SecuriHeat d-LIST/LIST

EARLY WARNING MONITORING SYSTEM FOR CONVEYING SYSTEMS

Case Study

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SECURITON

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Introduction

Belt conveyors are widely used

Belt conveyors are the most common means used for the transport of (bulk) material. They are often among the most critical pieces of equipment used in the mining industry, coal fired power plants, automated distribution and warehousing industry as well as manufacturing and production facilities.

Idlers are a critical component

Despite their importance, there are still significant challenges to guaranteeing their operation, because of an equipment extent that ranges from a few metres to several kilometres. Only a relatively small number of components are grouped around the head and tail sections of belt conveyors, most of them are spread all along the extension of the belt conveyor. One of the critical components are the idlers. A small belt conveyor of 150 m has nearly 450 carrying idlers and around 50 return idlers [1].

Belt conveyors often operate under very harsh conditions and suffer from severe wear and tear. Nonetheless, in most cases they are vital to the continuing operation of a facility. Furthermore, fires are a common reason for downtime of a belt conveyor, caused by either overheating of belt conveyor components or ignition of the transported goods.

Damage mitigation with an adequate early warning scheme

An outage of a belt conveyor can have a significant impact on the business continuity of the facility. It is therefore paramount to the operator of the facility to have a professionally designed early warning monitoring system, capable of detecting overheating conveyor system components, as well as fires. This allows for the protection of the whole conveyor system by detecting and reacting upon relevant temperature changes as early as possible.

Risk, Cause & Damage

Fire risks

Fire statistics from the mining industry in Australia show that fires which started with conveyor belts rank in the top three, where fires starting in vehicles or mobile equipment being the most common starting object [2].

The Maritime Terminal of Ponta da Madeira, located in São Luís, Brazil, operates a total length of 120 km (74.56 mi) of conveyor belts and around 200’000 idlers scattered on roughly 500 ha (1’235.5 acres). Internal data shows that between 2014 and 2016 fires caused by idler failures amounted to a total material loss of approximately US$ 485’000 combined with a total downtime of operation of around 600 hours. A particular fire incident, caused by a broken bearing in a belt conveyor, lead to the loss of around 300 m (984 ft) of belt as well as damage to all the electrical and automation systems [1].

Cause

Common causes of fires are mainly

- Overheating of idlers
- Grinding of the lower (return) belt on construction parts, triggering the ignition of dust deposits underneath or next to the belt conveyor
- Ignition of transported goods

Damage

Damage resulting from large, uncontrolled fires include

- Injuries and fatalities, primarily in underground mines
- Loss of machinery, installations and buildings
- Loss of business contracts

Challenges

Harsh environmental conditions

Not considering systems installed in automated distribution and warehousing facilities or manufacturing and production facilities, belt conveyors are often installed in harsh environmental conditions. An early warning monitoring systems faces mainly the following challenges

- Outdoor or semi-outdoor environment with a high temperature variation
- High humidity
- Dust and debris
- Additional installations running alongside the belt conveyor, such as piping and cable trays

Figure 1 Challenges in harsh conditions

Maintenance is a priority

Idlers are vast in number, spread over a large area and are among the top causes for fires. In such harsh conditions, the bearings of all moving parts are the most vulnerable pieces of equipment. A damaged or blocked bearing of an idler roll can easily heat up several hundred degrees. Consequently, their maintenance is a top priority for the operator.

Pinpoint location of issues is paramount to efficient maintenance

However, identifying an individual idler (slowly) developing a maintenance issue, poses yet another significant challenge to the temperature detection system. A good early warning monitoring system design therefore offers pinpoint location capabilities and thus aims to support the operator's maintenance crews to plan maintenance assignments most efficiently.

Standards & Codes

Performance-based Design

The diverse nature of facilities operating belt conveyors and in many cases the absence of compulsory standards, require the design of the fire detection and early warning monitoring system to be simple and flexible to meet Deem-to-Satisfy (DtS) fire safety provisions such as NFPA 15, NFPA 122 or DS 7-11 [3], [4], [5]. Applying a Performance-based Design (PBD) approach does address risk-based detection and monitoring needs over and beyond prescriptive requirements to ensure business operations and asset protection.

Application Scenarios

Narrow range for reliable solutions

The harsh environment found in many facilities operating belt conveyor systems narrow down the range of solutions considerably. One reliable solution to overcome the challenges declared above, is the use of line-type heat detectors.

Individual sensors allow for temperature measuring

Securiton SecuriHeat d-LIST is a resetable line-type heat detector system. It is comprised of a series of **individual hybrid temperature sensor circuits** extruded in a robust cable. The sensor cable can operate in a large temperature range from -40°C to 120°C (-40°F to 248°F) and each heat sensor circuit has a resolution 0.1°C (0.18°F). However, a line-type heat detector must not be confused with a linear heat detection cable. The latter is able to trigger an alarm when

a certain portion of the cable is exposed to temperatures above a certain limit, but cannot measure (and report!) temperatures along the length of the cable.

Main issues covered by the solution

This case study focuses on recommendations for the Securiton SecuriHeat d-LIST line-type heat detector system. The system consists of a variety of components, such as control units, sensor cables, individual external sensors and connection boxes (see Figure 2). As a solution, it addresses the main issues for the protection of conveyor systems

- Reliable temperature monitoring of conveyor equipment
- Detecting fires at transfer points and along the conveyor
- Maintenance free operation

Different organisational units involved

While temperature monitoring primarily serves the maintenance organisation of the facility, the receiver of fire alarms in most cases is the (plant) fire brigade (see Figure 2).

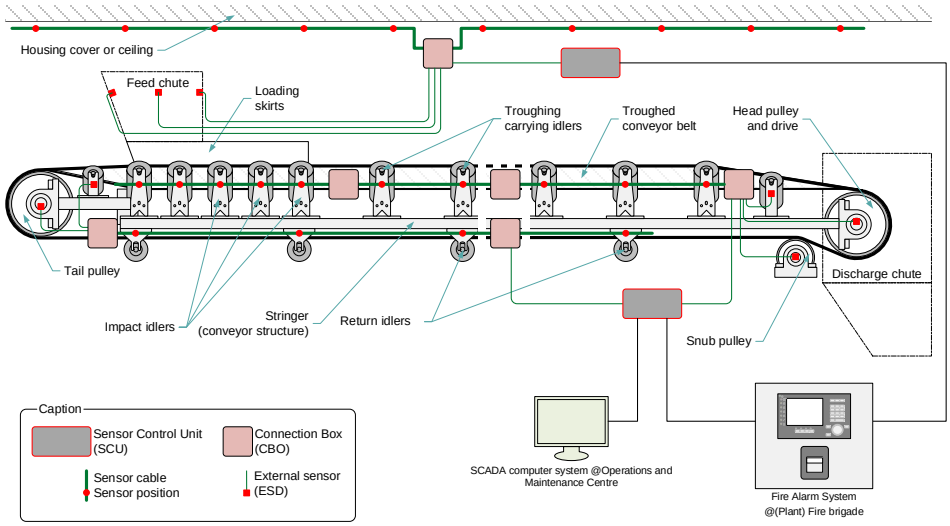

Figure 2 Protection of a conveyor system

The following chapters reflect the diverse needs and requirements these different organisational units have regarding an early warning monitoring system.

System boundaries

Individual projects differ in many aspects such as total system length or number of components to be monitored. The technical description [6] offers detailed information regarding the system boundaries.

All application scenarios described in the following are also valid for the Securiton SecuriHeat LIST system, which offers longer sensor cable lengths, more sensors and full redundancy. For more details refer to the System Description [7] or contact Securiton.

Reliable temperature monitoring of conveyor equipment

Common key aspects

Although projects differ from one-another, two key aspects remain the same for each application scenario:

- The components (moving parts) that make up the system
- The maintenance organisation and their operational procedures

Early warning monitoring enables preventive maintenance

A reliable temperature monitoring system for all the moving parts of a belt conveyor system such as various idlers, pulleys and drives, allows for early warnings and thus enables preventive maintenance.

Monitoring idler temperature

While idlers make up for the largest number of individual units in a conveying system, they are not evenly spaced along the belt conveyor. Typically, the impact

idlers in the load zone are spaced closely whereas the carrying idlers are spaced more widely. Typically, the spacing of the return idlers is wider still (see Figure 2).

Tailor sensor spacing to idler spacing

Having identified the bearings as the major heat source, monitoring their temperature as close as possible is key for a most effective early warning system. Therefore, tailor the sensor spacing within the sensor cable to the spacing of the idlers in each section of the belt conveyor. Individual sections of the sensor cable are linked with help of connection boxes.

Define zones in accordance with maintenance process

Connection boxes also allow branching off a part of the sensor cable, or the division of longer sections into physically manageable zones. The length of a zone is best defined in accordance with the maintenance procedures in effect. Since the sensor cable is clamped to the frame of the idler, it must be removed before the idler can be replaced. In this case an individual zone covers a shorter length of the belt conveyor allowing for convenient locations to disconnect the sensor cable.

On the other hand, if the maintenance procedure foresees the changing of individual idler rolls, the sensor cable is less a hindrance and there is no need to remove it for the changing of a roll, hence an individual zone can be longer.

Installing the sensor cable

For most reliable temperature monitoring, consider installing a sensor cable on either side of the idlers. Use the cable clamp CLIC for mounting the sensor cable to the idler frame. CLIC can be opened and closed without a special tool. Removing the sensor cable, for maintaining the idlers, is therefore greatly simplified.

Install the sensor cable and adjust the individual sensors for different idler configurations according to the recommendations in Figure 3. Refer to the Instructions for use for more information regarding the parameters and the configuration of the system [8].

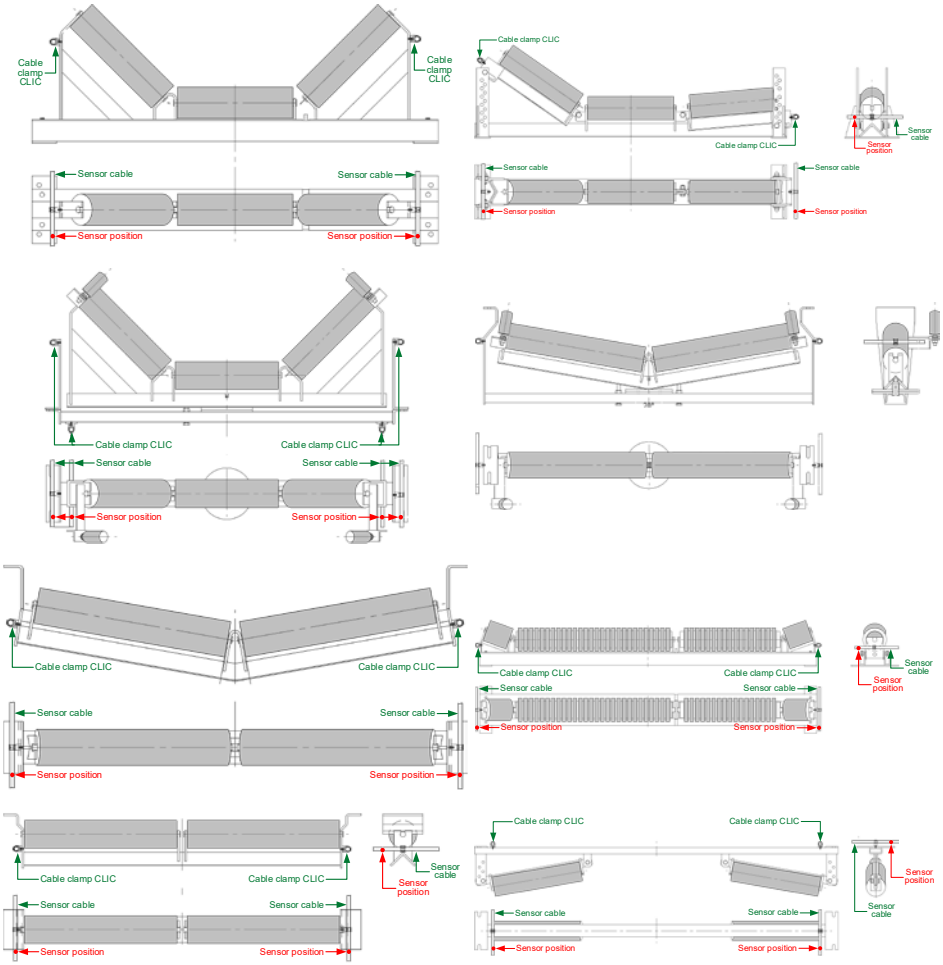

Figure 3 Idler configurations (non-exhaustive)

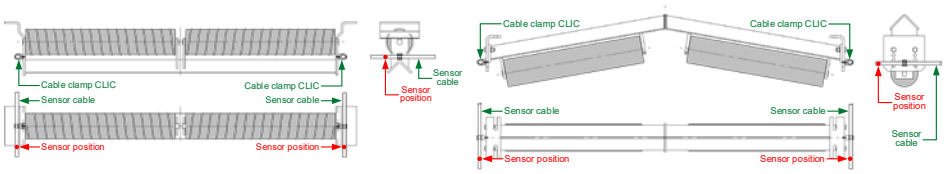

Figure 3 Cont'd: Idler configurations (non-exhaustive)

Monitoring pulleys, drives and other components individually

As with idlers, the bearings of pulleys and drives (including their motors) are main heat sources. To monitor the temperature of these components, external sensors are the best choice (see Figure 2 and Figure 4). External sensors (ESD) are fitted in stainless casings and can be screwed directly[1] onto the component to be monitored.

Fast heat transfer

The stainless steel casing furthermore is a good heat conductor, temperature changes of the component monitored are detected fast and reliably.

Refer to the technical documentation regarding the maximum number of external sensors in relation to the total length of sensor cable [6].

Figure 4 Temperature monitoring of idlers and other equipment

Operations and Maintenance Centre

Real-time information is key to low downtime

Keeping the conveying system operational at all times is the main objective of the operator of the facility. He will therefore have an adequate maintenance organisation in place in order to keep the downtime of the conveying systems as low as possible. Providing the maintenance team with temperature information in real-time will allow them to either schedule preventive maintenance task or intervene on short notice in case of a fast developing situation.

[1] Only ESD mounted in rectangular casings

Modbus interface to SCADA systems

Process information and maintenance information typically converge in the operations and maintenance centre (OMC) through SCADA[2] systems.

The SCADA system can retrieve data from the SecuriHeat d-LIST system via a Modbus interface[3] and can query – among others – the following data:

- the temperature at each sensor
- the average temperature of each alarm zone
- the status of each sensor (alarm, pre-signal, switched off, defect)
- the alarm status of every zone (alarm, pre-signal, switched off, defect)
- the fault status of Sensor Control Unit

Additional information regarding the use of the Modbus protocol and the structure of the data tables can be found in [9].

Detecting fires at transfer points and along the conveyor

Another application scenario aims to protect assets by detecting fires at the transfer points of the conveying system as well as along the conveying system, if it is installed in a housing or in a tunnel.

In this scenario, the SecuriHeat d-LIST system is configured to comply with local codes and standards for fire protection, such as EN 54-22, UL 521 or GB 16280. Alarm and fault messages are sent to the connected Fire Alarm System (FAS), which in turn alerts the (plant) fire brigade (see Figure 2). Refer to the Instructions for use for more information regarding the parameters and configuration [8].

Fire detection at transfer points

Because belt conveyor systems transport goods at considerable speed over large distances, it is vital to the operation of the facility to detect transported goods aflame as early as possible in order to stop fire from spreading.

Best practice

External sensors, mounted as high up as possible inside or protruding into the hopper or chute, are the best practice for detecting fire and deflagration at transfer points (see Figure 5).

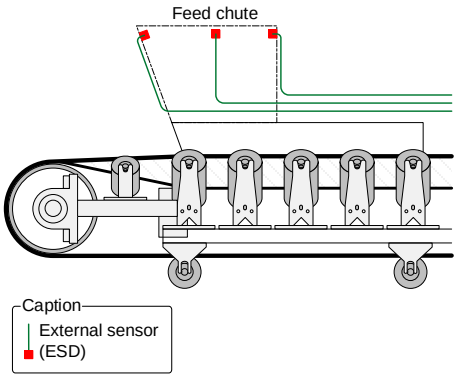

Figure 5 Local detection

Multilevel alarms

Another advantage of using SecuriHeat d-LIST are the two levels of alert ('Pre-signal') and alarm signal ('Alarm'). Alerts escalating to alarms from an overheating or a deflagration provide the early warning needed to prevent the fire from spreading out. The following table summarises the use of multilevel alarms.

Level	Signal	Typical use
1	Pre-signal	Verify and control (manual stop of belt conveyor)
2	2nd sensor pre-signal	Automatic stop of belt conveyor; call emergency team
3	Alarm	Initiate fire alarm; call fire brigade; initiate suppression

[2] SCADA: Supervisory Control And Data Acquisition
[3] Modbus TCP and Modbus RTU

Fire detection along the belt conveyor

In case the belt conveyor is installed in a tunnel or is otherwise encased, a large uncontrolled fire can cause a lot of damage to the installed assets as well as endanger staff working in this area. Detecting fires at an early stage ensures the highest possible level of asset protection and protection of health and life of humans.

Best practice

Installing the sensor cable above the belt conveyor at the ceiling is the best practice to ensure maximum asset protection. With a sensor spacing of for example 4 m (13.12 ft) one sensor covers an area of 12.57 m^2 (135.3 ft^2) [6]. Figure 2 illustrates the open space protection and the connections to the FAS schematically, while Figure 6 illustrates examples of installed sensor cables.

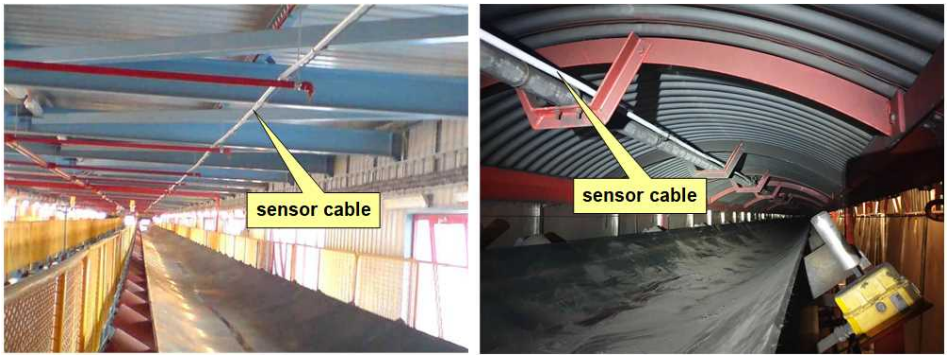

Figure 6 Fire detection along the belt conveyor (examples)

Maintenance free operation

The SecuriHeat d-LIST sensor cable and the external sensors are maintenance free, because they are completely shielded against external influences. In addition the individual sensors are tested for their function in each measuring cycle. Individual sections of the cable can be replaced easily in case of mechanical damage.

Securiton 360° Fire Protection Solution

A Securiton 360° Fire Protection Solution is built on its advanced Securiton Fire Alarm Systems (FAS). SecuriFire is not just reliable in operation with its modular, decentralised system architecture, it is also versatile and expandable to cater for current and future needs to connect all approved fire safety devices such as signalling, alarming, display and control units as well as extinguishing systems.

Securiton provides high quality technical expertise to support your projects in facilities using conveying systems through its extensive network of offices and distribution partners around the world. Please contact Securiton or any of the local offices in your region.

Testing the PBD solution

Testing and documenting is imperative

Apart from the open space protection along the belt conveyor, which largely follows codes and standards in force, the fire detection at transfer points and the temperature monitoring of equipment is a solution created on a Performance-Based Design approach. It is imperative to test and document this PBD solution for the AHJ[4] and the insurers.

Function test

At least the functionality of the sensor cable and the external sensors must be tested. To perform a function test, follow the commissioning instructions [10] and fill in the commissioning protocol [11].

Best practice: execute a performance test

Best practice however, is to test the performance of the whole solution, including the response plan for fire or operations and maintenance respectively, by applying heat to the individual components monitored.

- Use a hot air gun or a welding torch as a heat source; in hazardous areas, hot water or PCM[5] heating pads serve as a safe heat source
- Heat up the monitored equipment (idlers, rolls, pulleys, drives, etc.)
- Repeat the test in each zone and for each piece of equipment monitored by external sensors
- Document the test setup and the obtained test results for the AHJ and the insurer

Key Criteria & Benefits

An Early Warning Fire Detection solution based on Securiton SecuriHeat d-LIST satisfies the key criteria

- Reliable temperature monitoring of belt conveyor equipment
- Detecting fires at transfer points and along the belt conveyor
- Maintenance free operation of the temperature monitoring system

This in turn is beneficial for the operator because

- Overheating of equipment is detected at an early stage
- Maintenance tasks can be scheduled ahead
- Fire alarms are reacted upon in a professional manner before they become a major fire incident
- The loss prevention is at a maximum while the risk for business interruption is at a minimum
- The SecuriHeat d-LIST system is largely maintenance free

Successful implementations

Securiton SecuriHeat d-LIST systems successfully protect – among others – facilities of

- Arcelor, Germany
- Inditex, Spain
- CoCo power plant, Thailand
- SES Megalopolis, Greece
- UNA, The Netherlands
- Ferry Bridge Power Station, Great Britain
- Traspaso Andina, Chile
- EKO Stahl, Germany
- Boxberg Power Station, Germany

[4] AHJ: Authority Having Jurisdiction
[5] PCM: Phase Change Material

List of References

[1] Nascimento Richardson et al. (April 2017), An Integrated Inspection System for Belt Conveyor Rollers, Advancing in an Enterprise Architecture, SciTePress, Portugal

[2] Hansen Richard (March 2018), Fire statistics from the mining industry in New South Wales, Queensland and Western Australia, Technical Report, Queensland, Australia

[3] NFPA (2017), NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection, Quincy, MA, USA

[4] NFPA (2020) NFPA 122 Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities, Quincy, MA, USA

[5] FM Global (July 2020), Data Sheet DS 7-11, Conveyors, Norwood, MA, USA

[6] LISTEC GmbH (June 2020), d-LIST® Line Type Heat Detector, Guidelines for planning / installation, Sensor Control Unit SCU 835, Sensor Cable SEC 15, Isen, Germany

[7] Securiton AG, SecuriSens LIST System Description, Zollikofen, Switzerland

[8] LISTEC GmbH (May 2020), d-LIST® Line Type Heat Detector, Instructions for use, Sensor Controller Unit, Sensor Cable SEC 15, Isen, Germany

[9] LISTEC GmbH (June 2020), d-LIST® Line Type Heat Detector, MODBUS, Isen, Germany

[10] LISTEC GmbH (April 2020), d-LIST® Line Type Heat Detector, Commissioning Instructions, Sensor Controller Unit, Sensor Cable SEC 15, Isen, Germany

[11] LISTEC GmbH (April 2020), d-LIST® Line Type Heat Detector, Commissioning protocol SCU 835, Isen, Germany

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