

Australian/New Zealand Standard™

Safety of machinery

**Part 3611: Conveyors—Belt conveyors
for bulk materials handling**



AS/NZS 4024.3611:2015

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Australian/New Zealand Standard™

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Part 3611: Conveyors—Belt conveyors for bulk materials handling

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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 provide guidance and clarity in applying the principles articulated in the AS 4024.1 series of Standards to BMH belt conveyors.

This Standard comprises the safety measures to be implemented for the lifecycle of bulk materials handling (BMH) belt conveyors and conveyor systems, both above ground and underground. This Standard also sets out the necessary risk control measures against hazards experienced by workers and others in the vicinity of such plant.

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 only for information and guidance.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	4
1.2 APPLICATION	4
1.3 REFERENCED DOCUMENTS.....	4
1.4 DEFINITIONS.....	4
SECTION 2 REQUIREMENTS FOR DESIGN	
2.1 DESIGN RISK ASSESSMENT.....	5
2.2 GENERAL DESIGN REQUIREMENTS.....	6
2.3 ENVIRONMENTAL CONTROL	7
2.4 DESIGN FOR OPERABILITY AND MAINTAINABILITY	8
2.5 ENERGY AND ISOLATION	10
2.6 ELECTRICAL REQUIREMENTS	11
2.7 ILLUMINATION	12
2.8 BMH BELT CONVEYOR CONTROL	12
2.9 FIRE PROTECTION	15
2.10 SAFEGUARDS	15
2.11 TRAMP MATERIAL REMOVAL	21
SECTION 3 REQUIREMENTS FOR SPECIFIC LOCATIONS AND TYPES	
3.1 RECLAIM TUNNELS IN HAZARDOUS AREAS AND COAL MINES	22
3.2 BMH BELT CONVEYORS FOR MINING—PRESTART WARNING.....	22
3.3 BELTING AND ACCESSORIES IN UNDERGROUND COAL MINES	22
3.4 FLEXIBLE CONVEYOR TRAINS (FCTs).....	22
3.5 CABLE BELT TYPE CONVEYORS	23
3.6 TRAVELLING TRIPPERS, SHUTTLE AND RADIAL CONVEYORS FOR BMH	23
3.7 PERSON-RIDING ON CONVEYOR BELTS	25
SECTION 4 INSTALLATION COMMISSIONING	
4.1 BELT ALIGNMENT AND TRACKING.....	26
4.2 BELT SPLICES AND MECHANICAL JOINTS.....	26
SECTION 5 MAINTENANCE	
5.1 MAINTENANCE INVOLVING STORED ENERGY	27
5.2 IDLER MANAGEMENT	27
5.3 BELT TRACKING	27
5.4 BELT SPLICES AND MECHANICAL JOINTS.....	27
5.5 BELT INTEGRITY	27
APPENDICES	
A EXAMPLES OF RISKS ASSOCIATED WITH BMH BELT CONVEYORS	29
B BMH BELT CONVEYOR FATALITIES IN MINING	33
C BMH BELT CONVEYOR TYPES.....	41
D REFERENCED DOCUMENTS.....	45

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Safety of machinery**Part 3611: Conveyors—Belt conveyors for bulk materials handling**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out minimum lifecycle safety requirements for belt conveyors for bulk materials handling, which are in addition to the general requirements of AS/NZS 4024.3610. It also contains requirements for systems comprising multiple conveyors and is intended to be used by all persons conducting a business or undertaking in relation to belt conveyors for bulk materials handling.

This Standard excludes light duty belt conveyors used for—

- (a) transport of unit loads (e.g. parcels, boxes, cans, containers, luggage, industrial goods of all kinds and foodstuffs—see AS/NZS 4024.3612); and
- (b) bulk materials applications indoors, typically found in chemical, pharmaceutical, cosmetic, food and tobacco industry (see ISO 21183).

1.2 APPLICATION

This Standard specifies additional requirements for belt conveyors for bulk materials handling that supplement and shall be applied in conjunction with the general requirements of AS/NZS 4024.3610. Where this Standard and AS/NZS 4024.3610 cover the same scope, this Standard shall take precedence.

1.3 REFERENCED DOCUMENTS

A list of documents referred to in this standard is given in Appendix D.

1.4 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 4024.3610 and the following apply.

1.4.1 BMH belt conveyor

A conveyor using a moving belt for conveying bulk materials.

NOTE: BMH refers to 'bulk materials handling'.

1.4.2 Bulk material

Solid particulate materials such as ores, coal, grains, wood-chips, sand, gravel and stone in bulk form. It also applies to the handling of mixed wastes.

1.4.3 Underground (coal) mine

The underground parts of a (coal) mine.

SECTION 2 REQUIREMENTS FOR DESIGN

2.1 DESIGN RISK ASSESSMENT

2.1.1 General

A design risk assessment is the first step in the design process.

2.1.2 Characteristics of BMH belt conveyors

Bulk materials handling (BMH) belt conveyors typically have unique characteristics which impose additional hazards such as high drive energies and multiple stored energy systems. These characteristics shall be considered in the design risk assessment.

These characteristics typically include the following:

- (a) Power requirements (including the size and type, e.g. electric, diesel, hydraulic, etc.).
- (b) Topography—distance, lift, profile, contour, etc.
- (c) Operating environment (e.g. hot, cold, dusty, windy, wet, icy, day or night).
- (d) Volumetric capacity—speed, belt width, trough angle, etc.
- (e) Belt tension.
- (f) Material properties—density, size, moisture content, etc.
- (g) Belt handling systems for installation and maintenance.
- (h) Splicing facilities.
- (i) Take-up systems.
- (j) Transfer points, trippers, splitters and similar.
- (k) Other associated equipment—crushers, magnets, dewatering chutes, feeders, bins, metal detectors, weightometers and similar.
- (l) The diversity of BMH belt conveyors used, including the following:
 - (i) Shuttles.
 - (ii) Non-conventional BMH belts (e.g. cable belts, pipe conveyors, pouch conveyors, flexible conveyor train (FCT), air-supported, etc.).
 - (iii) Travelling bulk material handling conveyors—ship loaders, barges and rail, stackers and reclaimers, etc.

2.1.3 Specific hazards associated with BMH belt conveyors

Specific hazards shall be considered in the design phase.

In addition to the general hazards listed in AS/NZS 4024.3610, specific hazards for BMH belt conveyors for bulk material handling are listed in Appendix A.

Specific lifecycle hazards include, but are not limited to, a release of uncontrolled energy from—

- (a) deterioration of belt joints (e.g. splice, clips failing);
- (b) deterioration of brakes, holdbacks;
- (c) damage to the belt from tramp material, rubbing on structures, accumulation of material, material hardness, worn idlers;
- (d) deterioration of the belt (e.g. steel cord deterioration);

- (e) idler change-out;
- (f) fires and explosions;
NOTE: In addition to obvious fuel and ignition sources, less obvious considerations include explosive dusts contacting ignition sources such as bearing failures and unintended friction.
- (g) maintenance of scrapers, pulleys, take-up systems and similar;
- (h) fatigue and corrosion failures (pulleys, structural components); and
- (i) failure of control devices.

2.1.4 Risk control

Risks arising from the identified hazards shall be controlled in the design phase, as far as reasonably practicable.

2.2 GENERAL DESIGN REQUIREMENTS

2.2.1 Design standards

BMH belt conveyors shall be designed by a competent person in accordance with a recognized Standard(s).

NOTE: Recognized Standards for design of belt conveyors for bulk materials handling include CEMA 'Belt conveyors for bulk materials handling', ISO 5048 and DIN 22101.

2.2.2 Belt design

Conveyor belting shall be designed and manufactured in accordance with AS 1332, AS 1333 or other equivalent Standards. Where a conveyor's belting is required to be fire resistant and antistatic, then it shall comply with AS 4606.

2.2.3 Design considerations

The design shall consider the following without limitation:

- (a) For structures and components—
 - (i) flooded belt;
 - (ii) material build-up;
 - (iii) conveyor belt dynamics (e.g. start-up and stopping tensions and characteristics);
 - (iv) installed and induced power including effects of operating environment;
 - (v) unintended impact by mobile plant;
 - (vi) subsidence;
 - (vii) intended design life;
 - (viii) ability to inspect and maintain;
 - (ix) corrosion and fatigue;
 - (x) installation loads (e.g. belt installation); and
 - (xi) the effect of vertical and horizontal curves.
- (b) Unplanned movements causing hazards to people.
- (c) A person inadvertently on a moving belt.
- (d) Fire and explosion.
- (e) Material falling from the belt.
- (f) Components falling from heights.

- (g) Failure of control systems (e.g. emergency stop systems, belt tracking switches, feed control, belt speed comparator, chute-full limits, etc.).
- (h) Failure of mechanical components (e.g. anti-runaway devices, brakes, tension winches, transmissions, couplings, pulleys, etc.).
- (i) Undulating profiles with varying load conditions causing changes in energy transfer.
- (j) Regenerative system runaway and braking torques.
NOTE: A regenerative system is where power is transmitted from the belt to the drive/driven pulley then back to the power source.
- (k) Belt specification (see AS 1333, AS 1332 and AS 4606).
- (l) The effect of free water or water in material causing spillage.
- (m) Sequencing of multiple in-line conveyors.
- (n) The running of services in and about BMH belt conveyors to prevent the undue loading of the conveyor due to the services and debris build-up.
- (o) Where a BMH belt conveyor is hung from the roof, appropriate sideways bracing to prevent conveyor swing.
- (p) Frictional characteristics of the system that are worst case for power and regenerative design.
NOTE: For regenerative BMH belt conveyors, minimal frictional characteristics should be applied to ensure there is sufficient energy absorption/braking capacity provided.

2.2.4 Design information

The following design information shall be provided for inclusion in the plant safety file for each installation:

- (a) Belt line profile and data sheet (shows grades, lengths, widths, speeds and similar).
- (b) Nominal/rated capacity (tonnes per hour).
- (c) Installed drive power (e.g. motor size(s)).
- (d) Belt tension profile including maximum and minimum under varying load conditions.
- (e) Belt designation (see AS 1333, AS 1332 and AS 4606).
- (f) Take-up belt tensions.
- (g) Design assumptions used (e.g. conveyed material properties).
- (h) Key components technical specifications (e.g. gearboxes, couplings, idler rolls, anti-runbacks, brakes, pulleys, drive and motor, starting and stopping characteristics, and similar).
- (i) Functional safety design parameters.

2.3 ENVIRONMENTAL CONTROL

2.3.1 General

The designer shall consider the following environmental matters:

- (a) Effect of wind (e.g. loading on structures, belt lift-off, spillage, side tracking and dust).
NOTE: This is particularly applicable to elevated stackers, reclaimers, trippers, gantries and cyclone prone areas.
- (b) Induced voltages from running parallel or under overhead power lines.
- (c) Water effects of heavy rain.

- (d) Lightning.
- (e) Ice build-up (e.g. loading on structures, change in friction characteristics).
NOTE: This is particularly applicable to travelling trippers where wheels may lose friction on the rails).

2.3.2 Dust generation and control

The design should consider—

- (a) explosive dusts;
- (b) harmful dusts (e.g. silica, natural asbestos, lead and radioactive substances);
- (c) management of dry fines (spontaneous combustion);
- (d) dust control in enclosed areas (e.g. gantries and tunnels);
- (e) dust impact on components; and
- (f) dust impact on surrounding communities, flora and fauna.

2.3.3 Accumulation of materials

To prevent accumulated material creating a hazard, the following minimum distances shall be provided, where possible (see Figure 2.1)—

- (a) not less than 300 mm from the floor to the under-side of belt; and
- (b) not less than 150 mm from rotating parts (e.g. idlers and pulleys) to the floor for the removal of accumulated material.

These requirements shall not reduce the minimum safeguarding distances.

NOTE: For tail-end loading points, these dimensions may be reduced if they are impractical. In which case sufficient clearance should be provided to prevent contact between the belt surface or any rotating element and any spillage which might occur.

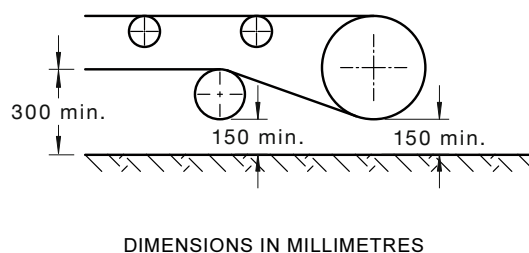


FIGURE 2.1 CLEARANCE FOR ACCUMULATION OF MATERIALS

2.4 DESIGN FOR OPERABILITY AND MAINTAINABILITY

2.4.1 General

All BMH belt conveyors should have walkway access along at least one side and to other areas requiring inspection or maintenance that may be accessed frequently (e.g. head pulley).

NOTE: Where access is required more than monthly, good practice is to provide walkway access along both sides.

Where walkway access is not provided, the designer shall provide for a safe system of access to provide for safe operation and maintenance of the BMH belt conveyor. This system shall be documented.

2.4.2 Design for maintenance

As far as reasonably practicable, the conveyor system shall be designed so that it does not require the removal of guards to carry out routine inspection and maintenance activities that need to be carried out such as tracking, lubrication, servicing, inspection, adjusting monitoring devices, re-setting belt tracking switches, condition monitoring and similar.

2.4.3 Belt installation, replacement and maintenance

2.4.3.1 General

The design shall provide for the safe installation, replacement and maintenance of conveyor belt. This should include a means for—

- (a) belt roll handling;
- (b) splicing of the belt;
- (c) lifting and securing of the counterweight;
NOTE: If impractical to position a crane to perform the counterweight lift then a safe and effective alternative means to lift the counterweight is to be provided.
- (d) securing and clamping the belt at appropriate locations; and
NOTE: Where fixed belt clamp stations are provided, consideration should be given to interlocking to prevent the belt running when clamps are either engaged or not fully disengaged.
- (e) pulling the belt on and off using winches and belt reels, etc.

2.4.3.2 Splicing station—General

Appropriate facilities for safely splicing conveyor belting shall be provided for both installation and ongoing belt maintenance activities where applicable.

Consideration should be given to the following:

- (a) Amenities for splicing operation such as power, lighting and water.
- (b) A flat area with protection from the elements.
NOTE: Splicing requires the use of hand tools. Provision should be made for the area to be dry where electrical powered tools are intended for use.
- (c) Sufficient clearance in the area where the splice is to be performed.
- (d) An appropriate structure onto which to position the splicing table, bars, platens and other vulcanizing and splicing equipment.
- (e) Where there is a risk of falling (e.g. where guard-rails are removed to facilitate belt splicing), a means of fall protection.
- (f) Adequate ventilation and environmental controls.

NOTES:

- 1 Splicing should not be done in potentially explosive atmospheres, such as hazardous areas or hazardous zones.
- 2 Good ventilation is required for the dilution of harmful vapours from toxic solvents.

2.4.3.3 Splicing station—Electrical requirements

NOTE: The electrical equipment in splicing stations is regularly utilized in harsh environmental conditions often involving mud, water and dust. Further, some of the electrical equipment is cumbersome to use, e.g. splicing platens. Double insulated power tools are also regularly used in these areas and these devices are prone to fail dangerously in such environments. As a consequence, a higher level of electrical protection is recommended for these areas.

The following applies:

- (a) Splicing equipment shall have an earth leakage circuit-breaker with an earth leakage trip value not greater than 30 mA for protection of any hand-held electrical equipment used in conjunction with the splicing equipment.
- (b) The resetting device for the short-circuit and earth leakage protection shall be capable of being locked to prevent unauthorized resetting.
- (c) The plug connecting the platen cable to the platen shall be secured with a retention device to ensure the plug cannot inadvertently come free from the platen.
- (d) The splicing control box shall contain circuitry that ensures the platens have an effective earth connection at all times (a form of pilot circuit will be regarded as complying with this requirement).

2.4.4 Loading, transfers and discharge points

Belt loading, transfers and discharge points shall be designed to minimize belt tracking issues, blockage, spillage, noise, wear and dust generation/emission.

NOTE: Good practice is—

- (a) placing the material in the centre of the belt at the same velocity as the receiving belt;
- (b) minimizing the number of direction changes to preserve the velocity of the material; and
- (c) minimizing the impact angle.

Consideration shall be given to the following:

- (a) The varying bulk material properties.
- (b) The varying discharge trajectory due to variable belt speeds, and during start-up and stopping.
- (c) The minimization of the release of dust by—
 - (i) limiting external air velocity through the transfer;
 - (ii) minimizing free-fall of material; and
 - (iii) using suitable dust suppression systems (see the requirements for handling fugitive material in AS/NZS 4024.3610).
- (d) Fines/carry-back management to minimize spillage and dust.
- (e) Space limitations (e.g. low height).
- (f) Noise.

2.5 ENERGY AND ISOLATION

2.5.1 General

In the design of energy isolation systems, the following shall be considered:

- (a) Identification of energy sources requiring isolation (see requirements for 'energy and isolation' in AS/NZS 4024.3610).
- (b) Group isolation methods.
- (c) Remote isolation methods and limitations.

2.5.2 Main electrical isolation

Each conveyor controller assembly shall be provided with a single point of isolation (i.e. main isolator).

Where multiple supplies feed a single drive assembly, the isolation devices should, where possible, be interlocked so that operation of a single isolation actuator operates all isolation devices.

Isolating switches shall be one of the following types (for guidance refer to AS 3007):

- (a) Fault make/fault break.
- (b) Fault make/load break.
- (c) Off load make/off load break devices.

Where an off load make or off load break devices is used, the device shall be fitted with an interlocking device that removes the load before the device is operated and has a suitable category, performance level or safety integrity rating relevant to the risk.

2.6 ELECTRICAL REQUIREMENTS

2.6.1 Equipotential bonding

All discontinuous structures or frames of BMH belt conveyors shall be equipotentially bonded or earthed by fit-for-purpose flexible earth bonds to protect the electrical conductors and devices against lightning strikes, coupling hazards (capacitive or inductive) and minimize indirect contact voltages and induced voltages.

NOTES:

- 1 An equipotential bond is an electrical connection intended to bring exposed conductive parts or extraneous conductive parts to the same or approximately the same potential to prevent electric shock and arcing during faults or lightning, but not intended to carry current in normal service.
- 2 It is assumed that moveable BMH belt conveyors are such that induction hazards are minimized by either the short length of the conveyor or by separation from induction sources. For the principles that apply to hazards on metallic structures, see AS/NZS 4853.
- 3 The use of flexible 35 mm² equipotential bonding conductors is generally considered adequate for lightning protection of discontinuous metal structures.

This Clause does not apply where deliberate separations are made in conveyor structures, such as at the portal of a mine to provide electrical separation in such structures for the purpose of attenuating the effects of lightning entering a mine to minimize transfer potentials or reduce coupling effects. See AS 3007 regarding separated earthing systems.

2.6.2 Cables

Cables used for power supply and distribution shall be suitable for the intended application, duty and environment such as exposure to extreme temperatures, U/V radiation, vibration, and similar. Cables that are likely to suffer mechanical damage to an unprotected sheath during normal operation shall have metallic screens or armouring, or both.

The screens and/or armouring can be utilized to help limit the touch voltages, as specified in AS/NZS 3000 and AS/NZS 3007 (as applicable), and to ensure reliable operation of the electrical protection systems.

For low voltage cables, the suitability of the earthing conductor cross-sectional area shall be confirmed in accordance with AS/NZS 3008.1.1.

NOTES:

- 1 Touch voltages and step voltages can arise in the event of a cable fault.
- 2 Examples of high vibration areas include process plants and crushing plants.
- 3 Examples of areas where mechanical damage to insulation can occur include industrial workshops and welding bays.
- 4 For high voltage cables, the suitability of the sheath bonding method should be confirmed in accordance with AS 2067.

2.6.3 Variable speed drives (VSDs) on BMH belt conveyors near hazardous areas

Where VSD drives are used on BMH belt conveyors whose conductive structure may pass into hazardous areas, care should be taken to ensure that hazardous levels of circulating capacitively coupled currents do not travel along the conveyor into the hazardous area. The use of electromagnetic interference (EMI) filters in the VSD drive, as well as high frequency earth bonding between the drive, motor and gear box case should be considered to assist with managing this hazard.

NOTE: For guidance on potential hazards and risks associated with the use of variable speed drives in coal mines, refer to AS/NZS 4871 for underground installations and AS/NZS 3007 for surface applications.

2.7 ILLUMINATION

2.7.1 Emergency lighting

Where emergency egress is required from structures or tunnels, emergency lighting shall be provided.

NOTE: Consideration should be given to—

- (a) surface night operations during power failure; and
- (b) explosion protection ratings that may be necessary for the environment.

2.7.2 Underground mines

For underground mining, lighting should be provided at every tipping point (i.e. at crushers, transfer points, drive heads and belt starters, main return pulleys, and belt maintenance areas).

A cap lamp or other portable light is acceptable for other locations.

2.8 BMH BELT CONVEYOR CONTROL

2.8.1 Pull wire emergency stops

Pull wires shall be installed—

- (a) on all BMH belt conveyors where readily removable guards are installed; and
- (b) to all areas where nip and shear points are accessible (see requirements for shear and nip points in Clause 2.10.3, Zone B in Figure 2.2 and relevant requirements in AS/NZS 4024.3610).

NOTES:

- 1 Nothing in this Clause obviates requirements in AS/NZS 4024.3610 for emergency stops in areas where pull wires are not installed (see the requirements for emergency stops in AS/NZS 4024.3610).
- 2 Pull wires provide a means for stopping a BMH belt conveyor in emergency.
- 3 Pull wires should not be a substitute for guards.
- 4 For BMH belt conveyors, safe stopping times may be minutes.
- 5 Typically, on BMH belt conveyors, guards at the head and tail end are of a readily removable type, as such pull wires should extend to the full length of the conveyor to a permanently fixed or interlocked guard. Pull wires are not expected across the width of the BMH belt conveyor at the head or tail end where there is no access to nip or shear points.

2.8.2 Protective stop controls

2.8.2.1 General

This Clause (2.8.2) applies to BMH belt conveyors used in all underground mines and hazardous areas such as confined areas and reclaim tunnels.

This Clause should be considered for all surface BMH belt conveyors and should be applied where a risk exists.

Protective stop controls shall be provided to stop the conveyor in accordance with Table 1 and where mandatory, Clause 2.8.2.2 to Clause 2.8.2.9. Where the table recommends the provision, risk management methods shall be used to determine whether the device will be used.

The device should provide an alarm or signal to alert of the impending risk as appropriate.

TABLE 1
PROTECTIVE STOP CONTROLS FOR BMH BELT CONVEYORS

Parameter	Underground coal mines	Other underground mines and hazardous areas*	Surface conveyors
Belt slip	M	M	R
Fluid coupling over-temperature	M	M	R
Brake over-temperature	M	M	R
Brake release	M	M	R
Belt tracking	M	M	R
Belt load control	R	R	R
Mobile tripper unplanned movement	N/A	N/A	R
Gearbox oil temperature/level	R	R	R
Fire detection	M	R	R
Pulley bearing over-temperature	R	R	R
Blocked chute	M	R	R
Person-on-conveyor	R	R	R
Vibration monitoring	R	R	R

LEGEND:

M = Mandatory

R = Recommended where risk exists

N/A = Not applicable

* In this context 'hazardous areas' may include confined areas, reclaim tunnels, underground unloading/loading facilities and similar

2.8.2.2 Belt slip

A protective stop control shall be fitted to detect slippage between every independently driven pulley and the belt. This device shall automatically bring the belt to a stop if the slip exceeds 10% of the conveyor's intended speed for any period exceeding a nominated time. The nominated time shall be as short as possible and shall not exceed 4 s.

2.8.2.3 Fluid couplings over temperature

Fluid coupling shall be fitted with an over temperature device which operates before—

- (a) the fluid reaches the maximum operating temperature as recommended by the manufacturer of the fluid, whichever is the lesser; or

NOTE: Fluid couplings should be fitted with a high-temperature trip device and a high temperature thermal plug.

- (b) the coupling surface reaches 150°C for underground coal mines.

2.8.2.4 *Brake over temperature*

Braking systems shall have an over-temperature protective stop control arranged to stop the BMH belt conveyor. The designer shall specify the over temperature trip set point. It shall not allow a surface temperature of greater than 150°C for underground coal mines.

2.8.2.5 *Brake release*

Mechanical brakes shall be fitted with a device designed to detect the released position of the brake. The device shall be arranged to stop the BMH belt conveyor in the event of the brake failing to release when required.

2.8.2.6 *Belt tracking*

Belt tracking devices shall be provided to detect and stop the BMH belt conveyor in the event of excessive side movement of the conveyor belt while operating.

NOTES:

- 1 Excessive side movement is where the belt contacts stationary steelwork and/or contributes to uneven loading across the conveyor belt.
- 2 This can cause frictional heating, structural failures, spillage, belt damage.

These devices shall be installed within the minimum distance necessary to ensure effective detection of excessive side movement of the belt, typically this distance should be less than 5 m.

These devices shall be installed to detect excessive side movement near the following:

- (a) Head pulley.
- (b) Drive head.
- (c) Loop take-up.
- (d) Tail pulleys on fixed conveyors (excludes conveyors with tail ends which move while in operation).
- (e) Receiving belt at a transfer that is not adjacent a tail pulley.

Consideration should also be given to installing these devices where there is a significant change in belt direction or inclination, e.g. trippers.

Belt tracking devices shall be installed and limits set such that they prevent contact between the return belt and any stationary steelwork. Where there is a risk of structural movement, e.g. in underground mines, the interval between tracking devices might need to be shorter.

NOTE: A timer may be fitted to prevent nuisance trips of the BMH belt conveyor, which could occur due to momentary tracking problems or a small protrusion to the side of the belt.

Resetting of a belt tracking fault shall be done at the location of the fault, unless there is another system that verifies that it is safe to reset, e.g. closed circuit television.

A self-resetting override device may be provided to allow the belt to restart following a trip. This override shall be hold-to-run at the device.

2.8.2.7 *Fire detection*

Devices shall be installed to detect fire at BMH belt conveyor drive locations and other areas where the risks of fire require these devices. The device shall provide an appropriate alarm or signal to alert of the impending risk of fire.

NOTE: The requirement to stop the conveyor in accordance with Clause 2.8.2.1 need not apply.

2.8.2.8 *Bearing over-temperature*

Where a hazard may result from the overheating of a pulley or high speed gearbox bearing, devices should be installed to detect the overheating.