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Automatic Fire Detection Systems

1. Introduction

A fire alarm system is primarily installed for reasons of life safety to ensure all occupants have time to escape from a building safely. The need for and scope and extent of a system to be installed will usually be determined by the conclusions of the Fire Risk Assessment. Whilst life safety is the primary focus of such an installation it is also possible that a detection system may provide a benefit in terms of property preservation and business continuity. Whether this can be achieved will be dependent on the strategy that is implemented by the emergency responders and, more relevantly, the Fire Service. These two things will be influenced by.

- The level of compartmentation within a building: detection within a large undivided warehouse is unlikely to provide any significant property protection benefits but in a hospital, for example, is likely to be very effective
- Separation between structures: early detection may allow the Fire Service to prevent fire spread to surrounding buildings
- The building structure. Where there are combustible elements present or uncertainty around passive fire protections the Fire Service may act defensively
- The occupation of the premises: a high and continuous fire load will deter an active response
- The initial emergency response: whether a level of active intervention is a company standard
- The quality of the premises information the Fire Service are provided with on arrival (or beforehand)

A balanced approach therefore has to be taken and, with the specific goal of property preservation in mind, an appreciation of if and where a level of early automatic fire detection could provide a benefit.

There is no statutory requirement to install a physical fire alarm or fire detection system. You are only required to have 'an appropriate fire detection system' and this requirement could be satisfied by a high level of occupancy and verbal warnings. However, unless the premises is very simple, the Fire Risk Assessment is likely to lead you towards a physical system.

2. Standards

In the UK installation and maintenance of commercial automatic fire alarm systems is governed by ***BS 5839-1:2017, the code of practice for designing, installing, commissioning, and maintaining fire detection and alarm systems in non-domestic buildings.***

The Fire Service will only respond to systems that they have issued with a URN (Unique Reference Number). To be issued a URN, competency must be demonstrated and this can be achieved by employing third party certificated companies. Companies certificated to one of the **NSI Fire Schemes (Gold Standard)** or ***LPS 1014 Requirements for Certificated Fire Detection and Alarm System Firms*** (Loss Prevention Standard overseen by the Loss Prevention Council) are considered as "competent" for the requirements of the RRO (Regulatory Reform Fire Safety Order 2005) and the NFCC (National Fire Chiefs Council) policy. Both schemes use BS5839 Pt1 as their core but can be extended to include BS 5839 Pt 6: 2019 (Domestic Systems) and ***BS 6266: 2011 Fire protection for electronic equipment installations. Code of practice*** .

LPS 1014 requires **one** encompassing Certificate of Conformity for the project, i.e. single point responsibility and also requires, where available, the use of third party approved products. BAFE have adopted the LPS 1014 scheme as their own SP201 certification (in effect the same).

BAFE operate the SP203 scheme, which enables a different certificate to be issued for each of the 4 stages of design, installation, commissioning & handover and maintenance. SSAIB also offer certification for this scheme under licence from British Approval for Fire Equipment (BAFE)

2. Categories of system

BS 5839-1:2017, contains recommendations for the locations of fire alarm system components based on the objective the system should fulfil - known as Categories. These Categories are L and M for systems designed to protect life and Category P for those intended to protect property. It is perfectly acceptable, and very common, for a fire alarm system installed in a building to incorporate a mixture of Categories.

2.1 Category M

Providing the least responsive level of protection, Category M simply requires Manual Call Points (MCPs) installed throughout a site. This Category is not often used for entire premises, though is well suited to specific situations such as workshops or factories where the occupants are likely to notice a fire quickly or automatic detection would not be reliable. Category M is usually used for specialist areas of a building in addition to other Categories. All Category M installations need to have alarm devices - sounders, beacons, bells, voice alarms, etc. - throughout the site. Manual call points need to be prominently sited, readily distinguishable from non-fire alarm call points, and distributed such that, from any point in the building, it is impossible to leave the storey or building itself without passing one.

2.2 Category L

Category L systems are designed to protect life and thus focus on escape routes and areas of the building with a high fire risk. They can be thought of as cumulative, with each increasing the level of protection provided by the previous Category. All Category L installations should have alarm devices - sounders, beacons, bells, voice alarms, etc. - throughout the building regardless of their requirements for detection devices.

Category L4

Building on Category M, L4 has MCPs throughout the building for occupants to manually identify a fire while automatic fire detection **(AFD) should be installed along escape routes including stairwells**. AFDs used for Category L4 systems should be smoke detectors - specifically, optical point detectors or aspirating smoke detectors (ASD) that rely on optical smoke sensors.

PROTECTOR insurance

Category L3

In addition to MCPs throughout and optical AFD in escape routes, Category L3 stipulates **AFD be installed in all rooms, corridors and compartments that open onto escape routes.** These rooms may use any of the common detector types, unlike escape routes, so appropriate detectors should be chosen based on the purpose and fire risks within them. However, the standard does recommend that certain specialist detectors such as flame or video should only be used in these rooms in addition to common detectors.

Category L2

While the fire risks in rooms opening onto escape routes should be taken into consideration for L3 systems, this can often be done by common sense or in discussion with the client. **L2 systems, however, require that a thorough Fire Risk Assessment (FRA) be carried out by a competent person to identify areas of high fire risk. Appropriate AFD should then be used in the identified locations in addition to the requirements of L3.**

Category L1

L1 systems are the "ultimate" in life protection as they recommend both manual call points (MCPs) and automatic fire detection **(AFD) be installed throughout the entire premises**. For the AFD installed in addition to L2 requirements care should be taken to choose the detector types according to not only the fire risks in each room, but also the persons at risk. For example, heat detectors should not be the primary detector type in bedrooms as they will not provide quick enough warning to protect the occupant's life.

Category L5

Similar to L2, this Category can only be **designed and installed based on the findings of a thorough FRA** - except that L5 should not actually be attempted by designers or installers unless specified in the FRA. Category L5 is for meeting specialist fire safety objectives, often in variation to the recommendations where strict adherence would not be possible. Such systems could include automatically closing metal shutters on a shopfront to contain the fire away from a shared concourse, or adding optical point detectors to bedrooms not adjoining the escape route in addition to an L4 system. L5 systems should be designed in conjunction with, and agreed by, relevant authorities before they can be signed off for installation.

2.3 Category P - Property Protection

Although defined as a system designed to protect property, most Category P systems will provide some protection of life cover and will be used in addition to Category L requirements for certain reasons. Category P systems are usually added in response to assessments made by insurance companies.

Category P1

This type of system is designed to protect the entire building, and thus requires AFD throughout the premises. While not dependent on a thorough fire risk assessment (FRA), a FRA is helpful for designing P1 systems, as appropriate detectors will need to be installed in each room to cover the specific risks present. However, as it is focused on the protection of property, alarm devices (sounders, beacons, bells, voice alarms, etc) are only required where specified - in an on-site security office, for example.

Category P2

Category P2 requires AFDs in high risk areas, only. Category P2 systems are commonly used when combining with a life protection system other than Category M. For example, a building may have

Category L3 protection for escape routes and adjoining rooms, with an additional AFD in the server room that is not directly connected to an escape route.

"**L5"** - systems designed to satisfy a specific fire safety objective (other than that of a Category L1, L2, L3 or L4 system).

"L4" - installed within escape routes comprising, such as corridors and stairways.

"L3" - as "L4", plus automatic detection to rooms which open onto an escape route.

"L2" - as "L3, plus automatic detection installed in defined parts of the building.

"L1" - systems installed throughout all areas of the building.

"P2" - systems installed only in defined parts of the premises.

"P1" - systems installed throughout the premises.

3. Types of System

3.1 Conventional Fire Alarm (Zoned or 2 state)

- divides the premises into broad zones for both detection and evacuation
- in the event of an alert, the fire alarm panel identifies the zone, but not the precise detector/area
- most suitable for smaller or lower risk environments

Detection zones

Sub-division of a building into detection zones, which are typically protected by a number of manual call points and / or automatic detectors, is recommended for all but the smallest of premises. This is to ensure that those responding to the alarm are directed to the actual location of the fire and is a recommendation even for premises with addressable systems.

Alarm zones

Many premises have a simple evacuation procedure in the event of fire: when a manual call point or automatic detector is activated, an alarm sounds throughout the building to tell everyone to leave. In some, more complex buildings, however, a phased evacuation policy might be in place, in which case separate alarm zones might be required. In such situations, it is recommended that the boundaries of every alarm zone (other than external walls) are of fire-resisting construction. As the use of Alarm Zones implies that occupants in certain areas of a building will not be expected to evacuate immediately, the configuration of Alarm Zones might require approval by relevant authorities.

3.2 Addressable Fire Alarm

- each individual device has its own unique electronic address
- if one activates, the fire alarm panel tells you precisely where the problem is and can communicate with the control and indication equipment (cie) for identification, alarm and fault messages but can also communicate all states from normal up to fire in small steps. The cie takes the decision based on

condition from the analogue levels received from the detector. A pre-alarm can be acted upon before the evacuation sequence is initiated.

- most suitable for larger or higher risk environments - e.g. schools, care homes, hospitals

3.3 Wireless Fire Alarm

- uses a secure wireless link between the sensors and the fire alarm panel
- typically works like an addressable system, just without the wires
- most suitable for premises where you don't want lots of cables - e.g. churches, historic buildings

Systems may comprise: the fire alarm panel (control and indicating equipment or CIE), wiring, alarm sounders (and/or visual strobes), voice alarm, manual call points and detectors (the choice of which will be determined by the environment).

4. Choice of Detector

Fire detectors are designed to detect one or more of the four characteristics of fire: heat, smoke, combustion gas or infrared / ultraviolet radiation. Detectors will trigger an alarm system once one of these characteristics is identified. The choice of detector depends on the environment it's to be used in, combined with consideration of the type of fire it will be detecting. Choice is dictated by:

- The speed of fire detection required, based on an assessment of the fire risk
- Minimising false alarms, which can be caused by incorrect detection devices
- The nature of the fire hazard to be protected
- The probable growth and spread of a fire
- Environmental factors present – for example dust, humidity, temperature and smoke from other sources
- The size and expanse of the area to be protected
- Maintenance issues: accessing the detectors for testing

Ionisation smoke detector. Uses low level radioactive source to detect small and invisible products from a fire. Sensitive to initial stages of a fire. Have become less popular due to problems with disposal.

Optical (photo electric) detector. Use scattering and deflection of light to detect visible smoke particles. Unsuitable in dusty environments. Good for smouldering fires with white smoke e.g. electrical in origin.

Heat detector. Available at various fixed temperatures ranging from 60deg to 90deg C. Maybe used in areas such as kitchens where cooking activities may cause false alarms and temperatures fluctuate.

Rate of rise heat detector. More sensitive as it senses the rate of increase of temperature as well as a fixed temperature. May be used in smoking rooms or rooms with showers, kettles and limited cooking facilities.

Beam detector. Utilise optical technology and are suitable for protection of lofty and long (up to 100 metres) buildings where point detectors may present a challenge in terms of maintenance.

Aspirating detection. Continually samples the air by drawing it in through a perforated tube and detects incipient fire at a very early stage. Used where rapid detection (up to 100 times more sensitive) is essential to prevent damage e.g. computer rooms. Now used widely in a variety of applications due

to early detection and the reduced maintenance issues (detectors can be sited close to the ground and tubes run to inaccessible areas.

Carbon monoxide detectors. Maybe used where necessary to detect a smouldering fire before it takes hold e.g. a sawmill.

Multi-sensor detector. Combining more than one technology within a single sensor is proven to help in eliminating false alarms e.g. optical/heat and optical/heat/carbon monoxide. They perform well in most types of fire and are promoted heavily by the insurance industry in the drive to reduce false alarms.

Flame sensor. Four types: ultraviolet (UV), ultraviolet/infrared (UV/IR), multi-spectrum infrared (MSIR), and visual flame imaging. Suitable for clean burning fires such as those involving flammable liquids.

Linear heat detection. Heat sensitive cable. May be used to cover large areas where there is a dusty or smoky environment e.g. cable tunnels, loading canopies or high rack storage.

CCTV detection. Software incorporated into the cameras looks for movement of air, smoke and flames. If cameras are monitored can provide visual verification of a fire incident (which some Fire Authorities may require before attending)

Intrinsically safe. Used in hazardous areas with potential for explosive atmospheres.

The FIA have published a guide to help in the selection of the appropriate sensor: see appendix and

https://www.fia.uk.com/uploads/assets/uploaded/f76936fa-6ae3-4e1a-af85d9b34ab0c6d5.pdf

5. Design Considerations

The appropriate extent of automatic fire detection is normally determined by a fire risk assessment, rather than a rigid application of a system category to every building of a specific type or occupancy. Whilst it is not important to know the detail in the British Standard, the following information may be of relevance when assessing a detection system.

- Control equipment should be located close to where the Fire Service will enter the building and in an area of low fire risk. Repeater panels can be utilised where panels are required in a fire control centre or other occupied area.
- There is very detailed guidance in the standard relating to the siting of detectors but, in general, smoke detectors on flat ceilings are designed to cover 100 sq ms and no point in a room should be more than 7.5m from a detector (giving an approximate spacing of 15ms between detectors). Heat detectors cover 50 sq ms with no point being more than 5.3 ms from a detector. More detailed guidance relates to corridor widths, ceiling obstructions, walls, pitched roofs and stairwells. Optical beam spacings are 15 metres apart with no part of the protected area greater than 7.5ms from a beam.
- Detectors must be mounted close to the ceiling, up to 600mm for smoke and 150mm for heat but in both cases no closer than 25mm (most heads have this built into their design).
- Voids greater than 800mm should be provided with coverage as should ducts (interfaced to isolate the air handling equipment).
- Sound levels should be 65dBA in general areas and 75dBA at the bed head in sleeping risks. Note that 30dBA is lost through a fire door.
- Stand-by power should be provided to allow the system to operate for at least 24 hours after which sufficient capacity should remain to operate all fire alarm devices for at least 30 minutes.

- Many types of wiring can be used but should resist the effects of fire for 30 minutes: this applies only to the alarm function or an interface; detector and call point cables need not be fire resistant. Resistance can be achieved by using mineral insulated cable (MIC) or that conforming to BS6387. Segregation of cables can be achieved by using FR cable or physically separating from others by 300mm, or by using dedicated metal trunking
- Ancillaries may be operated directly by the volt free contacts in the panel or via an interface unit: this is usually an addressable device operating on a loop system. Ancillaries may be employed (for example) to: release a fire door; drop a smoke curtain; shut down plant; isolate the gas supply; initiate a smoke extraction system; open smoke vents. These should be designed to fail safe in the event of a fault.
- System components, e.g. manual call points, detectors, CIE (control and indicating equipment) and other fire alarm devices, must conform to relevant British Standards or Harmonised European Standards and have undergone type testing to these standards. Furthermore, it is advised that all components used have been certified under a recognized product certification scheme, i.e. third-party certification of product conformity to the relevant standard(s).
- The design should limit the effect of faults in and / or work on the system. A fault (but not fire) signal needs to be given at the CIE in the event of any failure in the critical signal path, which comprises all the components and interconnections between every fire alarm initiation point (whether manual or automatic) and the input terminals of each fire alarm device, as well as transmission equipment within the premises for routing of signals to an Alarm Receiving Centre (ARC).
- Communication with the Fire and Rescue Service is essential to derive the maximum benefit. For L systems this might be a phone call but for P systems there should be automatic transmission of alarm signals. N.B. automatic transmission of a signal is not a requirement of a Category P alarm.

6. Limitation of false alarms and unwanted fire alarm signals

It is vital that the selection and siting of each of the fire alarm devices in a system, whether manual, automatic or a combination of both, are such that the possibility of false alarms is limited as much as possible: for example, smoke detectors should never be fitted in kitchens or bathrooms; consideration must be given to dusty/corrosive atmospheres, air movement and transient fumes from vehicles. A person should be appointed to manage the fire alarm system, investigate and record false activations and liaise with the Installer / Fire Service to rectify problems. Responsibility for false alarm management rests with all parties: user; designer; installer and purchaser. The log book for the system should show the reason for activation, classified as one of four categories: unwanted alarms; equipment false alarms; malicious false alarms and false alarms with good intent. This will help identify trends and assist in rectifying problems.

7. Commissioning

The commissioning process involves the thorough testing of the installation to the recommendations of the Standard and to the designer's requirements (i.e. system specification). The work must be carried out by a "competent person", i.e. one who possesses the relevant current training, experience and capability to perform the task in accordance with all the relevant drawings and reference materials.

Part of the commissioning process involves ensuring that adequate records and all other relevant documentation have been provided to the end user or purchaser of the fire detection and fire alarm system. Of particular importance are accurate "as-fitted" drawings of the installed system and system-specific operation and maintenance manuals. Other requisite documentation includes: certificates for

the design, installation and commissioning of the system; all relevant records, e.g. any agreed variations on the original system design specifications; and a logbook for recording all system events e.g. fire alarm / fault signals, routine maintenance visits, etc.

8. Certification

Once a system has been commissioned, certificates must be provided for each of the three separate processes: design, installation and commissioning. Certification can be carried out by a single or multiple organisations but, in all cases, it is essential that the person who signs these certificates is competent to verify whether the recommendations of this Standard in respect of the process to which the certificate refers have, or have not, been satisfied.

Once the certification process has been satisfactorily completed, the system will be formally handed over to the user / purchaser. At this point, it is important that the organisation bearing contractual responsibility for the system issues a certificate of acceptance to the purchaser, for completion by them.

Once the final stages of handover, including certification, have been completed, responsibility for the day-to-day running and maintenance of the system passes to the management of the premises in which it has been installed.

9. Maintaining the system

No matter how technologically advanced a fire detection and fire alarm system might be with state-of-the-art self-monitoring and automatic fault detection features, there will always be the need for human observation and intervention to ensure its continuous smooth running and optimum performance. There are three main reasons for routine maintenance and testing:

- To identify any faults signalled and take the appropriate action to rectify them;
- To ensure there have been no major failures of the system, either as a whole or in part;
- To familiarise occupants of the building with the fire alarm signal(s).

As such, it is important for the premises management to institute a schedule of system testing, which can be sub-divided into weekly and monthly routines. Details of all tests should be recorded in the system logbook.

Weekly routine

The operation of a manual call point during normal working hours out at approximately the same time each week. Additional tests to be made at least once a month for any employees not usually present during the normal weekly test. In systems with multiple manual call points, a different one to be tested each week, so that all are eventually included in the schedule of testing over a period of time. The routine test time should not normally exceed one minute, so that the occupants of the premises can learn to distinguish between this weekly alarm and an actual fire alarm.In respect of voice alarm systems, the Standard recommends that these are tested weekly in accordance with BS 5839-8.

Monthly routine

The Standard applies two detailed recommendations for monthly testing by the user which can be summarised as follows:

- If the standby power supply to the system includes an automatically started emergency generator, this should be tested monthly;

PROTECTOR insurance

- If the standby power supply is provided by vented batteries, these should be inspected visually. Furthermore all vented batteries and their connections should be examined on a quarterly basis (i.e. every three months) by a person competent in battery installation and maintenance technology.

Inspection and servicing

Regular inspection and servicing of the system to be carried out in order to identify and rectify any faults, including false alarm problems. The inspection should also ensure that the user is notified of any changes made to the actual fabric of the building – e.g. extensions, alterations or remedial work – that might have been made in the meantime that have affected the system in any way. Changes in use and / or occupancy levels of a building can also have a detrimental effect on the protection offered by existing fire protection and fire alarm systems so any such factors must also be taken into consideration during the inspection process. The recommended period between successive inspection and servicing visits should not exceed six months – failure to implement this recommendation will result in the system not being compliant with BS 5839-1, with no allowance for variation. Because of the specialist nature of the work, inspections are usually contracted out to a fire alarm service organisation, whose competence can be assured by third-party certification.

Documentation

The logbook is a key document and, as well as the details of the manager / supervisor to whom responsibility for the fire detection and fire alarm system has been delegated, should contain a record of all the events that concern the system, whether these occurrences were scheduled or not (e.g. routine maintenance visits, test signals, fault signals, etc.). This comprehensive information can be valuable to whoever services the system and might also provide evidence of compliance with certain aspects of fire safety legislation, should such need arise.

Further information and guidance on this subject is available from:

- The Health and Safety Executive - https://www.hse.gov.uk/
- The Fire Protection Association - https://www.thefpa.co.uk/
- Other trade bodies

LPS 1014	http://www.redbooklive.com/
NSI	http://www.nsi.org.uk/approval/fire-detection-- alarms.aspx
BAFE SP203	http://www.bafe.org.uk/fire_protection/sp203.html

For clarification or further information please contact –

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Appendix: Extract form FIA Guidance: Fire Alarm Detector Application and Documentation of the Selection

EXAMPLE FIRE RISKS

Fire risk detection key: very good = ★★★★★ good = ★★★★ moderate = ★★★ poor = ★★ very poor = ★

Fire risk	Example fire(s)	Ionisation detection	Optical (scatter) detection	CO detection	Heat detection	Flame detection	Typical multisensor detection, eg optical-heat*	Typical multisensor detection, eg optical-heat-CO*
Smouldering white smoke	Electrical fire	★★	★★★★★	★	★	★	★★★★★	★★★★★
	Smouldering wood	★★★	★★★★★	★★★★	★	★	★★★★★	★★★★★
Smouldering dark smoke	Smouldering furnishings	★★	★★★★	★★★★★	★	★	★★★★	★★★★★
Smouldering changing to flaming	Waste paper bin fire	★★★★	★★★★	★★	★★	★★★	★★★★	★★★★
Flaming (clean burn)	Burning solvents	★	★	★	★★★	★★★★★	★★★	★★★★
Flaming (dirty)	Burning oils	★★	★★★	★★	★★★	★★★★★	★★★★	★★★★

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