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   1.2- Conveyor components
   1.3- Hazards
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2- Safe guards against mechanical hazards
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3- Preventive measures against control system failures or malfunctions
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4- Preventive measures against maintenance hazards
   4.1- General principles
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5- Operators and maintenance operatives training
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1- General information

1.1-Introduction on belt conveyors

Belt conveyors are mainly characterized by their length that can vary from some meters to several kilometers.
A large part of accidents occur in drums areas (drive or tail drum), near a roller or near the drive mechanism zone.
The majority of accidents occurs during cleaning or maintenance operations.
Belt conveyors are linked to many hazards related to:
- Power transmission moving parts.
- The belt itself and its motion with other equipments (mainly drums and rollers).
- Moving loads.
- Moving sub-assemblies (e.g.: devices that change the direction of the load).
- Proximity to circulation areas, throughways passing above or under conveyors.
- Conflicts between stops (e.g.: to clear chokes) and production requirements.
- Stoppages due to causes unknown from operators located far from the equipment and that can lead to unsafe behaviors.
- Fall of the conveyed load.
- Fall of return rollers.
1.2- Conveyor components

The main conveyor components are defined and illustrated below.

**Bulk loads**

**Individual loads**

1. **Belt**
   - 1a. Upper strand.
   - 1b. Lower strand.

2. **Load carrying rollers**

3. **Return rollers**

4. **Drums**
   - 4a. Live drum.
   - 4b. Head drum.
   - 4c. Tail drum.
   - 4d. Snub drum.
   - 4e. Tensioning drum.

5. **Tension system**
   - 5a. Gravity system.
   - 5b. Manual or self-adjusting system.

6. **Power transmission moving parts**

7. **Loading system**

8. **Unloading mechanism**

9. **Belt and drum cleaner**

10. **Curved zone**

11. **Transition zone**
1. Belt
   **Function:** Convey or transport material.
   1a. Upper strand (generally the load carrying strand).
   1b. Lower strand (generally the return strand).

2. Load carrying rollers
   **Function:** Support the belt. Some load carrying rollers may also be impact reducing, self-aligning, or able to change the inclination of the belt.
   Depending on the rollers, there are 2 shapes of belts:

   ![Throughed belt](image1)
   ![Flat belt](image2)

3. Return rollers
   **Function:** Support the belt. Some return rollers may also be self-aligning or able to change the inclination of the belt.

4. Drums
   **Function:** Drive a belt or change its inclination. There are several 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 using a take-up system.

5. Tension system
   **Function:** Ensure proper belt tension. Types of tension systems:
   5a. Gravity system - a guided counterweight pulls the tensioning drum to provide the required tension.
   5b. Manual system - adjustment screws provide the required tension.

6. Power transmission moving parts
   **Function:** 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.
   - 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: Guide and control the load feed on the belt. There are many possible systems: hoppers, chutes, automatic loaders, 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 is bolted on to it.
   7c. Skirt - Stops loose material from leaking off the belt and holds fine material.

8. Unloading mechanism
Function: Guide the load exiting the conveyor. Various devices may be used: chutes, slides, packagers, etc.

9. Belt and drum cleaner
Function: 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 of the belt changes from troughed to flattened and vice versa.

12. Switch mechanism
Function: Change the load direction. Various devices may be used like bumpers, pushers, ejectors, etc.
1.3-Hazards

Hazards associated with conveyors are mainly mechanical. 4 main sources of hazards are presented hereafter:
- Power transmission moving parts hazards
- Other conveyor moving parts hazards
- Confinement zone hazards
- Moving sub-assemblies hazards

1.3.1- Power transmission moving parts hazards:

These hazards are associated with the power transmission parts between the motor and the live drum. They include grooves (1), pins (2), bolts (3), sharp edges (4), in-running nips in coupling systems, like chains (5), pulley belts (6) or sprockets (7). Dragging or crushing with rotating parts or pinch points can result in serious injuries.

1.3.2- Other conveyor moving parts hazards:

They are associated with the moving conveyor belt and in-running nips near rollers and drums, and with 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 contact with the belt, and injuries from being struck by a ruptured belt or a falling roller.
Typical mechanical hazards

In-running nips

Typical accident due to in-running nip
1.3.3- Confinement zones hazards:

They are injuries resulting from being crushed between the load and a fixed object, (e.g.: hoppers, skirtboards or skirts).
Injuries can also be caused by falling loads or impacts with loads.
3 hazardous confinement zones on the following picture.

1.3.4- Moving sub-assemblies hazards:

They are injuries resulting from being crushed between the load and moving sub-assemblies, mainly with equipments that re-orient the load.
5 hazardous zones on the following picture.

1.4- Risk assessment and risk reduction

Once hazards have been identified, they must be eliminated or controlled by applying and implementing the appropriate control measures. It is necessary to carry out a risk assessment to determine which hazards to address first and what are the most effective methods to control them.
2- Safe guards against mechanical hazards

2.1- General principles

There are many danger zones in and around belt conveyors. A conveyor must be constructed in a way to not allow access to danger zones or, by default, must be equipped with guards and protective devices. It is also possible to use deterrent devices.

Hereafter are described various types of protectors and deterrent devices.

2.2-Guards

A guard is an element that makes the danger zone inaccessible, by isolating it. Guards on belt conveyors must be designed taking operating conditions into account.

They must be capable of resisting the loads to which they will be subjected.

Guards must not create additional hazards or tempt workers to bypass their use.

Dimensions and weight of movable guards must allow an easy handling. For this, 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.

There are three types of guards:

- Fixed guards:
  - Surrounding fixed guards
  - Barrier guards (fixed distance)
  - In-running nip fixed guards
- Interlocking guards
- Interlocked guards with guard locking

Opening a guard must be possible only with a tool
2.2.1- Dimensions for guard openings

Guards can have openings. Specifications for allowable dimensions for guard openings are shown in the below table.

Guard opening dimensions can be verified with a tool called Safety Ruler. This tool makes possible to check if the hazard can be reached through the guard.

<table>
<thead>
<tr>
<th>Part of the body concerned</th>
<th>Opening width e (mm)</th>
<th>Safe distance c (mm)</th>
<th>Slot shape</th>
<th>Square shape</th>
<th>Circle shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremity of the finger</td>
<td>e ≤ 4</td>
<td>≥ 2</td>
<td>≥ 2</td>
<td>≥ 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 &lt; e ≤ 6</td>
<td>≥ 10</td>
<td>≥ 5</td>
<td>≥ 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 &lt; e ≤ 8</td>
<td></td>
<td>≥ 15</td>
<td>≥ 15</td>
<td></td>
</tr>
<tr>
<td>Finger</td>
<td>6 &lt; e ≤ 8</td>
<td>≥ 20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 &lt; e ≤ 10</td>
<td>≥ 80</td>
<td>≥ 25</td>
<td>≥ 20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 &lt; e ≤ 12</td>
<td>≥ 100</td>
<td>≥ 80</td>
<td>≥ 80</td>
<td></td>
</tr>
<tr>
<td>Hand</td>
<td>12 &lt; e ≤ 20</td>
<td>≥ 120</td>
<td>≥ 120</td>
<td>≥ 120</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 &lt; e ≤ 30</td>
<td>≥ 120</td>
<td>≥ 120</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 &lt; e ≤ 40</td>
<td>≥ 200</td>
<td>≥ 200</td>
<td>≥ 120</td>
<td></td>
</tr>
<tr>
<td>Arm</td>
<td>20 &lt; e ≤ 30</td>
<td>≥ 850*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 &lt; e ≤ 40</td>
<td>≥ 850</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 &lt; e ≤ 120</td>
<td>≥ 850</td>
<td>≥ 850</td>
<td>≥ 850</td>
<td></td>
</tr>
</tbody>
</table>

*: If the length of the slot is less or equal 65 mm, the safe distance can be decreased at 200 mm (blockage due to the thumb).
2.2.2- Fixed guards

A fixed guard is a guard that can be removed only by using a tool or that is permanently set in place (e.g.: by welding).
Guards may be easily opened with tools or keys. When keyed latches are used, responsibility for controlling and distributing keys or tools must be assigned.

2.2.2.1- Surrounding fixed guards

Because of openings required for belt and load passage, surrounding fixed guards only partially surround the danger zone.
In conveyor belts, these fixed guards are designed on two main shapes:
- Partial cages (used mainly for head and return drums).
- Side screens.
Guards must extend beyond in-running nips between belts and rollers so as to make them inaccessible from above, below and from the ends.

### 2.2.2.2- Barrier guards

Barrier guards do not completely surround danger zones but restrict or prevent access by their size and separation from the danger zone.

#### Examples of barrier guards

<table>
<thead>
<tr>
<th>Surrounding fixed guard (partial cage)</th>
<th>Surrounding fixed guard (side screen)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
</tbody>
</table>

### 2.2.2.3- In-running nip fixed guards

A fixed guard can be placed near in-running nips in order not to allow access to this zone. In-running nip fixed guards can be form fitting or made with deflectors and side plates.
2.2.3- Interlocking guards

A guard equipped with an interlocking device should have the following characteristics.
It should:
- Stop the machine as soon as it is slightly opened.
- Make impossible to start the machine as long as it is not in place.
- Not restarts the machine 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).

**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.

### Principle of interlocking guard

<table>
<thead>
<tr>
<th>Closed guard</th>
<th>Open guard</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Closed guard" /></td>
<td><img src="image2" alt="Open guard" /></td>
</tr>
<tr>
<td>The equipment can run</td>
<td>The equipment cannot run</td>
</tr>
<tr>
<td>[On]</td>
<td>[Off]</td>
</tr>
</tbody>
</table>

2.2.4- Interlocked guards with guard locking

An interlocked guard equipped with a locking device should have the following characteristics.
It should:
- Remain locked in place as long as the machine is moving.
- Make impossible to start the machine as long as it is not in place and reactivated.
- Not restarts the machine once it is restored to its place and reactivated.

<table>
<thead>
<tr>
<th>Principle of interlocked guard with guard locking</th>
</tr>
</thead>
<tbody>
<tr>
<td>The equipment can run</td>
</tr>
<tr>
<td>Closed and blocked guard. Impossible to unblock</td>
</tr>
</tbody>
</table>

| The equipment cannot run                           |
| Closed and blocked guard. Possible to unblock      |

| The equipment cannot run                           |
| Closed and unblocked guard. Possible to open       |

| The equipment cannot run                           |
| Open guard                                         |

| Safe area                                          |

Diagram:
- Blocked guard
- Open guard
- Safe area
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).

### 2.3-Deterrent devices

They are devices (other than guards) that reduce the risk of contact with a danger zone. They are often physical obstacles which, without totally preventing access to a danger zone, reduce the possibility of access. **Note:** In order to be considered as deterrent devices, guardrails must be at least 1000mm height with a minimum of 1400mm separation from the danger zone.

Deterrent devices must be designed taking operating conditions into account. They must be able of resisting the loads to which they will be subjected. These devices must not create additional hazards or tempt workers to bypass their use.

![Typical deterrent devices:](image)

- Roller side plates
- Guardrails with mid rails

### 2.4-Throughways

Where 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.

Where a throughway crosses under or is located below a conveyor, the clearance below the conveyor should be more than 2m and the width of the throughway at least 600mm.

For a throughway passing over a conveyor, the footbridge must be equipped with a guardrail.

Throughways can be divided into two groups:
• Well-marked (footbridge along the conveyor, single-file access way under the conveyor, etc.): the measures in paragraph 2.6 apply only to hazardous components along throughways.
• 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.

<table>
<thead>
<tr>
<th>Safe throughways under and above conveyors</th>
</tr>
</thead>
</table>

2.5-Falling or projecting objects

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

2.5.1- Conveyor elements

Hazards of falling or projecting conveyor elements can be caused by:
• Forces during normal operating conditions (centrifugal force, pressure).
• Exceptional forces (jarring, ramming).
• Worn material.
It's important to implement measures to prevent hazards such as a falling return roller or belt breakage that can lead in accidents with high potential severity.

2.5.2- Carried loads

The whole conveyor circuit, specifically loading, unloading and transfer points, must be designed to reduce spill-over hazards of carried loads. Equipments installed high above the floor or ground must be equipped with protective devices to prevent the fall of loads. This is particularly important where conveyors are above or near throughways.

2.6-Conveyor belt safety requirements during operating conditions

The following pages outline safety requirements for conveyor belt parts in operation, in the following order:
1) Power transmission moving parts
2) Belt
3) Loading hoppers
4) Upper and lower strands in a straight run
   - 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
5) Throughways under conveyors
• In-running nips between lower strand and return rollers in a straight run
• Return rollers
6) Scrapers
7) Curved zone
8) Transition zone
9) Drums
10) Counterweights
11) Junction between two conveyors
12) Moving loads
• Skirtboard and individual moving loads
• Individual loads and fixed obstacles not part of the conveyor (e.g.: wall, tunnel entrance, fixed equipments (detectors), etc…).
• Loads and load carrying rollers exceeding belt width
• Loads falling from the belt
13) Moving sub-assemblies
14) Moveable conveyors
2.6.1- Power transmission moving parts

**Hazards:**
Drive shaft, shaft end, sprocket, pulley, chain, drive belt, gear coupling.

**Possible consequences:**
Crushing, entanglement of a loose piece of clothing.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Surrounding fixed guards.

<table>
<thead>
<tr>
<th>Examples of surrounding fixed guards</th>
</tr>
</thead>
<tbody>
<tr>
<td>For pulleys and power transmission belts</td>
</tr>
<tr>
<td>![Example for pulleys and power transmission belts]</td>
</tr>
<tr>
<td>For shafts</td>
</tr>
<tr>
<td>![Example for shafts]</td>
</tr>
</tbody>
</table>

**Example of shafts protections**
2.6.2- Belt

**Hazards:**
Deteriorated belt or belt splice.

**Possible consequences:**
Drawing-in, burns, pokes, cuts.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Change the belt splice design or manufacture.
Maintenance of belt and/or splice.

<table>
<thead>
<tr>
<th>Splice in proper condition</th>
<th>Damaged splice</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Splice in proper condition image" /></td>
<td><img src="image2.png" alt="Damaged splice image" /></td>
</tr>
</tbody>
</table>
2.6.3- Loading hoppers

**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, burns from the belt.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
- Surrounding or barrier guard.
- Replace rollers with sliding blocks.

*Note:* Greasing points have to be located beyond guards.
Sliding blocks to replace rollers

Detail of sliding blocks

Belt

No more in-running nip

Sliding block

Example of sliding blocks
2.6.4- 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 2.5m from the floor or working platform):**
Workstation: surrounding fixed guards, barrier guards, plates between rollers.
Throughway: risk analysis.
Prevent access from guard ends

- Side screens must extend 1000mm 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 620mm from the center of a roller and 1000mm from the center of a drum (see figure 1).
- Whatever the length of side screens or cages is, in-running nips must remain inaccessible at screen or cage ends and from under the belt.

Prevent access from above guards

- Side screens must make in-running nips inaccessible from above the guard. The distance between the guard and the belt must be at least 100mm to prevent the hand to be jammed. For throughed conveyors, the distance, which is calculated perpendicularly from the angled roller, must be equal to 1/3 the roller length from the roller top (see figure 2).
- The following table (which applies to barrier guards) can be used to determine the height of upright side screens.

### Required distances for fixed barrier guards

(Based on NF EN ISO 13857:2008)

<table>
<thead>
<tr>
<th>Danger zone height a (mm)</th>
<th>Protective structure height b (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>2600</td>
<td>900</td>
</tr>
<tr>
<td>2400</td>
<td>1100</td>
</tr>
<tr>
<td>2200</td>
<td>1300</td>
</tr>
<tr>
<td>2000</td>
<td>1400</td>
</tr>
<tr>
<td>1800</td>
<td>1500</td>
</tr>
<tr>
<td>1600</td>
<td>1500</td>
</tr>
<tr>
<td>1400</td>
<td>1500</td>
</tr>
<tr>
<td>1200</td>
<td>1500</td>
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<tr>
<td>1000</td>
<td>1500</td>
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<tr>
<td>800</td>
<td>1500</td>
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<tr>
<td>600</td>
<td>1400</td>
</tr>
<tr>
<td>400</td>
<td>1400</td>
</tr>
<tr>
<td>200</td>
<td>1200</td>
</tr>
<tr>
<td>0</td>
<td>1100</td>
</tr>
</tbody>
</table>

- No interpolation from the above values is allowed.
- If a measured distance falls between two values, select the safer value.
- Structures less than 1400mm height should be used in addition to other safety measures..
Prevent access from under the conveyor

- Under conveyor access can be prevented by a screen.
- Where there is no access-restricting screen under a conveyor, side screens must extend 1000mm below roller and belt in-running nips.
- When in-running nips are 1000mm or less from the floor, the guard must extend to the floor. For cleaning purposes, a 300mm opening may be allowed under the guard provided if it extends 550mm or more under the pinch point for which it was designed to restrict access.
- When in-running nips are more than 1000mm from the floor, openings under the guard must not exceed 300 mm. Bars may be used to block these openings.
Hazard:
In-running nips between lower strand and return rollers in a straight run.

Possible consequences:
Drawing-in, impact with rollers.

Protective measures if hazard is less than 2.5m 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.
- Throughway parallel to conveyor (in-running nip is located at a height between 0.7m and 2.5m): surrounding in-running nip guard or barrier guard, or other deterrent devices (guardrail).
- Throughway parallel to conveyor (in-running nip is located at a height less than 0.7m): deterrent devices (guardrail or side plate).

A fixed guard can be placed near in-running nips in order not to allow access to this zone. In-running nip fixed guards can be form-fitting or made with deflectors and side plates.

Form-fitting guards, deflectors and side plates are well suited for individual load conveyors, and for rollers and drums with a smooth and unbroken surface. They may be used in troughed conveyor belts as long as they follow the belt profile. However, these guards are not adapted for all types of belts. If it is impossible to maintain a maximum clearance of 5mm 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. Then, to this distance “C”, add either 150mm for rollers or 600mm for drums.

<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 + 150mm)</th>
<th>Minimum guard length from drum center (C + 600mm)*</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>
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<tr>
<td>500</td>
<td>98</td>
<td>248</td>
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<td>630</td>
<td>110</td>
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</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: $C = \sqrt{(d/2)^2 - [(d/2) - 20]^2}$

Various types of in-running nip fixed guards
Plates under a belt and between rollers may also serve as safeguards from in-running nips. However, a maximum gap of 5 mm must be maintained between a roller and adjacent plates.
2.6.5- Throughways under conveyors

**Hazards:**
In-running nips between lower strand and return rollers in a straight run.

**Possible consequences:**
Drawing-in, impact with rollers.

**Protective measures if hazard is less than 2.5m from the floor or working platform:**
Throughway under a conveyor: surrounding in-running nip or barrier guards, or deterrent devices (guardrail) and addition of protection plates.

<table>
<thead>
<tr>
<th>Protections for throughways: plate and deterrent guardrail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection plate</td>
</tr>
<tr>
<td>Min. 1400 mm</td>
</tr>
<tr>
<td>Min. 1400 mm</td>
</tr>
<tr>
<td>Min. 600 mm</td>
</tr>
<tr>
<td>Min. 2500 mm</td>
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<tr>
<td>Min. 2500 mm</td>
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<tr>
<td>Min. 600 mm</td>
</tr>
<tr>
<td>Min. 1000 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protections for throughways: plate and surrounding fixed guards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection plate</td>
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<td>Min. 2500 mm</td>
</tr>
<tr>
<td>Min. 600 mm</td>
</tr>
<tr>
<td>Min. 1000 mm</td>
</tr>
</tbody>
</table>
**Hazard:**
Return rollers.

**Possible consequences:**
Impact with rollers, crushed by falling rollers.

**Protective measures (throughway under conveyor more than 2.5m):**
Retaining device for return rollers. It is possible to reduce the risk with a preventative maintenance program, which should be taken into account when doing the risk analysis.
2.6.6- Scrapers

Hazard:
Bottom strand scrapers.

Possible consequences:
Trapping and crushing, abrasions from the belt.

Protective measures (if hazard is less than 2.5m from the floor or working platform):
In accordance with risk analysis results the scraper protection device may be combined with the drum protection device.

Form and dimensions to be defined according to the opening that is necessary to adjust the scraper. Add a guard to close the opening after adjustments.

Surrounding barrier guard for drum and scraper
2.6.7- Curved zone

**Hazard:**
In-running nip between the belt and rollers in the curved zone.

**Possible consequences:**
Drawing-in.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Surrounding in-running nip or separation barrier guard.

---

**In-running nip guards**

![Diagram of in-running nip guards]

**Surrounding fixed guards**

![Diagram of surrounding fixed guards]
2.6.8- 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 2.5m from the floor or working platform):
Surrounding or in-running nip guard.

Head drum and transition zone protectors
2.6.9- Drums

**Hazard:**
In-running nips between belt and drums.

**Possible consequences:**
Drawing-in.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Surrounding guards or in-running nip guards.
In-running nip guard for head drum

* In order to determine the value of $C$, refer to the table page 27.
2.6.10- Counterweights

**Hazard:**
Counterweight system.

**Possible consequences:**
Crushed by falling weights, drawing-in at pinch points.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Surrounding or barrier guards.

If the weight is always more than 2.5m from the floor or working platform: deterrent device (guardrail) to prevent access under the weight.

For gravity-type tensioning devices, the height of the barrier preventing access under the counterweight must be 2.5m.

Tensioner drums (head or tail) must also be protected.

An opening of 300mm maximum from the floor should be allowed for cleaning tasks.
2.6.11- Junction between two conveyors

**Hazard:**
Junction between two conveyors.

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

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Fixed guard (plate) or free-wheeling pop-up roller.

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**Fixed guard at conveyor belt junction**

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**Pop-up roller at conveyor belt junction**
2.6.12- 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 2.5m from the floor or working platform):**
- **Workstation:**
  - Limit the gap between the skirtboard and belt to a maximum of 5mm
  - 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 when removing the skirtboard.
**Hazard:**
Individual loads and fixed obstacles not part of the conveyor (e.g.: wall, tunnel entrance, fixed equipments (detectors), etc.).

**Possible consequences:**
Crushed between loads and fixed objects.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Fixed guard or deterrent device in accordance with risk analysis results, in respecting the safe distances between loads and obstacles (here are minimum distances for different situations):

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

**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 on body part risk of being trapped and the weight of the load, as determined in the risk analysis. The guard must not create a drawing-in or trapping area.
Hazard:
Loads and load carrying rollers exceeding belt width.

Possible consequences:
Trapping, crushing.

Protective measures (if hazard is less than 2.5m from the floor or working platform):
Workstation: Fixed barrier guard (separation type or plates between rollers).
Other areas: Fixed barrier guard (separation type or plates between rollers) or deterrent device.
Hazard: Loads falling from the belt.

Possible consequences: Impact with moving loads, crushed by falling loads.

Protective measures (if hazard is less than 2.5m from the floor or working platform): Protection plate, net, or guiding rail to maintain individual loads on the conveyor and prevent their fall, in accordance with risk analysis results.
2.6.13 Moving sub-assemblies

**Hazard:**
Pushers, bumpers, ejectors.

**Possible consequences:**
Crushing.

**Protective measures (if hazard is less than 2.5m from the floor or working platform):**
Surrounding fixed or barrier guards.

**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: 500mm minimum
- If arms can be drawn in: 120mm minimum
- If legs can be drawn in: 180mm minimum
2.6.14 Moveable conveyors

Hazard:
Vertical and/or horizontal movement.

Possible consequences:
Crushing; entanglement; trapping.

Protective measures (If hazard is less than 2.5m 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. It is also possible to use electronic safety devices (surface detectors, etc.).
3- Preventive measures against control system failures or malfunctions

3.1-Start-up

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

- The closing of a guard
- The activation 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 ensure proper sequential start-up and prevent conveyor loading when not in use or when fully loaded.

For automatic 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.

To prevent unexpected start-ups, replace two-stable position switches (start-stop) with self-powered (contacts maintained by power) control devices. These switches will bring the controls to an off-circuit mode in case of power outage or conveyor failure.

3.2-Regular stop

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

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

The emergency stop device of a conveyor is made up of several control devices located at loading and unloading points and at other locations along the conveyor’s path. In addition, these devices have the following characteristics:

- They are easily visible;
- One single action activates them;
- They are clearly identified.

Emergency stop devices should also be activated by a positive action. Emergency stop devices must be installed at a height between 0.6m and 1.7m from the floor and must include the following:

- One or more emergency stop pull cords along the full conveyor length;
- One or more push-button switches installed in such a manner that at least one is accessible within a 10m distance from any equipment access point;
- A conveyor power disconnect device, if the distance to the disconnect device is less than 10m from any conveyor access point.

The resetting of the emergency stop device must not, by itself, cause the start-up of the machine. Moreover, startup 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. 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. 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.

3.4-Emergency stop pullcords

All conveyors must be equipped, where operatives may access a conveyor while it is in operation, with an emergency shut-down device along its full length between the head drum and the tail drum. Therefore, the emergency shutdown device must take the form of a cable along the full length of the conveyor.

A metal strand cable shut-down device must act 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 125N 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 300mm.

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.

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.

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.).
4- Preventive measures against maintenance hazards

4.1- General principles

Equipment must be designed in such a way that various tasks like adjustments, greasing, cleaning, etc. can be accomplished away from danger zones. Therefore, all adjustment and greasing points must be accessible without having to remove guards or other protective devices. When it is necessary to open or remove guards, or to neutralize protective devices in order to carry out a task, protective measures must be implemented to ensure the safety of operatives in the areas transformed into danger zones. Before performing any job in a machine’s danger zone, the lock-out/tag-out (LOTO) procedure must be applied.

4.2- Lock-out/Tag-out procedure

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

LOTO procedure involves the following basics:
- Bringing the machine to a complete stop.
- Disconnecting all the machine’s energy sources: electric, pneumatic, hydraulic, mechanical and thermal.
- Dissipating all accumulated energy (removing counterweights, unloading springs, etc.) and checking for absence of energy.
- Lock-out and tag-out of energy disconnect devices.
- Double-checking to ensure that the equipment is effectively disconnected (e.g.: running a start-up test).

For more information, refer to Lock-out/Tag-out Group Standard ST05 (issued in January 2012).
### 4.3-Summary of maintenance preventive measures

<table>
<thead>
<tr>
<th>Activity</th>
<th>Preventive measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repairs Changing mechanical, electrical, hydraulic</td>
<td>LOTO conveyor or related accessory.</td>
</tr>
<tr>
<td>or pneumatic parts on conveyors or related</td>
<td></td>
</tr>
<tr>
<td>accessories</td>
<td></td>
</tr>
<tr>
<td>Belt replacement and splicing</td>
<td>LOTO and application of a written safety procedure.</td>
</tr>
<tr>
<td>Welding and cutting</td>
<td>LOTO if conveyor is located under the welding area. LOTO if the closed unprotected danger zone is less than 2.5m from the work area.</td>
</tr>
<tr>
<td>Adjustment and fit</td>
<td>Authorized at all times when adjustment points (e.g.: scraper, drum and take-up system adjustment) are outside the danger zone. LOTO if adjustment</td>
</tr>
<tr>
<td></td>
<td>points are inside the danger zone.</td>
</tr>
<tr>
<td>Greasing and lubrication</td>
<td>Authorized at all times where greasing points are outside the danger zone. LOTO if greasing points are inside the danger zone.</td>
</tr>
<tr>
<td>Housekeeping under and around conveyor; disposal</td>
<td>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</td>
</tr>
<tr>
<td>of material recovered on the belt</td>
<td>belt located less than 2.5m from the floor (belt risk analysis).</td>
</tr>
<tr>
<td></td>
<td><strong>Reminder:</strong> A 300mm high opening measured from the floor will help in housekeeping. LOTO if the danger zone is not protected with a guard.</td>
</tr>
<tr>
<td>Cleaning or maintenance of conveyor parts (drums,</td>
<td>LOTO procedures apply.</td>
</tr>
<tr>
<td>rollers, structure, ...)</td>
<td></td>
</tr>
<tr>
<td>Inspection</td>
<td>Permissible at all times as long as the worker remains outside the danger zone. If the conveyor remains operational while the worker enters to make</td>
</tr>
<tr>
<td></td>
<td>contact with a machine part (e.g.: to measure vibrations), the point where the measurements are taken must be protected by a guard. LOTO for all</td>
</tr>
<tr>
<td></td>
<td>other cases.</td>
</tr>
<tr>
<td>Unclogging</td>
<td>LOTO procedures apply.</td>
</tr>
<tr>
<td>Maintenance activities not covered above</td>
<td>LOTO procedures apply at all times.</td>
</tr>
</tbody>
</table>
5- Operators and maintenance operatives training

All operators and maintenance workers who work on or near conveyors must be informed of the hazards they may encounter, and receive training about preventive measures and work procedures. All safety procedures and instructions must be documented.

5.1- Operators training

Only trained and authorized persons must be allowed to start up, operate and interrupt the normal operation of a conveyor. Operators instruction should include:

- Conveyor start-up
- Normal shut-down and emergency stop devices (their locations and how to operate them)
- Required checks before starting a conveyor after an emergency shut-down or accidental stoppage
- Actions to do in order to avoid conveyor overload

Moreover, operators must be trained on LOTO procedure.

5.2- Maintenance operatives training

Maintenance operatives must be trained on LOTO procedures. Moreover, maintenance operatives must ensure that guards and deterrent devices are back in place when maintenance tasks are completed.

5.3- Training checks and recordings

Training materials should remain visual and include an on-site practical session. Training material must be updated in case of accident/incident, in case of change of machines or in case a new risk appears. At the end of the training, an individual test should be performed in order to assess the knowledge of attendees and ensure that the training has been understood. Training documentation (material and attendance sheets) must be easily available.
Trainings outputs should be recorded in a training matrix detailing who (name of the person) has been trained to what (topic of the training). This matrix should be available at site level.

This document is available on Group intranet portal I-Like under the chapter 6 “Standards for performance”. For more information, contact SDD Safety.