

Australian/New Zealand Standard™

Safety of machinery

**Part 3610: Conveyors—General
requirements**



AS/NZS 4024.3610:2015

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Australian/New Zealand Standard™

Safety of machinery

Part 3610: Conveyors—General requirements

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee SF-041, Safety of Machinery, to supersede (in part) AS 1755—2000, *Conveyors—Safety requirements*.

The objective of this Standard is to apply the principles articulated in the AS 4024.1 series of Standards to conveyors and to protect workers and other persons against harm to their health, safety and welfare through the elimination or minimization of lifecycle risks associated with conveyor systems.

This Standard comprises the safety measures to be implemented for the lifecycle of conveyors and conveyor systems, both above ground and underground and the necessary risk controls against hazards experienced by operators of such plant.

The revision of this Standard covers the general safety requirements for large and small conveyors and conveyor systems. Technical and editorial revisions have been incorporated in line with available ISO documentation for mechanical handling equipment.

Major changes include—

- (a) the inclusion of risk management concepts;
- (b) the inclusion of hazards relating to conveyors;
- (c) contemporizing guarding requirements and providing clarity;
- (d) alignment with the AS 4024 series of Standards;
- (e) lifecycle management of conveyors; and
- (f) contemporizing of electrical requirements and conveyor control/protection.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard whereas an ‘informative’ appendix is provided for information and guidance.

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FOREWORD

The publishing of the AS 4024.1—2006 series of Standards for Safety of Machinery, based on international Standards published by the International Standards Organization for Standardization (ISO), paved the way for the continued alignment of Australian Standards with international Standards. It also began the development of a set of Standards that would be internally consistent, therefore removing various anomalies and inconsistencies that had previously developed over time between individual Standards.

The resulting suite of Standards consists of a three-tiered structure for the AS 4024 series:

- (a) Part 1: Series of foundation Standards for all machinery.
- (b) Part 2: Series of supportive technical Standards.
- (c) Part 3: Series of application Standards.

This publication is an application Standard.

Conveyors represent wide-ranging and varied applications from simple conveyors carrying light loads, e.g. as found in the retailing and pharmaceutical industries to large conveyors carrying tonnes of material as seen, in mining and extractive industries and heavy industrial applications.

Conveyors present wide variation in design and operating environments so they demand equally wide-ranging safety strategies. The safety requirements for some conveyors can be addressed by applying the principles set out in the AS 4024.1 series without the need for further guidance.

However, potential uncertainty, interpretation and ambiguity can result in a lower standard of safety than would be the case if application guidance of the principles set out in AS 4024.1 were not provided. Specific application guidance on applying AS 4024.1 to conveyors is addressed in this Standard. This revision will address these issues and result in uniformity across the suite of machinery Standards.

During its work, the committee reviewed a number of International Standards to see if there were any that related specifically to the types of conveyors covered under AS 1755. This did not prove to be the case, and the committee decided to set out the safety requirements for conveyors in a number of new parts of the AS 4024.3 series, drawing on the existing Standard (AS 1755), the AS 4024.1 series and the expertise of personnel representing those industries using conveyor systems.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Safety of machinery**Part 3610: Conveyors—General requirements**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out the minimum lifecycle safety requirements for conveyor systems. This Standard is intended to be used in conjunction with other conveyor Standards in the AS 4024 series (i.e. AS/NZS 4024.3611, AS/NZS 4024.3612 and AS/NZS 4024.3614) by all persons that design/modify, manufacture, supply, install, commission, operate, maintain or dismantle conveyor systems.

The conveyor Standards are not intended to apply to platform elevators, moving stairways or conveyors specifically designed for the conveyance of people. They do not apply to materials hoists, conveying material by fluids (e.g. slurries). This Standard does not cover disposal.

NOTES:

- 1 The conveyor Standards (AS/NZS 4024.3610, AS/NZS 4024.3611, AS/NZS 4024.3612 and AS/NZS 4024.3614) apply the principles set out in the AS 4024.1 series of Standards to conveyor systems.
- 2 Alternative risk controls based on risk assessment may be used, provided that the risk reduction achieved by the alternatives is at least equivalent to that provided by the requirements given in this Standard.
- 3 The committee intends to add a Standard to this series that will address screw conveyors.

1.2 OBJECTIVE

The objective of the conveyor Standards (AS/NZS 4024.3610, AS/NZS 4024.3611, AS/NZS 4024.3612 and AS/NZS 4024.3614) is to protect workers and other persons against harm to their health, safety and welfare through the elimination or minimization of lifecycle risks associated with conveyor systems.

1.3 APPLICATION

This Standard provides general requirements that apply to all conveyors as defined in this Standard. These requirements shall be applied in conjunction with the relevant particular requirements of AS/NZS 4024.3611, AS/NZS 4024.3612 and AS/NZS 4024.3614.

1.4 REFERENCED DOCUMENTS

A list of the documents referred to in this Standard is given in Appendix A.

1.5 DEFINITIONS

For the purpose of this Standard the definitions below apply.

1.5.1 Anti-runaway protective device

A safety device to stop a declining or inclining conveyor and thus prevent running away in event of an electrical or mechanical failure.

Typical types include the following:

- (a) Eccentric pinch roller or rollers on the return run.
- (b) Brake.
- (c) Ratchet and pawl, or overrunning clutch, on a shaft of the drive.
- (d) Self-locking worm gear reducer Z.
- (e) Roller clutch backstop in gear reducer.
- (f) Sprags or wedges located in the annular space between concentric inner and outer races.

1.5.2 Automatic stop control

Includes controls which automatically stop conveyor systems such as over dimensional load, tension mechanism over travel and temperature limit controls.

1.5.3 Carrying rollers (carrier rollers)

A series of rollers used to support a conveyed load.

1.5.4 Competent person

A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to correctly perform a specified task.

1.5.5 Conveyor

Apparatus or equipment operated by any power other than manual, by which loads are (capable of being) raised, lowered, transported, or continuously driven by—

- (a) an endless belt, rope or chain or other similar means;
- (b) buckets, trays or other containers or fittings moved by an endless belt, rope, chain or other similar means;
- (c) a rotating screw;
- (d) a vibrating or walking beam;
- (e) rollers; or
- (f) pulleys.

It includes the supporting structure and auxiliary equipment used in connection with the conveyor.

NOTE: See Appendix E for illustrations.

1.5.6 Conveyor system

An installation comprising one conveyor or multiple conveyors whose control is integrated.

1.5.7 Danger zone

Any zone within or around a conveyor in which a person is exposed to unacceptable risk of injury or damage to health.

1.5.8 Designer

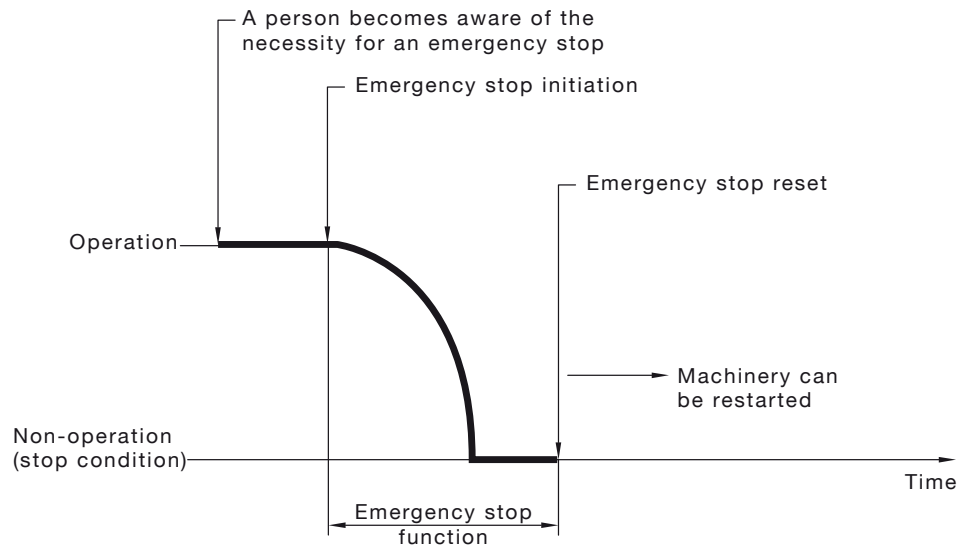
The person that designs or controls design functions, exercises control over a particular design or part of a design, or modifies an existing design.

NOTE: Refer to Guidance on the principles of safe design for work, by Safe Work Australia.

1.5.9 Emergency stop

Manually actuated control device used to initiate an emergency stop function which is intended to—

- (a) avert arising or to reduce existing hazards to persons, damage to machinery or to work in progress; and
- (b) be initiated by a single human action.



NOTE: Hazards are those which may arise from—

- (a) functional irregularities (e.g. malfunctioning of the conveyor(s), unacceptable properties of the processed material, human errors); or
- (b) normal operation.

FIGURE 1.1 GRAPHICAL REPRESENTATION OF EMERGENCY STOP FUNCTION

1.5.10 Energy isolating device

Any device that physically prevents the transmission or release of energy. These may include, but are not limited to, electrical isolators, disconnect switches, line valves and blocks.

1.5.11 Guard

Part of a conveyor system specifically used to provide protection by means of a physical barrier.

1.5.12 Harm

Physical injury or damage to health.

1.5.13 Idler

A rotating element which provides support or guidance to belt, chain or cable.

1.5.14 Interlocked guard

Guard associated with an interlocking device so that—

- (a) the hazardous conveyor functions protected by the guard cannot operate until the guard is closed;

- (b) if the guard is opened while hazardous conveyor functions are operating, a stop instruction is given; and
- (c) when the guard is closed, the hazardous conveyor functions protected by the guard can operate, but the closure of the guard does not by itself initiate their operation.

1.5.15 Interlock

Mechanical, electrical or other types of device, the purpose of which is to prevent the operation of conveyor elements under specified conditions, generally as long as a guard is not closed.

1.5.16 Isolation and energy dissipation

A procedure which consists of all of the four following actions:

- (a) Isolating (disconnecting or separating) the conveyor (or defined parts of the conveyor) from all energy sources that can cause harm.
- (b) Locking (or otherwise securing) all the isolating units in the isolated position.
- (c) Dissipating or, if this is not possible or practicable, restraining (containing) any stored energy which may give rise to a hazard.
- (d) Verifying that the actions taken according to Items (a), (b) and (c) above have produced the desired effect.

See AS 4024.1603 and AS 60204.1 for additional information on preventing unexpected start-up.

NOTE: Energy considered in Item (c) above may be stored in—

- (a) mechanical parts continuing to move through inertia;
- (b) mechanical parts liable to move by gravity;
- (c) capacitors and accumulators;
- (d) pressurized fluids; or
- (e) springs.

1.5.17 Lifecycle

Includes the period of its design, manufacture, construction, installation, commissioning, operation, maintenance, repair, decommissioning and disposal.

1.5.18 Maintainability

The ease with which maintenance work can be done. It involves the process of ensuring that products can be easily and safely maintained, and that the maintenance support requirement is minimized.

1.5.19 Mining

A system of obtaining and processing minerals or coal, including quarrying.

1.5.20 Muting

Temporary automatic suspension of a safety function(s) by safety-related parts of the control system.

1.5.21 Nip point

The point at which a moving conveyor element meets a fixed or moving element, so that it is possible to nip, pinch, squeeze, entangle or entrap parts of the human body.

1.5.22 Normal stop

A manual or automatically operated system designed to stop the conveyor under normal operating conditions.

1.5.23 Permanent(ly) fixed guard

Permanently fixed physical barriers which are designed to be welded or otherwise incorporated into the body of the conveyor, or its components, so that access to the danger zone is not required during normal operation, maintenance or cleaning (e.g. gearbox covers and head chute covers).

NOTES:

- 1 Removal of a permanent fixed guard is typically time consuming.
- 2 Permanently fixed guards generally only need removal where major repairs are being carried out.

1.5.24 Planned shutdown stoppage

A planned shutdown of the conveyor system during which all energy systems of the conveyor system which can cause harm are totally isolated (see Clause 2.13.3.3).

1.5.25 Pulley

A rotating element with tension applied which changes direction of the belt, chain or cable.

1.5.26 Operability

Is the ability to keep the conveyor in a safe and reliable functioning condition, according to predefined operational requirements.

1.5.27 Plant safety file

A structured compilation of documents providing traceable evidence/information relating to the health and safety features, incorporating each phase of the life cycle of the conveyor(s) from design through to demolition. It also contains a record of all 'as-built design features', including information on risks to health and safety that could arise at any phase of its life cycle.

1.5.28 PL

Performance level.

1.5.29 PLC

Programmable logic controller.

1.5.30 Protective stop control

A stop control provided for the protection of the conveyor or personnel from a hazard which, when activated, stops the conveyor and includes emergency stop controls.

NOTE: Examples include tracking, overflow, blocked chute, temperature controls and interlocked guards.

1.5.31 Pull wire

A wire connected to a device, normally provided for emergency stop control which, when pulled, activates the device.

NOTE: A pull wire could also be known as a lanyard when used as an emergency stop control.

1.5.32 Readily removable guard

A removable fixed guard that can be removed quickly. These types of guards are typically designed with a limited number of fasteners for ease of removal for routine maintenance, cleaning or inspection activities.

NOTE: These are a sub-set of removable guards and require the use of tools that are only available to competent personnel.

1.5.33 Return roller

A roller supporting the return run of the conveyor drive belt.

1.5.34 Reasonably practicable

That which is, or was at a particular time, reasonably able to be done to ensure health and safety, taking into account and weighing up all relevant matters including—

- (a) the likelihood of the hazard or the risk concerned occurring;
- (b) the degree of harm that might result from the hazard or the risk;
- (c) what the person concerned knows, or ought reasonably to know, about the hazard or risk, and ways of eliminating or minimizing the risk;
- (d) the availability and suitability of ways to eliminate or minimize the risk; and
- (e) after assessing the extent of the risk and the available ways of eliminating or minimizing the risk, the cost associated with available ways of eliminating or minimizing the risk, including whether the cost is grossly disproportionate to the risk.

NOTE: There are two elements to what is 'reasonably practicable'. First, consider what can be done, that is, what is possible in the circumstances for ensuring health and safety. Then consider whether it is reasonable in the circumstances to do all that is possible. This means that what can be done should be done unless it is reasonable in the circumstances to do something less.

For a full explanation of 'reasonably practicable', refer to *'Interpretive guideline—Model work health and safety act—The meaning of 'reasonably practicable'* by Safe Work Australia.

1.5.35 Regulatory authority

A Minister of the Crown, a government department or other public authority that has the power to issue regulations, orders or other instructions which have the force of law in respect of any subject covered by this Standard.

1.5.36 Removable guard

A fixed guard that is not permanently fixed.

1.5.37 Risk control

A means intended to reduce a risk (see Clause 1.6.4).

1.5.38 Runaway

Uncontrolled movement of the conveyor in either direction.

1.5.39 Safeguard

A guard or protective device.

1.5.40 Sequence

A control system designed to stop or start a conveyor, depending upon the state of other equipment.

1.5.41 Shall

Indicates that a statement is mandatory.

1.5.42 Shear point

The point at which, or the line along which, a moving part meets or passes close enough to a stationary part or object, so that parts of the human body can be caught, trapped or pinched between them.

1.5.43 Should

Indicates a recommendation.

1.5.44 SIL

Safety integrity level.

1.5.45 Snub pulley

A pulley used to deflect the belt, chain or cable, usually less than 90 degrees.

1.5.46 Start

A manual or automatically operated control system designed to start the conveyor under normal operating conditions.

1.5.47 Take-up

A means to control tension in belt, chain or rope.

NOTE: Tension is typically controlled by one of the following:

- (a) Screw.
- (b) Counterweight.
- (c) Springs.
- (d) Pneumatic.
- (e) Hydraulic.
- (f) Winch.

1.6 RISK MANAGEMENT

1.6.1 General

The lifecycle risks arising from hazards associated with conveyor systems shall be identified and controlled over their lifecycle in a risk management process (see AS 31000 for guidance).

1.6.2 Lifecycle hazards associated with conveyor systems

All lifecycle hazards associated with conveyor systems shall be identified. Table 1.1 lists typical hazards associated with conveyor systems and their potential consequences.

NOTES:

- 1 AS 4024.1201 provides further guidance on assessing machinery hazards.
- 2 Appendix B provides further guidance on stored energy systems.
- 3 Clause 2.13.2 provides guidance on typical hazardous situations requiring safeguards.

TABLE 1.1
CONVEYOR SYSTEM HAZARDS

Source	Hazard	Potential consequences	
		People	Conveyor
Bio-mechanical	Ergonomic design failure Foreseeable misuse	Excessive effort Human error, human behaviour Injuries from neglected use of PPE Slips, trips, falls Sprains, strains Unhealthy posture	
Chemical	Dust Explosion Fires Fluids Fumes Gases Mists	Asphyxiation Burn injuries Cancer Irritation Lung damage Poisoning	Corrosion Explosion Fire Melting

(continued)

TABLE 1.1 (*continued*)

Source	Hazard	Potential consequences	
		People	Conveyor
Electrical energy	Direct contact Indirect contact Electrostatic phenomena Loss of control	Electric shock/death	Fire/explosion Unsafe movement
Gravity Stored potential energy	Weight in elevated machine components Material being conveyed falling	Crush injuries Fall injuries	Plant damage
Magnetic energy		Interference with medical devices (e.g. pacemakers) Interference with electronic devices (e.g. testing, monitoring)	
Mechanical	Crushing Drawing-in or trapping Entanglement Friction or abrasion Impact Shearing Stored potential energy—springs Unexpected movement	Amputations Crush injuries Entanglement injuries Impact injuries	Impact damage Structural failure
Noise	Excessive noise levels	Hearing loss Make errors Miss alarms or acoustic signals Tinnitus	
Pressure	Stored potential energy—liquids and gases under pressure	Fluid injection injuries Struck by ejected projectiles	
Radiation		Radiation sickness	
Temperature	Contact with extreme high or low temperature objects Explosions Flames Heat radiation Hot or cold work environments	Burns, scalds Cancer Freezing Heat stress Hypothermia	Explosion Fire Melting Thermal damage
Vibration	Hand held machine vibrations	Neurological, vascular disorders Whole body vibration damage	

NOTES:

- 1 AS 4024.1301 provides further guidance.
- 2 For bulk materials handling belt conveyors, see AS/NZS 4024.3611.

1.6.3 Risk assessment

Where risk assessments are carried out, they should be carried out in accordance with AS 4024.1301 or ISO/IEC 31010 or other equivalent Standards.

1.6.4 Risk control

All risks arising from hazards that can cause harm shall be effectively controlled. Residual risks shall be minimized so far as is reasonably practicable.

In the treatment of risks, the following hierarchy shall be followed:

- (a) Eliminating the hazard through design.
- (b) Substituting the hazard giving rise to the risk with a hazard that gives rise to a lesser risk.
- (c) Isolating the hazard from the person put at risk.
- (d) Minimizing the risk by engineering means.
- (e) Minimizing the risk by administrative means (e.g. by adopting safe working practices, or providing appropriate training, instruction or information).
- (f) Using personal protective equipment.

SECTION 2 REQUIREMENTS FOR DESIGN

2.1 GENERAL

2.1.1 Design parameters

The design of a conveyor shall take into full account the magnitude, incidence, conditions and manner of all loading and forces likely to be applied to the conveyor.

The design shall specifically address the maximum (flooded) load condition, except where controls are incorporated to prevent such a condition occurring.

NOTE: Where controls are used, they should be fail-safe or have sufficient integrity to prevent catastrophic failure of the system.

In addition to the requirements of the conveyor Standards (AS/NZS 4024.3610, AS/NZS 4024.3611, AS/NZS 4024.3612 and AS/NZS 4024.3614), conveyor systems shall be designed and constructed consistent with the relevant requirements of AS 4024.1 (all parts as applicable) and other relevant Standards.

Conveyors shall be designed by a competent person to recognized Standards, where applicable.

NOTE: Recognized Standards for conveyors include relevant CEMA Standards (<https://www.cemanet.org/safety-publications/>) and for belt conveyors includes ISO 5048.

The slope and characteristics of the conveying system shall be designed to prevent hazardous unintentional sliding of the conveyed material under operating conditions.

Adequate clearance shall be provided to prevent inadvertent contact between the conveyed material and any part of the conveyor system, including installed equipment or structures.

2.1.2 Design information

2.1.2.1 General

The designer shall provide adequate information as specified in Clause 2.1.2.2 to Clause 2.1.2.5 to be included in the plant safety file (see Clause 6.4).

2.1.2.2 Synopsis of plant

The following information shall be included in the synopsis of plant:

- (a) Conveyor system name and description.
- (b) The purpose for which the conveyor was designed, and the environment, rated capacities and performance limits.
- (c) General arrangement drawings including identification of system components.
- (d) Schematic and logic drawings of power, control facilities and other services.

2.1.2.3 Design

The following information shall be provided:

- (a) Hazards and lifecycle risk controls.
- (b) System functional specification.
- (c) Any conditions necessary to ensure safety of the conveyor system when used for the purpose for which it was designed.
- (d) Information on safeguards, interlocking mechanisms, energy control, energy isolation/lock-out provisions and procedures (see Clause 1.5.13(d)).

- (e) A design statement including references to relevant design standards and design assumptions (e.g. duty cycles, environmental conditions).
- (f) For complex conveyor systems, validations of safety related control and protection systems where reliability of these systems are critical to safe operation.

2.1.2.4 *Installation, commissioning and dismantling*

The designer shall provide sufficient information for the safe installation, commissioning and dismantling of the conveyor(s).

The following information should be provided:

- (a) Installation procedures.
- (b) Pre-operational servicing procedures including lubrication requirements.
- (c) Procedures for the adjustment and setting of controls.
- (d) Isolation procedures for energy sources.
- (e) Isolation or dissipation procedures for stored energy, or both.
- (f) Knowledge, training or skill necessary for persons undertaking tasks.
- (g) Commissioning and testing procedures.
- (h) Dismantling, transport or removal procedure.
- (i) Emergency procedures in the event of a conveyor malfunction.

2.1.2.5 *Operation and maintenance*

The designer shall provide sufficient lifecycle information for the safe operation and maintenance of the conveyor(s).

The following information should be provided:

- (a) Lifecycle maintenance instructions and schedules which include maintenance, inspection and repair procedures.
- (b) Operating instructions which incorporate clear instructions for the operation of the conveyor system from start up to shut-down, including all possible sequences of control.
- (c) Parts list and recommended spares.
- (d) Knowledge, training or skill necessary for persons undertaking tasks.
- (e) Emergency procedures.
- (f) Repair, overhaul or test documentation.

All information should be presented in English (and other languages where necessary) with clear illustrations. As far as possible, the information should be contained in a single source dossier laid out in a logical manner that lends itself to change management, including revision of documentation pertaining to life cycle of conveyor system.

NOTE: The user should maintain all information relating to the lifecycle use of the conveyor system.

2.2 DESIGN RISK ASSESSMENT

2.2.1 Objective

The designer shall carry out a risk assessment(s) (see Clause 1.6.4) so that conveyor systems are designed to minimize risks to the health and safety of people who are associated with the lifecycle use of the conveyor system.

NOTES:

- 1 This includes anyone in the vicinity of the conveyor.
- 2 The designer should consult with parties involved throughout the lifecycle of the conveyor system.

In completing the design risk assessment, the designer shall carry out, or arrange the carrying out of, any calculations, analysis, testing or examination that may be necessary.

Outputs of a risk assessment should include a residual risk register for the conveyor system.

2.2.2 Foreseeable hazards

The designer shall address any foreseeable hazard that has the potential to harm the health or safety of any person during the conveyor system life cycle. In achieving this, the designer of the conveyor system shall consider all energy sources and shall eliminate the need for safeguarding or other risk controls where reasonably practicable.

NOTES:

- 1 Clause 1.6.2 provides a list of some foreseeable hazards associated with conveyor systems.
- 2 AS 4024.1201 and AS 4024.1202 provide further guidance.
- 3 The concept of listing energy sources, understanding the magnitude thereof, and contemplating the conveyor safeguarding mitigating and containment measures is critical.

2.2.3 Design risk evaluation and control measures

When carrying out the design risk evaluation, the designer shall consider—

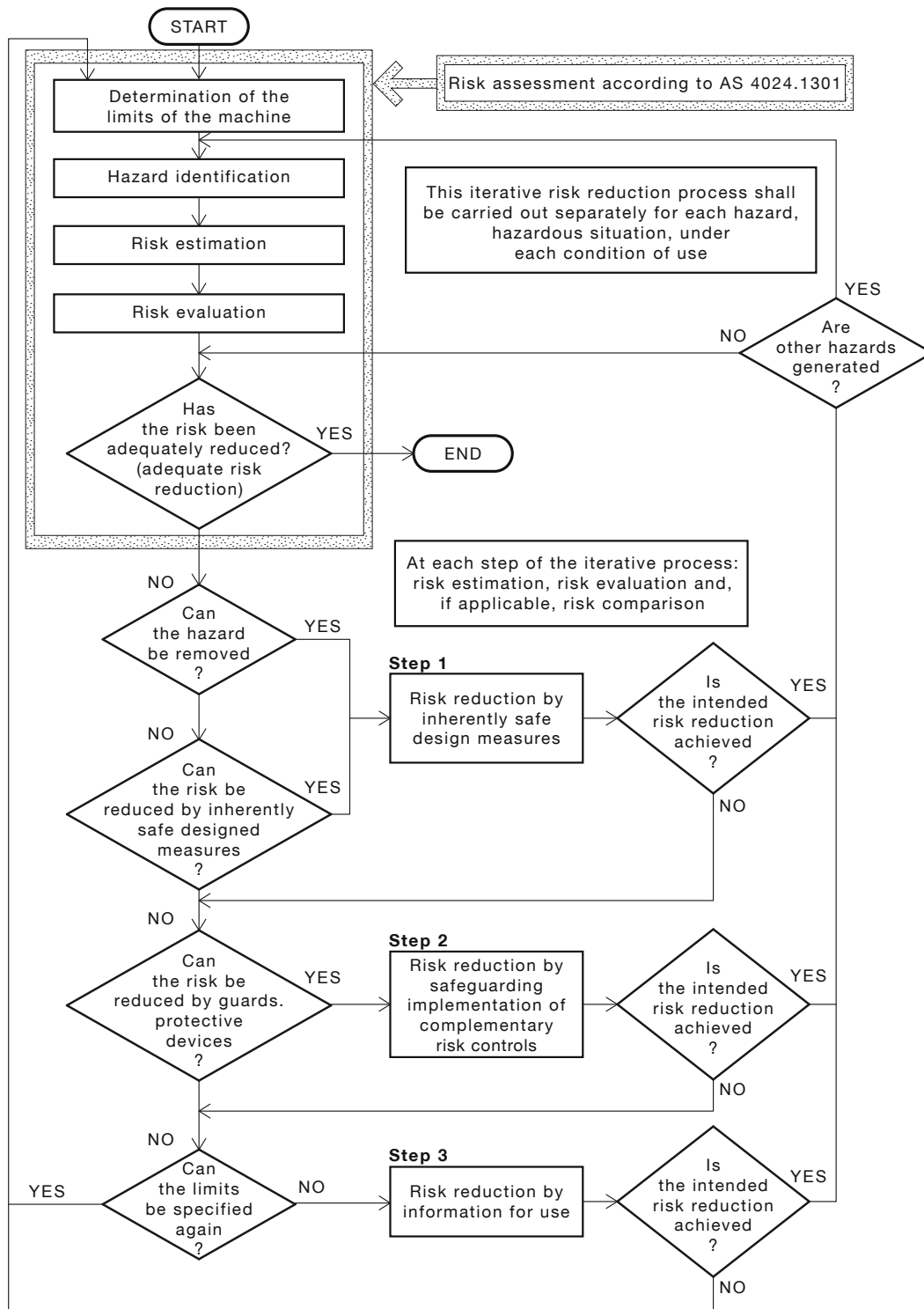
- (a) the impact of the conveyor system on the work environment in which it is designed to operate;
 - (b) the range of environmental and operational conditions in which the conveyor system is intended to be manufactured, transported, installed and used;
 - (c) the ergonomic needs of any person who may install, erect, use, maintain or dismantle the conveyor system;
 - (d) the need for safe access and egress for persons who install, erect, use, maintain or dismantle the conveyor system;
 - (e) the designed operational and maintenance requirements;
 - (f) any specific risk controls required by this Standard;
 - (g) functional safety of the control system; and
 - (h) risks associated with tunnels, galleries, pits, confined spaces and hazardous areas
- NOTE: See Appendix D for guidance on tunnels, galleries, pits, confined spaces and hazardous areas.

2.2.4 Design risk controls

The design risk assessment shall apply risk controls according to the following sequence of steps:

- (a) Inherently safe design measures.
NOTE: The design stage is the most effective stage at which hazards can be eliminated, therefore avoiding the need for additional risk control measures such as safeguarding or complementary risk control measures.
- (b) Safeguarding and any complementary risk controls.
- (c) Information about the residual risk(s).

See AS 4024.1201, AS 4024.1202, AS 4024.1301 and Figure 2.1 for further guidance.



NOTE: The first time the question is asked, it should be answered by the result of the initial risk assessment.

FIGURE 2.1 SCHEMATIC REPRESENTATION OF THE ITERATIVE 3-STEP METHOD FOR THE RISK REDUCTION PROCESS

2.2.5 Design risk assessment review

The design risk assessment(s) or risk controls shall be reviewed whenever—

- (a) the designer becomes aware that a control measure does not control the risk as intended;
- (b) a new hazard or risk is identified, e.g. an injury occurs;
- (c) alterations, modifications or relocations occur;
- (d) the residual risks identified require controls or management actions; or
- (e) there is evidence that the original risk assessment relating to the conveyor system is no longer valid.

2.3 ENVIRONMENTAL CONTROL

2.3.1 Environmental elements impacted by the conveyor

Environmental elements impacted by the conveyor shall be considered, including, but not limited to, the following:

- (a) Potential health impacts of the product being transported.
- (b) Potential for generating explosive atmospheres.
- (c) Fugitive material (e.g. spillage, dust, product, wash water and similar).
- (d) Potential for harmful emissions to the atmosphere.
NOTE: Additional hazards may occur in enclosed environments such as galleries, tunnels, underground mines, pits and confined spaces.
- (e) Potential impacts from emergency situations (e.g. large spills or fire).
- (f) Products of combustion in the event of a fire.
- (g) Noise emissions.

2.3.2 Environmental elements which impact the operation of conveyor

Environmental elements impacting conveyor operations shall be considered, including, but not limited to, the following:

- (a) Systems for handling fugitive material (e.g. spillage, dust, product, wash water and similar).
- (b) Potential impacts from emergency situations (e.g. subsidence or fire).
- (c) Flora and fauna.
- (d) Terrain and ground conditions (e.g. washout of foundations).
- (e) Weather conditions (e.g. heat, cold, rain, wind and lightning).
- (f) Corrosive environments (e.g. salt spray, process waters) which may affect conveyor components such as structures, rollers and control devices (e.g. emergency stops and interlocks).

2.3.3 Systems for handling fugitive material

2.3.3.1 Dust

Where dusts are present or may be generated due to the operation of a conveyor, measures shall be taken to minimize the generation and control the presence of dust.

For areas of a conveyor which may generate significant dust (e.g. transfer points or areas of high air velocity), means should be provided to collect or suppress the dust. These means may include, but are not limited to, the following:

- (a) Water sprays.
- (b) Dust cover hoods.
- (c) Dust collections systems.
- (d) Conditioning of material conveyed (e.g. pre-treatment of moisture content and material cutting methods).

Areas where dust can accumulate should be minimized.

NOTES:

- 1 Accumulated dusts can present a fire or explosion hazards, promote corrosion, falling material hazards.
- 2 Self-cleaning surfaces are preferred.
- 3 See also Clause 2.11.1 for combustible dusts.

2.3.3.2 *Material spillage*

Where material spillage may be generated due to the operation of a conveyor, measures shall be taken to minimize its generation.

The following apply:

- (a) Scrapers, ploughs or shedders should be provided where material may be drawn into a pulley to the belting contact area. The device should divert the material clear of the contact area.
- (b) Means should be provided at the discharge point of a conveyor to minimize carry back of material.

2.4 DESIGN FOR OPERABILITY AND MAINTAINABILITY

2.4.1 General

Conveyors shall be designed such that they are safe to operate and maintain over their lifecycle.

NOTES:

- 1 When proper consideration is given at the design stage, more effective risk controls are usually possible.
- 2 Unsafe conditions have occurred where the design does not provide safe facilities for access, lubrication, inspection condition monitoring and minor adjustments.

The conveyor design shall allow operation and maintenance to be carried out under the environmental and operational conditions of the site.

NOTE: Human ability to perform even simple tasks is dramatically affected by adverse environments. It is therefore necessary to take into account the maintenance environmental conditions.

Operability and maintainability reviews on the conveyor shall be conducted during the design phase such that routine and periodic operation and maintenance tasks are considered.

NOTE: In carrying out the review, the designer should consult with parties involved throughout the lifecycle of the conveyor system.

The reviews should consider—

- (a) safety requirements for operation and maintenance people;
- (b) environmental conditions in which conveyor will operate and be maintained;

- (c) the life required from the conveyor and its disposal method;
- (d) competence of people maintaining the conveyor;
- (e) functional interchange-ability of components;
- (f) availability requirements;
- (g) preventive maintenance requirements;
- (h) access and space to work around the conveyor;
- (i) adequate illumination;
- (j) standardization of fasteners;
NOTE: For areas where frequent access is required for maintenance, quick access fasteners with interlocks may be required.
- (k) standardization of tools, where possible;
NOTE: The need for special tools should be minimized except where required to enhance the effectiveness of risk controls.
- (l) lubrication/servicing requirements;
- (m) servicing when conveyor is operating; and
- (n) handling of large components during installation or removal, particularly in restricted areas where handling may be complex.

2.4.2 Design for safe access

2.4.2.1 General

The design shall consider allowing for operation and maintenance access such as lubrication, inspections and condition monitoring.

Where inspection and maintenance tasks need to be undertaken while the conveyor is running (e.g. vibration monitoring on a gearbox), safe access shall be provided.

Means of access to the conveyor and its controls for the purpose of working, operating, inspecting or servicing shall be provided, see AS 4024.1702 and AS 4024.1703.

2.4.2.2 Walkways

Where fixed platforms, walkways, stairways or ladders are used for providing access, they shall comply with the requirements of AS 1657.

NOTE: ISO 14122 Parts 1 to 4 may be used for machinery elements of conveyors provided a risk review is undertaken and there is no increase in risk.

Routine operation and maintenance work shall be able to be carried out from floors or platforms, not from stairways or ladders, where practicable.

Where a conveyor fire may create an unacceptable risk to access ways, a safe means of escape shall be provided.

NOTE: This may be alternative egress, safe standing zones/shelters and similar.

Where a conveyor is alongside a walkway and there is potential for a person to be injured by falling on the conveyor, a means shall be provided where practicable to prevent people falling on the conveyor (see also Clause 2.10.5.4).

2.4.2.3 *Crossovers for aisles and passageways*

Where access to either side of the conveyor is required, crossovers or underpasses shall be provided where appropriate such as at the head and tail end, the drive, transfers, and other relevant points along the conveyor. Where a conveyor crosses a walkway, aisle or passageway and the lowest part of the conveyor or material or attachment is less than 2.1 m above the floor or walkway surface, a designated crossover or underpass as appropriate shall be provided.

A crossover should be equipped with handrails to prevent accidental fall onto the conveyor. In the case of an underpass, the conveyor should be guarded to prevent rock falling onto workers travelling underneath the conveyor and accidental contact with moving parts.

NOTES:

- 1 The underpass or overpass may be a crawl-way where no alternative is reasonably practicable.
- 2 Incidents have occurred in the past where safe means of crossing the conveyor have not been conveniently located.

2.4.2.4 *Working clearance*

Adequate clearance shall be provided to prevent inadvertent contact between the conveyed material and any part of the conveyor system, including installed equipment or structures.

Where access is required alongside an operating conveyor, a minimum clearance of 600 mm coupled with minimum headroom of 2.0 m should be provided.

Both sides of the conveyor should have sufficient clearance to allow any spillage or unintended movement of material conveyed to fall clear of the conveyor. Adequate clearance shall also be provided between the material being conveyed and the roof or cover.

The provision for a minimum headroom of 2.0 m need not apply to underground mines.

2.4.2.5 *Access to take-up*

Means of accessing the take-up for repair and maintenance purposes, together with provision for releasing or securing the stored energy shall be incorporated in the design of the system.

2.4.3 Design for lubrication, inspection and adjustments

2.4.3.1 *General*

Components of conveyor shall be laid out with adequate space for maintenance work around the conveyor.

Maintenance points such as lubrication, monitoring, and adjustment points shall be outside danger zones where reasonably practicable.

2.4.3.2 *Guard design*

Guards should be designed so it is not necessary to remove them for regular lubrication, servicing, inspection or adjustments such as, adjusting monitoring devices, re-setting belt tracking switches.

There should be a provision for the placement of remote lubrication points that should remain readily visible and enable visual verification that lubrication is effective (e.g. grease purging).

Where an access door has been designed into the guard, it shall comply with Clause 2.13.4.7.

Pulley guards should make provision for safe access to the bearings, and this should be done by fully enclosing guards where the guards fit behind the pulley bearings enclosing the hazard posed by the bearing shaft and pulley sides.

It should be possible to safely access the pulley bearing to allow for vibration monitoring, lubrication and inspection while the conveyor is running.

NOTE: Where it is not possible to safely access the bearing, remote lubrication lines and bearing monitoring points should be placed so that personnel are kept well clear of any potential nip points while conducting maintenance and inspection activities.

2.4.4 Design for cleaning and inspection

2.4.4.1 General

The design shall make provisions for the removal or disposal of spillage where required.

The design shall include the provision for safe cleaning around known spillage points, such as, transfer chutes, loading points, crushers, etc.

NOTE: Housekeeping and removal of spillage is an important safety consideration required to reduce dust and eliminate the potential for fire if material comes in contact with the conveyor's moving or rotating parts.

Where manual loading of spilt material is a requirement, a safe means of returning the material to the conveyor shall be provided. This may be in the form of a chute that separates the person from exposure to all moving parts of the conveyor.

2.4.4.2 Guard design for cleaning and inspection

Guards shall be designed to allow for easy cleaning and inspection. Where applicable, guards should be designed—

- (a) with sufficient clearance to the ground to enable spillage and material build-up to be safely removed (e.g. such as hosing with water);
- (b) to enhance the ability of a person to view through the guards for inspection purposes while considering the safe-reach distance to the hazard being guarded (see Clause 2.13.4.5); and
- (c) to allow hosing/blowing out fines/spillage in the vicinity of moving items without the need to remove guards (e.g. holes in the guards or flexible mesh complying with reach dimensions).

NOTE: It is industry practice to paint guards with a bright colour such as safety yellow or orange. However, the bright and contrasting colours can make it difficult to see through the guards. Consideration should be given to painting inspection viewing sections a mat black colour to facilitate visual inspection.

2.5 SYSTEMS TO STOP AND HOLD A CONVEYOR

2.5.1 Safe stopping

Conveyors shall be designed to ensure that they will stop safely when the driving energy is disconnected and remain stopped until the energy is restored.

For emergency stops, see Clause 2.10.5.

2.5.2 Anti-runaway device

Any conveyor which can run away due to the effect of gravity shall be provided with device(s) which will automatically prevent runaway.

The anti-runaway device shall be installed in the drive train in a position that it is unlikely to fail during the intended lifecycle of the conveyor taking into consideration fatigue, environment and dynamic loading conditions during operation and testing. Where the device is not installed directly on the drive/driven pulley, the potential for failure of any component in the load train shall be assessed and sufficient strength rating applied to all load train elements.

Anti-runaway devices shall not be installed between the drive motor and a belt, chain drive, fluid coupling or similar device.

Where a hazard to people exists from the failure of an anti-runaway device then at least two automatically operated devices shall be provided to prevent run away. Each device shall be capable of holding the load independently. These devices should be monitored for wear and effective operation. Where there are more than two devices the loss of one device shall maintain at least 150% of the load. Appropriate proof-test intervals shall be stated to detect any failures.

Each anti-runaway device shall be rated to stop and hold at least 150% of the maximum normal load applied by the conveyor including dynamics.

Consideration shall be given to abnormal dynamic effects and the potential for the conveyor to be overloaded.

NOTES:

- 1 These devices include but are not limited to brakes, anti-runbacks or holdbacks.
- 2 Consideration should be given to one anti-runback device being installed without any interposing devices.
- 3 It is not intended for the 150% to be applied to abnormal dynamic effects such as aborted starts or aborted stops. The anti-runaway device should be capable of withstanding these loads.

2.5.3 Controlled braking

Where a conveyor will run on, and in doing so create a hazard, then a system shall be provided to bring the conveyor to a controlled stop. A braking system shall be provided to achieve this for emergency situations. The safe stopping time shall be determined so that the hazard(s) is reduced to an acceptable level, as determined by risk assessment.

The braking system shall provide a minimum braking torque to stop the conveyor in the time determined by risk assessment, allowing for any single component failure of the braking system.

The braking system shall be capable of applying a brake torque of at least 150% of the design braking torque, allowing for any single line component failure of the braking system.

Braking devices shall operate automatically in the event of power loss.

NOTE: AS 4024.1501 provides guidance in assessing system integrity.

2.5.4 Prevention of unplanned or hazardous movement

A system shall be provided to prevent brakes or anti-runaway devices from being released until the torque has been applied to the main driving shaft of the conveyor.

2.5.5 Controlled speed of descent

Brakes which are manually released and applied by the movement of operating devices shall be designed so that if the power is interrupted with the brakes in the release position, the load can descend only at a controlled speed.

2.6 ENERGY AND ISOLATION

2.6.1 Stored energy systems

2.6.1.1 General

The design of the conveyor shall consider all energy sources and be designed to eliminate or minimize the hazards from the energy sources where practicable.

Where stored energy or gravity can present a hazard, a means to isolate and dissipate that energy shall be provided.

NOTES:

- 1 Typical stored energy systems on a conveyor include gravity take-ups, winch systems, belt or chain stretch, pressurized fluids, conveyed material under gravity and similar. Appendix B gives further guidance.
- 2 Particular attention should be addressed to the contained and safe release of energy in all failure modes of the conveyor or its sub-systems.

2.6.1.2 Energy isolation and dissipation**2.6.1.2.1 General**

Conveyors shall be provided with means intended for energy isolation and dissipation to prevent or control energy hazards associated with the operation and maintenance of conveyor systems (see AS 4024.1603).

Energy isolation device(s) shall be provided that effectively isolate all portions of a conveyor system from all sources of energy.

NOTE: Group isolation systems may be used.

Each energy isolation device shall be labelled to clearly identify the conveyor and the energy source being isolated by that device. Where the energy isolation device is remote from the conveyor, then the conveyor itself shall be labelled.

NOTE: Instances have occurred where people have isolated a conveyor and then worked on the wrong conveyor.

2.6.1.2.2 Gravity take-up isolation

A means shall be provided to secure and isolate any gravity take up weight to allow maintenance activities to be carried out safely.

2.6.1.3 Control of take-up

Controls for the take-up shall be accessible from outside the guarded area.

NOTE: This does not apply to gravity take-ups with no controls.

Where automatic control of the power operated take-up is provided, then isolation of the automatic operation and selection of a manual operation should be provided.

Where control operated remote isolation is employed on a belt, this system should also provide compatible isolation and confirmation for the loop take-up drive as a part of the belt's isolation system.

Manually operated tension devices shall not be capable of free-wheeling under any condition and shall be accessible from outside the guarded area.

The following minimum safety factors shall apply to all wire ropes used for take-ups and counterweights of conveyors:

- (a) 4.5—relative to the maximum static load that can be applied by the tension system.
- (b) A dynamic factor of safety of 2.25.

2.6.1.4 Raising and lowering systems

Conveyors which include an articulated or mobile part that is raised and lowered shall be fitted with devices for automatically immobilizing these parts in the event of loss of power.

The raising or lowering system shall be designed to prevent accidental movement or kickback when operated.

The system controls shall be located so they can be operated from a safe location.

Stops or limiting devices shall be provided to prevent movement of the articulated or mobile part beyond its designed limits.