Considerations When Specifying and Installing Beam Smoke Detectors

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Typical beam application
(click to enlarge)

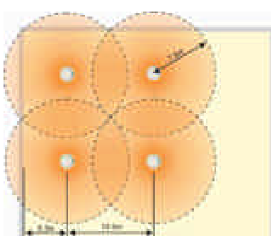

Figure 1a: maximum area coverage for point detectors
(click to enlarge)

Feature Article

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. 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 effective 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 and 40m for property protection.

BEAM DETECT\OR 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, End-to-End or reflective, 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 End-to-End detector has separate transmitter and receiver units mounted at either end of the area to be protected. End-to End 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 detectors have all the electronics mounted in the same housing: the beam is transmitted towards a reflector mounted at the far end of the area to be protected, and the receiver monitors the attenuation of the returned signal.

Although reflective detectors are now more commonly used than End-to-End devices due to the substantial saving in installation costs, 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's path, particularly if close to the unit, may cause sufficient reflection back to the receiver even though the signal to most of the detection area is blocked.

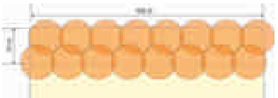

Figure 1b: point detector coverage over beam detector maximum area
(click to enlarge)

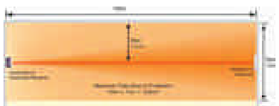

Figure 1c: maximum area coverage for beam detectors
(click to enlarge)

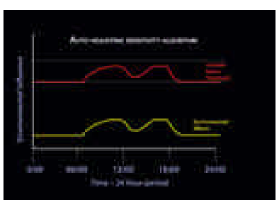

Figure 2: Auto short-term sensitivity adjustment
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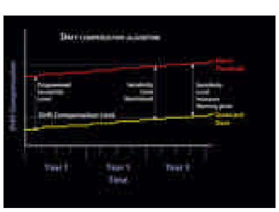

Figure 2: Auto short-term sensitivity

This is likely to be more of a problem for beam detectors with low amounts of reflection, usually small reflector types.

RELATIVE COST

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. 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. 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.

AIR MOVEMENT

High air movement presents a special problem in 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 a 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. Although reduced spacing is not normally required in high airflow areas, attention should be given to the anticipated behaviour of smoke in these applications.

TOLERANCE TO BUILDING MOVEMENT

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 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. 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

adjustment
(click to enlarge)

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, which 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 100m2 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 reflective 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 challenge for the detector manufacturer is the compromise in the sensitivity setting to balance performance between early detection of real fires and excessive 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 fork lift trucks active during the working day. 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 frequently cleaning will be required.

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.

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.

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