
FIRE
FAULT
TEST
0
RESET

Article for Rupert Gilbey, *Fire Prevention*

Considerations when specifying and installing beam smoke detectors

Steve Scorfield
Technology Manager
System Sensor Europe

Beam smoke detectors are the obvious choice for protecting buildings with high ceiling areas such as atriums, lobbies, gymnasia, sports arenas, museums, churches, factories and warehouses. Many of these applications present special problems for the installation of point detectors, and even greater problems for their proper maintenance. Typically, fires will start at the lower elevations of the property, at or near the floor level. When this is the case, the smoke produced by the fire will rise to the ceiling; the column of smoke begins to spread out as it travels from its point of origin, forming a smoke field in the shape of an inverted cone, becoming more dilute as it rises. As a result of the drop in smoke density, point detectors tend to become less sensitive the higher they are mounted. BS5839 part 1 thus limits the mounting height of point detectors for life protection to 10.5m, or 15m for property protection. On the other hand, beam smoke detectors, which sample across the entire smoke plume, are ideally suited for high ceiling applications. This is reflected in BS5839 part 1 which permits the use of beam detectors up to heights of 25m for life protection (type L), and 40m for property protection (type P).

Beam detector types

European approved beam smoke detectors are tested to EN54-12: 2002 Fire Detection and Fire Alarm Systems - Smoke Detectors - Line Detectors using an optical light beam.

There are two basic types of projected light beam detectors, both of which operate on the principle of light obscuration: a light beam is projected across the area to be protected, and is monitored for obscuration due to smoke. The two basic types are either an End-to-End beam detector or a reflective beam detector. The End-to-End detector has separate transmitter and receiver units, mounted at either end of the area to be protected. A beam of infrared light is projected from the transmitter towards the receiver, and the signal strength received is monitored. End-to End type detectors require power to be supplied both to the transmitter and the receiver, leading to longer wiring runs, and thus greater installation costs than the reflective type device. Reflective or Single-Ended type detectors have all the electronics, including the transmitter and receiver, mounted in the same housing; the beam is transmitted towards a specially designed reflector mounted at the far end of the area to be protected, and the receiver monitors the attenuation of the returned signal. Reflective devices are now the norm.

Although reflective beam detectors are now more commonly used than End-to-End beam detectors due to the substantial saving in installation, certain considerations need to be taken into account when they are used. It is important to understand that in the case of an End-to-End beam detector any object placed in the way of the beam that will decrease the signal strength of the beam will not compromise the operation of the beam detector, the worst that can happen is that a false alarm can be given. With a reflective beam detector, a reflective object placed in the beam detector path may cause sufficient reflection back to the receiver even though the signal to most of the detection area is blocked. This is particularly a problem in the first few metres of a beam detector with long beam path and special attention needs to be considered in the installation to ensure that this does not happen. This is likely to be more of a problem for beam detectors that use reflectors with lower amounts of reflection, usually small reflector types.

Relative cost

The cost of providing effective coverage is a significant issue. According to BS5839 part 1, a point smoke detector has a maximum radius of coverage of 7.5m. For a simple spacing plan, *figure 1a*, this translates to a maximum distance between detectors of 10.5m. Careful manipulation of the detector layout, *figure 1b*, can reduce the number of point detectors required to cover a given area, however to cover large areas, many point detectors will be required. For beam smoke detectors, BS5839 part 1 allows a maximum range of 100m, and coverage of 7.5m either side of the beam, giving theoretical area coverage of 1500m², *figure 1c*, an area which normally would require sixteen or more point smoke detectors to cover. Reducing the number of devices used will lower installation and maintenance costs. Manufacturer's recommendations and other factors, such as room geometry, may impose practical reductions of this maximum coverage; however, even with these reductions, beam smoke detectors will cover an area that would otherwise require a dozen or more point detectors. The major limitation of the projected beam smoke detector is that it is a line-of-sight device and consequently subject to interference from any object or person, which may enter the beam path, rendering its use impractical in most occupied areas with normal ceiling heights.

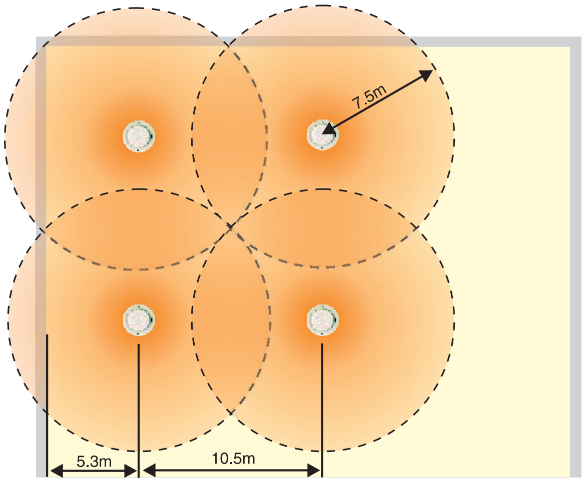

Figure 1a: maximum area coverage for point detectors

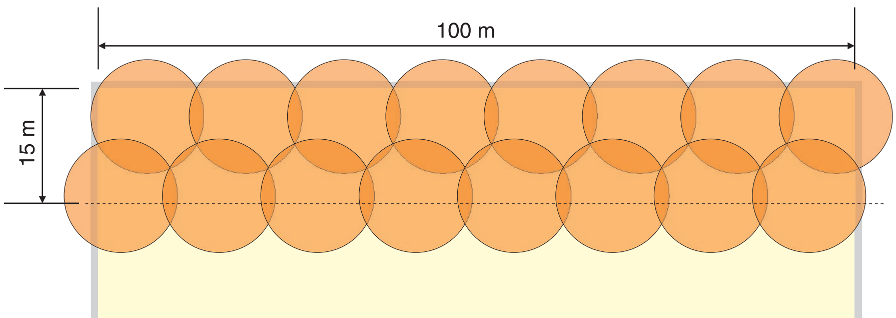

Figure 1b: point detector coverage over beam detector maximum area

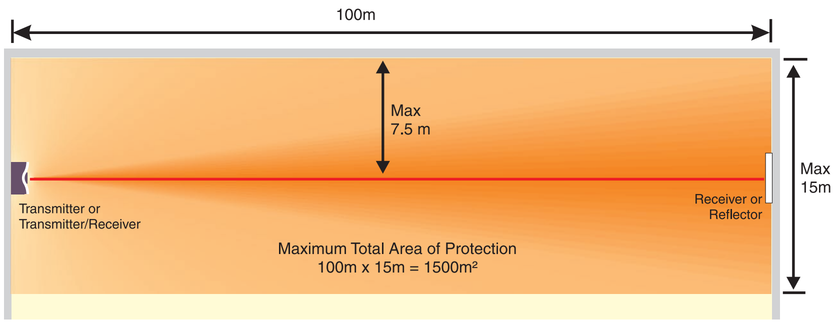

Figure 1c: maximum area coverage for beam detectors

Air movement

High air movement presents a special problem for detecting smoke for both point and smoke detectors because the propagation of smoke developing under normal conditions may not occur. High air velocity may also flush smoke out of the sensing chamber of a point detector, so careful consideration should be given to the point detector's performance where air velocities exceed 1.5 metres per second, or when air changes in the protected area exceed 7.5 changes per hour. Beam smoke detectors are not normally tested for stability in high airflow during approval testing because high air movement does not have as great an effect on their detection capabilities. A beam smoke detector's sensing range can be as long as 100m, so it is less likely that smoke will be blown out of the beam smoke detector's sensing area. Although reduced spacing is not normally required in high airflow areas, attention should be given to the anticipated behaviour of smoke in these applications.

Stratification

Stratification occurs when the air within a room forms into layers at different temperatures: for example, the area just beneath an atria roof may be heated by sunlight, and create a layer of hot air above the main volume of the room. Smoke is heated by the fire, and rises though cooler lower layers until it reaches the warmer layer, where it will not rise any further but will spread along the hot / cold boundary, rather than the ceiling, possibly never reaching detectors mounted on or near the ceiling. Normally on smooth ceilings, beam smoke detectors should be mounted between 300 and 600mm from the ceiling.

Tolerance to building movement

The main point to consider is that beam detectors require a very stable mounting surface for proper operation, a surface that moves, shifts, vibrates, or warps over time may cause false alarm or fault conditions. The detector should be mounted on a stable surface such as brick, concrete, a sturdy load-bearing wall, support column, structural beam or other surface that is not expected to experience vibration or movement over time. The unit can either be mounted directly to the structure of the building where typically ±10° of adjustment are provided, or, if for instance the detector needs to aligned on a diagonal across an area or has to be ceiling mounted, an adjustable mounting bracket that provides a much greater adjustment range can be used. The two beam detector components should never be mounted on easily deformed sections such as metallic cladding; if it is not possible to mount both components onto solid construction, then the transmitter should be fixed to the more solid surface, since movement of the reflector or receiver will have less effect than displacement of the transmitter.

A beam detector needs to be highly tolerant of movement in the building as it is subjected to various environmental forces. Wind, snow, rain and temperature changes can all cause a building to flex; for example, a 60km/h wind acting on a 100m^2 wall can generate a pressure of 4 tonnes. Over long ranges, even slight deformations of the mounting structure can cause the beam to move considerably from its target - over a 100m range, a movement of 0.5° at the transmitter will cause the centre point of the beam to move nearly 900mm. To ensure reliable operation, the beam detector should work satisfactorily with maximum angular misalignments of ±0.5° at the detector and ±10° at the reflector, allowing considerable temporary disturbances in the building's geometry to be accommodated without causing nuisance alarms or fault conditions to be generated.

Initial installation and set-up

The alignment of a beam detector is typically divided into four steps: coarse alignment, fine adjustment, gain adjustment and verification. The following description applies to a typical beam detector and a broadly similar process will be followed for any type of beam detector. End-to-End beam detectors will require an extra procedure as it will be necessary to correctly align both ends of the transmitter/receiver pair. The initial coarse alignment is achieved by using an integral optical gun sight and horizontal and vertical alignment knobs to centre the reflector in the alignment mirror. Once the unit has been roughly aligned, the fine adjustment process can be carried out. A digital display is provided on the detector circuit board and the engineer adjusts the vertical and horizontal alignment screws to achieve the maximum possible value on the display. During this procedure, the detector monitors the beam, and will adjust its internal gain to achieve the optimum response. When the cover is replaced, the unit automatically makes one final internal gain adjustment.

The final step is for the engineer to test the detector's fire and fault performance. Using a non-reflective opaque material, the reflector is completely blocked, which should cause a beam-blocked fault to be signalled after about 30 seconds. Sensitivity is then checked. The reflector is blocked to just below the relevant sensitivity setting using the graduated scale marked on the reflector - this should not cause any change to the beam state. Finally, the reflector should be blocked to just above the relative sensitivity setting, which should result in a fire alarm being signalled.

Sensitivity adjustment and drift compensation

The perennial balancing act for the detector manufacturer is the compromise in the sensitivity setting to balance performance between early detection of real fires and excessive numbers of nuisance alarms. In order to achieve optimum performance, technically advanced beam detector manufacturers provide automatic compensation to offset the effects of both short and long-term environmental changes. An auto–adjusting sensitivity algorithm automatically adjusts the alarm threshold over a period of hours to compensate for short-term changes in the protected environment, such as, for instance, fork lift trucks active during the working day, which could otherwise result in unwanted alarms. Such adjustments do not compromise the detector's ability to respond quickly to a fire incident.

As dust builds upon a beam detector's optical components, its sensitivity will increase leading to an increased susceptibility to nuisance alarms. Algorithms are provided to compensate for the gradual build up of dirt to maintain maintenance intervals whilst retaining constant sensitivity. However, the detector lenses and reflector (on a reflective type) will still need to be cleaned periodically. The maintenance interval will be dependant on site conditions: obviously enough, the dirtier the site the more frequent cleaning will be required.

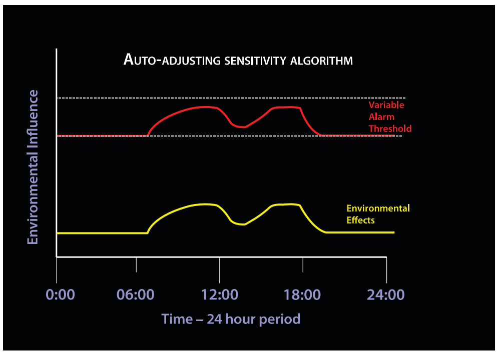

Figure 2: Auto short-term sensitivity adjustment

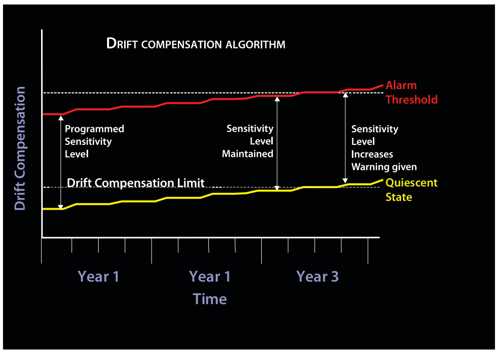

Figure 3: Auto long-term drift compensation

Maintenance and test

An issue associated with the installation of any smoke detector at a high level has been the need for costly and time-consuming access to the detector in order to conduct a full alarm test during annual routine maintenance. Most manufacturers provide remote test facilities for the electronics of their units, but the engineer would normally still be required manually to insert a filter into the beam in order to demonstrate that the device will go into alarm in the presence of smoke, the filter being an acceptable alternative to the smoke test normally required for point detectors. Only one manufacturer has so far developed conventional and addressable beam detectors fitted with a servo-controlled calibrated filter that can be moved in front of the receiver, simulating the effect of smoke entering the beam. If the correct signal reduction in the returned light is detected then the unit will enter the alarm condition, otherwise a fault signal is returned. This functionality, known as Asuretest, meets the periodic maintenance and testing requirements of most local standards as it fully exercises the complete alarm path, testing both the electronics and optics of the unit. Asuretest can be initiated from the ground level Remote Test Switch or, in the addressable version, directly from the control panel.

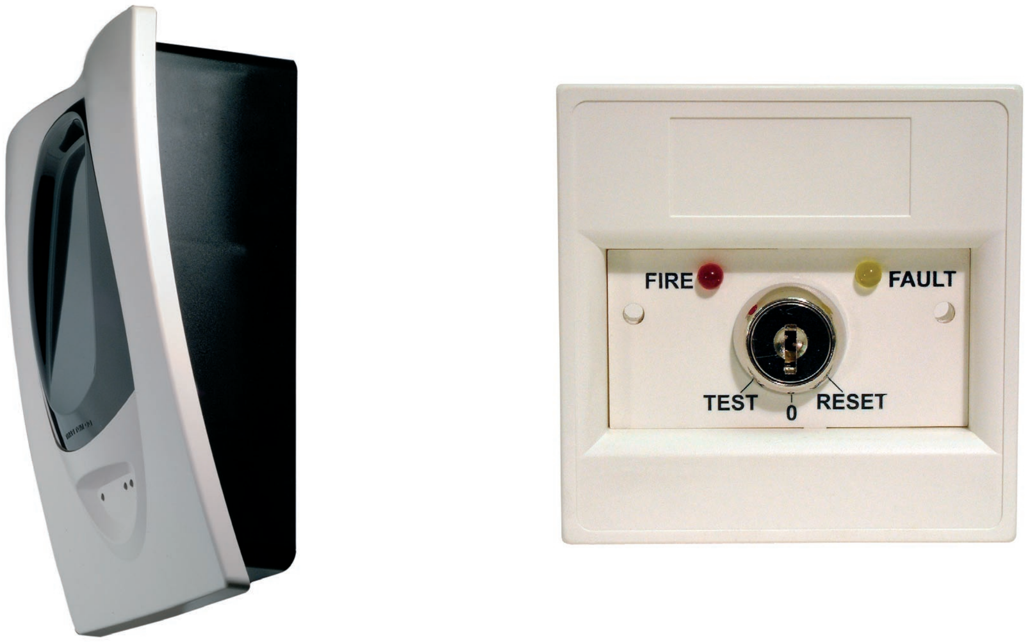

Figure 4: System Sensor Europe 6500 beam detector with Asuretest remote capability

Conclusions

Beam detectors give fire system designers an effective way of providing cost-effective protection of large high-ceilinged areas. Recent advances in set-up, automatic sensitivity adjustment and testing make the deployment of beam detectors as part of a fire detection system a less complicated and easier to manage option. In particular, System Sensor's remotely initiated Asuretest function, which provides a complete test of the optical and electronic elements of the alarm path, satisfies local standards, means that high level access equipment will not have to be hired, the Health and Safety implications associated with high-level working are not relevant and the costs of routine maintenance are significantly reduced.

*** Ends: body copy 2243 words ***

Notes to Rupert Gilbey, 10 January 2005.

Copy supplied by email. Drawings and scans to follow on CD. For further information:

Stuart Ball
System Sensor Europe
15 – 19 Trescott Road
Trafford Park
Smallwood
Redditch
B98 7AH
Tel: + 44 1527 406700
Fax: + 44 1527 406699
sales@sseuk.com
www.systemsensoreurope.com

Agency contact:
Nigel May
Parkfield Communications Limited
Parkfield House
Damerham
Hants
SP6 3HQ
tel: + 44 (0)1725 518321
fax: + 44 (0)1725 518378
nigel.may@parkfield.co.uk
www.parkfield.co.uk

System Sensor Europe is the world's largest manufacturer of smoke and thermal detectors for use in conventional and addressable fire detection systems.

Honeywell International is a $23 billion diversified technology and manufacturing leader, serving customers worldwide with aerospace products and services; control technologies for buildings, homes and industry; automotive products; turbochargers and specialty materials. Based in Morris Township, N.J., Honeywell's shares are traded on the New York, London, Chicago and Pacific Stock Exchanges. It is one of the 30 stocks that make up the Dow Jones Industrial Average and is also a component of the Standard & Poor's 500 Index. For additional information, please visit www.honeywell.com.

This release contains forward-looking statements as defined in Section 21E of the Securities Exchange Act of 1934, including statements about future business operations, financial performance and market conditions. Such forward-looking statements involve risks and uncertainties inherent in business forecasts as further described in our filings under the Securities Exchange Act.