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SecuriSmoke ASD

EARLY WARNING FIRE DETECTION IN ANIMAL SHEDS

Case Study

December 2020

SECURITON

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Introduction

Rationalisation has a negative impact on fire risks

Rationalisation is a key driver in the agricultural sector leading to an increase in the size of production buildings and an increase in the level of mechanisation. In the wake of rationalisation, the electric and electronic installations on a modern farm are ever more complex. It also leads to storing growing quantities of highly flammable materials, such as hay and straw, together with the animals in the same buildings. All of this increases the fire risk and fire losses.

Growth in size puts more animals at risk

Likewise, this growth in size evidently leads to more animals being at risk at a single farm. Animal advocates feel strongly about the loss of thousands of animal lives in fires and other disasters.

Farm fires are common

According to LBK, the Swedish Fire Protection Committee of Agriculture, Sweden records around 20’000 fire incidents a year among its 75’000 farms [1]. In Norway, the number of farm fires is decreasing in recent years because of stronger regulations for fire protection. However, 2019 still registered 132 fires in farming buildings and 179 fires in residential buildings on farms [2].

Few regulations in force

Because of modern rescue services legislation, the responsibility for good fire protection rests on the individual farmer in many countries. Government agencies as well as some local authorities and fire services, provide advice for farmers on avoiding fires (and how to respond to them), but these guidelines are voluntary and farmers often fail to heed such recommendations.

Business continuity is at risk

Buildings, other infrastructure and often the animals as well are insured against the risks of fire. Yet the loss of business contracts, for example the long term supply contract with a meat processing company further down the value chain, and the economic damage resulting from it, are rarely insured.

Detecting fires early is key

On one hand, regulations permit huge numbers of animals to be kept inside single buildings. On the other hand, smoke is the biggest cause of death for both humans and animals [3]. This makes the evacuation in the event of a fire a highly complex matter. Sprinkler systems alone trigger the fire alarm way too late, thus complicating the already challenging task of the evacuation further. Only an Early Warning Fire Detection system with multiple alert levels ensures a timely warning that helps to gain time for an investigation and an adequate intervention.

Damage mitigation with an adequate fire protection scheme

Damage resulting from property loss and the loss of contracts after an uncontrolled fire incident may drive a farm out of business. It is therefore paramount to farmers 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

Fire risks

Barns normally are loaded with substantial quantities of dry, flammable materials such as bedding, hay, grain, and wood. When these materials ignite, they burn with savage intensity. Liquid fuel sources found in barns include alcohol, liniment, hoof paints, and creosote, among others.

The barn structure itself can be a major contributor to how quickly a barn fire spreads. Barns are often wooden structures, and they are often airy and filled with combustible materials such as wood stalls and hay.

Other risks for fires are mainly

- cobwebs, dust, and grain dust
- horse blankets
- paint
- fertilizer
- pesticides and herbicides
- rodents
- machinery and mechanical equipment

Cause Smoke is the major hazard in the event of a fire, causing most animal and human deaths [3]. Only in case a fire is discovered in its incipient stage there is a good chance to effectively put it out. Smouldering fires, e.g. from faulty electrical installations, can last hours in some cases days before the break out into flames.

In 50% of the cases, the cause of the barn fire is never determined. The most common known cause is equipment failure (both heating and electrical) as shown in Figure 1.

NFPA also reports that nearly half of all barn and stable fires occur in a time period when it is less likely that there is a watchful eye present. Also noteworthy is, more stable and barn fires happen during the colder months of the year, when devices previously listed are more likely to be used but when there may be less traffic in and out of the barn in general.

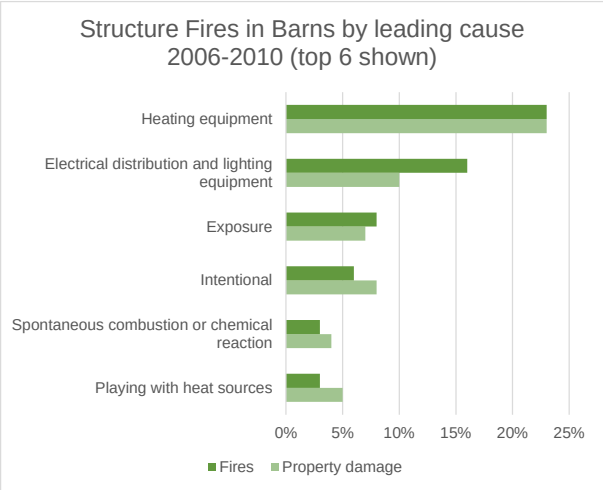


Figure 1 Structure fires in barns [4]

Damage While the NFPA states US$ 38 million annually for prosperity damage between 2006 and 2010 [4], the Animal Welfare Institute (AWI) focusses on the loss of animal life and highlights that more than 2.7 million US farm animals died in barn fires that potentially could have been prevented from 2013 to 2017 [5].

Consequential loss of business contracts and the economic damage resulting from it to the farmers themselves is considered substantial, although statistically not widely documented.

Challenges

Barns and animal sheds pose several challenges to an effective fire protection system, mainly

- humidity and aggressive gases
- overvoltage due to lightning strike
- dirty and dusty environment
- large, partly open space
- changes in the airflow

Figure 2 Challenges in animal sheds

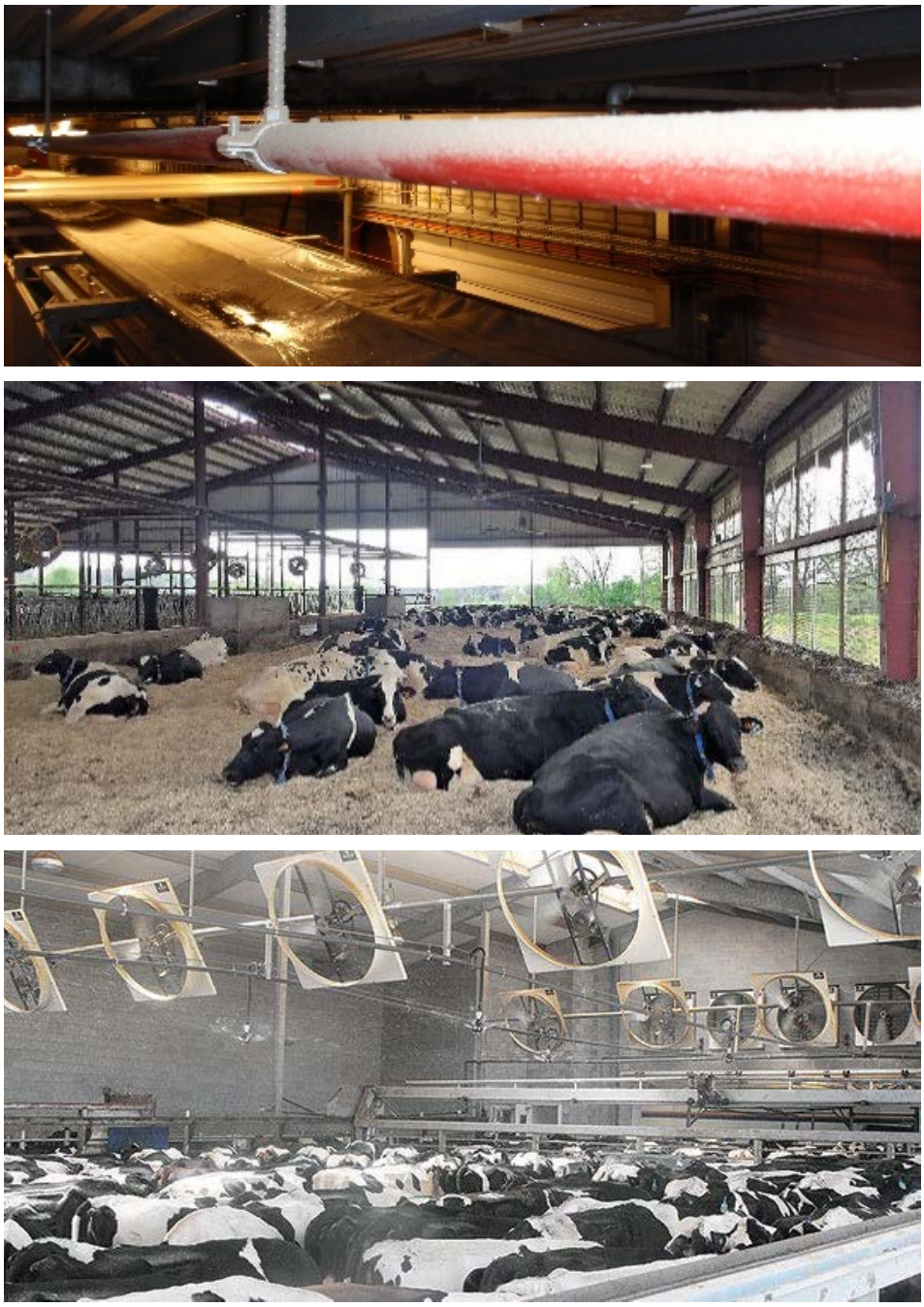


Figure 2 Cont'd: Challenges in animal sheds

Standards & Codes

Codes and standards differ

For Scandinavian countries there are codes and standards in force which cover requirements for products used (FG-740:3 [6]) and their application in farming facilities (NS 3960 [7]). The design of a fire detection system needs to be simple and flexible to meet Deem-to-Satisfy (DtS) fire and building safety provisions, such as NFPA1, NFPA 72 [8] or BS 5839-1.

Performance-based Design

Applying a Performance-based Design (PBD) approach addresses risk-based detection needs over and beyond prescriptive requirements to ensure business operations and asset protection as recommended for example in NFPA 150 [9], CFPA-E 17 [10]. Additional recommendations can be found among others in [3], [11] or [12].

Application Scenarios

Narrow range for solutions

The harsh environment found in animal sheds narrows down the range of solutions considerably. There are two approved solutions to overcome the challenges mentioned before:

1. Detecting smoke within the environment. This is the case when a linear smoke detection system is used as fire detection method. An example of this solution can be found in [13].
2. 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.

This case study focuses on recommendations for the use of SecuriSmoke ASD HD[1] as the core element of a reliable Early Warning Fire Detection system and it addresses the main issue of

- reliable fire detection in a harsh environment with aggressive gases, high humidity and lightning strikes

Designing the Early Warning Fire Detection System

Key design factors

As animal shed design and utilisation differ, the fire protection solutions differ. When designing an Early Warning Fire Detection solution based on SecuriSmoke ASD, bear in mind the following key factors:

- Use the SecuriSmoke ASD HD which is hardened for the use in environments with corrosive gases (all PCBs[2] are coated) and features an enhanced overvoltage protection
- Airflow and changes in the airflow with the protected area due to ventilation systems installed
- General characteristic of the building (the protected area), e.g. flat roof, pitched roof – with or without ventilation through openings in the pediment – thus taking possible smoke stratification effects into consideration
- General partitioning of the protected area (e.g. milking stalls, individual stalls for calves, foals, etc.)
- Localised protection of (electrical) equipment (e.g. robotic mixer/feeder, grooming brushes, milking stalls, etc.)
- Ensure that alarm (and fault) notifications can be heard and reacted upon (in case the animal shed is at a remote location or is operated unattended)

Design for open areas

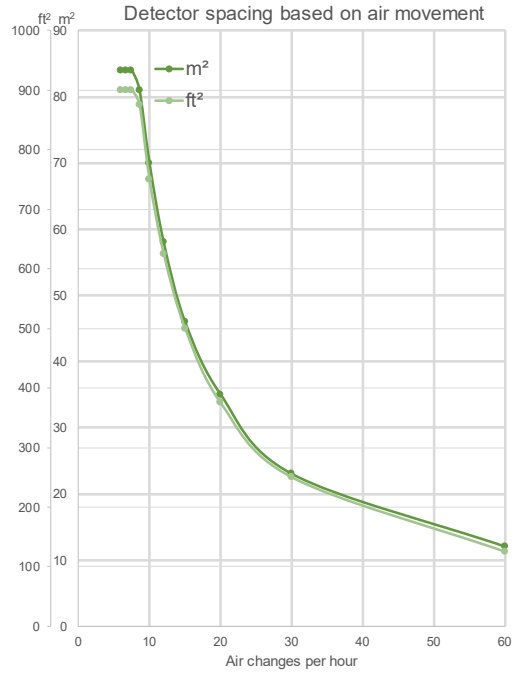
For a large open space such as an animal shed, a SecuriSmoke ASD Early Warning Fire Detection system is used for ceiling level detection to meet prescriptive code requirements. It is also used in enhanced detection performance designs to meet risk-based fire safety objectives, to avoid losses due to fire damages and to ensure business continuity.

In case the ventilation of the shed has a significant impact on the dispersion of smoke it is strongly recommended to analyse the air currents in the protected area and subsequently incorporate the results of such analyses into the design of the Early Warning Fire Detection system.

[1] HD: Heavy Duty
[2] PCB: Printed Circuit Board

Smoke detector spacing based on air changes (NFPA 72 [8])

ACH[3]	Spacing [m² (ft²)]
60.0	12 (125)
30.0	23 (250)
20.0	35 (375)
15.0	46 (500)
12.0	58 (625)
10.0	69 (750)
8.6	81 (875)
7.5	84 (900)
6.7	84 (900)
6.0	84 (900)



Open space and localised detection

Figure 3 illustrates how SecuriSmoke ASD sampling holes are located under the beam/joist structure underneath the roof for open space detection (sampling holes in blue and green) and for localised protection (sampling holes in orange).

For simplicity only the ASD is shown in Figure 3, for accessories such as filters, dirt trap boxes, blow out devices, etc. refer to Figure 4 below.

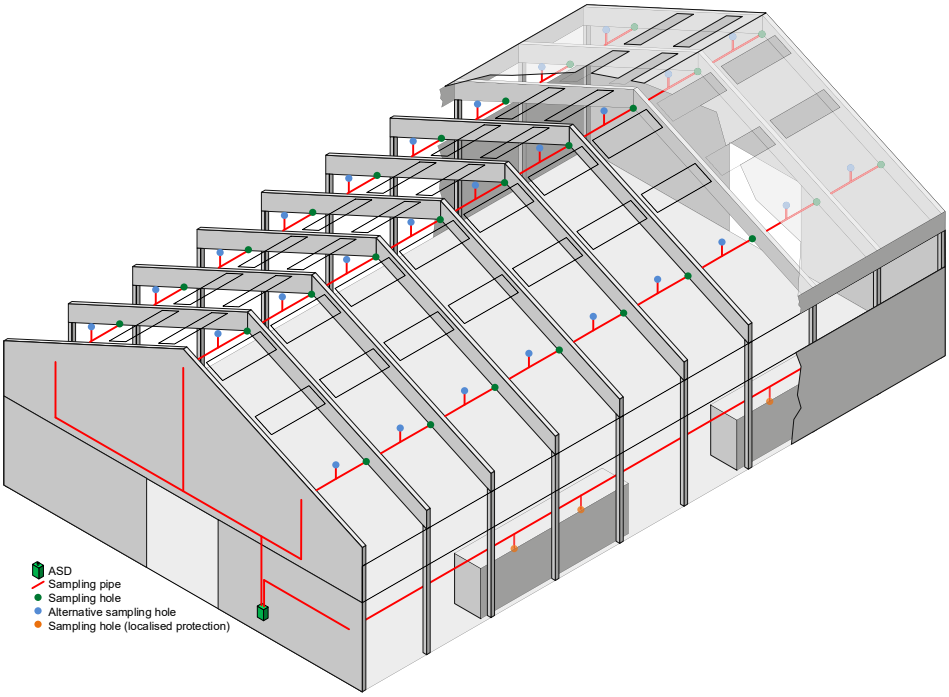


Figure 3 Fire detection placement underside roof with beam/joist

The airflow and changes in its velocity shall be taken into consideration when designing the spacing and the placement of the sampling holes. It is recommended to choose the spacing and placement recommendations fitting the provisions of the table above closest.

[3] ACH: Air Changes per Hour

Sampling holes

Variable	Design recommendation (ceiling with beam/joist)
Spacing	In relation to airflow, refer to table above. ASD sampling pipes are generally installed under the beams according to the following: Beam depth < 10% of ceiling height: smooth ceiling spacing is applied, on the bottom of the beams (see sampling holes in green) Beam depth ≥ 10% of ceiling height: (i) Beam spacing < 40% of ceiling height: use smooth ceiling spacing ***parallel*** to the beams and half the spacing ***perpendicular*** to the beams, on the bottom of the beams (see sampling holes in green) (ii) Beam spacing ≥ 40% of ceiling height: a sampling hole shall be placed on the ceiling within each beam pocket (see alternative sampling holes in blue).
Placement	Refer to PBD design approach per [14] or prescriptive codes such as NS 3960 [7]
Orientation	Perpendicular downwards

SecuriSmoke ASD offers five alarm levels

One of the advantages of using SecuriSmoke ASD detectors is the five levels of alerts (‘Pre-signal1’, ‘Pre-signal2’, ‘Pre-signal3’) and alarm signals (‘Alarm’, ‘Alarm2’). Staged alerts escalating to alarms from an overheating incident provide the early warning needed to prevent the situation from developing into a real fire event. The table below shows a typical use of these alarm signals.

Level	Signal	Typical use
1	Pre-signal1	Verify and control (manual extinguishing as needed)
2	Pre-signal2	Manual shutdown of ventilation and power-down other equipment if required; call emergency team
3	Pre-signal3	Auto shutdown of ventilation or smoke vents and related equipment; evacuate the site
4	Alarm	Actuate suppression; initiate fire alarm; call fire brigade
5	Alarm2	Actuate pre-action sprinkler

The main objective: gain time

The objective of early detection is to provide personnel with the opportunity to investigate and intervene as soon as possible in the event of a fire so that can be avoided.

In general, SecuriSmoke Early Warning Detection Systems are considered to be adequate to detect smouldering overheating or a fire at its incipient stage for the prevention of the majority of fire outbreaks.

Accessories for a challenging environment

For a reliable fire detection with best performance over time, the use of the following accessories is strongly recommended.

Refer to Securiton Aspirating Smoke Detector manuals (e.g. [15]) for design details and usage of accessories. The data sheets of an individual accessory are referenced to in the following table.

Challenging Environment	Illustration	Description
Dirty and dusty		**CLIP x.y PA** Sampling hole clip Recesses the sampling hole slightly, minimising the build-up of dust in front of the hole and thus preventing fault messages and false alarms.
		**DFU 911S** Dust filter unit [16] Increases the service life of the smoke sensors and greatly reduces the likelihood of false alarms. A missing filter element will trigger a fault message in accordance with [6] and [7].
		**DTB 25 PC** Dirt trap box [17] Used in very dirty environments. Inserted into the sampling pipe before dust filter.
		**ADB 500** Automatic blow-out device [18] One sampling pipe is periodically, automatically and therefore unattended, blown out and cleaned, to prevent fault messages caused by clogged aspiration points as well as to avoid false alarms.
		**MV 25 PVC or MV 25 ABS** Manual ball valve For revision and cleaning works with compressed air as an alternative to the ADB 500.
High Humidity		**WRB 25 ABS/PVC** Water retaining box [19] Used in protected areas where temperature differences cause condensation (see [7]) or otherwise high humidity.
Lightning strikes		**OPB 911 CP** Overvoltage protection board [20] Protecting the ASD against atmospheric overvoltage (lightning) in accordance with [6] and [7].

Figure 4 shows accessories used in harsh environments.

Figure 4 Accessories for challenging conditions (qualitative)

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.

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Testing the PBD solution

Testing and documenting is imperative

As the fire protection of an animal shed with an Early Warning Fire Detection system largely is a Performance-based design approach, 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.

The performance of the Early Warning Fire Detection system is best tested with a test fire similar to test fire TF2 in accordance with the relevant standard [21].

- Use approximately 10 dried beech wood sticks (moisture content ≈ 5%), each stick having dimensions of 75 mm × 25 mm × 20 mm (2.95 in × 0.98 in × 0.79 in) as fuel
- Use a hotplate with a diameter of ~220 mm (~8.66 in) with a grooved surface with concentric grooves and a rating of approximately 2kW as heat source
- Make sure the surface and immediate surroundings of the test fire equipment is clean of other flammable material, protect sensitive installations with fire blankets
- Depending on the height of and the airflow within the protected area, an additional heat source, to allow for the smoke to rise, may be required. If so, use a flat steel bin and pour ~0.3 l (~10.56 fl. oz) of petroleum in. Set the petroleum on fire once the wood sticks start smouldering.
- Repeat the test in various locations of the protected area and for various ventilation patterns.
- Document the test setup and the obtained test results for the AHJ[4]

Maintaining the Early Warning Fire Detection System

Keeping the pipes clean is key

Key element to ensuring the SecuriSmoke ASD Early Warning Fire Detection system is operational at all times is to keep the pipe network and the sampling holes free from blocking up (see Figure 5).

[4] AHJ: Authority Having Jurisdiction

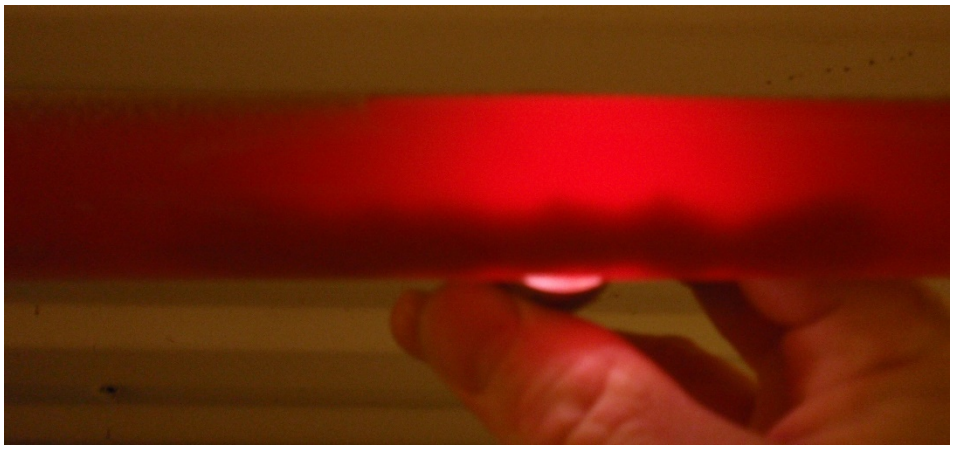


Figure 5 Dirt and dust in the sampling pipe

Automatically cleaning the pipe network

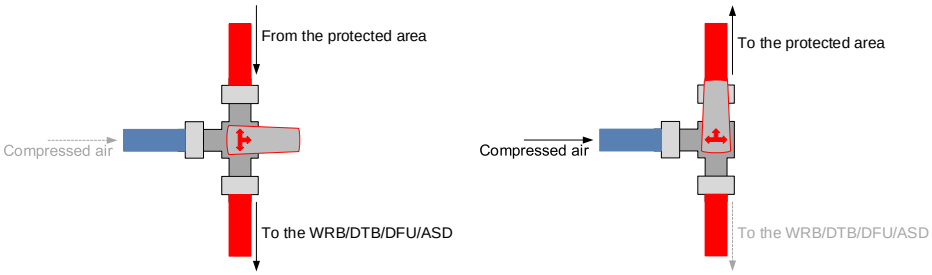
With the use of an automatic blow-out device (ADB 500) the pipe is automatically cleaned either in a programmable interval or triggered by the ASD when it detects an airflow fault. Installing an ADB 500 according to the respective technical documentation [18] will ensure that the sampling pipes are clean of dust and dirt. This will prevent fault messages and reduce the risk of false alarm considerably.

This solution is preferred for animal sheds in which other day-to-day operation is automated (e.g. feeding, milking, etc.) as the service interval can be reduced to the scheme shown in the table below.

Manually cleaning the pipe network

In case a fully automated pipe network cleaning scheme is not the preferred solution, at least a manual cleaning procedure must be established to keep the performance of the Early Warning Fire Detection system at a high level. As soon as the ASD signals an airflow fault, this procedure shall be executed.

In this case, a manual ball valve MV 25 PVC or MV 25 ABS is installed in the pipe network instead of an ADB 500 (see Figure 4). The valve insures the pressured air is only blown towards the protected area and not in direction of the accessories and the ASD. See Figure 6 for operation modes.



(a) Normal operation (b) Pipe network cleaning

Figure 6 Operation modes

Do not apply pressured air before the lever is securely locked in the cleaning position.

Key design factors

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

- The air pressure must be constant and at least 4 bar (58 psi)
- Refer to the technical documentation regarding the quality requirements for the compressed air [18]
- The correct dimensioning of the pressured air network can be demanding, seeking expert advice is recommended

Inspection, Test and Maintenance (ITM)

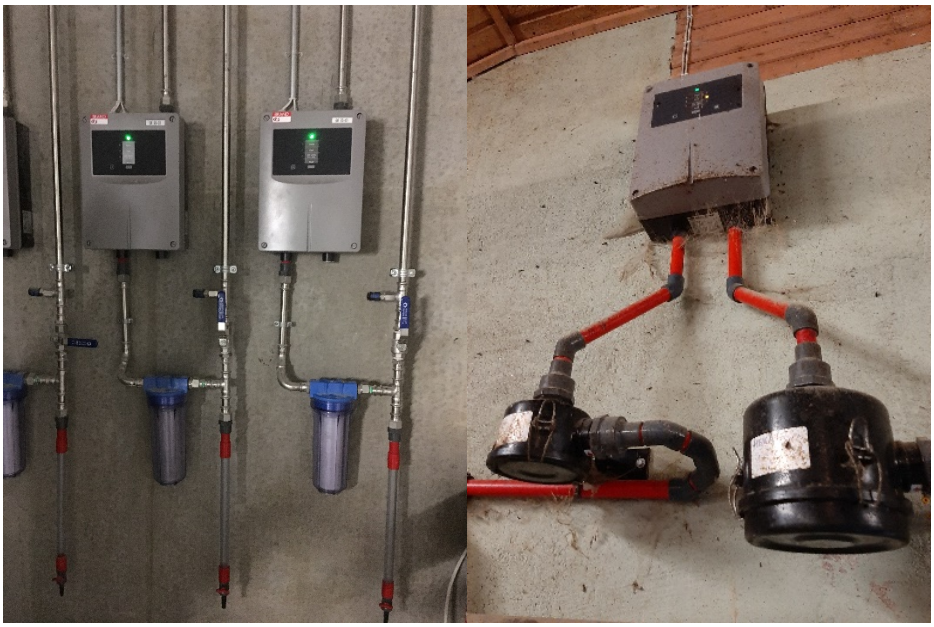
The table below is a simplified ITM schedule for SecuriSmoke ASD product services. Refer to Securiton product manuals for more details.

Service Item	Fault/ Alarm	Every 3 months	Yearly
Cleaning the detector housing exterior (air outlet)	(✓)	✓	✓
Cleaning of sampling pipe tube network, accessory parts, airflow sensors	(✓)	✓	✓
Replacement of dust filters	(✓)	✓	✓
Cleaning of air flow sensor	(✓)	✓	✓
Check correct seating (no leakage)	(✓)	?	✓
Check of fault and alarm release	✓	?	✓
Update maintenance protocol	✓	?	✓
Analyse event memory	✓	?	✓
Analyse airflow issues (caused by operational changes)	✓	?	✓

✓ indicates 'shall do'; (✓) indicates 'as needed'; ? indicates 'only if required by local codes and standards'

Figure 7 Installation of SecuriSmoke ASD and accessories[5]

[5] The figures show installations prior to the release of the DFU 911S filter unit



Key Criterion & Benefits

An Early Warning Fire Detection solution based on Securiton SecuriSmoke ASD satisfies the key criterion of providing

- reliable fire detection in a harsh environment with aggressive gases, high humidity and lightning strikes

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 while the risk for business interruption is at a minimum
- The cost for maintenance is low

Successful implementations

Securiton SecuriSmoke ASD Early Warning Fire Detection systems are – among others – successfully installed at the following facilities:

- Research farm, Helsinki, Finland
- Cowshed, Kurrika, Finland
- Cowshed, Kopsvatn, Iceland
- Cowshed, Nupstun, Iceland
- Horse stable, Oslo, Norway

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