SECURITON

Wood Drying Facilities

SecuriHeat ADW

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1 Introduction

Wood drying facilities use an air heating and circulation system that forces warm, dry air through large stacks of wood. The temperature inside of these kilns is controlled but is still too high for most forms of fire detection to survive in. Nevertheless, the risks and hazards involved in the drying process and the vast fire loads present at wood drying sites make a reliable fire detection system highly desirable from a business continuity standpoint.

Wood drying facilities may be categorised into conventional kilns, which use a conventional air-circulation system that operates at temperatures below 100°C (212°F), and High-Temperature Drying (HTD) that involves heating the timber to temperatures up to 160°C (320°F), allowing water to vaporize and be removed more quickly. In both cases, the combination of combustible wood and hot, dry conditions leads to some major fire risks, for example:

- Wood dust/chips that accumulate in drying areas and are exposed to heat for an extended period of time present a major fire hazard.
- Stacked timber can spontaneously combust if the moisture content is high and oxygen levels are sufficient.
- Wet wood can emit flammable gases, over drying can lead to brittle wood that is more susceptible to catching fire.

Other fire risks could be due to overheating from faulty fans and light fittings inside the kilns, as well as plant or control equipment attached to the facility structure from outside, such as the heating source and associated high current electrical supply and control. Once a fire is ignited inside such an enclosed building, it can rapidly escalate due to the high density of combustible timber, favoured by ventilation circulation with enhanced oxygen supply Such a fire can grow and spread very quickly, overwhelming fire suppression systems and causing major damage.

A well-designed and reliable fire detection system provides risk mitigation to potentially prevent a fire from happening or developing out of control before orderly system shutdowns can be put in motion. A staged alert and alarm approach can also facilitate the local site and fire services response well before the situation develops into a life-threatening situation. A suitable fire detection system can also be used to actuate gaseous suppression systems, pre-action sprinkler and mechanical fan operation as part of an emergency response plan.

Securiton's SecuriHeat ADW line-type heat detector (LTHD) offers a robust, reliable and quick-acting fire detection system well suited for all types of harsh industrial and challenging environments. The SecuriHeat ADW is a sensing tube system that has been specially designed for EN 54-22. The sensing tube material can be copper or stainless steel and it can be installed in extremely challenging environments. Key advantages include the ability to operate in high temperatures of up to +300°C, its relatively high sensitivity; its real-time system fault self-check and alarm; and the fact that it is free of routine maintenance, fully water resistant, and easy to install.

The purpose of this Case Study is to provide fire safety and protection consultants, qualified fire system specifiers, design engineers or technicians, with recommendations for the application and use of SecuriHeat ADW LTHD to protect wood drying facilities of varying size and design. A key design objective is to enhance fire detection methods to provide risk-based object and area protection both inside and outside wood drying facilities and mitigate risks through best fire prevention practices.

Where applicable, the Case Study also provides key requirements on Inspection, Testing and Maintenance (ITM[1]) of SecuriHeat ADW LTHD; and world-class technical and application support offered by Securiton through its headquarters teams in Europe and its vast global network of local employees and distribution partners.

2 Aspects of fire safety and prevention

Wood drying generally involves the use of a kilns or large drying room, capable of circulating warm air around a considerable amount of stacked lumber. They may be sited alone, alongside other kilns or dryers, or be part of a wider timber storage and processing yard. In all cases, they pose a significant fire risk due to the presence of flammable materials and high temperatures, with electrical or other heat sources and other fittings providing a further potential hazard.

[1] ITM: Inspection, Testing and Maintenance

2.1 Wood drying facilities

Wood drying facilities use an air heating and circulation system that forces warm, dry air through the wood stack, promoting moisture evaporation and a more uniform drying process. This is achieved using fans and controlled temperature kilns.

The kiln-drying process involves placing the wood in a chamber where the temperature, humidity, and air circulation are controlled and reducing the moisture content of the wood to a target level without causing drying defects. The type of wood, size of the pieces and intended use of the timber determine how long the wood takes to dry. Thicker or higher density wood can take more time to dry out.

The drying temperature and drying duration are also determined by the timber surface areas exposed and range of permissible drying. Some timber products may require exposure to very high temperatures in order to remove as much moisture as possible, as quickly as possible.

Wood drying facilities may be categorised into:

- Conventional kilns that use a conventional air-circulation system that operates at temperatures below 100°C (212°F)
- High-Temperature Drying (HTD) that involves heating the timber to temperatures up to 160°C (320°F) or higher, allowing water to vaporize and be removed more quickly

The focus of this Case Study covers mainly the modular type or purpose-built wood drying enclosures and structures using a powered heating source to dry wood. These can be either a standalone building or a part of a large timber mill. Examples are illustrated in Figure 1 below:

(a) Small modular wood drying unit (left) and 'turnkey' wood drying facilities (right).

(b) Large scale wood drying facilities in timber mills.

(a) Small modular wood drying unit (left) and turnkey wood drying facilities (right)

(b) Large scale wood drying facilities in timber mills

Figure 1 Wood drying facilities

2.2 Fire risk, consequence and safety

Since wood drying facilities are often part of a large timber mill, they pose well-documented fire hazards and risks of fire associated with industrial manufacturing sites with harsh operating environments (refer to Securiton AG Design Guide [1] and Case Study [2]). The unique fire hazards, risks and consequences of fire damage stemming from wood drying facilities, as a standalone or as part of a large industrial manufacturing site, are addressed through international and national codes and standards. These range from relevant general building and fire codes, to wood industry specific codes of practice and established risk management approaches. Examples of the latter include woodworking building hazard categories based on predominant occupancy classification per FM Global

DS 3-26 [3]; NFPA 664 [4] concerning the prevention of fires; as well as risk management and insurance loss prevention guidelines (e.g. FM Global DS 7-76 [5] and DS 7-10 [6]).

The following points highlight fire risks specifically related to wood drying facilities in the context of fire safety and prevention [7] [8]:

- Spontaneous ignition of wood dust/chips that accumulate in drying areas, which if exposed to heat (even from faulty machines or lights) for an extended period of time, can ignite.
- Stacked timber can spontaneously combust if the moisture content is high and oxygen levels are sufficient.
- Most wood starts to discolour and char above 200 - 250°C (392 - 482°F), and its structure breaks down above 300°C (572°F), leading to cellulose decomposition and flammable gases.
- Drying wood in kilns or ovens can involve high temperatures, increasing the risk of fires if the drying process isn't carefully monitored and managed (either due to lack of monitoring and control equipment or failure of said equipment).
- Ignition sources may also be outside the kiln, such as the heater and associated high current electrical supply and control.
- Once a fire is ignited inside such an enclosed building, it can rapidly escalate due to the high density of combustible timber, favoured by ventilation circulation with enhancement of oxygen supply. A fire can grow and spread very quickly.
- Due to the nature of wood drying facilities, they are often remote and unmanned during their operation, rendering emergency response to a fire critically time sensitive. Many rely on fully automatic fire safety systems from detection to fire extinguishing.

A common fire safety and fire protection principle is to ensure a suitable fire detection system is provided for not only the alarm signalling but also to trigger alarms for the purpose of firefighting system actuation. With a reliable fire detection system for wood drying facilities, fire incidents can be managed to avoid or minimise operation interruption and damages. Unnecessary power-shutdowns may also be avoided. Even as the fire situation progresses, fire services or nearby emergency response teams can be notified automatically and arrive at the scene much earlier before the fire spreads from the fire of origin to the surrounding buildings or other nearby wood drying units.

3 Challenges to reliable fire detection

Operating conditions can be challenging with HTD taking place at temperatures up to 160 °C (320°F). Even the conditions in an ordinary wood-drying kiln, at a little under 100 °C, will be beyond the operational range of many fire detection devices. Given the forced movement of air, the heat in the kiln, and the likely presence of vapours from the drying wood, smoke detection is impractical even if a device capable of withstanding the conditions can be procured.

SecuriHeat ADW LTHD with its sealed sensing tube system, is a cost-effective solution for various types of wood drying facility that often require only single fire zone coverage. It uses metal tubing in the detection zone, which is capable of operating at 300 °C and surviving even more. It is a sealed system impervious to vapours and gases, and the control unit, though itself robust, is typically sited outside of the monitored area. Not only can SecuriHeat ADW operate inside a kiln, but it can also provide accurate temperature monitoring focused on key areas even while the facility is operating.

Challenge	Securiton advantages
Heat and diluted hot smoke dispersion due to forced ventilation	▪ Use of SecuriHeat ADW LTHD for highly sensitive and very reliable heat detection.
Wide ambient temperature range	▪ SecuriHeat ADW operating temperature range: main control unit -30 to +70°C (-22 to +158°F), Sensing tube -40°C to +300°C (-40 to +572°F)
Need to balance sensitivity with false alarm issues	▪ SecuriHeat ADW LTHD offers two levels of alert and alarm per detection zone, facilitating both earlier incident alert to tackle potential fires to minimise damage and disruption, and fire alarm to be integrated with fire suppression and extinguish system.

Challenge	Securiton advantages
Obstructed or difficult access	▪ SecuriHeat ADW main detector unit can be installed outside the protected area and is used for maintenance. ▪ Long tube run (up to 2 x 200 m (2 x 656 ft))[2] can be monitored by a single main control unit, and it has the sensitivity and flexibility to react to relatively small fires even in an open area.
False alarms	▪ Self-testing and proven reliability in tough environments. ▪ Two levels of alert and alarm per detection zone, facilitating both earlier incident alert to tackle potential fires to minimise damage and disruption.
Low TCO and easy access for maintenance	▪ SecuriHeat main control units are installed locally or remotely in an easy access area with only the sensing tube running into the protected areas. ▪ Routine service and testing are done from the main control unit outside with no interruption to business operation inside wood drying facilities.

Table 1 Challenges to and solutions for Wood drying facilities protection with reliable fire detection

4 Optimised design & use case

The cost-effective SecuriHeat ADW is an integrated line-type heat detector with a response behaviour based on heat differential and/or maximum heat. It is a reliable, fit-for-purpose fire safety solution to protect wood drying facilities which require single fire zone coverage. The self-check feature and its periodic, automatic tests are other advantages for use in applications such as wood drying facilities where the legally prescribed functional and maintenance checks are performed at difficult access sites due to environmental and operational conditions.

This chapter outlines design recommendations and methods using SecuriHeat ADW to protect wood drying facilities:

1 Design codes of practices
2 Design criteria of SecuriHeat ADW
3 Application scenarios
4 Feature and benefits
5 Minimal system access for ITM
6 Support with peace of mind

4.1 Design codes of practices

Wood drying facilities, including kilns and other drying methods, pose a significant fire risk due to the presence of flammable materials and high temperatures. Effective fire protection strategies include early detection, quick intervention and suppression, and proper handling of combustible materials. Since wood drying facilities are often part of a large timber mill, unique fire hazards, risks and consequences of a fire in wood drying facilities are addressed through international and national codes and standards (such as International Building Code (IBC) [9] and NFPA 1 [10]). There are also wood industry specific codes of practices and best risk management approaches such as these described in chapter 2.2. Other codes (e.g., FM Global and AXA XL Risk Consulting [11], NFPA 13 [12] and NFPA 15 [13]), cover where and how fire protection systems are installed. Based on the types of occupancy classification and fire safety measures concerning a timber mill and its related processing, safety codes such as general electrical safety codes (e.g. IEEE National Electrical Safety Code and NFPA 70 National Electric Code) also apply.

Although there might be marginal differences from one country to another in Deem-to-Satisfy (DtS) prescriptive building and fire code requirements on fire detection, a combination of DtS prescriptive and risk-based design approach is the best engineering practice to meet prescriptive requirements as well as to satisfy facility operators' need for business continuity and property protection.

[2] Applicable standards (for example EM 54-22 or KFI) limit the tube length to below the system limit.

Performance-based Design (PBD) is typically implemented when elements of fire safety and protection system design are not covered in the prescriptive codes among others due to unique building structure, environmental conditions, added detection for early warning or extended egress considerations [14]. A PBD approach is commonly adopted for either of the following:

1. As a means to determine equivalency to a prescriptive code or standard
2. As an approach to achieve broadly defined fire safety goals and objectives

While codes and standards may not explicitly prescribe the exact fire safety and protection measures for wood drying facilities, risk-informed PBD method is a fitting fire engineering methodology to devise a suitable fire detection solution, taking into account specific risk areas within the facilities for both open space area and object-oriented fire safety design.

To select a suitable fire detection system, relevant design and alarm codes must be applied. Examples of these include NFPA 72 [15], BS 5839-1 [16], VdS 2095 [17], and others like AS 1670.1 in Australia [18], NEN 2535 in Netherland [19], R7 in France [20] and DBI 232 in Denmark [21]. As an example for the design and installation of LTHD, NFPA 72 [15] stipulates that LTHD cables or tubing installed must be no more than 50.8 cm (20 in.) from the ceiling. However, such standard requirement is limited because it applies to only flat ceilings and is not affected by the total ceiling height. Other research and performance testing may be referred to for better linear heat cable placements (e.g., [22]).

An adequate fire detection system that automatically alarms local fire services can make a huge difference in minimising the damage that a potential fire can cause. The ability to detect and alert early also allows local site management or facility operators to control the initial outbreak or to remove potential hazards that would help the fire grow. Reliable fire detection solution can be optimised with detection earlier to prevent avoidable business interruption, as well as a low TCO[3] over the product lifecycle.

4.2 Design Criteria: SecuriHeat ADW LTHD

This chapter describes design criteria using SecuriHeat ADW in wood drying facilities. Being a LTHD, SecuriHeat ADW detects temperature changes and signals levels of alert and alarm almost instantly on detecting any potential fire incident or developing fire event. The ADW tubing is a sealed system, immune to dust and moisture.

A summary of SecuriHeat ADW LTHD key performance parameters is shown in Table 2 below.

Design Parameters	BS/EN 54-22 [23][4]		NFPA 72 [15]	
Class vs. Detection Range	**Response Class**	**Detection Range °C (°F)**	**Temperature Class**	**Response Temperature °C (°F)**
	A1	54 - 65 (129 - 149)	Ordinary	58 - 79 (136 - 174)
	A2	54 - 70 (129 - 158)	Intermediate	80 - 121 (176 - 250)
	B	69 - 85 (156 - 185)	High	122 - 162 (252 - 324)
	C	84 - 100 (183 - 212)		
	D	99 - 115 (210 - 239)		
	E	114 - 130 (237 - 266)		
	F	129 - 145 (264 - 293)		
	G	144 - 160 (291 - 320)		
Environment Group	**Environment Group**	**Temperature Range °C (°F)**	n/a	
	(E)1	-5 to +40 (+23 to +104)		
	(E)2	-10 to +55 (+14 to +131)		
	(E)3	-25 to +70 (-13 to +158)		
Typical Applications and Boundary Conditions	E1: Indoor; Stable and Clean Conditions; Commercial and industrial E2: Indoor; Varying and polluted environment; Commercial and industrial E3: Outdoor; Harsh conditions			

Table 2 Design and performance parameters for LTHD per codes and standards

[3] TCO: Total Cost of Ownership (of reliable fire detection system)
[4] ISO 7240-22 is derived from BS/EN 54-22.

A summary of SecuriHeat ADW products key performance parameters is shown in Table 3 below.

Model	Key performance parameters
SecuriHeat ADW Classes and tube	
Classes	See Table 2
Sensing tube length	2 x 10 - 200 m (33 - 656 ft)[5]
Tube type	Copper (TU 5/4 Cu), stainless steel (TU 5/4 SS)
Rating and operational data	
IP device approvals	IP65
Operating temperature (main control unit)	-30 to +70°C (-22 to +158°F)
Operating temperature (sensing tubes)	Copper/stainless steel: -40 to +300°C (-40 to +572°F)
# of Relays: Built-in (Expanded – Module)	2 (10 – 2 x RIM36)
Product Type Approval Standards and compliance level	
EN 54-22	Classes A1I to GI
UL 521 – ULC-S530-M91	per EN 54-22 Classes A1I to GI
FM 3210 / NFPA 72	Classes Ordinary, Intermediate, High

Table 3 SecuriHeat ADW product key performance parameters

4.3 Application Scenarios

To protect wood drying facilities, SecuriHeat ADW can be used following the risk-informed, Performance-Based Design (PBD) principle in addition to prescriptive code requirements. The essence of the design objective is to place SecuriHeat ADW tubing inside the drying room at ceiling level and any risk location of fire, as well as close to plant operation equipment attached to a wood drying facility which represents a potential fire risk (such as heating sources). Based on the actual business operation, additional considerations may be required to address different fire risk scenarios and ambient conditions to ensure high level of protection as a whole.

Variable	Design recommendation
Spacing	▪ For ceiling level detection refer to chapter 4.1 and chapter 4.2 as references for detail design criteria in regards spacing, ceiling height limits and response classes per product type approvals and design standard compliance per NFPA 72 or EN 54-22 requirements (illustrated in Figure 2). ▪ Spacing is also reduced when the heat detectors are installed on other than flat, smooth or slightly sloped (generally a slope no greater than 10% of the roof height) ceilings. ▪ To incorporate risk-based design where placement of SecuriHeat ADW tubes is in close proximity of the protected objects or areas, the same tubing can be extended to cover areas in the same room, such as these voided space hosting flow fan units. Alternatively, the two-channel ADW is used to offer object-based protection for a second group or area outside the main protected area, such as control room or boiler area.
Placement	▪ Under the ceiling for general open spaces protection taking into account relevant code requirements. For example, NFPA 72 stipulates that LTHD cables or tubing installed must be no more than 50.8 cm (20 in.) from the ceiling. ▪ Distance to the wall and to the ceiling when the sensing tubes are mounted on the wall are also prescribed depend on the adopted design codes and standards. For example, when installed on the ceiling, NFPA 72 stipulates that spot type heat detectors must be located a minimum of 10 cm (4 in.) from side walls; when installed on side walls, the detector must be between 10 cm (4 in.) and 30 cm (12 in.) from the ceiling. As per BS/EN 54-5 [24], heat detectors may be positioned 3.5 m (11 ft.) from a wall.
Orientation	▪ Sensing tube at ceiling level can be positioned taking into account other fixtures such as lighting, mounts for equipment such as flow fans and heating elements. ▪ Sensing tube generally runs straight lines but is flexible enough to be bended to go around obstacles, safety barriers or other structural fittings when needed.

[5] For EN 54-22 designs the sensing tube length is limited to 2 x 10 - 140 m (33 - 459 ft)

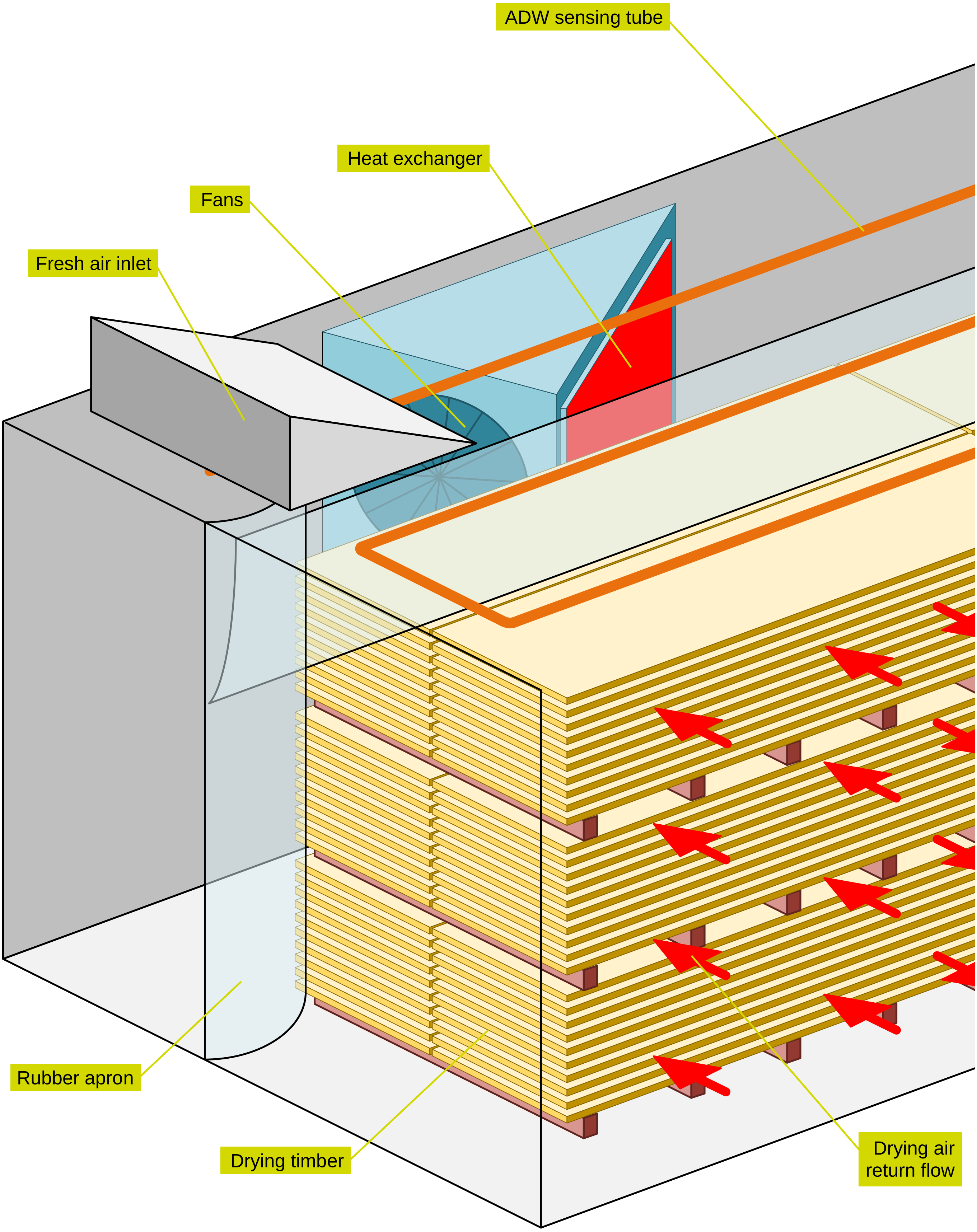
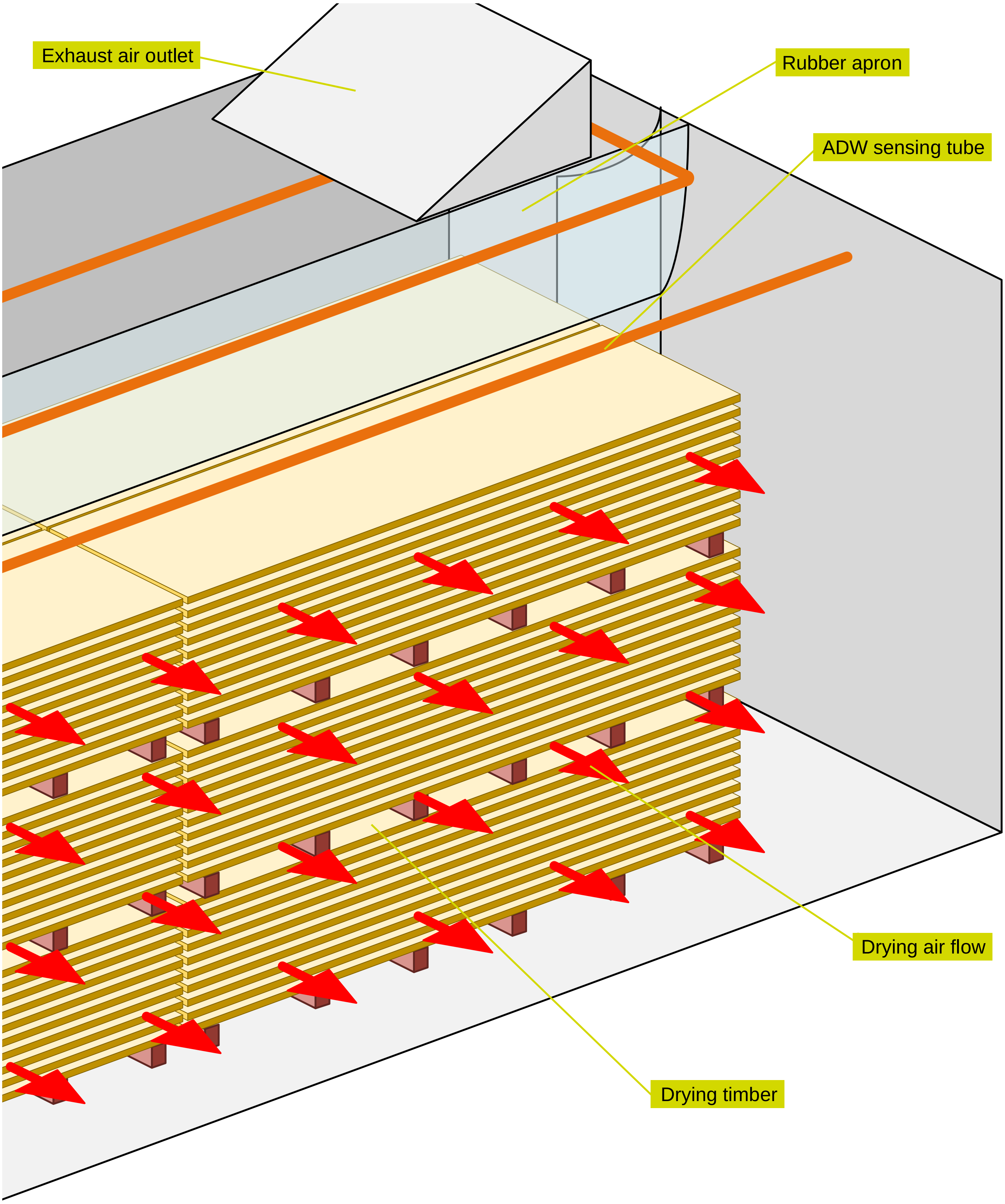


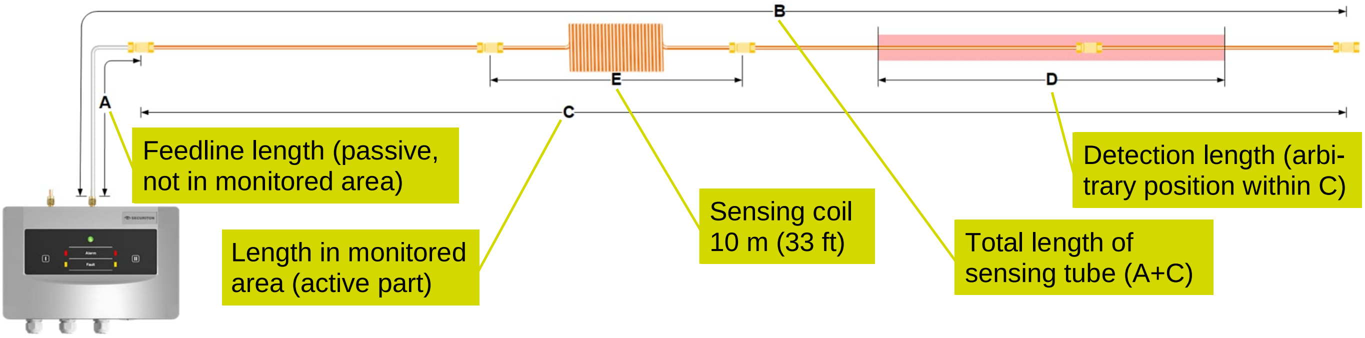
Figure 2 Illustration of a wood drying facility



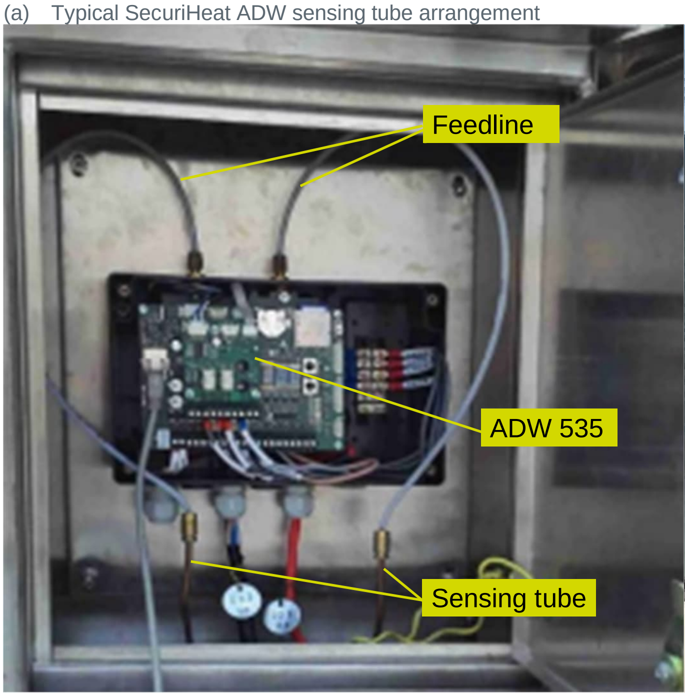
Additional notes:

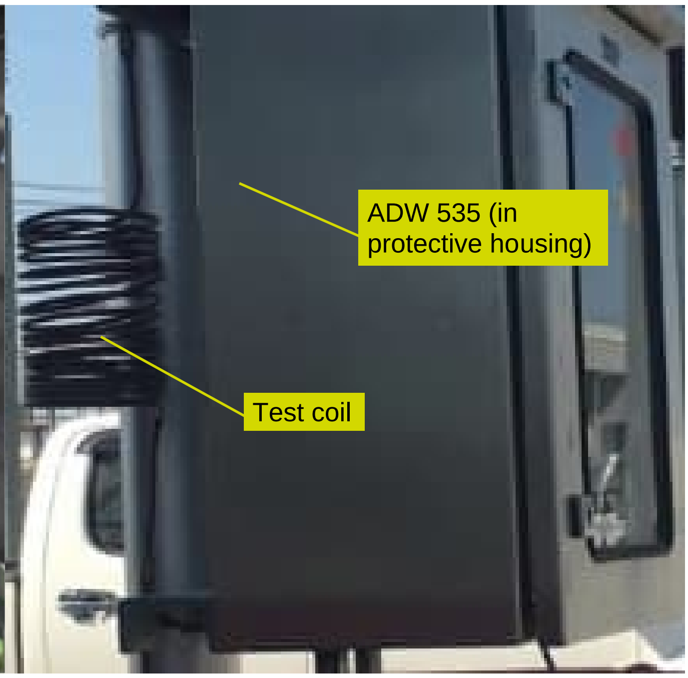
- Consideration must be given to the fact that the detection length (“D” in Figure 3 (a)) is at least 10% of the total sensing tube length (“B” in Figure 3 (a)) must be exposed to known potential fire ignition points to reliably detect a fire. SecuriHeat ADW LTHD main detector unit can be installed outside the protected area due to difficult access to inside for ongoing service and maintenance. In this case, passive feed-line tubing (“A” in Figure 3 (a)) can be used outside the monitored area.

- To avoid leaks in the sensing tube due to mechanical stress, use a length of flexible Polyamide tube as a feedline between the ADW unit and the sensing tube (see Figure 3 (b))
- When integrating with other building control systems, only Securiton authorised accessories and modules, such as RIM 36, XLM 35 and SIM 35 can be installed.
- A test coil is recommended for functional tests away from the protected areas or outside the protected rooms (Figure 3 (c)).
- In case there is a temperature difference between the protected area (where the sensing tubes are installed) and the mounting location of the SecuriHeat ADW control unit, an external temperature sensor should be installed to compensate for this difference.
- Choice of Max-Alarm, Diff-Alarms threshold respectively; Integration Alarm to enable Pre-signal for early alert for rapid local site response.



(a) Typical SecuriHeat ADW sensing tube arrangement





(b) Connection of feedline to tube and ADW (c) Test coil

Figure 3 Illustration of SecuriHeat ADW LTHD design and applications

4.4 Features and Benefits

Securiton AG as a whole is certified in accordance with ISO standards 9001, 14001 and 45001 and thus meets globally applicable standards with regard to quality management, environmental management, and occupational health and safety management systems. SecuriHeat ADW offers unobtrusive, easy to install heat detection that is immune to harsh environments and can easily be cleaned and maintained. It is compatible with the principles of Intrinsically Safe Design.

SecuriHeat ADW 535 offers optimal protection from false alarms with in-built intelligent DHW algorithm (Dynamic Heat Watch) and self-check constantly via an integrated pressure generator, ensuring maximum reliability and minimal maintenance. A single unit can cover up to 1,600 m^2 (17,222 ft^2) of open space with 2-zone individual alert and fire alarm. Choices of different type of sensing tube materials also optimise further the low cost of product ownership.

4.5 Minimal system access for ITM

Due to the advanced automatic sealing test and automatic self-test functions of SecuriHeat ADW 535, the detection system is largely maintenance free. However, local codes and standards may require a periodic function check or visual inspection.

4.6 Support with peace of mind

SecuriHeat ADW LTHD products are supported with range of software tools as followings:

Tool	Usage
Design	ADW HeatCalc allows the design and planning of heat detection systems at a very early stage.
Install and Service	EasyConfig for simple systems. The practical ADW Config software tool is used for more complex systems and application-specific adaptations.
Monitor and manage	ADW HeatCalc and ADW Config. Extensive analysis functions and setting options ensure safe, cost-effective operation of your system.

Applications and design support includes mainly:

- Partner accreditation program
- Application and field engineering support
- Worldwide reach through a network of partners as well as subsidiaries and investment companies, with branch offices or local employees around the world.

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Securiton AG

Alarm- and Security Systems
Alpenstrasse 20, 3052 Zollikofen, Switzerland
www.securiton.com, info@securiton.com

A company of the Swiss Securitas Group

09.2025