt in the protected area. On the exit side, they must extend 620 mm[9] from the center of a roller and 1,000 mm from the center of a drum (figure 2-3).
- Whatever the length of side screens or cages, in-running nips must remain inaccessible at screen or cage ends and from under the belt.

| Table 2-1: Allowable Dimensions for Guard Openings | |
|---|---|
| **Safe Distance c (mm)** | **Maximum Aperture Width e (mm)** |
| 6 ~ 38 | 6 |
| 39 ~ 64 | 10 |
| 65 ~ 89 | 13 |
| 90 ~ 140 | 16 |
| 141 ~ 165 | 19 |
| 166 ~ 191 | 22 |
| 192 ~ 318 | 32 |
| 319 ~ 394 | 38 |
| 395 ~ 445 | 48 |
| 446 ~ 800 | 54 |
| Greater than 800 | 152 |

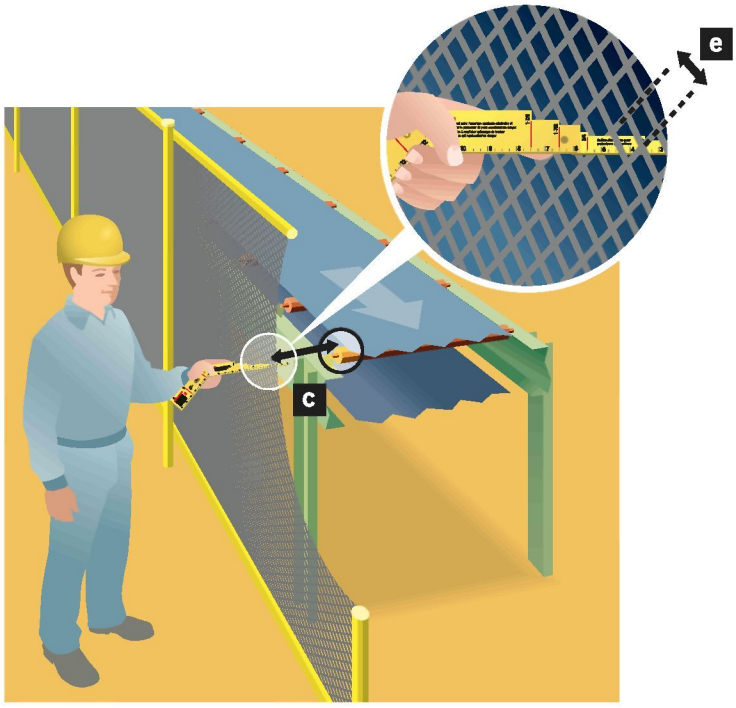



How to Measure Openings




Using the Safety Ruler


The Safety Ruler

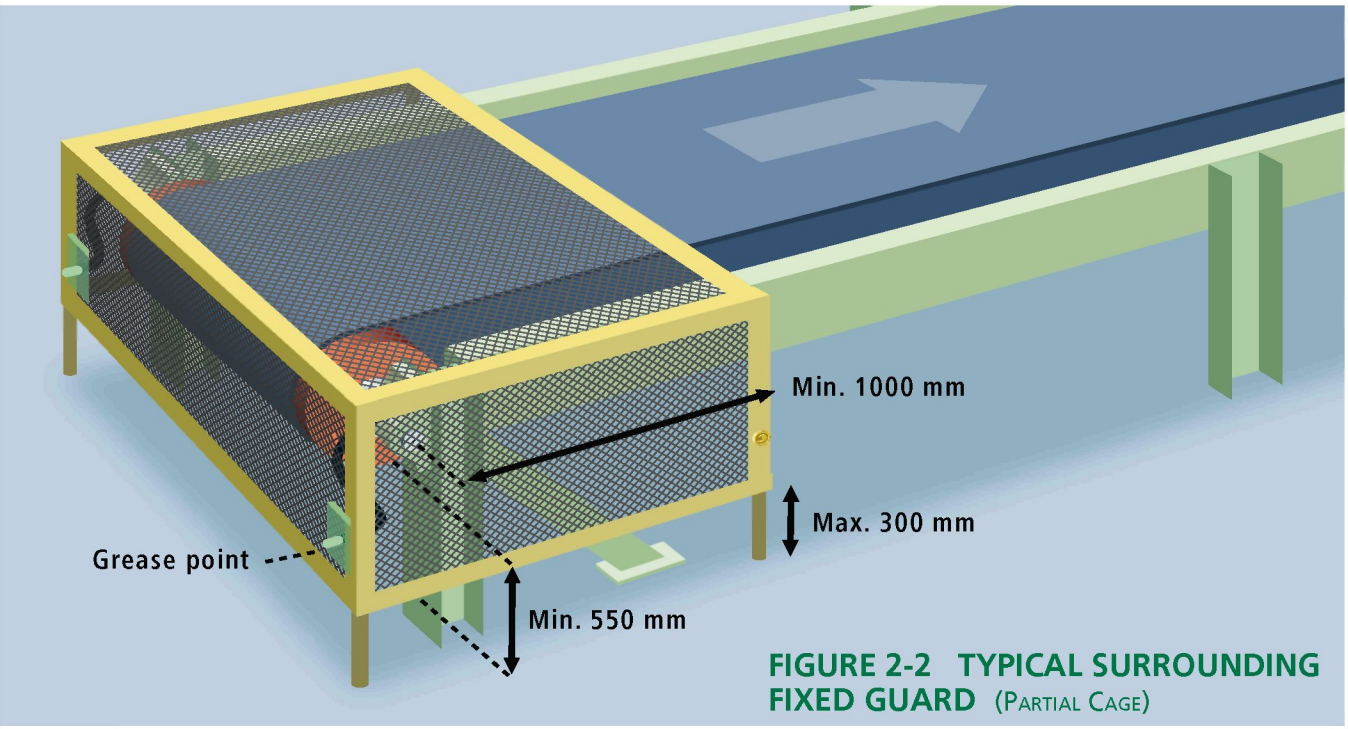



**FIGURE 2-2 TYPICAL SURROUNDING FIXED GUARD** (PARTIAL CAGE)

## To Prevent Access from Above Guards

- Cages should be closed on top.
- Side screens may take on a variety of shapes, as shown in figures 2-3 and 2-4 (screens with a 90° or other angle bend) to make in-running nips inaccessible from above the guard. The distance between the guard and the belt must be at least 100 mm to prevent a hand from getting jammed in between. For troughed conveyors, the distance, which is calculated perpendicularly from the angled roller, must be equal to one third the roller length from the roller top (figures 2-3 and 2-4).
- Table 2-2, which applies to barrier guards, can be used to determine the height of upright side screens.

## To Prevent Access from Under the Conveyor

- Under conveyor access can be prevented by a screen such as the one illustrated in figure 2-3.
- Where there is no access-restricting screen under a conveyor, side screens must extend 1,000 mm below roller and belt in-running nips.
- When in-running nips are 1,000 mm or less from the floor, the guard must extend to the floor. For housekeeping purposes, a 300 mm opening[10] may be allowed under the guard provided it extends 550 mm[9] or more under the pinch point for which it was designed to restrict access (figures 2-2, 2-5A and 2-33). If the distance of 550 mm cannot be maintained, the opening under the guard must meet the specifications in table 2-1.
- When in-running nips are more than 1,000 mm from the floor, openings under the guard must not exceed 300 mm. Bars, like those illustrated in figure 2-5B, may be used to block these openings.

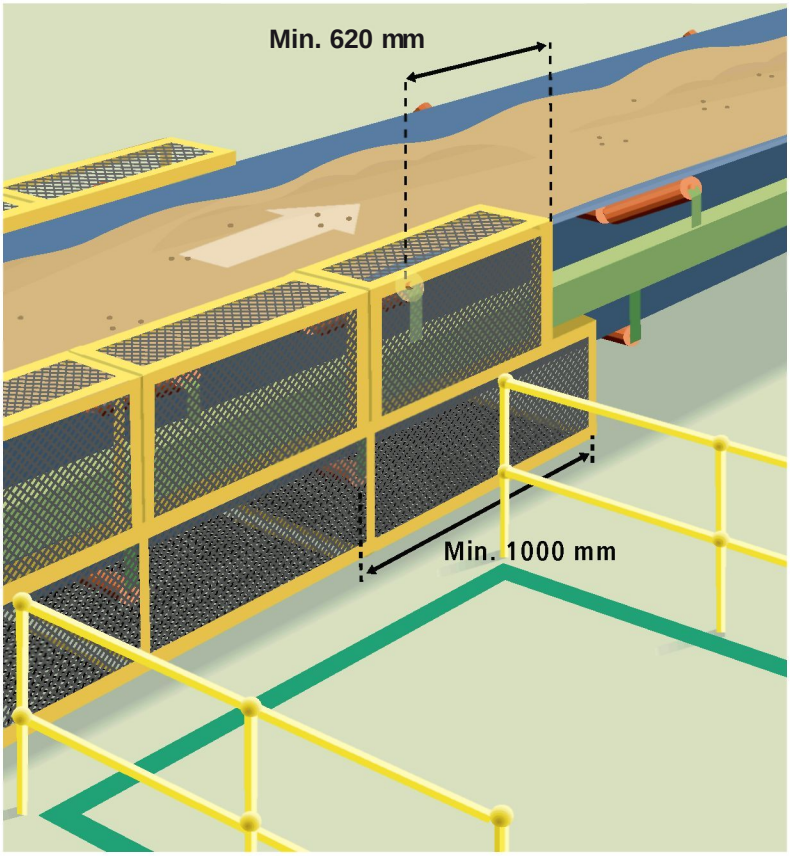



FIGURE 2-3
SURROUNDING BARRIER GUARD
FOR LOAD CARRYING ROLLERS
AND RETURN ROLLERS

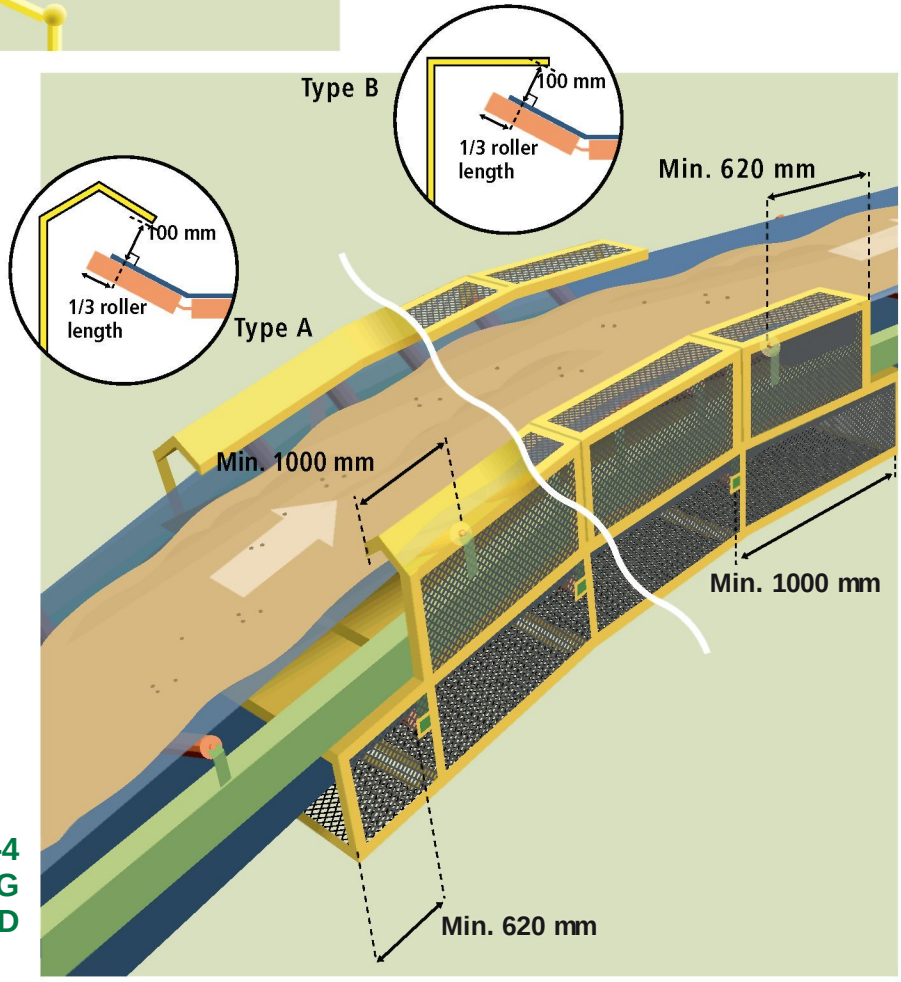
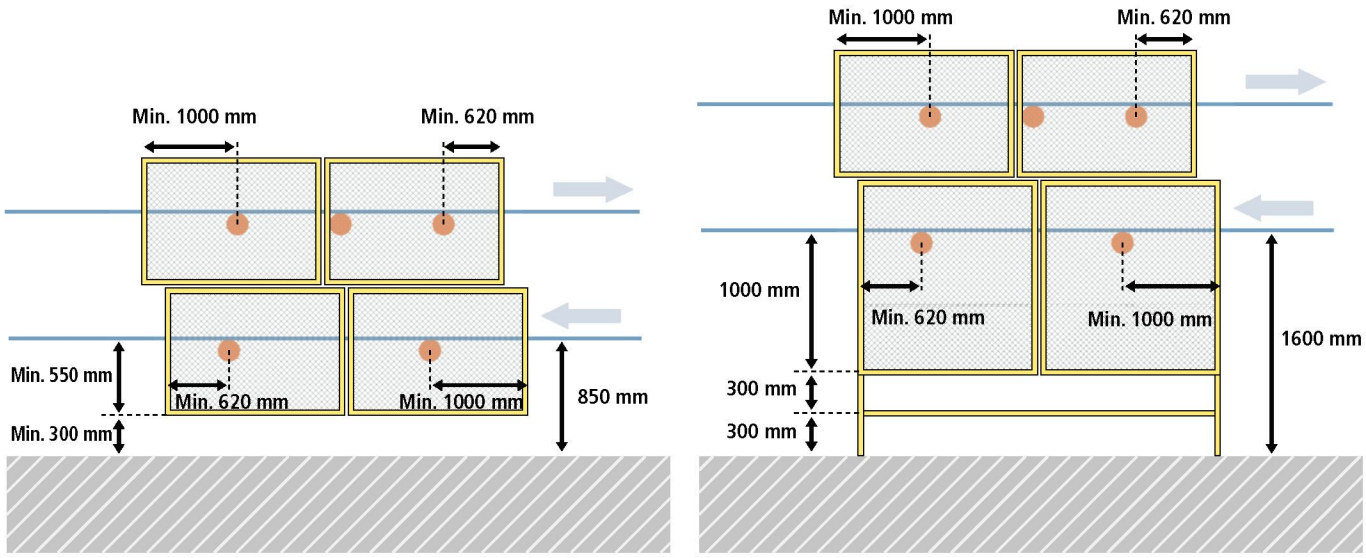



FIGURE 2-4
CURVED ZONE SURROUNDING
FIXED GUARD




**A** – Hazard at 850 mm from floor
(WARNING: Access to the return strand under the conveyor must be restricted)

**B** – Hazard at 1,600 mm from floor

**FIGURE 2-5 TYPICAL SURROUNDING FIXED GUARDS** (SIDE SCREENS WITH NO PROTECTION UNDERNEATH)

### 2.2.2.2 Barrier Guard (NF EN Standard 953, section 3.2.2)[11]

Barrier guards do not completely surround danger zones but rather restrict or prevent access by their size and separation from the danger zone. An example is a surrounding enclosure (figure 2-6).

For this guard to be effective, it must be placed at a safe distance in accordance with NF EN standard 294[9] and there must be no willful act to reach the danger zone (table 2-2). For examples illustrating use of this table, see Appendix B.

An opening of not more than 300 mm from the floor should be allowed for housekeeping.

If the vertical distance from the hazard and bottom edge of the guard is less than 550 mm, the opening for housekeeping under the guard must be in accordance with specifications in table 2-1.

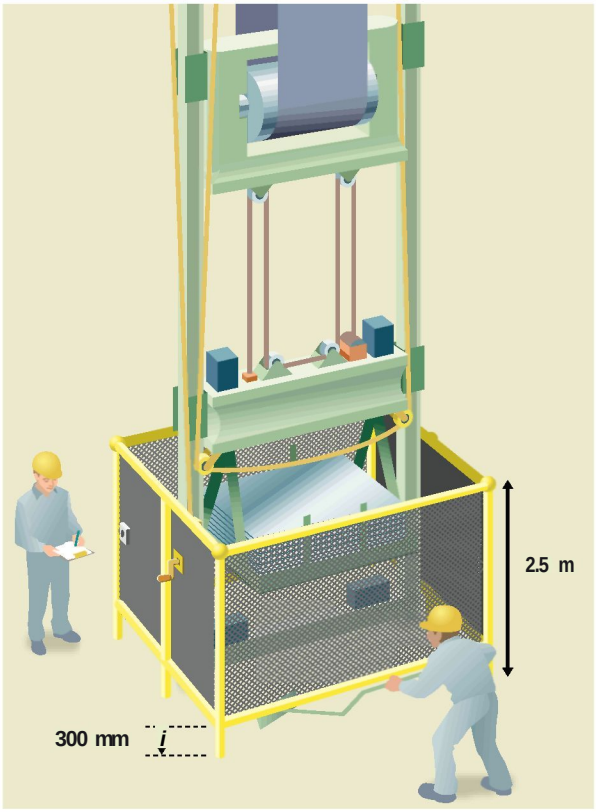



**FIGURE 2-6 TYPICAL BARRIER GUARD**
(DANGER ZONE IS AT LEAST 100 MM FROM THE GUARD)

## Table 2-2 Required Distances for Fixed Barrier Guards
**(Based on NF EN Standard 294)**

| Danger Zone Height a (mm) | Protective Structure Height b (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1400 | 1600 | 1800 | 2000 | 2200 | 2400 | 2500 |
| | Horizontal Distance from the Danger Zone c (mm) | | | | | | |
| 2400 | 100 | 100 | 100 | 100 | 100 | 100 | |
| 2200 | 500 | 500 | 400 | 350 | 250 | | |
| 2000 | 700 | 600 | 500 | 350 | | | |
| 1800 | 900 | 900 | 600 | | | | |
| 1600 | 900 | 900 | 500 | | | | |
| 1400 | 900 | 800 | 100 | | | | |
| 1200 | 900 | 500 | | | | | |
| 1000 | 900 | 300 | | | | | |
| 800 | 600 | | | | | | |
| 600 | | | | | | | |
| 400 | | | | | | | |
| 200 | | | | | | | |
| 0 | | | | | | | |

**Notes:**
- > No interpolation from the above values is allowed.
- > If a measured distance falls between two values, select the safer value.
- > Structures less than 1,400 mm high are considered to be deterrent devices (see section 2.3).


FIGURE 2-7 ILLUSTRATION FOR TABLE 2-2

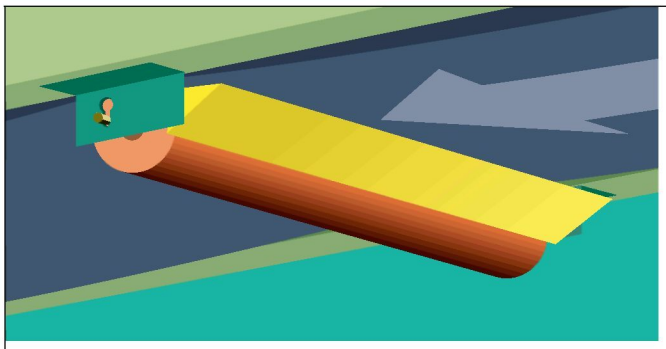
### 2.2.2.3 In-Running Nip Fixed Guards
**(EN Standard 620, sections 3.4.17 and 5.1.4.2)**[7]

A fixed guard can be placed at a height of an in-running nip that will not allow access to this zone. In-running nip fixed guards may be form-fitting (figure 2-8) or made from angled deflectors with side plates (figure 2-9). They are well suited to individual load conveyance, as well as to rollers and drums with a smooth, unbroken surface. They may be used in troughed conveyor belts as long as they follow the belt profile. However, these guards are ill-suited to cleated-type, ribbed or raised-edge belts.

If it is impossible to maintain a maximum clearance of 5 mm between the guard and the roller or drum surface, or between the guard and the belt, then the use of the in-running nip fixed guard is not recommended.

The minimum length that an in-running nip fixed guard must extend beyond the roller or drum center depends upon the diameter of the roller or drum. To determine this length, first determine the maximum distance "C" which is the distance from the center of the roller to where a finger may get pinched and drawn in (table 2-3). Then, to this distance "C", add either 150 mm for rollers or 600 mm for drums (figures 2-8 and 2-9).

Plates under a belt and between rollers may also serve as safeguards from in-running nips (figure 2-20). However, a maximum gap of 5 mm must be maintained between a roller and adjacent plates.



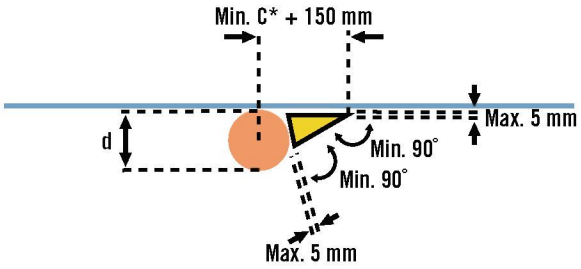
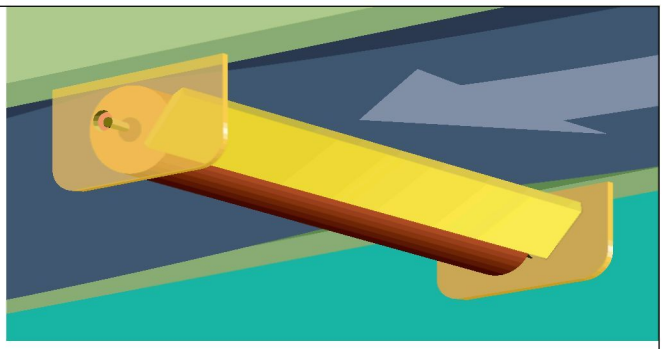



**FIGURE 2-8 IN-RUNNING NIP FIXED GUARD**
(FORM-FITTING ELEMENT)



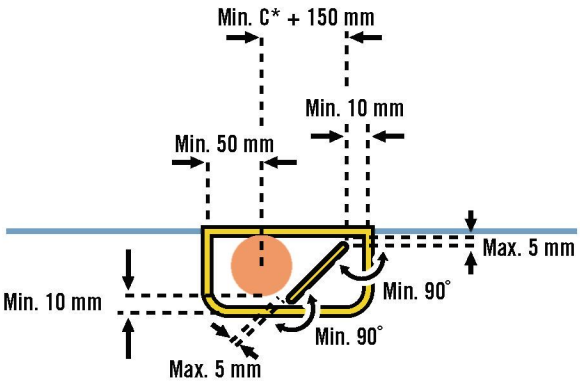



**FIGURE 2-9 IN-RUNNING NIP FIXED GUARD**
(ANGLED DEFLECTOR WITH SIDE PLATES)

*For "C" values, see Table 2-3

| Table 2-3: Minimum Lengths of In-Running Nip Fixed Guards | | | |
|---|---|---|---|
| **Drum or Roller Diameter d (mm)** | **Entrapment Zone Length C*** | **Minimum Guard Length from Roller Center (C + 150 mm)** | **Minimum Guard Length from Drum Center (C + 600 mm)*** |
| 200 | 60 | 210 | 660 |
| 315 | 77 | 227 | 677 |
| 400 | 87 | 237 | 687 |
| 500 | 98 | 248 | 698 |
| 630 | 110 | 260 | 710 |
| 800 | 125 | 275 | 725 |
| 1000 | 140 | 290 | 740 |
| 1250 | 157 | 307 | 757 |
| 1400 | 166 | 316 | 766 |
| 1600 | 177 | 327 | 777 |
| * For roller or drum diameters not listed above, C may be calculated using the formula: $C = \sqrt{(d/2)^2 - [(d/2) - 20]^2}$ . | | | |

## 2.2.3 Interlocking Guard (figure 2-10)

A guard equipped with an interlocking device should have the following characteristics. It should:

- cause the machine or the operation of its hazardous components to stop as it is slightly opened
- make it impossible to start the machine or to operate its hazardous components for as long as it is not in place
- not cause the machine or its hazardous components to restart once it is fully restored to its place

This type of guard may only be used if the hazard disappears before a worker can access the danger zone (low-inertia conveyor with rapid stop) (figure 2-10).

WARNING: In the case of interlocking guards and interlocked guards with guard locking, it must not be possible for a person or any part of the body to be in the danger zone or between the danger zone and the guard, when the guard is closed. For more information on the design of interlocking guards and interlocked guards with guard locking, refer to ISO Standard 14119, 1998.[12]

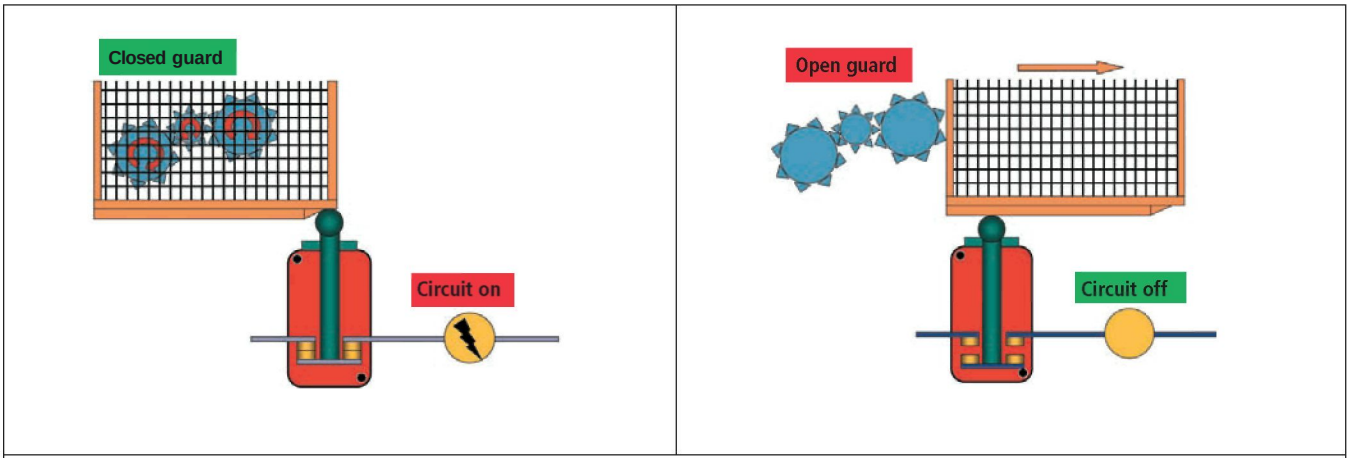



FIGURE 2-10 OPERATING PRINCIPLE OF INTERLOCKING GUARDS

**NOTE:** CSA Standard Z432, section 8.1.1.5, defines this type of guard as an interlocking guard.

## 2.2.4 Interlocked Guard with Guard Locking (figure 2-11)

An interlocked guard equipped with a locking device should have the following characteristics. It should:

- remain locked in place for as long as the machine or its hazardous components are moving
- make it impossible to start the machine or to operate its hazardous components for as long as it is not in place and reactivated
- not cause the machine or its hazardous components to be restarted once it is restored to its place and reactivated

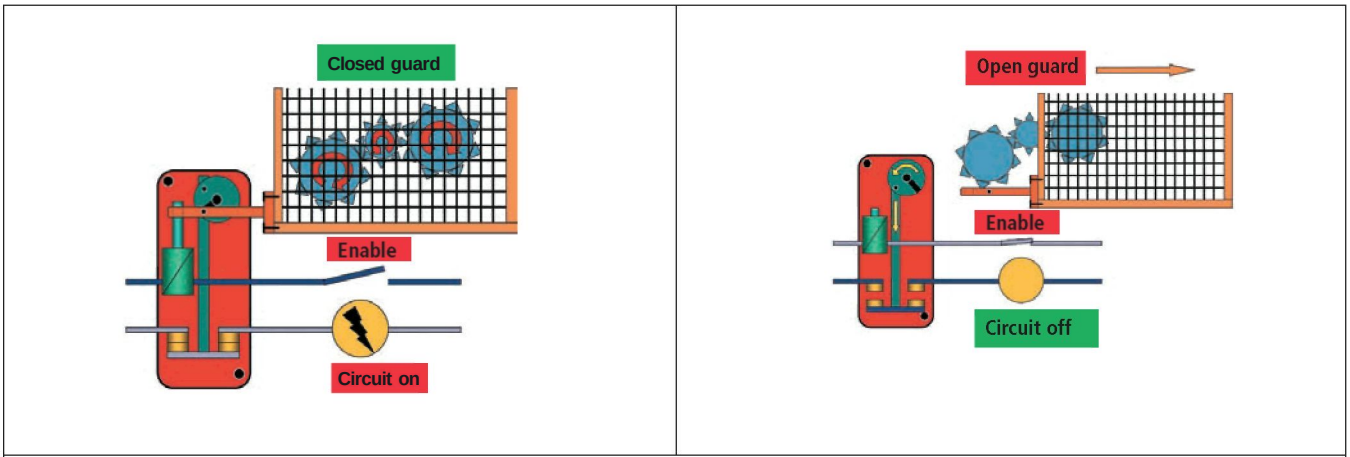



FIGURE 2-11 OPERATING PRINCIPLE OF INTERLOCKED GUARD WITH GUARD LOCKING

This type of guard may be used when it's possible to access the danger zone before the hazard has disappeared (large-inertia conveyors and long-to-stop conveyors).

**NOTE:** CSA Standard Z432, section 8.1.1.6. defi nes this type of guard as a interlocking guard with guard locking.

## 2.3 Deterrent Devices

These are devices (other than guards) that reduce the risk of contact with a danger zone. These are often physical obstacles which, without totally preventing access to a danger zone, reduce the possibility of access (NF EN Standard 292-1, section 3.24).[13]

Deterrent devices (figure 2-12) include:

- Roller side plates
- Guardrail with mid rails

**Note:** In order to be considered a deterrent device, guardrails must be at least 1,000 mm high with a minimum of 1,400 mm separation from the danger zone. Sections 12 and 13 of the Regulations Respecting Occupational Health and Safety describes other characteristics.

Deterrent devices must be designed with operating conditions in mind. They must be capable of resisting the loads to which they will be subjected. These devices must not create additional hazards or tempt workers to bypass their use. For information on user-related characteristics (colour, ease of manipulation, etc.) and construction, see Appendix A.

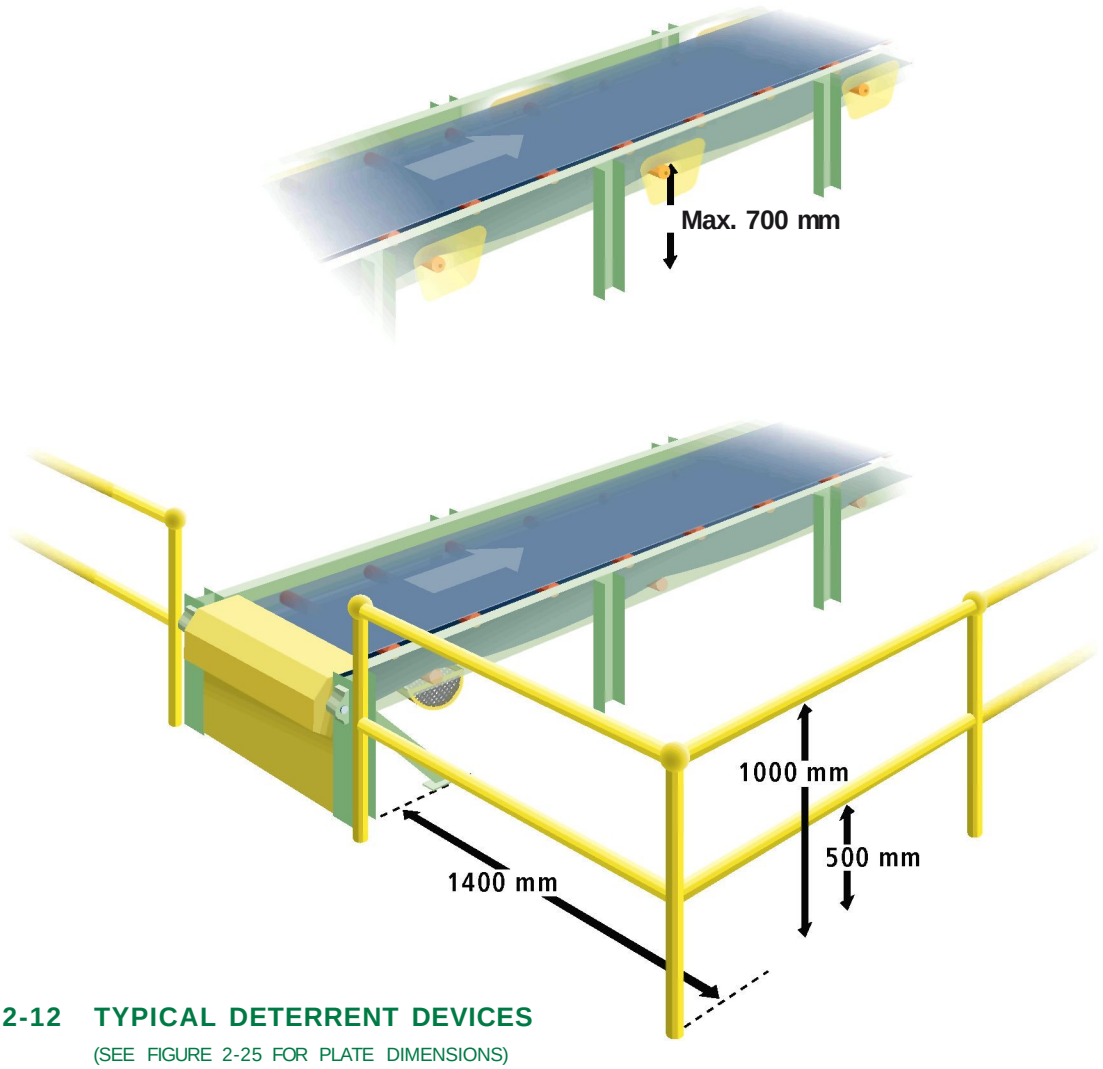



**FIGURE 2-12 TYPICAL DETERRENT DEVICES**
(SEE FIGURE 2-25 FOR PLATE DIMENSIONS)

## 2.4 Service Ways and Throughways

Where service ways and throughways run parallel to or underneath conveyors, danger zones must be made inaccessible and the hazards of falling conveyor parts or falling loads must be prevented. Safety requirements are outlined in section 2.6.

These measures can only be applied correctly if throughways are well and clearly marked (painted floor lines, guardrails, etc.). Where a throughway crosses under or is located below a conveyor, the head room below the conveyor should be more than 2 m and the width of the throughway at least 600 mm. For a throughway passing over a conveyor, the footwalk must be equipped with a guardrail (section 31 of the Regulation Respecting Occupational Health and Safety and section 373.3 of the Regulation Respecting Occupational Health and Safety in Mines).

Service ways can be divided into two groups:

- Well-marked (footwalk along the conveyor, single-file access way under the conveyor, etc.): the measures in paragraph 2.6 apply only to hazardous components along service ways.
- Not marked or poorly marked (under a conveyor to access certain machine elements): the measures in paragraph 2.6 apply to all components deemed to be hazardous.

## 2.5 Falling or Projecting Objects

Hazards of falling or projecting machine components or loads are created when machine parts break or there is a sudden jarring in sub-assemblies.

### 2.5.1 Conveyor Elements

Hazards of falling or projecting conveyor elements can be caused by the following:

- Forces during normal operating conditions (centrifugal force, pressure)
- Exceptional forces normally foreseeable (jarring, ramming)
- Aging material

It's important to implement measures to prevent hazards such as a falling return rollers or belt breakage (see section 2.6).

### 2.5.2 Carried Loads

The complete conveyor circuit, specifically loading, unloading and transfer points, must be designed to reduce the spill-over hazards of carried loads.

Equipment installed high above the floor or ground must be equipped with protective devices (for example, roller restraining device, protective plate, gutter, fillet, mesh) to prevent the fall of loads and debris. This is particularly important where conveyors are above or near throughways (see section 2.6).

## 2.6 Conveyor Belt Safety Requirements for Operating Conditions

The following pages outline the safety requirements for conveyor belt parts in operation, in the following order:

**1) Power Transmission Moving Parts**

**2) Belt**

In good condition

Deteriorated belt or belt splice

**3) Upper and Lower Strands in a Straight Run**

In-running nips between upper strand and rollers under the hopper – upper strand under a skirtboard or skirt

In-running nips between upper strand and support rollers in a straight run

In-running nips between lower strand and return rollers in a straight run

Return rollers

Lower strand scrapers

**4) Curved Zone**

**5) Transition Zone**

**6) Drums**

In-running nips between belt and drum

Take-up system

Junction between two conveyors

**7) Moving Loads**

Skirtboard and individual moving loads

Individual loads and fixed obstacles not part of the conveyor, e.g., post, wall, tunnel entrance, enclave, associated fixed equipment (detectors), etc.

Loads and carrying rollers larger than the belt

Loads falling from the belt

**8) Moving Sub-Assemblies**

**9) Moveable Conveyors**

## 2.6.1 Power Transmission Moving Parts

**Hazards**
Drive shaft; shaft end; sprocket; pulley; chain; drive belt; gear coupling

**Possible Consequences**
Drawing-in and crushing
Entanglement of a loose piece of clothing in a protruding moving part

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)**
Surrounding fixed guards (figures 2-13 to 2-16)

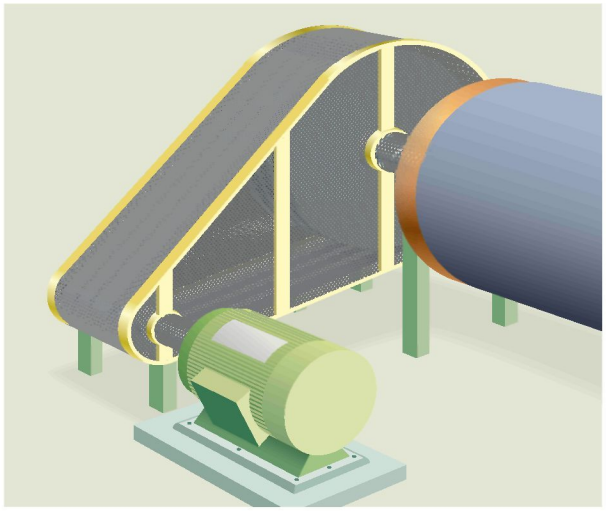


FIGURE 2-13 SURROUNDING FIXED GUARD FOR PULLEYS AND POWER TRANSMISSION BELTS

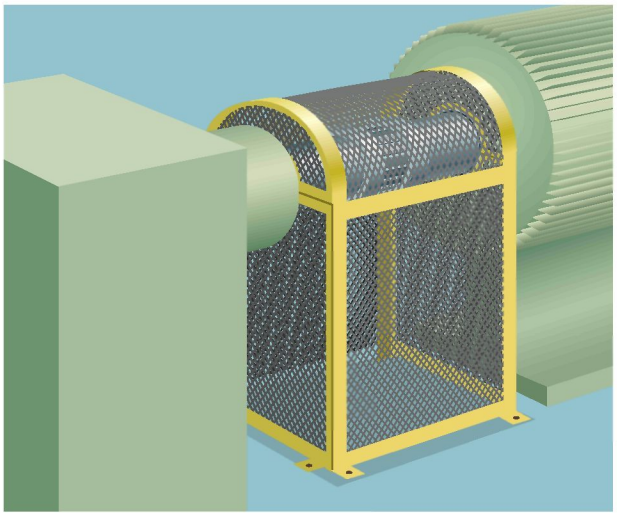


FIGURE 2-14 SURROUNDING FIXED GUARD FOR COUPLINGS

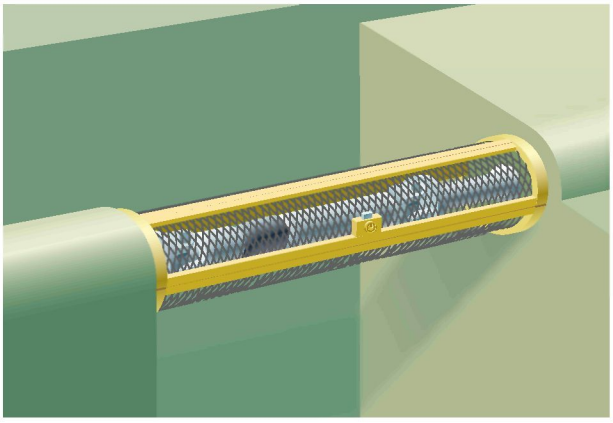


FIGURE 2-15 SURROUNDING FIXED GUARD FOR SHAFTS

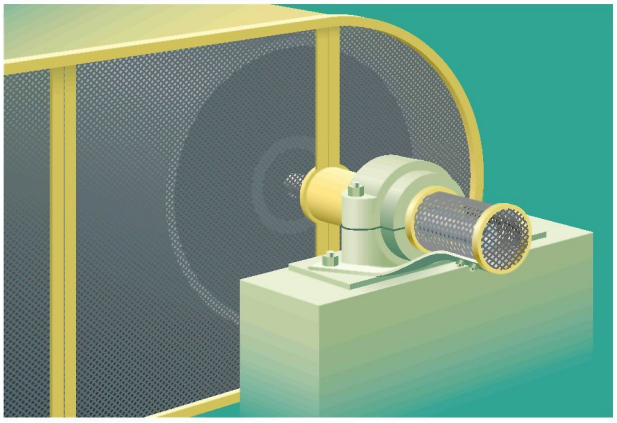


FIGURE 2-16 SURROUNDING FIXED GUARD FOR SHAFT ENDS

**Note:** Extend grease points and belt tension adjusters outside the guards.

*Regulation Respecting Occupational Health and Safety specifi cations are 2.1 m, but international standards specify 2.5 m.

## 2.6.2 Belt

**Hazard**
Belt in good condition

**Possible Consequences** *(Depending upon the speed and belt characteristics)*
Friction burns or abrasion
Impact with belt, drawing-in

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

**Upper Strand**

*Work station*
Install guard, in accordance with risk analysis results

**Lower Strand**

*Work station*
Install guard, in accordance with risk analysis results

*Throughway parallel to conveyor (figure 2-17)*
Install guardrail, in accordance with risk analysis results

*Throughway passing under conveyor (figure 2-17)*
Protection plate (able to withstand belt impact in case of breakage)

*Service way passing under conveyor*
Install protection plate, as determined by risk analysis

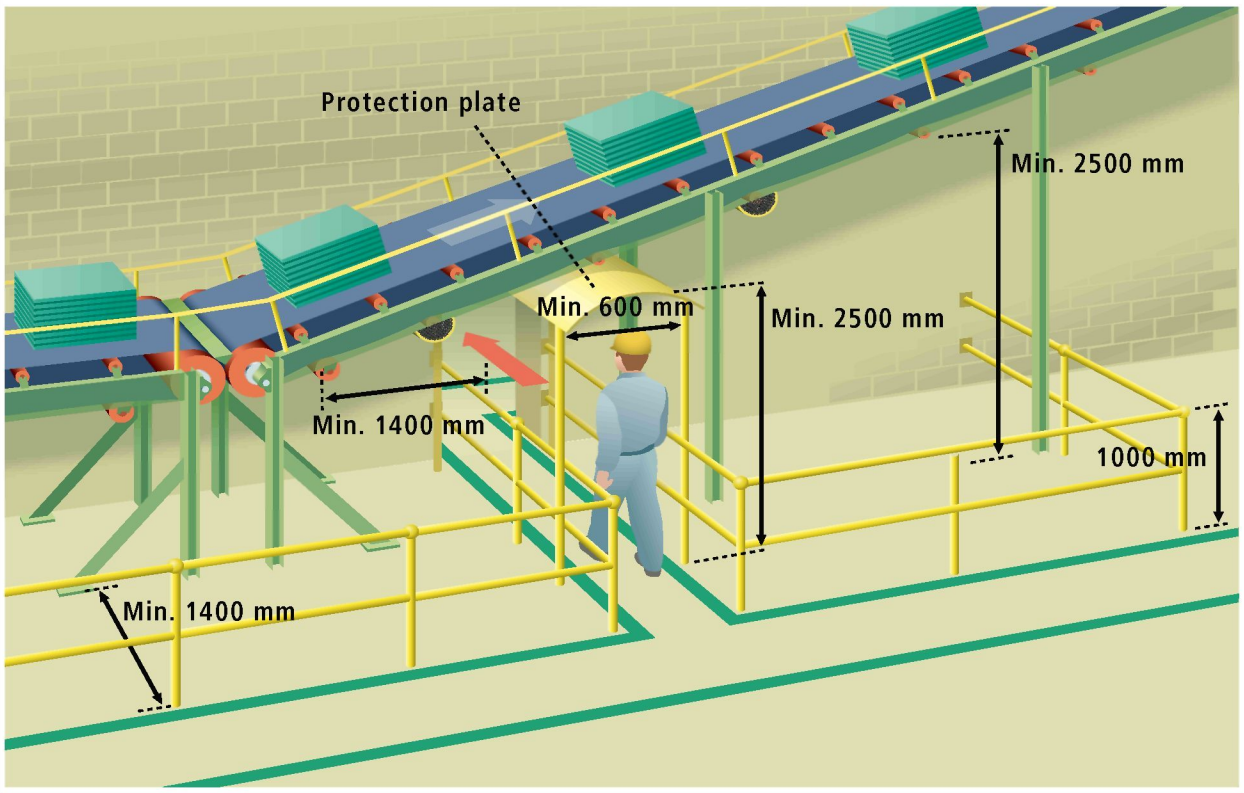



**FIGURE 2-17 TYPICAL PROTECTIVE MEASURES FOR THROUGHWAYS**

**Note:** Cleated, ribbed or raised-edge belts present additional hazards (impact, drawing-in) which must be considered during the risk analysis.

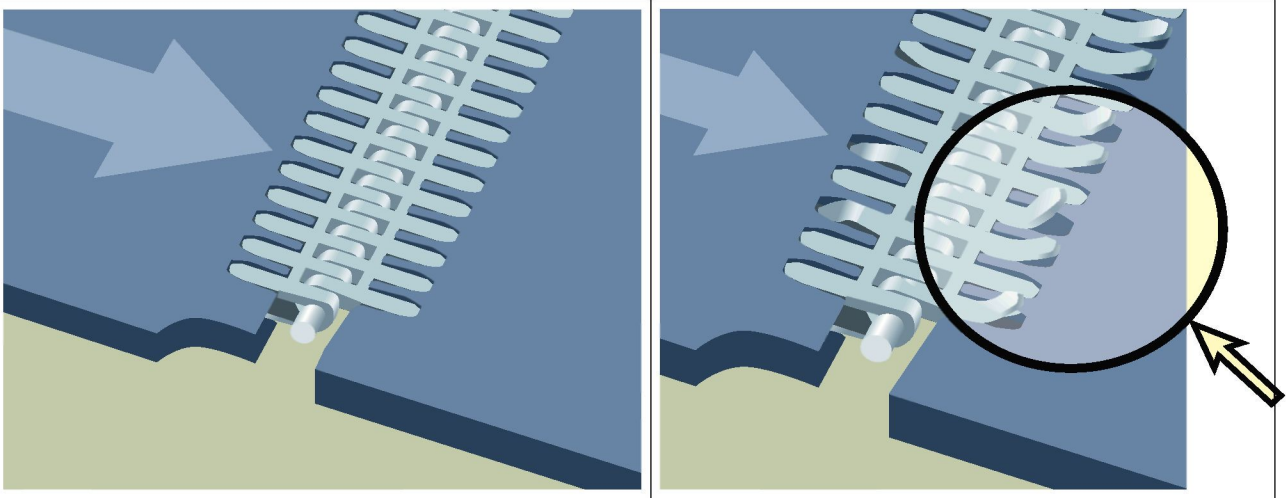
## Belt

**Hazards**
Deteriorated belt or belt splice (figure 2-18)

**Possible Consequences**
Drawing-in, burns, pokes, cuts

**Protection Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

Change the belt splice design or manufacture
Maintenance of belt and/or splice



A – Splice in proper condition

B – Damaged splice

**FIGURE 2-18 MECHANICAL SPLICES**

**Note:** Refer to “Types of Splices” in *Sécurité des convoyeurs à courroie : guide du concepteur (A Designer’s Guide to Conveyor Belt Safety).*

## 2.6.3 Upper and Lower Strands in a Straight Run

**Hazards**
In-running nips between the upper strand and the rollers under the hopper
Upper strand under the skirtboard or skirt

**Possible Consequences**
Drawing-in
Shearing
Burns from the belt

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*
Surrounding or barrier guard (figure 2-19)

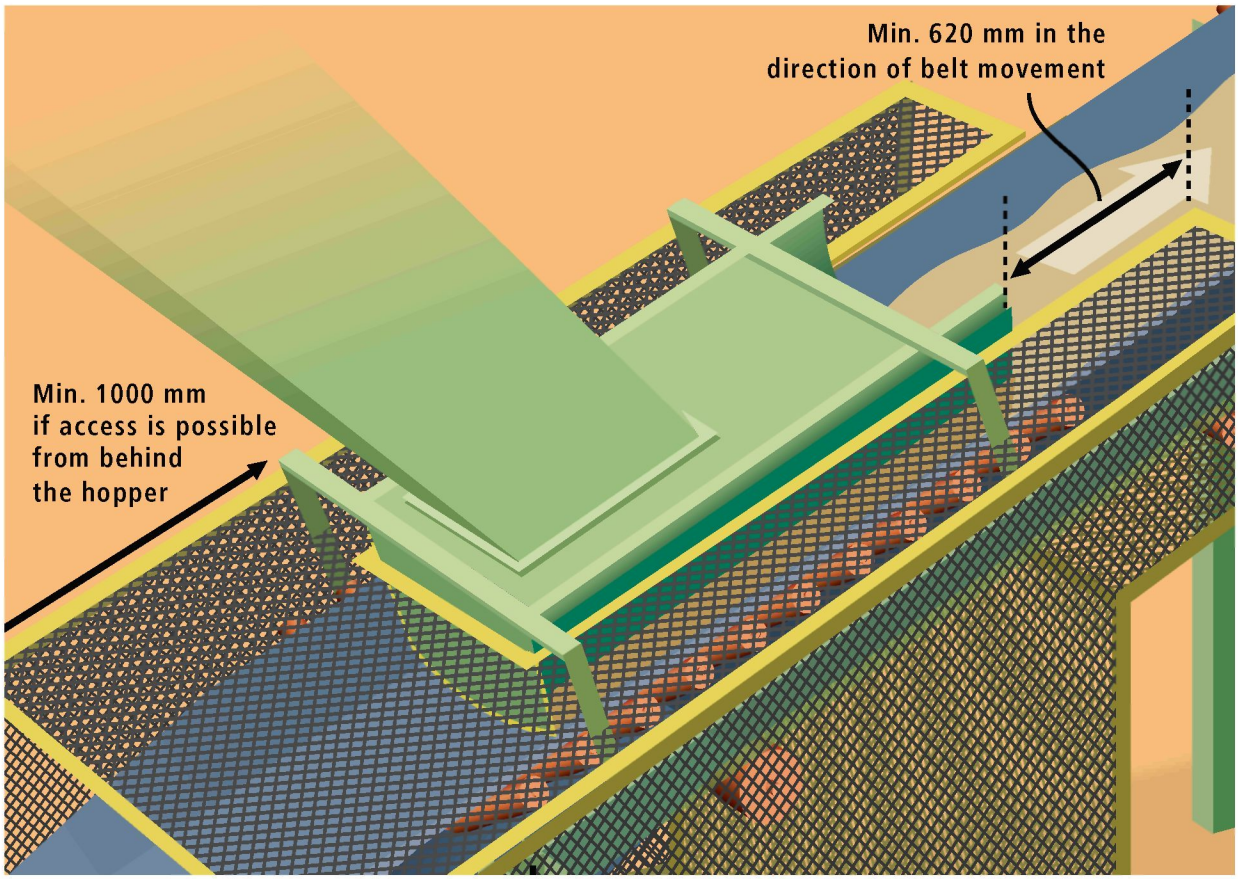



**FIGURE 2-19 SURROUNDING FIXED GUARD IN LOADING AREA**

**Note:** Extend grease points beyond the guards.

## Upper and Lower Strands in a Straight Run

**Hazards**
In-running nips between upper strand and support rollers in a straight run

**Possible Consequences**
Drawing-in

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

**Workstation**
Surrounding fixed guard (plates between rollers) (figures 2-20 and 2-21)

**Throughway and Service Way**
Risk analysis (except for mines (section 373.4 of the Regulations Respecting Occupational Health and Safety in Mines))

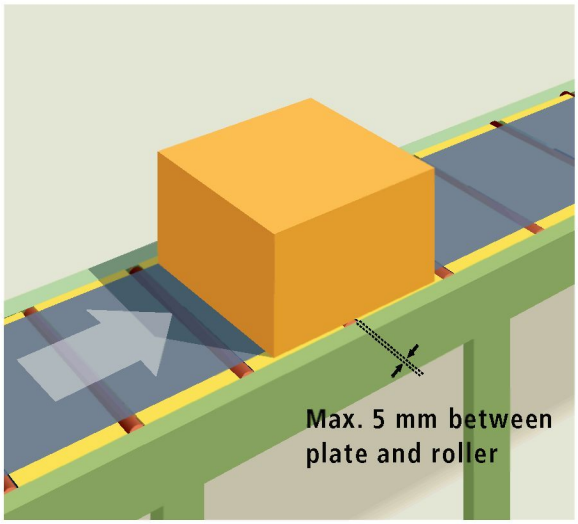



FIGURE 2-20 IN-RUNNING NIP FIXED GUARD FOR SUPPORT ROLLERS (PLATES)

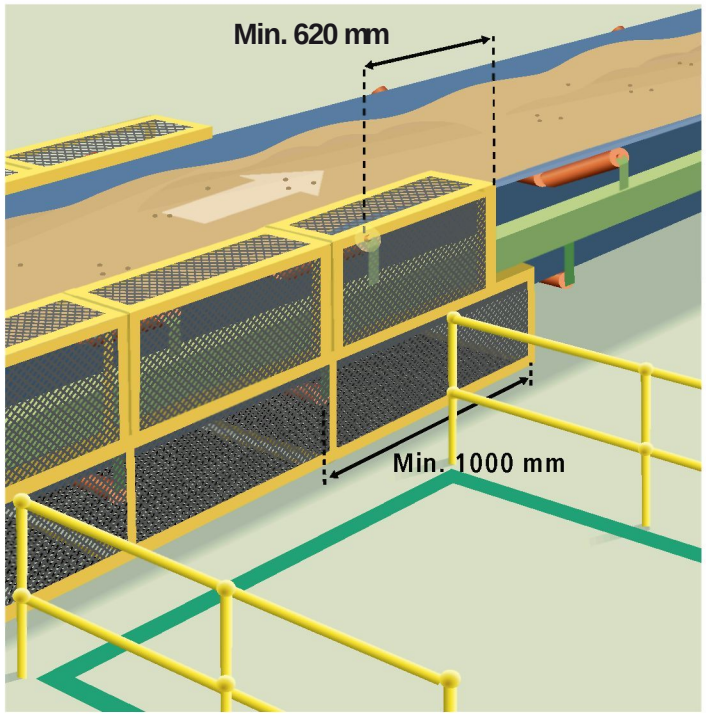



FIGURE 2-21 SURROUNDING FIXED GUARD FOR SUPPORT ROLLERS

**Note:** Special Case: When support rollers are themselves supported from above, this configuration must be taken into account during risk analysis.

## Upper and Lower Strands in a Straight Run

**Hazards**
In-running nips between lower strand and return rollers in a straight run **(1 of 3)**

**Possible Consequences**
Dragging
Impact with rollers

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)**

**Workstation** (beside or under conveyor)
Surrounding or in-running nip guards and additional protection plates if the control station is located below return rollers (figures 2-22 and 2-23)

**Throughway Parallel to Conveyor**
(In-running nip is located at a height between 0.7 m and 2.5 m)
Surrounding in-running nip guard or barrier guard, or other deterrent devices (guardrail)** (figures 2-22 to 2-24)

(In-running nip is located at a height less than 0.7 m) Deterrent devices (guardrail or side plate) (figures 2-24A and 2-25)

**Throughway Under a Conveyor**
Surrounding in-running nip or barrier guards, or deterrent devices (guardrail)** and the addition of protection plates (figures 2-22 to 2-24)

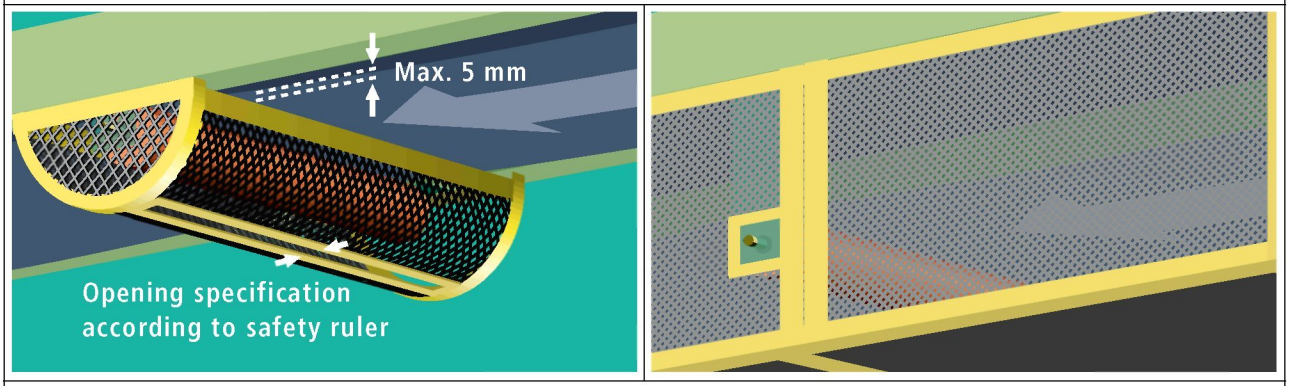



**FIGURE 2-22 SURROUNDING FIXED GUARDS FOR RETURN ROLLERS**

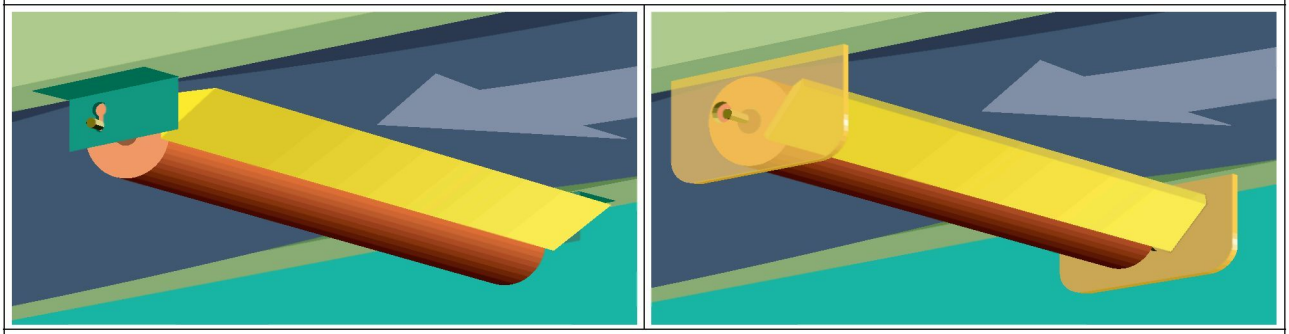


**FIGURE 2-23 IN-RUNNING NIP FIXED GUARDS FOR RETURN ROLLERS**
**(SEE FIGURES 2-8 AND 2-9 AND TABLE 2-3 FOR DIMENSIONS)**

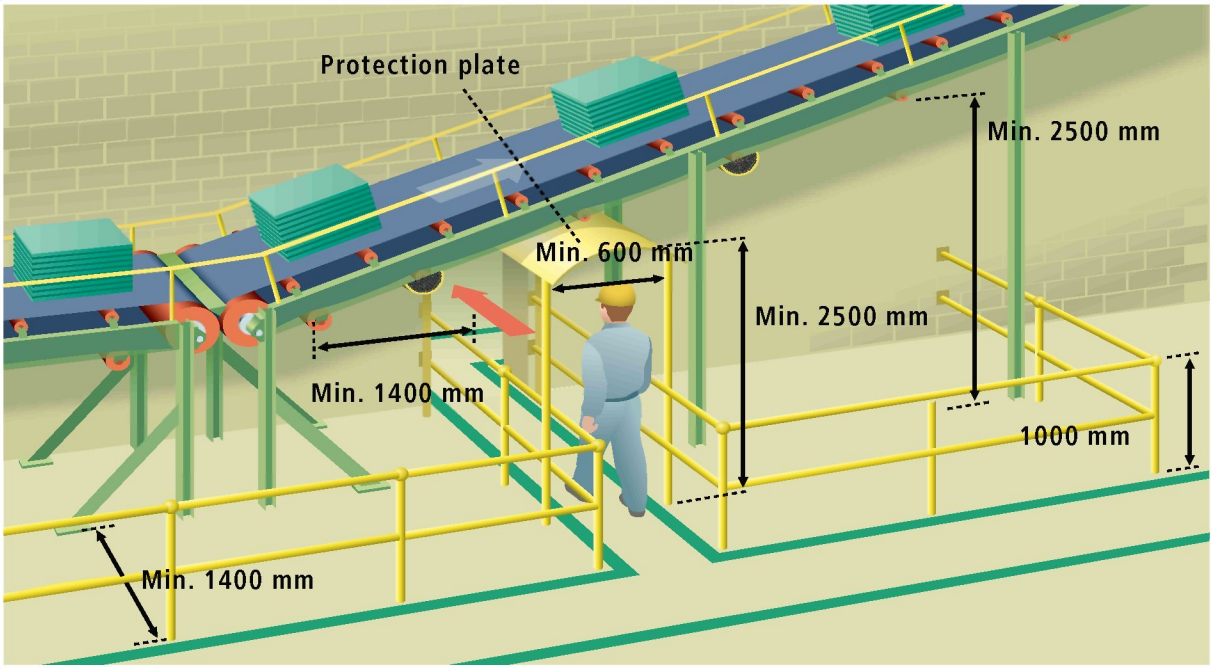
* Regulation Respecting Occupational Health and Safety specifications are 2.1 m, but international standards specify 2.5 m.

**If, after risk analysis, another solution is deemed appropriate, it may be adopted.

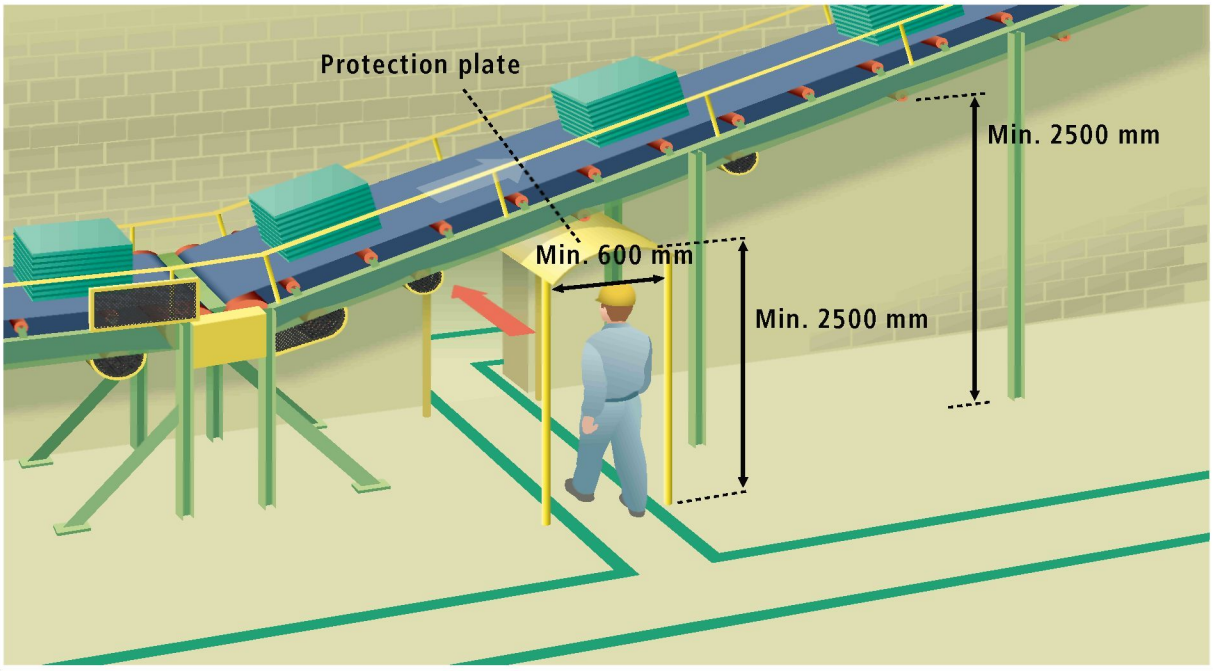
## Upper and Lower Strands in a Straight Run

**Hazards**

In-running nips between lower strand and return rollers in a straight run **(2 of 3)**




A – Protection Plate and Deterrent Device (Guardrail)




B – Protection Plate and Surrounding Fixed Guards

**FIGURE 2-24 TYPICAL PROTECTIVE DEVICES FOR THROUGHWAYS**

## Upper and Lower Strands in a Straight Run

**Hazard**
In-running nips between lower strand and return rollers in a straight run only **(3 of 3)**

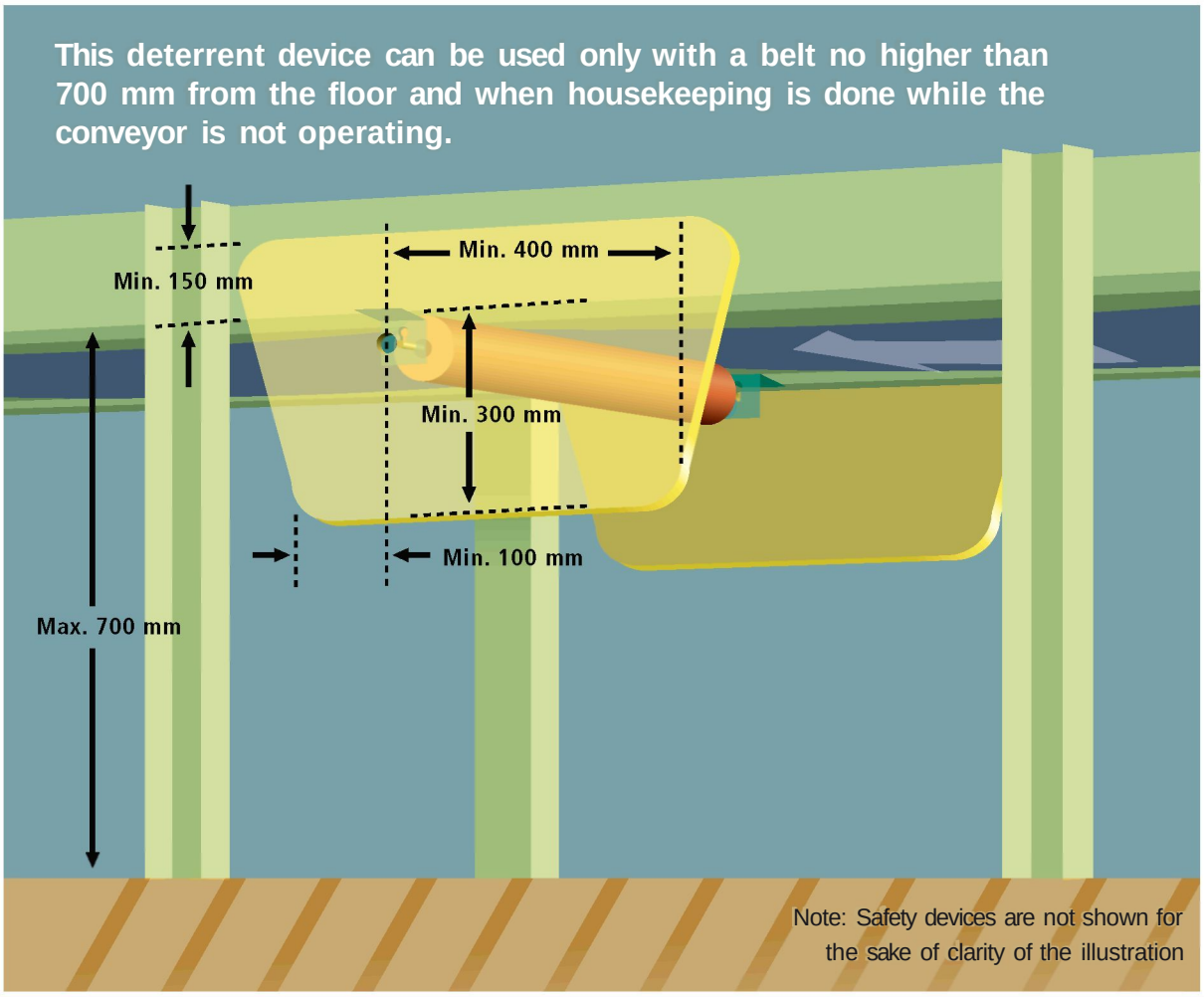



**FIGURE 2-25 DETERRENT DEVICE (SIDE PLATE) FOR RETURN ROLLERS LOCATED LESS THAN 700 MM FROM THE FLOOR**
**(NOTE THE RESTRICTIONS ON USE)**

## Upper and Lower Strands in a Straight Run

**Hazard**
Return rollers

**Possible Consequences**
Impact with rollers
Crushed by falling rollers

**Protective Measures**
*(Throughway under conveyor more than 2.5 m)*

Retaining device for return rollers, (figure 2-26) according to risk analysis results. It is possible to reduce the risk with a preventative maintenance program, which should be taken into account when doing the risk analysis.

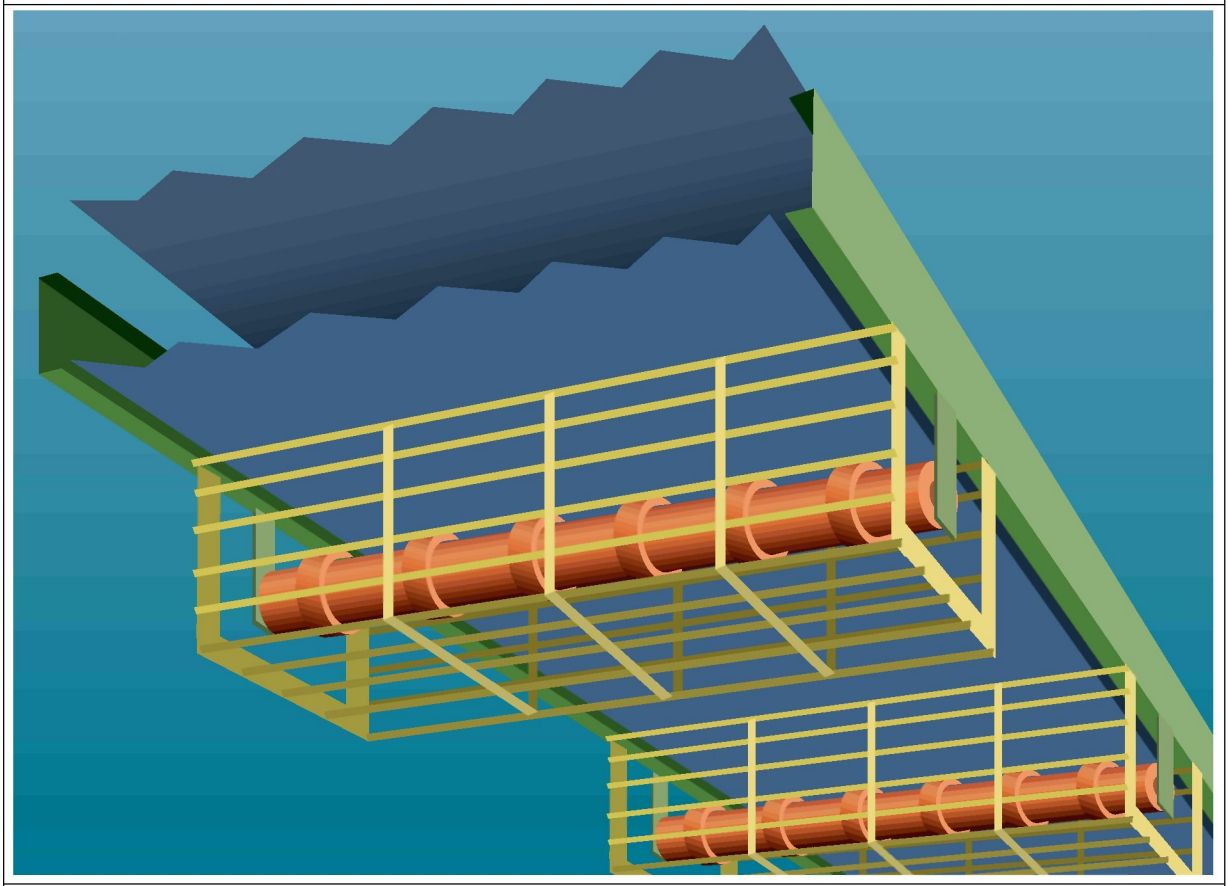


**FIGURE 2-26 RETURN ROLLER RETAINING DEVICE**

## Upper and Lower Strands in a Straight Run

**Hazard**
Bottom strand scrapers

**Possible Consequences**
Trapping and crushing
Abrasions from the belt

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

In accordance with risk analysis results the scraper protection device may be combined with the drum protection device (figure 2-27)

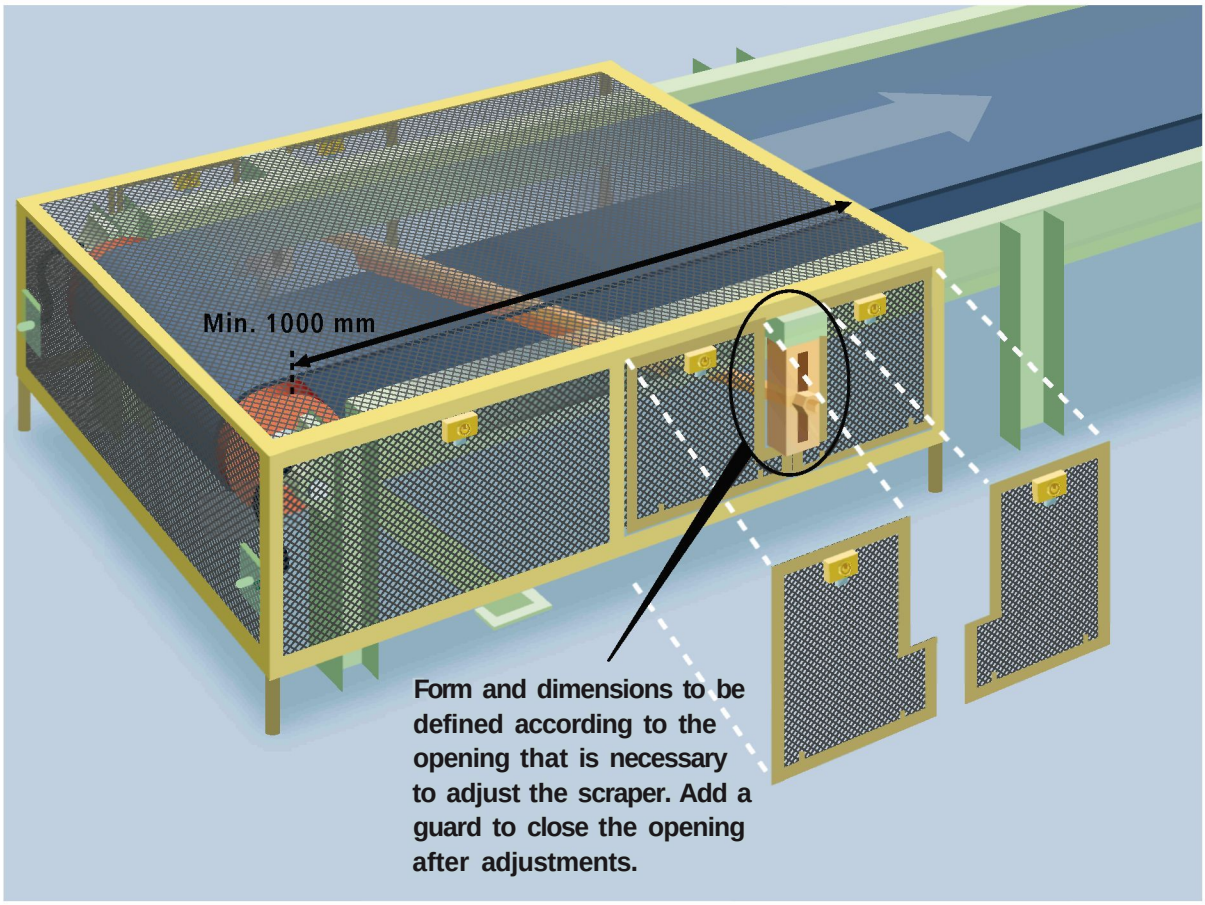



**FIGURE 2-27 SURROUNDING BARRIER GUARD FOR DRUM AND SCRAPER (PARTIAL CAGE)**

## 2.6.4 Curved Zone

**Hazards**
In-running nip between the belt and rollers in the curved zone

**Possible Consequences**
Drawing-in

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*
Surrounding in-running nip or separation barrier guard (figures 2-28 and 2-29)

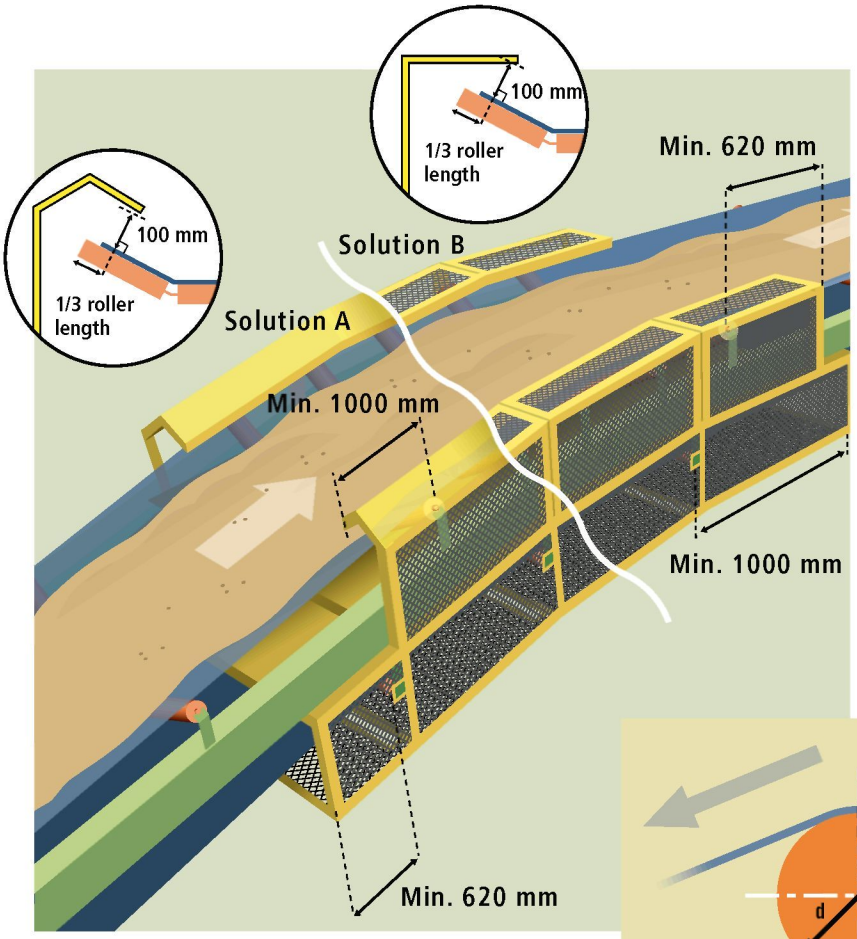



FIGURE 2-28 SURROUNDING FIXED GUARDS FOR CURVED ZONE

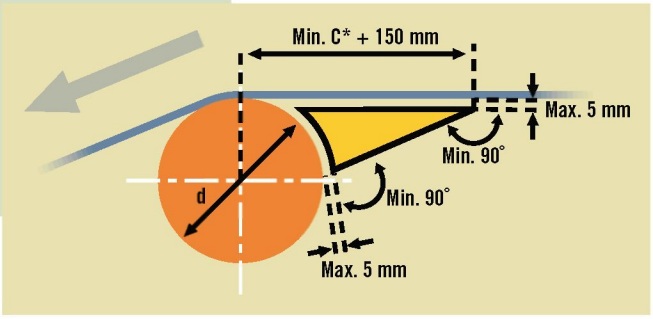



FIGURE 2-29 CURVED ZONE IN-RUNNING NIP GUARD
*SEE TABLE 2-3 FOR C DIMENSION

**Note:** Belt edge tension is greater in the curved zones.

## 2.6.5 Transition Zone

**Hazard**
In-running nips between the upper strand and the load carrying rollers in the transition zone

**Possible Consequences**
Drawing-in

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*
Surrounding or in-running nip (figure 2-30)

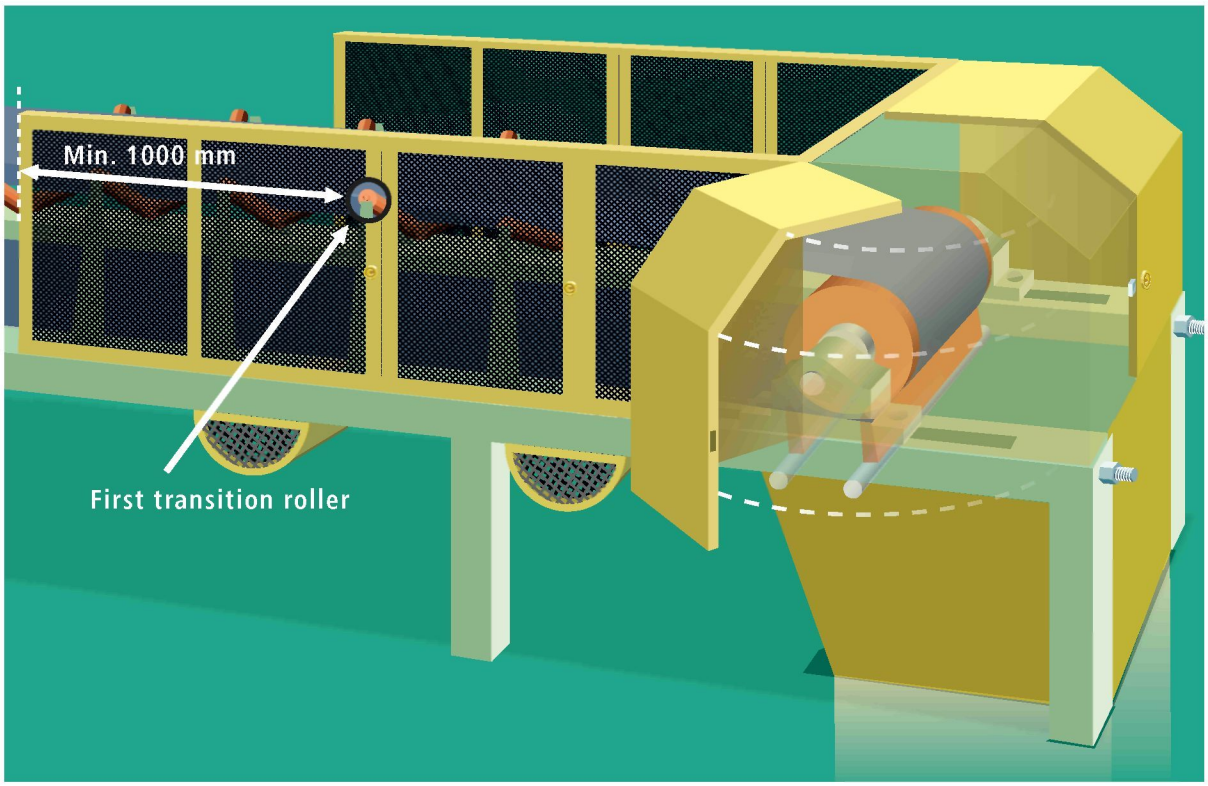


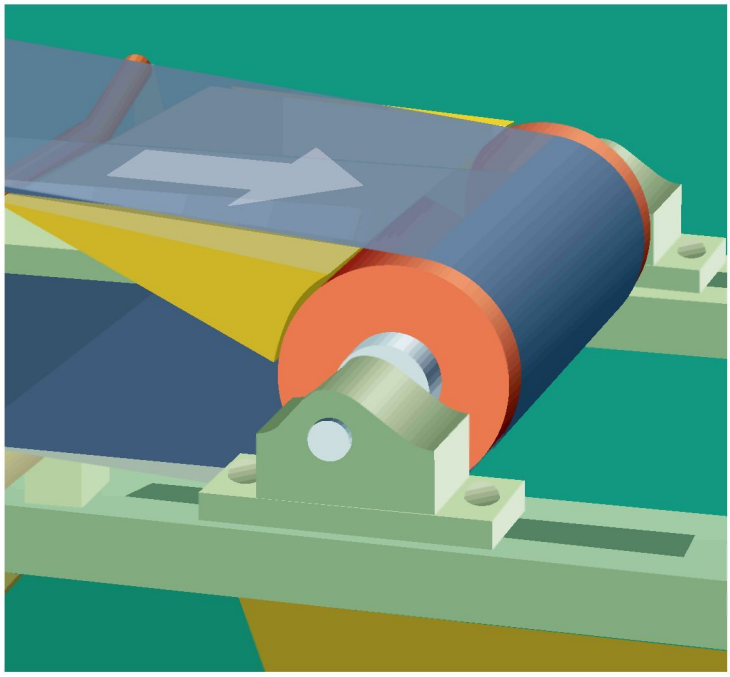

**FIGURE 2-30 PROTECTORS FOR HEAD DRUM AND TRANSITION ZONE**
**(TO DETERMINE LATERAL SCREEN HEIGHT, SEE TABLE 2-2)**

## 2.6.6 Drums

**Hazards**
In-running nips between belt and drums **(1 of 2)**

**Possible Consequences**
Drawing-in

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*
Surrounding in-running nip or barrier guards (figures 2-30 to 2-33)



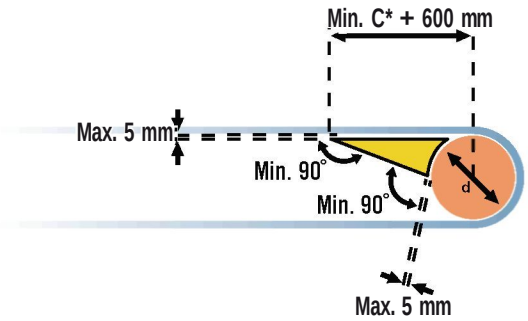



**FIGURE 2-31 IN-RUNNING NIP GUARD FOR DRUM**
***SEE TABLE 2-3 FOR C DIMENSIONS**

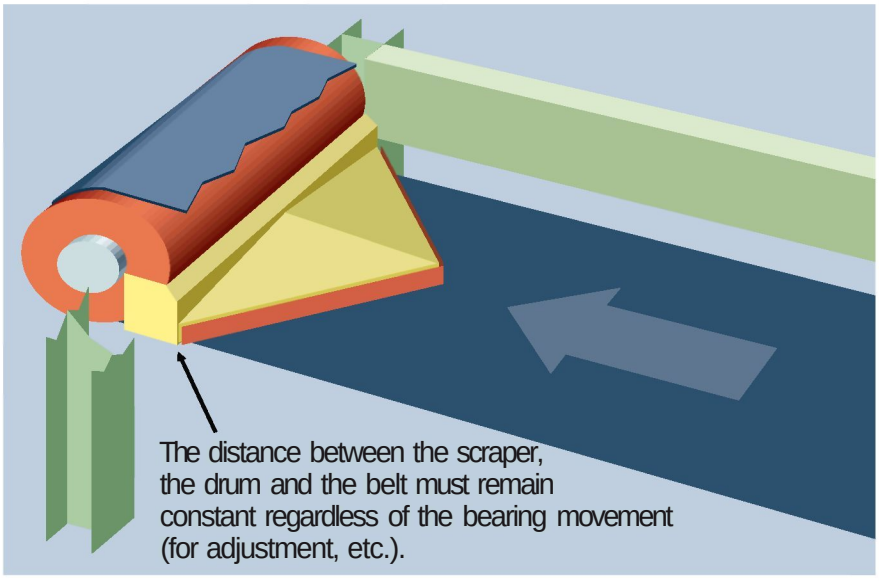



**FIGURE 2-32 SCRAPER SERVING AS AN IN-RUNNING NIP GUARD**

## Drums

**Hazard**
In-running nips between belt and drums **(2 of 2)**

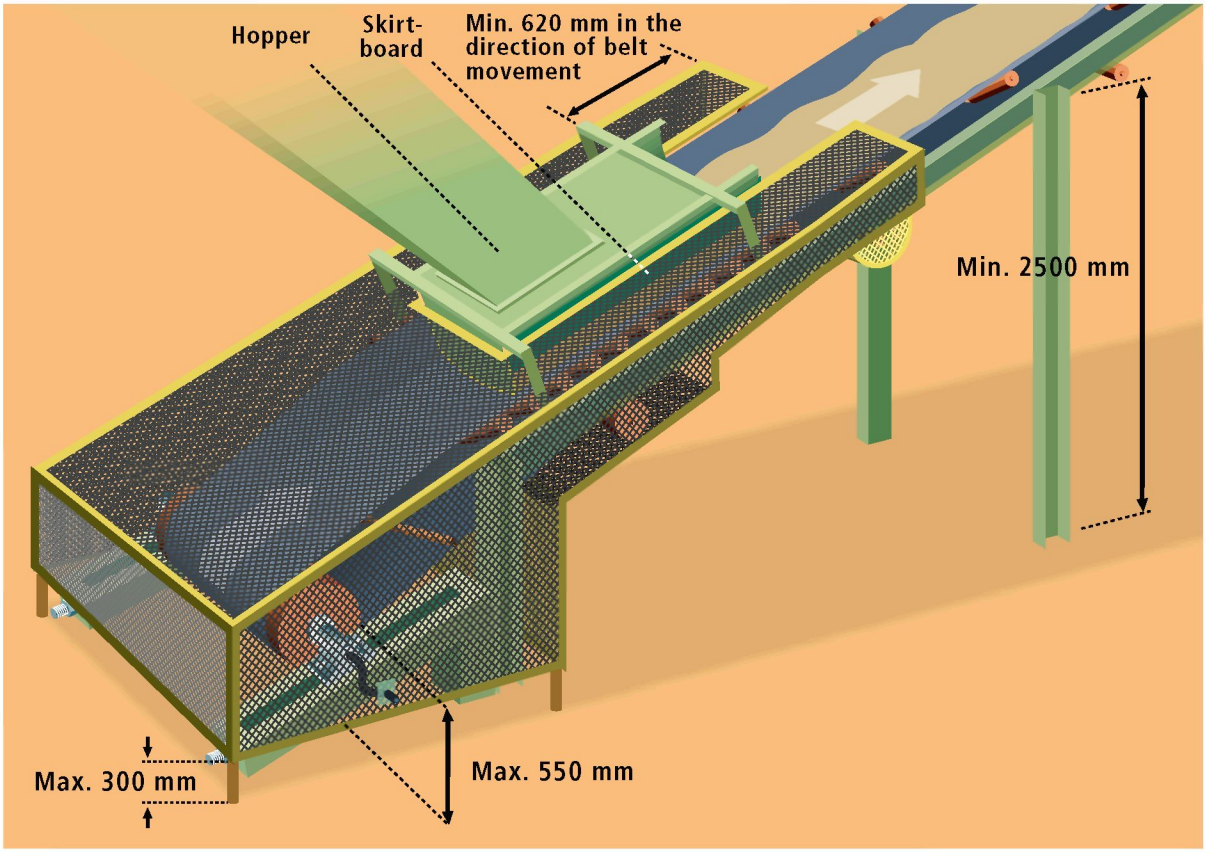



**FIGURE 2-33 SURROUNDING FIXED GUARD FOR TAIL DRUM**

**Note:** If it's not possible to comply with the 550 mm minimum distance between the in-running nip and the bottom edge of the surrounding fixed guard, the opening for housekeeping should be in accordance with table 2-1.

## Drums

**Hazard**
Take-up system

**Possible Consequences**
Crushed by falling weights
Drawn in at pinch points

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

Surrounding or barrier guards (figures 2-33 and 2-34)

**If the weight is always more than 2.5 m from the floor or working platform**

Deterrent device (guardrail) to prevent access under the weight

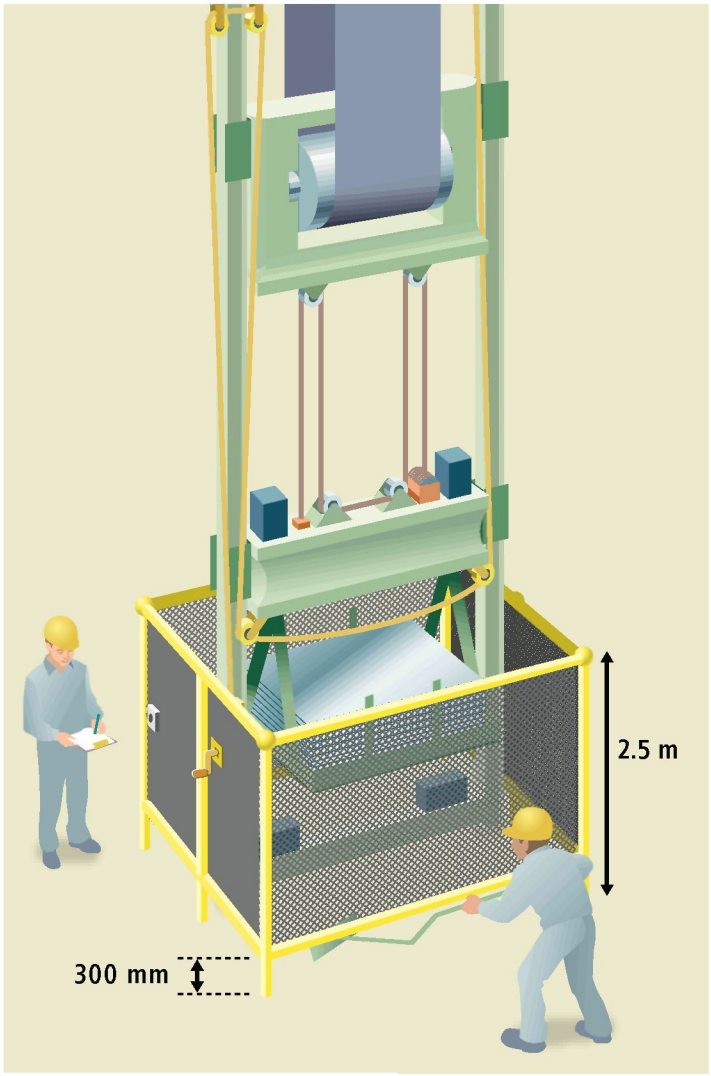



**FIGURE 2-34 BARRIER GUARD FOR GRAVITY-TYPE TENSIONER**

**Note:** For gravity-type tensioning devices, the height of the barrier preventing access under the counterweight must be 2,500 mm.
Tensioner drums (head or tail) must also be protected.

## Drums

**Hazard**
Junction between two conveyors

**Possible Consequences**
Drawing-in and trapping, if the gap is greater than 5 mm

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*
Fixed guard (plate) or free-wheeling pop-up roller (figures 2-35 and 2-36)

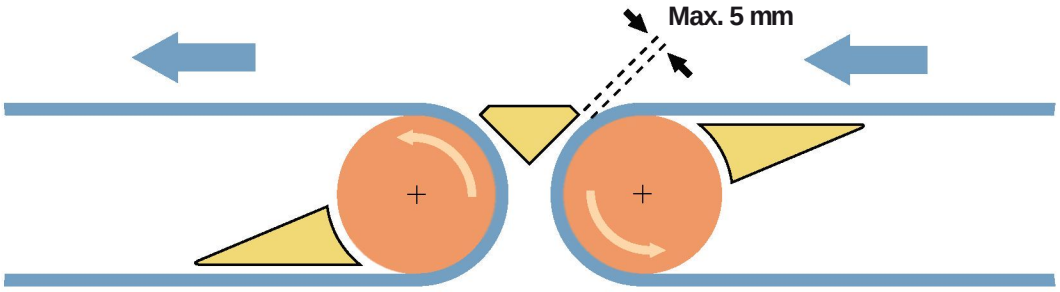



FIGURE 2-35 FIXED GUARD AT CONVEYOR BELT JUNCTION

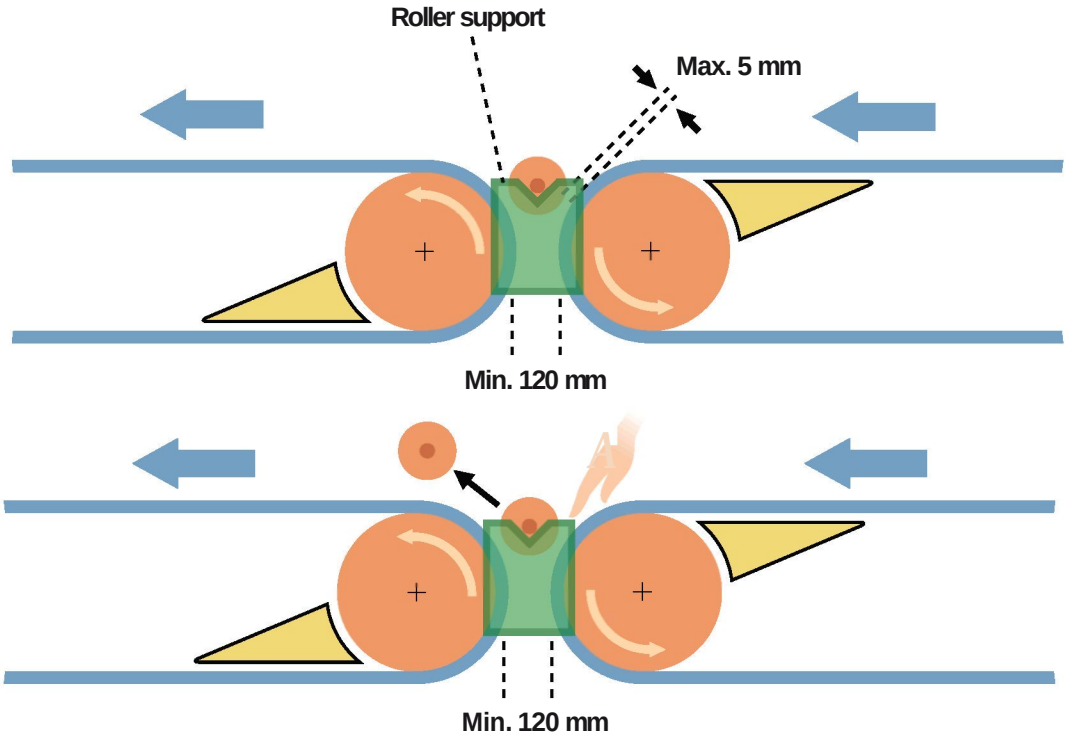



FIGURE 2-36 POP-UP ROLLER AT CONVEYOR BELT JUNCTION

## 2.6.7 Moving Loads

**Hazard**
Skirtboards
Individual moving loads

**Possible Consequences**
Trapped between belt and skirtboard or between the load and the skirtboard

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

**Workstation**
Limit the gap between the skirtboard and belt to a maximum of 5 mm
Remove the skirtboard
Design a surrounding fixed guard if need determined in risk analysis

**Other Areas**
Risk analysis

**Note:** When doing the risk analysis, take into account the possibility of falling loads with the removal of the skirtboard.

## Moving Loads

**Hazard**
Individual loads and fixed obstacles not part of the conveyor, e.g., post, wall, tunnel entrance, enclave, associated fixed equipment (detectors), etc., large bulk sized loads (e.g., boulders)

**Possible Consequences**
Crushed between loads and fixed objects
Shearing
Impact with loads or other objects

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

Fixed guard or deterrent device (figure 2-37) in accordance with risk analysis results, in respecting the safe distances between loads and obstacles (following are minimum distances for different situations):

If the entire body can be drawn in: 500 mm, minimum
If arms can be drawn in: 120 mm, minimum
If legs can be drawn in: 180 mm, minimum

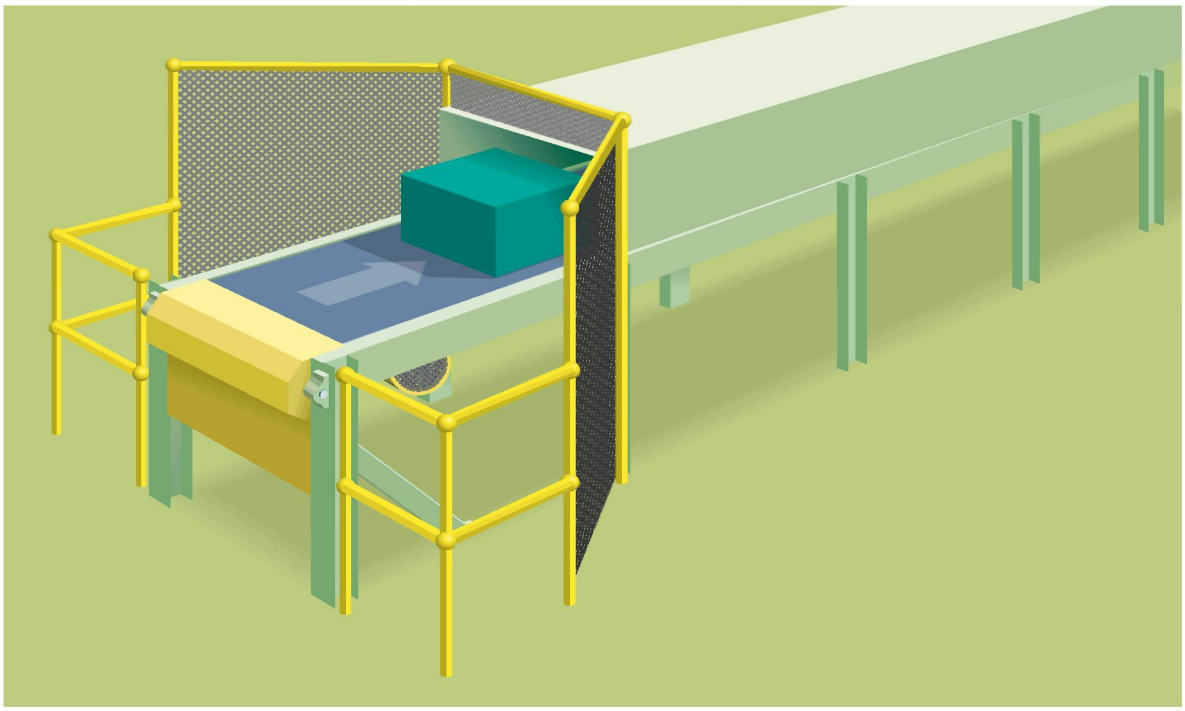


**FIGURE 2-37 TYPICAL PROTECTIVE MEASURES AGAINST HAZARDS ASSOCIATED WITH INDIVIDUAL LOADS AND FIXED OBSTACLES**

**Note:** The objective is to keep the body, arms and legs away from the crushing area.

The type of guard and its dimensions will depend upon body part at risk of being trapped and the weight of the load, as determined in the risk analysis.

The guard must not in itself create a drawing-in or trapping area.

## Moving Loads

**Hazard**
Load and load carrying rollers exceeding belt width

**Possible Consequences**
Trapping
Crushing

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

**Workstation**
Fixed barrier guard (separation type or plates between rollers) (figure 2-38)

**Other Areas**
Fixed barrier guard (separation type or plates between rollers) or deterrent device

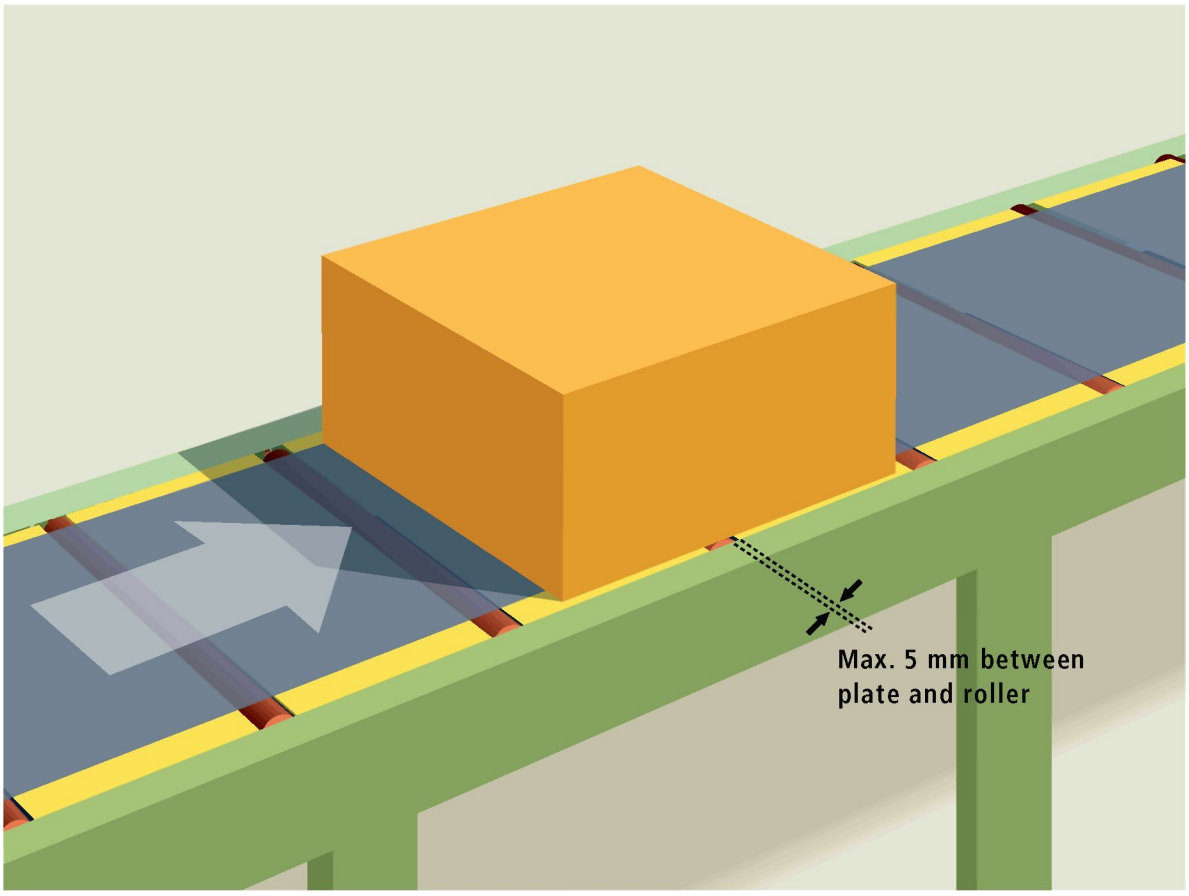



**FIGURE 2-38 TYPICAL GUARD FOR INDIVIDUAL LOADS AND ROLLERS EXCEEDING BELT WIDTH**

## Moving Loads

**Hazard**
Loads falling from the belt

**Possible Consequences**
Impact with moving loads
Crushed by falling loads

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

Protection plate, mesh, netting, or guiding rail to maintain individual loads on the conveyor and prevent them from falling off, in accordance with risk analysis results, (figure 2-39)

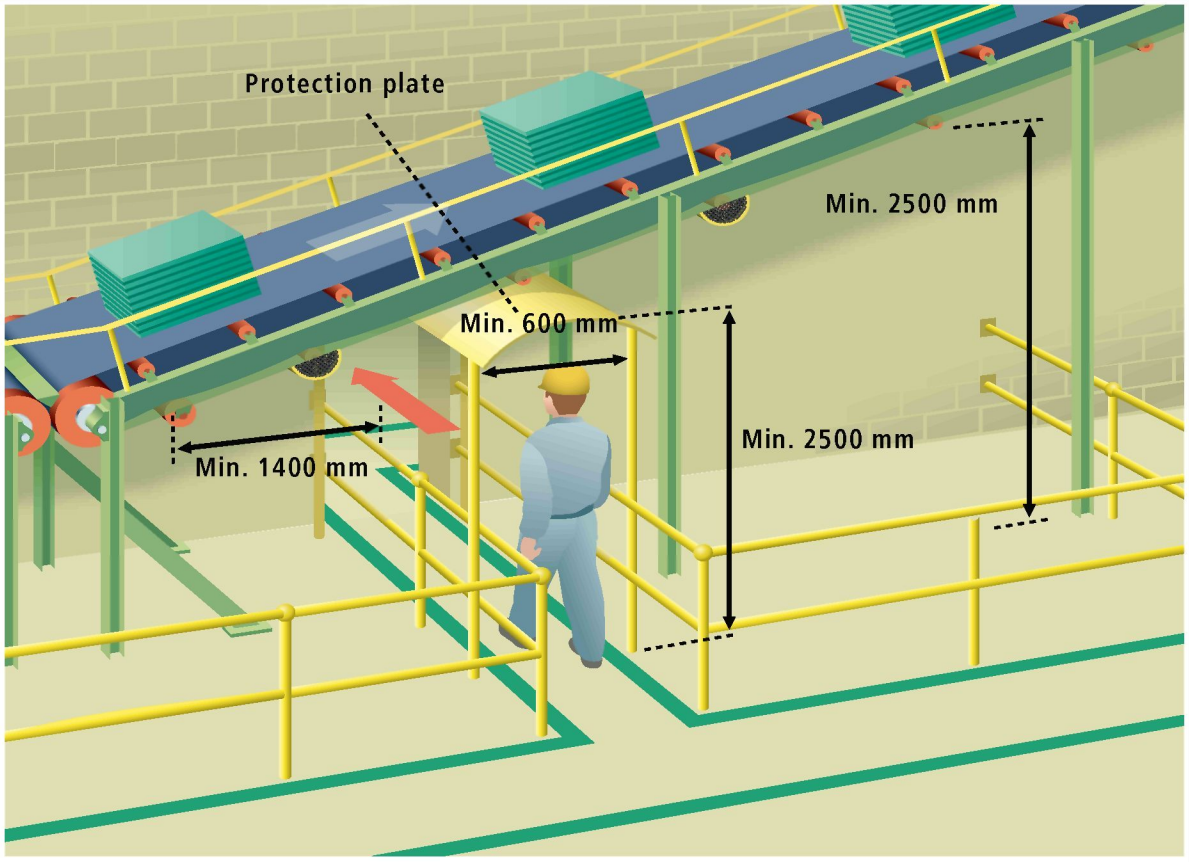



**FIGURE 2-39 TYPICAL PROTECTIVE DEVICES FOR THROUGHWAYS**

## 2.6.8 Moving Sub-Assemblies

**Hazard**
Pushers; bumpers; ejectors; sorters

**Possible Consequences**
Crushing and shearing

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*
Surrounding fixed or barrier guards (figure 2-40)

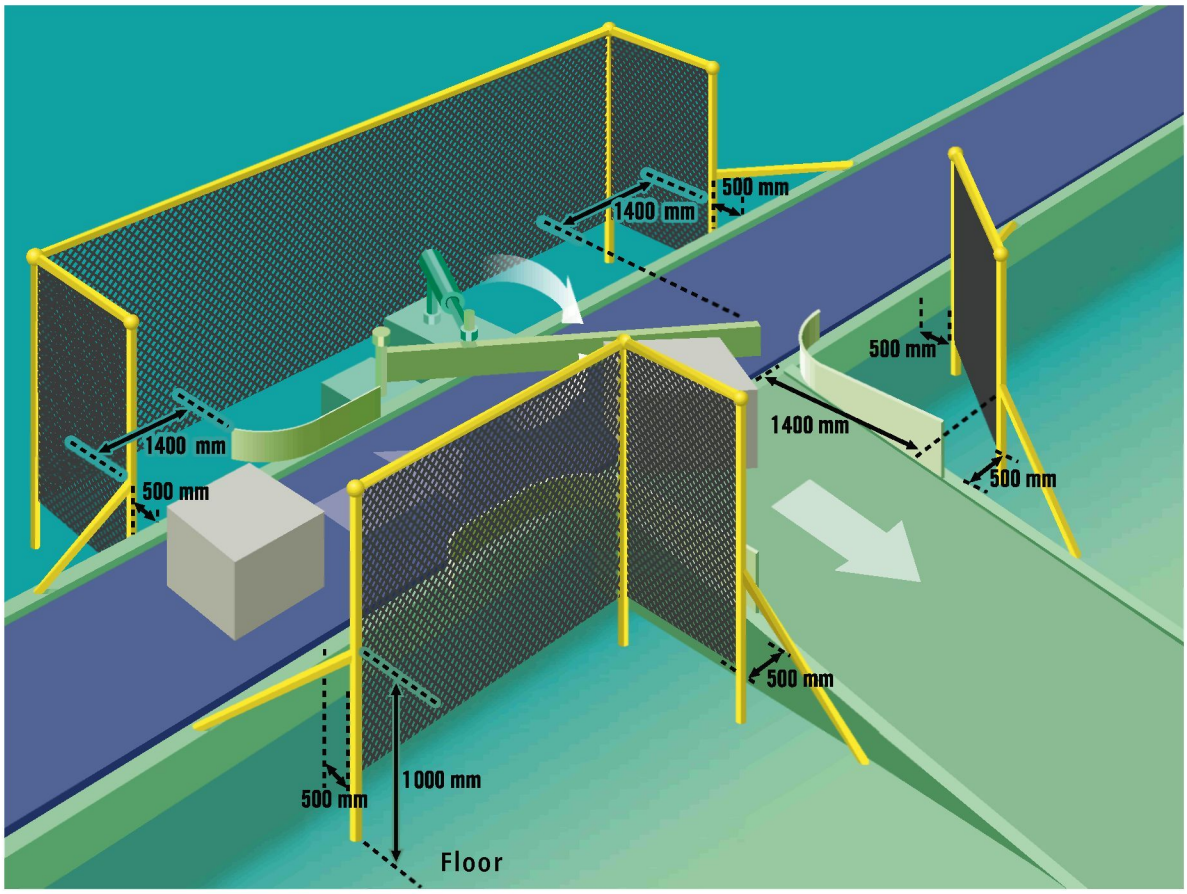



FIGURE 2-40 TYPICAL BARRIERS FOR EJECTORS

**Note:** Leave a safe distance between the load and the guard so as not to create a trapping hazard. Minimum distances are:

If the entire body can be drawn in: 500 mm, minimum
If arms can be drawn in: 120 mm, minimum
If legs can be drawn in: 180 mm, minimum

## 2.6.9 Moveable Conveyors

**Hazard**
Vertical and/or horizontal movement

**Possible Consequences**
Crushing; entanglement; trapping

**Protective Measures**
*(If hazard is less than 2.5 m from the floor or working platform)*

In accordance with risk analysis results: barrier guard, deterrent device, or ground markings or signs to indicate the conveyor's operating area (figure 2-41)

It is also possible to use electronic safety devices (surface detectors, etc.)

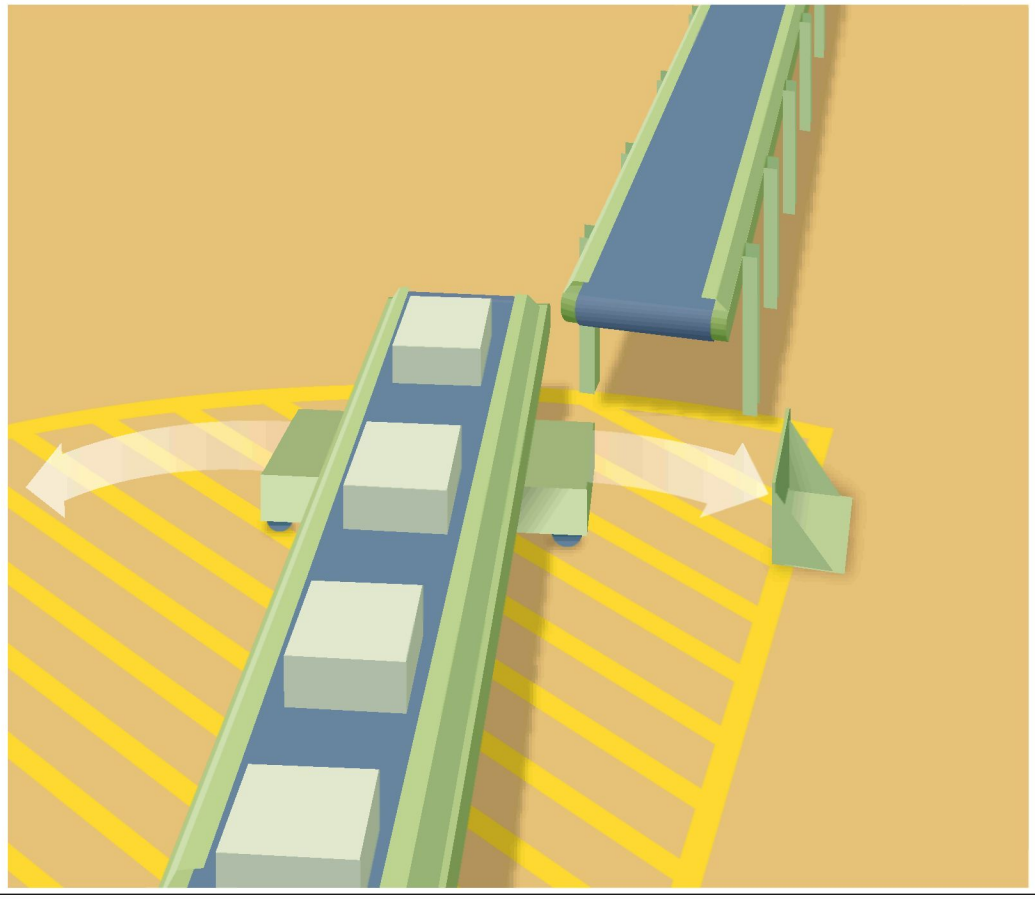


**FIGURE 2-41 MOVEABLE CONVEYOR**

**Note:** The limits of the operating area must be considered before applying protective measures.

# 3 Safeguards against Other Hazards

## 3.1 Hazards Generated by Poor Ergonomic Design

Equipment must be designed so that operators and other users need not assume constraining work postures, overexert themselves or carry out repetitive movements.

Control devices must be grouped near workstations to allow operators and other users easy access. They must be located outside danger zones so that activating them does not create hazards and workers do not have to enter the danger zones to access them. To prevent unexpected start-ups, they must be positioned and protected.[14]

Every workstation or intervention area must be provided with adequate lighting for the nature of the work being done or the nature of the work environment (section 125 of the Regulation Respecting Occupational Health and Safety).

## 3.2 Heat-Related Hazards

Where conveyed products or any part of the equipment may cause burns, take the following precautions:

- Prevent contact with conveyed loads and hot (or cold) surfaces by the use of screens, fixed surrounding or barrier guards
- Reduce the temperature of hot surfaces

## 3.3 Electrical Hazards

Conveyor electrical equipment must conform to the *Québec Electrical Code*. Such equipment includes: materials, accessories, devices, appliances, fasteners and other equipment used in the electrical power supply of a conveyor or in connection with a conveyor, these include power disconnect devices.

In mines, electrical equipment must also conform to the CAN/CSA Standard M421-93,[15] particularly those sections dealing with conveyors.

## 3.4 Fire and Explosion Hazards

The use of conveyors can in itself be a fire and explosion hazard. These hazards can be caused by the use of the conveyor itself or by the load the conveyor is carrying (for example, combustible particles). These hazards may be amplified by tunnels or the stack effect. Preventative measures to implement are described in division VIII of the Regulation Respecting Occupational Health and Safety and in section 374 of the Regulation Respecting Occupational Health and Safety in Mines.

In underground mines, fire and explosion hazards related to belts can have particularly serious consequences. Belts must conform to CAN/CSA Standard M422-M87.[16]

# 4 Safeguards against Control System Failures or Malfunctions

## 4.1 Start-Up

The start-up of equipment must require a voluntary action. Equipment start-up must be prevented in the following situations.[14]

- The closing of a guard
- The actuation of an operation mode selector
- The resetting of an emergency stop device
- The resetting of a thermal protection device

In conveyors designed to supply loads to other conveyors, start-up of the supply conveyor must be linked with the receiving conveyors, using appropriate interlocking devices. These devices must control and ensure proper sequential start-up and prevent conveyor loading when not in use or when fully loaded.[7]

For automatic or remote-control start-up conveyors, as well as conveyors for which the operator or the user cannot see the entire conveyor, a visual or audible warning device shall announce the starting of the conveyor (sections 191 of the Regulation Respecting Occupational Health and Safety and 373.6 of the Regulation Respecting Occupational Health and Safety in Mines).

To prevent unexpected start-ups, replace two-stable position (toggle) switches (start-stop) with self-powered (contacts maintained by power) or single-stable position (stable at the unenergized condition) control devices. These switches will bring the controls to an off-circuit mode (open contacts) should there be a power outage or conveyor failure.

## 4.2 Regular Stop

There must be a device or a method accessible to the operator and other users whereby equipment operations can be interrupted safely, while guaranteeing that the equipment cannot be unexpectedly restarted.

An all-stop switch is not designed to put an end to a recurring dangerous situation; this is the role of an emergency stop switch. A stop command must have priority over a start command.

## 4.3 Emergency Stop

According to section 270 of the Regulation Respecting Occupational Health and Safety, *the emergency stop device of a conveyor to which workers have access comprises several control devices located at loading and unloading piers as well as at other points along the conveyor's itinerary. In addition, these devices have the following features:*

**(1)** *they are easily visible;*

**(2)** *one single action activates them;*

**(3)** *they are clearly identified.*

An emergency stop device should also be activated by a positive action and be forced to break contact type device (symbol illustrated in figure 2-42).

**FIGURE 2-42 STANDARD SYMBOL DESIGNATING FORCED TO BREAK CONTACT DEVICES**

Emergency stop devices must be installed at a height between 0.6 m and 1.7 m from the floor and must include the following:[7]

- One or more push-button switches installed in such a manner that at least one is accessible within a 10 m distance from any equipment access point;
- One or more emergency stop pull cords along the full conveyor length (compulsory measure for mines where workers may have access to conveyors in operation [section 373.5 of the Regulation Respecting Occupational Health and Safety in Mines]);
- A conveyor power disconnect device, if the distance to the disconnect device is less than10 m from any conveyor access point.

An emergency stop device must allow equipment to shut down in the best possible manner, that is, by slowing down moving parts at an optimal rate by:

- An immediate interruption of power to the motors;
- A controlled stop — motors remain energized to bring the equipment to a progressive stop and power is interrupted once the equipment has come to a halt.

The resetting of the emergency stop device must not, by itself, cause the start-up of the machine, unless the conveyor is a slow moving type and workers can access it safely (section 270 of the Regulation Respecting Occupational Health and Safety). Moreover, start-up must be confirmed by a distinct and deliberate manual action (manual resetting).

The emergency stop command must have priority over all other commands and cannot be allowed to create dangerous situations such as load spillage. The conveyor emergency stop device must also stop any downstream or upstream conveyors if their continued operation constitutes a safety hazard for workers (section 193 of the Regulation Respecting Occupational Health and Safety). An emergency stop device must not be used to bring the conveyor to an all-stop state. The emergency stop must not be used as a regular stop.

Remember that the installation of an emergency stop device does not replace appropriate protective devices. As well, emergency stop devices must not replace equipment lockout procedures during maintenance requiring access to danger zones.

For more information on the operation of emergency stop devices, consult ISO Standard 13850[17] and NF EN 60947-5-5.[18]

## 4.4 Emergency Stop Pull Cords

According to section 373.5 of the Regulation Respecting Occupational Health and Safety in Mines, all conveyors must *be equipped, where the workers may access a conveyor while it is in operation, with an emergency shut-down device along its full length between the head pulley and the return pulley* (tail pulley)*; (…).* Therefore, for all mines, the emergency shut-down device must take the form of a cable spanning the full length of the conveyor.

In other workplaces, an emergency stop cable may not be necessary where another shut-down device has been installed in accordance with section 270 of the Regulation Respecting Occupational Health and Safety.

A sheathed metal strand cable shut-down device must function as an emergency stop switch whatever direction the cable is pulled in or when it is broken. A spring failure must also create an emergency stop.

A horizontal force of less than 125 N must be all that is needed to activate an emergency stop cable, when applied midway between two support rings and perpendicularly to the cable. The lateral movement of the cable (between the position while at rest and the activation point) must not exceed 300 mm.[7]

The cable must be able to resist a tension force 10 times greater than the tension required to activate the emergency shut-down switch, when applied perpendicularly to the cable.[18]

The cable must move freely within its supports, particularly at bends. Cables must not be twisted nor suffer the risk of being twisted during use.

If the belt width is equal to or less than 800 mm, a single central cable may be used above the belt.[19]

Maximum cable length and other characteristics must conform to the supplier's recommendations (for support rings and pulley protection, freeze-up prevention, variations in length due to temperature changes, etc.).

Sensitive cable devices may be used where activation of the switch is done by pressure, compression, torsion or tension applied to the cable. This method is best suited to complex cable runs and to dusty or heavy vibration environments.

# 5 Safeguards against Maintenance Hazards

*Sécurité des convoyeurs à courroie : guide du concepteur* (*A Designer's Guide to Conveyor Belt Safety)* provides additional information on this subject. It discusses the incidence of the design factor on conveyor safety, explains conveyor failure and diagnostics, and suggests solutions for use during the problem-solving process. A fault tree helps establish the relationship between failures and accidents.

## 5.1 General Principles

Equipment must be designed in such a way that maintenance (adjustments, greasing, cleaning, unjamming, unclogging, etc.) can be accomplished away from danger zones. Therefore, all adjustment and grease points must be accessible without having to remove guards or other protective devices.

When it is necessary to open or remove guards, or even to neutralize protective devices in order to carry out a maintenance procedure, safeguards must be implemented to ensure worker safety in the areas transformed into danger zones. These measures must conform to sections 185 and 186 of the Regulations Respecting Occupational Health and Safety.

According to section 185 of the Regulation Respecting Occupational Health and Safety: *Subject to the provisions of section 186, before undertaking any maintenance, repair or unjamming work in a machine's danger zone, the following safety precautions shall be taken:*

**(1)** *turn the machine's power supply switch to the off position;*

**(2)** *bring the machine to a complete stop;*

**(3)** *each person exposed to danger locks off all the machine's sources of energy in order to avoid any accidental start-up of the machine for the duration of the work.*

## 5.2 Lockout Procedures

The goal of lockout procedures is to allow workers to carry out their tasks (maintenance, repairs, cleaning, etc.) on a conveyor and its accessories (bumpers, ejectors, etc.) without risk.

Lockout procedures* involve the following basics:

- Bringing the machine to a complete stop.
- Disconnecting all the machine's sources of power: electric, pneumatic, hydraulic, mechanical and thermal.
- Dissipating all accumulated energy (purging reservoirs, removing counterweights, unloading springs, etc.) and checking for absence of energy.
- Padlocking of energy disconnect devices by each worker accessing the work area.
- Double-checking to ensure that the equipment is in fact disconnected (e.g., running a start-up test).

*Consult document DD 754,[20] ANSI Standard Z244.1[21] or the CSA Standard Z460.

## 5.3 Safeguards for Maintenance within Operating Danger Zones

Section 186 of the Regulation Respecting Occupational Health and Safety stipulates: *When a worker must access a machine's danger zone for adjustment, unjamming, maintenance, apprenticeship or repair purposes, including for detecting abnormal operations, and to do so, he must move or remove a protector or neutralize a protective device, the machine shall only be restarted by means of a manual control or in compliance with a safety procedure specifically provided for allowing such access. This manual control or this procedure shall have the following characteristics:*

**(1)** *it causes any other control mode or any other procedure, as the case may be, to become inoperative;*

**(2)** *it only allows the operating of the dangerous parts of the machine by a control device requiring continuous action or a two-hand control device;*

**(3)** *it only allows the operation of these dangerous parts under enhanced security conditions, for instance, at low speed, under reduced tension, step-by-step or by separate steps.**

For these measures to produce the desired results and given the serious hazards associated with conveyors, they should incorporate the following recommendations:

- Operation control devices, including two-hand controls, should require hold-to-run input
- The operation control device used by the worker should have priority over all other control devices on the machine
- When maintenance is carried out by more than one worker, while some hazards may be reduced; those related to machine operation controls may increase – establish a clear communication procedure to ensure clear communication between workers
- Prohibit the use of remote wireless operation controls
- Control cables should be long enough to allow visual contact with the danger zone, all the while making access to the danger zone impossible

## 5.4 Summary of Maintenance Safeguards

Table 2-4 lists the safeguards required when carrying out most maintenance activities on conveyor belts or in proximity to conveyor belts. They should be addressed in maintenance procedures.

* The inching forward of an operation control should allow limited advance in separate steps; no further advancement of machinery should be allowed until the operator releases the control device and then actuates the controls anew.

## Table 2-4 Safeguards for Maintenance Activities

| Activity | Safeguards |
|---|---|
| **Repairs**<br>**Changing mechanical, electrical, hydraulic or pneumatic parts on conveyors or related accessories** | Lockout conveyor or related accessory. |
| **Belt replacement and splicing** | Lockout and application of a written safety procedure. See *Sécurité des convoyeurs à courroie : guide du concepteur (A Designer's Guide to Conveyor Belt Safety)* section 4.1.1 for required tools and facilities. |
| **Welding and cutting*** | Lockout if conveyor is located under the welding area.<br>Lockout if the closed unprotected danger zone is less than 2,500 mm from the work area. |
| **Adjustment and fit** | Authorized at all times provided adjustment points (for example: scraper, drum and take-up system adjustment) are outside the danger zone.<br>Lockout if adjustment points are inside the danger zone.<br>Application of stipulations in section 5.3 (drum and scraper restrictions). |
| **Greasing and oiling (lubrication)** | Authorized at all times where grease points are outside the danger zone.<br>Lockout if grease points are inside the danger zone. |
| **Housekeeping under and around conveyor; disposal of material recovered on the belt** | Authorized at all times as long as the danger zone remains protected by a guard. Particular attention should be paid to the space under an inclined belt located less than 2.5 m from the floor (belt risk analysis).<br>**Reminder:** A 300 mm high opening measured from the floor will help in housekeeping.<br>Lockout if the danger zone is not protected with a guard.<br>Apply measures in section 5.3 should the conveyor need to be operational.<br>**Note:** Should the removal of material accumulation from an operating conveyor become frequent, consider installing an operator work station. |
| **Conveyor parts cleaning or maintenance (drums, rollers, chassis, etc.)** | Lockout procedures apply.<br>Operation authorized if housekeeping can be done:<br>> With an automated jet (air or water); or<br>> According to section 5.3 above. |

*See also paragraph 3.4, Fire and Explosion Hazards.

| | |
|---|---|
| **Inspection** | Visual and auditory inspection: Permissible at all times as long as the worker remains outside the danger zone.<br>If the conveyor remains operational while the worker enters to make contact with a machine part (for example, to measure vibrations), the point where the measurements are taken must be protected by a guard.<br>If a conveyor must remain operational while a guard is removed, apply measures in section 5.3.<br>Lockout for all other cases (for example, mechanical free play measurements). |
| **Unclogging, unjamming*** | Lockout procedures apply.<br>Apply measures in section 5.3 should the conveyor need to be operational. |
| **Maintenance activities not covered above** | Lockout procedures apply at all times. |

* Unclogging may create new specific hazards, which must be analyzed before starting work (hazard of falling in the hopper, etc.).

# 6 Operator and Maintenance Crew Training

All operators and maintenance workers, who work on or in proximity to conveyors, must be informed of the hazards they may encounter, and receive training in established preventative measures and work procedures. All safety-related procedures and instructions must be documented.

## 6.1 Operator Training

Only trained and authorized persons must be allowed to start up, operate and interrupt the normal operation of a conveyor. Among other things, instruct operators in the following:

- Conveyor start-up
- Normal shut-down and emergency stop devices
- Required checks before starting up a conveyor after an emergency shut-down or accidental stoppage
- Proper loading procedures to avoid conveyor overload

## 6.2 Maintenance Crew Training

Assign only knowledgeable and trained workers possessing the necessary technical expertise to maintain conveyors. Assigned workers must be informed of the conditions under which the various maintenance tasks are to be completed. Among other training, they must be trained in lockout procedures.

When the removal of a guard or deterrent device is scheduled, the assigned maintenance crew must receive detailed instructions related to their tasks, including procedures for installing or repositioning guards or deterrent devices. Supervisors and workers must check that guards and deterrent devices are back in place when maintenance tasks are completed.

# **Appendix A:** Guard Design

This appendix deals only with the design and ergonomics of guards. For information on types of guards and deterrent devices, application, dimensions and selection, see sections 1 and 2 of Section 2 of this guide. For detailed information on the construction of guards and selection of material, consult EN Standard 953.[11]

Guard construction and design must take into account all aspects of foreseeable use. Guards must not be the source of new hazards.

It is important to consider ergonomic issues when designing guards. Correct application of ergonomic principles can enhance safety and reduce physical effort. Moveable guards should be designed so that the dimensions and weight of their parts allow for easy handling. To this end, articulated or hinged guards are preferred (figure A-1).

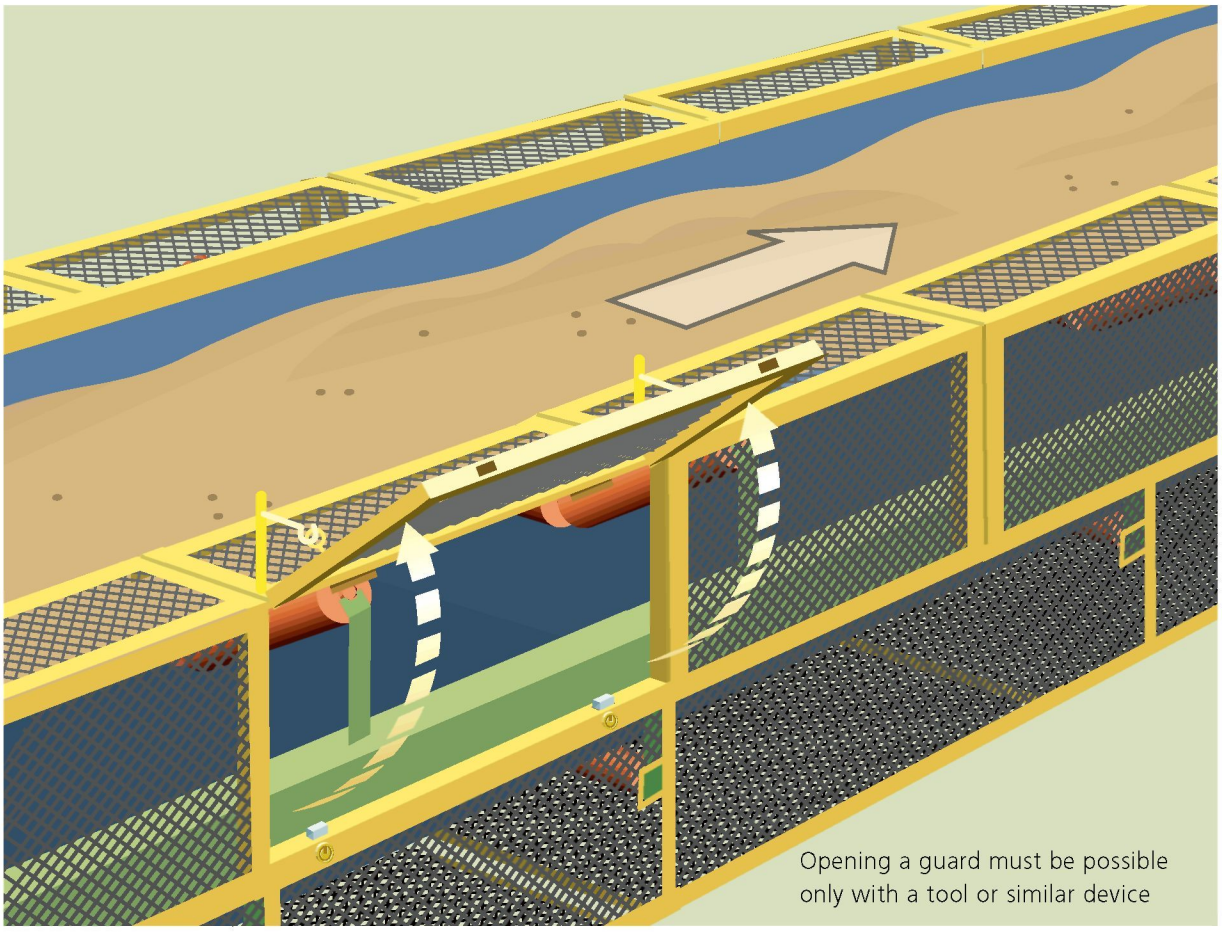



**FIGURE A-1 TYPICAL HINGED FIXED GUARD**

Guard removal and reinstallation must be quick and easy, for example, quarter-turn keyed latches (figure A-2). Ideally, guards should be self-locking when closed.

In order to reduce as much as possible the number of times guards need to be opened, guard construction should be such that the protected components can be easily seen. Therefore, it is suggested that the screen of the guard be painted in a dark colour (flat black, charcoal grey), with the frame in a light colour. By painting hazardous machine components in bright, contrasting colours, attention is drawn to the danger zone when a guard is opened or removed.

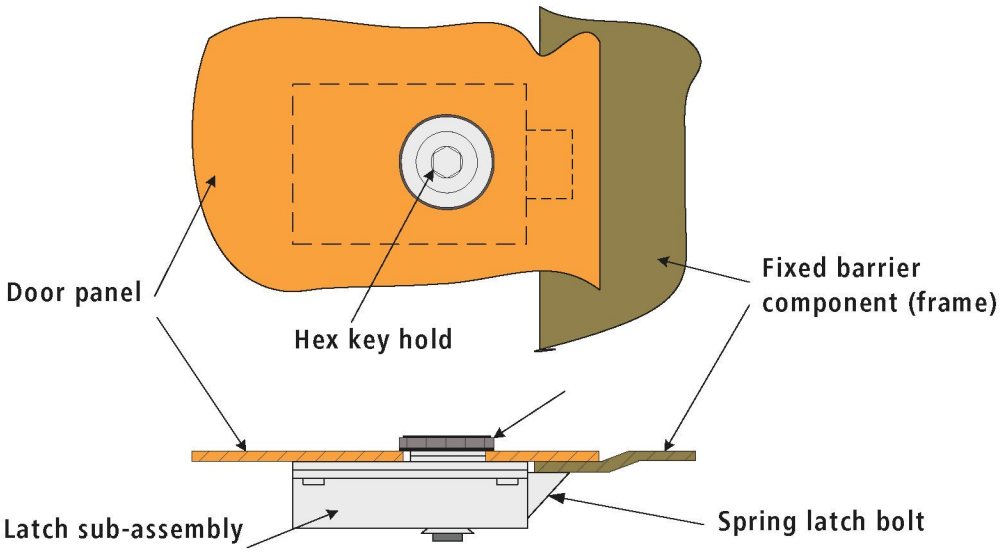



**FIGURE A-2 TYPICAL QUARTER-TURN KEYED SPRING LATCH**

Fasteners should remain permanently connected to the guards (“captive fasteners”). This precaution prevents the loss of fasteners and the need to replace them (figure A-3).

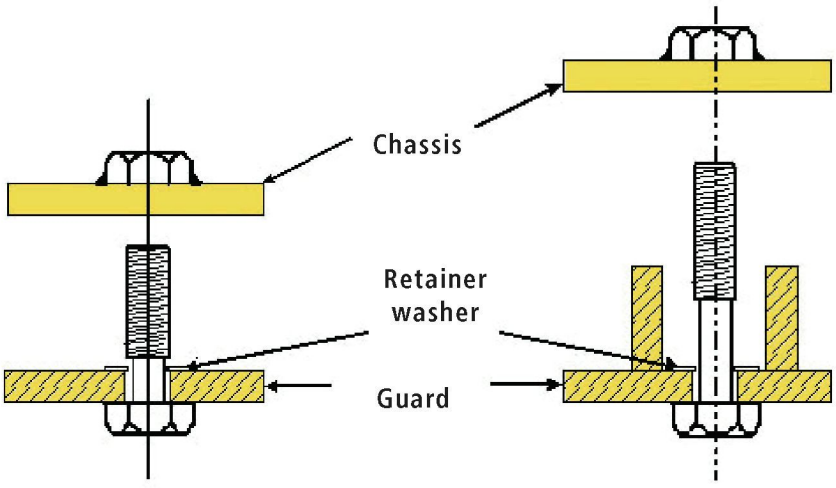



**FIGURE A-3 CAPTIVE FASTENERS**

# Appendix B How to Use Table 2-2 (Required distances for separation barrier guards)

## Example 1 Calculating Protector Height (“b”)

### Initial Data

Danger zone height (“a”) is 1,500 mm and the horizontal distance (“c”) from the guard to be installed is 700 mm.

### Rationale

Always select a barrier ensuring the greatest level of security.

Since the danger height (“a”) 1,500 mm is not listed in table 2-2, the values for the nearest upper height (1,600 mm) and the nearest lower height (1,400 mm) must be used in the calculation.

Next, for each of these heights, locate the corresponding horizontal distance (700 mm) in column “c” of the table to find the appropriate protector height (“b”).

- When the danger zone height (“a”) is 1,400 mm and the horizontal distance (“c”) is between 100 mm and 800 mm, the protector height (“b”) must be at least 1,800 mm.
- When the danger zone height (“a”) is 1,600 mm and the horizontal distance (“c”) is between 100 mm and 800 mm, the protector height (“b”) must be at least 1,800 mm.

Finally, the selected protector must ensure the highest level of safety. In this example, both possibilities yield the same minimum height (“b”) of 1,800 mm.

### Conclusion

The minimum height of the barrier guard must be 1,800 mm when the danger zone height is 1,500 mm and the horizontal distance is 700 mm (figure B-1).

**Excerpt from Table 2-2 - Example 1**

| Danger Zone Height a (mm) | Protective Structure Height *“b”* (mm) | | | |
|---|---|---|---|---|
| | 1400 | 1600 | 1800 | 2000 |
| | Horizontal Distance from Danger Zone “c” | | | |
| 2400 | 100 | 100 | 100 | 100 |
| 2200 | 500 | 500 | 400 | 350 |
| 2000 | 700 | 600 | 500 | 350 |
| 1800 | 900 | 900 | 600 | |
| 1600 | 900 | 900 | 500 | |
| 1400 | 900 | 800 | 100 | |
| 1200 | 900 | 500 | | |

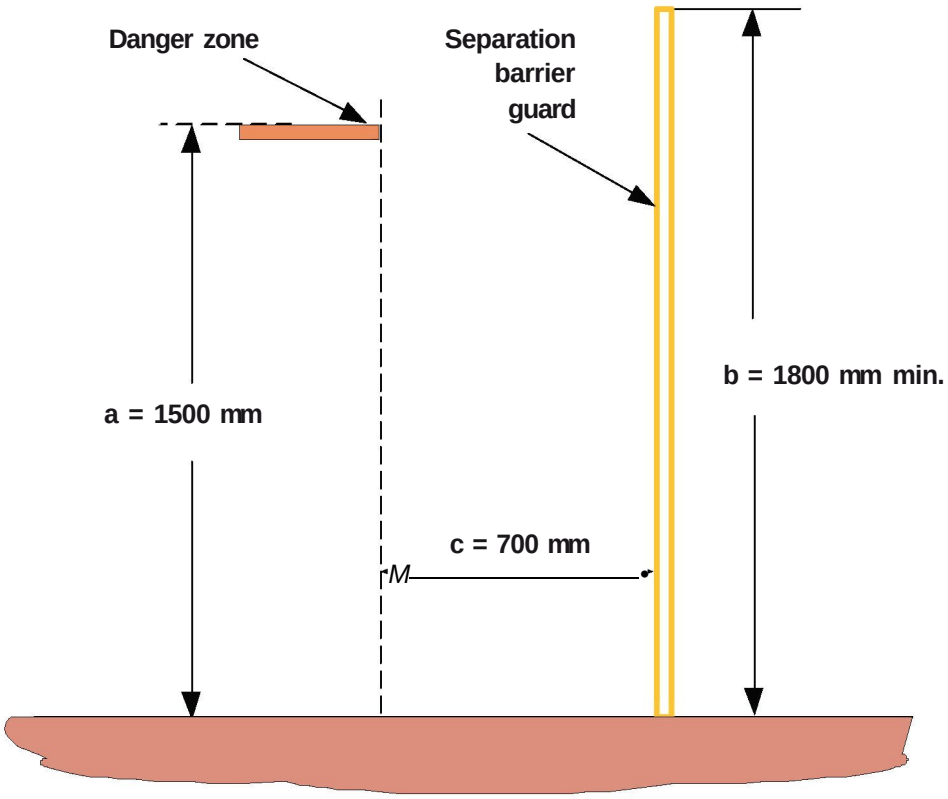



**FIGURE B-1 SEPARATION BARRIER GUARD - EXAMPLE 1**

If the horizontal distance ("c") between the danger zone and the planned guard is increased to more than 900 mm, then the height can be reduced to 1,400 mm.

## Excerpt from Table 2-2 - Example 1 (Cont'd.)

| Danger Zone Height a (mm) | Protective Structure Height "b" (mm) | | | |
|---|---|---|---|---|
| | 1400 | 1600 | 1800 | 2000 |
| | Horizontal Distance from Danger Zone "c" | | | |
| 2400 | 100 | 100 | 100 | 100 |
| 2200 | 500 | 500 | 400 | 350 |
| 2000 | 700 | 600 | 500 | 350 |
| 1800 | 900 | 900 | 600 | |
| 1600 | 900 | 900 | 500 | |
| 1400 | 900 | 800 | 100 | |
| 1200 | 900 | 500 | | |

### Example 2 Calculating Horizontal Distance (“c”) between Protector and Danger Zone

**Initial Data**

Protector height (“b”) is 1,500 mm and the danger zone height (“a”) is 2,100 mm.

**Rationale**

In table 2-2, consider the allowable distances (“c”) when the protector height (“b”) is between 1,400 mm and 1,600 mm, and the danger zone height (“a”) is between 2,000 mm and 2,200 mm. Always select the distance that will yield the greatest level of safety.

**Conclusion**

Minimum horizontal distance (“c”) between the danger zone and the protector must be 700 mm when the protector height (“b”) is 1,500 mm and the danger zone height (“a”) is 2,100 mm (figure B-2).

**Excerpt from Table 2-2 - Example 2**

| Danger Zone Height a (mm) | Protective Structure Height *“b”* (mm) | | | |
|---|---|---|---|---|
| | 1400 | 1600 | 1800 | 2000 |
| | Horizontal Distance from Danger Zone “c” | | | |
| 2400 | 100 | 100 | 100 | 100 |
| 2200 | 500 | 500 | 400 | 350 |
| 2000 | 700 | 600 | 500 | 350 |
| 1800 | 900 | 900 | 600 | |
| 1600 | 900 | 900 | 500 | |
| 1400 | 900 | 800 | 100 | |
| 1200 | 900 | 500 | | |

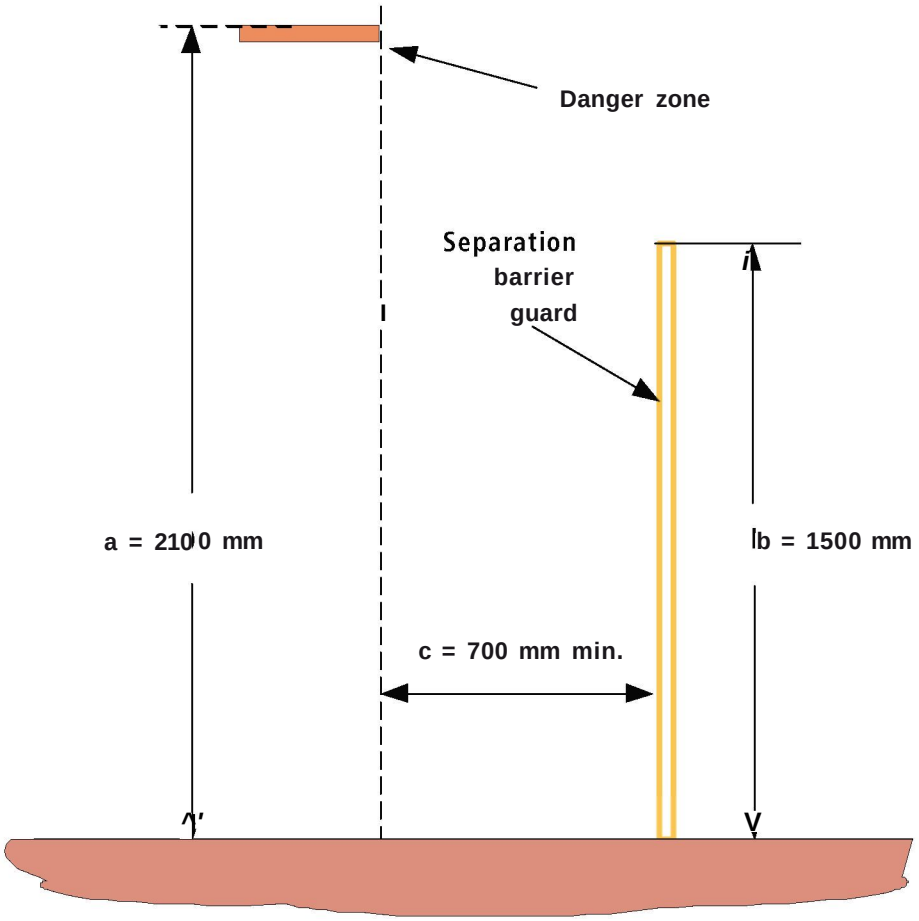



FIGURE B-2 SEPARATION BARRIER GUARD - EXAMPLE 2

### Example 3 Calculating Danger Zone Height ("a")

#### Initial Data

Protector height ("b") is 1,700 mm and horizontal distance ("c") from the danger zone is 550 mm.

#### Rationale

First, find the horizontal distances ("c") for protector heights of 1,600 mm and 1,800 mm. The required distance ("c") being greater for 1,600 mm high protectors, this value must be used since the safest distance is to be considered.

Then find the "c" values that are 550 mm or smaller. The danger zone can now be located to the corresponding "a" values.

#### Conclusion

The danger zone height must be less than 1,200 mm or more than 2,200 mm when the protector height ("b") is 1,700 mm and the horizontal distance ("c") separating them is 550 mm.

Where the horizontal distance (“c”) is not shown in table 2-2, use the last value given in the corresponding columns. For example, with a protector height (“b”) of 1,600 mm and a danger zone height (“a”) of less than 1,000 mm, the minimum separation distance (“c”) is 300 mm.

For danger zone heights greater than 2,500 mm, a guard is not required.

## Excerpt from Table 2-2 - Example 2

| Danger Zone Height a (mm) | Protective Structure Height “*b*” (mm) | | | |
|---|---|---|---|---|
| | 1400 | 1600 | 1800 | 2000 |
| | Horizontal Distance from Danger Zone “c” | | | |
| 2400 | 100 | 100 | 100 | 100 |
| 2200 | 500 | 500 | 400 | 350 |
| 2000 | 700 | 600 | 500 | 350 |
| 1800 | 900 | 900 | 600 | |
| 1600 | 900 | 900 | 500 | |
| 1400 | 900 | 800 | 100 | |
| 1200 | 900 | 500 | | |
| 1000 | 900 | 300 | | |
| 800 | 600 | | | |
| 600 | | | | |
| 400 | | | | |
| 200 | | | | |
| 0 | | | | |

# Appendix C Ontario Legislation Reference

The following table is a list of applicable sections of the Ontario Occupational Health and Safety Act and its Regulations in regards to conveyor belts.

Please note, that CSA standard **CSA Z432-04** should be used in regards to conveyors.

## Applicable Acts and Regulations

| Statutes | Applicable Sections | |
|---|---|---|
| The Occupational Health and Safety Act of Ontario (R.S.O. 1990, C. 0.1) | 18 | Functions and powers of Committee |
| | 25 | Duties of employers |
| | 27 | Duties of supervisors |
| | 28 | Duties of workers |
| | 31 | Duties of suppliers |
| R.R.O. 1990, Regulation 851, for Industrial Establishments (amended to O. Reg. 280/05) | 21 | Lighting |
| | 24 | Guards - machines, prime movers, transmission equipment |
| | 25 | Guards - in-running nip hazards |
| | 27 | Emergency stop |
| | 28 | Operating controls acting as guards |
| | 33 | Automatic start-up warning devices |
| | 34 | Guards - beneath conveyors |
| | 40 | Suitability and certifi cation of electrical equipment |
| | 75 | Maintenance - stopping and blocking moving parts precautions against accidental start-up |
| | 76 | Locking and tagging |
| R.R.O. 1990, Regulation 854 for Mines and Mining Plants (amended to O. Reg. 31/04) | | *Part VII Electrical, contains the following provisions:* |
| | 159 | Operation of electrical equipment |
| | 160 | Locking and tagging |
| | | *Part VIII Mechanical, contains the following provisions:* |
| | 185 | Guards - machines, prime movers, transmission equipment<br>Stopping moving parts and dissipating energy sources before carrying out work on moving parts |
| | 196 | This section relates specifi cally to conveyors and covers the following:<br>> Riding on conveyors prohibited<br>> Pull cords<br>> Safe means of applying belt dressing<br>> Start-up warning devices<br>> Guarding of tension pulleys<br>> Guards beneath conveyors<br>> Conveyors in underground mines<br>> Maintenance |
| | 262 | Lighting, underground mines |
| | 263 | Lighting, on the surface |

# References


1. COMMISSION DE LA SANTÉ ET DE LA SÉCURITÉ DU TRAVAIL (CSST). *Sécurité des machines : phénomènes dangereux – situations dangereuses – événements dangereux – dommages*, Publication Number DC 900-337, 2002. (Machine Security: Hazards – Hazardous Situations – Hazardous Events – Damages).

2. COMMISSION DE LA SANTÉ ET DE LA SÉCURITÉ DU TRAVAIL (CSST). *Guide de prévention en milieu de travail : à l'intention de la petite et de la moyenne entreprise,* Publication Number DC 200-16082-2, 2000. (A Guide to Prevention in the Workplace for Small- and Medium-Sized Businesses).

3. QUÉBEC GOVERNMENT. *Regulations Respecting Occupational Health and Safety,* Decree 885-2001, 5-2.1, r.19.01, July 2001. Available from the CSST Document Center (English Web site under construction) (RJ-510071).

4. QUÉBEC GOVERNMENT. *Mines Occupational Health and Safety Regulations,* 5-2.1, r.19.01, June 2002. Available from the CSST Document Center (English Web site under construction) (RJ-510068).

5. QUÉBEC GOVERNMENT. *Safety Code for the construction industry,* 5-2.1, r.6, August 2001. Available from the CSST Document Center (English Web site under construction) (RJ-530000).

6. CANADIAN STANDARDS ASSOCIATION. CSA Z432-94, *Machine Safety,* 1994. Available from the CSST Document Center (English Web site under construction) (NO-001570).

7. AFNOR. NF EN 620, *Continuous handling equipment and systems – Safety and EMC requirements for fi xed belt conveyors for bulk materials*, 2002. Available from the CSST Document Center (English Web site under construction) (NO-003033).

8. BRITISH STANDARD INSTITUTE. BS 7300, *Code of Practice for Safeguarding of the Hazard Points on Troughed Belt Conveyors,* 1990. Available from the CSST Document Center (English Web site under construction) (NO-002753).

9. AFNOR. NF EN 294, Sécurité des machines – *Distances de sécurité pour empêcher l'atteinte des zones dangereuses par les membres supérieurs,* September 1992. Available from the CSST Document Center (English Web site under construction) (NO-120491). (Safety of machinery. Safety distances to prevent danger zones being reached by the upper limbs).

10. COMITÉ EUROPÉEN DE NORMALISATION. EN 811, Sécurité des machines – *Distances de sécurité pour empêcher l'atteinte des zones dangereuses par les membres inférieurs,* 1996. Available from the CSST Document Center (English Web site under construction) (NO-002202). (Safety of machinery. Safety distances to prevent danger zones being reached by the lower limbs).

11. AFNOR. NF EN 953 Sécurité des machines – *Protecteurs – Prescriptions générales pour la conception et la construction des protecteurs fi xes et mobiles,* December 1997. Available from the CSST Document Center (English Web site under construction) (NO-002266). (Safety of machinery. Guards. General requirements for the design and construction of fi xed and moveable guards).

12. INTERNATIONAL STANDARDS ORGANISATION. ISO 14119, Sécurité des machines – *Dispositifs de verrouillage associés à des protecteurs, Principes de conception et de choix,* 1998. Available from the CSST Document Center (English Web site under construction) (NO-120715). (Safety of machinery. Interlocking devices associated with guards. Principles for design and selection).

13. AFNOR. NF EN 292-1, Sécurité des machines – *Notions fondamentales, principes généraux de conception – partie 1 : Terminologie de base, méthodologie,* December 1991. Available from the CSST Document Center (English Web site under construction) (NO-001500). (Machine Safety – Fundamental Notions and General Design Principles – Part 1: Basic Terminology and Methodology).

14. CENTRE TECHNIQUE DES INDUSTRIES MÉCANIQUES. *Équipements de manutention continue pour charges isolées – Mise en conformité, CETIM,* 1996. Available from the CSST Document Center (English Web site under construction) (MO-018973). (Continuous Individual Load Handling Equipment – Adherence Principles (CETIM)).

15. CANADIAN STANDARDS ASSOCIATION. CAN/CSA-M421-F00, *Use of Electricity in Mines,* 2000.

16. CANADIAN STANDARDS ASSOCIATION. CAN/CSA-M422-FM87, *Fire Resistance and Anti-Static Requirements for Conveyor Belts*, 2000.

17. INTERNATIONAL STANDARDS ORGANISATION. ISO 13850, Safety of machinery. *Emergency stop. Principles for design*, 1996. Available from the CSST Document Center (English Web site under construction) (NO-002190).

18. UNION TECHNIQUE DE L'ÉLECTRICITÉ (UTE). NF EN 60947-5-5, *Low-voltage switchgear and controlgear. Part 5-5: control circuit devices and switching elements. Electrical emergency stop device with mechanical latching function,* April 1998. Available from the CSST Document Center (English Web site under construction) (NO-002622).

19. CAISSE RÉGIONALE D'ASSURANCE MALADIE D'ÎLE DE FRANCE (CRAMIF). *Installation et utilisation des transporteurs à bande dans les carrières, dispositions générales n° 4,* 1994. Available from the CSST Document Center (English Web site under construction) (Belt Conveyor Installation and Operation for Quarries, General Rules #4).

20. INSTITUT NATIONAL DE RECHERCHE ET DE SÉCURITÉ (INRS). *Consignations et déconsignations*, ED 754, 1993. Available from the CSST Document Center (English Web site under construction) (MO-126203). (Holds and Releases).

21. AMERICAN NATIONAL STANDARDS INSTITUTE. ANSI Z244.1, *Safety Requirements for the Lock Out / Tag Out,* 1993.

# Bibliography

## CONVEYOR BELTS


AFNOR. NF EN 1554, *Courroies transporteuses — Essais de frottement au tambour*, août 1999.

AFN0R. NF EN 1724, *Courroies transporteuses légères — Méthodes d'essai pour la détermination du coefficient de frottement*, juin 1999.

AFNOR. NF H 95-320, *Engins de manutention continue — Transporteurs à courroies destinés à être équipés d'un instrument de pesage totalisateur continu — Caractéristiques*, mai 1988.

BRITISH STANDARD INSTITUTE. *Steel Cord Conveyor Belts — Adhesion Strength Test of the Cover to the Core Layer,* BS EN 28094: 1994, ISO 8094, 1984.

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION. ANSI/CEMA 402-2002, *Conveyor belts — Unit Handling Conveyors,* 2002.

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION. ANSI/CEMA 502-2001, *Bulk Material Conveyor Belt Troughing and Return Idlers — Selection and Dimensions*, 2001.

MINE SAFETY AND HEALTH ADMINISTRATION. *MSHA's Guide to Equipment Guarding*, OT 3, U.S. Department of Labor, 2000.

NATIONAL SAFETY COUNCIL. *Conveyor Belt for Bulk Materials — part 1: Equipment,* I-569, 1990.

SUVA. *Liste de contrôle — Transporteurs à bande pour marchandises en vrac*, SUVAPro, réf. 67043.f, Suisse.


## CONVEYORS — GENERAL


AMERICAN SOCIETY OF MECHANICAL ENGINEERS. *Safety Standard for Conveyors and Related Equipment*, ASME B20.1-2000 and addenda, 2000.

AMERICAN SOCIETY OF SAFETY ENGINEERS. Safe use of conveyor, *Professional Safety*, vol. 38, no. 4, April 1993.

COMITÉ EUROPÉEN DE NORMALISATION. EN 618, *Équipements et systèmes de manutention continue — Prescriptions de sécurité et de CEM pour les équipements de manutention mécanique des produits en vrac à l'exception des transporteurs fixes à courroie,* avril 2002.

COMITÉ EUROPÉEN DE NORMALISATION. Projet définitif prEN 619, *Équipements et systèmes de manutention continue — Prescriptions de sécurité et de CEM pour les équipements de manutention mécanique des charges isolées,* octobre 2000.

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION. ANSI/CEMA 102-2000, *Conveyor Terms and Definitions*, 2000.

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION. ANSI/CEMA No. 401-2002, *Roller Conveyors — Non Powered*, 2002.

FYSON, R. Oliver. Conveying safety to the user, *Professionnal Engineering*, June 1990, p. 30-31.

ONTARIO PRINTING AND IMAGING ASSOCIATION, INDUSTRIAL ACCIDENT PREVENTION ASSOCIATION AND WORKPLACE SAFETY INSURANCE BOARD. *Printing Industry Health and Safety Guide*, 2002.

S. D. , << Manutention en vrac des solides — Technologies et critères de choix >>, *Informations Chimie*, n° 326, mars 1991, p. 148-153.

SCHULTZ, George A. Conveyor Safety Requirements when Using Older Equipment, American Society of Safety Engineers, *Professional Safety,* May 2001.

SCHULTZ, George A. *Conveyor Safety — Safety in the Design and Operation of Material Handling Systems*, American Society of Safety Engineers, 2000.

SCHULTZ, George A. *What a Safety Engineer Should Know About Conveyor Safety,* ASSE's 2001 Professional Development Conference, June 2001.

SMANDYCH, R. Susan et al. Dust Control for Material Handling Operations: a Systematic Approach, *American Industrial Hygiene Association Journal,* vol. 58, no. 2, Febuary 1998, p. 139-146.

SLJOKAS, Jouko. Evaluation of the Effect of Safety Regulation, Case Studies in Press and Conveyor Regulations, *Safety Science*, vol. 16, No. 3-4, 1993, p. 307-324.

## MACHINE SAFETY

AFNOR. NF EN 292-2, Sécurité des machines — *Notions fondamentales, principes généraux de conception — partie 2 : Principes et spécifi cations techniques*, décembre 1991.

AFNOR. NF EN 292-2/A1, Sécurité des machines — *Notions fondamentales, principes généraux de conception — partie 2 : Principes et spécifications techniques*, juin 1995.

AFNOR. NF EN 349, Sécurité des machines — *Écartements minimaux pour prévenir les risques d'écrasement de parties du corps humain*, septembre 1993.

AFNOR. NF EN 894-2, Sécurité des machines — *Spécifications ergonomiques pour la conception des dispositifs de signalisation et des organes de service — partie 2 : dispositifs de signalisation*, avril 1997.

AFNOR. NF EN 954- 1, Sécurité des machines — *Parties des systèmes de commande relatives à la sécurité — Partie I : Principes généraux de conception*, février 1997.

AFNOR. NF EN 999, *Positionnement des équipements de protection en fonction de la vitesse d'approche des parties du corps*, décembre 1998.

AFNOR. NF EN 1037, Sécurité des machines — *Prévention de la marche intempestive*, mars 1996.

AFNOR. NF EN 1050, Sécurité des machines — *Principes pour l'appréciation du risque*, janvier 1997.

AFNOR. NF EN 1088, Sécurité des machines — *Dispositifs de verrouillage associés à des protecteurs, Principes de conception et de choix*, juin 1996.

AMERICAN NATIONAL STANDARDS INSTITUTE. ANSI/RIA R15.06-1999, *American National Standard for Industrial Robots and Robot Systems — Safety Requirements*, June 1999.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. ASME B15.1-2000, *Safety Standard for Mechanical Power Transmission Apparatus*, 2000.

BRITISH STANDARD INSTITUTE. PD 5304-2000, *Safe Use of Machinery*, 2000.

COMMISSION DE LA SANTÉ ET DE LA SÉCURITÉ DU TRAVAIL (CSST) ET L'INSTITUT DE RECHERCHE ROBERT-SAUVÉ EN SANTÉ ET EN SÉCURITÉ DU TRAVAIL (IRSST). *Amélioration de la sécurité des machines par l'utilisation des dispositifs de protection,* publication n° DC 100-1313.

COMMISSION DE LA SANTÉ ET DE LA SÉCURITÉ DU TRAVAIL (CSST) ET L'INSTITUT DE RECHERCHE ROBERT-SAUVÉ EN SANTÉ ET EN SÉCURITÉ DU TRAVAIL (IRSST). *Mode d'emploi du sécurimètre*, publication n° DC 500-191, 2002.

GORIS, Anne-Marie. << Les dangers des points rentrant >>, *Travail et sécurité*, n° 586-587, juillet-août 1999, p. 36.

LUGDUNUM, Bernard. << Contrat de prévention — Concassage en douceur à la carrière Roffat >>, *Travail et sécurité*, n° 585, juin 1999.

LUPIN, Henriet et Jacques MARSOT. *Sécurité des machines et des équipements de travail — Moyens de protection contre les risques mécaniques*, INRS, ED 807, 2000.

MAUGE, Michel. *Machines et équipements de travail — Mise en conformité*, INRS, ED 770, 1998.

ORGANISATION INTERNATIONALE DE NORMALISATION. ISO 13853, Sécurité des machines — *Distances de sécurité pour empêcher l'atteinte des zones dangereuses par les membres inférieurs*, 1998.

PAQUES, Joseph-Jean et Réal BOURBONNIÈRE. *Formation en sécurité des machines : appréciation et réduction du risque*, IRSST, septembre 2002.