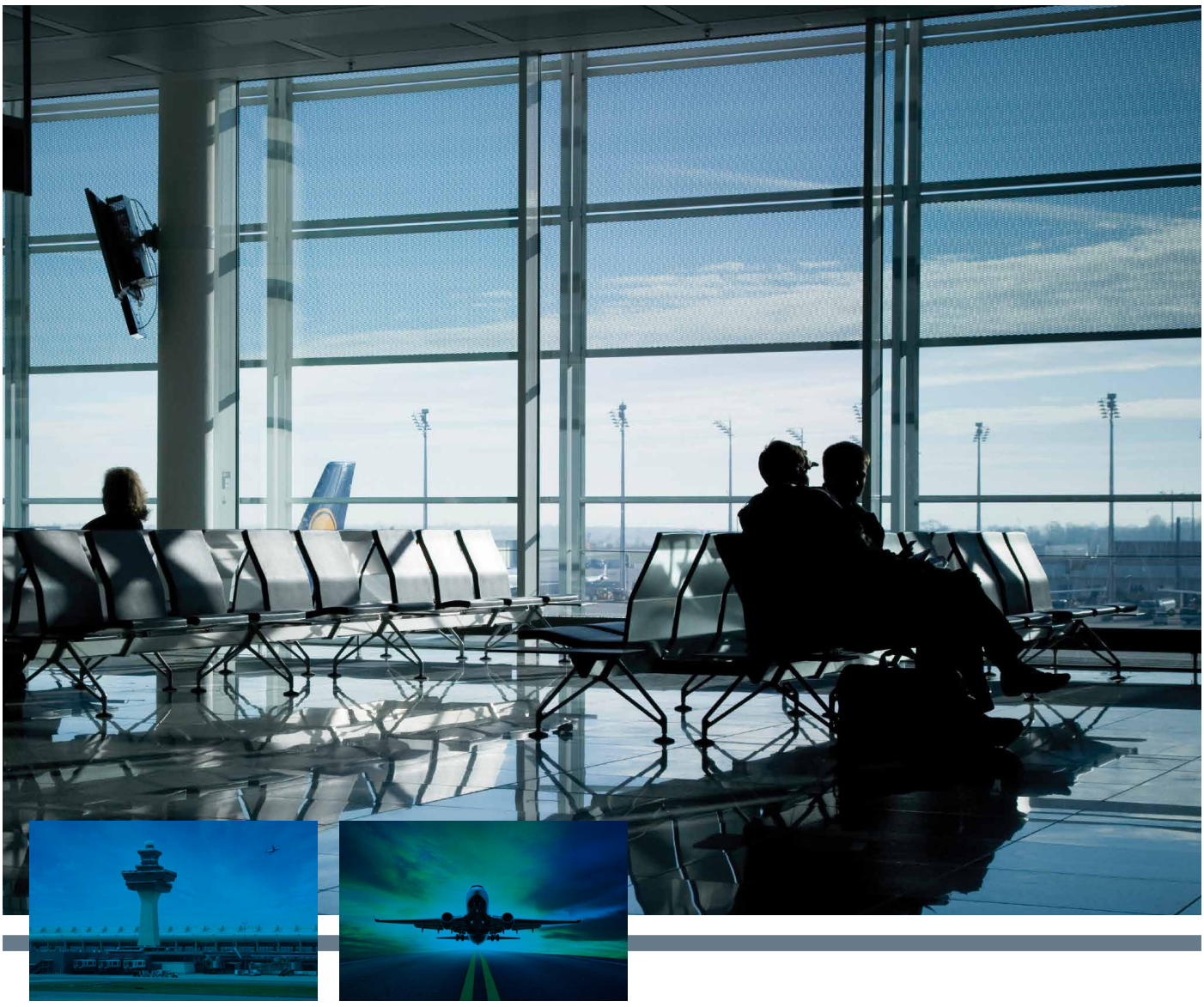
THE ULTIMATE GUIDE TO ADVANCED FIRE DETECTION AND SAFETY IN AIRPORTS: RISKS, REGULATIONS, DETECTION OPTIONS



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WHY IS PREVENTING FIRES IN AIRPORTS SO CRITICAL TODAY?

Airport traffic is growing at an unprecedented rate. According to Airports Council International (ACI), the number of passengers worldwide already reached a staggering 8.8 billion in 2018 and is set to more than double to around 21 billion by 2040[1]. Strikingly, some of the world's largest airports are already dealing with over 100 million travelers a year[2]. To ease this mounting pressure on the existing airport infrastructure, global investment in new terminal and runway construction and expansion projects rose from $59 billion in 2018 to $75 billion in 2019[3].

With these figures in mind it is not difficult to understand why fire prevention is critical. Not only is the safety of a growing number of people at stake, but as airports grow, any disruption can have a catastrophic impact on operational security. Even a minor incident can trigger a major evacuation that could impact on the lives of hundreds if not thousands of people. This would, in turn, translate into huge costs for the airport; from cancelled flights through to compensation claims from airlines and passengers alike, not to mention reputational damage.

Maintaining business continuity is even more critical as airports transform from mere transport hubs into entertainment and attraction centers designed to make the passenger experience smoother and more enjoyable[4]. Increasingly, airports are also becoming the focal points of entire new urban areas, the so called 'aerotropolises'. These areas include not only hotels and restaurants, but also a variety of transport-focused or transport-dependent businesses[5].

The consequences of a fire-related incident can, therefore, be far reaching and extend well beyond an airport's boundaries.

It's also important to bear in mind that, increasingly, airports are becoming ambassadors for entire cities or even entire countries; a matter of regional and national pride. New terminal buildings are designed to impress, featuring huge, bold and futuristic structures that push the boundaries of architecture. As we will illustrate below, this sometimes creates new challenges when it comes to preventing fires.

CAUSES AND CONSEQUENCES OF FIRES IN AIRPORT FACILITIES

Airport fires are often associated with aircraft-related incidents on runways[6], but they can in fact happen virtually anywhere, with dire consequences.

In December 2017, the world's busiest airport, Hartsfield-Jackson Atlanta, was brought to a standstill by an electrical fire within a cable and service tunnel, which caused a major power outage[7]. The incident led to Delta Air Lines alone canceling an estimated 1,400 flights[8] over two days and facing losses in the region of $40 million, which the airline would ultimately recover (in part) from the airport[9]. This huge price tag added to costs deriving from compensation claims and reputational damage, with at least 30,000 passengers having their journeys disrupted[10]. Not to mention costs to repair and upgrade the airport's electrical system.

Besides obvious fire hazards such as hot works, anything from a Christmas tree through to a marketing promotion stand, such as a car on display, can increase an airport building's fire load[11]. In other words, hazards can vary from one airport to another and over time, therefore it is important to identify potential fire hazards within an airport environment on a case-by-case basis. This means taking into consideration various factors, including building layout, ignition and fuel sources and operational activities. It is, however, possible to identify four typical fire hazard categories in airport facilities:

- Electrical equipment failure (e.g. overheating of electrical cabling/relays and arcing of transformers).
- Mechanical equipment failure (e.g. moving parts in baggage handling systems and lifts).
- Lighting failure.
- Flammable liquids and gases (in battery rooms, aircraft hangar, fuel storage and fueling, and cable tunnels/vaults).

Disruption can also be caused by vehicles catching fire, for example buses in pick-up areas outside the terminal[12] or passengers' cars in adjacent multi-story car parks[13].

With so many different hazards to look out for, it is not difficult to understand why fires can be a real threat in airports. Not only are people's lives at stake; airport as well as third-party assets (aircraft, cargo, baggage, retail, consignment) are at risk.

What is vital to understand here is that fire threats can cause havoc already way before they escalate into actual fires. Even a relatively small amount of smoke from an undetected source may be enough to trigger an evacuation that can cause distress among passengers and huge financial costs for the airport. In the summer of 2018, **for example, one evacuation cost Munich Airport €1 million**[14].

Incidents of this kind also often generate negative media coverage and bad publicity for the airport involved, particularly if they turn out to be false alarms.

KEY CHALLENGESS

So why do fire-related incidents continue to happen and cause disruption in airports around the world? One reason for this is that airport facilities present peculiar architectural and environmental features that often require a performance-based design when it comes to fire safety. Unlike other, more conventional buildings, where the design of fire safety systems is often dictated by prescriptive standards, airports require a more complex, engineered approach.

The key challenge here is detecting the very early signs of a potential fire, which generally consist of very small amounts of smoke or gas being released into the environment. There are several reasons as to why this can be especially tricky, including:

1. Airports, particularly terminal buildings, often consist of large open spaces with high ceilings where smoke tends to get diluted or dispersed easily as it rises.
2. Smoke may not even reach the ceiling, where smoke detection devices are normally installed, due to phenomena such as thermal stratification and/or lateral movement.
3. Airports sometimes feature peculiar, futuristic structures, which may include curved/unusually-shaped ceilings and the use of a variety of materials (glass, wood, etc.) that can all affect the airflow and create concealed areas and/or obstructions.
4. Mechanical ventilation systems may disturb smoke, pushing it out of the detector's reach.

One area that can be particularly challenging when it comes to smoke detection is the baggage handling system. This often comprises baggage conveyors, sorters, platforms, walkways, open staircases and mezzanines that can all obstruct smoke, preventing it from reaching the ceiling (and the detector).

These structures also present airports with another set of challenges; the areas where detectors are normally located are typically hard to reach, which makes installation and maintenance particularly tricky. Commissioning a detector located on a high ceiling, for example, may require the use of access equipment in a busy area of the airport, causing downtime and disrupting business continuity.

False alarms, also referred to as nuisance alarms, are another key challenge that is often associated with airport environments., smoke and steam originating from bar and restaurant kitchens can be an obvious source of false alarm, but there are also other common causes including dust, insects and reflections (especially when it comes to beam detectors, which are covered in more detail below). Designing fire safety systems so that they minimize the risk of false alarms can be a real challenge.

HOW TO KEEP ON TOP OF COMPLIANCE

We have seen how airports' unique features mean that simply following existing fire safety codes and standards to the letter is not enough. There are, however, some key standards that are important to bear in mind when it comes to specifying and designing an airport's smoke detection system. These often vary from one country to another as illustrated in the examples below:

- **NFPA 72[16] (USA)** - covers the application, installation, location, performance, inspection, testing, and maintenance of fire alarm systems, supervising station alarm systems, public emergency alarm reporting systems, fire warning equipment and emergency communications systems (ECS), and their components.
- **AS 1670.1:2018 (Australia)[17]** - sets out requirements for the design, installation and commissioning of fire detection and alarm systems.
- **BS 5839-1:2017 (UK)[18]** - provides recommendations for the planning, design, installation, commissioning and maintenance of fire detection and fire alarm systems in and around non-domestic premises.

Other standards may be relevant to specific airport facilities. For example, when it comes to control towers, NFPA 75 (Fire Protection of Information Technology Equipment)[19] and NFPA 76 (Fire Protection of Telecommunications Facilities)[20] should be considered. Similar standards may be available in other countries, so it is always recommended to keep up wo date with the latest national legislation.

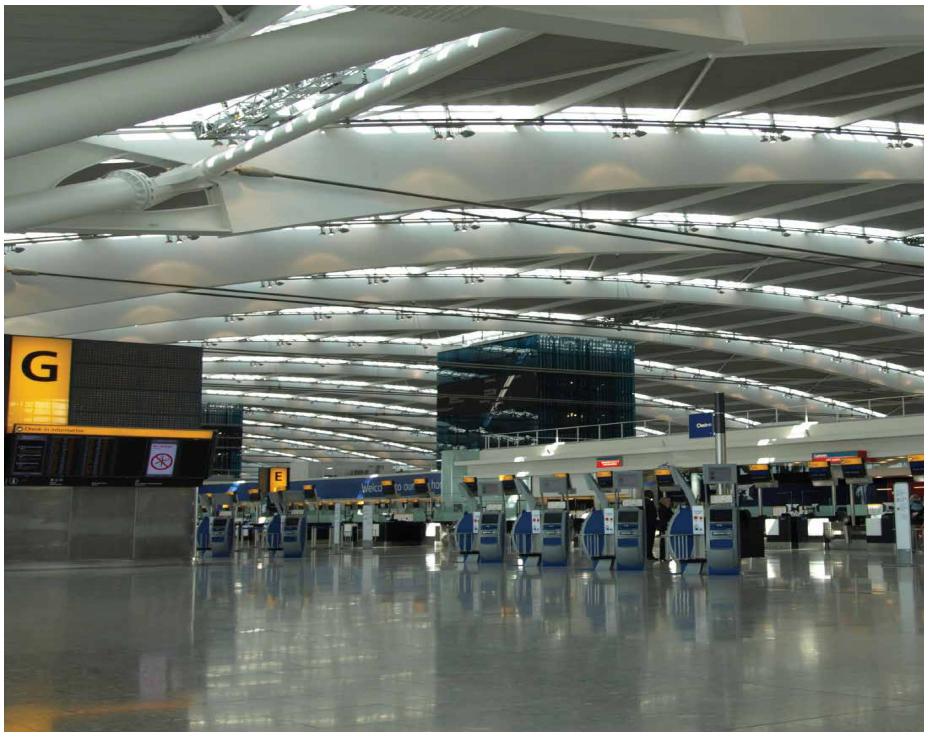
It is also essential to be aware of national codes that provide good foundations on which to base a performance-based design. For example:

- **NFPA 415 (USA)** - Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways: specifies the minimum fire protection requirements for the construction and protection of airport terminal buildings[21].
- **NFPA 409 (USA)** - Aircraft Hangars: helps safeguard life and property through requirements for the proper construction and fire protection of aircraft hangars used for aircraft storage, maintenance, or related activities[22].
- **BS 7974:2019 (UK)** - Application of fire safety engineering principles to the design of buildings: provides a framework for an engineering approach to the fire safety of buildings, giving recommendations and guidance on applying scientific and engineering principles to the protection of people, property and the environment from fire[23].

HOW TO CHOOSE AND USE SMOKE DETECTORS CORRECTLY

Now that we've analyzed some of the main fire-related risks and the key standards to look out for, how can we ensure that the smoke detection systems we specify are fit for purpose? The first step is getting to know what's available out there. There are three main smoke detection technologies:

- **Point-type:** this is the most common type of detection and also the most commonly used. It is generally mounted on a ceiling and shaped like a cone in which a sensor is placed. The point-type category mostly comprises optical detectors that monitor levels of smoke by using an internal light source.
- **Beam:** this technology is based on an infrared light beam that is generated by a transmitter and captured by a receiver. These detectors are activated when smoke reduces the intensity of the light beam, triggering an alarm.
- **Aspirating:** this is an active system designed to draw air through a series of sampling holes, via a network of pipes, to sample and detect smoke using a sophisticated detection chamber. Aspirating detectors can be of two types: **1)** based on a network of fixed pipes with sampling holes **2)** based on a system of flexible sensing tubes that can pinpoint the exact location of the smoke (this technology is called 'addressable' or 'pinpoint' aspirating smoke detection).



Each of these technologies has its pros and cons. Generally speaking, point-type detectors are the most affordable and a great fit for standard residential or office building applications. However, they are often ill-suited for airport environments. The main reason for this is that they can only measure smoke at a single point in space and require sufficient smoke to reach them for an alarm to be triggered. As mentioned above, this can be a problem in large open spaces where smoke can be heavily diluted and impacted by air movement.

Beam detectors provide standard detection where a clean line of sight is possible and basic beam detectors can be vulnerable to false alarms; for example dust build up on the receiver or an intruding object, which can reduce or block the light transmission.

Aspirating detection systems are the most advanced choice. Multiple sampling locations, distributed across the building horizontally and vertically, are more likely to detect smoke very early, even if it is diluted and doesn't reach the ceiling. The ability to actively draw air from the building air conditioning overcomes variations in smoke movement caused by changing airflow conditions. Aspirating detectors are, therefore, the best choice for settings such as terminal buildings and baggage handling system.

Another key consideration are false alarms. In addition to the sophisticated detection chamber that can help distinguish between smoke and dust, aspirating smoke detectors can have multiple pre-alarms with associated time delays to help eliminate transitionary nuisance smoke events.

When specifying smoke detection systems, ease of installation and maintenance is another important consideration. We've seen how airport facilities are often characterized by hard-to-reach locations, from high ceilings through to confined spaces. Installing, commissioning and maintaining detectors can, therefore, be a real challenge, involving access equipment, risky work at height or in confined spaces, and time-consuming installation and maintenance operations. That is why centralizing monitoring by using a distributed network of pipes connected to a monitor installed in convenient, easy-to-reach location (away from the busiest areas of the airport), may be something to consider.

FROM SMOKE DETECTION TO CONNECTED SMOKE DETECTION

Connectivity is opening up unprecedented opportunities when it comes to using smoke detection systems in airports. Some of the latest technology comes with extensive connectivity options and remote diagnostics tools including Ethernet, WiFi, USB, VESDAnet and Relays. Downloadable apps enable maintenance engineers to monitor the status of each detector remotely through tablets or smartphones. Detailed alarm, fault and other key status information such as smoke trends, airflow and filter life can be accessed immediately. Important configuration parameters such as pipes in use and smoke alarm thresholds can also be changed directly from a handheld device. This reduces the need to access smoke detection devices in hard-to-reach locations while bringing maintenance time to a minimum. Perhaps more importantly, it helps keep users connected with the system in real time.

CONCLUSION

Airports around the world are expanding to cater for unpreceded numbers of passengers and this trend is set to continue in years to come. This guide illustrated how failing to address the very early signs of an impending fire can have catastrophic consequences, for both passengers and airports. Having an effective fire prevention system in place is, therefore, vital.

This guide provided an overview of the key international standards to be aware of when designing and specifying fire detection systems. At the same time, it highlighted the need to adopt a performance-based approach that factors in the unique architectural and environmental features of airports, which often fall outside the scope of prescriptive codes and standards.

The final section of the guide focused on the different smoke detection technologies currently available and what to consider when specifying them. This theme will be addressed in more detail in our Application Guide – Airports, which provides guidelines on the design and deployment of smoke detection systems in specific airport facilities, from terminal buildings through to hangars. You can download the Guide here.

ABOUT THE AUTHOR

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