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, 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, 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.

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.  

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.

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.

- 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 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

<table>
<thead>
<tr>
<th>Safe Distance c (mm)</th>
<th>Maximum Aperture Width e (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 ~ 38</td>
<td>6</td>
</tr>
<tr>
<td>39 ~ 64</td>
<td>10</td>
</tr>
<tr>
<td>65 ~ 89</td>
<td>13</td>
</tr>
<tr>
<td>90 ~ 140</td>
<td>16</td>
</tr>
<tr>
<td>141 ~ 165</td>
<td>19</td>
</tr>
<tr>
<td>166 ~ 191</td>
<td>22</td>
</tr>
<tr>
<td>192 ~ 318</td>
<td>32</td>
</tr>
<tr>
<td>319 ~ 394</td>
<td>38</td>
</tr>
<tr>
<td>395 ~ 445</td>
<td>48</td>
</tr>
<tr>
<td>446 ~ 800</td>
<td>54</td>
</tr>
<tr>
<td>Greater than 800</td>
<td>152</td>
</tr>
</tbody>
</table>

How to Measure Openings

Using the Safety Ruler

The Safety Ruler
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\(^1\) may be allowed under the guard provided it extends 550 mm 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.

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

FIGURE 2-4
CURVED ZONE SURROUNDING
FIXED GUARD
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 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)*

<table>
<thead>
<tr>
<th>Danger Zone Height a (mm)</th>
<th>Protective Structure Height b (mm)</th>
<th>1400</th>
<th>1600</th>
<th>1800</th>
<th>2000</th>
<th>2200</th>
<th>2400</th>
<th>2500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal Distance from the Danger Zone c (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2400</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td>500</td>
<td>500</td>
<td>400</td>
<td>350</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>700</td>
<td>600</td>
<td>500</td>
<td>350</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1800</td>
<td>900</td>
<td>900</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>900</td>
<td>900</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1400</td>
<td>900</td>
<td>800</td>
<td>100</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td>900</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>900</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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).

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#### 2.2.2.3 In-Running Nip Fixed Guards

*(EN Standard 620, sections 3.4.17 and 5.1.4.2)*

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.

![Diagram of in-running nip fixed guard](image)

**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

<table>
<thead>
<tr>
<th>Drum or Roller Diameter d (mm)</th>
<th>Entrapment Zone Length C*</th>
<th>Minimum Guard Length from Roller Center (C + 150 mm)</th>
<th>Minimum Guard Length from Drum Center (C + 600 mm)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>60</td>
<td>210</td>
<td>660</td>
</tr>
<tr>
<td>315</td>
<td>77</td>
<td>227</td>
<td>677</td>
</tr>
<tr>
<td>400</td>
<td>87</td>
<td>237</td>
<td>687</td>
</tr>
<tr>
<td>500</td>
<td>98</td>
<td>248</td>
<td>698</td>
</tr>
<tr>
<td>630</td>
<td>110</td>
<td>260</td>
<td>710</td>
</tr>
<tr>
<td>800</td>
<td>125</td>
<td>275</td>
<td>725</td>
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<tr>
<td>1000</td>
<td>140</td>
<td>290</td>
<td>740</td>
</tr>
<tr>
<td>1250</td>
<td>157</td>
<td>307</td>
<td>757</td>
</tr>
<tr>
<td>1400</td>
<td>166</td>
<td>316</td>
<td>766</td>
</tr>
<tr>
<td>1600</td>
<td>177</td>
<td>327</td>
<td>777</td>
</tr>
</tbody>
</table>

* 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