Smoke Detection Technology for Industrial Buildings: Navigating the Myriad of Regulations and Certification REV2

Grainne Murphy: Marketing Manager, Analog Devices Inc.

Smoke Detection and why it matters

Smart building technology is evolving to transform static buildings into living, efficient entities i.e. Intelligent Buildings. This requires technologies to drive lower running and maintenance costs. The megatrend of greener buildings, zero emissions and lower carbon footprint requires more modalities to be monitored and controlled within a building. Some of these solutions and measurements are to enhance worker comfort and productivity. However, buildings also require solutions and measurements for safety and these can be guided by increasingly stringent regulations.

In safety, smoke detection has the biggest challenge: Saving lives.

The smoke detection market has innovated due to some key factors including:

- **The growth in industrial buildings: The International Energy Agency, the IEA, predicts growth in global buildings floor area at approximately 3% per year. This is driven by the increasing urbanization towards cities and the improved access to energy in developing countries.**
- **The increasing use of synthetic material within buildings.**

That's why, where the value proposition is as basic as human life, industrial smoke detection regulations are critically important. The challenge is that false evacuations can cause downtime and panic particularly as buildings are now designed to hold thousands of people (for example the Boeing Everett Factory in Washington was designed to hold approx. 40 thousand people). Kitchens that generate cooking vapors or steam can cause false alarms in precisely the locations where smoke detectors should not be disabled due to nuisance alerts. In a genuine emergency, there is now less time to evacuate a building due to

synthetic materials that may be smoldering and where fumes can kill very quickly. New fire regulations now specify zero nuisance alarms with faster alerts. This article will examine some of the pending and current global certifications and what it means for smoke detection technology and market.

There are two smoke detection technologies used in smoke detector systems:

Ionization systems have a small amount of radioactive material between two electrically charged plates. This ionizes the air and causes current to flow. When smoke enters the chamber, it reduces the flow of current and activates the alert/alarm.

Photoelectric smoke detectors use light to detect fire. Inside the alarm, there's a light-sensing chamber. In this chamber a Photo Diode (PD) and Light-Emitting Diode (LED) are placed offset from each other such that LED light can not be detected unless there are smoke particles present which scatter the LED light into the PD. When a pre-determined obscuration threshold is reached an alarm is triggered. Photodetection is particularly useful for smolder detection.

A Summary of Global Standards

There are basically 5 main global standards to compare with different requirements to pass respective certification. Smoke detector systems need to be fully tested as an end product but there is also testing that can happen at sub system level of smoke detection technology. This does not substitute for the full certification but can give peace of mind before costly end-system certification[1]

US and Canada

- **UL 268 - Smoke Detectors for Fire Alarm Systems**
  - **7th edition - in effect 29th May 2020**
- **UL 217 - Smoke Alarms**
  - **8th edition - in effect 29th May 2020**

(Updates to polyurethane flaming and smouldering and cooking nuisance (hamburger) test)

Europe

- **EN 14604 - Smoke alarm devices (2006)**
- **BS EN 54 - Fire detection and fire alarm systems (2015)**

[1] ADI ADPD188BI optical smoke detection platform is currently pending UL listing

(Part 29: Multi-sensor fire detectors — Point detectors using a combination of smoke and heat sensors)

International

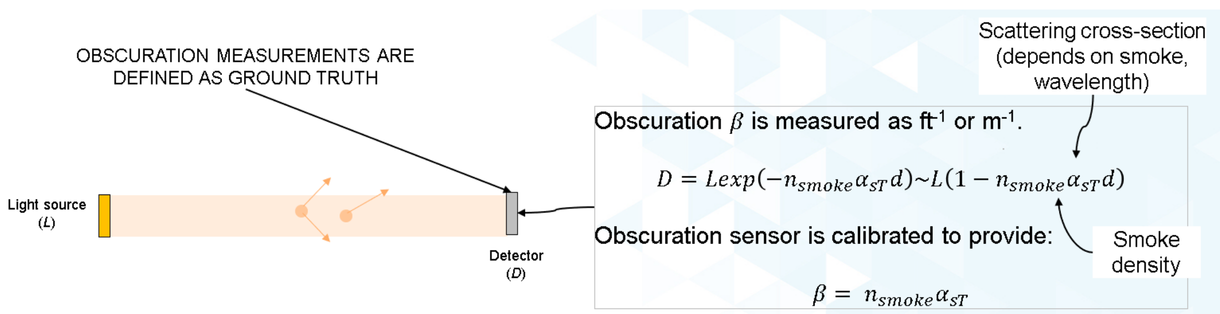
- **ISO 7240 - Fire detection and alarm systems (2018)**
- **Chinese standard for point-type smoke detectors follows 2003 edition of this standard**

(Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization)

UL 268 and UL 217 cover US and Canadian regulations and are the standards which effectively require technologies (and algorithms) to differentiate between smoke from a flaming polyurethane or smoke from cooking a hamburger. (note *Canadian regulations require a different smoke test chamber set up).* The other three standards are EN 14604, which is a European standard published in 2006, BS EN 54 which is the British interpretation of the European EN 54 standard published in 2015 (part 29 of this standard refers to smoke detection) and ISO 7240 is an international standard published in 2018 (part 7 of this standard is the relevant piece for smoke). The current Chinese standard for point-type smoke detectors follows the 2003 version of this standard.

<u>Detail on Testing</u>

There are 2 aspects to each standard which we will discuss next: The tests and the requirements for test set up. Obscuration is a unit of measurement for sensitivity of smoke detector. The higher the value of obscuration, the higher the smoke concentration levels.



- **Typical dimensions are d = 5 ft or 2 m, beam diameter 4-6 in (10.2-15.2cm) . uses sodium vapor lamp (589 nm)**

Fire room tests are expressed in terms of time to alarm after initiation of fire or in terms of obscuration levels (or in some cases both). It should be noted that when ADI performed testing they used an external proprietary smoke chamber.

The most stringent testing is currently the NA/Canada UL217/UL268. Some of the relevant tests are listed here, but there are many more:

UL217 Edition 8/UL268 Edition 7

- **Paper Fire**
  - **Must give an alarm before t = 240s**
- **Wood Fire**
  - **Must give an alarm before t = 240s**
- **Smoldering Smoke**
  - **Must give an alarm before obscuration levels exceed 29.26%/m**
- **Flaming Polyurethane Foam**
  - **Must give an alarm before obscuration levels exceed 15.47%/m and t = 360s**
- **Smoldering Polyurethane**
  - **Must give an alarm before obscuration levels exceed 34.3%/m**
- **Hamburger (Nuisance Alarm)**
  - **Must not give an alarm/fault before obscuration levels exceed 0.987%/m or MIC value in range 59.3-49.2**
- **Sensitivity Test, Dust Test, High Humidity Test**
  - **Must not give an alarm/fault**
- **Flammable Liquid Fire (UL268 Canada Only)**
  - **Must give an alarm before t=240s**

For EN 14604 , BS EN 54 and ISO 7240, there can be different levels on the same test or additional specifications for example Liquid (heptane) Fire, Glowing Smoldering Cotton or Low Temperature Black Smoke Liquid Fire.

Note for a complete set of tests, the relevant specification must be referenced in full.

Provisions for Testing and how International Regulations can Overlap

The following are the requirements for the 5 main test regulations

- **UL 268 and UL 217**

    - **28 assembled specimens – all of which are used for each test (unless otherwise agreed with the testing agency).**

- **EN 14604**
    - **20 specimens - Specimens numbered in order of increasing response threshold (decreasing sensitivity)**

- **BS EN 54**
    - **22 specimens - Six least sensitive specimens numbered 17-22 and the others numbers 1-16 arbitrarily**

- **ISO 7240**
    - **20 specimens - Four least sensitive numbered 17-20 and the others numbered 1-16 arbitrarily**

The test sets are important as they determine how many detectors are needed for each test within the 5 standards. UL 268 and 217 require 28 specimens, all of which are used for each test. For the other three standards, the specimens are numbered as detailed and specific specimens are then required to pass specific tests. For example in ISO 7240 all specimens are tested for the reproducibility test, yet only specimen no. 3 is tested for the dazzling light test and so forth. What this means for global compliance is that because specific devices are required to pass specific tests for compliance, each test in each standard has to be performed and standards cannot be overlapped. However, in some cases in the UL standards (where all devices are tested in every test) the testing conditions are identical so compliance with one standard will mean compliance with the other.

EN 54-29, EN 14604 and ISO 7240 have identical requirements for the smoke tunnel and fire room – both of which certain tests are carried out in. The required atmospheric conditions for these standards are also identical. However, overlapping of standards here will only give an indication of compliance as the standards state specific devices are needed to pass certain tests.

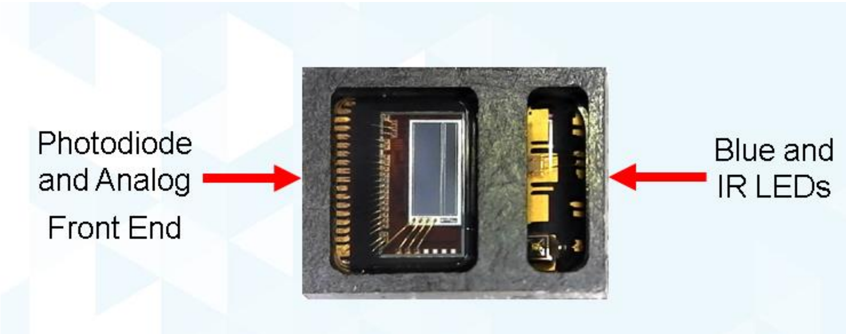
Smoke Detection Technology: One Size does not fit all

This article has summarized some of the smoke detection technology, definitions and smoke detector tests over 5 international standards. It is not meant to be a detailed analysis of one standard over another, rather using some examples to show how stringent and complicated the process can be. Each international

region has a very detailed set of tests that have different methods (and setups) for testing.

However, by passing UL217/268, currently the most stringent set, it can give a good indication of compliance, while not a substitute for regional testing. For regional compliance, a very detailed examination of local test requirements and methods is required. Even at local country level, regulations will increasingly become more stringent in the future.

Using a component or sub system that is UL listed, such as ADI's ADPD188BI Integrated Smoke Detection Module plus smoke chamber provides ease of mind for initial technology selection. This means that UL has tested representative samples of a product and determined that the product meets specific, defined requirements. These requirements are based on UL's published and nationally recognized Standards for Safety.



ADPD188BI Smoke Detection Module integrates LEDs, photodiode, and analog front end (AFE) in one small 3.8 x 5.0 x 0.9 mm package

- **Reduces component count**
- **Eliminates LED supply chain management requirements**
- **Runs on standard SMT assembly process**
- **Small size enables more industrial design options**

ADI Smoke chamber has 2 models: Standard or Bug Mesh version

The Future

Regulatory changes have driven the trend for smaller, more accurate smoke detection systems. Systems that use dual wavelength detection can reduce nuisance alarms, a requirement of the new test regulations. Systems with higher signal to noise ratio (SNR) and high dynamic range also help here as well as in the better identification of smoke type. Optical technology enables smaller form factor at lower power.

The future is not only to create larger networked fire detection systems therefore lower power requirements will enable battery operation (longer lifetime) or more devices on a mains loop. But at a system level, for wireless networks, the faster alert requirement means the need for low latency networks. Because of the life safety aspect of smoke detection, it will continue to remain as a stand alone system. However, in the future, there may also be the need to incorporate smoke detection additionally into other building control systems for example within evacuation or emergency lighting where smaller form factor will increasingly become important .

Acknowledgement

I would like to thank Hugo Hegarty, an intern at ADI during 2019, for his work to summarize the relevant standards.

Biography

Grainne Murphy is a Marketing Manager with Analog Device's Industrial and IoT Solutions Group. With over 25 years of engineering experience, she manages customer needs, engagement and marketing/communications strategy for ADI's key product portfolios and future direction within Intelligent Buildings.

She is a University of Limerick, Ireland graduate (BENG) and also holds an MBA from Oxford Brookes University.