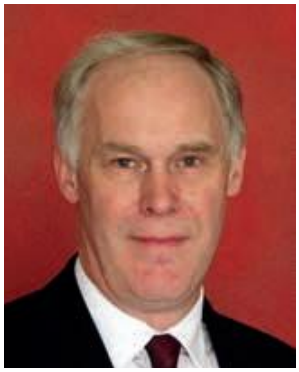
Aspiring to an addressable future

Simple but effective, the technique of analysing samples of air drawn from an area for the first traces of smoke and a potential fire threat continues to evolve. In this article, we consider the benefits and the compromises of cumulative sampling and consider some of the most recent developments in Aspirating Smoke Detection (ASD) technology which are addressing the challenges associated with detecting smoke.



Peter Massingberd-Mundy

Many articles have appeared over the years on the benefits and the limitations of ASD. When it first appeared, the simple technique of drawing air samples to a very sensitive central detector from multiple locations was considered to be at odds with the common approach of providing a matrix of many point-type detectors. People struggled with the concept that each sampling hole individually can be considered to have equivalent sensitivity to a single point-type detector while the combined sensitivity of many holes is significantly higher – making an ASD system particularly effective when smoke is distributed (or diluted) within a space; by high airflows, or simply by the height or geometry of the space.

Understandably, other benefits of ASD, such as the ability to conceal the sampling points (for heritage, architectural or prison applications) or the provision of an easy-to-maintain-at-ground-level detector, or the need to tolerate (and filter out) dust or dirt, are easier to comprehend and have often driven the decision to use them. However, it remains a fact that ASD systems take a fundamentally different cumulative approach to detecting smoke compared with traditional point-type detectors. This has advantages and some consequences.

Focused investment

With ASD systems, the investment is concentrated into one sophisticated detector – as opposed to distributing across many detectors. On balance the sampling pipe, with its multiple sampling

▼ **The VESDA VEA system identifies the source of an alarm to direct early intervention.**

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The table below summarises TF2–TF5

		EN 54-7 (points) & EN 54-20 Class C (ASD)			Class B (ASD)	Class A (ASD)
Test Fire	**Description**	**Limit for m**	**Limit for y**	**Time limit***	**Limit for m**	**Limit for m**
TF2	Smouldering wooden blocks	2 dB/m	1.23–2.05	570–840 s	0.15 dB/m	0.05 dB/m
TF3	Smouldering cotton wick	2 dB/m	3.2–5.33	120–750 s	0.15 dB/m	0.05 dB/m
TF4	Flaming Polyurethane foam	1.27–1.73 dB/m	6	140–180 s	n/a	n/a
TF5	Flaming n-heptane	0.92–1.24 dB/m	6	120–240 s	0.3 dB/m	0.1 dB/m

* EN 54-20 includes a limited allowance (up to 60s) for the transport time that is inherent to ASD systems

holes, can be compared with the wires linking point-type detectors so the installation costs are similar. This means that the ASD detector can incorporate features deemed too costly for normal point detectors including; informative displays, multisensory capability and adaptive algorithms or, in the case of VESDA, the unique feature of a clean air bleed to maintain the integrity of the optical chamber without resorting to adaptive algorithms or drift compensation.

Localisation

The main consequence of using cumulative sampling is that the source of the smoke is not generally indicated. When first introduced, point-type detectors were similarly limited as a string of detectors, covering a single zone, were connected to the fire panel without any ability to identify which specific point had detected smoke. Such systems are now widely known as 'conventional point detectors' and they provided the essential zonal information needed to direct the Fire and Rescue Services to the correct area. While they are still used in some small premises, they have been largely superseded by 'addressable' or 'analogue addressable' systems.

The term analogue here is typically related to the idea that a measurement of the smoke level at each point is available at the fire panel – in contrast to a non-analogue system which provides only a basic indication of the alarm status (e.g. normal, pre-alarm & alarm) at each point. Of course, most advanced addressable panels are now digital in the sense that that they use digital protocols to communicate with individual point detectors to provide information beyond the alarm status and the smoke level (or 'analogue value') at each point.

Regardless of being analogue, digital or digital-analogue, the key advantage is that the modern detection systems are 'addressable' and able to direct the Fire & Rescue Services to the individual source device. Despite this, the concept of attending to a zone still dominates the first response with fire panels required to give clear zonal indication supported by a clear zone map of the premises. Arguably, the real value of addressable detection is in determining the source of false or unwanted alarms, helping to identify a poorly sited or unreliable detector giving nuisance alarms or the source of a short transient thermal event which has not escalated to a fire. In an emergency situation, zonal indication is deemed sufficient.

Early detection – for early warning

As already described, ASD systems are particularly effective when detecting diluted smoke entering several sampling holes and thus provide earlier detection of such conditions compared to point detectors. However, like point detectors (meeting EN 54-7), they also are required (by EN 54-20) to provide timely detection of fast-growth fires, as characterised by the TF4 and TF5 flaming test fires.

In practice, such fast and clean-burning fires involving a single material are unlikely to occur and it is widely acknowledged that TF4 & TF5 represent the extremes of what a normal optical detector should detect. Similarly, the TF2 and TF3 smouldering fires represent the extremes of what an ionisation detector should detect. The table above summarises TF2-TF5.

While all four tests are equally appropriate from a life-safety point of view – there can be little doubt that there is significantly more time available to attend to a smouldering fire and prevent it escalating – but only if the smouldering is detected early enough! This is where the cumulative sampling of ASDs comes to the fore – but it is further accentuated by the provision of Class-B and Class-A ASD systems which, as illustrated by the values presented in the table, require a sensitivity to the smouldering fires of ~x13 and ~x40 respectively compared to the requirements for a normal optical point detector. This combined effect of cumulative sampling and higher sensitivity is what makes ASD systems so suitable to the prevention of fires – when there is time (and personnel available) to investigate and intervene as opposed to taking to their heels and evacuating the premises.

Having emphasised this point, it is appropriate, in the interest of balance, to note that most optical point detectors respond to TF2 and TF3 long before the limits prescribed. It is generally accepted that many operate when m~0.5dB/m and some can detect the Class B and even the Class A fires defined in EN 54-20. However, with a few exceptions, detection systems using point-type detectors do not provide cumulative alarms or warnings – even though it may be technically possible in modern addressable systems.

Time to investigate

Earliest possible warning of a smouldering fire is a laudable objective but it must be balanced against the inconvenience of false alarms – and the dangerous complacency that they can instil. Hence it is important to distinguish between alarm signals (that indicate a need to evacuate) and warning signals (that indicate an opportunity to investigate). In fact, effective early warning is one useful tool in the war against false alarms – but it is only truly effective where there is an appropriate response plan in place.

◀ **Cumulative *and* addressable detection PLUS individual hole supervision.**

An early-warning response strategy should ideally consider the possibility of elusive warning signals – i.e. those where the root cause is difficult to identify. As with all problem-solving challenges the accuracy and reliability of information is key and the comprehensive logs and trend graphs provided by the more sophisticated ASD systems can be extremely valuable when identifying the cause of elusive warnings. Moreover, getting back to the heart of this article, the extent (area covered by) the ASD system should be considered. For example, a four-pipe arrangement monitored by one detector could, if necessary, be replaced by a device which can offer pipe identification.

In a nutshell – for the BEST early warning – a detection system which can combine cumulative detection with addressability is likely to be a winner.

While it is possible for addressable point systems to provide a cumulative effect – i.e. signalling an alarm based on the combined response of several detectors – it is rare for them to do so. In contrast, cumulative ASD systems have, over the years, taken advantage of several techniques to provide an element of addressability or localisation. Essentially there are three approaches that have been commercialised:

1. Each incoming pipe has its own detector…While a 4-pipe/4-detector ASD was available, only 2-pipe/2-detector products exist these days which allow a single zone (of up to 2000m^2) to be divided in two.
2. Pipes are scanned sequentially using valves to control the flow… and there are effectively two approaches:
   - **a** A 4-pipe scanner is available which monitors all 4 pipes simultaneously. Each pipe can have many holes but the zone is effectively divided into 4 sectors to assist with directing responders to the correct sub-area. When smoke across all 4 pipes is detected it starts a fast scan to identify the source pipe and then runs an intelligent scan, preferentially monitoring the source pipe while alternately checking each of the other pipes in turn.
   - **b** Multi-pipe scanners with only 1 (or perhaps 2) sampling holes to each pipe are also available. These use many small-bore capillary pipes which run individually out to each sampling location. While this would appear to be a costly option it is, in fact, quite cost-effective – particularly when the integrity monitoring features provided by the latest device using this technique (see below) are taken into account.
3. A purge-and-time technique is used. There is currently only one device using this technique, which uses a single pipe with several holes and a reverse-flow pump to purge the pipe with clean air after smoke is first detected. Once purged, forward flow is re-established, and the time when smoke arrives at the detector is used to determine which (out of five holes) was the source of the smoke. This process takes some time and relies on there being sufficient distance between the holes and on smoke still being present at only one sampling hole when forward flow is re-established.

The future is here

The latest incarnation of an addressable ASD system is a multi-pipe product supporting up to 40 small-bore tubes. The product uses two detection chambers (20 tubes on each) and normally samples from all 20 tubes simultaneously – thereby retaining the cumulative detection explained above. In an early-warning (slow fire growth) scenario, scanning is not automatically initiated because monitoring for any escalation of smoke to an alarm level needs to continue uninterrupted. However, once an alarm is detected, the product samples from each pipe in turn to identify which one(s) are making a significant contribution to the cumulative reading. Thus, Fire and Rescue Services personnel responding to an alarm are summoned without delay and directed to the source hole(s) when they arrive – while early-warning responders have the option to manually initiate a scan.

Finally, in addition to retaining cumulative detection while providing addressability, the 40-tube detector has the unique ability to regularly confirm that each sampling hole is operational – neither blocked nor disconnected due to a broken pipe.

For more information, go to www.xtralis.com

VESDA-E VEA

Addressable Smoke Detection

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