INTERNATIONAL STANDARD

ISO 21873-2

First edition
2009-10-15

Building construction machinery and equipment — Mobile crushers —

Part 2: Safety requirements

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

Partie 2: Exigences de sécurité

Reference number
ISO 21873-2:2009(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 21873-2 was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*.

ISO 21873 consists of the following parts, under the general title *Building construction machinery and equipment — Mobile crushers*:

— *Part 1: Terminology and commercial specifications*

— *Part 2: Safety requirements*

Introduction

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

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.

Building construction machinery and equipment — Mobile crushers —

Part 2: Safety requirements

1 Scope

This part of ISO 21873 establishes the safety requirements for mobile crushers, as defined in ISO 21873-1, used in the building construction industry for crushing concrete debris and stones.

It deals with all the significant hazards, hazardous situations and events relevant to mobile crushers when used as intended and under the conditions foreseen by the manufacturer (see Clause 4).

2 Normative references

The following referenced documents are indispensable for the application 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 3744:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in 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 relating to systems*

ISO 4414, *Pneumatic fluid power — General rules relating to systems*

ISO 6011:2003, *Earth-moving machinery — Visual display of machine operation*

ISO 6395, *Acoustics — Measurement of exterior noise emitted by earth-moving machinery — Dynamic test conditions*

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

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 9533, *Earth-moving machinery — Machine-mounted forward and reverse audible warning alarm — Sound test method*

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, *Earth-moving machinery — Operator's controls*

ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 12508, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*

ISO 13333, *Earth-moving machinery — Dumper body support and operator's cab tilt support devices*

ISO 13766, *Earth-moving machinery — Electromagnetic compatibility*

ISO 13850, *Safety of machinery — Emergency stop — Principles for design*

ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

ISO 15817:2005, *Earth-moving machinery — Safety requirements for remote operator control*

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 21507, *Earth-moving machinery — Performance requirements for non-metallic fuel tanks*

ISO 21873-1:2008, *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 12100-1 and ISO 21873-1 apply.

4 Safety requirements and/or protective measures

4.1 General

Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the machine shall be designed according to the principles of ISO 12100 for relevant but not significant hazards which are not dealt with by this document.

Hazards not listed in Annex A but found by risk assessment shall be addressed in accordance with ISO 12100-1 and ISO 12100-2 to reduce the hazard to an acceptable level.

Hazards identified as being “significant” by risk assessment require action to eliminate or reduce the risk. Risk assessment should be performed using the principles and methods given in ISO 14121-1 and ISO/TR 14121-2.

4.2 Access

Appropriate access systems, which shall be in accordance with ISO 2867, shall be provided at the operator's station and in areas where routine maintenance is to be performed.

4.3 Operator's station

4.3.1 General

If the travel and working controls are in different locations, the requirements of this part of ISO 21873 shall be met at each location.

4.3.2 Moving parts

Measures shall be taken to avoid accidental contact with moving parts from the operating station. This includes working equipment, attachments, and tracks (if so equipped).

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, e.g. instrument panels and access to the operator's station, shall not present any sharp edges or acute angles/corners. The radius of corners and bluntness of edges shall comply with ISO 12508 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 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 Visibility

4.4.1 Operator's field of view

If an operator's station is mounted on the machine, it shall be designed to provide sufficient visibility for the intended operation of the equipment.

4.4.2 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 Controls and indicators

4.5.1 General

Self-propelled mobile crushers equipped with an operator station for travel shall have the controls located, designed and manufactured in accordance with ISO 10968.

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.

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.

Remote controls 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).

4.5.2 Emergency stop

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.

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 (e.g. diesel engine) shall be equipped with a starting system that complies with ISO 10264.

4.5.4 Inadvertent activation

Controls shall be located, deactivated or guarded so as to minimize the risk of inadvertent activation when the operator enters or exits the operator station or operating position within the operator station.

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.

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

Controls for machine functions shall be designed to limit movement from the holding position unless activated by the operator. Motion due to drift or creep shall be limited so that it will not create a risk to exposed personnel. This shall apply whether the power supply is working or stopped.

4.5.6 Control panels, instrument and symbols

4.5.6.1 Control panels

Control panels for self-propelled mobile crushers equipped with plant-mounted operator stations shall be located to minimize visual obstructions. Switches, instruments and indicator lights on plant-mounted panels shall be designed for visibility in low light conditions. The colour of switches shall comply with IEC 60204-1.

4.5.6.2 Operating instrumentation

Control indicators for proper operation shall comply with ISO 6011.

4.5.6.3 Symbols

Symbols for use on operator controls and other displays shall be in accordance with ISO 6405-1 or ISO 7000.

4.6 Steering systems

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

4.7 Brake systems

Wheel-mounted, self-propelled and towed mobile crushers shall be equipped with service, emergency, and parking brake systems.

Self-propelled mobile crushers equipped with tracks shall be provided with service and parking brake systems.

The service brakes for track-mounted mobile crushers shall be individually controlled, one for each track, and may be combined with the steering system.

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

Brake systems for track-mounted mobile crushers shall comply with ISO 10265.

The parking brakes shall be of a size sufficient to withstand the maximum tractive effort of the drive system without damage.

4.8 Feeding units (hopper, feeder)

If a platform is mounted in close proximity to the feed device, a guard shall be provided to prevent the operator from falling into the feed device. The minimum height of the guard is to be 1,1 m above the walking surface of the platform. If a handrail is used as a guard, it shall conform to ISO 14122-3. 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 (flywheels, drive belts, etc.) 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.

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 units

4.9.1 Operator's manual

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).

The operator's manual shall also indicate the proper set-up, operation and maintenance of the guards for the crushing units specified in 4.9.2 to 4.9.6.

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

4.9.2 Guard on feed opening

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

4.9.3 Jaw crusher

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. If a handrail is used as a guard, it shall conform to ISO 14122-3. 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.

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.

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

The following shall 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).

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.

Guards shall be in accordance with 4.15.4.

4.9.4 Impact crusher (horizontal and vertical shaft types)

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. If a handrail is used as a guard, it shall conform to ISO 14122-3. 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.

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.

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.

When the frame for the crushing device 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.

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.

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

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.

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

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

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.

Guards shall be in accordance with 4.15.4.

4.9.5 Gyratory and cone crushers

Parts transmitting power to the crusher (flywheels, drive belts, etc.) shall be guarded. 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. Guards shall be in accordance with 4.15.4.

The design of the gyratory crusher allows for dump trucks to tip their load directly into the feed opening of the crusher. In order to allow access for these vehicles, it is virtually impossible to completely guard the feed opening in order to prevent access. As this constitutes a major residual hazard, instructions covering it shall be included in the operator's manual.

For primary gyratory crushers, an unobstructed view to the crusher inlet shall be provided, e.g. by use of a TV camera or suitable inspection platforms.

Maintenance platforms shall be used on primary gyratory crushers where maintenance work has to be done inside the crushing chamber.

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.

When zinc is used as a backing material for the mantles or concaves, the operator's manual shall include a safe method for pouring molten zinc so as to prevent “splash-back”.

When a cone 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. All coil springs that compress during operation shall be guarded to prevent pinch points.

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. If a handrail is used as a guard, it shall conform to ISO 14122-3. 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.

4.9.6 Roll crusher

Parts transmitting power to the crusher (flywheels, drive belts, etc.) shall be guarded. 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. Guards shall be in accordance with 4.15.4.

For primary roll crushers, an unobstructed view to the crusher inlet shall be provided, e.g. by means of a TV camera or suitable inspection platforms.

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. If a handrail is used as a guard, it shall conform to ISO 14122-3. 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.

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.

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

4.10 Belt conveyor

4.10.1 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.

4.10.2 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.

4.10.3 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

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.

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 (horn) controlled from the operator's station, whose A-weighed sound pressure level shall be $\geqslant$ 93 dB, measured 7 m from the foremost point of the machine with the equipment/attachment in its travel position, as defined in ISO 6395, and that shall be tested in accordance with ISO 9533;

b) machine safety labels and hazard pictorials in accordance with ISO 9244.

4.13 Stability

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.

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 and vibration

4.14.1 Noise reduction at source

Machines shall be designed and constructed so as to minimize the emission of airborne noise and 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.

4.15 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

Parts that are hot during operation of, or routine maintenance on, the machine shall be designed, positioned, or provided with a thermal guard, so as to minimize or eliminate the risk of contact between personnel and hot surfaces during operation or maintenance.

4.15.3 Moving parts

Moving parts that create a hazard shall be designed, positioned, or provided with protective devices, so as to minimise the hazard. 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 tools 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 12100-2:2003, 5.5.4, 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 in areas that can be accessed during operation and routine maintenance shall conform to ISO 12508.

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 Tie-down

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 tie-down points shall also be identified in the operator's manual. Tie-down provisions shall conform to ISO 15818.

4.16.2 Lifting

Lifting provisions shall be installed to lift the entire machine and major subassemblies that are removed for transport. The lifting provisions shall be sized to support the mass of the heaviest configuration of the machine or subassembly.

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.

4.17 Electromagnetic compatibility (EMC)

Machines shall comply with the requirements of electromagnetic compatibility given in ISO 13766.

4.18 Electrical and electronic systems

4.18.1 General

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

Electrical components and conductors shall be designed and installed such that corrosion and other damage from exposure to environmental conditions (corresponding to the intended use of the machine) is avoided.

Electrical component insulation should have flame-retardant properties. Electrical conductors shall be protected from abrasion where they cross sharp edges or pass through bulkheads.

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

Safety-related machine control systems using electronic components shall comply with ISO 15998.

4.18.2 Environmental protection

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

— components installed exterior to the machine or directly exposed to the environment shall have the minimum degree of protection IP 55 according to IEC 60529;

— 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

Electric wires and cables used to connect components in electric circuits shall be marked and identified in accordance with ISO 9247, in order to avoid incorrect connections.

4.18.4 Over-current protective devices

Electric equipment shall be protected with an over-current protective device (e.g. fuse, fusible link or circuit breaker).

4.18.5 Batteries

Batteries shall be firmly attached in a ventilated space. The location shall be easily accessible. Batteries should be easily removable. Handles and/or grips shall be provided on those batteries of a mass greater than 20 kg.

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 overturning of the machine.

The positive terminal (not connected to the frame) and connectors shall be covered with non-conductive material so as to prevent accidental contact.

4.18.6 Battery disconnection

It shall be possible to disconnect batteries easily, e.g. by a quick coupling or an accessible isolator switch. Battery disconnect switches should have a provision for isolating the main energy source (lockout provisions).

4.19 Pressurized systems

4.19.1 Hydraulic lines

Hydraulic lines shall be designed and installed according to ISO 4413.

Pipes and hoses shall be routed and restrained to prevent damage from hot surfaces, sharp edges and other potential sources of damage. Installation that allows visual inspection of pipes, hoses and fittings is recommended.

4.19.2 Hydraulic hoses

Hydraulic hoses containing fluid with a pressure of more than 5 MPa and/or a temperature greater than 50 °C, which are located within 1,0 m from the operator, shall be guarded in accordance with ISO 3457.

Parts or components placed between pipes or hoses and the operator that divert a hazardous spray of a fluid may be considered as being sufficient as a protective device.

Hoses intended to withstand a pressure of more than 15 MPa shall not be fitted with reusable fittings.

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

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 and shall include a device for automatically relieving pressure or vacuum that exceeds the design pressure for the tank.

4.20.2 Filler openings

The filler openings of tanks shall be easily accessible for filling (ground level fuel access is preferred) and shall have lockable filler caps. Filler caps located inside lockable compartments (e.g. engine compartment) or inside a cover that can only be opened with a tool, or filler caps that are only able to be opened with a special tool, do not need to be lockable.

4.20.3 Fuel tanks

Fuel tanks shall withstand an internal pressure of 0,03 MPa 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 4414.

4.21 Fire protection

4.21.1 Fire resistance

If an enclosed operator station is installed on the machine, its interior, upholstery and insulation 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 one or more locations for installation of fire extinguishers or a built-in extinguishing system. Fire extinguishers shall be easily accessible to the operator. The extinguisher or built-in system rating shall be adequate for the types of combustible materials on the machine.

4.22 Maintenance

4.22.1 General

Machines shall be designed and built such that routine lubrication and maintenance operations can be carried out, whenever possible, with the power disconnected. Where it is only possible to undertake lubrication and maintenance with the power connected, the recommended procedure shall be described in the operator's manual.

Openings intended for maintenance purposes shall comply with ISO 2860.

It is recommended that the design permit ground level access for lubricating the machine and filling the fuel tank.

Components (batteries, lubrication fittings, filters, etc.) that require frequent maintenance shall be easily accessible for checking and changing.

A lockable storage box should be provided on the machine for storing special tools required for service and maintenance.

4.22.2 Support devices

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 and ISO 13333.

Large engine access panels that are suspended overhead during engine service shall be provided with a device to hold them in the open position.

4.22.3 Access to the engine compartment

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

— a locking device;

— a panel installation that requires the use of a key or tool;

— a latch with access inside a lockable area.

5 Verification of safety requirements and/or protective measures

Verification that the safety requirements and/or protective measures specified in this part of ISO 21873 shall be carried out by the use of one or a combination of the following means:

— measurement;

— visual examination;

— testing using a method as specified in this part of ISO 21873;

— for purchased components, a review of the file documentation provided by the manufacturer/supplier.

6 Information for use

6.1 Machine safety labels

Machine 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.

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

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 12100-2:2003, 6.5.

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.

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;

s) provisions against entering hazard zones;

t) safety precautions for minimizing possible chemical hazards during operation, maintenance and dismantling;

u) the sound power level of exterior noise and its test conditions;

v) any other safety-related items specified in this part of ISO 21873.

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 bear, legibly and indelibly, at least the following information:

a) name and address of the manufacturer;

b) year of construction;

c) designation of series or type;

d) serial number, e.g. PIN according to ISO 10261;

e) mass of the machine in operating mode.

Annex A
(informative)

List of significant hazards

No.	Hazard	Clause/subclause of ISO 12100-1:2003	Clause/subclause of ISO 12100-2:2003	Clause/subclause of this part of ISO 21873
A.1	**Mechanical hazards**			
	— Parts and components EXAMPLE Shape, relative location, substance, velocity, or mechanical strength.	4.2.2	4.2	4.3.4, 4.8, 4.9, 4.10, 4.11.2, 4.13
	— Stored energy EXAMPLE Elastic elements (springs), liquids or gases under pressure or vacuum.	4.2.2	4.2.2, 4.10, 5.5.4	4.3.5, 4.19
A.1.1	Crushing	4.2.1	4.2.1	4.8, 4.9, 4.15.3
A.1.2	Shearing	4.2.1	4.2.1	4.8, 4.9
A.1.3	Cutting or severing	4.2.1	—	4.3.4, 4.9
A.1.4	Entanglement and drawing-in or trapping	4.2.1	—	4.8, 4.9, 4.10.1, 4.10.3, Annex B
A.1.5	Impact	4.2.1	—	4.5.5, 4.8, 4.9, 4.10.2, 4.11.2, 4.13
A.1.6	Stabbing or puncture	4.2.1	—	4.9, 4.19
A.1.7	Friction or abrasion	4.2.1	—	4.8, 4.9
A.1.8	High-pressure fluid injection or ejection	4.2.1	4.10	4.3.5, 4.19
A.2	**Electrical hazards**			
A.2.1	Contact (direct) with live parts	4.3	4.9, 5.2	4.18
A.2.2	Thermal radiation, projection of molten particles or chemical effects from short-circuits or overloads	4.3	4.9	4.18.5
A.3	**Thermal hazards**			
A.3.1	Burns and scalds from an extreme temperature, flames or explosions and radiation from heat sources	4.4	—	4.3.5, 4.19
A.4	**Hazards generated by noise**			
A.4.1	Permanent hearing loss (tinnitus), physical disorder (tiredness, stress, loss of balance, loss of awareness)	4.5	4.2.2, 5.4.2, 4.3 c), 4.4 c), 4.8.4	4.14
A.4.2	Interference with speech communication, acoustic signals, other noises	4.5	4.2.2, 5.4.2, 4.3 c), 4.4 c), 4.8.4	4.14

No.	Hazard	Clause/subclause of ISO 12100-1:2003	Clause/subclause of ISO 12100-2:2003	Clause/subclause of this part of ISO 21873
A.5	**Hazards generated by materials and substances**			
A.5.1	Ingestion or inhalation of fluids, gases, mists, fumes, fibres, dusts or aerosols	4.8	4.2.2, 4.3 b), 5.4.4	4.3.3, 4.15.7, 4.18.5,
A.5.2	Fire and explosion	4.8	—	4.21
A.6	**Hazards generated by neglecting ergonomic principles in machine design**			
A.6.1	Unhealthy postures, excessive or repetitive efforts	4.9	4.7, 4.8.2, 5.5.6	4.2, 4.3.6
A.6.2	Arm and leg anatomy	4.9	4.8.3	4.3.6
A.6.3	No use of personal protective equipment	—	4.8.7	6.2.1
A.6.4	Inadequate local lighting	—	4.8.6	—
A.6.5	Mental overload or under load, stress	4.9	4.8.1, 4.8.5	4.3
A.6.6	Human error	4.9	4.5.2, 4.8, 4.11.9, 4.11.10, 6.1	4.3, 4.4, 4.10, 4.18.3, 4.22
A.6.7	Selecting, locating and identifying manual controls	—	4.8.1, 4.8.7, 4.11.8	4.5, 4.6, 4.7, 4.10
A.6.8	Selecting, designing, locating visual display units	—	4.8.1, 4.8.8, 6.2	4.5, 6.1
A.6.9	Assembly	—	—	4.2, 4.3, 4.4, 4.9
A.6.10	Guards and protective devices	3.25, 3.26	5.2, 5.3	4.3.6, 4.8, 4.9, 4.10, 4.11.1, 4.22.3
A.6.11	Location and movement	4.9	4.8.7, 4.8.8	4.3.6, 4.5
A.6.12	Locating maintenance, lubrication, setting points for access to danger zones	3.3, 3.19	4.7, 4.11.12, 4.15, 5.5.6	4.2, 4.8, 4.9, 4.10, 4.20, 4.22
A.7	**Unintended/unexpected start-up, uncontrolled speed change**			
A.7.1	Failure of control system	—	4.11.1, 4.12, 5.5.4	4.5.5, 4.18
A.7.2	Electromagnetic compatibility	—	4.11.11	4.17
A.7.3	Error by operator (mismatch with human characteristics and abilities)	4.9	4.8, 4.11.9, 4.11.10, 5.5.2, 6.1	4.5.4
A.8	**Impossibility of stopping under optimum conditions**	—	4.11.3, 4.11.5, 5.5.2	4.5, 4.7, 4.10.1
A.9	**Internal power source**	—	4.11.2 to 4.11.6, 4.12, 5.5.4	4.10.1
A.10	**Failure of safety functions**	—	4.11, 4.12, 5.5.4	4.18
A.11	**Error of stoppers**	4.9	4.7, 6.5	4.9, 4.19
A.12	**Falling/exploding materials or liquids**	4.2.1, 4.2.2	4.3, 4.10	4.3.5, 4.8, 4.9, 4.10.2, 4.11, 4.19
A.13	**Lack of machine stability/overturn**	4.2.2	4.6, 5.2.6	4.13, 4.16
A.14	**Slipping, tripping and falling**	4.10	5.5.6	4.2, 4.8, 4.9

No.	Hazard	Clause/subclause of ISO 12100-1:2003	Clause/subclause of ISO 12100-2:2003	Clause/subclause of this part of ISO 21873
A.15	**Hazards generated by machine movement**			
A.15.1	**Related to travelling**			
A.15.1.1	Engine start-up	—	4.11.2	4.5.3
A.15.1.2	Absence of operator at control position	—	—	4.5.6
A.15.1.3	Travelling function	—	—	4.5.2, 4.7
A.15.1.4	Slowdown, cease, stop	—	—	4.7
A.15.1.5	Remote control	—	—	4.5.6
A.15.2	**Related to machine working position**			
A.15.2.1	Falls from lifting platform	—	5.5.6	4.2, 4.3.6, 4.8, 4.9
A.15.2.2	Emission/lack of oxygen	—	—	4.3.3, 4.15.7
A.15.2.3	Fire (flammability, lack of extinction)	—	—	4.20.3, 4.21
A.15.2.4	Working position			
	a) wheel collision	—	5.2	4.3.2
	b) rolling over	—	5.2	4.13
	c) falling, going through	—	5.2	4.10.2
A.15.2.5	Insufficient sight from operating station	—	—	4.4.1
A.15.2.6	Inappropriate work/light	—	—	4.4.2
A.15.2.7	Noise	—	—	4.14, 6.2
A.15.3	**Related to control system**	—	4.11	—
A.15.3.1	Design of machine control system	5.3	4.11.1	4.6, 4.18
A.15.3.2	Unsuitable design of control system	—	4.11.1	4.5
A.15.3.3	Design of manual control systems/ operating mode	—	4.11.1	4.5
A.16	**Machine handling**	—	—	4.16, 6.2
A.17	**Moving transmission parts**			
A.17.1	Engine or battery	—	4.11.1	4.18.5, 4.18.6
A.17.2	Power supply between machines	—	—	4.8, 4.9
A.17.3	Retrieval, transportation, lifting	—	5.5.5	4.16
A.18	**Hazards generated by third party**			
A.18.1	No permission to start-up/use	—	—	4.22.3
A.18.2	Lack or inappropriate visual or acoustic warning	—	—	4.12, 6.1
A.19	**Instructions to operator (specifications, signals, warnings, displays)**	—	—	4.12, 6.1, 6.2, 6.3

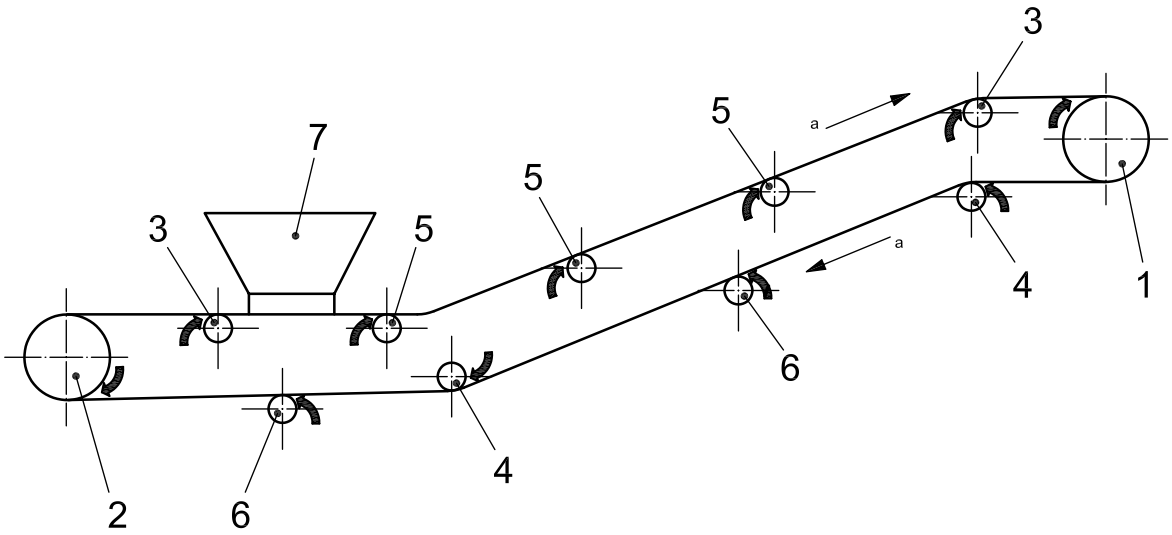
No.	Hazard	Clause/subclause of ISO 12100-1:2003	Clause/subclause of ISO 12100-2:2003	Clause/subclause of this part of ISO 21873
A.20	**Hazards generated by lifting**			
A.20.1	Falling of load, collision, overturning of machine	—	—	4.9.2, 4.13
A.20.2	Lack of stability	—	5.2.6	4.13, 4.15
A.20.3	Unexpected/unintended load movement	—	—	4.10.1, 4.10.2, 4.15.4
A.20.4	Mechanical strength of parts	—	—	4.9, 4.13, 4.15.2

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

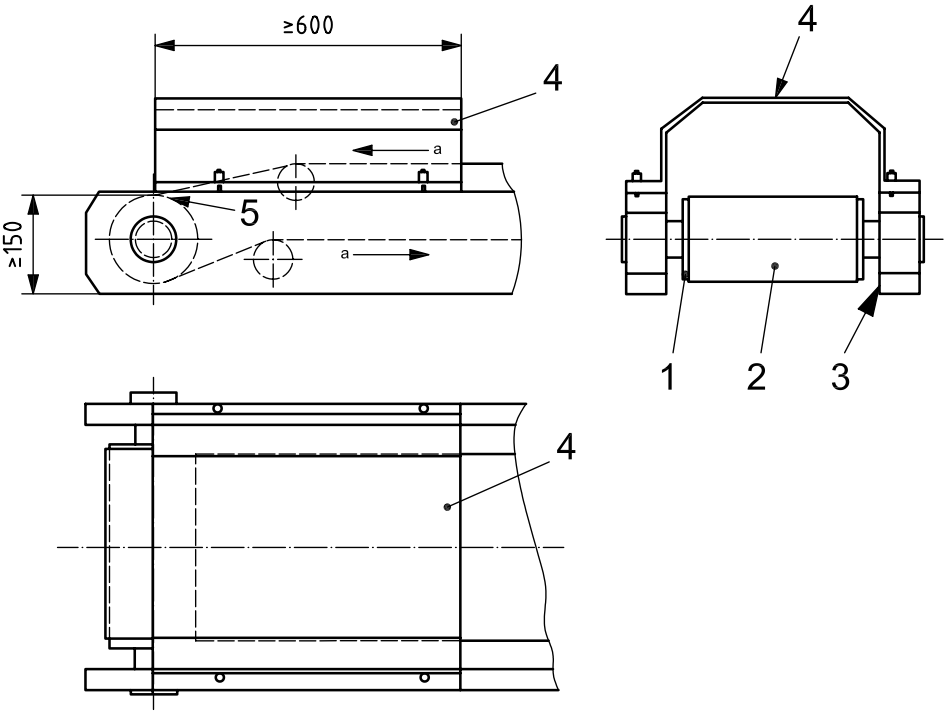
Examples of fixed guards installed at a nip point in order to prevent personnel from touching the nip point are illustrated in Figures B.4, B.7, and B.9. The maximum clearance between the nip guard and the face of the moving pulley is 5 mm. The maximum distance between the nip guard and the moving belt 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.

Dimensions in millimetres



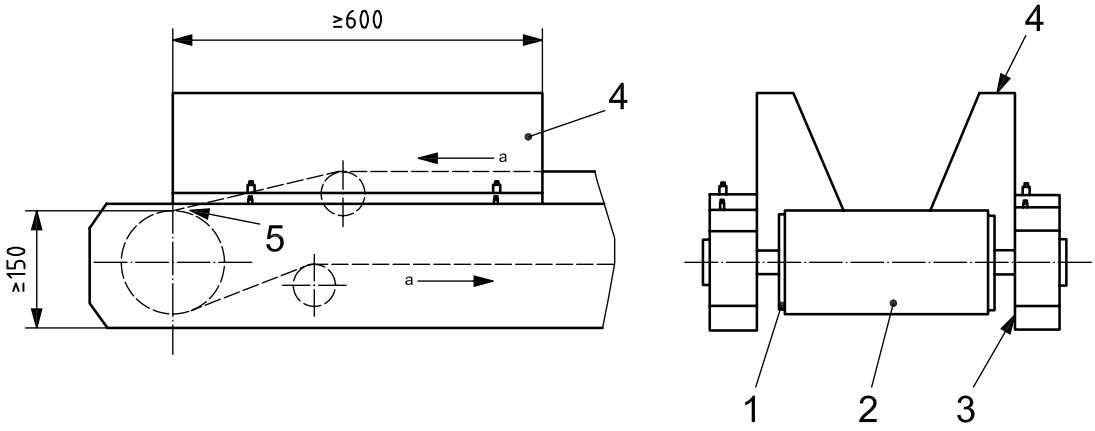
Key

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

Dimensions in millimetres



Key

1 head pulley

2 belt

3 side frame

4 enclosure guarding

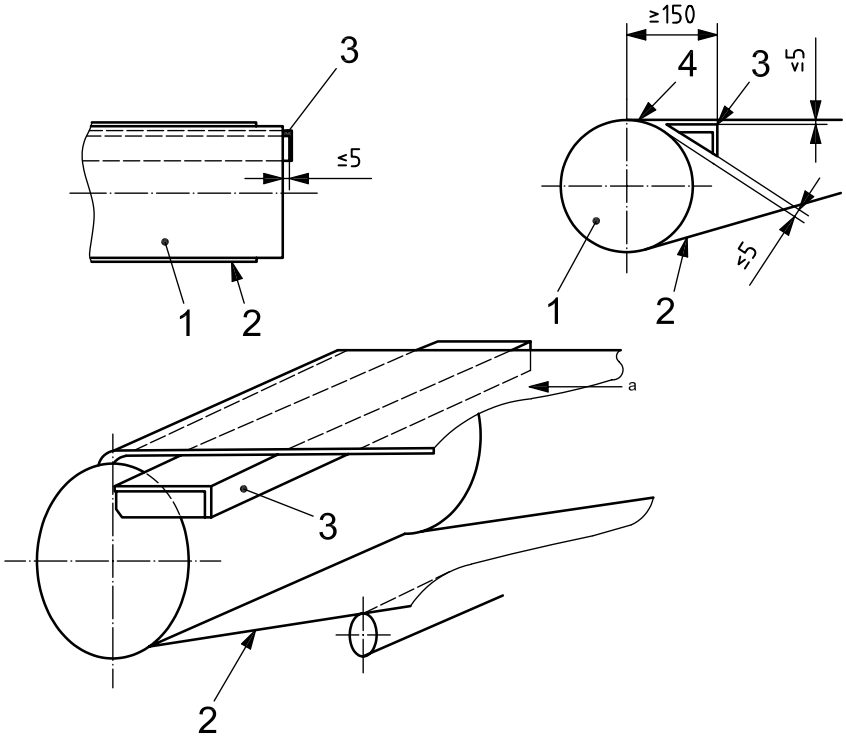
5 nip point

[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.

Dimensions in millimetres



Key

1 head pulley

2 belt

3 nip guard

4 nip point

a Direction of belt travel.

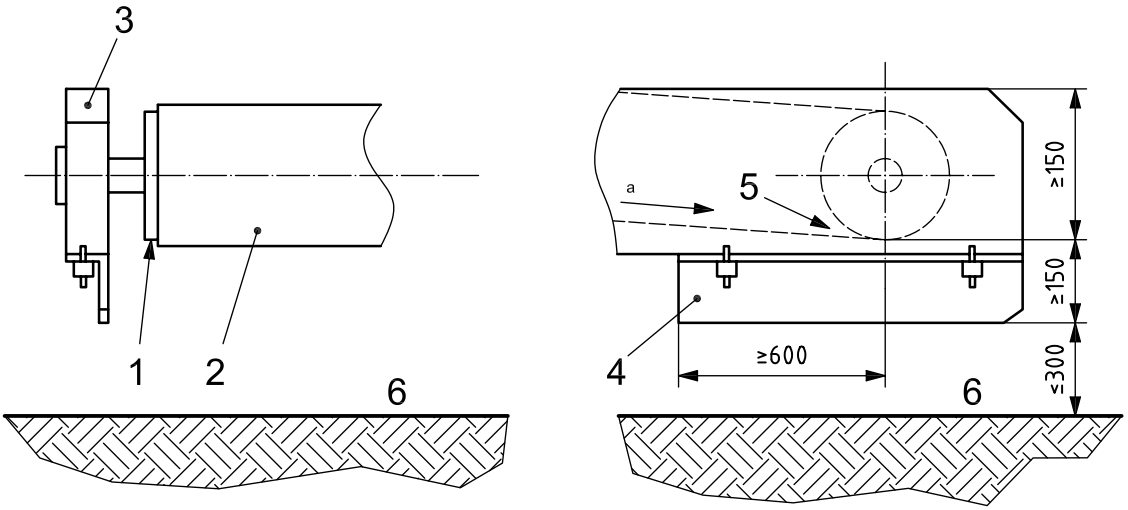
Figure B.4 — Nip guard at head pulley — Example 3

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 can not 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

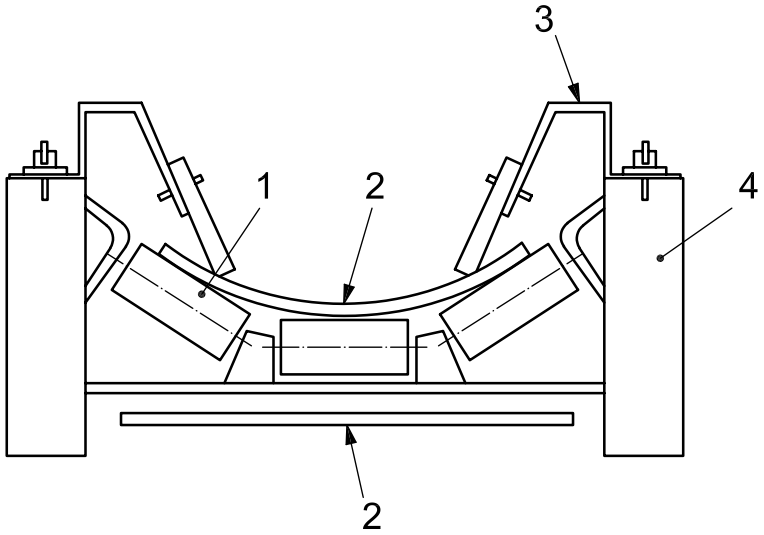
1 tail pulley
2 belt
3 side frame
4 guard
5 nip point
6 ground reference plane (GRP)

[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.



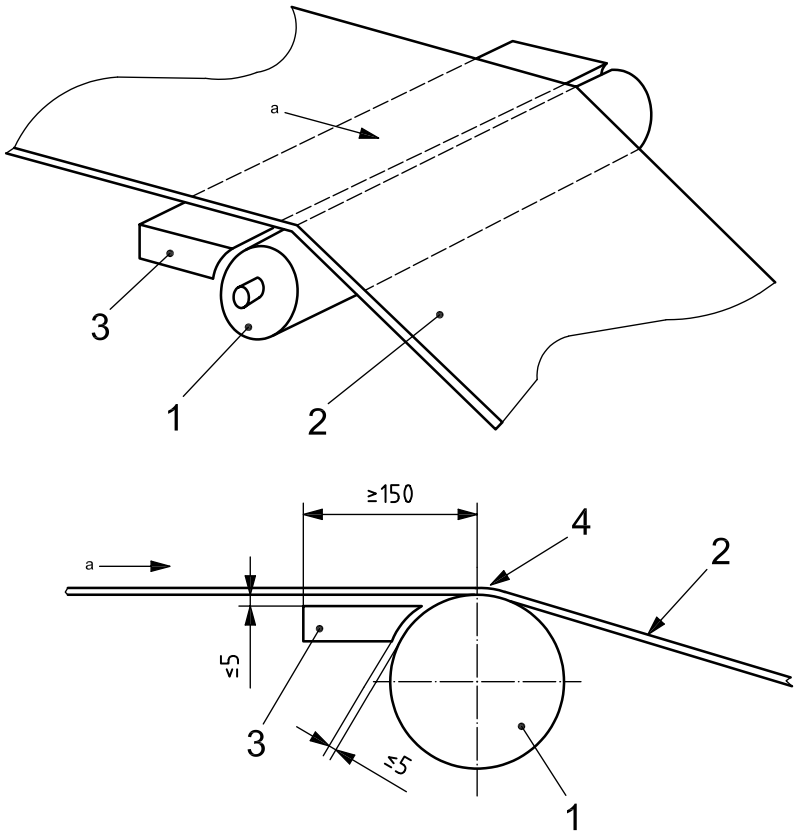
Key

1 carrier roller
2 belt
3 enclosure guarding
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.

Dimensions in millimetres



Key

1 roller

2 belt

3 nip guard

4 nip point

a Direction of belt travel.

Figure B.7 — Nip guarding at carrier roller

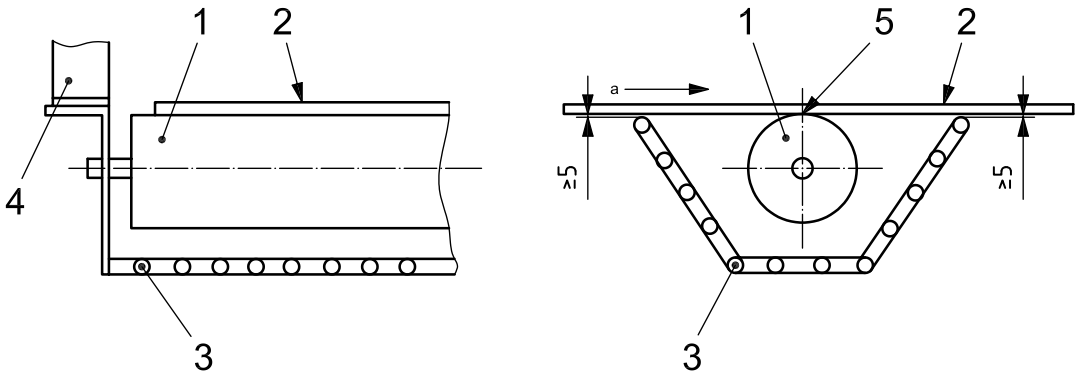
B.6 Safeguarding at return roller

An example of enclosure guarding at the return roller is shown in Figure B.8. If the guard has openings to minimize material build-up, the distance between the openings and nip point should be in accordance with ISO 13852.

NOTE This guard is usually a mesh guard to reduce build-up of material inside the guard.

An example of a nip guarding at return roller is shown in Figure B.9. Safeguarding against access from side will also be necessary.

Dimensions in millimetres



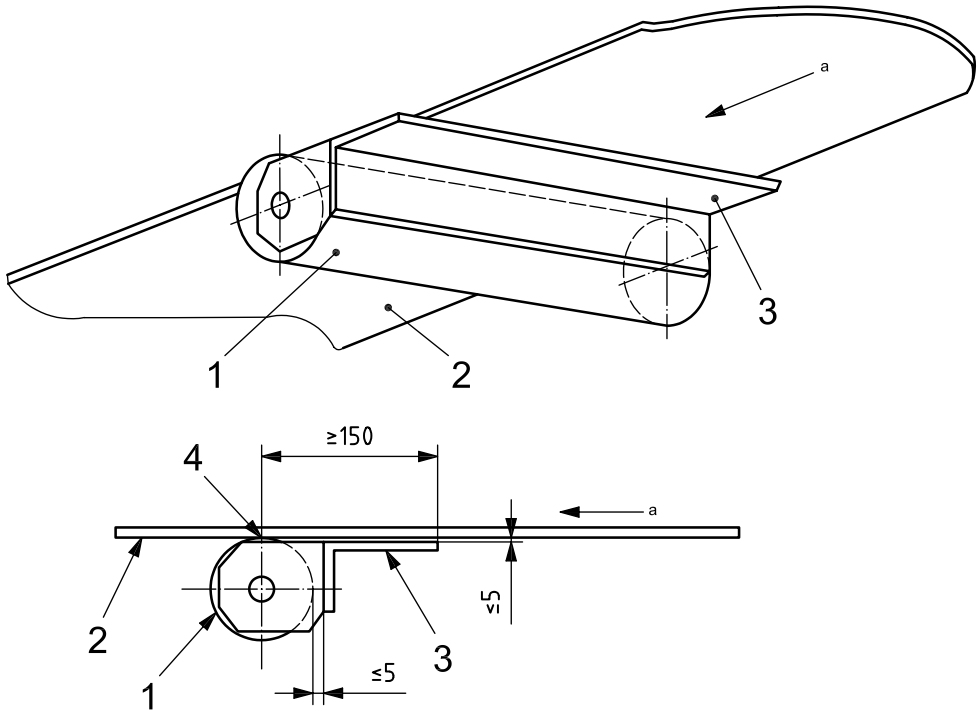
Key

1 return roller
2 belt
3 enclosure guard
4 side frame
5 nip point

a Direction of belt travel.

Figure B.8 — Enclosure guarding at return roller

Dimensions in millimetres



Key

1 return roller
2 belt
3 nip guard
4 nip point

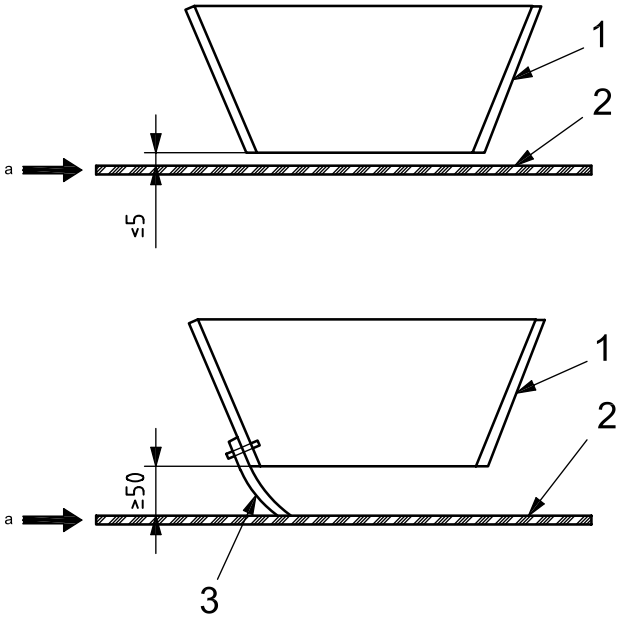
a Direction of belt travel.

Figure B.9 — Nip guard at return roller

B.7 Safeguarding between belt and fixed components

If a moving belt is in proximity to a fixed component (e.g. a hopper or external frame cross members), it is recommended that the clearance be less than 5 mm or greater than 50 mm as shown in Figure B.10. This applies to components on the top or return sides of the conveyor.

Dimensions in millimetres



Key

1 steel hopper, chute

2 belt

3 rubber chute

a Direction of belt travel.

Figure B.10 — Safeguarding between belt and fixed hopper

Annex C
(informative)

Guidelines for safely clearing blocked crushers

C.1 General

This annex offers guidelines to manufacturers and users for developing a procedure to safely clear blocked crushers. It is recommended that manufacturers and users develop and maintain their own procedure, specific to their operations, for clearing blocked crushers. This procedure should include a risk assessment and should be reviewed with the appropriate local safety officials.

C.2 Terms and definitions

C.2.1
blocked crusher
crusher that does not accept feed because of a bridged or a stalled condition

C.2.2
bridged crusher
crusher that does not accept feed due to an obstruction either at the feed opening, preventing material from entering the crusher, or at the discharge, preventing material from leaving the crusher

C.2.3
stalled crusher
crusher forcibly stopped while crushing due to uncrushable material ingestion or other situations where the crusher seizes during operation

C.3 General warnings

Always wear approved personal protection equipment when working around a crusher.

Never try to unblock a crusher while the crusher is running or powering down.

Do not work around a crusher unless all energy sources have been isolated and locked out. Keep in mind that rock or uncrushable material in a stalled compression type crusher can contain significant stored energy.

Never use explosives to unblock a crusher.

Do not stand inside the crushing chamber while clearing a blocked crusher. The sudden release of stored energy can cause the crusher to move, potentially causing injury.

Never work under a crusher to clear a blockage. Falling material can cause injury.

When working around a blocked crusher, be aware that rocks rolling can create a pinching or falling rock hazard.

When working around a blocked crusher, be aware of any rock overhead on a feed device (feeder, conveyor, chutes, etc.). Start at the top when clearing blockages to prevent additional hazards due to falling rock.

Do not re-start a crusher until all guards are properly installed.

C.4 Bridged crushers

C.4.1 General

Primary consideration should be given to the prevention of bridging at crushers. This can be done through proper design of the feed and discharge systems, and operational procedures that minimize the potential for bridged crushers. Even with these precautions in place, it is possible for a crusher to occasionally become bridged.

C.4.2 Bridged at feed

C.4.2.1 Primary crushers (large feed size)

If bridging is caused by oversized feed material, use of an external breaker, such as a hydraulic rock breaker, is recommended for reducing the oversized or slabby feed material to a size that will fit into the crusher. A hydraulic boom should be used to help guide material into the crusher, if the problem is related to feed shape (e.g. elongated material) rather than size. If the problem is rock shape (e.g. round river rock) that will not allow the crusher to get traction to grab the rock, some compression crushers can be cleared by opening up the crushing chamber setting. A hinged or movable feed plate can be helpful for some types of impact crushers, if the bridging is internal. In some cases, a crane can be required to remove a rock. Exercise caution to avoid overloading the crane. It can be necessary to mount anchors into the oversized rock in order to lift safely. Always block the rock to prevent unexpected movement while working around it. Exercise caution when sizing anchors to prevent overload. Never try to force material farther into a crusher, especially if it is running.

C.4.2.2 Secondary, tertiary, and subsequent crushers (smaller feed size)

It is recommended that the source of the bridging be located and cleared using bars, shovels or other devices to prevent hand and finger pinch points. Hand pick only if risk assessment has indicated that it is safe to do so. Never try to force material farther into a crusher, especially if it is running.

C.4.3 Bridged at discharge

If possible, lower the tail section of the product conveyor. Use of high-pressure water or shovels is recommended, if a risk assessment has indicated it is safe to do so. Never get under the crusher if a falling rock hazard exists, due to build-up inside the crusher or at the feed device. Once the source of the bridging has been cleared, the product discharge conveyor can be used to clear material out of the under-crusher area, if it has enough starting torque and can be started and run without endangering personnel.

C.5 Stalled crushers

Stalling is more common with compression type crushers than with impact type crushers. Stored energy in the crusher should be released in a controlled manner to prevent injury. The preferred method for clearing a stalled compression type crusher is to open up the crusher setting to allow passing of the item(s) causing the stalled condition. Furthermore, caution needs to be exercised in respect of the following maintenance activities and risks.

— If the crusher setting cannot be adjusted to clear the item(s), it is recommended that the crusher be opened by rotating the flywheels opposite the normal drive rotation. A hydraulic ram, ratcheting lever hoist, winch or other device can be used to rotate the flywheels backwards. This can also be accomplished using a reversing hydraulic crusher drive, if available.

— Never cut the toggle plate to clear a stalled jaw crusher. This can place personnel in a position of potential injury due to a rapid release of energy.

— Never use a torch to cut out the item(s) causing the stalled condition. This can place personnel in a position of potential injury due to a rapid release of energy.

Bibliography

[1] ISO 3746, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

[2] ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*

[3] ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

[4] ISO 10261, *Earth-moving machinery — Production identification numbering system*

[5] ISO 13852:1996, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*

[6] ISO 14121-1:2007, *Safety of machinery — Risk assessment — Part 1: Principles*

[7] ISO/TR 14121-2:2007, *Safety of machinery — Risk assessment — Part 2: Practical guidance and examples of methods*

[8] EN 1009-1, *Feeding, crushing, milling, sizing and sorting machines for mechanical processing of minerals and similar solid materials — Safety — Part 1: Common requirements for single machines and processing plants*

[9] EN 1009-3, *Feeding, crushing, milling, sizing and sorting machines for mechanical processing of minerals and similar solid materials — Safety — Part 3: Crushing and milling machinery*

ICS 91.220

Price based on 31 pages