AirSense™
TECHNOLOGY LTD

System Sensitivity Guide

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Aspirating smoke detection system sensitivity

One of the most useful aspects of HSSD (High Sensitivity Smoke Detector) aspirating smoke detection is 'high sensitivity'. This usually means that the higher the degree of sensitivity employed, the earlier can be the detection of life, business or building threatening fire situations. An alternative way of looking at this scenario is that the greater the sensitivity of the detector, the greater can be the volume protected with a single product.

An aspect of system performance that is often misunderstood, or not fully considered is the effect of increasing building volume on system sensitivity. It is important that the designer and client have the same expectations for system performance, and the following sections explain what may be expected in terms of overall performance. There are numerous design strategies possible with this type of smoke detection system, as well as (in the United Kingdom) 3 defined categories of sensitivity possible. It may be appreciated that an understanding of what factors affect performance is therefore crucial. One single very high sensitivity detector may be able to protect a relatively great volume at the same overall sensitivity as several lower sensitivity devices.

Sensitivity

Smoke detector sensitivity is normally defined in terms of 'percentage obscuration per metre' (%obs./mtr.); that is to say, the amount of smoke required to obscure the passage of light by a given percentage across a distance of one metre.

The British Fire Protection Systems Association Code of Practice for aspirating smoke detection systems defines three sensitivity categories for smoke detection systems as listed below:

- Normal: Sensitivity equal to normal point smoke detectors @ 5% obs./mtr.
- Enhanced: Sensitivity better than 2% obs./mtr.
- High: Sensitivity better than 0.8% obs./mtr.

It is interesting to note that although a 'high sensitivity' aspirating detector can provide for all three categories of protection, a 'conventional' smoke detector system can only conform to the 'Normal' sensitivity category. This is because the high sensitivity aspirating detector will detect smoke at substantially lower dilution, and can therefore be applied to a substantially greater volume.

System sensitivity is to a great extent dependent upon the volume of a building or room to be protected. This is because building ***volume*** (note - not ‘area’) effects smoke dilution. Another factor effecting smoke dilution is ‘fresh air make-up’ in ‘Close Controlled’ air-conditioned premises such as Electronic Data Processing environments.

Together with different categories of detection sensitivity, are system performance acceptance tests. The detection systems applied to the protection of environments where specific categories of sensitivity are required are often specified in terms of a particular performance test. Usually a ‘lactose’ test for normal sensitivity Point Detection systems or a ‘wire overload’ test for the simulation of incipient fires, such as may be detected with a high sensitivity aspirating smoke detection system. These tests are normally detailed in the appropriate local codes or standards such as BS5839 Part 1 or BS6266.

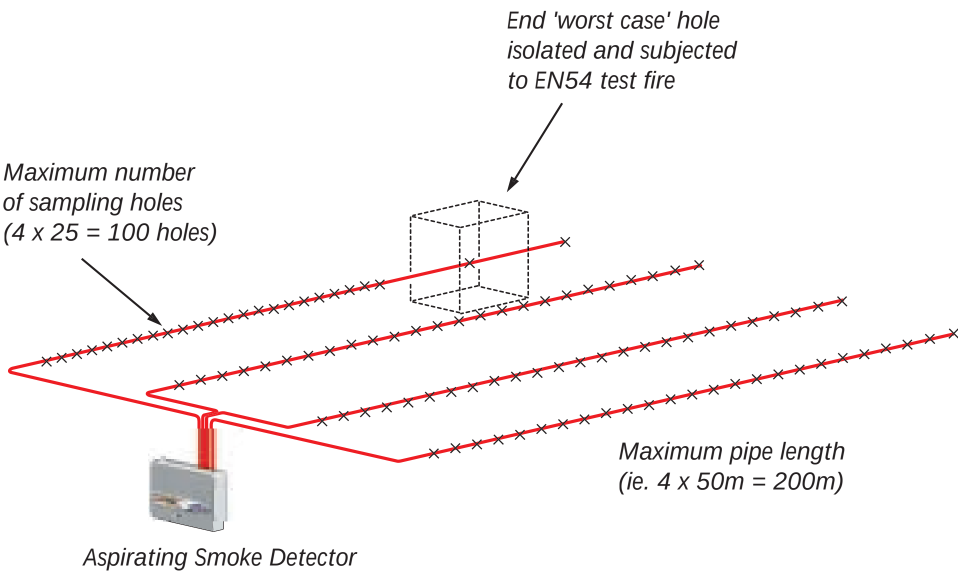
It is relatively easy for an aspirating smoke detection system to achieve the levels of performance required for ‘normal’ sensitivity. Such systems are generally designed on an ‘area’ basis where dilution of the smoke sample is not significant because of the relatively low sensitivity that is required. Conversely high sensitivity may need a different approach since performance criteria is more rigorous. These different requirements require different approaches: design by area and design by volume.

System Response

It is worth noting that the sensitivity of the system is irrespective to its speed of response. A detection system that is more sensitive will detect smaller amounts of smoke quicker than a less sensitive detector that has a faster response. Tests that include large step inputs such as a smoke bomb can be misleading in showing the true early warning performance of a detection system. Many detectors have their speed of response reduced to ensure that an alarm is genuine to prevent unwanted alarms.

Furthermore, approval testing of aspirating smoke detectors is based on a worst case scenario using standard point detector smoke test criteria. For example, if a manufacturer claims their detector will support 100 sampling holes and 200m of sampling pipe, the furthest sampling hole will be subjected to all the tests suitable for point smoke detectors (ie BS5445 Part 9 1984 / EN54 Part 9). Since most manufacturers have their equipment tested, these approvals provide a good insight into the potential performance available. It follows that the more sampling holes a system is permitted the greater the detector/system sensitivity.

Fig. 1 *Approvals test outline*



Design by Area

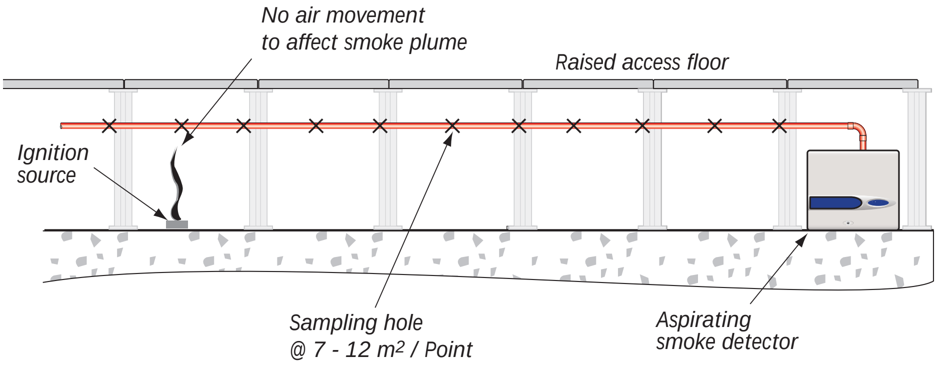
When using an area design strategy the design will normally be based on 'Secondary Protection' criteria where each sampling hole is assigned the spacing characteristics of a point smoke detector. There are a number of local and international standards that define the design criteria requirements for point smoke detectors and the appropriate design code (such as NFPA or BSI for example) should be used. An example (taken from the BFPSA Code of Practice for Category 1 Aspirating Smoke Detection Systems) of how different sensitivities require different hole positioning is detailed below:

Table 1 BFPSA Recommended Sampling Hole Design Criteria:

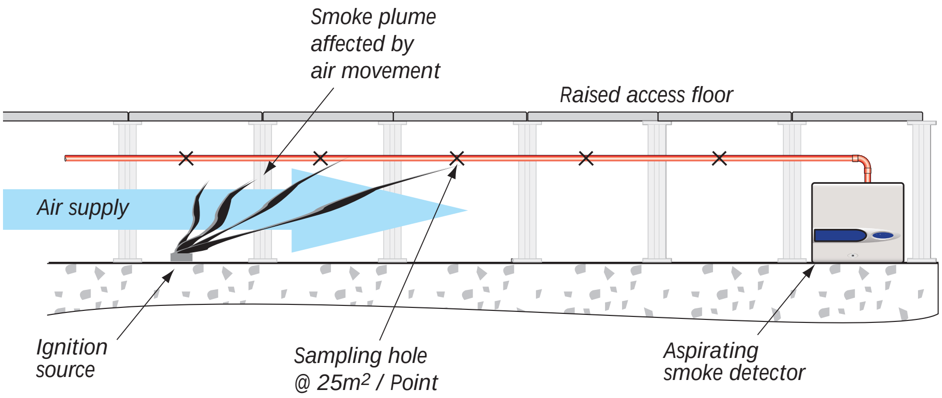
	Still Air		Comfort Cooling		Fast Air
Sensitivity Test	***Area***	***Any point***	***Area***	***Any point***	***Area***
High Sensitivity	7-12m^2	2.5m	25m^2	3.5m	BS 6266
Enhanced Sensitivity	25m^2	3.5m	50m^2	5.0m	BS 6266
Normal Sensitivity	BS 5839	7.5m	BS 5839	7.5m	BS 6266

The sensitivity of the detector is shared by all the sampling holes. It follows that a more sensitive detector will be able to sample from more holes than a less sensitive detector and still provide acceptable performance. Systems that require higher sensitivities are designed with greater densities of sampling holes to reduce the time needed for smoke to travel to a sampling hole. Table 1 recommends different sampling hole densities for still air and slow moving air (see Figure 2 below).

Fig. 2 *Secondary floor void protection, still and moving air*



Still air design - Sampling hole coverage @ 7 -12m^2 for high sensitivity coverage in 'still' air conditions.



Moving air design - Sampling hole coverage @ 725m^2 for high sensitivity coverage in 'comfort cooling' air conditions.

The number of sampling holes affects the sensitivity of the 'system. For example if a detector has conditioned itself to 0.05% sensitivity and a single pipe with 10 sampling holes is fitted then the sensitivity of each hole will be 0.05% x 10 = 0.5% obscuration per metre. If a second pipe of 10 sampling holes is added then the sensitivity of each hole will be 0.05% x 2 x 10 = 1% obscuration per metre.
In this way it is obvious that one HSSD (high sensitivity smoke detector) unit can easily protect a whole fire alarm zone of @ 2000m^2 where normal sensitivity is required.

Table 2 Comparison of system sensitivity and area coverage:

Detector Sensitivity	System Sensitivity	Quantity of Sampling Holes	Area Protected
0.05%	Normal 5%	100	2000m^2
0.05%	Enhanced 2%	40	800m^2
0.05%	High 0.8%	16	320m^2

In general terms; the higher the sensitivity the smaller the area that may be protected since less sampling holes will be permissible to achieve the desired performance.

So the more sampling holes that are added make the 'system' less sensitive overall. This process is called dilution.

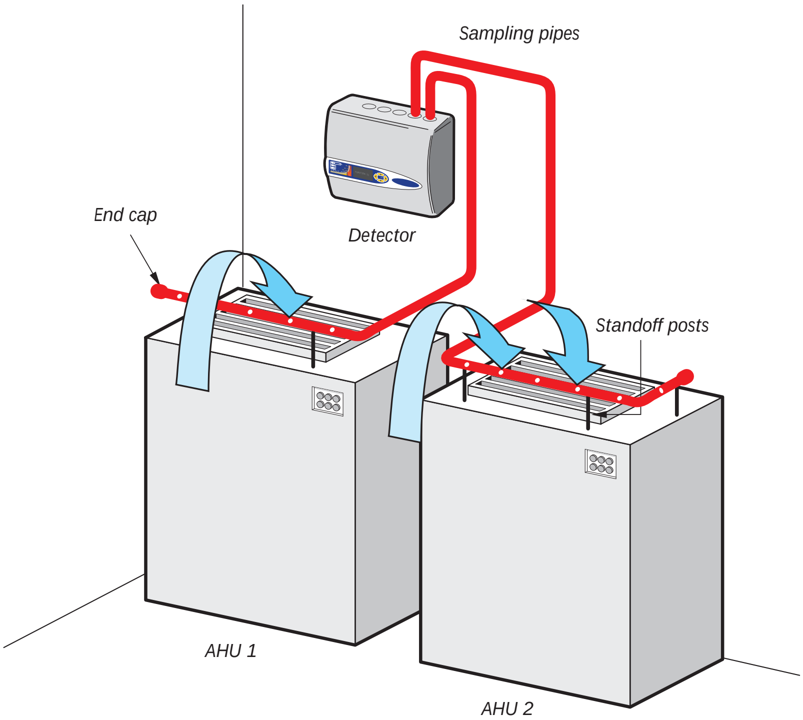
The example above assumes that smoke will only enter a single sampling hole. In practice smoke will spread in a rising fire plume subject to any air movement and is likely to enter more than one hole; thus increasing the overall sensitivity of the system.

If there is a large amount of air movement then consideration should be given to volume protection since any smoke will be rapidly diluted into the normal airflow by any air handling equipment.

Design by Volume

When there is a need to provide high sensitivity, Primary Protection (sampling return air only) is normally used on the pretext that the objective is to identify a relatively small amount of smoke that has mixed with the normal room volume –hence the term volume protection.

Fig. 3 Primary Protection – design by volume



Because return air is sampled at a limited number of locations each sampling hole will be correspondingly more sensitive.

From Table 2 above we can take the area for high sensitivity and using a typical telecommunications equipment room height of @4.5m extrapolate an appropriate volume of protection for each detector when high sensitivity is required (i.e. 320m^2 x 4.5m height = 1440m^3).

Table 3 Comparison of system sensitivity and volume:

Detector Sensitivity	System Sensitivity	Quantity of Sampling Holes	Volume Protected
0.05%	0.8%	16	1500m^3

Using information from Table 3, which is validated by many site tests and successful installations, we can comfortably use a figure of @1500m^3 as a realistic guide to how many detectors are required to protect a risk based on its volume.

It should be remembered that this volume criteria is the starting point of a successful design, consideration should also be given to operation of the air handling system as well as other site conditions discussed elsewhere.

Consideration should always be given to the level of protection required in the event of the cessation of air movement. In such conditions requirements may be different and a design relative to area coverage will be more appropriate.

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