

Mining Industry Leadership Group

Conveyor Fire Protection

Guidance Document



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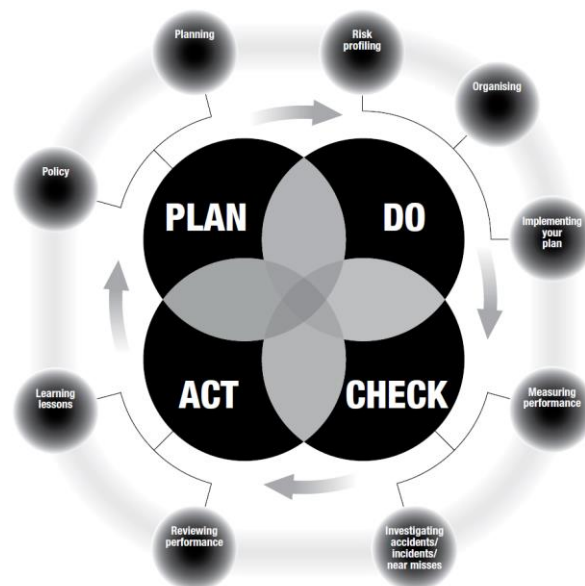
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INTRODUCTION

Fire underground is a major hazard. Fires on conveyors may be the result of component failure, be caused by friction or by some other external factor and may have the potential to propagate rapidly.

This guidance sets out the key elements for the prevention of fires and safe operation of belt conveyor systems and installations (conveyors) at mines and advocates current good practice for conveyor fire prevention.

Fire is a rapid chemical reaction that takes place when fuel combines with oxygen to produce light, heat and flame. The flames seen are a result of the burning of fuel as it passes into a gaseous state. A smouldering fire is a flameless form of combustion, one in which the oxygen combines with the surface of the fuel. A smouldering fire has a considerably slower rate of combustion of the fuel but has the potential to develop into a fire.

Fire also produces smoke and fumes that in an underground situation can lead to a significant danger; the constituents of these “products of combustion” are likely to contain toxic gasses and will depend on the type of fuel being consumed. The quantity of products of combustion can be greater from a smouldering fire than a conventional fire.

PLAN

Fire Risk Assessment

A suitable and sufficient assessment of the risks to health and safety to which employees at work are exposed must be undertaken.

The risk assessment structure may include a generic assessment reflecting the core hazards and risks associated with fire prevention on conveyors; this may be adapted to address the specific hazards of each installation.

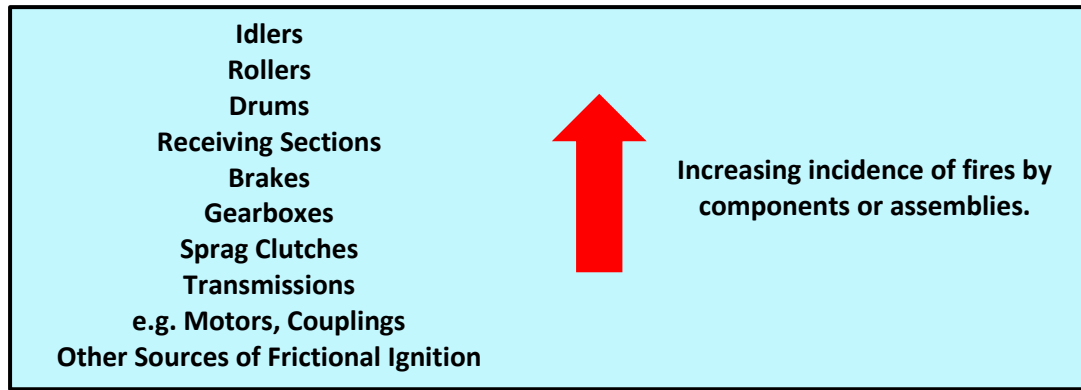
Dynamic, on-site risk assessments should be undertaken and identify specific hazards and subsequent control measures, resulting from changing circumstances, for example breakdown and maintenance.

Potentially Safety Critical Components and Conditions

Safety critical components include single-line components or assemblies, which, if they were to fail in service, have the potential for functional inadequacy of the component and/ or result in a significant fire.

Safety critical conditions include scenarios whereby the consequences of operational, environmental failure and/ or degradation and/ or human error may combine to engender unsafe events and/ or result in a significant fire.

The highest incidence and risk of fires on conveyors are attributable to the following range of components or assemblies:



The highest incidence and risk of fires on conveyors are typically attributable to the following range of conditions:

- Bearing failure.
- Frictional heat due to slip/ rubbing mechanical sparking.
- Electrical energy.
- Accumulation of combustible material (flammable mineral debris).
- Exceeding design tolerances.
- Overloading and alignment.
- Maintenance regimes.

Fire risk areas associated with conveyors are typically:

- Gantries Belting Catenary Loop Winches.
- Fines/ Debris Handling (AFC) Chutes.
- Maintenance Stations.
- Tripper Units.

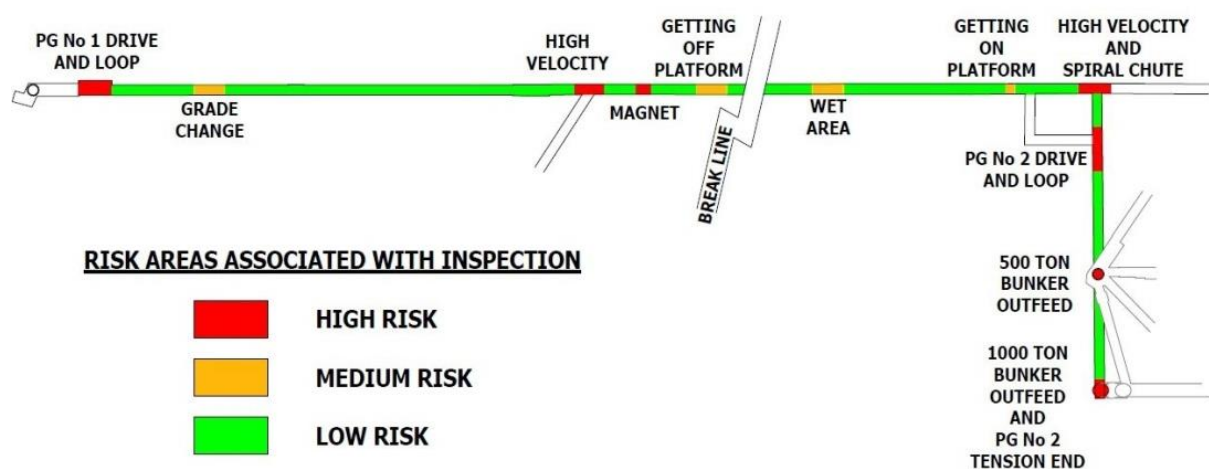
These areas can be risk ranked as shown in the table below:

High Risk Areas	Medium Risk Areas
Jib Area • High tension rollers. • Spillage, fines and belt trim. • High wind velocity. • Security of structures/ A frames.	Intermediate Belt Line • Tracking. • Areas where combustible material may collect. • Under belt – fines, combustibles.
Drive and Loop • Drive, snub and loop drums. • Belt tracking. • Buildup of debris and spillage. • Cleanliness of Drive i.e. oils, greases. • Security of structures/ floor bolts.	
Intermediate Structure • High velocity areas. • Changes in grade/ catenary. • Structure close to the floor. • Areas where combustible materials may	Low Risk Areas
	• Intermediate Belt Line. • Good, well aligned structure at a good height from the floor.

collect.	- Well maintained rollers. - Clear under belt, free from spillage and combustible material. - Well stone dusted (if needed).
Receiving Section - Return end roller. - Build-up of spillage and fines.	

Then a risk map can be produced (example below):

PARKGATE No 1 & 2 CONVEYORS



Design Considerations

Consideration should be given to complete system design to ensure the compatibility and suitability of all elements to control the risk of fire. Provision of design drawings, compiled by suitably competent persons, should be incorporated into a technical file.

A technical file should be created for each conveyor specifying and detailing, relevant aspects of its construction, components, operation, duty, design calculations and adequate factors of safety.

Loading

Safe and effective transfer of mineral by conveyors is dependent on specified installation loading parameters. These are determined by mineral composition, speed, distance, gradient, and the specific transfer arrangements of each installation.

Fire Resistant Belting

Fire Resistant (FR) belting is available in a range of sizes and duties and should be used; although it will burn in the presence of a flame, removal of that flame causes the belt

to self- extinguish. These properties mitigate the propagation of fire and noxious fumes (details of properties and testing of FR belting can be found in Appendix 1).

Transmissions (Motors, Couplings, Gearboxes)

Conveyor transmissions, including motors, couplings and gearboxes, should be designed, installed and maintained taking into account the OEM instructions, to ensure the safe conveying of mineral between all parts of the system. They should be rated commensurately with the intended duty of the conveyor, as overloading or excessive repeated starting, significantly increases inherent fire risks.

Drums

Drums types can be crowned, parallel, lagged or combinations of these. Particular types of drums are more suitable for specific operational requirements than others, e.g. a crowned drum may aid correct tracking of belting whereas lagged drums may reduce the propensity for belt slippage, frictional heating and a potential ignition source. Degradation of the chosen drum type, due to wear, will result in a reduction of their designed intrinsic advantages resulting in misalignment of belting and/ or excessive slip and increased fire risk.

Brakes

Brakes on conveyors can introduce increased fire risks. The use of braking systems should be avoided, wherever practicable, as they introduce a concentrated dissipation of energy, potential heat and ignition sources, into the system.

Where design parameter constraints and conditions require the use of braking systems, they should have sufficient thermal capacity to effectively stop the conveyor in the most onerous operating conditions without overheating and/ or creating an ignition source.

Sprag Clutches

The gravitational load of mineral raised by an inclined conveyor may induce a risk of run-back.

Sprag clutches are anti-run back devices designed and fitted to inclined conveyors to minimise this effect. They should be rated sufficiently for the installation capacity and have sufficient capacity to effectively address the most onerous operating conditions, without overheating and/ or creating an ignition source and be temperature monitored.

Sprag clutches have a fixed life span and should be replaced in accordance with manufacturers' specification; single units should be avoided to negate single line component failure.

Speed

All moving parts of the conveyor should be configured to travel at the same speed to avoid belt damage and excessive spillage, especially during transfer.

Start-up operations on high capacity conveyors increase power, energy, tension and load system demands, these can be alleviated by the introduction of variable speed transmission systems affording smooth, slow, controlled initiation and stopping.

The correlation between speed and load and the effect on idler bearing life should be considered in selection of idlers, speed of conveyors, loading and duty.

Maintaining optimum belt speed is essential to ensure effective and efficient mineral clearance and safe man-riding operations.

Typically a 22% increase in belt speed from 3.29m/s to 4.0m/s equates to a 27% decrease in the bearing life of a 6 5/8" (168.3mm) idler.

Reducing the idler size from 6 5/8" to 5" (127mm) or 5" to 4" (101.6mm) equates to an increase in belt speeds of 32% and 25% respectively.

Idlers

A range of different sizes and types of idlers (rollers) are available for varying duties. Specific idlers are designed, and have suitability, for differing operational requirements of the conveying system e.g. heavy duty idlers may be more suitable where changes of gradient impart a greater loading on the conveyor.

Removing one idler increases the load on adjacent idlers by 50% and reduces the calculated bearing life by 70%.

Idlers having design parameters that predominantly engender shell wear out failure before bearing failure should be selected.

Idler bearing failure results in a significantly increased risk and incidence of fire.

Bearing failures are typically caused by:

- Increased loading.
- Ingress of contaminants.
- Loss of lubricant and grease.
- Misalignment.
- In-service degradation.
- Incorrect idler selection.

The bearing failure process can typically include:

- Increasing frictional forces.
- Impeded bearing rotation.
- Heat generation.
- Loss of concentricity due to internal bearing misalignment.

- Bearing displacement.
- High frictional rubbing and heating between hard bearing races as shell continues to rotate.

Temperatures emanating from bearing failure can significantly exceed 600°C and are sufficient to ignite coal dust, CH₄, coal dust/ air mixture or any hydrocarbon vapors from the grease, paint, seal etc.

Fire Resistant (FR) grease has been adopted for idler end bearings in the UK coal mining industry since 1986 as it is less likely to ignite if exuded from a bearing during collapse.

The table below shows a comparison between the auto-ignition temperatures of FR and mineral grease.

	FR Grease	Typical Mineral Grease
Auto-ignition temperature	475 to 600°C	340 to 370°C

The ignition temperature is higher for FR grease. This has a minimal effect during the collapse of a bearing where temperatures may be in excess of 600°C, and either type of grease can ignite.

FR grease is contained within clay and is resistant to running when heated. The temperature at which the grease becomes liquid is referred to as the drop point, and for mineral grease it is about 270°C after which dripping occurs.

Bearings should be fitted with efficient dust seals irrespective of the grease used. Bearings having FR grease are less tolerant to ingress of contaminants as debris becomes suspended in the clay abrading the moving parts.

Tests have been carried out that indicate:

- Both FR and non FR grease lubricated bearings catch fire.
- FR and non FR grease melt and exude from the bearings during failure.
- Exuded grease, and/ or with flame present, dripped onto coal dust on the floor.
- Non FR grease ignited coal dust after several minutes.
- FR grease did not ignite coal dust.

It should be noted that the lubrication properties of standard mineral grease are superior to those of fire-resistant grease.

Whilst the fire-resistant standard was adopted by the coal mining sector, other sectors have opted for the enhanced lubrication properties of standard grease.

The decision on which type of grease is appropriate will be influenced by the flammable nature of the materials being transported and the presence of other potential flammable materials that could result in a significant fire should the bearing failure.

Receiving Sections

Delivery chutes, belting and receiving sections should be designed, installed and maintained to ensure the safe transfer of mineral between parts of the system.

All parts should have sufficient capacity to convey mineral without undue spillage, to reduce fire risks associated with excessive spillage/ accumulation of flammable products.

Cleanliness

Belt installations should be designed to minimise the amount of cleaning necessary; the build-up of debris can lead to problems with tracking, friction and heat which may then result in a fire.

Effective scraping of the belt surface should be considered at the design stage and access for cleaning all components needs to be inherent within the design of the installation.

Training and Competence

Demonstration of competence will typically include a combination of sufficient training, Experience, knowledge, practical skill and the personal and interpersonal attributes and qualities necessary to comply with the requirements.

Formalised and structured training should be developed and delivered to operatives, supervisors and safety representatives for all tasks e.g., spillage cleaning, belt inspection, testing and maintenance, conveyor extension, coupling and tensioning activities.

Specific training in conveyor system and protection transducer alarms should be provided to recognise and respond correctly to alarms and emergencies.

The competence of staff deployed on conveyors should be determined by their demonstrated ability to recognise and safely and effectively undertake a range of activities, typically:

- Transportation.
- Installation.
- Commissioning.
- Operation.
- Diagnostics.
- Maintenance.
- Remedial actions.

DO

Conveyor Installation

Conveyors are a range of assemblies; these can be from different manufacturers and/ or comprise a variety of compatible components combined to form an integral system or installation.

The capacity, power and size of conveyors can vary significantly from small mineral fines handling systems to high-powered heavy-duty mineral clearance or man riding

systems.

It is the responsibility of those assembling a conveyor to ensure that the essential health and safety requirements (EHSR) are met in accordance with the formal legislative documentation process.

All conveyor installations should be designed and planned to a schedule and constructed using suitably selected equipment, appropriate to the maximum potential operating conditions, environment and pre-determined duties to minimise the risk of fire.

Installation Standards

The installation should meet the design parameters and standards, be undertaken robustly and safely, by sufficient numbers of competent persons, in accordance with plans, method statements, risk assessments and the commissioning process.

Conveyor support structure is designed to carry the conveyor belt with all rollers taking a share of the load.

The structure comprises longitudinal carrying framework (stringers) designed with 1.0° maximum articulations (50mm vertical displacement over 3mt length and equating to a circle radius of 180 m) to allow for changes in ground levels.

Should convex radii smaller than 180 m be required, these should be adequately engineered with additional idlers.

Concave radii should be large enough to prevent the belt leaving the idlers under all conditions of operation.

Standard rollers should not be used for belt deflection as this will put additional load through the bearings leading to premature failure (guidance on structure installation and suspension can be found in appendix 2).

Clearances

Adequate clearances throughout the conveyor are essential and should be maintained to permit effective inspection, cleaning and maintenance. Accumulations of material that may combust, if exposed to any ignition source, should be minimised or cleaned to prevent the accumulation of a dangerous quantity.

Dimensional convergence of roadways (geological movement) can typically impair the safe operation of the conveyor by restricting design clearances. Suspended conveyors are a practicable solution to geological movement of the mine floor and improve access whilst meeting operational design requirements.

Foundations

Conveyor foundations should adequately restrain and support the installation, permit effective inspection, cleaning and maintenance and afford removal of combustible material.

Access and Egress

To afford adequate escape and rescue provision at least two means of access/ egress should be provided. It is not always possible for single line development roadways to be so equipped and the numbers of personnel deployed in that area should be restricted by mine operator's rules and special provisions.

Services, Communications and Utilities

To reduce the propensity for fire, effective services, communications and utilities should be installed, maintained, available and positioned to permit access and use. They should be arranged to avoid any damage, obstruction or interference to the conveyor or services.

Fire hydrants (if these form part of the fire-fighting measures) and fire-fighting equipment should be provided in sufficient quantities and positioned to allow ease of access, inspection, testing, maintenance and effective use when required.

Typically, fire equipment is installed at high risk locations:

- Transfer points.
- Drive and loop take up.
- Switch gear housings.
- Tripper or booster drives.
- Intermediate loading points.
- Additional high risk areas identified.

Ventilation

Excess air velocities can cause airborne debris, leading to accumulations of material, which can engender component failure, malfunction and/ or a greater risk of fire.

Fire propagation is aided by ventilation. Any products of combustion will be carried throughout the mine by ventilating currents, velocity and direction.

Installing conveyors in the return air roadways reduces the consequences of any potential outbreak of fire and the amount of heat and humidity emanating from conveyor operation and mineral production. Return ventilation currents aid removal of these products.

Construction Materials

Fire hazards will be significantly reduced by the selection and use of construction materials having non-flammable or fire resistant properties. The use of combustible material should be avoided. Any materials used in the construction of air locks or for levelling conveyor structure should, where practicable, be non-flammable or fire resistant.

Belt Tracking

Tracking (or belt alignment) is necessary to ensure that the conveyor belting runs centrally within the conveyor structure. Incorrect tracking can lead to excessive spillage, damaged structure, damaged belt and the production of “strimmings”. These strimmings can accumulate around rollers and under certain circumstances can provide fuel for a belt fire.

Conveyor components including structure should be aligned with a roadway centre line or offset, and then rollers adjusted locally using the tracking system within the structure itself. (Further details explaining how to track a conveyor belt are contained in Appendix 3.)

Commissioning of Conveyors

The conveyor should conform to relevant regulations, design standards, mine operator’s rules and the specification determined at the design stage. Static inspections and dynamic testing should demonstrate conformity; defects can then be identified and rectified before the commissioning process is completed and the conveyor becomes operational.

Commissioning checks should be systematic and consistent across all installations and should consider engineering aspects, operation of transducers and alarms and firefighting provision (an example of a commissioning check sheet is shown in appendix 4).

Fire Detection and Fire Fighting Provision

Various types of fire detection and environmental monitoring systems and monitors are available. Risk assessment should determine if fire detection is needed and aid the selection of devices. Important considerations are the mineral being conveyed, underground environment and operating conditions.

Fire detection and environmental monitoring systems should be regularly calibrated and tested.

Examples of fire detectors typically include:

- Carbon Monoxide (CO) detectors.
- Products of combustion (POC) detectors.
- Smoke particle detectors.
- Fume sensors (e.g. Fire Detection Sensor & Carbon Monoxide – FIDESCO).
- Volatile organic compounds (VOC).

Monitoring and detection systems should be able to effectively detect the presence of products of combustion during the early stages of any fire and trigger an alarm.

Fires on conveyors have the potential to produce copious amounts of smoke and/ or toxic fumes. Monitoring and detection systems should be sited at suitable locations along a conveyor to ensure any product of combustion is detected promptly. If installed, products of combustion and/ or CO monitors should be positioned with regard to airflow, to detect fire on the return side of high risk areas identified in the risk map.

Advice on fire detection and the positioning and installation of transducers is contained in the document “Guidance Notes: Underground fire detection equipment: Selection, installation, use and maintenance”.

Fire detection and environmental monitoring systems should be independent and separate to the conveyor operating system. Any alarm generated should be transmitted immediately to the designated command or control point to elicit the appropriate reactive response.

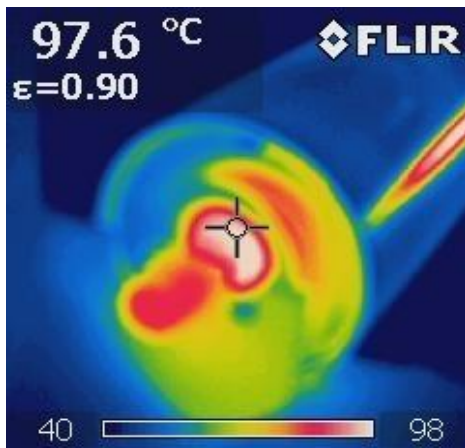
Cognisance should be given to the selection of instruments for detection and environmental monitoring systems with regard to their limitations in use, for example:

- POC detectors may be sensitive to a range of contaminants present in the general body of mine air and may not work reliably, for example in return airways, or in fluctuating temperatures and pressures.
- Smoke detectors may be unsuitable for use in high velocity airstreams.
- Advice should be sought from OEMs where the suitability of any particular detector or monitor, for a specific application, is in doubt.
- Examination, calibration, testing and maintenance of the instruments/ equipment should not be compromised by the installation conditions and locations.
- Electrical transducers, suitably positioned, provide instantaneous information readings at the detector and remotely, enabling data trending at particular locations.
- Infrared heat sensors (thermal imaging) provide an instantaneous indication of the concentration of heat generation at particular points. Portable sensors are typically deployed periodically, dependent on the applications, to ascertain temperature status. Fixed sensors continuously monitor specific high-risk conveyor areas.

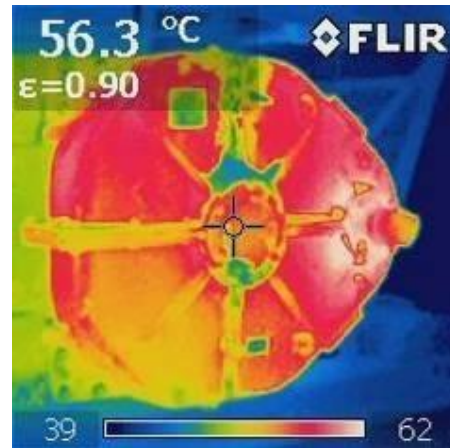
Temperature Monitoring

The risk assessment will also determine if temperature monitoring is necessary. Temperature at critical points on machinery and equipment can be assessed and continuously monitored to ensure that OEM parameters for the safe use of the machinery are adhered to and the risk of fire is minimised.

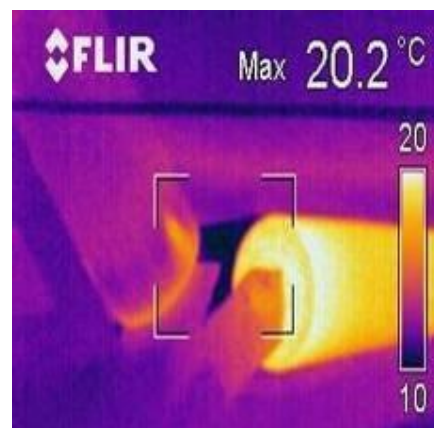
Thermal monitoring using infrared devices (thermal imaging) of e.g. idlers may identify rising temperatures and potential fire. Examples are shown:



Bottom idler bearing collapse



Gearbox radiant heat



Temperature monitoring in normal operating conditions.



Belt edge temperature raised due to rubbing structure.

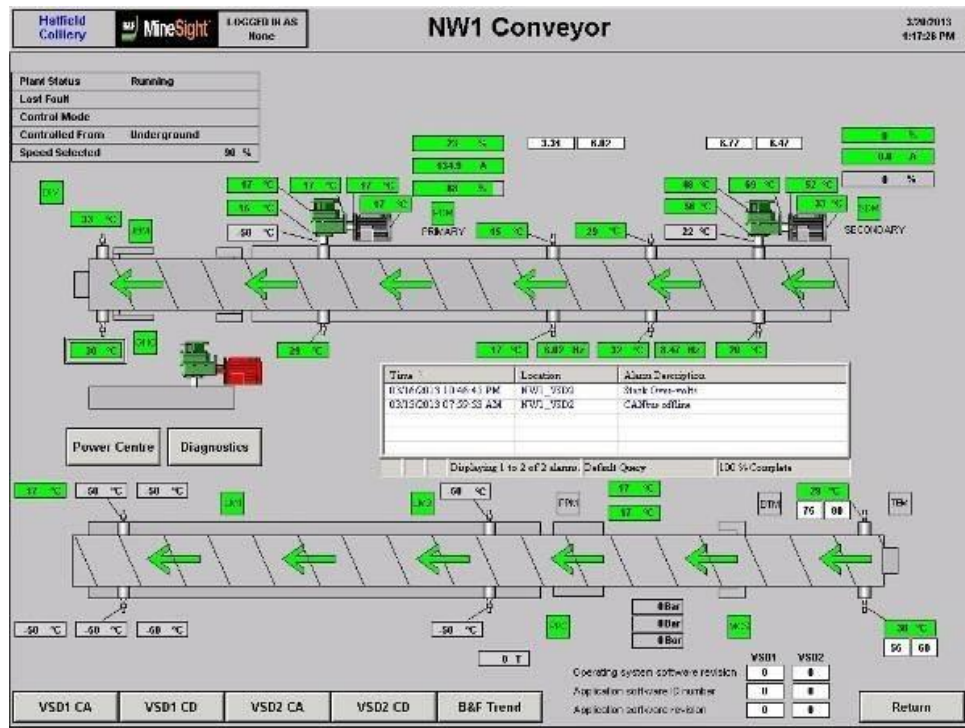


Bottom idler normal operating conditions.

Various types of temperature monitors are available and careful selection of devices for the environment and operating conditions should be carried out to identify most appropriate instruments. Environmental monitoring and temperature monitoring systems should be regularly calibrated and tested.

Examples of temperature monitors typically include:

- Digital probes and transducers.
- Surface contact (external temperature devices).
- Insertion type probes.
- Analogue devices (incremental temp indication).
- Thermometers.
- Infrared monitors.



Typical temperature monitor diagram.

A defined safe operating envelope for each sensor is specified by OEMs. Temperature monitoring systems should have warning and alarm levels appropriately set and should automatically trip equipment when necessary.

Types of Temperature Monitoring

Direct contact monitoring of definitive areas of a machine, such as a bearing, can be achieved via specific drilled points, or the grease way, by utilising purpose designed temperature probe devices (temperature pockets). Direct contact devices accurately indicate operating temperatures at given points whereas surface contact monitoring devices indicate local surface temperatures only.

Analogue monitoring devices incrementally indicate temperature measurements, facilitate a trend analysis of the operating range of normal conditions and configuration of predetermined temperature alarm and trip levels.

Analogue monitoring should be used in preference to digital state indication of fixed temperature levels; a number of digital monitors are required to provide the same level of

protection.

Temperature alarms should be set at a practicable level above the normal operating conditions to eliminate spurious indications. Trip levels should be set to mitigate the risk of fire from excessive temperature.

Hydrokinetic transmission systems typically incorporate fusible plugs as thermal protection devices to prevent any risk from transmission fluid fire resulting from overload, misalignment or component failure.

Alarm systems should be designed to provide immediate warning of any change in temperature, environmental condition and/ or products of combustion that may indicate a risk of fire.

Fire Fighting

A fire risk assessment will determine the types and locations of fire-fighting equipment appropriate to the installation, environment and hazards therein from the risk map above and from the mineral that is being conveyed.

The mine operator should determine the strategy for staff to follow when dealing with an underground fire. This may be to place emphasis on extinguishing any fire as soon as possible or the strategy may be to withdraw staff to a place of safety and allow any fire to burn itself out and self-extinguish. It may be a combination of these where first responders make the decision on which course of action to take.

In all cases, underground staff will need to be given clear instructions on what action to take; if staff are expected to fight fires, they must be competent to do so and understand the risks associated with fighting fires below ground.

Fire-Fighting Equipment

Fire-fighting equipment should be clearly visible, inspected, tested and examined periodically, its position readily accessible and indicated with clear signage. The fire-fighting equipment provided should be appropriate for the hazard present and the strategy for dealing with an outbreak of fire.

CHECK

Planned Preventative Maintenance

Planned, periodic and documented inspection, test, examination and maintenance schemes should be designed and implemented to demonstrate risk controls are effective and the conveyor is maintained in a safe operational state.

A typical inspection, test, examination and maintenance scheme could include the following:

- Simple visual external inspections.
- Detailed comprehensive inspections and examination.

- Dismantling and testing of certain safety critical components.
- Continuous environmental monitoring.
- Fixed plant integral monitoring.
- Routine condition monitoring.
- Vibration analysis.
- Thermal imaging.
- NDT.
- Pre-determined, planned component changes (life cycle).
- OEM recommendations.
- Conformity inspections and checks.

For high risk installations, (high power, a flammable product or potentially explosive atmospheres) the scheme may need to include all of the above. For lower risk installations the (inert products and a low risk of a significant fire) a simpler scheme may well be more suitable.

Conveyor and infrastructure inspection, test, examination and maintenance schemes should be undertaken competent personnel.

Modifications, adjustments, planned component changes, defects and any remedial action should be recorded and documented in accordance with test, examination and documented maintenance schemes.

To ensure continued safe performance of the conveyor the degree and frequency of maintenance should reflect the:

- Operating environment.
- Specific operating conditions.
- Design life of conveyor.
- Mode of operation (manned/ unmanned).
- Operating life cycles.
- Duty.
- Loading effects.
- Physical conditions.
- Extraneous hazards (e.g. transport systems).
- High hazard areas of the system.

Inspection, testing, examination and maintenance on conveyors should be carried out in accordance with the OEM technical publications.

Periodic Operator Belt Patrols

Visual and sensory belt patrol examinations should be performed whilst the conveyor is operating; instructions and rules should detail suitable and sufficient control measures to obviate persons contacting dangerous moving parts.

The frequency of such inspections should be risk based, with consideration given to the operating environment, the mineral being conveyed and the risk ranking. (An example of a pro-forma belt patrol sheet can be found in appendix 4.)

These checks should normally include:

- System cleanliness and presence of spillage.
- Missing or failed idlers.
- Frictional heat from misalignment/ belt rubbing.
- Presence of belt strimmings.
- Structure alignment and cross level.
- Obviously defective components.
- Overheating components.
- Checking monitoring devices and transducers are in place.
- Presence and condition of fire-fighting equipment.

To aid maintenance and defect reporting and identification, conveyor structure should be uniquely numbered for reference.

Craftsmen/ Technician Examinations

Detailed and rigorous prescribed examinations should be carried out in accordance with the inspection, test, examination and maintenance scheme by competent appointed persons to minimise fire risks, and may typically include:

- Lubrication levels and oil analysis.
- Bearings, drive shafts, gears and couplings.
- Vibration analysis.
- Oil sampling to indicate component deterioration.
- Alignment checks.
- Performance and diagnostics temperature devices.
- Environmental monitors.
- Belt protection devices.
- Belt and joint condition.
- Brakes and sprag clutches (anti run-back devices).
- Scraper adjustment.

Functional/ Engineering Supervisor's Examinations

Over-inspections should be undertaken by supervisors to ensure that the routine inspection programmes are carried out with sufficient rigour and are adequate to control fire risks.

Safety Performance Indicators

Safety Performance Indicators (SPIs) provide information, which can be used to identify, understand, and control major hazard risks associated with conveyors, including fires.

There are two types of SPI:

Leading indicators are proactive monitors focused on critical risk control systems to ensure their continued effectiveness. They are factual precursors to weaknesses in the risk control system and can be identified during routine auditing (pre event) and prevent significant events and include:

- Failure modes and effects analysis (FMEA).
- Threats to barriers and control measures.
- Inspections, testing and maintenance completed on time.
- Prioritised resolution of defects according to severity.
- Training and competence of operatives.
- Compliance with operational procedures.
- Correct calibration, use and operation of instrumentation, alarms and environmental monitoring.
- Quality assurance.
- Routine condition monitoring techniques.
- Complaints are routinely investigated.
- Over inspections and audits.

Lagging indicators identify weaknesses discovered following an incident or near miss (post event) and could be a precursor event to an undesirable outcome (fire), including:

- Conveyor idler failure rates.
- Inadequately trained operatives.
- Failure of components.
- Contamination and debris.
- Repeated alarms.
- Belt wear.
- Belt joint life.
- Inadequate maintenance of installation standards.

- Non-compliance with recognised standards.
- Dangerous occurrences.
- Near miss/ incidents.

Analysis of SPIs for root cause failure of incidents and trend analysis of leading and lagging indicators may provide precursors to major hazard events and fires.

ACT

Review

A revision of specified operational procedures should take place periodically and following identification of any significant changes of equipment, activities or personnel to ensure continued relevance.

Changes to operating procedures and fire prevention assessments must be effectively communicated to the workforce as part of the audit programme. Root cause analysis of incidents, accidents, information and events must be undertaken and communicated effectively to ensure any significant findings are reviewed and identified and addressed.

Audit

An audit may include a periodic, risk-based audit programme to ensure:

- Effective control of the major hazards and other risks.
- Compliance with legislative requirements.
- Adherence to operating rules.

Audits may typically include:

- Director and management overviews.
- Thorough inspection.
- Investigation.
- Spot checks.
- Documentation review.
- Quality assurance.
- Observation.
- Discussion.
- Communication.
- Human factors and behavioral assessments.
- Safety representative's review.
- Asset management (planned replacement programme).

Auditing determines whether vehicles are inspected, maintained and operated to documented commissioning.

Parameters, and typically review:

- Fire prevention and control measures.
- Pre-use inspection programmes.
- Multi-user vehicle operations and traceability.
- Statistical information to inform trending of operating.

History and data:

- Compliance with maintenance and repair programmes.
- Fault diagnostics.
- Human factors.

Other Sources of reference material:

- Health and Safety at Work Act 1974.
- Mining Regulations 2014.
- Provision and Use of Work Equipment 1998.
- Management of Health and Safety at Work Regulation 1999.
- The supply of Machinery (Safety) Regulations 2008.
- The equipment and protection systems intended for use in potentially explosive atmospheres 1996.
- The dangerous substances and explosive atmospheres regulations 2002.

APPENDICES

Appendix 1 – Testing fire resistance properties of conveyor belting

There are standard tests for FR belts including:

Drum Friction Test - EN 1554:2012. A sample of belt is held in contact with a moving drum until it is worn through by friction. On parting, the belt must not show any sign of flame or glowing.



Drum friction test



Belt sample after drum friction test

Ignition Test - EN ISO 340:2013, A sample of belt is suspended and heated with a torch: the belt must not ignite.



Ignition test

Extent of the damage to the upper surface determines the pass or fail criteria, the belt must not propagate the flame.

To reduce risks to as low as reasonably practicable only fire resistant belting should be used underground.

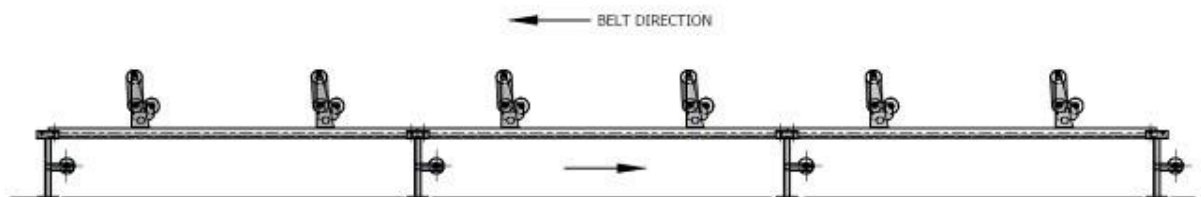
Appendix 2 – Guidance on structure installation and suspension

The installation should meet the design parameters and standards, be undertaken robustly and safely, by sufficient numbers of competent persons, in accordance with plans, method statements, risk assessments and the commissioning process.

Conveyor support structure is designed to carry the conveyor belt with all rollers taking a share of the load. Missing or badly aligned rollers will cause greater than normal loading on adjacent rollers leading to reduced life and premature failure.

Contour limitations.

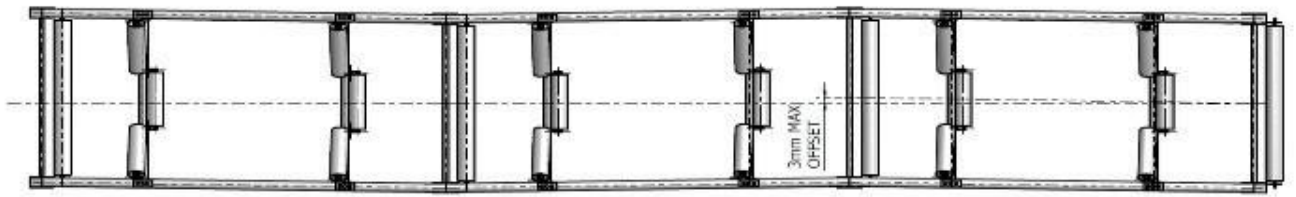
Preferred installation.



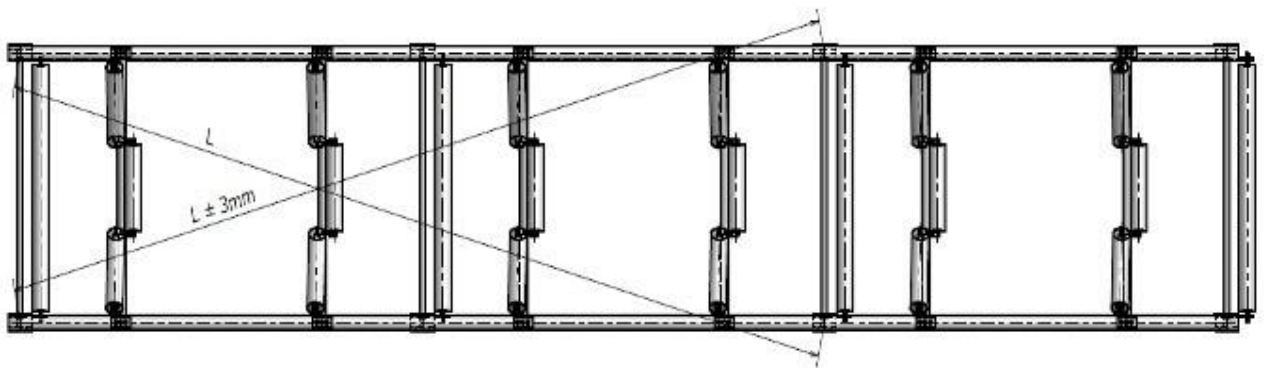
Max acceptable level of deviation.



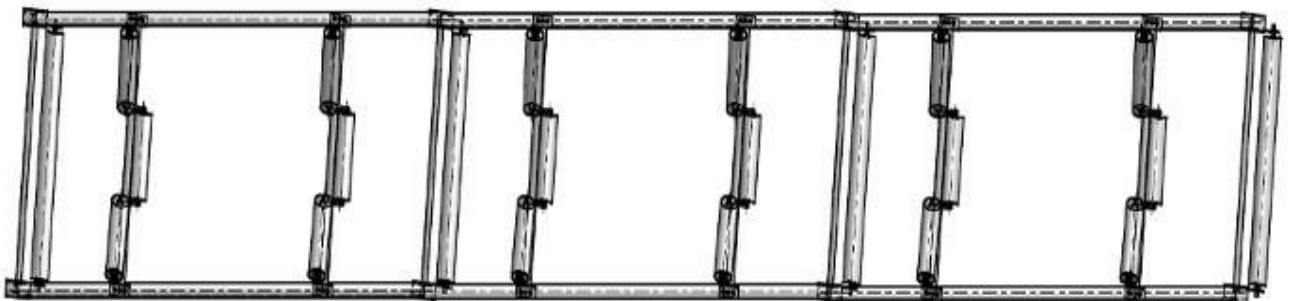
Structure straightness tolerance.



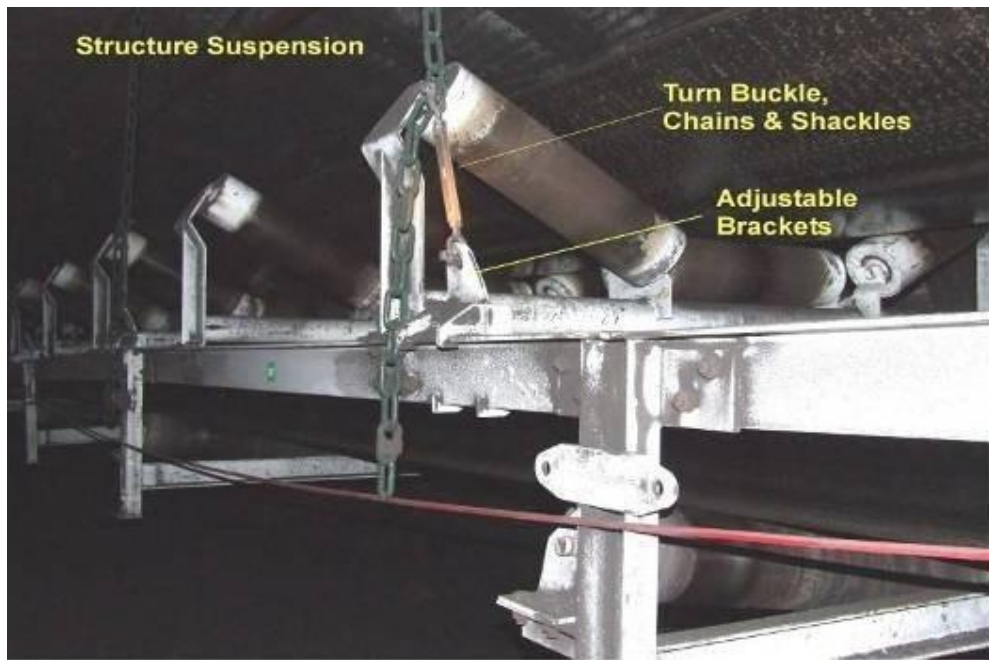
Stringer squareness tolerance



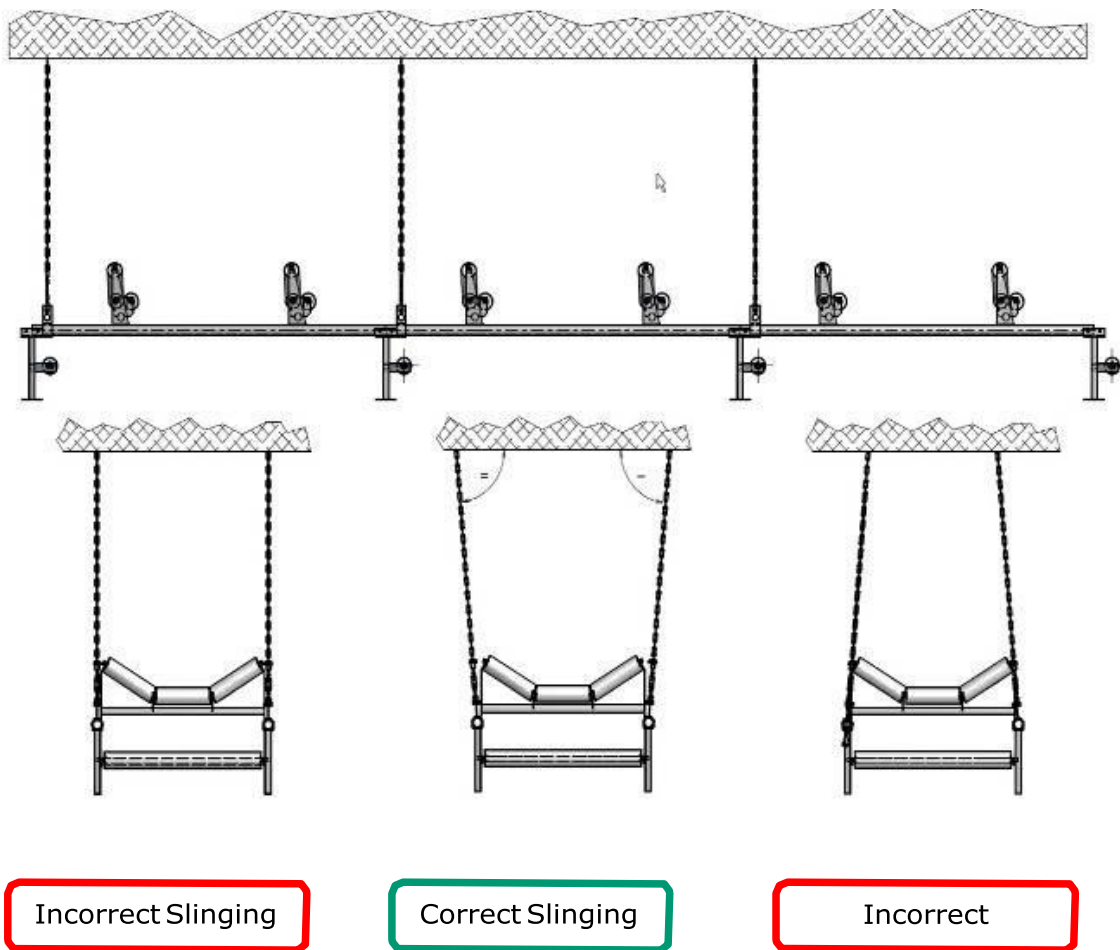
Correct Installation



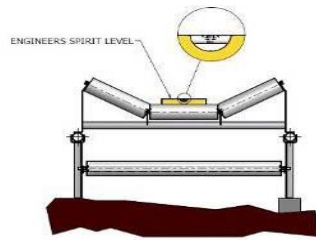
Incorrect Installation



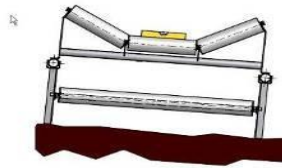
Chain slinging methods.



Cross Levelling



Correct Cross
Levelling



Incorrect Cross
Levelling

Floor mounted structure shown as an example, slung structure to be cross levelled using the same method.

Appendix 3 – Guidance on Belt Tracking

Tracking (alignment) of belting should be intrinsic within system design. It is essential to ensure design parameters are maintained and the risk of frictional ignition, due to belt rubbing, is negated.

Tracking the belt on a conveyor system is a process of adjusting idlers, pulleys and loading conditions in a manner which will correct any tendency of the belt to run other than centrally. The basic rule when tracking a conveyor belt is that the belt moves forward toward that end of the idler it contacts first.

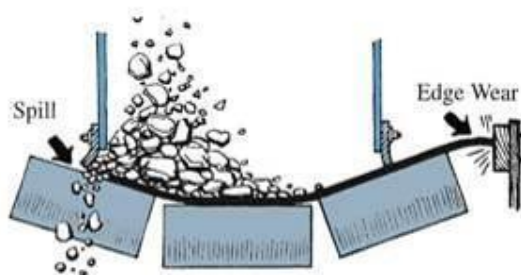
When all portions of a belt run off line through a localised section of the conveyor length, the cause is most likely to be incorrect alignment or leveling of the conveyor structures, idlers or pulleys in that section.

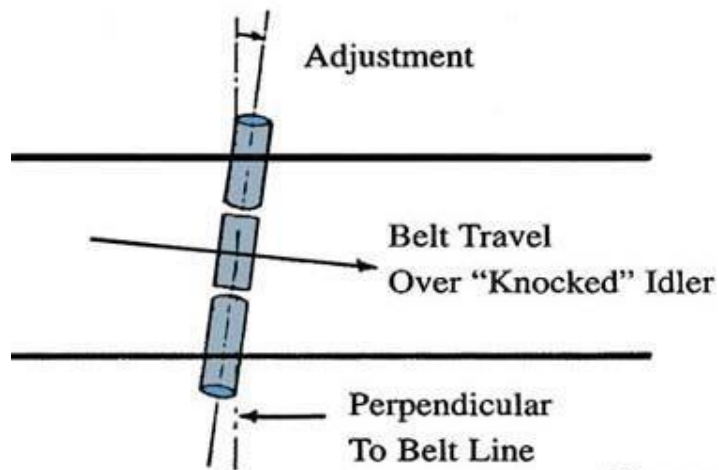
If one or more lengths of belt run off line at all points along the conveyor, the cause is most likely to be within the section of the belt itself, for example the condition of the belt or its splices or loading. When the belt is loaded off-centre, the centre of gravity of the load gravitates to the centre of the troughing idlers causing the belt to track away from the load as illustrated.

These basic indications help diagnose abnormal belt running conditions. Combinations of conditions sometimes produce events that do not appear obvious. Observations of the running pattern will help to determine the root causes.

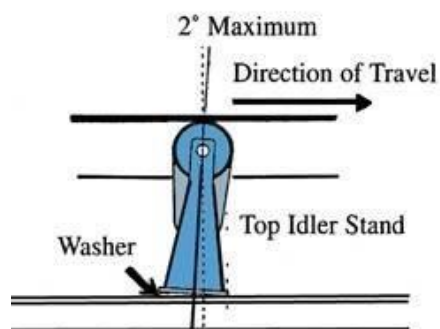
All drums/ pulleys should be level with their axis at 90° to the intended path of the belt. There are facilities to adjust these as wear takes place to maintain correct belt alignment.

Pulleys with their axes at other than 90° to the belt path will cause the belt to steer in the direction of the edge of the belt which first contacts the misaligned pulley. When pulleys are not horizontal the belt steers to the low side.





Belting can be tracked by adjusting the axis of the troughing idlers, altering the path of the belt. It is important to keep the troughing idlers in contact with the belt as illustrated. Additional proprietary tracking devices can be utilised to enhance and control belt alignment as a short term measure.



Conveyor correctly suspended and aligned.

Appendix 4 – Examples of pro-forma belt patrol sheets

MASHAM Regulations 1993 Managers Scheme for the Mine				ME 5	
<u>CONVEYOR PATROL SHIFTLY/DAILY CHECKLIST / REPORT</u>					
<u>Anything which constitutes a danger and which you cannot deal with shall be reported to a person superior to yourself in the chain of command.</u>					
NAME OF CONVEYOR	DATE	SHIFT	DAY	Manriding	
				Yes	No

Check - Examination	IN ORDER	REMARKS
(1) Check conditions and effectiveness of chute?	YES / NO	
(2) Is blocked chute device in position?	YES / NO	
(3) Are scrapers in position and working effectively?	YES / NO	
(4) Check tracking rollers if fitted	YES / NO	
(5) Check delivery/jib roller excessive noise and heat	YES / NO	
(6) Check jib idler rollers are rotating freely	YES / NO	
(7) Check jib, drive & loop for cleanliness	YES / NO	
(8) Check drive & loop for excessive heat & noise	YES / NO	
(9) Check jib, drive & loop guards are in position	YES / NO	
(10) Are all nip guards fitted and secure?	YES / NO	
(11) Is fire fighting equipment in order & in position?	YES / NO	
(12) Are smoke detectors in position?	YES / NO	
(13) Is the belt alignment in order through the loop?	YES / NO	
(14) Check effectiveness of dust suppression equipment	YES / NO	
(15) Check belt alignment through box end	YES / NO	
(16) Check plough/wiper is in position & effective	YES / NO	
(17) Check return end for spillage	YES / NO	
(18) Check return end roller for excessive heat, noise & vibration	YES / NO	
(19) Check idler & return rollers for excessive heat & noise	YES / NO	
(21) Check any mid position receiving section for spillage	YES / NO	
(20) Are there adequate cleaning tools available	YES / NO	
(22) Check and record number of spare rollers on site	YES / NO	
(23) Check for spare oils at drive areas	YES / NO	
(24) Check general condition of belting	YES / NO	
(25) Check general condition of joints	YES / NO	
MANRIDING CONVEYORS ONLY		
(26) Check safety gate is in position.	YES / NO	
(27) Check that the belt is free from holes, slits & other damage that could present danger to persons riding	YES / NO	
(28) Check all joints appear visibly in good condition	YES / NO	
(29) Check that the structure of boarding & alighting platforms are free from all defects and obstructions (including steps and handrails)	YES / NO	

JML/E

