# SecuriBeam ILIA Pro

# FIRE AND SMOKE DETECTION IN RECYCLING FACILITIES

Case Study

June 2020

SECURITON

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# Introduction

**Awareness for sustainability drives the demand for recycling**

The awareness that sustainability is the basis for healthy ecosystems and environments, which in turn are necessary to the survival of humans and other organism, is ever growing. Therefore, most industrialised nations and many emerging countries have some practises – albeit different in different countries – in place to manage waste. The cornerstone of most waste minimisation strategies is the waste hierarchy, which refers to the "3 Rs" Reduce, Reuse and Recycle. Recycling is a resource recovery practise aiming to the collecting and reusing of waste materials [1].

This growing awareness for sustainability and thus recycling drives the demand for specialised facilities handling waste.

**Waste is 'dirty' with unknown details of composition**

In many cases, the material composition of the waste is not known in detail but is referred to in general terms, such as for example electronic and electrical scrap or liquid waste. In addition, waste is per se something 'dirty'; hence, the environmental conditions within recycling facilities are most challenging.

**The number of fires grow and pose additional threats**

Furthermore, fires in recycling facilities are far from rare and as the number of facilities is growing, the number of fires is unsurprisingly rising too [2], [3] and [4]. Due to the unknown nature and composition of the waste, fires in recycling plants pose additional threats, such as

- Releasing of toxic gases into the environment as a direct result of fire.
- Releasing of toxic substances into flowing water bodies and phreatic water because of contaminated fire water.

**Damage mitigation with an adequate fire protection scheme**

Damage resulting from property loss, fines, payments to settle civil damages claims as well as loss of reputation after an uncontrolled fire incident may drive the operator or owner of the recycling facility out of business. It is therefore paramount to them to have a professionally designed fire protection scheme established, which allows to detect and react upon a fire as early as possible.

# Risk, Cause & Damage

**Risk of false alarm**

Statistics show that a recycling plant faces a fire incident in average every second year. Fire protection consequently is a critical element in the operation of a recycling plant. A fire protection scheme includes that staff is thoroughly trained and stays alert to react in a professional manner to a fire alarm. False alarms undermine the alertness of the staff, which in turn can lead to false reactions in case of a real fire. False alarms and its consequences are therefore a particular risk that results from poor fire protection design and/or inadequate fire detection products and must be addressed in the fire protection design. Reducing false alarms however, poses some serious challenges.

**Fire risks**

The risks for fires in recycling facilities are mainly

- Processing substances with an unknown thermal load or fire load.
- Processing substances that produce combustible dust.
- Processing substances that, when mixed suddenly or uncontrolled, become combustible and/or fire accelerants.

**Cause**

Independent from the type of waste processed at a recycling facility, the common causes of fires are

- Spontaneous ignition of waste material.
- Smouldering waste material delivered to the stock.
- Cutting or shearing containers, in particular when they contain compressed flammable gases.
- Hot works such as cutting, welding and soldering.

- Overheating and/or flying sparks resulting from malfunctions in machinery (conveyor belts, shredders, vehicles, etc.).
- Bad housekeeping (smoking, maintenance of equipment, etc.).

**Damage**

Damage resulting from large, uncontrolled fires in recycling facilities include

- Loss of machinery, buildings and other installations.
- Fines and compensation payments to settle civil damage claims.
- Loss of business contracts and reputation.

# Challenges

**Dirty and highly dynamic environment**

As waste by definition is ‘dirty’, the environment of a recycling facility per se is a far from clean environment (see Figure 1). In addition to that, the environment is highly dynamic, the level of dust changes very quickly when, for example, trucks are loaded or unloaded.

Other challenges are

- Large, partly open space.
- High temperature variation.
- High variation in airflow.
- Diesel exhaust fumes.
- Build-up of foggy clouds at ambient temperatures below 10°C.
- Birds and other flying objects (plastic bags, wrappings, packaging, etc.).

**Figure 1 Challenges in harsh conditions**

**False alarms are a main issue**

These circumstances, but in particular the heavy dust load, potentially lead to false alarms, which are a major challenge in itself, as they lead to risks mentioned above.

**High maintenance intervals are a main issue**

A yet unmentioned challenge is the maintenance interval of the fire protection equipment. Exposing technical equipment to harsh environmental conditions unprotected, inescapably lead to high maintenance requirements. A good fire protection design for recycling plants therefore aims to reduce the maintenance interval to the absolute minimum by protecting the equipment adequately.

# Standards & Codes

**Performance-based Design**

The diverse nature of recycling facilities and the varied nature of the waste treated at a specific facility, require the design of a fire detection system to be simple and flexible to meet Deem-to-Satisfy (DtS) fire and building safety provisions such as NFPA 1, NFPA 72 or BS 5839-1. Applying a Performance-based Design (PBD) approach does address risk-based detection needs over and beyond prescriptive requirements to ensure business operations and asset protection as recommended for example in [5], [6], [7] or [8].

# Application Scenarios

**Narrow range for solutions**

The harsh environment found in a recycling facility narrows down the range of solutions considerably. There are two approved solutions to overcome the challenges declared before:

1. Dust is filtered out of the air before it is tested for smoke particles. This is the case when aspirating smoke detection systems, such as Securiton SecuriSmoke ASD, is used as fire detection method.
2. Detecting smoke within the environment. This is the case when a linear smoke detection system is used as fire detection method.

However, a solution based on detecting smoke with a linear smoke detection system requires an industrial grade linear type smoke detector and an 'integrating element' to even out very fast changes in the dust load.

**What is an industrial grade linear type smoke detector?**

In order to cope in a highly dynamic environment, the linear type smoke detector must have a ***high dynamic range***, to be able to self-adjust when fast changing dust loads occur. A low dynamic range results in the detector signalling a fault condition (beam obstructed) more often. In addition, an industrial grade linear type smoke detector offers ***flame detection capabilities***, to detect fires even in persistent high loads of dust.

**What is an integrating element?**

An integrating element by definition accumulates input signals over a defined time to produce a representative output signal. In the scope of this solution, it means to even out peaks in the smoke signal of the detector by applying an ***alarm buffer function*** between the detector and the fire alarm signal.

This Compact Design Guide focuses on recommendations for Securiton advanced, industrial grade linear type smoke detectors SecuriBeam ILIA Pro and its integration with key control elements, such as Securiton fire alarm systems SecuriFire and fire suppression systems.

The solution addresses two main issues

- The risk for false alarms.
- The undesired high maintenance intervals.

**Tuning a PBD solution**

A solution based on a Performance-based design approach, possibly requires a certain amount of tuning (or fine-tuning) to reach its optimal level of performance. As each project is different from another, the amount of tuning required differs. The following chapters describe the steps required to reach this level in detail. They base on experience gained from applying this solution in many projects.

## Preventing false alarms

Three elements are crucial to prevent false alarms

**Align correctly**

1. **The SecuriBeam ILIA Pro transmitting and the receiving units must be 100% correctly aligned!** After the installation of the units, perform the following steps, refer to the technical documentation [9] for more information.
    a. Set the diaphragm (at the receiver) to position 0, the default.
    b. Select «AUTO adjust.», this will continuously increase the transmitted signal until it reaches 100% on the receiver («Rx») .
    c. Increase the «Tx» signal level by 20%, which will result in an «oversignal» at the receiver, signalled by a blinking yellow LED on the receiving unit. Unlike mentioned in the training documentation [10], **do not** just set the «Tx» signal to the maximum of 100.7%. Doing so will make the precise alignment required in the dusty environment of a recycling facility difficult if not impossible.
    d. First always align transmitter unit (both horizontally and vertically) before aligning the receiver unit (horizontally and vertically), refer to the training documentation [10] for details.
    e. From experience it will require between 7 and 9 ‘quarter-turns’ for a distance of 50 m between the units.
    f. Important! Allow the system to adjust by applying maximum 1 ‘quarter-turn’ in 2 seconds.
    g. Set the diaphragm (at the receiver) temporarily to position 5.
    h. Repeat steps b and c, followed by e and f carefully for a 100% alignment of both the transmitter and receiver units.
    i. Important! Reset the diaphragm (at the receiver) back to position 0 for normal operation.
    j. Select «AUTO adjust.» to allow the receiver to reach an «Rx» level of 100% (from experience will this reduce the «Tx» level to below 25% for a distance of 50 m between the units, refer to the technical documentation [11] for more details).
    k. Reduce the «Tx» level until the «Rx» level reaches 85%, which will ensure best operational performance in the dusty environment of a recycling facility.

**Set sensitivity correctly**

2. **The sensitivity must be set correctly for an application in dusty environments!** Refer to the technical documentation [11] for more information.
    a. Set the alarm sensitivity[1] for smoke to 3’938.
    b. Set the presignal to 3’200.
    c. Set the alarm sensitivity for fire to 1’462 (this value can be increased up to 3’938 depending on the interferences in the environment).

**Configure an alarm buffer**

3. **The fire alarm panel must be configured with an alarm buffer!** Refer to the technical documentation [12] of the SecuriFire 500 fire alarm panel for the configuration of the alarm buffer.

[1] In some technical documentation the term ‘sensibility’ is used, in the context of this document ‘sensitivity’ and ‘sensibility’ are used synonymously.

## Alarm buffer explained

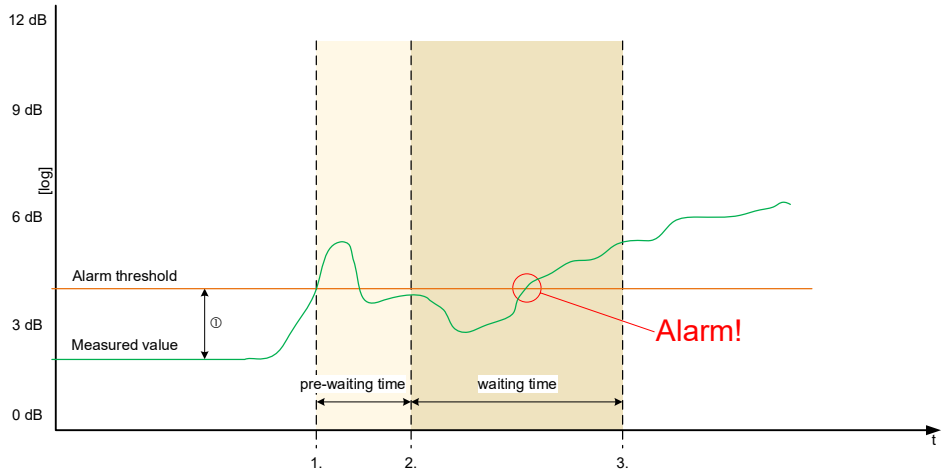


**Figure 2 Alarm buffer**

The SecuriBeam ILIA Pro system has a built-in active compensation for drift. The signal distance between the measured value and the alarm threshold is kept at for example 2 dB[2] for the smoke sensitivity level (see ① in Figure 2).

1. If the measured value rises quickly and above the alarm threshold, the pre-waiting time starts. The pre-waiting time must be set in such a way that swirled-up dust can settle within it, or the ILIA Pro can compensate (see above). A recommended value to start with is 30 s. During the pre-waiting time, the fire alarm panel does not signal the alarm but buffers it in the intermediate alarm storage.
2. Once the pre-waiting time has expired the fire alarm panel sends a reset command to the SecuriBeam ILIA Pro system and starts the waiting time, recommended are 60-90 s. Keeping the waiting time too short may result in unwanted retriggering of the waiting time, thus ignoring successive rises of the measured value above the alarm threshold. In other words, the longer the waiting time the higher the sensitivity of the system.
3. During the waiting time, the fire alarm panel will immediately signal an alarm in case the measured value rises above the alarm threshold. Should the measured value not rise above the alarm threshold, the intermediate alarm storage is cleared, after the waiting time has expired.

## Additional steps to reduce false alarms

Although the approach with the alarm buffer configuration usually provides very good results, in some cases – depending on the environmental conditions of a specific site – additional measures to reduce false alarm have to be considered. They include

- Two detector dependency[3]
  Two specific SecuriBeam ILIA Pro detection lines must be in an alarm condition before the fire alarm panel signals the alarm.
- Multi detector dependency
  In a configuration where more than two SecuriBeam ILIA Pro lines are used, any two (or more) lines in alarm result in an alarm signal at the fire alarm panel.
- Multi criteria detection
  In addition to the smoke detection with SecuriBeam ILIA Pro other detectors (e.g. flame detectors) are installed. The fire alarm panel will only signal an alarm when both the smoke detector and the other detector trigger an alarm.

[2] 2 dB are a value of approximately 2'000 regarding the smoke sensitivity of the ILIA Pro; however there is no direct comparison of the two values (as the dB scale is logarithmical)

[3] Commonly used in coincidence/cross zone smoke detection (a.k.a. 'double knock' or interlock or double-interlocked)

## Securiton 360° Fire Protection Solution

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.

**Powerful combination for PDB solutions**

For recycling plants the combination SecuriFire 500 fire alarm control panel and SecuriBeam ILIA Pro is a very advantageous arrangement for performance-based design fire protection solutions due to its powerful configuration features such as alarm buffer and multi detector dependency.

Securiton provides high quality technical expertise to support your projects in the recycling industry 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**

As the alarm buffer function in essence is a Performance-based design approach for the fire protection system, it is imperative to test the performance by means of a test fire and to document both the test setup and the results of the test.

Obtaining the correct material and ingredients for test fire TF5 in accordance with the relevant standard [13] might prove difficult. Alternative, the following procedure comes close enough to the specified TF5:

- Mix 4-4.5 l of petroleum and 0.5 l of diesel
- For a roof height of 12 m, depending on the airflow and ventilation of the facility:
  - Depending on the room height, pour some of the blend into a flat steel bin, allowing for a large surface of the flammable liquid. Use 0.3 l for room heights up to 12 m, 0.35 l for heights up to 16 m or 0.4 l for heights up to 20 m.
  - Place the bin underneath a line of the SecuriBeam ILIA Pro system.
  - Set the blend on fire, the petroleum will create the required flames and heat to allow for the smoke – generated by the diesel – to rise to the roof and trigger the alarm.
  - Adjust sensitivity and waiting time (see above) if required.
  - Repeat the procedure for all other lines of the SecuriBeam ILIA Pro system.
  - Document the test and the obtained test results for the AHJ[4].

**Figure 3 Testing the PBD solution**

[4] AHJ: Authority Having Jurisdiction

## Keeping the maintenance interval low

**Keeping the lenses clean is key**

Key element to ensuring the SecuriBeam ILIA Pro system is operational at all times is to keep the optical lenses of the transmitting and receiving units clean from dust. Figure 1 illustrates that this is a challenging task. In addition, access to the units for cleaning is hampered in most cases.

**Prevent from accidental misalignment with SOHI, protective housing for ILIA**

Placing SecuriBeam ILIA Pro transmitting and receiving units in a protective housing that provides an IP65 protection level and thus protects the units from acid concentrations in the air or aggressive dust concentrations as well as protection against accidental misalignment.

**Prevent from build-up of dust with ASIS, air shield for ILIA and SOHI**

A dust deposit in front of the pane of the protective housing is most unwanted. To prevent this, the use of an air shield, which creates a homogenous air curtain in front of the lens, is highly recommended. Figure 4 impressively illustrates the effectiveness of the air shield in the harsh environment of a recycling facility.

**Figure 4 ILIA Pro with SOHI and ASIS**

**Key design factors**

When designing the pressured air network for the air shields, the following key factors must be taken into account:

- The air pressure at the air shield of a unit should be set in the range of 0.83-1.38 bar (12-20 psi)
- The pressured air must be oil-free to prevent clogging up the sintered metal filter ring or to deposit an unwanted oil film on the lenses.
- The correct dimensioning of the pressured air network can be demanding, seeking expert advice is recommended.

# Key Criteria & Benefits

A fire detection solution with Securiton SecuriBeam ILIA Pro system satisfies the two key criteria

- False alarms reduced to an absolute minimum.
- Maintenance intervals at an acceptable frequency.

This in turn is beneficial for the operator because

- Fires are detected at an early stage.
- The staff stays alert and reacts skilfully to alarms signalled.
- Fire alarms are reacted upon in a professional manner before they become a major fire incident.
- The loss prevention is at a maximum and the risk for business interruption at a minimum.
- The cost for maintenance is commensurate.
- SecuriFire 500 fire alarm control panel and SecuriBeam ILIA Pro build a powerful combination for the fire protection in recycling plants.

# Successful implementations

Securiton SecuriBeam ILIA Pro fire detection solutions are – among other – successfully in operation at the following facilities:

- KORN Recycling, Germany
- Clean R Recycling, Latvia
- SITA Rohstoffwirtschaft, Germany
- Durmin Entsorgung und Logistik GmbH, Germany
- Otto Dörner, Germany

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