Conveyor Belt Fire Safety

Regulations and Designs
Regulations

– MINE HEALTH AND SAFETY ACT, 1996 (ACT NO 29 OF 1996)

• Chapter 8: Machinery and Equipment
  – Amendment of regulation 8.9 of the Mine Health and Safety Regulations

• Definitions
  – “‘Designated sections’ means the drive section, take up tension section, snub pulley sections, transfer point sections and tail pulley sections.”.

• 8.9 Conveyer belt
  – “(3) The employer must take reasonably practicable measures to prevent persons from being exposed to flames, fumes or smoke arising from a conveyer belt installation catching fire, including instituting measures to prevent, detect and combat such fires.”

Reasonably Practicable Measures to prevent persons from being exposed to flames, fumes or smoke

• Prevent conveyer belt installation catching fire
• Detect conveyer belt installation catching fire
• Combat such fires

Prevent a fire?

• Regulatory Safety Systems
• Routine Preventative Maintenance
• Good Housekeeping
• Historical data
Detect a fire?

- Statement: “Conveyor belts do not spontaneously burst into flames”
- General ignition temperatures
  - PVC 460°C for 14 seconds
  - Neoprene 430°C for 23 seconds
  - Rubber 410°C for 30 seconds
- A typical conveyor belt can easily travel more than 40 meters within the 15 seconds sufficient for a belt sample to pass the EN/ISO 340 test.
- This would still allow the belt to carry flames over a potentially dangerous distance

Current Detection methods:
  - Linear Heat Detection Cable
  - UV/IR Flame Detection
  - Carbon Monoxide Monitoring
  - Fire Sprinkler Head (FM 7-11)

Linear Heat Detection Cable
  - Two cores separated by a polymer plastic that is designed to melt at a specific temperature.
  - Disadvantages
    - Requires extreme ambient temperature to react, as generated by an burning conveyor belt
    - Very slow response time
    - Prone to mechanical damage
    - High false alarm rate
    - High ambient temperatures require extremely high alarm set points.
UV/IR Flame Detection

- By measuring the radiation intensity of two frequencies ranges of the electromagnetic spectrum, namely the Ultra-Violet (UV) and the Infra-Red (IR), both of which are present in fires.

- Disadvantages
  - Requires a burning conveyor belt to react
  - Designed for flammable fuel fires
  - Slow response needs stationary fire
  - High maintenance
  - False alarming due to arc welding and grinding

Carbon Monoxide Monitoring

- Detecting the presence and measure of the concentration of Carbon Monoxide in the immediate vicinity of the detector in parts per million.

- Disadvantages
  - Requires a burning conveyor belt to react
  - Accuracy very affected by high air flow
  - High Maintenance and periodic calibration required
  - Slow fire discrimination
  - Background CO levels could easily mask early stages of fire CO levels

Fire Sprinkler Head (FM 7-11)

- Sprinkler heads with a glass container filled with a glycerine-based liquid that expands at the pre-set ambient temperature, the glass will break and activate the sprinkler head.

- Disadvantages
  - Requires extreme ambient temperature to react, as generated by an burning conveyor belt
  - Very slow response time
  - 107 seconds to activate a 68°C Bulb at an ambient of 100°C with an air speed of 1m/s
Compliance to Act 29 of 1996, Chapter 8.9.3?

To prevent persons from being exposed to flames, fumes or smoke

<table>
<thead>
<tr>
<th>Current fire detection methods</th>
<th>Prevent</th>
<th>Reason</th>
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<tr>
<td>Linear Heat Detection Cable</td>
<td>NO</td>
<td>Slow reaction needs high ambient temperature (Smoke)</td>
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<tr>
<td>UV/IR Flame Detection</td>
<td>NO</td>
<td>Needs Flames</td>
</tr>
<tr>
<td>Carbon Monoxide Monitoring</td>
<td>NO</td>
<td>Slow reaction needs smoke (unreliable)</td>
</tr>
<tr>
<td>Fire Sprinkler Head (FM 7-11)</td>
<td>NO</td>
<td>Slowest reaction needs extreme ambient temperatures</td>
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Current fire “combating” methods

– FM Global Property Loss Prevention Data Sheets 7-11 for Belt Conveyors.

FM Global Property Loss Prevention Data Sheets 7-11 for Belt Conveyors.

– 2.3.3.5.6 Base sprinkler design for horizontal conveyors and inclined conveyors with a pitch of less than 10° on the operation of the 10 most hydraulically remote sprinklers.

– 2.3.3.5.7 Base sprinkler design for inclined conveyors with a pitch of 10° or greater on the operation of the 15 most hydraulically remote sprinklers

– 2.3.3.5.8 Ensure a minimum end sprinkler pressure of 0.96 bar, Limit sprinkler spacing on lines to 3.7 m, use FM Approved sprinklers with a K factor of 115 and a temperature rating of 79°C.

– 2.3.3.5.10 Protect sprinklers, piping, and detectors against impact damage from oversized pieces of conveyed material.

– 2.3.3.5.11 To prevent collapse of a gallery due to water weight from sprinkler discharge, provide adequate drainage via floor openings or by conveyor pitch.

– 2.3.3.5.12 Ensure there is sufficient water supply to accommodate 950 L/min hose streams.
Disadvantages

- Conveyor belt to be replaced, production losses
- Very late detection increased fire spread
- Water spray not directed to designated areas
- Very high flow rate: approx. 1800 l/min
- Water accumulation 108000 litres over one hour
- High water damage potential


- 4-3.3.1.1 Open nozzles shall be located to direct water spray onto the surfaces to extinguish fire in hydraulic oil, the belt, the contents on the belt, or the drive unit. Water spray impingement on structural elements shall provide exposure protection against radiant heat or impinging flame.

- 4-3.3.1.2 Interlocks shall be provided between the detection system and the machinery to shut down belt conveyor operation, including upstream feed.

- 4-3.3.1.3 The water supply shall be capable of supplying both the design flow rate and 946 L/min for hose streams for a minimum duration of 1 hour.

- 4-3.3.2* Drive Unit. The water spray system shall be installed to protect the drive rolls, the take-up rolls, the power units, and the hydraulic-oil unit. The net rate of water application shall be not less than 10.2 (L/min)/m² of roll and belt.

- 4-3.3.3.1* The water spray system shall be installed to automatically wet the top belt, its contents, and the bottom return belt. Discharge patterns of water spray nozzles shall envelop, at a net rate of not less than 10.2 (L/min)/m², the top and bottom belt surface area, conveyor surfaces where combustible materials are likely to accumulate, the structural parts, and the idler-rolls supporting the belt.

- Disadvantages

  - Belt on fire when system is actuated, belt damaged and resultant production loss
  - Reliant on current fire detection methods to activate
  - High flow rate for 15m: 600 l/min (per designated area)
  - Water accumulation 36000 litres over one hour
  - Complex piping and control system

- 3.3.5.1* Foam-Water Deluge System. A foam-water sprinkler system employing open discharge devices, which are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system, which is installed in the same areas as the discharge devices.

- 3.3.6.2* Aqueous Film-Forming Foam Concentrate (AFFF). A concentrate based on fluorinated surfactants plus foam stabilizers and usually diluted with water to a 1 percent, 3 percent, or 6 percent solution.

- 5.3.3* There shall be a reserve supply of foam concentrate to meet the design requirements of the system and to put the system back in service within 24 hours after operation.

- 5.7.1 Storage tanks for foam concentrates shall be constructed of materials compatible with the liquid, shall be solidly mounted, and shall be permanently located.

- 6.2.3.1* Water supplies shall be designed to supply the system at the design discharge rate and pressure for at least 60 minutes.

- 7.3.2.1 The design discharge density shall be in accordance with the applicable occupancy standard for water or foam-water systems but in no case less than 6.5 mm/m².

- 7.3.3.1 The foam solution shall be designed to discharge for a period of 10 minutes (based on the density as specified in 7.3.2.1) over the entire system area for deluge and spray foam-water systems and over the design area for wet pipe, dry pipe, and pre-action foam-water systems.

- Disadvantages
  - Belt on fire when system is actuated, belt damaged and resultant production loss
  - Reliant on current fire detection methods to activate
  - High flow rate for 15m: 400 l/min (per designated area)
  - Water accumulation 4000 litres over ten minutes
  - Complex foam proportioning, piping and control system
Water Based Systems

- Disadvantages

  - “The water supply to Rustenburg’s platinum mines has been restricted to half of their usual quota, the Department of Water Affairs said on Thursday” October 2013 BusinessDay
  - A possible false discharge can lead to 110,000 litres of water going to waste
  - NFPA 25: 9.2.6.1.1 The interior of steel tanks without corrosion protection shall be inspected every 3 years.
  - NFPA 25: 9.2.6.1.2 The interior of all other types of tanks shall be inspected every 5 years.
  - Requires dedicated water supply for 60 minutes
  - Requires complex fire water pump sets diesel and electric.
  - Requires dedicated fire water reticulation infrastructure
  - Linear system, if one component fails whole system fails no redundancy
  - High water damage and accumulation
  - Foam water system require complex foam storage and proportioning systems

Compliance to Act 29 of 1996, Chapter 8.9.3?

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<td>NO</td>
<td>Slowest reaction to fire, high fire spread, no protection for designated areas</td>
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<tr>
<td>NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection.</td>
<td>NO</td>
<td>Slow reaction due to current detection requiring a burning belt</td>
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<tr>
<td>NFPA 16 Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.</td>
<td>NO</td>
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How to Comply?

- **Old Methodology: Reactive**
  - Suppress a burning belt
  - Detection of high ambient temperature or flames from burning conveyance system components and then applying Water to extinguish or at least suppress the burning conveyance system components.

- **New Methodology: Proactive**
  - Cool a hot belt
  - Detection of overheating conveyance system components, and the cooling of hot components with a Wet chemical system to below ignition temperatures.
  - No Fire = No flames, fumes or smoke
  - Early detection of operational temperature rise, dramatically reduces ignition potential
  - Increased operator safety, minimized down time
  - Designated area protection
  - No flooding and associated operational issues
  - Compact and efficient

Research indicating that belt slippage is the main cause of conveyor belt fires on hard rock conveyor belts.

- Areas were slippages occur
  - Tail Pulley
  - Transfer Areas
  - Head Pulley including Snub Pulley
  - Take-up and Tensioning Pulleys
Detection

• Pulley Bearing Temperature Monitoring
  – Resistance temperature detectors (RTD) accurately sense temperature with an excellent degree of repeatability.
  – In most standard lubricants, for every 15°C increase in temperature above 70°C, the lubricant life is more than halved and there is a negative effect on bearing life.
  – In no case should bearing temperature ever exceed the maximum rating of either the bearing or the lubricant

• Conveyor Belt Surface Temperature
  – Conveyor belts only ignite in excess of 400°C
  – There is an measurable rate of temperature increase in belt surface temperature when the belt is slipping over a stationary pulley.
  – A linear rate of rise detector using a capillary tube can detect the increase in temperature proximate to the belt as a function of the rate of change over time (Δt) irrespective of the starting temperature

Le havot Delta Detector 6.2: Spillage Test
Suppression

- **Conveyor Belt Wet Chemical System**
  - The system must be able to reach a density of 6mm/minute/m² over the risk area.
  - System discharge to be in excess of 30 seconds to provide sufficient heat absorption and protection against re-ignition.
  - All system components to carry approvals from the UL, FM or any other similar institution.
  - The system must be robust and capable of enduring high vibration levels.
  - Suppressing agent shall inhibit a fire’s chemical chain reaction
  - Suppressing agent shall have a cooling effect upon discharge to reduce the possibility for re-ignition.
  - Suppressing agent shall form a film over the area onto which it is discharged to reduce the possibility for re-ignition.
  - Suppressing agent shall have a certified life span of at least 10 years
  - Suppressing agent shall be non-corrosive to steel, rubber, plastics and any other elements making up a typical conveyor.
  - Suppressing agent shall be stored in storage container that is not pressurised.
  - Operation of the suppression system shall not be influenced by the installation orientation of the agent storage tank.
  - The system shall allow means for automatic activation by a dedicated fire control panel as well as for manual mechanical activation un-reliant on electrical supply located next to the conveyor.
  - Distribution pipework shall be of stainless steel construction with a nominal bore of 12mm
  - Piping shall be supported by means of IC heavy duty clamps.
  - Nozzles shall be installed over drive units as well as under top and over return belt surfaces.
  - Fan nozzles shall have a K-factor of 0.912
  - Fan nozzles shall have a Extra-wide 145° spray angle
  - Fan nozzles shall have a Spray discharge deflected 75° from inlet axis
  - Fan nozzles shall be clog resistant
Typical Hydraulic Considerations

Area to be protected: 16m²
Design Density: 6mm/min/m²
Nozzle K-factor of 0.912 = 4.08L/min @ 20Bar
Number of Nozzles: 24
Nozzle total flow: 97,92L/min
Actual Density: 6.12mm/min/m²