

---

---

**Building construction machinery and  
equipment — Mobile crushers —**

**Part 2:  
Safety requirements and verification**

*Machines et matériels pour la construction des bâtiments —  
Concasseurs mobiles —*

*Partie 2: Exigences de sécurité et vérification*

STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019



STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
Foreword .....	v
Introduction .....	vii
<b>1 Scope .....</b>	<b>1</b>
<b>2 Normative references .....</b>	<b>1</b>
<b>3 Terms and definitions .....</b>	<b>3</b>
<b>4 Safety requirements and/or protective/risk reduction measures .....</b>	<b>3</b>
4.1 General .....	3
4.2 Access .....	3
4.3 Operator's station .....	3
4.3.1 General .....	3
4.3.2 Moving parts .....	3
4.3.3 Engine exhaust .....	3
4.3.4 Sharp edges .....	3
4.3.5 Pipes and hoses .....	3
4.3.6 Construction .....	3
4.4 Lighting .....	4
4.5 Operator's controls and indicators .....	4
4.5.1 General .....	4
4.5.2 Emergency stop .....	4
4.5.3 Starting systems .....	5
4.5.4 Inadvertent activation .....	5
4.5.5 Uncontrolled motion .....	5
4.5.6 Remote control .....	5
4.5.7 Control panels, instrument and symbols .....	5
4.6 Steering system .....	6
4.7 Brake systems .....	6
4.7.1 General .....	6
4.7.2 Parking brakes .....	6
4.8 Feed hopper and feed device .....	6
4.8.1 Guarding requirements .....	6
4.8.2 Safety information for the operator's manual .....	6
4.9 Crushing device (crusher) .....	7
4.9.1 Feed opening .....	7
4.9.2 Jaw-type crushing device (jaw-type crusher) .....	7
4.9.3 Horizontal shaft impact (HSI) and vertical shaft impact (VSI) crushing device .....	8
4.9.4 Cone-type crushing device (cone-type crusher) .....	9
4.9.5 Roll-type crushing device .....	9
4.10 By-pass device .....	10
4.10.1 General .....	10
4.10.2 Inadvertent movement .....	10
4.10.3 Prevention of falling material .....	10
4.10.4 Hazard of trapping or entanglement .....	10
4.11 Magnetic separator .....	11
4.11.1 Magnetic hazard .....	11
4.11.2 Magnet discharge .....	11
4.12 Warning devices .....	11
4.13 Stability .....	11
4.14 Noise emission measurement .....	11
4.14.1 Noise reduction at source .....	11
4.14.2 Sound power level .....	11
4.14.3 Sound pressure level .....	12
4.15 Protective measures and devices .....	12
4.15.1 General .....	12

4.15.2	Hot parts	12
4.15.3	Moving parts	12
4.15.4	Guards	12
4.15.5	Isolation of energy sources	13
4.15.6	Sharp edges and acute angles	13
4.15.7	Exhaust gases	13
4.16	Lifting and tie-down	13
4.16.1	Lifting for transport	13
4.16.2	Tie-down for transport	13
4.16.3	Lifting and tie-down for maintenance	13
4.17	Electromagnetic compatibility (EMC)	13
4.18	Electrical and electronic systems	13
4.18.1	General	13
4.18.2	Degrees of protection	14
4.18.3	Electrical connections	14
4.18.4	Over-current protective devices	14
4.18.5	Batteries	14
4.18.6	Battery disconnection	14
4.18.7	Electrical connectors for auxiliary starting aids	15
4.18.8	Electric sockets for lighting	15
4.19	Pressurized systems	15
4.19.1	General	15
4.19.2	Hydraulic lines	15
4.19.3	Hydraulic hoses	15
4.20	Fuel tanks, hydraulic tanks and pressure vessels	15
4.20.1	General	15
4.20.2	Filler openings	16
4.20.3	Fuel tanks	16
4.20.4	Hydraulic tanks	16
4.20.5	Air pressure vessels	16
4.21	Fire protection	16
4.21.1	Fire resistance	16
4.21.2	Fire extinguisher	16
4.22	Maintenance	16
4.22.1	General	16
4.22.2	Frequent maintenance	16
4.22.3	Support devices	17
4.22.4	Access to the engine compartment	17
<b>5</b>	<b>Verification of safety requirements and/or protective/risk reduction measures</b>	<b>17</b>
<b>6</b>	<b>Information for use</b>	<b>17</b>
6.1	Safety labels	17
6.2	Operator's manual	17
6.2.1	Content	17
6.2.2	Storage of manual	19
6.3	Marking	19
<b>Annex A</b>	<b>(informative) List of significant hazards</b>	<b>20</b>
<b>Annex B</b>	<b>(informative) Conveyor guard recommendations</b>	<b>23</b>
<b>Annex C</b>	<b>(informative) Guidelines for safely clearing blocked crushers</b>	<b>33</b>
<b>Bibliography</b>		<b>36</b>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*.

This second edition cancels and replaces the first edition (ISO 21873-2:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

- general — applying to the entire document:
  - "and verification" has been added to the title for consistency;
  - additional clause numbering has been added for better readability and consistency;
  - "this part of ISO 21873" has been changed to "this document";
- in the Introduction, additional information has been added to conform with ISO Guide 78;
- in [Clause 2](#), normative references have been updated as appropriate;
- in [Clause 3](#), a reference to the ISO and IEC terminological databases has been added;
- in [Clause 4](#):
  - [4.2](#) has been simplified as the former text was already covered in the reference;
  - in [4.3.2](#), examples have been added;
  - in [4.4](#), the text related to visibility has been removed as it was ambiguous and not verifiable;
  - in the title of [4.5](#), the term "Operator's" has been added;
  - a new [4.5.6](#) relating to remote control has been added;

## ISO 21873-2:2019(E)

- [4.7](#) on brake systems has been split into 2 parts: one general and one for parking brakes;
- in [4.9](#), the term "crusher" has been replaced by "crushing device";
- in [4.8](#), [4.9](#), [4.10](#), and [4.11](#), titles have been added for better readability;
- in [4.9.5](#), gyratory crushers have been removed and the clause has been rewritten;
- in [4.14](#), an alternative method for noise emission measurement has been added;
- in [4.16](#), lifting and tie-down clarifications have been added on what requirements are for transport and what requirements are for maintenance;
- in [Clause 5](#), clarifications have been made regarding documentation;
- in [Clause 6](#), the term "machine" has been removed when relating to safety labels;
- in [Annex A](#):
  - references have been updated as appropriate;
  - column for ISO 12100-2 has been removed;
- in [Annex C](#), a new general warning related to rock breakers has been added;
- in the Bibliography, the references have been updated and a reference to ISO 13732-1 for hot surfaces has been added.

A list of all parts in the ISO 21873 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019

## Introduction

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organisations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in the case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

This document deals with mobile crushers which are used for crushing rocks or reprocessing construction materials.

STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019

# Building construction machinery and equipment — Mobile crushers —

## Part 2: Safety requirements and verification

### 1 Scope

This document establishes the safety requirements for mobile crushers, as defined in ISO 21873-1, for crushing rocks or for reprocessing construction materials and capable of re-location between worksites.

It applies to mobile crushers that are either

- self-propelled (mounted on a chassis);
- lorry (truck) mounted;
- or semi-trailer mounted.

It does not apply to

- fixed (stationary) crushers;
- large mining-type movable crushers.

This document deals with significant hazards, hazardous situations and events relevant to mobile crushers when used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer.

This document is not applicable to machines which are manufactured before the date of its publication.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2860, *Earth-moving machinery — Minimum access dimensions*

ISO 2867, *Earth-moving machinery — Access systems*

ISO 3457, *Earth-moving machinery — Guards — Definitions and requirements*

ISO 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

ISO 3795, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 6011, *Earth-moving machinery — Visual display of machine operation*

ISO 6405-1, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

## ISO 21873-2:2019(E)

- ISO 6750, *Earth-moving machinery — Operator's manual — Content and format*
- ISO 9244, *Earth-moving machinery — Machine safety labels — General principles*
- ISO 9247, *Earth-moving machinery — Electrical wires and cables — Principles of identification and marking*
- ISO 10264, *Earth-moving machinery — Key-locked starting systems*
- ISO 10265, *Earth-moving machinery — Crawler machines — Performance requirements and test procedures for braking systems*
- ISO 10533, *Earth-moving machinery — Lift-arm support devices*
- ISO 10968:2004, *Earth-moving machinery — Operator's controls*
- ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- ISO 12508, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*
- ISO 13766-1, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 1: General EMC requirements under typical electromagnetic environmental conditions*
- ISO 13766-2, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 2: Additional EMC requirements for functional safety*
- ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*
- ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*
- ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*
- ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*
- ISO 15817, *Earth-moving machinery — Safety requirements for remote operator control systems*
- ISO 15818, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements*
- ISO 15998, *Earth-moving machinery — Machine-control systems (MCS) using electronic components — Performance criteria and tests for functional safety*
- ISO 16528-1, *Boilers and pressure vessels — Part 1: Performance requirements*
- ISO 16528-2, *Boilers and pressure vessels — Part 2: Procedures for fulfilling the requirements of ISO 16528-1*
- ISO 17063, *Earth-moving machinery — Braking systems of pedestrian-controlled machines — Performance requirements and test procedures*
- ISO 21507, *Earth-moving machinery — Performance requirements for non-metallic fuel tanks*
- ISO 21873-1:2015, *Building construction machinery and equipment — Mobile crushers — Part 1: Terminology and commercial specifications*
- IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*
- IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and ISO 21873-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 4 Safety requirements and/or protective/risk reduction measures

#### 4.1 General

**4.1.1** Machinery shall comply with the safety requirements and/or protective/risk reduction measures of this clause.

**4.1.2** In addition, the machine shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

#### 4.2 Access

Access systems shall be in accordance with ISO 2867.

#### 4.3 Operator's station

##### 4.3.1 General

If the travel and working controls are in different locations, the requirements of this document shall be met at each location.

##### 4.3.2 Moving parts

Measures shall be taken to avoid accidental contact from the operating position with moving parts, for example, wheels, tracks or working equipment and/or attachments, in accordance with the relevant sub-clauses of [Clause 4](#).

##### 4.3.3 Engine exhaust

The engine exhaust system shall release the exhaust gas away from the operator.

##### 4.3.4 Sharp edges

The operator's working space within the operator's station, for example, instrument panels and access to the operator's station, shall not present any sharp exposed edges or acute angles/corners. The radius of corners and the bluntness of edges shall comply with ISO 12508, in order to avoid sharp edges.

##### 4.3.5 Pipes and hoses

Pipes and hoses shall be guarded in accordance with [4.19.2](#).

##### 4.3.6 Construction

For self-propelled mobile crushers equipped with an operator station, all handrails shall be constructed in accordance with ISO 2867. Especially for travel, the operator station shall be large enough to prevent injury to the operator during travel over irregular surfaces. It shall include provisions for stopping the

operator from falling on, or being ejected from, the machine and for allowing the operator to maintain control when travelling over irregular surfaces. The operator station shall be provided with a ROPS (roll over protective structure) if there is a risk of the machine rolling over, or FOPS (falling object protective structure) if there is a risk from falling objects.

#### 4.4 Lighting

Machines shall be equipped with lighting devices for travel only. If required, illumination for operation should be provided by surrounding light sources. This shall be noted in the operator's manual.

#### 4.5 Operator's controls and indicators

##### 4.5.1 General

**4.5.1.1** Self-propelled mobile crushers equipped with an operator station for travel shall have the controls (for example, hand levers, joysticks, pedals, switches) and indicators located, designed and manufactured in accordance with ISO 10968, and such that

- a) they are of easy access, in accordance with ISO 6682 and ISO 10968,
- b) the neutral positions of the controls are in accordance with ISO 10968:2004, 5.1.3,
- c) they are clearly identified in accordance with ISO 6405-1 and ISO 6405-2 in the operator's station and explained in the operation manual (see [6.2](#)),
- d) the movement of their controls for activating functions and indicators shall correspond to the intended effect or common practice whenever possible,
- e) the normal engine stop device is within the zone of reach as defined by ISO 6682, when a control such as a keyboard or joystick control (see the requirements for joysticks given in ISO 10968) is designed and constructed to carry out several of the machine's functions, the activated function(s) are clearly identified,
- f) for the safety-related functions of control system(s), the principles outlined in ISO 13849-1 shall be followed.

**4.5.1.2** A mobile crusher shall be equipped with components to allow isolation of the main power source (lockout/tag-out of the machine). This can be accomplished by providing a locking battery disconnect and/or e-stop switch. These lockout/tag-out provisions shall be noted in the operator's manual.

**4.5.1.3** The controls shall include a pre-start warning alerting that a function is about to start in case the operator cannot verify that personnel are clear of all hazard zones from any control position. An acoustic and/or visual warning signal shall be activated prior to the start of a function for a duration sufficient to allow personnel to leave the hazard zone.

##### 4.5.2 Emergency stop

**4.5.2.1** Self-propelled mobile crushers equipped with an operator station for travel shall have an emergency stop conforming to ISO 13850 located in close proximity to the travel controls.

**4.5.2.2** All mobile crushers shall have at least one emergency stop mounted on each side of the machine that is accessible while standing on the ground. Emergency stops shall not be located such that personnel have to enter a hazard zone in order for them to be activated. Emergency stops shall have a provision for isolating the main energy source (lockout provisions), if no other lockout provisions are provided on the machine.

### 4.5.3 Starting systems

Mobile crushers equipped with an on-board power supply (for example, a diesel engine) shall be equipped with a starting system that complies with ISO 10264.

### 4.5.4 Inadvertent activation

**4.5.4.1** Controls that can cause a hazard due to inadvertent activation shall be so arranged, deactivated or guarded as to minimize the risk — particularly while the operator is getting into or out of the operator's station. The deactivation device shall either be self-acting or shall act by compulsory actuation of the relevant device.

**4.5.4.2** Controls shall be placed automatically in a neutral (or safe) starting condition when the mobile crusher is shut down so as to prevent accidental activation at re-start.

**4.5.4.3** Where there is more than one control position, the control system shall be designed such that one control position will preclude the use of controls in other positions. This does not include stop controls or emergency stops.

### 4.5.5 Uncontrolled motion

Machine and equipment/attachment movement from the holding position — other than by actuation of the controls by the operator — due to drift or creep (for example, by leaking) or when power supply stops, shall be limited to the extent that it cannot create a risk to exposed persons.

### 4.5.6 Remote control

Remote operator control used for machine travel and operation shall comply with ISO 15817. The remote control shall

- a) provide neutral control positions in accordance with ISO 10968, and
- b) identify each control and explain it in the operator's manual (see ISO 6405-1 and ISO 7000).

### 4.5.7 Control panels, instrument and symbols

#### 4.5.7.1 Control panels

Control panels for self-propelled mobile crushers equipped with machine-mounted operator stations shall be located to minimize visual obstructions. The operator shall be able to see from this operator's station, in either daylight or darkness, the necessary indicators allowing a check of the proper function of the machine. Glare shall be minimized. Switches, instruments and indicator lights on machine-mounted panels shall be designed for visibility in low light conditions.

#### 4.5.7.2 Operating instrumentation

Control indicators for the safe and proper operation of the machine shall be in accordance with ISO 6011 in respect of the use of safety colours (in compliance with IEC 60204-1) and related aspects.

#### 4.5.7.3 Symbols

For symbols used on operator controls and other displays on mobile crushers, see, for example, ISO 6405-1 or ISO 6405-2 or ISO 7000.

## 4.6 Steering system

The steering system shall be such that the movement of the steering control corresponds to the intended direction of steering according to ISO 10968.

## 4.7 Brake systems

Self-propelled, lorry (truck) mounted and semi-trailer mounted mobile crushers shall be equipped with service, emergency, and parking brake systems.

### 4.7.1 General

**4.7.1.1** All brake systems shall be designed to perform adequately under all intended service conditions, including load, speed, terrain and slope.

**4.7.1.2** Self-propelled mobile crushers equipped with tracks shall be provided with service and parking brake systems. The service brakes for these mobile crushers shall be individually controlled, one for each track, and may be combined with the steering system.

**4.7.1.3** Brake systems for wheeled self-propelled mobile crushers with an off-road chassis shall comply with ISO 3450.

**4.7.1.4** Brake systems for wheeled self-propelled mobile crushers with an on-road chassis are deemed to comply with national and/or regional requirements for road vehicles.

**4.7.1.5** Brake systems for self-propelled mobile crushers equipped with tracks shall comply with ISO 10265 (design speed 20 km/h or less) or ISO 17063 (design speed less than 6 km/h), according to the speed capability of the tracks.

### 4.7.2 Parking brakes

The parking brakes shall be of a size sufficient to withstand the mass of the machine, at the maximum incline recommended by the machine manufacturer.

## 4.8 Feed hopper and feed device

### 4.8.1 Guarding requirements

An emergency stop device shall be mounted with easy access for personnel standing on the platform facing the crusher and/or feed device. The emergency stop device shall be as specified in 4.5.2. A guard shall be provided to protect the operator from material ejected from the crusher. Parts transmitting power to the feed device (for example, flywheels, drive belts) shall be guarded. If inspection openings are added to drive guards, they shall be enclosed by a cover that is keyed or requires the use of tools to open.

### 4.8.2 Safety information for the operator's manual

The following shall be noted in the operator's manual.

- “Stop the feed device, shut down power to the machine and lockout/tag-out the energy sources before entering the feed device for any reason.” This should also be indicated by the use of a machine safety label affixed to the equipment.
- “Stand clear of the feed hopper to avoid injury due to falling material.” This should also be indicated by the use of a machine safety label affixed to the equipment.

- Location of pinch points that can cause injury, with particular mention of the surging action of a vibratory feeder when started and stopped. Pinch points should also be indicated by the use of a machine safety label affixed to the equipment.
- “Stop equipment and shut down power to the machine and lockout/tag-out the energy sources before performing any maintenance on the equipment.” This should also be indicated by the use of a machine safety label affixed to the equipment.
- “All guards shall be in place before starting the feeder.” This should also be indicated by the use of a machine safety label affixed to the equipment.

## 4.9 Crushing device (crusher)

### 4.9.1 Feed opening

#### 4.9.1.1 Guarding requirements

The feed opening of the crusher shall be provided with a guard to minimize hazards caused by ejected material.

#### 4.9.1.2 Safety information for the operator's manual

4.9.1.2.1 The following shall be included in the operator's manual:

- the types of material the crusher is intended to process;
- the maximum feed size for material fed to crusher;
- a procedure for safely removing blockages and foreseen risks associated with the particular activity (see [Annex C](#)).

4.9.1.2.2 The operator's manual shall also indicate the proper set-up, operation and maintenance of the guards for the crushing device as specified in [4.9.2](#) to [4.9.5](#).

4.9.1.2.3 See below for indications specific to a crushing unit that are also to be included in the operator's manual.

### 4.9.2 Jaw-type crushing device (jaw-type crusher)

#### 4.9.2.1 Guarding requirements

4.9.2.1.1 If a platform is mounted in close proximity to the feed opening of a jaw-type crusher, a guard shall be provided to prevent the operator from falling into the feed opening. The minimum height of the guard shall be 1,1 m above the walking surface of the platform. The platform shall be positioned so as to minimize direct exposure to material ejected from the crusher. An emergency stop device, as specified in [4.5.2](#), shall be mounted on the platform.

4.9.2.1.2 The following areas shall also be guarded:

- parts transmitting power to the crusher (flywheels, drive belts, etc.);
- pinch points in areas accessed during normal operation or maintenance (including coil springs that compress during operation).

#### 4.9.2.2 Inspection openings

If inspection openings are added to drive guards, they shall be enclosed with a cover that requires a key or the use of tools to open.

#### 4.9.2.3 Maintenance

**4.9.2.3.1** A safe method for preventing the unintended swing of the movable jaw of a jaw-type crusher during maintenance shall be included in the operator's manual.

**4.9.2.3.2** Compression springs and tension rods shall be guarded so as to contain any sudden release of energy in the event of component failure. These guards shall remain in position when routine maintenance is performed on the crusher.

#### 4.9.3 Horizontal shaft impact (HSI) and vertical shaft impact (VSI) crushing device

##### 4.9.3.1 Guarding requirements

**4.9.3.1.1** If a platform is mounted in close proximity to the feed opening of the HSI or VSI crusher, a guard shall be provided to prevent the operator from falling into the feed opening. The minimum height of the guard shall be 1,1 m above the walking surface of the platform. The platform shall be positioned so as to minimize direct exposure to material ejected from the crusher. An emergency stop device, as specified in [4.5.2](#), shall be mounted on the platform.

**4.9.3.1.2** All coil springs that compress during operation shall be guarded to prevent pinch points.

**4.9.3.1.3** Parts transmitting power to the crusher (flywheels, drive belts, etc.) shall be guarded.

**4.9.3.1.4** Guards shall be in accordance with [4.15.4](#).

##### 4.9.3.2 Inspection doors and openings

**4.9.3.2.1** All inspection doors into the crusher shall be able to withstand forces generated during normal crushing operations, and shall require a key or the use of tools to open.

**4.9.3.2.2** Means shall be provided for verifying whether the main shaft of the crushing device is rotating or has stopped, without opening the crusher and without the need to use a tool for access.

**4.9.3.2.3** If inspection openings are added to drive guards, they shall be enclosed with a cover that requires a key or the use of tools to open.

##### 4.9.3.3 Maintenance

**4.9.3.3.1** When the frame for the crusher has been opened for maintenance, the moving frame section shall be held open by mechanical means to prevent accidental closure. If the centre of gravity of the moving frame section is positioned to prevent the crusher frame from closing, external assistance is not required. A counterbalance valve mounted directly on the ports of a hydraulic cylinder or built into the hydraulic cylinder is considered to be a mechanical lock.

**4.9.3.3.2** Compression springs and tension rods shall be guarded so as to contain any sudden release of energy in the event of component failure. These guards shall remain in position when routine maintenance is performed on the crusher.

**4.9.3.3.3** A mechanical locking device shall be included to prevent the rotor(s) from turning unexpectedly during routine maintenance. The device shall be able to withstand a shift in the centre of gravity due to maintenance, but is not required to withstand the torque of the device that powers the crusher. Mechanical locking devices shall be automatically actuated or actuated by hand without the means of an external power source.

**4.9.3.3.4** A device shall be mounted on the crusher to prevent the crusher drive motor from starting while the crusher frame is open for maintenance.

#### **4.9.4 Cone-type crushing device (cone-type crusher)**

##### **4.9.4.1 Guarding requirements**

**4.9.4.1.1** If a platform is mounted in close proximity to the feed opening of the crusher, a guard shall be provided to prevent the operator from falling into the feed opening. The minimum height of the guard shall be 1,1 m above the walking surface of the platform. The platform shall be positioned so as to minimize direct exposure to material ejected from the crusher. An emergency stop device, as specified in [4.5.2](#), shall be mounted on the platform.

**4.9.4.1.2** When a cone-type crusher is fitted with coil springs as a tramp release mechanism, compression springs and tension rods shall be guarded to contain any sudden release of energy in the event of component failure. These guards shall remain in position when routine maintenance is performed on the crusher.

**4.9.4.1.3** All coil springs that compress during operation shall be guarded to prevent pinch points.

**4.9.4.1.4** Parts transmitting power to the cone-type crusher (flywheels, drive belts, etc.) shall be guarded.

**4.9.4.1.5** If a crusher is equipped with an overload protection system, it shall be guarded to contain sudden release of energy in case of a component failure. These guards shall remain in position when routine maintenance is performed on the crusher. The operator's manual shall show proper set-up, operation, and maintenance for the guard.

**4.9.4.1.6** Guards shall be in accordance with [4.15.4](#).

##### **4.9.4.2 Inspection openings**

If inspection openings are added to drive guards, they shall be enclosed with a cover that requires a key or the use of tools to open.

##### **4.9.4.3 Maintenance**

A safe procedure shall be given in the operator's manual on how to install and exchange the hydraulic cylinder, eccentric assembly, main shaft and spider.

#### **4.9.5 Roll-type crushing device**

##### **4.9.5.1 Guarding requirements**

**4.9.5.1.1** If a platform is mounted in close proximity to the feed opening of the crusher, a guard shall be provided to prevent the operator from falling into the feed opening. The minimum height of the guard shall be 1,1 m above the walking surface of the platform. The platform shall be positioned so as to

minimize direct exposure to material ejected from the crusher. An emergency stop device, as specified in [4.5.2](#), shall be mounted on the platform.

**4.9.5.1.2** The following areas shall also be guarded:

- parts transmitting power to the crusher (flywheels, drive belts, etc.);
- pinch points in areas accessed during normal operation or maintenance (including coil springs that compress during operation).

**4.9.5.1.3** When a roll-type crusher is fitted with coils springs as a tramp release mechanism, compression springs and tension rods shall be guarded to contain any sudden release of energy in the event of component failure. These guards shall remain in position when routine maintenance is performed on the crusher.

**4.9.5.1.4** Guards shall be in accordance with [4.15.4](#).

#### **4.9.5.2 Inspection openings**

If inspection openings are added to drive guards, they shall be enclosed with a cover that requires a key or the use of tools to open.

#### **4.9.5.3 Maintenance**

Instructions for the safe maintenance of the roll cleaning devices shall be included in the operator's manual.

### **4.10 By-pass device**

#### **4.10.1 General**

Bypass devices (e.g., chute, belt conveyor, vibrating screen) shall be designed to protect against:

- a) inadvertent movement;
- b) falling material;
- c) trapping or entanglement.

#### **4.10.2 Inadvertent movement**

For inclined conveyors, a means shall be provided to prevent a loaded conveyor from moving in the reverse direction of operational travel when the power is turned off.

#### **4.10.3 Prevention of falling material**

Conveyor systems shall be designed to minimize spillage of material. A falling material machine safety label should be affixed to the sides of the conveyor in a place that is visible to personnel working in the hazard zone.

#### **4.10.4 Hazard of trapping or entanglement**

All nip points between ground level and 2,5 m above the ground shall be guarded. Guards are not required for areas that are inaccessible due to location during normal operation, e.g. where access to a tail pulley is blocked by tracks and/or frame members.

NOTE [Annex B](#) can be used to identify potential nip points and offers some general recommendations for guarding.

## 4.11 Magnetic separator

### 4.11.1 Magnetic hazard

A machine safety label, in accordance with ISO 9244, indicating a hazard caused by the magnet to people with pacemakers shall be affixed to the machine. This should be placed in a location where it is visible both to personnel working around the unit and from outside the hazard zone. This information shall also be included in the operator's manual.

### 4.11.2 Magnet discharge

**4.11.2.1** The discharge area for the magnet shall be designed to minimize the scattering of discharge material. A machine safety label, in accordance with ISO 9244, indicating a hazard due to discharged material shall be affixed to the machine. This should be placed in a location where it is visible both to personnel working around the unit and from outside the hazard zone. This information shall also be included in the operator's manual.

**4.11.2.2** In addition, gaps in the product conveyor around the magnet discharge area should be designed to minimize intrusion of material discharged from the magnet into the working parts of the conveyor.

## 4.12 Warning devices

The machine shall be equipped with the following:

- a) an audible warning device, whose A-weighted sound pressure level shall be as per EN ISO 7731, measured 7 m from any point on the machine;
- b) machine safety labels and hazard pictorials in accordance with ISO 9244.

## 4.13 Stability

**4.13.1** Machines shall be designed and constructed so as to be stable in all intended operating and travel conditions. This includes all attachments designed by the original manufacturer for use with the machine. The recommended operation limits shall be listed in the operator's manual.

**4.13.2** Devices intended to improve machine stability in operation mode (e.g. outriggers or oscillating axle locks) shall be equipped with a means to lock the device in case of an external system failure, such as hose failure.

## 4.14 Noise emission measurement

### 4.14.1 Noise reduction at source

Machines shall be designed and constructed so as to minimize the emission of operational noise and noise coming from structural vibration. It is recommended that noise be reduced at its source wherever possible.

### 4.14.2 Sound power level

**4.14.2.1** The sound power level shall be measured in accordance with ISO 3744, ISO 3746 or ISO 9614-1, as appropriate.

**4.14.2.2** Acoustic testing shall be completed in operation mode with every device running at maximum speed, but without crushable material.

**4.14.2.3** The sound power level test results shall be given in the operator's manual, expressed in A-weighted decibels.

#### **4.14.3 Sound pressure level**

**4.14.3.1** Measuring sound pressure level, as an alternative to measuring sound power level, shall be in accordance with ISO 11201 and ISO 11202.

**4.14.3.2** Acoustic testing shall be completed in operation mode with every device running at maximum speed, but without crushable material.

**4.14.3.3** The sound pressure level test results shall be given in the operator's manual, expressed in A-weighted decibels.

**NOTE** Noise emission values obtained from measurements are the accepted means of verifying the result of the noise-reduction measures taken at the machine design stage.

#### **4.15 Protective measures and devices**

##### **4.15.1 General**

The recommended safe operating and maintenance procedures shall be specified in the operator's manual.

##### **4.15.2 Hot parts**

**4.15.2.1** Parts which become hot in operation shall be designed, constructed, positioned or provided with a thermal guard to minimize the risk of contact with hot parts and/or surfaces in close proximity to the primary opening, operating position and maintenance area, in accordance with ISO 3457.

**4.15.2.2** For ergonomic data that can be used to establish temperature limit values for hot surfaces, see ISO 13732-1.

##### **4.15.3 Moving parts**

Risks associated with all moving parts shall be addressed by the fitting of guards, protective devices, or by applying the minimum safety distances described in ISO 13857. The panels that enclose the engine compartment (partition, hood, etc.) shall be considered as protective devices, provided they comply with the access requirements given in [4.22.3](#).

##### **4.15.4 Guards**

Guards shall be designed in accordance with ISO 14120 and such that they are securely held in place and prevent access to an area where a hazard exists.

###### **4.15.4.1 Fixed guards**

Fixed guards shall be provided for areas requiring occasional access. Attachment and removal by means of a key or tool is permitted.

###### **4.15.4.2 Movable guards**

Movable guards may be provided for areas requiring frequent access. Movable guards should remain attached to the machine whenever possible. Large or heavy movable guards shall be equipped with a support system (e.g. gas spring or hydraulic cylinder) that secures them in the open position. The support system shall be able to hold the guard in position against forces generated by wind up to a velocity of 8 m/s.

#### 4.15.5 Isolation of energy sources

A mobile crusher shall be fitted with means to isolate it from all energy sources (e.g. mechanical, electrical, hydraulic and pneumatic). Such isolators shall be clearly identified and should be lockable in the "OFF" position (see ISO 12100:2010 and IEC 60204-1). The capability shall be provided to safely dissipate stored energy in circuits after isolation of energy sources.

#### 4.15.6 Sharp edges and acute angles

Sharp edges and acute angles shall be in accordance with ISO 12508 in those areas that can be accessed during operation and daily maintenance, except for the area of the attachment. See also [4.3.4](#).

#### 4.15.7 Exhaust gases

The engine exhaust system shall release the exhaust gas away from personnel working on or around the equipment.

### 4.16 Lifting and tie-down

#### 4.16.1 Lifting for transport

**4.16.1.1** Lifting provisions shall be installed to lift the entire machine and/or subassemblies intended to be lifted or removed for transport. The lifting provisions shall be sized to support the mass of the heaviest configuration of the machine or subassembly.

**4.16.1.2** The lift points shall be identified with machine safety labels, in accordance with ISO 9244, affixed to the machine in close proximity to each lift point. The lift points shall also be identified in the operator's manual. In addition, any special procedure for lifting the machine or subassemblies shall be included in the operator's manual. Lifting provisions shall conform to ISO 15818.

#### 4.16.2 Tie-down for transport

Tie-down provisions shall be installed on machines that are intended to be transported on a trailer. The tie-downs shall be identified by means of a machine safety label, in accordance with ISO 9244, affixed to the machine in close proximity to each tie-down point. The symbol ISO 7000-2069 (see ISO 6405-1) shall be used for identification. Tie-down provisions shall conform to ISO 15818.

#### 4.16.3 Lifting and tie-down for maintenance

Lifting and/or tying-down points of components or subassemblies, which are not intended for lifting and/or tying down the whole machine, shall not be marked in accordance with [4.16.1](#), and these points shall be clearly described with text and figures in the manufacturer's instructions (e.g. operator's manual, service manual).

### 4.17 Electromagnetic compatibility (EMC)

Machines shall comply with the requirements of electromagnetic compatibility given in ISO 13766-1 and ISO 13766-2.

### 4.18 Electrical and electronic systems

#### 4.18.1 General

**4.18.1.1** Electrical voltages inside control and junction boxes shall be given in the operator's manual.

**4.18.1.2** Electrical components and conductors shall be installed in such a way to avoid damage from exposure to environmental conditions (corresponding to the intended use of the machine) that can cause deterioration. Electrical component insulation shall have flame-retardant properties. Lead-through, for example, through frames and bulkheads, shall be protected from abrasion.

**4.18.1.3** Electrical wires/cables not protected by over-current devices shall not be strapped in direct contact with pipes and hoses containing fuel.

**4.18.1.4** Safety-related machine control systems using electronic components shall comply with ISO 15998 or other standards providing equivalent integrity.

#### **4.18.2 Degrees of protection**

Depending on the location/installation of electrical and electronic components, the following degrees of protection are required:

- all components installed exterior to the machine or directly exposed to the environment shall have the minimum degree of protection according to IEC 60529, IP 55;
- conductors and components shall be selected to withstand the operational environment corresponding to the intended use of the machine;
- for outlet sockets equipped with a circuit breaker, the degree of protection shall be at least IP3X according to IEC 60529.

#### **4.18.3 Electrical connections**

**4.18.3.1** In order to avoid incorrect connections, electrical wires and cables used to connect components in electric circuits shall be marked and identified. ISO 9247 should be used as guidance.

**4.18.3.2** This requirement does not apply to the electrical circuits of anti-theft systems.

#### **4.18.4 Over-current protective devices**

Electric equipment, except for the starter motor, alternator and pre-heater, shall be protected with an over-current protective device (e.g. fuse) or other device giving the same protection.

#### **4.18.5 Batteries**

**4.18.5.1** Batteries shall be firmly attached in a ventilated space. The location should be easily accessible. Batteries should be easily removable. The batteries shall be provided with handles and/or grips.

**4.18.5.2** Batteries and/or battery locations shall be designed and built or covered so as to minimize any hazard to the operator caused by battery acid or acid vapours in the event of the machine overturning.

**4.18.5.3** Live parts (not connected to the frame) and connectors shall be covered with insulation material.

#### **4.18.6 Battery disconnection**

**4.18.6.1** It shall be possible to disconnect batteries easily, for example, by a quick coupling or an accessible isolator switch. The symbol ISO 7000-2063 (see ISO 6405-1) shall be used for identification.

**4.18.6.2** Battery disconnect switches should have a provision for isolating the main energy source (lockout provisions).

#### 4.18.7 Electrical connectors for auxiliary starting aids

If electrical connectors for auxiliary starting aids or power supply are mounted on the machine, the connectors shall be in accordance with ISO 11862.

#### 4.18.8 Electric sockets for lighting

**4.18.8.1** An electric socket intended for the connection of a lighting device for service and maintenance use shall be provided on the machine and shall be easily accessible.

**4.18.8.2** The design of the sockets shall be such as to prevent incorrect connection.

### 4.19 Pressurized systems

#### 4.19.1 General

Pressurized equipment shall be designed in accordance with ISO 4413 and shall be designed and constructed so as to withstand loading to the pressure to which they are subjected.

#### 4.19.2 Hydraulic lines

Pipes and hoses shall be located and, if necessary, restrained so as to minimize deterioration, e.g. through contact with hot surfaces, sharp edges and other damage-causing sources. Visual inspection of hoses and fittings shall be possible. Pipes and hoses located inside frames are exempt from this requirement.

#### 4.19.3 Hydraulic hoses

**4.19.3.1** Hydraulic hoses containing fluid with a pressure of more than 5 MPa (50 bar) and/or a temperature of more than 50 °C, and which are located within 1,0 m from any surface of DLV (deflection limiting volume, as defined in ISO 3164), shall be guarded in accordance with ISO 3457.

NOTE 1 bar = 0,1 MPa =  $10^5$  Pa; 1 MPa = 1 N/mm<sup>2</sup>.

**4.19.3.2** Any part or component that diverts a possible jet of fluid may be regarded as providing sufficient protection.

**4.19.3.3** Hoses intended to withstand a pressure of more than 15 MPa (150 bar) shall not be fitted with reusable fittings unless they require the use of dedicated tooling (such as a press) and are parts authorized by the machine manufacturer.

**4.19.3.4** Hoses and fittings intended to be reused shall be inspected and assembled according to the manufacturer's instructions.

**4.19.3.5** Hoses containing pressurized hydraulic fluid or other flammable fluids that are located close to a hot surface (such as an engine exhaust manifold) shall be guarded in order to minimize fluid contact with the hot surface in case of hose rupture.

### 4.20 Fuel tanks, hydraulic tanks and pressure vessels

#### 4.20.1 General

Fuel and hydraulic tanks shall be provided with a fluid level indicator. Pressure in the tanks exceeding the specified pressure shall be automatically compensated by a suitable device (vent, safety valve, etc.).

#### 4.20.2 Filler openings

The filler openings of tanks shall be easily accessible for filling (ground level fuel access is preferred) and have provisions for lockable filler caps, except for filler caps located inside lockable compartments (such as the engine compartment) or caps that can only be opened with a special tool.

#### 4.20.3 Fuel tanks

Fuel tanks shall withstand an internal pressure of 0,03 MPa (0,3 bar) without permanent deformation or leakage. Non-metallic fuel tanks shall be designed and tested in accordance with ISO 21507.

#### 4.20.4 Hydraulic tanks

Hydraulic tanks shall not be regarded as "pressure vessels".

#### 4.20.5 Air pressure vessels

Simple pressure vessels shall be designed and tested in accordance with ISO 16528-1 and ISO 16528-2.

### 4.21 Fire protection

#### 4.21.1 Fire resistance

If an enclosed operator station is installed on the machine, its interior, upholstery and insulation and other parts of the machine where insulation materials are used shall be made of flame-retardant materials. The burning rate shall not exceed 200 mm/min, tested in accordance with ISO 3795.

#### 4.21.2 Fire extinguisher

The mobile crusher shall have space for the installation of a fire extinguisher or extinguishers, easily accessible to the operator, or shall have a built-in extinguishing system to permit the operator safe exit from the machine.

### 4.22 Maintenance

#### 4.22.1 General

**4.22.1.1** Machines shall be designed and built such that routine lubrication and maintenance operations can be carried out safely, whenever possible with the engine stopped or with the power disconnected. Where it is only possible to undertake checks or maintenance with the engine running or power connected, the safe procedure shall be described in the operator's manual.

**4.22.1.2** Openings intended for maintenance purposes shall comply with ISO 2860.

**4.22.1.3** If possible, the design of the machine shall permit lubrication and filling of tanks from the ground.

#### 4.22.2 Frequent maintenance

**4.22.2.1** Components (batteries, lubrication fittings, filters, etc.) that require frequent maintenance shall be accessible from the ground or means of access shall be provided according to ISO 2867.

**4.22.2.2** A lockable storage box for tools and accessories, recommended by the manufacturer, should be provided on the machine.

### 4.22.3 Support devices

4.22.3.1 On machines where maintenance can only be performed with equipment in a raised position, such equipment shall be mechanically secured with a device in accordance with ISO 10533.

4.22.3.2 If the support device or devices are required for daily maintenance, they shall be permanently affixed to the machine or shall be stored in a secure place on the machine.

4.22.3.3 Engine access panels shall be provided with a device to hold them in the open position.

### 4.22.4 Access to the engine compartment

The engine compartment shall be guarded against unauthorized access by means of one of the following:

- a) a locking device;
- b) a panel installation that requires the use of a key or tool;
- c) a latch with access inside a lockable area.

## 5 Verification of safety requirements and/or protective/risk reduction measures

Verification of the safety requirements and/or protective/risk reduction measures specified in this document shall be carried out by the use of one or a combination of the following means:

- a) measurement;
- b) visual examination;
- c) as appropriate, testing means using a method as specified in this document;
- d) by assessment of the contents of the documentation required to be kept by the manufacturer, e.g. evidence that bought-in components have been manufactured to the required standard.

## 6 Information for use

### 6.1 Safety labels

6.1.1 Safety labels conforming to ISO 9244 shall be affixed so as to effectively warn against hazards that are not immediately obvious. Warnings against obvious hazards shall be conspicuously affixed near the approach or vicinity of the hazard. Any written or verbal information included in the label or added to the machine (e.g. by stencilling) shall be in the same language(s) as the operator's manual.

6.1.2 All machine safety labels shall be shown and explained in the operator's manual. It is preferred that the location of the label on the machine also be shown in the operator's manual.

### 6.2 Operator's manual

#### 6.2.1 Content

6.2.1.1 The operator's manual shall give instructions for operation and maintenance, and shall be supplied with the machine. The format and content shall be in accordance with ISO 6750 and ISO 12100:2010, 6.4.5.

**6.2.1.2** The intended uses of the machine under normal conditions and for operations described by the manufacturer shall be stated, including attachments, tools and accessories that the manufacturer can provide. Instructions on the correct assembly and use of attachments and accessories shall be included in the machine operator's manual or in a separate, additional manual.

**6.2.1.3** The terms, definitions, units and symbols should comply with the relevant International Standards. The operator's manual shall contain the following, as applicable:

- a) a description of the machine;
- b) the machine specifications;
- c) a description of the instrumentation and operator controls;
- d) a statement as to the need for personal protection equipment, if necessary;
- e) instructions to clear the feed device and under-crusher conveyor, stop the crusher, then shut down power to the machine and lockout/tag-out the energy sources before entering the crusher for any reason;
- f) information on the location of any pinch points that could cause injury during operation or routine maintenance;
- g) instructions to stop the equipment and shut down power before performing any maintenance on it;
- h) instructions that all guards shall be in place before starting the crusher;
- i) safety-relevant technical data;
- j) an indication of the need for a well-trained and competent operator;
- k) an indication that the operator and other personnel are to fully acquaint themselves with the operator's manual before operating the machine;
- l) a description of the hazard zones around the machine and a warning that all personnel are to stay out of hazard zones during machine operation or maintenance;
- m) instructions for the machine user to determine whether special hazards such as toxic gases or ground (underfoot) conditions are present and whether special precautions or measures to eliminate or reduce these are required;
- n) operating instructions (e.g. use of intended access systems, proper use of each device and check procedures);
- o) the procedure for safe set-up, tear-down and transportation of the machine;
- p) safety documentation such as the procedure for clearing blocked crushers (see [Annex C](#));
- q) a list of the masses of each component and sub-assembly that will need to be lifted during set-up, operation and maintenance of the machine;
- r) the procedures for safely lifting the machine and attachments or sub-assemblies as necessary for set-up, operation and maintenance of the machine as intended by the manufacturer's provisions against entering hazard zones;
- s) safety precautions for minimizing possible chemical hazards during operation, maintenance and dismantling;
- t) the sound power level of exterior noise and its test conditions;
- u) any other safety-related items specified in this document.

### 6.2.2 Storage of manual

For self-propelled mobile crushers, a space near the operator control station should be provided in which to store the operator's manual. This storage space shall be protected as much as possible from environmental influences and from pollution from machine components.

### 6.3 Marking

Each machine shall, as a minimum, bear the following minimal information in a legible and indelible condition:

- a) name and address of the manufacturer;
- b) mandatory marking;
- c) designation of series or type;
- d) serial number, e.g. PIN according to ISO 10261;
- e) mass of the machine in operating mode.

STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019

## Annex A (informative)

### List of significant hazards

**Table A.1 — List of significant hazards**

No.	Hazardous situation and event	Clause/subclause of this document Clause/subclause of this part of ISO 4254
<b>A.1</b>	<b>Mechanical hazards</b>	
	Parts and components EXAMPLE Shape, relative location, substance, velocity, or mechanical strength	<a href="#">4.3.4</a> , <a href="#">4.8</a> , <a href="#">4.9</a> , <a href="#">4.10</a> , <a href="#">4.11.2</a> , <a href="#">4.13</a>
	Stored energy EXAMPLE Elastic elements (springs), liquids or gases under pressure or vacuum	<a href="#">4.3.5</a> , <a href="#">4.19</a>
A.1.1	Crushing	<a href="#">4.8</a> , <a href="#">4.9</a> , <a href="#">4.15.3</a>
A.1.2	Shearing	<a href="#">4.8</a> , <a href="#">4.9</a>
A.1.3	Cutting or severing	<a href="#">4.3.4</a> , <a href="#">4.9</a>
A.1.4	Entanglement and drawing-in or trapping	<a href="#">4.8</a> , <a href="#">4.9</a> , <a href="#">4.10.1</a> , <a href="#">4.10.3</a> , <a href="#">Annex B</a>
A.1.5	Impact	<a href="#">4.5.5</a> , <a href="#">4.8</a> , <a href="#">4.9</a> , <a href="#">4.10.2</a> , <a href="#">4.11.2</a> , <a href="#">4.13</a>
A.1.6	Stabbing or puncture	<a href="#">4.9</a> , <a href="#">4.19</a>
A.1.7	Friction or abrasion	<a href="#">4.8</a> , <a href="#">4.9</a>
A.1.8	High-pressure fluid injection or ejection	<a href="#">4.3.5</a> , <a href="#">4.19</a>
<b>A.2</b>	<b>Electrical hazards</b>	
A.2.1	Contact (direct) with live parts	<a href="#">4.18</a>
A.2.2	Thermal radiation, protection of molten particles or chemical effects of short-circuits or overloads	<a href="#">4.18.5</a>
<b>A.3</b>	<b>Thermal hazards</b>	
A.3.1	Burns or scalds from an extreme temperature, flames or explosions and radiation from heat sources	<a href="#">4.3.5</a> , <a href="#">4.19</a>
<b>A.4</b>	<b>Hazards generated by noise</b>	
A.4.1	Permanent hearing loss (tinnitus), physical disorder (tired- ness, stress, loss of balance, loss of awareness)	<a href="#">4.14</a>
A.4.2	Interference with speech communication, acoustic signals, other noises	<a href="#">4.14</a>
<b>A.5</b>	<b>Hazards generated by materials and substances</b>	
A.5.1	Ingestion or inhalation of fluids, gases, mists, fumes, fibres, dusts or aerosols	<a href="#">4.3.3</a> , <a href="#">4.15.7</a> , <a href="#">4.18.5</a>
A.5.2	Fire and explosion	<a href="#">4.21</a>
<b>A.6</b>	<b>Crushing</b>	
A.6.1	Unhealthy postures, excessive or repetitive efforts	<a href="#">4.2</a> , <a href="#">4.3.6</a>
A.6.2	Arm and leg anatomy	<a href="#">4.3.6</a>
A.6.3	No use of personal protective equipment	<a href="#">6.2.1</a>
A.6.4	Inadequate local lighting	—

Table A.1 (continued)

No.	Hazardous situation and event	Clause/subclause of this document Clause/subclause of this part of ISO 4254
A.6.5	Mental overload or under load, stress	<a href="#">4.3</a>
A.6.6	Human error	<a href="#">4.3, 4.4, 4.10, 4.18.3, 4.22</a>
A.6.7	Selecting, locating and identifying manual controls	<a href="#">4.5, 4.6, 4.7, 4.10</a>
A.6.8	Selecting, designing, locating visual display units	<a href="#">4.5, 6.1</a>
A.6.9	Assembly	<a href="#">4.2, 4.3, 4.4, 4.9</a>
A.6.10	Guards and protective devices	<a href="#">4.3.6, 4.8, 4.9, 4.10, 4.11.1, 4.22.3</a>
A.6.11	Location and movement	<a href="#">4.3.6, 4.5</a>
A.6.12	Locating maintenance, lubrication, setting points for access to danger zones	<a href="#">4.2, 4.8, 4.9, 4.10, 4.20, 4.22</a>
A.7	Unintended/unexpected start-up, uncontrolled speed change	
A.7.1	Failure of control system	<a href="#">4.5.5, 4.18</a>
A.7.2	Electromagnetic compatibility	<a href="#">4.17</a>
A.7.3	Error by operator (mismatch with human characteristics and abilities)	<a href="#">4.5.4</a>
A.8	Impossibility of stopping under optimum conditions	<a href="#">4.5, 4.7, 4.10.1</a>
A.9	Internal power source	<a href="#">4.10.1</a>
A.10	Failure of safety functions	<a href="#">4.18</a>
A.11	Error of stoppers	<a href="#">4.9, 4.19</a>
A.12	Falling/exploding materials or liquids	<a href="#">4.3.5, 4.8, 4.9, 4.10.2, 4.11, 4.19</a>
A.13	Lack of machine stability/overturn	<a href="#">4.13, 4.16</a>
A.14	Slipping, tripping and falling	<a href="#">4.2, 4.8, 4.9</a>
A.15	Hazards generated by machine movement	
A.15.1	Related to travelling	
A.15.1.1	Engine start-up	<a href="#">4.5.3</a>
A.15.1.2	Absence of operator at control position	<a href="#">4.5.6</a>
A.15.1.3	Travelling function	<a href="#">4.5.2, 4.7</a>
A.15.1.4	Slowdown, cease, stop	<a href="#">4.7</a>
A.15.1.5	Remote control	<a href="#">4.5.6</a>
A.15.2	Related to machine working position	
A.15.2.1	Falls from lifting platform	<a href="#">4.2, 4.3.6, 4.8, 4.9</a>
A.15.2.2	Emissions/lack of oxygen	<a href="#">4.3.3, 4.15.7</a>
A.15.2.3	Fire (flammability, lack of oxygen)	<a href="#">4.20.3, 4.21</a>
A.15.2.4	Working position	
	a) wheel collision	<a href="#">4.3.2</a>
	b) rolling over	<a href="#">4.13</a>
	c) falling, going through	<a href="#">4.10.2</a>
A.15.2.5	Inappropriate work/light	<a href="#">4.4</a>
A.15.2.6	Noise	<a href="#">4.14, 6.2</a>
A.15.3	Related to control system	
A.15.3.1	Design of control system	<a href="#">4.6, 4.18</a>
A.15.3.2	Unsuitable design of control system	<a href="#">4.5</a>
A.15.3.3	Design of manual control systems/operating mode	<a href="#">4.5</a>

Table A.1 (continued)

No.	Hazardous situation and event	Clause/subclause of this document Clause/subclause of this part of ISO 4254
A.16	Machine handling	<a href="#">4.16</a> , <a href="#">6.2</a>
A.17	Moving transmission parts	
A.17.1	Engine or battery	<a href="#">4.18.5</a> , <a href="#">4.18.6</a>
A.17.2	Power supply between machines	<a href="#">4.8</a> , <a href="#">4.9</a>
A.17.3	Retrieval, transportation, lifting	<a href="#">4.16</a>
A.18	Hazards generated by third party	
A.18.1	No permission to start-up/use	<a href="#">4.22.3</a>
A.18.2	Lack of appropriate visual or acoustic warning	<a href="#">4.12</a> , <a href="#">6.1</a>
A.19	Instructions to operator (specifications, signals, warnings, displays)	<a href="#">4.12</a> , <a href="#">6.1</a> , <a href="#">6.2</a> , <a href="#">6.3</a>
A.20	Hazards generated by lifting	
A.20.1	Falling of load, collision, overturning of machine	<a href="#">4.9.2</a> , <a href="#">4.13</a>
A.20.2	Lack of stability	<a href="#">4.13</a> , <a href="#">4.15</a>
A.20.3	Unexpected/unintended load movement	<a href="#">4.10.1</a> , <a href="#">4.10.2</a> , <a href="#">4.15.4</a>
A.20.4	Mechanical strength of parts	<a href="#">4.9</a> , <a href="#">4.13</a> , <a href="#">4.15.2</a>

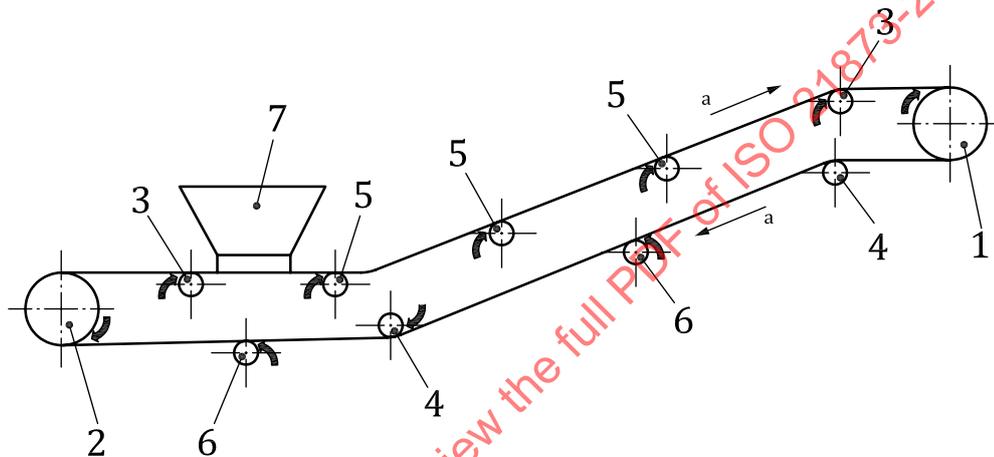
STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019

## Annex B (informative)

### Conveyor guard recommendations

#### B.1 Nip points

Nip points are hazardous locations occurring along the in-running side of two moving surfaces such as a pulley and moving conveyor belt. Typical conveyor nip points are illustrated in [Figure B.1](#).



#### Key

- 1 head pulley
- 2 tail pulley
- 3 transition idle
- 4 idlers at convex position
- 5 carrier roller
- 6 return roller
- 7 feed hopper (loading chute)
- ← nip point
- a Direction of belt travel.

Figure B.1 — Location of nip points

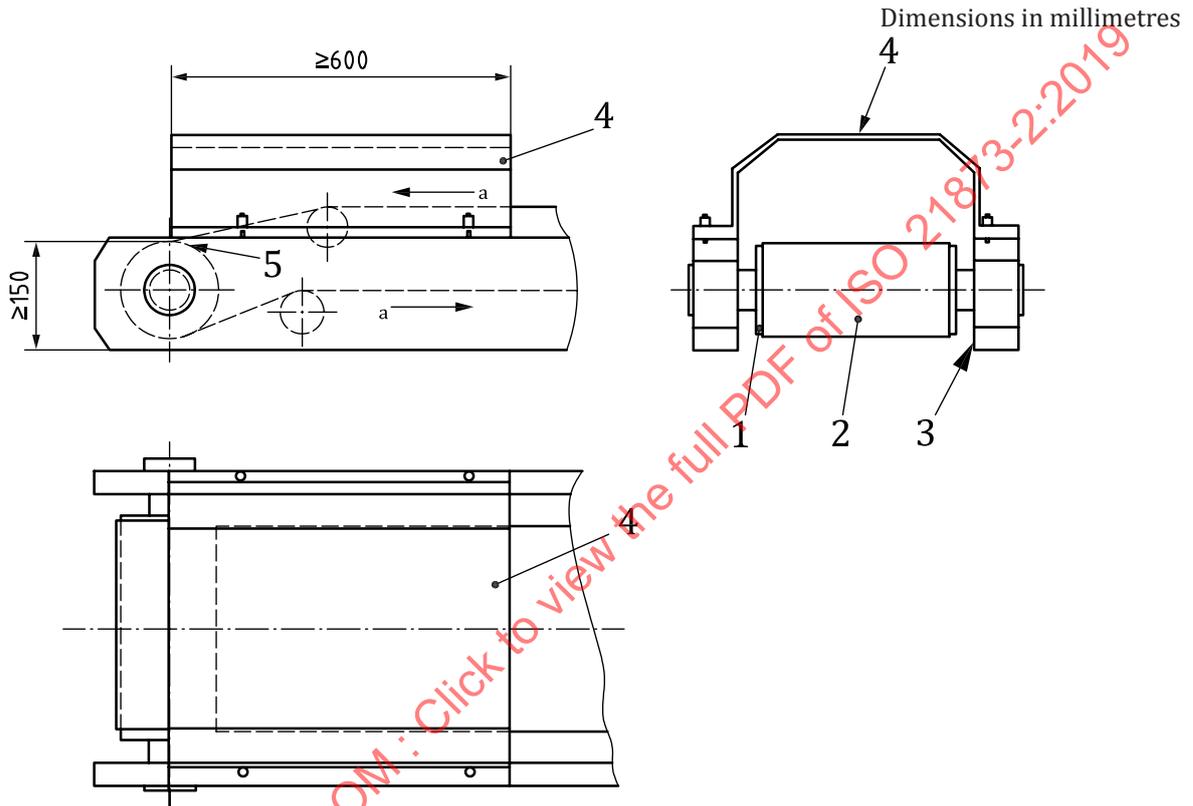
#### B.2 Nip guard

Examples of fixed guards installed at a nip point in order to prevent personnel from touching the nip point are illustrated in [Figures B.4](#), [B.7](#), and [B.9](#). The maximum clearance between the nip guard and the face of the moving pulley is 5 mm. The maximum distance between the nip guard and the moving belt is 5 mm. If the pulley location is movable, the guard position will move with the pulley (preferred) or the guard will be adjustable to maintain the 5 mm maximum clearance. The nip guard will extend a minimum of 150 mm from the centre of the pulley.

### B.3 Safeguarding for head pulley

Enclosing the area at the top of the head pulley will protect personnel from the nip point. The enclosure should extend from the centre of the head pulley a minimum of 600 mm away from the nip point. In addition, if the nip point can be accessed from under the head pulley, this area should also be guarded. Nip guards should be a minimum of 150 mm from the nip point, and area enclosure guards a minimum of 600 mm from the nip point. See [Figures B.2](#) and [B.3](#) for examples of head pulley enclosure guards.

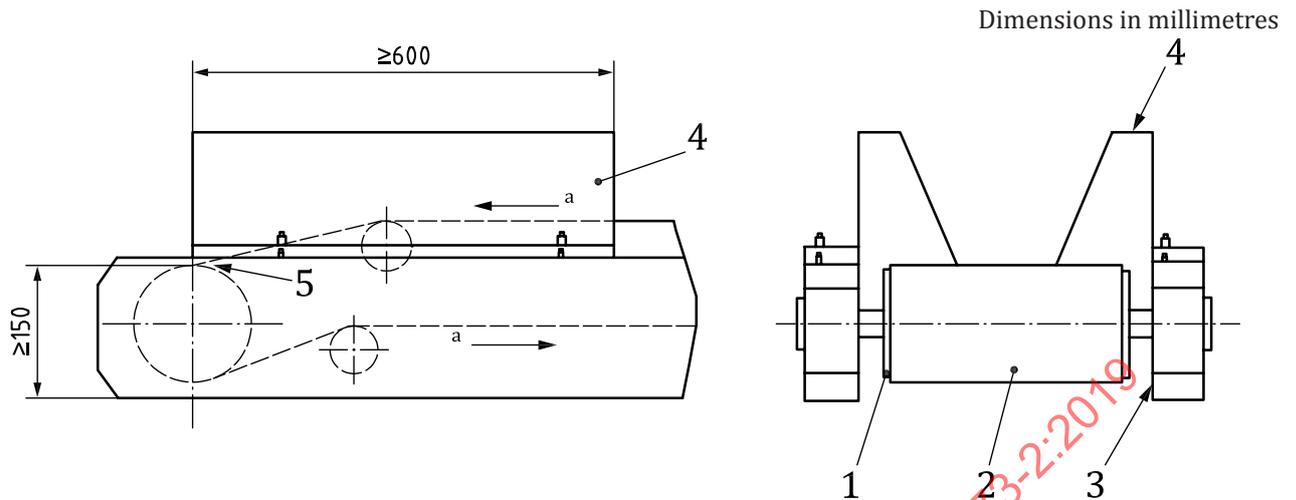
NOTE In the examples shown in [Figures B.2](#), [B.3](#) and [B.4](#), guards would be necessary for a snub pulley, but are not shown.



**Key**

- 1 head pulley
- 2 belt
- 3 side frame
- 4 enclosure guarding
- 5 nip point
- a Direction of belt travel.

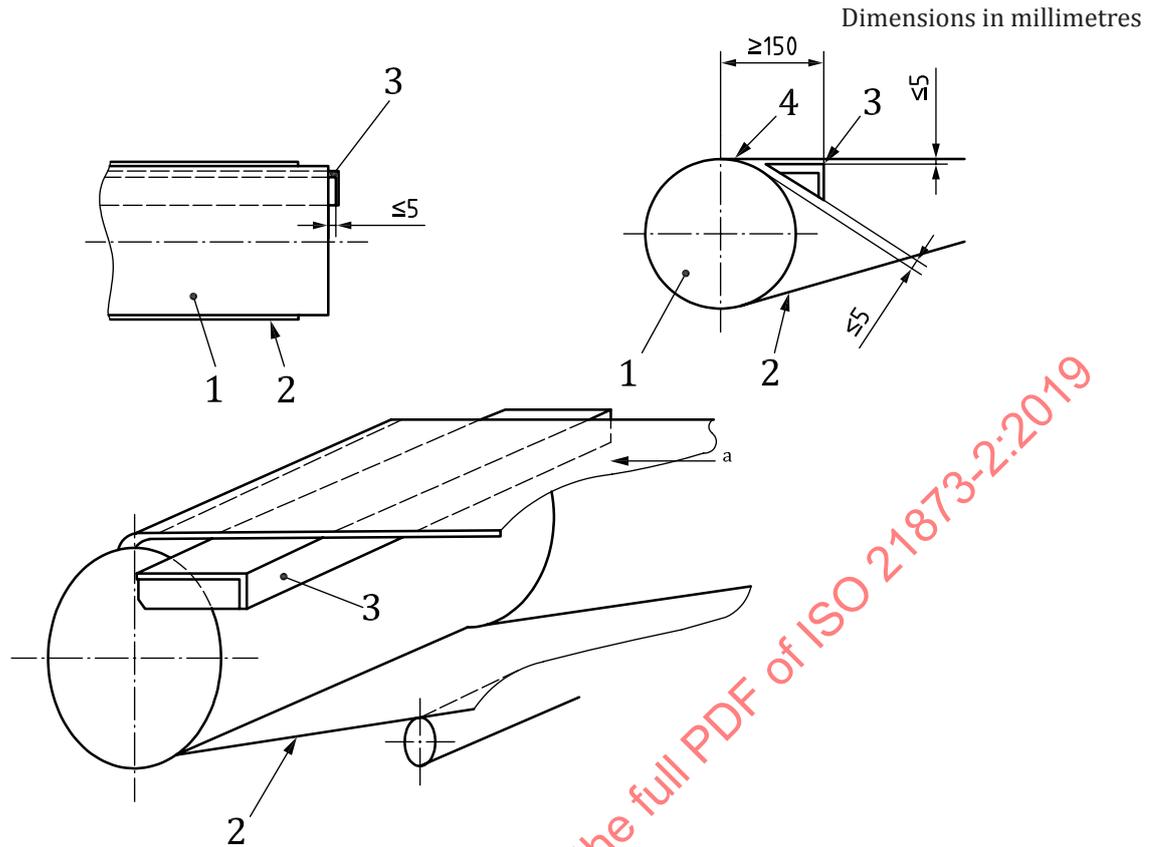
**Figure B.2 — Enclosure guarding at head pulley — Example 1**

**Key**

- 1 head pulley
- 2 belt
- 3 side frame
- 4 enclosure guarding
- 5 nip point
- a Direction of belt travel.

**Figure B.3 — Enclosure guarding at head pulley — Example 2**

An example of nip guarding at the head pulley is shown in [Figure B.4](#). In order to prevent access to the nip point from side, additional guarding can be added to the sides or the nip guard can be extended to connect with the conveyor side frames. The maximum clearance between the side of the belt and the side guarding is 5 mm. The maximum clearance between the end of the head pulley and the conveyor side frame (and the end of the nip guard) is 5 mm.



**Key**

- 1 head pulley
- 2 belt
- 3 nip guard
- 4 nip point
- a Direction of belt travel.

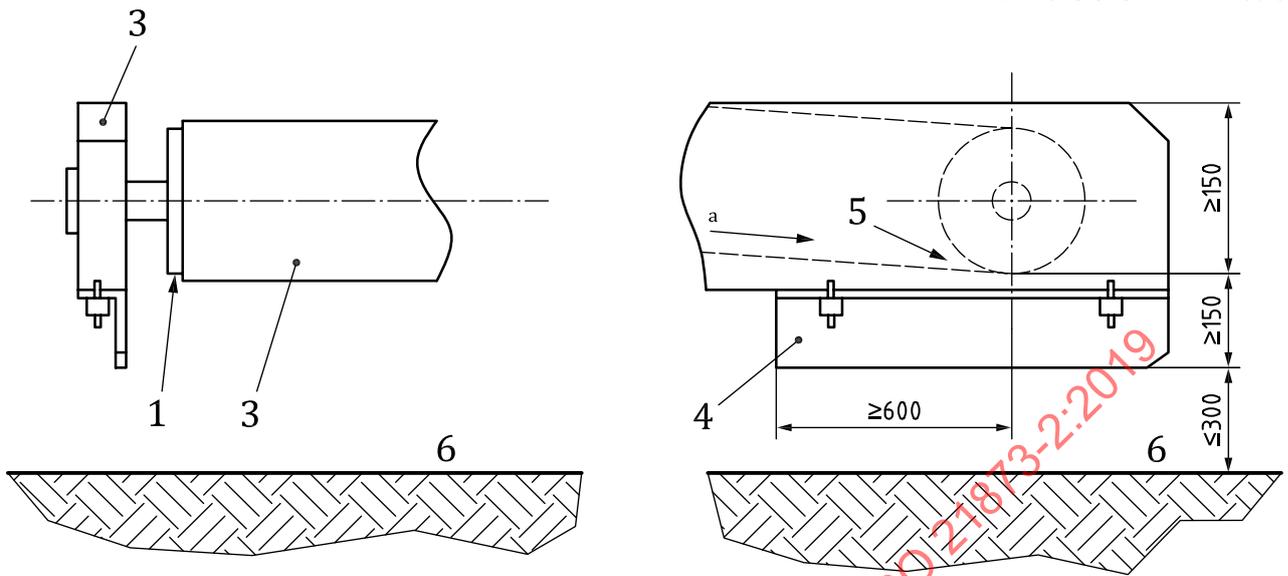
**Figure B.4 — Nip guard at head pulley — Example 3**

**B.4 Safeguarding for tail pulley**

An example of enclosure guarding at the tail pulley is shown in [Figure B.5](#). The enclosure guard should extend at least 600 mm in front, at least 150 mm above and below the nip point as shown in Figure B.5, and should take into consideration the travel of the tail pulley, if used to tension the conveyor belt. If the nip point is less than 450 mm above the ground, the guard shall extend within 300 mm above the ground, unless it has a bottom enclosure, in which case the bottom shall extend at least 150 mm from the edge of the conveyor belt.

**NOTE** Guards cannot cover the area up to 300 mm above ground reference plane (GRP), considering the impossibility of access and the minimum ground clearance when running.

Dimensions in millimetres



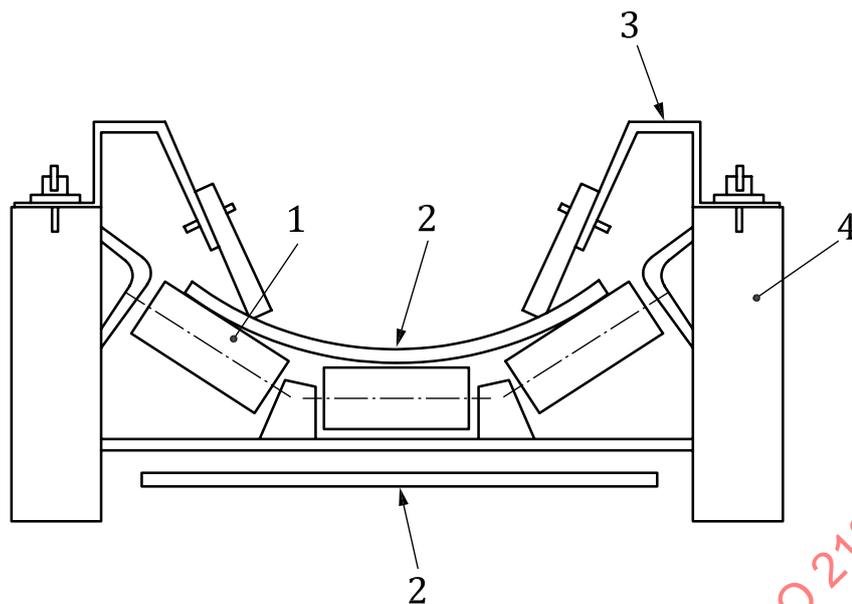
**Key**

- |   |                           |   |                              |
|---|---------------------------|---|------------------------------|
| 1 | tail pulley               | 4 | guard                        |
| 2 | belt                      | 5 | nip point                    |
| 3 | side frame                | 6 | ground reference plane (GRP) |
| a | Direction of belt travel. |   |                              |

**Figure B.5 — Nip guarding at tail pulley**

**B.5 Safeguarding for troughed or flat carrier rollers**

An example of enclosure guarding at the carrier roller is shown in [Figure B.6](#). The guard should extend at least 150 mm from the nip point.



**Key**

- |   |                |   |                    |
|---|----------------|---|--------------------|
| 1 | carrier roller | 3 | enclosure guarding |
| 2 | belt           | 4 | side frame         |

**Figure B.6 — Enclosure guarding at troughed or flat carrier roller**

A nip guard for use with a flat carrier roll is shown in [Figure B.7](#). This guard can be used in either a carrier roll or return roll position.

STANDARDSISO.COM : Click to view the full PDF of ISO 21873-2:2019