# Understanding the "normal" capability of Aspirating Smoke Detection

High-sensitivity Aspirating Smoke Detectors (ASD) have been in use for many years, but the basis of their approval has historically been the fire tests used to test normal sensitivity Optical and Ionisation Point-type Smoke Detectors. As many users of Aspirating Smoke Detectors will testify, ASD are generally used for Early Warning and the detection of incipient fires which means that they are "normally" configured and commissioned to be significantly more sensitive than "normal". Is that a problem? Does EN 54-20 help?

Starting with a review of the basics of ASD technology, this article explains the rationale behind and some of the results from testing ASD systems to EN 54-20. Most importantly, it presents three observations of installed systems to reveal that, in terms of EN 54-20, most ASD systems are currently installed to either Class B (enhanced sensitivity) or Class A (high sensitivity). It concludes with a recommendation that consultants and designers should be careful to clearly specify the sensitivity Class they require of any ASD system they propose.

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Regular readers will already be aware that EN 54-20 was published in June 2006 and introduced three classes of sensitivity. This is only useful if those people responsible for specifying and installing the technology actually use the Classes when defining and selecting ASD for the protection of particular risks. If the Class definitions are not used in the field then there is a risk that they will be omitted from future versions of the standard. So – use it or lose it!

### ASD – the cumulative advantage

ASD systems are by their nature a little more complex than point-type detectors because they are sampling from many different points in space. To keep the analysis simple, consider that an ASD

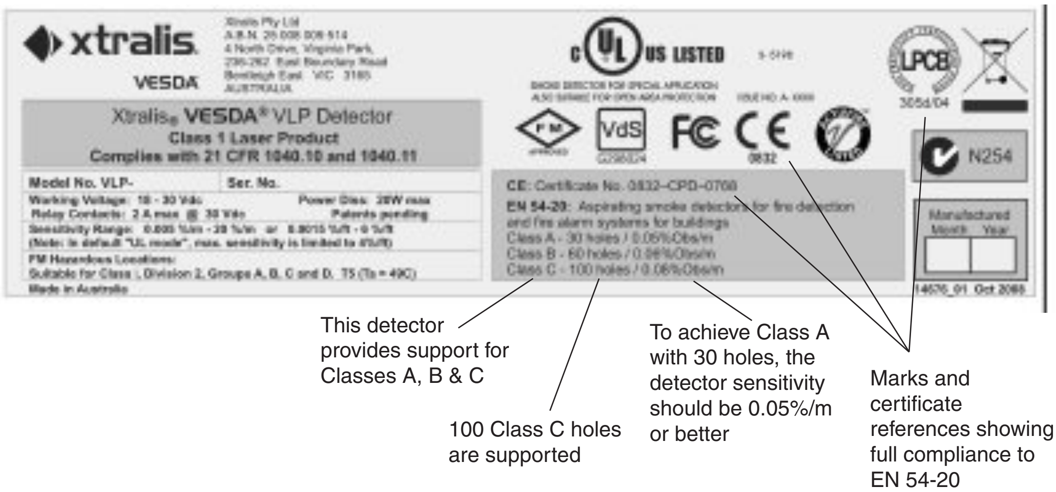


*Figure 1 – Product label showing Class and capability to EN 54-20*

system draws samples from several holes (let's assume 20). If smoke enters only one hole then it is mixed with clean samples from the other (19) holes before it reaches the detector. As such the detector in a multi hole ASD *must* be many times more sensitive than a standard point detector (*at least* 20 times for our example) in order to detect the standard test fires (TF2-TF5). The "at least" is a reflection that the sampling holes in a practical system do not all draw exactly the same amount of flow. Some (typically nearer the detector) draw more flow and are consequently more sensitive. Those drawing less flow (further from the detector) are effectively exposed to a greater dilution ratio. Fortunately, more and more ASD manufacturers are now providing pipe modelling programmes which calculate the sensitivity of each individual hole – such as ASPIRE2 used for VESDA and ICAM ASD systems.

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While this "dilution effect" does not need to be considered for point-type detectors, it has a distinct advantage in practise because smoke often spreads through a space. When smoke enters two or more sampling holes the dilution from the remaining holes is lessened. In effect the whole system becomes increasingly sensitive the more the smoke spreads and enters more holes. The fortunate consequence of this is that ASD systems provide an excellent measure of the size of the original 'packet' of smoke released into the protected space – whether released from a fast hot fire in the form of a classic plume or released slowly from an incipient file and diluted throughout the space by air currents and time. In the latter case ASD is preferred over point-type smoke detectors because measurement of the obscuration in the immediate environment of the point is of little value – you need to know how much smoke has been released and diluted in the larger space. It is for this reason that ASD systems perform so well in the windy datacentre and the large open spaces of building atria, large manufacturing & warehouse spaces and public buildings such as airports and railway stations – they maintain a better perspective on the size of the source.

To illustrate, if smoke with a 10% obscuration/m is sufficient to cause an alarm when entering 1 hole on a 20 hole ASD system then smoke with 5% obscuration/m entering 2 holes will also cause an alarm. Equally, smoke with a concentration of 2.5% obscuration/m entering 4 holes would result in an alarm and ultimately, smoke with a concentration of only 0.5% obscuration/m entering all 20 holes results in an alarm. This cumulative effect is particularly relevant when protecting large open spaces.

### EN 54-20 – a safe approach

EN54-20 takes no account of this cumulative effect and simply requires that each and every hole on any Class C system can independently detect the same four test fires that a point detector must detect. This is logical because, in a fast growth fire, smoke may only reach one hole in which case the cumulative effect is of no benefit. The result of a Class C approval to EN 54-20 is confidence that the particular system is at least as reactive to fire as any EN 54-7 point detector.

However, as already observed, ASD systems are often specified for their high sensitivity and early warning capabilities because they offer significantly more than equivalent fire detection to a point detector with the added benefit of cumulative sampling. In fact, they offer the ability to reliably signal early warnings when there are extremely low concentrations of smoke present. This being proven by successful detection of the smaller test fires for Class A and Class B systems.

**Nuisance alarms are a misconception**

Ignorance of the nature of ASD's cumulative effect underlies many misconceptions about false or unwanted alarms from such high sensitivity systems. Observing that smoke of only 0.5% obscuration/m is not enough to be certain there is a fire, they conclude that nuisance alarms from background levels will be the consequence. In fact, while 0.5% obscuration/m *at a single point* may not be sufficient to be confident of a fire, when spread through a space it indicates that there is a significant threat which is well above normal background levels. More importantly, our field experience with extremely stable, fixed calibration VESDA technology indicates that background levels are typically less than 0.02% obscuration/m and rarely exceed 0.05% obscuration/m (other than in particularly challenging environments) – so there is typically a safety factor of >10 before nuisance alarms become an issue.

The 10% obscuration/m figure quoted above is rooted in the EN 54-20 approvals of the VESDA system and relate to Class C. To be specific, all Xtralis VESDA detectors are approved to EN 54-20 Class C as long as the sensitivity of every hole is better than 10% obscuration/m in the installed system. As such, an Xtralis VESDA VLP can support (and has been tested with) up to 100 holes at detector sensitivity of 0.08 %/m. For Classes A & B the hole sensitivity must be better than 1.5% obscuration/m and 4.5% obscuration/m respectively. As such they can support (and have been tested with) 30 holes at 0.05% obscuration/m

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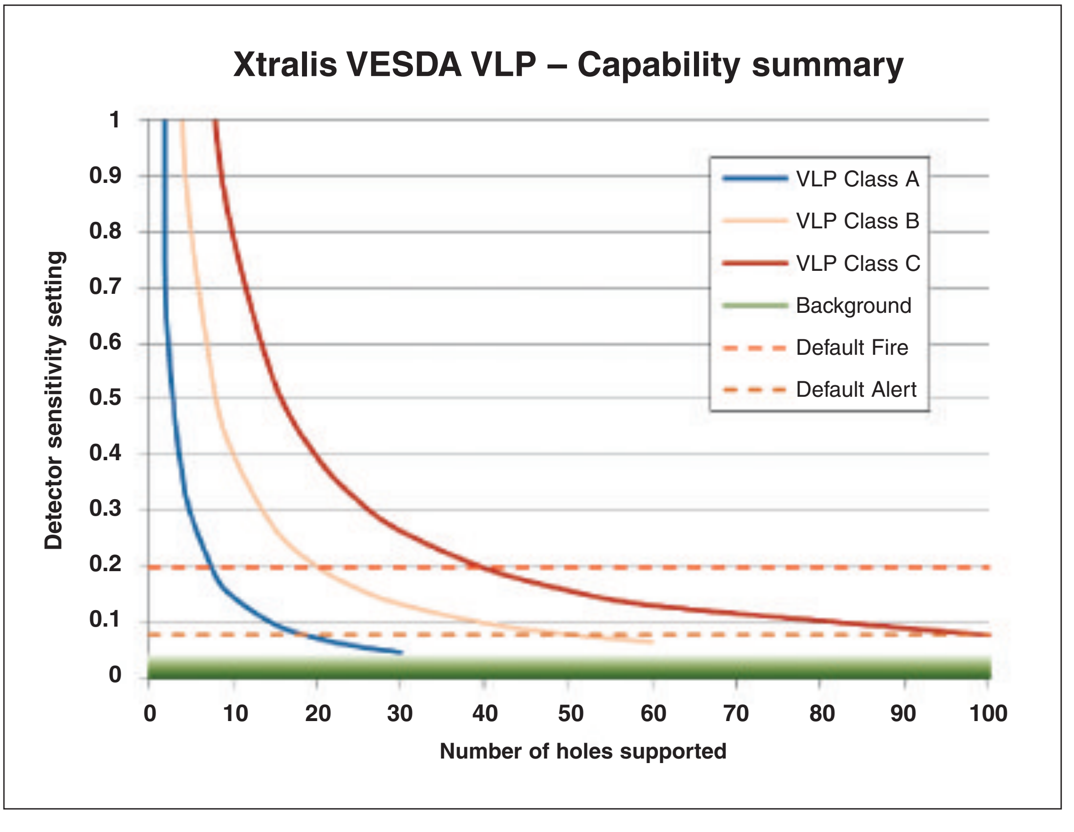


*Figure 2 – Summary of Xtralis VESDA VLP capability*

and 60 holes at 0.06% obscuration/m respectively. This information is published in the datasheet and appears on the product label (see Figure 1). Of course where fewer holes are drilled on a system the alarm thresholds can be correspondingly relaxed as summarised graphically in Figure 2.

Figure 2 reflects that a Class C system is with 100 holes is achieved with a detector sensitivity of 0.08% obscuration/m (as per the label) but a Class C system with 40 holes is achieved with a sensitivity of 0.2% obscuration/m. This is a simple general calculation. For a particular installation an ASPIRE2 calculation is recommended.

Most importantly, the graph makes it clear that with typical background readings of <0.02% obscuration/m, nuisance free Class A and Class B systems are realisable with a satisfactory safety margin against nuisance alarms.

## Field experience

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The first observation is grounded on the fact that the default thresholds on a VESDA are Fire = 0.2% obscuration/m (Alert = 0.08% obscuration/m and Action = 0.14% obscuration/m) and that many systems are operated successfully with these default thresholds in place. This is logical since the fire threshold is 10x higher than any typical background readings (the Alert threshold is 4x higher) so nuisance alarms are rare. Moreover, if the number of sampling holes is 20 or less (which is generally the case), the sensitivity of each individual sampling hole is better than 4.5% obscuration/m so the system is operating with Class B sensitivity.

An alternative way of setting the alarm thresholds on a VESDA system is to use a commissioning tool called AutoLearn. This monitors the background environment for a number of days (typically 14) then sets ALERT threshold with a safety factor of about 3 and the other thresholds correspondingly above. Our observations indicate that AutoLearn typically results in Fire thresholds of <0.1% obscuration/m and often significantly less in clean office environments. This means (with reference to Figure 1) that they are operating at Class B or better as long as they are supporting fewer than 40 holes.

A third observation that supports this conclusion comes from the fact that there is a tendency to directly compare ASD sensitivity values with the nominal values quoted for point detectors – typically stated as having a sensitivity of 3-5% obscuration/m. In fact, basic point detectors need to be set to this level of sensitivity to effectively detect the flaming fires (TF4 and TF5). In contrast, Xtralis VESDA detectors, as verified by testing to EN 54-20, only require a single hole with a sensitivity of better than 10% obscuration/m to successfully detect all 4 class C test fires (including TF4 and TF5). However, the practical consequence of this misplaced comparison is that many Xtralis VESDA systems (which are not left to operate at default thresholds or commissioned using AutoLearn) are configured to have individual hole sensitivities of better than 5% obscuration/m which is approaching the detector's Class B limit of 4.5% obscuration/m.

## Other sources

Xtralis are proud to be the first ASD company to achieve full approval to EN 54-20. To support designers of their systems Xtralis has invested considerable effort in its design tools and support documentation. For example ASPIRE2 has been modified to enable design to the Standard and Xtralis has taken a leadership role in the marking of all its products to explain the Class approvals. Though it is inevitable that other manufacturers will release compliant product prior to the standard becoming mandatory from July 2009 across most of Europe, it is important they make it clear how the Class of any particular ASD installation is to be determined. All ASD manufacturers should be encouraged to clearly publish their detector capabilities in terms of the number of holes they can support at a given sensitivity for a given Class.

## Conclusion

For the specifier and designer of ASD systems it is imperative to specify the sensitivity Class required for any particular ASD project. If it is left unspecified then there is a risk that the performance achieved will be significantly less than that expected. This is particular true given that the majority of ASD installations currently installed achieve a Class B capability or better – as supported by the evidence presented in this article.

Moreover, it is important to verify that the product selected is suitable for the application. Not only must it have an approval for the sensitivity Class required but it must also support the number of holes envisaged for the project and provide sufficient information to ensure that the alarm thresholds are correctly set at commissioning to achieve the Class required. IFP

*Further information is available at:*
www.en54-20.org and in the FIA Code of Practise for Aspirating Smoke Detectors