The Audit of Active Fire Safety Systems

Practitioners' Assessment and Approval Procedures Manual

FIRE SAFETY PANEL N.I.

BSi Business Information

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Contents

Foreword

The purpose of this manual is to assist regulatory and enforcing authorities and approved inspectors in England and Wales, in the audit, assessment and approval of active fire safety systems.

For ease of reference, regulatory and enforcing authorities are termed the ‘approving authority’. Surveyors and inspectors acting for regulatory and enforcing authorities, such as local authority building control departments, fire authorities, licensing authorities and approved inspectors are termed ‘assessors’ in the text of the manual.

Even though the manual is principally aimed to assist assessors, the Northern Ireland Fire Safety Panel acknowledges that the manual will assist fire safety professionals, designers and other interested parties in the wider fire safety community.

The origins of the manual emanate from the introduction of the Building Regulations (Northern Ireland) 1994, when local authority building control departments in Northern Ireland assumed increased responsibility for ensuring that buildings are designed and constructed in such a manner as to provide adequate levels of fire safety. To measure adequacy, deemed-to-satisfy documents were referenced and fire safety engineering techniques promoted. This shift in emphasis to functional requirements means that alternative solutions, to standards prescribed by guidance, can be provided, utilizing active fire precautions, as opposed to the more traditional passive measures. For example, the use of fire detection systems to equate, in life fire safety terms, to a higher level of fire resistance or increased travel distances.

The responsibilities and style of the Regulations required building control staff to acquire new skills and knowledge and, in consequence, the Fire Safety Panel undertook a survey of building control and fire authority staff throughout Northern Ireland in 1995, to identify training needs in relation to changes in fire safety legislation. In response to the survey’s findings, it was considered appropriate to produce a guidance document to cover the most common active fire protection systems.

It was self-evident to the Panel, whose members represent the fire safety interests of building control, fire authority, licensing authorities and the relevant Northern Ireland government department, that all approving authorities were facing the same problems and dilemmas when approving and/or accepting fire alarm systems.

In 1998, the Panel commissioned Colin Todd of C.S. Todd & Associates to produce guidance on six active systems. The brief was to offer informed direction for assessors in relation to plan assessment and site inspection, and to produce check sheets highlighting the most important issues involved. Guidance was also requested on the validation and assessment of specialist design and the importance of commissioning and test certificates.

Initially, the document was primarily intended for use by building control surveyors and was designed as an aide-mémoire to be used at each stage to ensure that the major aspects of the system design and installation had been considered, also providing building control staff with the appreciation necessary to raise appropriate questions in relation to design and construction.

It was quickly recognized that the use of the manual would assist all assessors in the fire safety community in the better adjudication of the relevant systems and installations.

First issued in 1998, the manual was subsequently reviewed and reissued in July 2002 to reflect subsequent changes in legislation and codes of practice.

This edition incorporates amendments to Procedure 1 to reflect the revision of BS 5839-1 in October 2002 (and subsequent amendment in 2004) and reflects the context of the appropriate legislation in Great Britain.

The Panel views this document as an important and pivotal tool in the assessment, approval and audit, both at plan stage and on site, of active fire safety systems, and believes that the procedures outlined in the manual establish an industry standard for such checking processes.

Clive Black

Northern Ireland Fire Safety Panel

June 2006

Introduction

NOTE: This is not a design guide, but a guide for a structured assessment of active fire precautions.

This manual sets out the recommended procedures for assessment and approval of active fire protection systems. It is envisaged that the assessment process will often be subdivided into three distinct stages, namely:

- initial design assessment, based on a specification and design drawings;
- assessment of installation work by means of periodic inspections as work progresses; and
- final acceptance after commissioning of the installation.

The format of the procedures contained in this manual reflects this subdivision. It is, however, appreciated that the level of detail provided at the design stage, and the extent of inspections at the work-in-progress stage, will vary according to the size and complexity of the project. Full application of the procedures described in relation to the first two stages will tend to be relevant only for large projects.

In the case of a small project, it may be relevant to base design assessment on a statement that the proposed system will conform to a relevant code of practice, such as a British Standard. Nevertheless and in general, as a minimum, the system specification (which may be performance based) and any drawings that are being prepared for tender purposes should be examined. Areas of coverage by the system should be readily identifiable from the documentation presented to the enforcing authority.

A certificate of conformity with the relevant code of practice will usually be required at the final acceptance stage of the project or installation. However, even in the case of a small project, acceptance should not be based solely on a certificate of conformity issued by an installer.

Case law tends to suggest that an assessor or enforcing authority cannot fully discharge their duties or avoid liability, purely by relying on certification by others. Accordingly, the procedures described for final acceptance will generally apply to all installations, regardless of size, albeit that, in the case of installations that have been certificated by others, inspection may be based on a degree of sampling, as opposed to inspection of every single component. Equally, it is expected that a certificate of conformity, issued by the installer, would normally be a prerequisite of assessment.

For each active fire protection system, the documentation in this manual comprises two parts. Firstly, there is a simple but comprehensive assessment checklist for each of the three stages of assessment. This checklist is an aide-mémoire to the assessor. It need not be followed slavishly, nor need plan checking or site inspection be carried out in the order of items in the checklist; the order of items is, nevertheless, intended to represent a logical process that will often reflect the order in which the procedures are carried out. Additionally, while it is recommended that *all* items in the checklists should be addressed, some items carry a higher priority, i.e. it is essential that they are addressed. **In each checklist, these items are marked with an asterisk and emboldened.**

On completion of the checking or inspection procedure, the checklist for the procedure should be perused to ensure that all relevant matters have been addressed. The tick boxes in the checklist may be used to record that each item has been checked, thereby constituting objective evidence for the purpose of, for example, compliance with BS EN ISO 9001, that the procedure has been carried out.

Secondly, the manual includes a description of the actual checking or inspection procedure to which the checklist refers. These procedures are provided as supporting guidance, to which the assessor can refer when addressing any point on the associated checklist. It is envisaged that, once assessors become familiar with the recommended procedures, they will need to make only occasional reference to this second part of the documentation; the primary document will be the relevant checklist.

The code of practice on which each procedure is based is clearly identified in both the procedure and associated checklist. This is usually a British Standard, but, in the absence of a British Standard, it may be another recognized code, such as one published by a nationally recognized body or trade association. It should be noted that, if another code of practice is adopted in the design of a system, variation of the procedures and checklists may be necessary.

The procedures in this manual do not attempt to reproduce the content of the relevant code of practice, with the exception of some of the most frequently required data; accordingly, the procedures make extensive reference to the codes of practice on which they are based. Again, however, as assessors become familiar with these procedures, they will also become familiar with the data in the codes of practice on which they are based, so that making reference to them becomes a less frequent task.

It is not possible in this manual to cover every detailed recommendation of any code in either the checklists or the procedures. Although major points are generally contained in the manual, assessors should ensure that their knowledge of the codes of practice is sufficient to enable a proper evaluation of any system. It should also be noted that the contents of this manual do not in any way attempt to interpret or modify the recommendations of the codes of practice that are addressed; in case of doubt, reference should always be made to the code of practice, which must take precedence over any information contained in the manual.

The manual is reproduced in loose-leaf format, so that specific procedures can be revised when appropriate without the need for revision of the entire manual. It is the responsibility of the user of this manual to ensure that all sections are current at the time of use. The manual should be regarded as a controlled document under any quality assurance system operated by the enforcing authority.

It has been assumed in the drafting of this manual that the execution of the procedures contained herein will be entrusted to suitably trained and skilled persons. Neither the Northern Ireland Fire Safety Panel, nor the consultants, C.S. Todd & Associates Ltd, accept any liability whatsoever for any consequences arising from the use of this manual or from any errors or omissions herein.

The Fire Safety Panel would welcome feedback from users of this manual regarding its contents. Comments, or suggestions for amendments or additions, should be sent to the Northern Ireland Fire Safety Panel.

Procedure 1

Assessment of a manual fire alarm system or automatic fire detection and alarm system for non-domestic proposals

Procedure 1: Introduction

This procedure relates to assessment of a manual fire alarm system or an automatic fire detection and alarm system. (In this procedure, the generic term 'fire alarm system' is used to cover both types of system.) In both cases, assessment is based on compliance with BS 5839-1. References in brackets to a clause number are references to clauses in BS 5839-1. In the case of a manual system, sections relating to automatic fire detection are not applicable and the associated not applicable (N/A) boxes on the checklist should be ticked.

It should be noted that BS 5839-1 is a code of practice and, as such, full compliance with all of its recommendations may not be appropriate in every case (see Clause 7). Variations from any recommendation should, however, be subject to agreement with the approving authority (and any other interested parties – see 7.2).

Any design for a fire alarm system should include a reference to system Category (see Clause 5 and Procedure 1A.1). Where a Category L2, L5 or P2 system is required, the design should identify the areas to be protected; in the case of L2, there should be identification of those areas that are to be protected over and above those required in a Category L3 system.

Normally, automatic detection systems should incorporate manual call points. The recommendations for a Category M system will normally be satisfied as well as the recommendations for the appropriate Category of automatic fire detection system. As such, it is not necessary to refer to Category M when specifying a Category L system. The exception is a Category L5 system (see later). If an L5 system is specified and manual call points are required, the system should be referred to as Category M/L5. The same would apply to Category P systems for property protection.

Procedure 1A
Assessment of specification and design drawings

Checklist

Assessment of specification and design drawings for a fire alarm system at:

Name/address of premises: ....

....

....

Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

....

....

....

....

....

*** It is essential that items marked thus, and in bold type, are checked.**

System Category (see BS 5839-1) ❑ M ❑ L1 ❑ L2 ❑ L3
❑ L4 ❑ L5
❑ P1 ❑ P2

1A.1* Are the areas in which automatic fire detection is provided sufficient to meet the system Category specified above? ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.1]

Comments:

....

....

....

1A.2* Are the types of automatic detector used appropriate? ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.2]

Comments:

....

....

....

1A.3* Is detector spacing and siting appropriate? (Check for features such as ceiling obstructions.) ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.3]

Comments:

....

....

....

1A.4* Is there adequate provision of manual call points? ❑ Yes ❑ No

[See Procedure 1A.4]

Comments:

....

....

....

1A.5* **Is the zoning adequate?** ❑ Yes ❑ No

[See Procedure 1A.5]

Comments:

....

....

....

1A.6 Is there adequate provision of short circuit isolators? (addressable systems only) ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.6]

Comments:

....

....

....

1A.7 Is there adequate tolerance to open circuit and multiple faults? (primarily addressable systems) ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.7]

Comments:

....

....

....

1A.8* **Does the sounder layout appear suitable for the sound levels required?** ❑ Yes ❑ No

[See Procedure 1A.8]

Comments:

....

....

....

1A.9* **Is the proposed location(s) of control and indicating equipment satisfactory?** ❑ Yes ❑ No

[See Procedure 1A.9]

Comments:

....

....

....

1A.10* **Has the correct standby battery duration been specified?** ❑ Yes ❑ No

[See Procedure 1A.10]

Comments:

....

....

....

1A.11* **Has the correct cable type been specified?** ❑ Yes ❑ No

[See Procedure 1A.11]

Comments:

....

....

....

Procedure 1A
Assessment of specification and design drawings

Procedures

Procedure 1A.1: Verification of system Category

(Refer to BS 5839-1:2002, Clause 5 and Clause 8.)

BS 5839-1 divides fire alarm systems into eight different system categories:

- Category L1 — automatic detection systems installed throughout the protected building.
- Category L2 — automatic detection systems installed only in defined parts of the protected building; a Category L2 system should normally include the coverage required of a Category L3 system.
- Category L3 — systems intended to give early warning to those beyond the room of fire origin to permit escape before escape routes are impassable.
- Category L4 — systems installed within escape routes only.
- Category L5 — systems installed within defined areas to meet a specific fire safety objective (other than that of Category L1, L2, L3 or L4 systems).
- Category M — manual systems containing no automatic fire detectors.
- Category P1 — automatic detection systems installed throughout the protected building for the protection of property.
- Category P2 — automatic detection systems installed only in defined parts of the protected building for the protection of property.

Category L systems are intended to protect life. Category P systems are intended to protect property, are not normally required by legislation and are not covered by the assessment processes outlined in this manual.

When examining plans for a manual fire alarm system, the concept of protected areas does not arise. Question 1A.1 on the checklist is, therefore, not applicable in this case.

When examining plans for an automatic fire detection system, it should be ensured that there are one or more detectors in every area that is required to be protected in order to satisfy the recommendations of BS 5839-1 for the particular system Category. (The adequacy of the number and siting of detectors is addressed in a later procedure.)

In the case of a Category L1 system, all rooms and areas should be protected. However, voids less than 800mm in depth need not normally be protected unless extensive spread of fire or smoke could take place within the void before detection or, based on a fire risk assessment, the risk warrants the provision of detectors.

There are other exceptions to the provision of detectors in a Category L1 system. Provided they are of low fire risk, areas from which detectors may be omitted are:

- toilets, shower rooms and bathrooms;
- stairway lobbies and toilet lobbies;
- small cupboards (typically less than $1m^2$).

In the case of a Category L5 system, selected rooms or areas are protected. These rooms or areas will often have been determined on the basis of a fire risk assessment or the outcome of a fire engineering solution. At one extreme, this might simply involve installing a smoke detector in an access room to compensate for inadequate vision from an inner room. However, it may require that detectors are installed throughout a large area, as early warning may form a key consideration in meeting a specific fire safety objective for that area. This may arise, for example, from relaxation of normal, prescriptive structural measures. The type and location of detectors used need careful consideration to ensure that the specified objective is satisfied.

Category L4 systems involve the provision of detectors only in defined escape routes – stairways, corridors and other areas that form part of the common escape routes.

Category L3 systems are intended only to protect escape routes. However, they have the specific objective of ensuring that warning is given at a sufficiently early stage to permit people to escape before the escape routes are blocked by smoke (e.g. in a sleeping risk). In order to satisfy this objective, BS 5839-1 recommends that detectors should be installed both on the escape routes and in rooms opening into the escape routes. This particularly applies to accommodation that comprises cellular rooms off corridors (other than certain very short corridors) where, if a fire starts in a room, there is a possibility of smoke logging of the corridor before people can be alerted by corridor detectors and make their escape.

The first step in verifying the protection provided by a proposed Category L2 system should be to ensure that the system meets the recommendations for a Category L3 system. In a Category L2 system, there will then be additional detection in specified areas of high fire hazard (i.e. where there is a high probability of fire) and/or high fire risk (i.e. there is high risk to occupants).

Thus, for example, in a hotel, there will be detectors in the bedroom corridors and in the bedrooms themselves, to satisfy the recommendations for a Category L3 system. If a Category L2 system were required, there would, in addition, be detection in other areas (e.g. kitchens, function rooms, etc.), regardless of whether these open directly into escape routes. Also, in a Category L3 system, detectors in bedrooms may be heat detectors. However, if, say, in rooms intended for disabled people, smoke detectors are installed to give early warning to disabled people in the event of a fire in their own room, the system effectively becomes Category L2.

Procedure 1A.2: Detector types

(Refer to BS 5839-1:2002, Clause 21.)

There are four basic types of detector, each of which responds to a different fire phenomenon, namely:

- heat;
- smoke;
- combustion gas (usually, carbon monoxide);
- flame.

Some detectors, known as multi-sensor detectors, respond to more than one of these of these phenomena. Some multi-sensor detection systems distinguish between a fire and non-fire phenomena by analysing the signals from sensing elements within each detector that respond to different phenomena.

This manual addresses primarily heat, smoke and combustion gas detectors; if flame detectors are proposed, specialist advice may be required.

In determining whether detector types are suitable, the prime concern should be whether the detectors will respond quickly enough to satisfy their objective. This will depend mainly on the type of detector (i.e. whether heat, smoke or carbon monoxide), but it may also depend on whether the height of the protected space is such that detection will be delayed.

However, account should also be taken of the propensity for false alarms. False alarms can negate the benefits of automatic fire detection by inducing complacency on the part of building occupants. It should be ensured that, subject to the overriding need for adequately early warning, the proposed detector types do not present an obvious potential for false alarms.

Carbon monoxide fire detectors are a relatively new innovation. The Standard recognizes that their use may be beneficial in some situations, but also that these detectors have limitations. They will not respond to freely burning fires, in which there is an unlimited supply of oxygen. They are, however, likely to respond to other fires faster than a heat detector. They may also be suitable for use in some situations in which a smoke detector would normally be used, but will have less potential for false alarms from environmental sources, such as steam, dust, cooking fumes, etc.

Smoke detectors must normally be used in escape routes in order to provide an adequately early warning; heat detectors would be unsuitable for this purpose. In Category L systems, smoke detectors installed within corridors and stairways forming part of the means of escape should normally be of the optical type. A mixture of smoke detectors and carbon monoxide detectors might be considered, subject to acceptance that a free burning fire with a plentiful supply of oxygen may not be readily detected by the carbon monoxide detectors.

However, in the case of an L3 system, since the objective is merely to, in effect, give a warning before the door of the room is seriously attacked by fire, heat, smoke or carbon monoxide detectors may be used within the adjoining rooms. (These detectors may also be mounted on the wall near the door, as opposed to in the conventional position on the ceiling.)

BS 5839-1 imposes limits on the ceiling heights at which different types of detector may be used. If the proposed design involves the use of heat detectors on ceilings higher than 7.5m or smoke detectors on ceilings higher than 10.5m, reference should be made to BS 5839-1:2002, Table 3 for further information.

In order to avoid false alarms, the following points should be considered in the review of a design:

- Rate-of-rise heat detectors can produce false alarms if the ambient temperature is subject to rapid fluctuation (e.g. in kitchens). A fixed-temperature heat detector should be used under these circumstances.

- Optical detectors are particularly responsive to steam; an ionization chamber detector is less likely to produce false alarms if sited close to a source of steam.
- Optical smoke detectors are more responsive than ionization chamber detectors to tobacco smoke, dust and clouds of small insects.
- Ionization chamber detectors are particularly responsive to fumes generated during certain cooking processes, including toasting of bread. They are more responsive than optical detectors to vehicle exhaust fumes and may become unstable if subject to rapid air velocities.
- Carbon monoxide fire detectors are less likely to generate false alarms from many environmental influences than smoke detectors.

Procedure 1A.3: Detector spacing and siting

(Refer to BS 5839-1:2002, Clause 22.)

A rough check that sufficient detectors have been provided in any area, particularly large open-plan areas, can be carried out by dividing the area (in square metres) by 50 if heat detectors are used or by 100 if smoke detectors are used; this gives the approximate number of detectors that should be present.

A more accurate check should be carried out with the use of a pair of compasses. Set the pair of compasses to 7.5m for smoke detectors or to 5.3m for heat detectors, in accordance with the scale of the drawing in question. Centre the pair of compasses on each detector and draw around each detector a circle of radius 7.5m or 5.3m (see Figure 1). The areas within the circles are the areas protected in accordance with BS 5839-1. No point within the protected area should lie outside one of these circles.

In the case of beam-type smoke detectors or line-type heat detectors, the protected area should be regarded as a rectangle centred on the beam or line-type heat detector and 15m or 10.6m in width, respectively (i.e. the protected area encompasses all points within 7.5m of the beam or 5.3m of the line-type heat detector).

Note that, in the case of sloping roofs, BS 5839-1 permits the aforementioned linear distances to be increased by 1 per cent per degree of slope, up to a maximum of 25 per cent. For example, if the roof slopes at 10°, the distance may be increased by 10 per cent to 1.1 times the given distance.

It is rare for design drawings to show structural features, such as deep beams. However, if such features are shown on the drawings, it should be confirmed that they are unlikely to result in the need for additional detectors [see 22.3j)]. Additional detectors will be required in the case of a honeycomb ceiling, where the beams/downstands form small cells [see 22.3k)].

Within staircases, detectors should be sited such that there is one detector at the top of the staircase and further detectors on each main landing.

Other than in Category L4 and L5 systems, detectors should also be sited within 1.5m of all shafts, such as open staircases and lifts. (This may also be appropriate in some Category L5 systems.) If there are any lantern lights used for ventilation or having a height above the ceiling greater than 800mm, detectors should be fitted within these.

Carbon monoxide detectors should be sited in exactly the same manner as smoke detectors.

a) Coverage of point detectors

b) Coverage of line or beam detectors

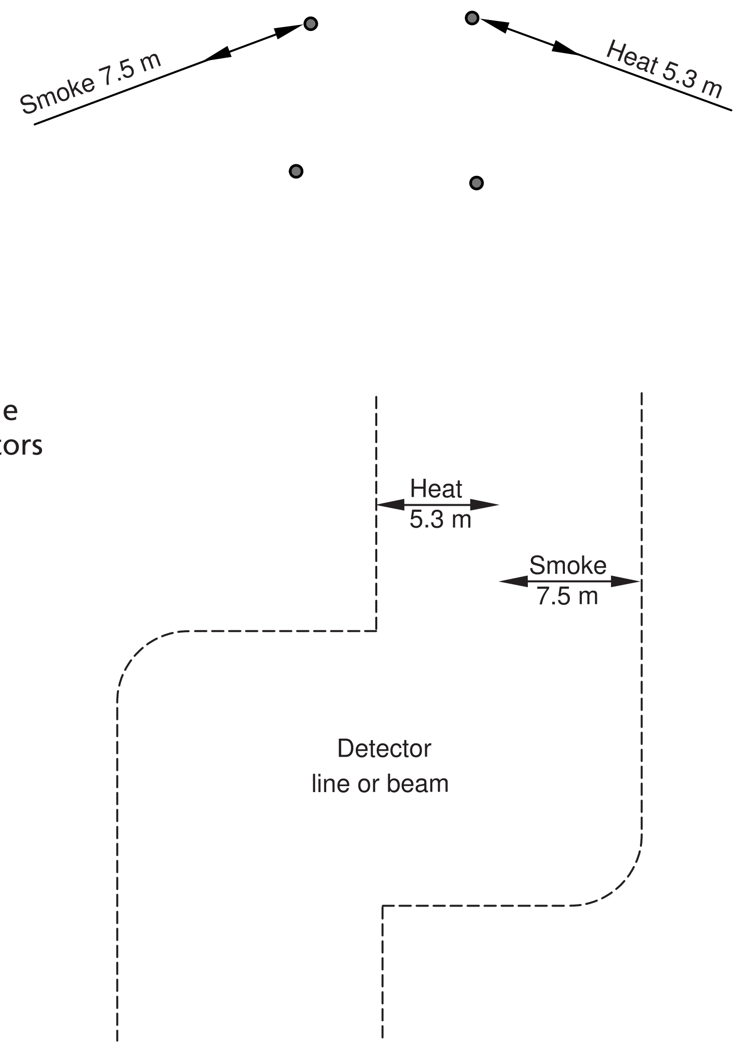

Figure 1 – Spacing under open flat ceilings

(Reproduced from Fire Detection and Alarm Systems: A guide to the BS Code, BS 5839 : Part 1: 1988 by Peter Burry.)

Procedure 1A.4: Siting of manual call points

(Refer to BS 5839-1:2002, Clause 20.)

Manual call points should be sited at all exits to the open air. (Note that this does not mean only fire exits.) Call points should also be sited at all storey exits. The latter call points may be sited within the accommodation, at the door to each staircase or on staircase landings. However, in phased evacuation buildings, only the former option should be adopted; call points should not be sited on staircase landings.

The drawings should then be checked to ensure that the maximum travel distance from any point in the building to the nearest manual call point does not exceed 45m. Note that shorter distances apply if rapid fire development is likely or a significant proportion of the occupants have limited mobility [see 20.2e)]. If actual travel distance cannot be measured (e.g. if layout is unknown), a direct distance of 30m should be applied.

Procedure 1A.5: Zoning

(Refer to BS 5839-1:2002, Clauses 13–14.)

At the design stage, proposals for zoning may or may not have been formulated. In addressable systems, in particular, where zoning is a software rather than hardware matter, final zoning of the system might not be undertaken until a later stage in the project.

Whether checking design drawings or reviewing a completed installation, the following points should be checked:

- The floor area of any detection zone should not exceed 2,000 m^2. However, in Category M systems, the detection zone size may be increased to 10,000m^2 in completely open-plan areas (such as warehouses).
- Detection zones should be restricted to a single storey [except in small buildings – see 13.2.1c)].
- Automatic detectors in enclosed shafts that form one fire compartment, such as staircases and lift shafts, should each be in separate detection zones. (See Figure 2.) Call points on stair landings should be part of the same zone as the detectors on that floor.

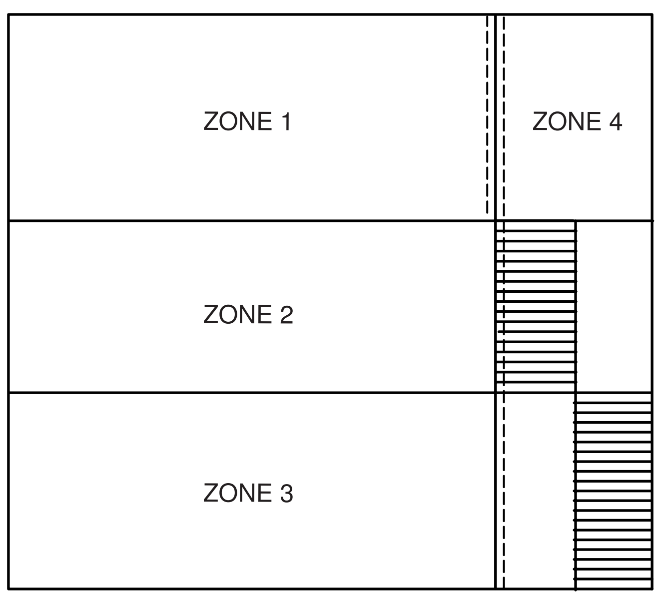

Figure 2 – Automatic fire detection in stairways

(Reproduced from Fire Detection and Alarm Systems: A Guide to the BS Code, BS 5839 : Part 1: 1988 by Peter Burry.)

- The search distance should not exceed 60m [see 13.2.3 b)]. Search distance is the distance that must be travelled within a detection zone to determine the position of a fire. In an open area, the actual search distance could be zero (see Figure 3), whereas, in cellular accommodation, long search distances can occur within a relatively small area (see Figure 4). Search distance restrictions do not apply to addressable systems in which it is possible to clearly identify the location of the detector that has activated.

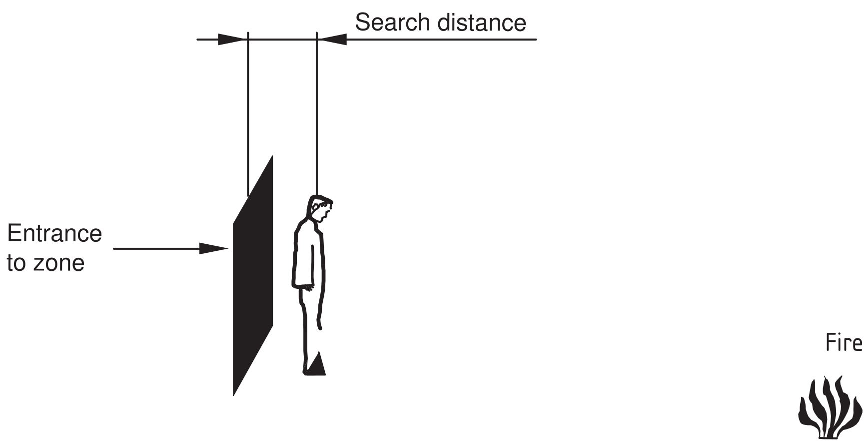

Figure 3 – Search distance in an open area

(Reproduced from Fire Detection and Alarm Systems: A Guide to the BS Code, BS 5839 : Part 1: 1988 by Peter Burry.)

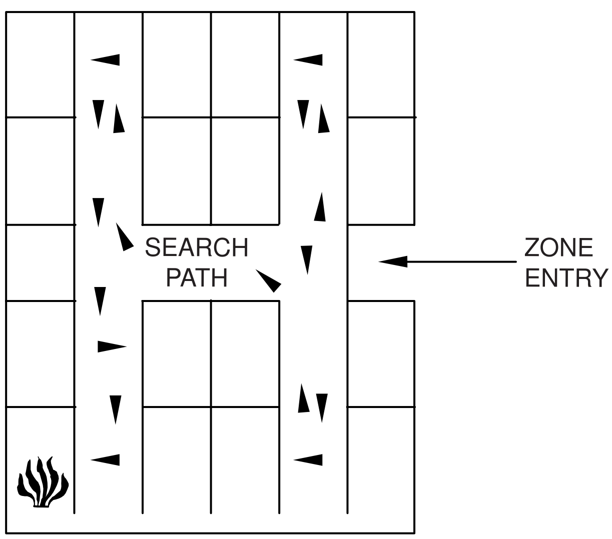

Figure 4 – Search distances

(Reproduced from Fire Detection and Alarm Systems: A Guide to the BS Code, BS 5839 : Part 1: 1988 by Peter Burry.)

Alarm zones differ from detection zones in that they constitute an area in which the alarm signal can be given separately and independently of alarm signals in other alarm zones. Simple systems in which there is simultaneous evacuation of the entire building are not divided into alarm zones. Conversely, where there is a two-stage alarm system, capable of giving alert and evacuate signals, there will be a number of alarm zones.

The following points should be noted regarding alarm zones:

- The boundaries of alarm zones should comprise fire-resisting construction.
- An alarm zone can incorporate more than one detection zone (but not vice versa). Alarm zone boundaries should coincide with detection zone boundaries.

Procedure 1A.6: Short circuit isolation

(Refer to BS 5839-1:2002, 12.2.2.)

This information is only relevant in the case of addressable systems and it may not be available at the design stage. If, however, the locations of short circuit isolators are shown on the design drawings, the adequacy of provision can be checked at this stage.

Equally, regardless of whether or not this matter has been considered at the design stage, it should be reviewed at final acceptance to ensure that the provision of short circuit isolators is adequate in relation to the as-installed wiring.

At whichever stage short circuit isolation is being checked, the easiest way to confirm conformity to the British Standard is to review the locations of short circuit isolators on drawings (specification or as fitted). However, it will be necessary for the drawings in question to show cable routes, making it more likely that this will be possible to check only on completion of the project.

Verification of whether the recommendations of the British Standard have been met can be carried out by reviewing the locations of detectors between pairs of short circuit isolators; these detectors will be isolated simultaneously in the event of a short circuit on wiring between isolators. Isolated detectors should:

a) not cover an area of more than 2,000 m^2;
b) all be located on the same floor of the building (other than, at most, five detectors on the floor above and five detectors on the floor below).

Procedure 1A.7: Verification of tolerance to other faults

(Refer to BS 5839-1:2002, 12.2.2.)

This relates primarily to addressable systems, as correct zoning of a conventional system will normally result in compliance.

In the case of addressable systems, it should first be confirmed that a single open circuit fault cannot remove protection from an area greater than that permitted for a single short circuit. In most addressable systems, wiring is run in a loop configuration and it is possible to communicate with detectors in both directions on the loop. Under these circumstances, the installation will inherently meet the recommendation in question.

However, in some addressable systems, radial circuits are run to serve specific areas. Since a single, open circuit fault at the start of the radial circuit will result in isolation of all detectors on that circuit, it is important to ensure that the radial circuit with fire detectors does not serve an area greater than 2,000m^2 or more than one floor of the building.

Two simultaneous faults should never remove protection from an area greater than 10,000 m^2. This means that, in a normal addressable system, no loop should serve more than this area.

Again, it may not be possible to check these matters at the design stage but they should, at least, always be checked at final acceptance.

Procedure 1A.8: Review of sounder siting

(Refer to BS 5839-1:2002, Clause 16.)

It is not possible to determine from design drawings whether the sound levels recommended in the British Standard will be achieved. This should be confirmed at final acceptance (see Procedure 1C.5).

However, a quick review of sounder layout may enable any major shortfalls in sounder provision to be identified. In particular, the following two points should be noted:

- In rooms where people sleep, a sound level of 75 dB(A) is unlikely to be achieved unless there is a sounder within the room. Normally, hotel bedrooms are likely to require a sounder in every bedroom. Refer to site inspection procedures.
- If there is more than one door between any point and the nearest sounder, a sound level of 65 dB(A) may not be achieved at that point (see Procedure 1C.5 regarding measurement of sound levels). Refer to site inspection procedures.

Procedure 1A.9: Siting of control and indicating equipment

[Refer to BS 5839-1:2002, 23.2.1 a).]

In general terms, control and indicating equipment should be sited on the ground floor and in the immediate vicinity of the entrance to the building that is likely to be used by the fire service. If there are a number of entrances that may be used, repeat indicators (and possibly controls) may be necessary.

The area in which the control equipment is sited should be of low fire risk. In the case of Category L and Category P systems, the area in which the control equipment is sited should be protected by the automatic detection, unless this area is manned continuously or the fire hazard is negligible. This should be confirmed by reference to the design drawings.

Procedure 1A.10: Required battery duration

(Refer to BS 5839-1:2002, Clause 25.)

The duration of the standby battery in Category L and Category M systems should be capable of maintaining the system in operation for at least 24 hours, after which there should be sufficient capacity to provide a full evacuation signal in all alarm zones for at least 30 minutes. Longer standby periods may be required for Category P systems.

An emergency generator may be used as a partial replacement for standby batteries in a Category L system and Category M system, provided that the generator is automatically started on failure of the normal supply. Under these circumstances, the standby duration may be reduced to a period of six hours [see BS 5839-1:2002, 25.4 e) 2)].

Procedure 1A.11: Cable types

(Refer to BS 5839-1:2002, Clause 26.)

Fire alarm systems should be wired throughout in fire-resisting cable. This includes mains supply circuits, call point and detector circuits, as well as sounder circuits.

BS 5839-1 refers to two levels of fire resistance termed as 'standard' and 'enhanced'. The level used will depend upon the application. In practice, the recommendations of the code [see 26.2 c)] are such that enhanced cables will normally be necessary in phased evacuation buildings, in which evacuation occurs in four or more phases, buildings greater than 30m in height and most hospitals, unless any of these buildings are fully sprinklered. If, in a fire engineering solution, the integrity of fire detection and alarm system circuits need to be maintained for a prolonged period, the use of cables of enhanced fire resistance should be considered.

Procedure 1B
Assessment of work in progress

Checklist

Asssessment of work in progress for a fire alarm system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

1B.1* **Are the required areas being protected?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.1]

Comments:

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1B.2* **Are the correct types of detector being installed?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.2]

Comments:

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1B.3* **Is detector spacing and siting appropriate?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1B.1]

Comments:

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1B.4* **Are sufficient manual call points being installed?** ❑ Yes ❑ No

[See Procedure 1A.4]

Comments:

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1B.5* **Are manual call points being installed at the correct locations?** ❑ Yes ❑ No

[See Procedure 1B.2]

Comments:

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1B.6* **Does the sounder layout still appear to be suitable, taking into account partitions, doors, etc?** ❑ Yes ❑ No

[See Procedure 1A.8]

Comments:

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1B.7* **Is the control and indicating equipment being installed in a suitable location?** ❑ Yes ❑ No

[See Procedure 1A.9]

Comments:

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1B.8* **Are the correct cable types being installed?** ❑ Yes ❑ No

[See Procedure 1A.11]

Comments:

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1B.9 Is mechanical protection being provided for cables where appropriate? ❑ Yes ❑ No ❑ N/A

[See Procedure 1B.3]

Comments:

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1B.10 Are fire alarm cables being segregated from all other cables? ❑ Yes ❑ No

[See Procedure 1B.4]

Comments:

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1B.11* Is the standard of cable installation satisfactory? ❑ Yes ❑ No

[See Procedure 1B.5]

Comments:

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1B.12* Has a suitable mains supply been provided? ❑ Yes ❑ No

[See Procedure 1B.6]

Comments:

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Procedure 1B
Assessment of work in progress

Procedures

Procedure 1B.1: On-site inspection of detector spacing and siting

(Refer to BS 5839-1:2002, Clause 22.)

Inspection on site provides the first opportunity to ensure that the detailed recommendations of BS 5839-1 are satisfied; much of this detail cannot be determined from drawings. As well as a broad check that the general rules for spacing are being satisfied (see Procedure 1A.3 and BS 5839-1:2002, 22.3), particular attention should be paid to the following recommendations of BS 5839-1:

- Detectors should be sited at the highest parts of the protected areas.
- Heat detectors should not be sited more than 150mm below the ceiling or roof, while smoke detectors should not be sited more than 600mm below the ceiling or roof.
- Detectors should be sited within each apex of a pitched or north-light roof (increased spacings apply to these detectors). These detectors should be sited in the actual apex, but may be displaced laterally provided they are not located more than 600mm below the apex.
- There is a limit to the ceiling height at which detectors will provide effective protection (see BS 5839-1:2002, Table 3 and Table 4).
- Detectors should not be mounted within 500mm of any walls or partitions; walls, partitions or storage racks reaching to within 300mm of the ceiling should be treated as reaching the ceiling, so dividing the space into separate rooms.
- Detectors should be mounted at least 1m from any air supply inlets in air-conditioning systems; where the air supply is through a perforated ceiling, the ceiling should be imperforate for a radius of at least 600mm around each detector.
- Ceiling obstructions, such as structural beams, deeper than 10 per cent of the ceiling height should be treated as walls.
- Shallow beams (less than 250mm) and isolated attachments, such as light fittings, cause a local disturbance to the flow of smoke; detectors should not be mounted closer to such beams and attachments than twice the depth of the attachment.
- In areas that are protected, voids greater than 800mm in height should also be protected.

Procedure 1B.2: Checking locations of manual call points

(Refer to BS 5839-1:2002, Clause 20.)

Manual call points should generally be fixed at a height of 1.4m above the floor, but minor variations from this height (of up to 200mm) are acceptable. Lower heights are also acceptable in premises in which the alarm is likely to be raised by, for example, wheelchair users. The locations chosen should be conspicuous, easily accessible and likely to remain free from obstruction.

The manual call points should stand out against the background. Where they will be viewed from the side (e.g. in corridors), they should not be flush mounted, although they may be semi-recessed, provided the front face is proud by at least 15mm. Although not a specific recommendation of the British Standard, it is sensible that manual call points are not mounted so close to walls that any side entry test keys required to test the devices cannot be inserted.

Procedure 1B.3: Checking that mechanical protection of cables is adequate

[Refer to BS 5839-1:2002, 26.2 h).]

Steel wire armoured and mineral insulated copper sheathed cables do not normally require any additional mechanical protection. Other cables should be provided with additional mechanical protection in the circumstances described in BS 5839-1, namely:

- where they are less than 2m above the floor, e.g. drops to manual call points (other than in relatively benign environments such as offices, shops and similar premises, in which cable is clipped to robust construction);
- where physical damage or rodent attack is likely.

Any cable may need additional mechanical protection if it is exposed to particularly arduous conditions, such as impact by forklift trucks.

Suitable means of providing mechanical protection comprises enclosure in conduit, trunking or ducts. Alternatively, the cable may be chased into plaster finishes or laid on tray.

Procedure 1B.4: Checking segregation of wiring

[Refer to BS 5839-1:2002, 26.2 k), l), m) and n).]

The purpose of segregation is to minimize any potential for other circuits to result in malfunction of the fire alarm system arising from:

- damage resulting from the need for other circuits to be installed in, or removed from, conduit, ducts or trunking containing the fire alarm system circuit(s);
- electromagnetic interference to the fire alarm system circuit(s) as a result of the proximity of another circuit.

The fire alarm cables should not be installed within the same conduit as the cables of other services, to avoid the risk of mechanical damage.

Fire alarm cables may be installed within the same trunking as the cables of other services, but, regardless of whether they are mineral insulated or soft skinned, a separate compartment should be provided solely for the fire alarm cables. The partition within the trunking should be strong, rigid and continuous. The purpose of the recommendation is to avoid damage to the fire alarm cables when modifications are carried out to other circuits (for example, when other cables are stripped out).

In certain cases, such as when a new fire alarm system is fitted to an existing building, it may not always be possible to provide a separate conduit, trunking or compartment for fire alarm cables. In such cases, a variation from the recommendations of the standard might be considered, but would need the acceptance of the approving authority. Care must be taken in such cases to avoid electromagnetic interference to fire alarm circuits from other cables.

Where a multicore cable is used for the interconnection of fire alarm circuits, none of the conductors should be used for circuits other than those of the fire alarm system. To avoid electromagnetic interference with the fire alarm signals, care needs to be taken that any recommendations made by the manufacturer of the fire alarm equipment in respect of separation of fire alarm cables from the cables of other services are followed.

Low voltage fire alarm cables (e.g. 230 V circuits) should be segregated from extra-low voltage fire alarm cables (e.g. 24 V circuits). Separate cables of the types permitted by the Code are, themselves, a suitable form of segregation, subject to compliance with any recommendations by the manufacturer of the fire alarm equipment in respect of separation for the purposes of avoiding electromagnetic interference.

The mains supply to any control, indicating or power supply equipment should not enter the equipment through the same cable entry as cables carrying extra-low voltage. Low voltage and extra-low voltage cables should be kept separate as far as practicable within equipment.

Having segregated the fire alarm circuits from the other circuits and, in the case of trunking, kept the fire alarm cables within a separate compartment from other circuits, it is important that this situation is maintained. It is also important that there is no interference with fire alarm circuits as a result of confusion between these circuits and other circuits. Accordingly, all fire alarm cables should be of a single, common colour that is not used for cables of general electrical services in the building. The colour red is preferred. However, it would be possible to conform to BS 5839-1 by using another colour, provided the same colour is not used for cables of other electrical services in the building.

Procedure 1B.5: Checking the standard of cable installation

[Refer to BS 5839-1:2002, 37.2.]

It should be ensured that surface run cables are neatly run and securely fixed at suitable intervals (e.g. if MICS cables are used, clips should be fitted every 600mm in the case of horizontal runs and 800mm in the case of vertical runs). Checks should be carried out to ensure that, within any false ceilings, fire alarm cables are securely supported to permanent constructions (and are not, for example, lying on top of the false ceiling tiles).

Where a cable passes through an internal wall, a smooth clearance hole should be provided. If additional mechanical protection is necessary, a smooth bore sleeve should be sealed into the wall. It should be ensured that the ends of the sleeve are free from sharp edges to guard against damage to cables during installation.

Joints in cables should be avoided. Where joints are necessary, they should be terminated in a suitable junction box, that should be marked 'FIRE ALARM'.

Methods of cable support should be such that circuit integrity is not reduced. [See 26.2 f).] The methods of support should withstand a similar temperature, and duration of temperature, as the cable itself, while maintaining adequate support. Plastic cable clips, cable ties or plastic conduit and plastic trunking, where these products are the sole means of cable support, are unlikely to be suitable.

Procedure 1B.6: Checking fire alarm mains supplies

[Refer to BS 5839-1:2002, 25.2 f).]

The contractor should be requested to identify, for the assessor, the source of the mains supply for the fire alarm system. The connection to the mains supply should be via an isolating switch-fuse or similar device (e.g. a dedicated miniature circuit breaker at a main distribution board) that is dedicated to the fire alarm system. The contractor should be requested to prove that the supply serves no other system. At final acceptance, it should be confirmed that the isolator that serves the fire alarm system is labelled 'FIRE ALARM: DO NOT SWITCH OFF'.

The mains supply should be fire resisting and be segregated from the cables of all other services, including emergency lighting (see Procedure 1B.4). It should also meet the requirements for protection against mechanical damage (see Procedure 1B.3).

There should be no residual current device (rcd) protection on the supply to the fire alarm system. Again, this should be demonstrated by the contractor. If rcd protection is necessary for electrical safety (e.g. in rural areas), the rcd should be dedicated to the fire alarm system.

The mains supply to all parts of the system, particularly the control and indicating equipment, should be provided with a double pole isolator, located in the vicinity of the equipment served. It should be possible to lock the facilities in both the normal and isolate positions to prevent unauthorized use.

Procedure 1C
Final acceptance

Checklist

Final acceptance of a fire alarm system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

1C.0* **Has the control equipment been examined and tests at the control equipment been witnessed?** ❑ Yes ❑ No

[See Procedure 1C.0]

List tests and results:

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1C.1* **Are the batteries provided of sufficient capacity to power the system for the duration required?** ❑ Yes ❑ No

[See Procedure 1C.1]

Comments:

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1C.2 Is the charger rating sufficient? ❑ Yes ❑ No

[See Procedure 1C.2]

Comments:

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1C.3* **Has a suitable mains supply been provided?** ❑ Yes ❑ No

[See Procedure 1B.6]

Comments:

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1C.4* **Is a suitable zone plan provided?** ❑ Yes ❑ No

[See Procedure 1C.3]

Comments:

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1C.5 Do all devices conform to relevant British Standards? ❑ Yes ❑ No

[See Procedure 1C.4]

Comments:

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1C.6* **Have detectors been installed in all areas that are required to be protected?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.1]

Comments:

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1C.7* **Have the correct types of detector been installed?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.2]

Comments:

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1C.8* **Is detector spacing and siting appropriate?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1B.1]

Comments:

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1C.9* **Is there adequate provision of manual call points?** ❑ Yes ❑ No

[See Procedure 1A.4]

Comments:

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1C.10* **Have manual call points been installed at the correct locations?** ❑ Yes ❑ No

[See Procedure 1B.2]

Comments:

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1C.11* **Is the zoning adequate?** ❑ Yes ❑ No

[See Procedure 1A.5]

Comments:

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1C.12 Is there adequate provision of short circuit isolators? (addressable systems only) ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.6]

Comments:

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1C.13 Is there adequate tolerance to open circuit and multiple faults? (primarily addressable systems) ❑ Yes ❑ No ❑ N/A

[See Procedure 1A.7]

Comments:

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1C.14* **Are sound levels and alarm signals adequate?** ❑ Yes ❑ No

[See Procedure 1C.5]

Comments:

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1C.15* **Is all control and indicating equipment suitably sited?** ❑ Yes ❑ No

[See Procedure 1A.9]

Comments:

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1C.16* **Have the correct cable types been used?** ❑ Yes ❑ No

[See Procedure 1A.11]

Comments:

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1C.17* **Are any visual alarms adequate?** ❑ Yes ❑ No ❑ N/A

[See Procedure 1C.6]

Comments:

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1C.18 Has mechanical protection been provided for cables, where appropriate? ❑ Yes ❑ No ❑ N/A

[See Procedure 1B.3]

Comments:

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1C.19 Are fire alarm cables segregated from all other cables? ❑ Yes ❑ No

[See Procedure 1B.4]

Comments:

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1C.20* Is the standard of cable installation satisfactory? ❑ Yes ❑ No

[See Procedure 1B.5]

Comments:

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1C.21* Have all fire alarm service penetrations been fire stopped? ❑ Yes ❑ No

[See Procedure 1C.7]

Comments:

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1C.22 Is the method of interfacing with any ancillary services satisfactory? ❑ Yes ❑ No ❑ N/A

[See Procedure 1C.8]

Comments:

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1C.23 Has adequate documentation been provided to the user? ❑ Yes ❑ No

[See Procedure 1C.9]

Comments:

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Procedure 1C
Final acceptance

Procedures

Procedure 1C.0: Witnessing tests at the fire alarm control equipment

There is a variety of tests that may be carried out at the fire alarm control and indicating equipment to confirm that the control equipment conforms to BS EN 54-2 and that it enables the installation to conform to BS 5839-1. It may not be appropriate to carry out every test in every case. For example, some tests that may be appropriate for an addressable system can be omitted or do not arise, in the case of a conventional system. Similarly, there may be greater confidence in a well-proven or commonly used control panel or, more particularly, in one that is certificated as conforming to BS EN 54-2 by an independent certification body.

While at the control and indicating equipment, the following points should *always* be confirmed:

- that there are at least two independent sounder circuits or an equivalent arrangement (to conform to BS 5839-1, in most cases, only one sounder need be fitted to the second circuit);
- that the control equipment is marked to indicate conformity to BS EN 54-2;
- that, on or adjacent to the control equipment, there is an evacuate control or controls, by which alarm signals can both be started and, after silencing, restarted;
- that there is a zonal display capable of giving a simultaneous indication of a fire in every detection zone by means of lamps or LEDs;
- that all controls are secure against unauthorized operation (either by a facility such as a ‘key enable’ control or by security over access to the controls themselves, e.g. by means of a locked door);
- that, if there is a need for transmission of mains failure to a remote manned centre, this facility operates correctly;
- that, if there is a separate power supply unit, the connections between the power supply unit and the control equipment are duplicated.

The following ‘menu’ of system tests should at least be considered and it should be agreed between the assessor, the contractor and the user as to which tests are to be carried out:

- **Three-second response test:** operation of any manual call point should result in an audible alarm signal, in at least the zone of origin, within 3 seconds.

- **Battery removal test:** disconnection of the standby power supply should result in a fault warning within 15 minutes; the system should be capable of operating normally and initiating a fire signal under these conditions.
- **Simulated mains failure test:** disconnection of the mains supply should result in a fault warning within 30 minutes; the system should be capable of operating normally and initiating a fire signal under these conditions.
- **Sounder circuit fault test:** disconnection of a sounder circuit and short circuit of a sounder circuit should each result in a fault warning within 100 seconds.
- **Detector circuit fault test:** an open circuit fault on a detector circuit should result in a fault warning within 100 seconds.

  A short circuit on the detector circuit should also result in a fault warning within 100 seconds. In the case of an addressable loop, an indication will normally be given at the control panel to identify any devices with which communication has been lost, so enabling the correct operation of the first short circuit isolator to be confirmed and enabling confirmation that it is suitably sited.
- **Detector removal test:** this test need normally be considered only in the case of conventional systems. Its purpose is to confirm that removal of any detector(s) does not result in disablement of any manual call point. If it is known that detectors are wired on different detection zones from manual call points or that the wiring is such that there are no manual call points 'downstream' of any detector, this test need not be carried out. Otherwise, it should be possible to remove any number of detectors on any detection zone without disabling any manual call point. If this test is carried out, ideally several detectors should be removed as, in some (non-compliant) systems, removal of one detector will not disable devices downstream, whereas removal of several will do so.

Where the cause and effect for the system has necessitated site-specific programming, the cause and effect should be proven or at least sampled. In particular, two-stage alarm logic, phased evacuation logic and plant shutdowns should be witnessed. Any preprogrammed sequences that involve timers (e.g. use of staff alarms or automatic conversion from alert to evacuate) should be checked to ensure that the timers are correctly set.

Procedure 1C.1: Checking adequacy of battery capacity

(Refer to BS 5839-1:2002, Annex D.)

The standby batteries for fire alarm systems normally comprise sealed lead acid batteries. In order to verify that sufficient battery capacity has been provided to cater for the standby duration required, the following test should be carried out by the fire alarm contractor and be witnessed by the assessor.

The quiescent current, I_Q (in amps), should be measured by inserting a calibrated ammeter in series with the battery and isolating the mains supply, permitting the audible fault warning to continue during the course of the test. A full evacuation signal should then be given throughout the building, so enabling the full alarm load, I_A, to be measured. (To be more accurate, it would be necessary to generate an alarm condition on every device in the installation, but this is generally impracticable.)

The battery capacity (in ampere-hours) is given by the formula:

$$C_{min} = 1.25\ (T \times I_Q + D\ I_A/2)$$

where *T* is the required standby period in hours and *D* is a derating factor based on the alarm load and the battery capacity (a commonly used figure is 1.75, but this may be unnecessarily onerous; however, *D* should never be less than 1).

Procedure 1C.2: Verification of adequacy of charger rating

[Refer to BS 5839-1:2002, 25.3 d).]

It should be confirmed that the power supply is capable of providing the maximum alarm load, I_A, measured in Procedure 1C.1. It should also be confirmed that the rating of the power supply is sufficient to charge flat batteries within 24 hours, while providing the quiescent load of the system.

Procedure 1C.3: Checking zone plans

[Refer to BS 5839-1:2002, 23.2.2 f).]

BS 5839-1 recommends that, on or adjacent to the control and indicating equipment, there should be a diagrammatic representation of the building, showing at least the building entrances, the circulation areas and the division into zones. This may, alternatively, be provided by an illuminated mimic, a VDU and printer or two (main and back-up) VDUs.

Procedure 1C.4: Conformity of components to British Standards

(Refer to BS 5839-1:2002, Clause 11.)

Confirmation should be obtained from the fire alarm contractor that all components (e.g. manual call points, automatic detectors and control and indicating equipment) conform to the relevant British Standard.

Procedure 1C.5: Verifying sound levels and frequencies

(Refer to BS 5839-1:2002, Clause 16.)

The assessor should witness measurements of sound levels in at least a sample of areas. Particular consideration should be given to suspect areas that, from an inspection of the building or a study of the drawings, may suffer from low sound levels. There is usually little point in measuring sound levels in normal-sized rooms in which sounders are located. Measurements should always be carried out in cases where there is more than one door between any point and the nearest alarm sounder or, in the case of sleeping risks, if there are no sounders within the rooms in which people sleep. Wherever measurements are made, it should be ensured that all doors in the area are closed at the time of the test.

The British Standard allows the sound level to be lower than the normal minimum of 65dB(A) [i.e. 60dB(A)] in areas of limited extent and in staircases and small rooms.

Care should also be taken in the case of buildings with acoustic partitioning, as the attenuation characteristics of the partitioning may be such as to reduce sound levels to well below those recommended in the British Standard.

It should also be confirmed that the sound level in any area in which an emergency call will be made to the fire brigade in the event of a fire is not so loud as to interfere with telephone communications. This recommendation will often apply, for example, in the case of a telephone switchboard.

The British Standard recommends that the frequency of sounders should lie between 500 Hz and 1,000 Hz, unless the frequency range of background noise would mask these frequencies. This can only be confirmed by reference to the data sheets for the alarm sounders.

In premises designed for public entertainment, retail premises, etc. in which sound levels of music are likely to be greater than 80dB(A), the music should be muted automatically when the fire alarm signal is given.

Any external sounders should silence automatically after 30 minutes.

Procedure 1C.6: Checking visual alarms

(Refer to BS 5839-1:2002, Clause 17.)

Where ambient noise levels are high [greater than 90 dB(A)], there may be a need for visual alarms to supplement the audible alarms. An example is a noisy plant room, such as a boiler room. There are no standards for these devices, nor relevant guidance on coverage, light levels, etc. They should, however, not be mounted lower than 2.1m above floor level.

A commonsense approach has to be adopted, but it should be ensured that the number, distribution and light output of the devices used would be sufficient to attract the attention of anyone working in the area in question.

Procedure 1C.7: Fire stopping

[Refer to BS 5839-1:2002, 37.2 l) and m).]

All penetrations for conduits, ducts, trunking and cables should be fire stopped to the full thickness of the barrier that is penetrated. Within ducts, trunking, etc., it may also be necessary to install appropriate barriers to prevent the spread of fire. It should be noted that this may not, contractually, be the responsibility of the fire alarm contractor. However, conformity to BS 5839-1 cannot be claimed until this work is completed.

Procedure 1C.8: Ancillary services

(Refer to BS 5839-1:2002, Clause 9.)

No power should be supplied from the fire alarm system to ancillary services when the system is in the quiescent state, although power may be drawn in the alarm state. The contractor should be requested to verify or demonstrate that the method of interfacing with any ancillary services is such that this recommendation is satisfied. It should also be checked that ancillary circuits are separately fused, so that a fault on an ancillary circuit cannot prejudice the fire alarm system. It should also be noted that BS 7807 recommends that all cables to emergency facilities should be wired directly to actuators or to motor control panels and not via an intermediate system, such as a BMS computer (unless the intermediate system has been designed with the integrity of the relevant emergency system).

Procedure 1C.9: Documentation

(Refer to BS 5839-1:2002, Clause 40.)

It should be confirmed that separate certificates of conformity to BS 5839-1 have been issued by those responsible for design, installation and commissioning. The certificates should unambiguously confirm full conformity to BS 5839-1 or clearly state all variations from the recommendations of the code.

In addition, the following documents should be provided to the user.

- An operation and maintenance manual.
- As fitted drawings. (These should show the locations of all equipment, such as manual call points, detectors, sounders, control and indicating equipment, short circuit isolators and junction boxes. The drawings should also show cable types and sizes and wiring routes; drawings should be carefully checked to show that they do indicate wiring routes, as these are often omitted from drawings.)
- A log book in which the user should record all faults, alarm conditions, service visits, etc.

NOTE: This is not a design guide, but a guide for a structured assessment of active fire precautions.

Procedure 2

Assessment of an automatic sprinkler system

Procedure 2: Introduction

NOTE: This is not a design guide, but a guide for a structured assessment of an automatic sprinkler system.

This procedure relates to assessment of an automatic sprinkler system. Approval is based on conformity to BS 5306-2. References in brackets to a clause number or table are references to subclauses or tables in BS 5306-2.

It should be noted that, for insurance purposes, BS 5306-2 is supplemented by technical bulletins, produced by the Loss Prevention Council (LPC); the combination of BS 5306-2 and these technical bulletins constitutes the LPC Rules for Automatic Sprinkler Installations. The technical bulletins make use of new developments resulting from research or service experience. Notwithstanding that the LPC Rules, and hence the technical bulletins, are intended for insurers, it may be relevant to take account of specific technical bulletins in considering any proposed sprinkler installation.

The fundamental basis for sprinkler system design is the hazard occupancy. Although BS 5306-2 provides some guidance on hazard occupancy, much more detailed guidance is given in the relevant technical bulletin contained within the LPC rules.

The performance requirement of a sprinkler system is based on two factors:

a) **Discharge density** – the amount of water discharged onto the risk, measured in millimetres per minute to cover a specified area of operation.

b) **Assumed maximum area of operation (AMAO)** – the maximum anticipated area involved in a fire before the sprinkler system gains control or extinguishment, measured in m^2.

Procedure 2A
Assessment of specification and design drawings

Checklist

Assessment of specification and design drawings for a sprinkler system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

System type (see BS 5306-2)	❑ LH	❑ OH	❑ HH Process	❑ HH Storage

Sprinkler protection and siting of heads

2A.1* **Are the areas of protection in accordance with the system type specified above, noting mandatory and obligatory exceptions?** ❑ Yes ❑ No

[See Procedure 2A.1]

Comments:

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2A.2* **Are there ceiling or floor voids requiring sprinkler protection?** ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.1]

Comments:

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2A.3* **Are the maximum areas per sprinkler and maximum distances between sprinklers correct for the particular hazard class?** ❑ Yes ❑ No

[See Procedure 2A.2]

Comments:

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2A.4 Do the sprinkler system dimensions add up to the building dimensions? ❑ Yes ❑ No

[See Procedure 2A.2]

Comments:

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2A.5 Is the sprinkler head spacing and siting appropriate? (Check, in particular, the relationship between heads and walls, partitions, obstructions, etc.) ❑ Yes ❑ No

[See Procedure 2A.3]

Comments:

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2A.6 Are there any open cell ceilings? Is there 800mm between the sprinkler and the top of the ceiling? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.3]

Comments:

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2A.7 Are there any sprinklers in positions prone to mechanical damage? (If so, are guards proposed?) ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.4]

Comments:

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2A.8 Are any water shields/heat baffle plates required (e.g. in-rack heads, cut-off heads)? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.4]

Comments:

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Sprinkler equipment

2A.9* Does all proposed equipment conform to the relevant British Standards? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.10* Is the equipment selected appropriate for the risk (e.g. spray or conventional heads, high temperature heads)? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.11* Are suitable precautions to be taken in any areas likely to experience freezing? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.12 Are the position and size of drain valves for trapped sections correct? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.13 Does the pipework slope for drainage? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.14 Is the length of gong line correct? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.15* Is the position of the alarm valve accessible to the fire service? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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Pipe sizing and configuration (precalculated arrays)

2A.16 Are all pipe sizes correct? ❑ Yes ❑ No

[See Procedure 2A.6]

Comments:

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2A.17* Are the calculations correct? ❑ Yes ❑ No

[See Procedure 2A.7]

Comments:

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2A.18 Are the range pipe configurations capable of being drained? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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2A.19* Do any pipes pass through unprotected areas? ❑ Yes ❑ No

[See Procedure 2A.8]

Comments:

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Water supplies

2A.20* **Does the proposed water supply conform to BS 5306-2? Confirm with water authority if necessary.** ❑ Yes ❑ No

[See Procedure 2A.9]

Comments:

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2A.21* **In the case of town mains supplies, has the water supply capability been confirmed as adequate for the sprinkler system hazard classification?** ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.10]

Comments:

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2A.22* **In the case of supplies involving pumps, are the pumps correctly rated for the hazard classification and the height of the highest sprinkler?** ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.11)

Comments:

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2A.23 Is there provision for remote alarm signalling system from sprinkler pumps? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.13]

Comments:

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2A.24* Is the water storage tank effective capacity adequate? ❑ Yes ❑ No

[See Procedure 2A.12]

Comments:

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2A.25* Does the water storage infill main have the ability to refill at the correct rate or provide a reduced capacity tank with sufficient water within the 30/60/90 minute period? ❑ Yes ❑ No

[See Procedure 2A.12]

Comments:

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Procedure 2A
Assessment of specification and design drawings

Procedures

Procedure 2A.1: Verification of system type

BS 5306-2:1990 defines four different types of occupancy:

- LH (light hazard) — non-industrial with room size limited to 126m^2 (see 5.2 and Table 7).
- OH (ordinary hazard) — covers an extensive range of 'normal' occupancies and consequently subdivided into four groups, i.e. OH – Group I, II, III and III special (see Tables 3 and 7).
- HHP (high hazard process) — again, this type of occupancy is subdivided to cover a full range of processes and risks, i.e. Types 1, 2, 3 and 4 (see Tables 4 and 7).
- HHS (high hazard storage) — The sprinkler system's performance is defined by three storage factors:
  - i) the commodity stored, expressed as one of four categories (see Table 2);
  - ii) how the commodity is stored, expressed as one of ten storage types (see Table 1).
  - iii) the maximum height of the stored commodity (see Table 1).

  The permutation of these three factors will determine the sprinkler system's performance requirement (see Table 1 and Tables 8–12).

  NOTE: A limited combination of these factors can lead to a storage risk being protected by a system designed to suit ordinary hazard demands and not considered as high hazard (see Table 1).

A building protected by sprinklers should be protected in all parts. However, there can be exceptions:

1. Obligatory exceptions (see 4.2.1). Examples are ovens and frying ranges.
2. Optional exceptions (see 4.2.2). Examples are fire-separated electrical plant rooms.

Where there are false ceilings, there may well be protection both above and below the ceiling. Roof spaces more than 0.8m deep should be protected. Floor and ceiling voids more than 0.8m deep, and any voids of combustible construction or containing combustible materials, should also be protected. This protection produces very complex pipework layouts. Contractors often produce a layout of sprinkler heads below the false ceiling minus the pipework, plus an entirely separate drawing showing only the pipework feed to the false ceiling sprinklers. These layouts are often complex because of the need to place the sprinkler heads in the centre of a tile where double drops are often used. Great care is needed in checking these parts of a drawing, particularly with regard to 'range pipe' and 'distribution pipe' sizing.

Procedure 2A.2: Maximum areas per sprinkler and maximum distances between sprinklers

(Refer to BS 5306-2:1990, Tables 70 and 71.)

BS 5306-2:1990, Table 70 sets out the maximum coverage and maximum spacing for non-sidewall sprinklers. (Table 71 should be used for sidewall sprinklers.) The maximum area per sprinkler given in BS 5306-2:1990 is 9m^2 for high hazard, 12m^2 for ordinary hazard and 21m^2 for light hazard. The figure of 9m^2 should also be used for attics, basements, boiler rooms, kitchens, laundries, storage areas and work rooms. For linear spacings between sprinklers, Table 70 should be consulted.

As a final check, it should be confirmed that the dimensions between sprinkler heads, as shown on the drawings, can be correctly summed to equal the dimensions of the building.

Procedure 2A.3: Sprinkler head siting

(Refer to BS 5306-2:1990, 26.3 and 26.5, Tables 76 and 77.)

It should be possible to confirm from the drawings that the maximum distance of non-sidewall sprinkler deflectors below roofs or ceilings is in accordance with BS 5306-2:1990 (see Table 76). According to the type of construction, the distance should lie between 75mm and a maximum of 150mm, 300mm or 450mm.

Horizontal spacing from walls, partitions and irregular boundaries should also be checked. Maximum distances are specified in 26.3.

Where the depth of a beam or joist exceeds 300mm (or 450mm for non-combustible ceilings) or there are other obstructions that form ceiling bays, the obstruction or the beam or joist should be regarded as a boundary. Otherwise, the location of sprinklers relative to beams, etc., should be in accordance with the recommendations of Table 77. Sprinkler locations should also take into account any obstructions caused by columns, girders and trusses. The recommendations of 26.5.2, 26.5.3 and 26.5.4 should be followed.

There are no specific rules relating to obstruction to water discharge by adjacent light fittings. However, as a general principle, the 'beam rule' may be used to check for clearance distances (see Table 77).

If the slope of a ceiling or roof is greater than 1 in 3 (i.e. is greater than 18.5° to the horizontal), a row of sprinklers should be sited not more than 750mm radially from the apex or sub-apex.

It is important to ensure that no obstructions below sprinkler heads affect the correct operation of the system. Throughout the protected area, the clear space below sprinklers should be at least 0.5m, but this is increased to 0.8m for sprinklers above open suspended ceilings and to 1.0m for high-piled combustible stock. Where there are services, walkways, galleries, stairways, chutes, etc., that are more than 0.8m wide and less than 150mm from adjacent walls and partitions (or otherwise more than 1.0m wide), sprinklers must be provided under these obstructions.

It is also possible for wind bracing to interfere with sprinkler siting, causing sprinklers to be out of spacing or too far from the roof.

Generally, sprinklers should not be spaced less than 2.0m apart to prevent cooling of one sprinkler head by the discharge from another. Closer spacing is inevitable where sprinklers in racks are sited in closely spaced flues. In other locations, closer spacing should be avoided but protection of wetting by metal baffles would otherwise be required.

Where there are any open-cell ceilings, there should be at least 800mm between the sprinkler and the top of the ceiling.

Inspection on site provides the first opportunity to ensure that the detailed recommendations of BS 5306-2 are satisfied; much of this detail can, however, be determined from drawings. As well as a broad check that the general rules for spacing are being satisfied, particular attention should be paid during site inspections to the following recommendations.

- Sprinklers should not be sited more than 300–450mm below the ceiling or roof, depending on whether the structure is considered combustible or non-combustible.
- Sprinklers should be sited within each apex of a pitched or north-light roof where the slope is greater than 1 in 3.
- Ceiling obstructions, such as structural beams, girders, trusses and columns need to be assessed.
- Other obstructions, such as ducting, cable trays or high-level walkways, if more than 800mm wide, will require the installation of additional sprinklers beneath them.
- A clear space of at least 500mm must be maintained below the sprinkler head elevations (1.0m in the case of high-piled combustible stock).
- Voids greater than 800mm in depth should be protected.

Procedure 2A.4: Sprinkler guards and baffle plates

(Refer to BS 5306-2:1990, 25.8–25.9.)

Consideration should be given to whether there are any locations in which sprinklers are likely to be exposed to mechanical damage. In such locations, sprinkler guards should be provided.

In some locations, water shields/heat baffle plates may be required. Examples are in-rack heads and cut-off sprinkler heads.

Procedure 2A.5: Equipment

Confirmation should be obtained from the sprinkler contractor, at least at final completion, that all equipment complies with the relevant British Standard.

LPC Technical Bulletin TB 1 contains a list of independently certificated sprinkler components, such as sprinkler heads, pipe couplings and fittings, etc.

The sprinkler heads used should be suitable for the risk. Guidance on the selection of sprinkler heads is contained in LPC Technical Bulletin 20.

It should be confirmed that:

(i) If there are any areas in which freezing is likely to occur, suitable precautions are taken. This would comprise trace heating and lagging or the use of tail-end alternate valves. (If the entire premises is likely to experience freezing during winter, an alternate installation should be used.);

(ii) Drain valves of suitable size are provided in appropriate locations (see 20.1.6 and Table 39);

(iii) Pipework slopes to enable drainage are provided (see Table 42).

(iv) The length of the gong line is correct (see 27.1.3);

(v) The position of the alarm valve is accessible to the fire service. It is important that the fire service are able to operate the sprinkler stop valve in an emergency.

Under a number of circumstances, heads that operate at temperatures other than the standard 68°C temperature may be required. The temperature rating of a sprinkler should not be less than 30°C greater than the highest expected ambient temperature of the location. In some areas, this necessitates the use of high-temperature heads. Examples are unventilated concealed spaces and unventilated shop windows. Similarly, higher temperature heads may be required under glazed roofs and plastic rooflights or over plant, such as drying ovens. For further guidance, see 25.7.

Procedure 2A.6: Pipe sizing and configuration

There are two methods of pipe sizing specified within the LPC Rules.

The first, referred to as the 'Precalculated Method', involves the use of pipe sizing tables referenced to the number of sprinklers being served by individual sections of pipework (see Tables 54–56 for light hazard risks; Tables 57–59 for ordinary hazards and Tables 60–64 for high hazards). The latter table for each of the hazards identifies pressure losses for predetermined flow rates through a selection of pipe sizes (see Tables 56, 59 and 64). This is due to the need for some elementary hydraulic calculation to be carried out.

Areas for careful checking include the sizes of range pipes, particularly the last one, two or three ranges, where sizes could be larger. It should also be ensured that the distribution pipe sizes are correct and that these have not been sized as range pipes, especially those feeding sprinklers in voids.

In order to check pipe sizes, it will be necessary to study carefully the recommendations of 24.2 and Tables 57–63.

The second method of pipe sizing involves a contractor undertaking a 'full hydraulic calculation', where precise calculation is carried out to determine system performance flow rates and pressure demands (see 24.3.1–24.3.8.2, Clause 18 and Tables 36 and 37).

This process, more often than not, is carried out using computer software. Correct interpretation of computer printouts with sprinkler piping networks requires more than a basic understanding of system requirements. Without such specialist knowledge, a checklist would not be particularly useful and would probably not identify all aspects requiring verification.

Furthermore, as perhaps more than 90 per cent of installed sprinkler systems are sized by the precalculated method, a checklist for full hydraulically calculated systems has not been included.

Procedure 2A.7: Checking calculations in precalculated systems

(Refer to BS 5306-2:1990, 24.2.)

It should be confirmed that the lengths of pipe runs shown in the drawings check arithmetically with the pressure loss calculation summary. The arithmetic on the summary sheet should be checked (precalculated systems only). It should be verified that the recommendations of 24.2 have been adopted.

Procedure 2A.8: Sprinkler pipes passing through unprotected areas

(Refer to BS 5306-2:1990, 21.2.2.2.)

In order to prevent damage to sprinkler pipework by fire, pipework should *not* pass through unsprinklered areas. Similarly, it is highly undesirable to route pipework through an unsprinklered building. If this is necessary, the pipework should be installed at ground floor level and should be enclosed by dwarf brick walls covered by concrete slabs (see 21.2.2.2).

Procedure 2A.9: Types of water supply

(Refer to BS 5306-2:1990, clause 13.)

BS 5306-2 defines three classes of water supply, namely:

- single supplies;
- superior supplies; and
- duplicate supplies.

For light and ordinary hazard occupancies, any of the three supplies may be used, subject to acceptance by the authority. However, generally, a superior supply or a duplicate supply should be provided. These supplies are essential in the case of high hazard occupancies. The various forms of supply are described in BS 5306-2:1990, Clause 13.

Procedure 2A.10: Checking town mains water supplies

(Refer to BS 5306-2:1990, 15.2 and Table 15.)

The water supplies should be confirmed as adequate by reference to flow/pressure test results that should have been undertaken by the designer and/or contractor. Pressure and flow requirements for light hazard, ordinary hazard and high hazard installations are given in 15.2 and Table 15).

Procedure 2A.11: Fire pump rating (precalculated)

(Refer to BS 5306-2:1990, 15.2.3.1 and Table 28.)

Recommended ratings for pumps serving light and ordinary hazards are given in Table 28.

For these occupancies, pumps are manufactured to suit various heights of building in increments of 15 metres, 30 metres and 45 metres, measured from the pump centre-line and the highest sprinkler.

Buildings over 45 metres are considered to be high rise and the datum changes to the difference between the highest and the lowest sprinklers. In this instance, the height difference between the pump centre-line and the lowest sprinkler becomes important. This can be a positive or a negative variable and is used to adjust the pressure demands of pumps in relation to the sprinklers.

In high hazard occupancies, the flow demands are gained from Tables 16–19. These tables also specify pressure demands at the design points with the system.

To establish pumping pressure demands, it is necessary to accumulate all known pressure losses to arrive at a total pressure requirement (see 15.2.3.1).

Procedure 2A.12: Water storage capacity

Any water storage tank should preferably hold sufficient water to enable a sprinkler system to run at a maximum flowing condition for the minimum duration of:

light hazard	30 minutes;
ordinary hazard	60 minutes;
high hazard	90 minutes.

For precalculated systems, these are given in Tables 21, 22 and 23, respectively.

The filling/refilling rate (f) shall not be less than 75 litres/min (see 16.2.2).

The volumes given in Tables 21, 22 and 23 should be adjusted, based on the refill rate, in accordance with 16.3.4.

It is acceptable to reduce the holding capacity of a water storage tank, provided that any ‘shortfall’ can be replenished by the filling connection within the aforementioned timescales. This is referred to as a ‘reduced capacity tank’ and its size is calculated in accordance with Table 25, subject to the absolute minima specified.

Procedure 2A.13: Remote signalling for sprinkler pumps

Where sprinkler pumps are utilized, the following conditions are required to be indicated both locally (on the electric motor starter panel or diesel engine controller within the sprinkler pump house/room) and at a responsibly manned location (an area such as a gate house that is manned 24 hours/day), by both a red warning light and an audible alarm:

- **Pump on demand** for both electric motor and diesel-driven pumps. (See 17.4.2.4.)
- **Power supply failure** for electric motor driven pumps. (See 17.4.12.3.)

- **Pump running** for diesel-driven pumps. (See 17.4.13.8.)
- **Trouble at engine/controller** for diesel-driven pumps. (See 17.4.13.8.)

These alarms are usually indicated at the responsibly manned location on a specific remote alarm panel, as supplied by sprinkler pump manufacturers, that is connected via volt free contacts from the electric motor starter, or the diesel engine, control panels.

Procedure 2B
Assessment of work in progress

Checklist

Assessment of work in progress for a sprinkler system at:

Name/address of premises: ....

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....

Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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....

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*** It is essential that items marked thus, and in bold type, are checked.**

2B.1* **Are the required areas being protected?** ❑ Yes ❑ No

[See Procedure 2A.1]

Comments:

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....

2B.2* **Are the sprinkler distances below the ceiling correct for the building structure?** ❑ Yes ❑ No

[See Procedure 2A.3]

Comments:

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....

2B.3* **Is the sprinkler head spacing and siting appropriate? (Check, in particular, the relationship between heads and walls, partitions, obstructions, etc.)** ❑ Yes ❑ No

[See Procedure 2A.3]

Comments:

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....
....

2B.4 Are there any sprinklers in positions prone to mechanical damage? (If so, are guards provided?) ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.4]

Comments:

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....
....

2B.5 Are any water shields/heat baffle plates required (e.g. in-rack heads, cut-off heads)? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.4]

Comments:

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2B.6* Are the correct sprinkler heads being installed (e.g. spray, conventional quick response, high temperature)? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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....

2B.7 Are the position and size of drain valves for trapped sections correct? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.5]

Comments:

....

....

....

2B.8 Does the pipework slope for drainage? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

....

....

....

2B.9* **Is the position of the alarm valve accessible to the fire service?** ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

....

....

....

2B.10* **Is any pipework being run through unprotected areas?** ❑ Yes ❑ No

[See Procedure 2A.8]

Comments:

....

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2B.11* **Is all pipework properly supported?** ❑ Yes ❑ No

[See Procedure 2B.1]

Comments:

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2B.12* **Are power supplies for any electrically driven sprinkler pumps adequate?** ❑ Yes ❑ No

[See Procedure 2B.2]

Comments:

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Procedure 2B
Assessment of work in progress

Procedures

Procedure 2B.1: Support of pipework

(Refer to BS 5306-2:1990, Clause 22.)

During site inspections, it should be ensured that there is adequate support for all pipework. Particular points to note are that:

- Sprinkler pipes should be supported from the building structure, which itself should be capable of supporting the additional load of the water-filled pipework.
- Sprinkler supports should not be used to support any other objects, except where primary support is designed for the suspension of piped services.
- Sprinkler pipes should not be supported from ceiling sheathing or cladding or from any associated suspension system.
- Pipes below ductwork should be supported either from the building structure or from a steel angle supporting the ductwork, adequate to support the combined weight of the ductwork and the water-filled sprinkler pipes.
- The spacings between pipe supports should be as shown in BS 5306-2:1990, Table 50 (reproduced at the end of this list).
- The locations of pipe supports should be as recommended in 22.8.2.

Table 50 — Maximum distance between pipe supports

Pipe nominal bore		Maximum support spacing
over	not greater than	
mm	mm	m
—	65	4.0
65	100	6.1
100	250	6.5

Procedure 2B.2: Power supplies for electric pumps

(Refer to BS 5306-2:1990, 17.4.12.1.)

Guidance on power supplies for electric pumps is contained in 17.4.12.1.

The supply to the pumps should comprise a dedicated circuit with its own isolating protective device, that should be suitably labelled. There should be duplicate indicator lamps in the vicinity of the pump to show that power is available. Failure of any one of the phases of the supply should be indicated. There should also be remote transmission of failure to a suitable manned location.

The supply cables within the buildings should be fire resisting or protected by fire-resisting construction against fire. It should be ensured that the wiring does not pass through any fire risk area, unless there is suitable protection against fire by means of separating walls, partitions or floors that are fire resisting.

More detailed guidance on the power supplies for electric pumps is given in LPC Technical Bulletin TB 22.

Procedure 2C
Final acceptance

Checklist

Final acceptance of a sprinkler system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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....

*** It is essential that items marked thus, and in bold type, are checked.**

2C.1* **Has there been suitable witness testing?** ❑ Yes ❑ No

[See Procedure 2C.1]

List tests and results:

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2C.2* **Has a suitable town mains water supply been provided?** ❑ Yes ❑ No ❑ N/A

[See Procedure 2C.2]

Comments and test results:

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....

2C.3 Is a suitable block plan provided? ❑ Yes ❑ No ❑ N/A

[See Procedure 2C.3]

Comments:

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....
....

2C.4* **Does all equipment conform to the relevant British Standards?** ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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....
....

2C.5* **Are the areas of protection in accordance with the system type specified, noting mandatory and obligatory exceptions?** ❑ Yes ❑ No

[See Procedure 2A.1]

Comments:

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2C.6* **Have the correct types of sprinklers been installed?** ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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....

....

2C.7* **Is sprinkler spacing and siting appropriate?** ❑ Yes ❑ No

[See Procedure 2A.3]

Comments:

....

....

....

2C.8 Are there any sprinklers in positions prone to mechanical damage? (If so, are guards provided?) ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.4]

Comments:

....

....

....

2C.9 Are the position and size of drain valves for trapped sections correct? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

....

....

....

2C.10 Does the pipework slope for drainage? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

....

....

....

2C.11 Is all pipework properly supported? ❑ Yes ❑ No

[See Procedure 2B.1]

Comments:

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....

....

2C.12 Is the length of gong line correct? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

....

....

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2C.13* Is the position of the alarm valve accessible to the fire service? ❑ Yes ❑ No

[See Procedure 2A.5]

Comments:

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....

2C.14* **Do any pipes pass through unprotected areas?** ❑ Yes ❑ No

[See Procedure 2A.8]

Comments:

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....

....

2C.15 Is there provision for remote alarm signalling system from sprinkler pumps? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.13]

Comments:

....

....

....

2C.16* **Does the water storage infill main have the ability to refill at the correct rate or provide a reduced capacity tank with sufficient water within the 30/60/90 minute period?** ❑ Yes ❑ No

[See Procedure 2A.12]

Comments:

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....

2C.17 Are any water shields/heat baffle plates required (e.g. in-rack heads, cut-off heads)? ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.4]

Comments:

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....

2C.18* **Are power supplies for any electrically driven sprinkler pumps adequate?** ❑ Yes ❑ No

[See Procedure 2B.2]

Comments:

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2A.19* **Have any suitable precautions been taken in any areas likely to experience freezing?** ❑ Yes ❑ No ❑ N/A

[See Procedure 2A.5]

Comments:

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2C.20 Has adequate documentation been provided to the user? ❑ Yes ❑ No

[See Procedure 2C.4]

Comments:

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Procedure 2C
Final acceptance

Procedures

Procedure 2C.1: Witness testing

There is a variety of tests that may be carried out to confirm that the sprinkler installation conforms to BS 5306-2 (see Clauses 10, 15 and 19, 35.2.5–9 and Appendix A).

The following should always be witnessed or written confirmation of satisfactory completion should be obtained:

- Pressure testing of all installation pipework.
- Proving of water supply capability with flow/pressure tests undertaken at the time of commissioning; results recorded.
- Automatic and manual pump start tests.
- Diesel-driven fire pump automatic six-attempt start test.
- Electrolyte level and density tests on batteries.
- Correct functioning of flow and pressure switches.
- Water motor alarm function and audibility test.
- Correct functioning of all alarm indicating equipment/panels.

Procedure 2C.2: Witnessing tests of town mains

The most important feature in respect of town mains connections is the continuing suitability for purpose. Proving tests should be undertaken prior to commencement of installation works and on completion. The latter test should, if possible, be witnessed. Should there be a noticeable drop in performance between the aforementioned tests, the supply should be reassessed since, even if it is still considered technically suitable according to the standard, the supply should be considered suspect.

Procedure 2C.3: Block plan

A block plan of the premises should be placed close to an entrance where it can be readily seen, particularly by the fire brigade; normally, this will be close to the main entrance to the premises. The information that should be shown on the plan is contained in Clause 29.

Procedure 2C.4: Documentation

It should be confirmed that the installer of the sprinkler installation has provided a completion certificate of the type contained in BS 5306-2:1990, Figure 6. The certificate should confirm full conformity to BS 5306-2 or state clearly all deviations from the recommendations of the code.

In addition, it would be desirable for the following documents to be provided to the user (see 10.3):

- a completion certificate;
- a complete set of operating and maintenance instructions;
- a complete set of as-installed drawings and pipe sizing calculations;
- pipework test certificates.

NOTE: This is not a design guide, but a guide for a structured assessment of an automatic sprinkler system.

Procedure 3

Assessment of a smoke control system

Procedure 3: Introduction

In the preparation of Procedure 3, assistance from Dr Eric W Marchant, Edinburgh Fire Consultants Limited, is acknowledged.

NOTE: This is not a design code, but a guide for a structured assessment of a smoke control system.

This procedure relates to the assessment of smoke control systems and, in particular, smoke and heat exhaust ventilation systems (SHEVS). It is applicable to both mechanical extract and natural ventilation systems.

These systems are designed to remove smoke and heat from a reservoir. Most SHEVS are designed to maintain a smoke-free layer. The mass flow rate at which smoke enters the layer should be equal to the extract or ventilation rate. Replacement air is required through inlets.

Some systems are required to raise the height of the clear layer in atria, to reduce the smoke temperature.

Smoke control systems may be required under Building Regulations, as additional measures for life safety, to protect escape routes and to provide assistance to fire fighters.

Smoke control systems can also be provided for other objectives, such as property protection.

Alternative smoke control strategies may be necessary or appropriate. These can include pressurization, which is not covered by this procedure.

There are a number of standards and guides available that cover the design of smoke control systems and reference to these in this Procedure are given in brackets. These standards and guides are:

- BS 5588-7, *Fire precautions in the design, construction and use of buildings — Code of practice for the incorporation of atria in buildings*.
- BS 5588-10:1991, *Fire precautions in the design, construction and use of buildings — Code of practice for shopping complexes*.
- BS 5588-11, *Fire precautions in the design, construction and use of buildings. Code of practice for shops, offices, industrial, storage and other similar buildings*.
- BS 7346-3, *Components for smoke and heat control systems — Part 3: Specification for smoke curtains*.
- BS 7346-4, *Components for smoke and heat control systems — Part 4. Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing steady-state design fires — Code of practice*.
- PD 7974-2, *Application of fire safety engineering principles to the design of buildings — Part 2: Spread of smoke and toxic gases within and beyond the enclosure of origin (Sub-system 2)*.
- BR 186: *Design principles for Smoke Ventilation in Enclosed Shopping Centres*. Building Research Establishment, 1990.

- BR 258: *Design Approaches for Smoke Control in Atrium Buildings*. Building Research Establishment, 1994.
- BR 368: *Design methodologies for smoke and heat exhaust ventilation*. Building Research Establishment, 1999.
- Guidance for the Design of Smoke Ventilation Systems for Single Storey Industrial Buildings, including those with mezzanine floors, and high-racked storage warehouses. Smoke Ventilation Association (SVA).

These guides and standards provide design guidance and information for calculation purposes, such as the design fire sizes, clear layer heights and reservoir sizes. They also address system design, installation and commissioning.

Additional guidance on the commissioning of powered extract systems is available in Commissioning Code A, Air Distribution Systems, Chartered Institution of Building Services Engineers (CIBSE).

These documents are codes of practice and design guides and, as such, full conformity to the recommendations may not be appropriate in every case. Deviations from the recommendations should be subject to agreement with the approving authority.

BS EN 12101, Parts 2 and 3 specify performance requirements for natural and powered smoke and heat exhaust ventilators respectively and BS 7346-3 specifies performance requirements for smoke curtains.

If a smoke control system is not designed to the aforementioned guidelines, then a reference to the design information sources should be included.

In using this guideline procedure, where a section is not appropriate the not applicable box should be used.

There are no checklists or procedures covering the work-in-progress stage, because, for a smoke control system, examination of the installed systems provides an adequate check of the system. It should be ensured, however, that the fire resistance of the wiring is checked when the emergency power supply system and the fire ducts, where appropriate, are checked.

Procedure 3A: Assessment of specification and design drawings

Checklist

Assessment of specification and design drawings for a smoke control system at:

Name/address of premises:	....
	....
	....
Name of assessor:	....
Date of assessment:	....
Application number:	....
Action required:	....
	....
	....
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	....
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*** It is essential that items marked thus, and in bold type, are checked.**

Smoke control strategy

3A.1 Is ventilation the appropriate method of smoke control? ❑ Yes ❑ No

[See Procedure 3A.1]

Comments:

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3A.2 Have the appropriate clear layer heights and smoke layer temperatures been selected? A minimum 2.5m clear layer, with smoke at 200°C maximum. ❑ Yes ❑ No

[See Procedure 3A.2]

Comments:

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Fire size

3A.3 If the design is based on a steady-state fire, is there an appropriate choice of fire size for the compartment type? (See BR 186, BR 258, BR 368, SVA Guide, BS 7346-4 and PD 7974-2) ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.3]

Comments:

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3A.4 Has the fire in a compartment that will produce the largest volumes of smoke for a mall or atrium smoke control system been selected? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.4]

Comments:

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3A.5 If the effect of fire growth is being considered in designing this system, has the appropriate growth rate been selected? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.5]

Comments:

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3A.6 If the space is not sprinklered, have the possibility and the effects of flashover been considered? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.6]

Comments:

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Single storey buildings

3A.7 Have the appropriate design calculations been chosen? ❑ Yes ❑ No

[See Procedure 3A.7]

Comments:

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3A.8 Have the correct dimensions been used in the calculations? ❑ Yes ❑ No

[See Procedure 3A.8]

Comments:

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3A.9 Could the smoke stratify below the ceiling? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.9]

Comments:

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3A.10 Are the reservoir areas within the recommended limits? ❑ Yes ❑ No

[See Procedure 3A.10]

Comments:

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3A.11 Have smoke curtains, screens or other measures been provided to ensure that smoke reservoir sizes do not exceed design limits? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.11]

Comments:

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3A.12 Has the building layout been checked to ensure that there are no openings to the outside that would cause ambient air to enter directly into the smoke reservoir? ❑ Yes ❑ No

[See Procedure 3A.12]

Comments:

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3A.13 Has sufficient inlet area for replacement air been provided? ❑ Yes ❑ No

[See Procedure 3A.13]

Comments:

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3A.14 Have the effects of mezzanines been considered? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.14]

Comments:

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Enclosed shopping malls and atria

3A.15 Have the appropriate design calculations been chosen? ❑ Yes ❑ No

[See Procedure 3A.15]

Comments:

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3A.16 Have the correct dimensions been used in the calculations? ❑ Yes ❑ No

[See Procedure 3A.16]

Comments:

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3A.17 Have smoke barriers (curtains, screens, etc.) been provided to limit line plume widths to meet the conditions in the calculations? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.17]

Comments:

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3A.18 Could the smoke stratify at upper levels in the mall or atria? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.18]

Comments:

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3A.19 In an atrium, could the temperature of smoke in the reservoir exceed the maximum temperature rating of the glazing, causing it to fail? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.19]

Comments:

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3A.20 Are the areas of single storey shop smoke reservoirs within recommendations?

❑ Yes ❑ No ❑ N/A

[See Procedure 3A.20]

Comments:

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3A.21 Are the areas of the mall or the atria smoke reservoirs within recommendations?

❑ Yes ❑ No ❑ N/A

[See Procedure 3A.21]

Comments:

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3A.22 Have smoke curtains, screens or other measures been provided to ensure that smoke reservoir sizes do not exceed design limits?

❑ Yes ❑ No ❑ N/A

[See Procedure 3A.22]

Comments:

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3A.23 Have the depths of smoke flowing under a ceiling for shop extract systems, and at high level in malls and atria, been checked to ensure that they are shallow enough to maintain a minimum clear layer height?

❑ Yes ❑ No

[See Procedure 3A.23)

Comments:

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3A.24 Have the effects of sprinkler cooling been calculated correctly in shop extract systems? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.24]

Comments:

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3A.25 Has sufficient inlet area for replacement air been provided? ❑ Yes ❑ No

[See Procedure 3A.25]

Comments:

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3A.26 Has the building layout been checked to ensure that there are no openings to the outside that would cause ambient air to enter directly into the smoke reservoir? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.26]

Comments:

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Natural vent systems

3A.27 Is there a risk of wind pressures adversely affecting smoke venting? ❑ Yes ❑ No

[See Procedure 3A.27]

Comments:

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3A.28 Has the correct value for the coefficient of discharge been used to calculate the vent area required? ❑ Yes ❑ No

[See Procedure 3A.28]

Comments:

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3A.29 Do the vents and inlets fail-safe to the 'open' position? ❑ Yes ❑ No

[See Procedure 3A.29]

Comments:

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3A.30 Is there an appropriate control method to operate the system? ❑ Yes ❑ No

[See Procedure 3A.30]

Comments:

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3A.31 With smoke layers less than 2m in depth, has the possibility of air being drawn through the vents instead of smoke been considered? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.31]

Comments:

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Mechanical extract systems

3A.32 Is the temperature rating of the fans adequate? ❑ Yes ❑ No

[See Procedure 3A.32]

Comments:

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3A.33 Has standby power with fire-rated cables been provided to maintain the electrical supply? ❑ Yes ❑ No

[See Procedure 3A.32]

Comments:

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3A.34 Is there an appropriate control method to operate the system? ❑ Yes ❑ No

[See Procedure 3A.33]

Comments:

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3A.35 With smoke layers less than 2m in depth, has the possibility of air being drawn through the extract system instead of smoke been considered? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.34]

Comments:

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Other features

3A.36 Has a minimum 25 per cent free area been provided, when smoke is to be extracted through false (suspended) ceilings? ❑ Yes ❑ No ❑ N/A

[See Procedure 3A.35]

Comments:

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3A.37 Check the pressure difference across suspended ceilings to avoid tile uplift when the smoke extract system is in operation. ❑ Yes ❑ No ❑ N/A

Comments:

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Procedure 3A
Assessment of specification and design drawings

Procedures

Procedure 3A.1: Method of smoke control

It is possible that ventilation, by mechanical or natural means, is not the most appropriate method of smoke control. Stairwells and corridors may need to be pressurized.

Procedure 3A.2: Clear area

A minimum clear layer height of 3m is recommended in BR 186 (chapter 2), BR 258, BR 368, the SVA Guide (sections 7 and 17) and BS 5588-10:1991 (section 20). This assumes that the maximum smoke layer temperature is 200°C. However, it is acceptable to provide a 2.5m clear layer, where it would be impracticable to provide a 3m clear layer (see BR 186, chapter 2).

If the smoke layer temperature exceeds 200°C, then the height of the clear layer might need to be raised to ensure that the occupants are not subject to excessive downward radiation from the smoke layer. In mall areas, it may be possible to provide sprinklers to reduce the smoke temperature further. The acceptable maximum limit for received radiation is 2.5kW/m^2.

Procedure 3A.3: Choice of fire size

Sprinkler-controlled steady-state fire sizes are as follows:

- 5MW in shops (see BR 186, chapter 2);
- 2.5MW in shops (if fitted with fast response sprinklers) (see BR 368, Chapter 3);
- 1MW in offices (see BR 258, chapter 2);
- 1MW in hotel bedrooms (see BR 258, chapter 2);
- a range of fire sizes for warehouses (see SVA Guide, sections 4 and 5).

This is not an exhaustive list of heat outputs for sprinkler-controlled fires. Other steady-state fire sizes can be used.

The choice of a steady-state design fire in unsprinklered buildings is problematic. However, guidance is given in BR 258, BR 368 and the SVA Guide.

Procedure 3A.4: Worst case fire compartment

There can be a number of compartments opening onto atria or malls. These compartments can have a range of geometries and fire sizes. The smoke control system capacity will need to be based on the largest volumes of smoke that will be produced.

Procedure 3A.5: Fire growth

The smoke control design may involve analysis of the developing hazards during the course of a fire, particularly in unsprinklered fires. Fire growth during this period can be modelled in various ways. The most commonly used fire growth model is the 'αt^2' model where the heat release rate is proportional to the time squared. This is described in BS 7974 and associated publications and in CIBSE Guide E. It is also discussed in relation to smoke control design in BR 368.

It is not possible to provide an exhaustive list of fire growth models. This is a specialist area and advice should be sought.

Procedure 3A.6: Unsprinklered fires

Fires in an unsprinklered space can cause flashover. The fire can then involve the whole compartment.

Fire size and smoke production in this situation is another specialist area and advice should be sought. (See also BR 368, Chapter 3.)

For fire locations against walls and in corners of spaces, specialist advice should be sought.

Single storey buildings

Procedure 3A.7: Choice of modelling method

The SVA does not provide calculations, but provides advice on the methods of determining the perimeter(s) and advice on the methods of determining the fire perimeter(s) and the height of rise for a plume. The conical plume calculations from BR 186 can be used. (See also BR 368.) For fire locations against walls and in corners of spaces, specialist advice should be sought.

Procedure 3A.8: Design dimensions

The dimensions that need to be checked include the smoke reservoir depth. This should be the vertical distance from the inlet to the fans (the extract plane) to the base of the smoke layer.

Procedure 3A.9: Buoyancy

If the temperature of the smoke entering the reservoir is less than the ambient temperature, then stratification may occur or the smoke reservoir could mix into the clear layer below.

Procedure 3A.10: Reservoir areas

The maximum area for a ceiling reservoir varies between 1,000m^2 and 3,000m^2 depending upon the application and whether natural ventilation or mechanical extract is used. The typical maximum area for a smoke reservoir is 2,000m^2 where there is natural ventilation and 2,600m^2 where mechanical extract is used.

The maximum length recommended for a smoke reservoir is 60m (measured along the midline).

All these limits are somewhat arbitrary. They are intended to prevent excessive cooling of the smoke and consequent loss of buoyancy. This will clearly depend on the thermal properties of the roof.

Variation from these values may be appropriate but would need to be fully justified.

Procedure 3A.11: Smoke barriers

Smoke curtains, screens and other barriers should be provided to form the reservoir sizes stated. Smoke curtains should meet the recommendations of BS 7346-3.

Procedure 3A.12: Powered extract reservoir integrity

If, with powered extract systems, external air can be drawn through large openings in close proximity to the reservoir, this will mix with the smoke. This produces larger volumes of smoke and, therefore, the clear layer height will be reduced. The velocity of the air when it comes into contact with the underside of the buoyant smoke layer should normally be less than 1m/s (see BR 368, 5.9).

Procedure 3A.13: Replacement air

Replacement air can be provided by automatically opening doors and windows. In large buildings, with a number of reservoir zones, it can also be provided by vents away from the fire zone, in adjacent non-fire zones.

The maximum inlet air velocity should be 5m/s where people need to escape against the incoming air flow (see BR 368, section 5.9).

The smoke layer should be 1–2m above the inlet, if the inlet velocity is above 1m/s. If the inlet velocity is less than 1m/s, it can be 500mm above the air inlet (see SVA Guide, section 12.4).

Procedure 3A.14: Mezzanines

Depending upon their size, mezzanines can be ignored and a conical plume calculation used for smoke control purposes.

In the case of large mezzanines, smoke can spill out from around the edge of mezzanines, creating large volumes of smoke. There are various methods for dealing with this (see SVA Guide, section 17.3).

Enclosed shopping malls and atria

Procedure 3A.15: Choice of modelling method

Guidance is available in BR 186, BR 258 and BR 368. The calculations to be used are dependent upon the location of the fire.

Procedure 3A.16: Design dimensions

The dimensions that need to be checked include:

- the smoke reservoir depth — this should be from the inlet to the fans (the extract plane) to the base of the smoke layer;
- the effective height of rise for line plumes.

Procedure 3A.17: Plume widths

Smoke barriers (curtains, screens and similar) need to be provided to limit line (spill) plume widths to meet the requirements of the models.

Procedure 3A.18: Smoke reservoir buoyancy

If the smoke temperature in the reservoir will be less than ambient temperature, then stratification may occur or the smoke reservoir could mix into the clear layer below.

Procedure 3A.19: Temperature rating of atrium

The temperature of the smoke in an atrium could exceed the rating of the glazing around the atrium and it should be checked that this is not the case.

Procedure 3A.20: Reservoir areas in shops

Smoke from shops can either be discharged into the mall and vented from the mall or it can be vented directly from the shops. Shops larger than 1,000m^2 (or 1,300m^2 if the smoke is extracted mechanically from the mall) should have direct ventilation from the shop. In these cases, BR 186, Chapter 2 recommends a maximum area for smoke reservoirs inside the shops of 2,000m^2 if naturally ventilated and of 2,600m^2 if mechanically extracted. The maximum length should be 60m.

Procedure 3A.21: Reservoir areas in malls and atria

BR 186, Chapter 2 and BR 258 recommend a maximum area for smoke reservoirs in malls and atria of 1,000m^2 if naturally ventilated and 1,300m^2 if mechanically extracted. The maximum length should be 60m.

Procedure 3A.22: Smoke barriers

Smoke curtains should meet the recommendations of BS 7346-3.

Procedure 3A.23: Flowing layer depth

Calculations are available in BR 186, Chapter 2 and BR 258, Chapter 3 for the depth of the flowing layer of smoke.

Procedure 3A.24: Sprinkler cooling

BR 186, Chapter 2 and BR 258, Chapter 3 provide guidance on how sprinkler cooling may be estimated for the flowing layers in shops.

Procedure 3A.25: Replacement air

Replacement air can be provided by automatically opening doors and windows (see BR 186, BR 258 and BR 368). In large buildings, with a number of reservoir zones, it can also be provided by vents away from the fire zone.

The maximum inlet air velocity should be 5m/s (see BR 186 and BR 258).

The smoke layer should be 1–2m above the inlet, if the air velocity is above 1m/s. If the air velocity is less than 1m/s, it can be 500mm above the inlet air.

Procedure 3A.26: Powered extract reservoir integrity

If, with powered extract systems, external air can be drawn through large openings in close proximity to the reservoir, this will mix with the smoke. This produces larger volumes of smoke and, therefore, the clear layer height will be reduced. The velocity of the air when it comes into contact with the underside of the buoyant smoke layer should normally be less than 1m/s (see BR 368, 5.9).

Natural vent systems

Procedure 3A.27: Wind pressures

If the roof angle is greater than 30°, if the vents are top hung or if adjacent taller buildings can create downdraughts, then positive pressures may affect the ventilators. The efficiency of the ventilators could be greatly reduced. In this situation, powered extract may be required.

Procedure 3A.28: Coefficient of discharge

Natural smoke ventilators should be tested in accordance with BS EN 12101-2. The aerodynamic coefficient of a smoke ventilator can vary from a low 0.4, to 0.7 for a well-designed vent. Test certificates of the results should be provided.

Procedure 3A.29: Fail-safe systems

If power is lost to the ventilation system, then vents and inlets should fail-safe to the open position. The ventilators should meet the requirements of BS EN 12101-2. Smoke curtains should fail-safe down.

Procedure 3A.30: Control system

The system can be activated by any of the following:

- smoke detection;
- heat detection; or
- sprinkler flow switches.

For life safety generally, smoke ventilators should be opened on smoke detection.

Ventilators should not be activated solely by fusible links.

NB. Where there are several smoke reservoirs in one large space, control systems may become more complex and specialist advice should be sought.

Procedure 3A.31: Air drawn into ventilators

If the smoke layer is less than approximately 2m in depth, then it is possible that plug-holing may occur. Calculations are available in BR 186, BR 258 and BR 368 to find the minimum number of ventilators required to overcome plug-holing.

Mechanical extract systems

Procedure 3A.32: Temperature rating of the fans

The fans should be capable of withstanding the temperatures generated by the fire. The fans should meet the requirements of BS EN 12101-3. It is normal practice to provide standby capacity, protected wiring and emergency power supply.

Procedure 3A.33: Control system

The system can be activated by any of the following:

- smoke detection;
- heat detection; or
- sprinkler flow switches.

For life safety generally, smoke extraction should operate on smoke detection.

Procedure 3A.34: Air drawn into extract system

If the smoke layer is less than approximately 2m in depth, then it is possible that plug-holing may occur. Calculations are available in BR 186 and BR 258 to find the minimum number of fans require to overcome plug-holing.

Other features

Procedure 3A.35: Extraction through ceilings

If smoke is to be extracted through a ceiling, then:

EITHER

1. It should have a minimum of 25 per cent free area, well distributed, to have no effect on smoke flow (see BR 186);

OR

2. The extract system should take into consideration the effect of plug-holing.

Procedure 3C
Final acceptance

Checklist

Final acceptance of a smoke control system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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Natural ventilation systems

3C.1 Have the vent areas been measured and confirmed as correct? ❑ Yes ❑ No

[See Procedure 3C.1]

List tests and results:

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3C.2 Have test certificates for the vent aerodynamic coefficients been provided, to be compared against the design? ❑ Yes ❑ No

[See Procedure 3C.2]

Comments and test results:

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3C.3 Is the operational sequence of the system correct? ❑ Yes ❑ No

[See Procedure 3C.3]

Comments:

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Mechanical extract systems

3C.4 Are the extract volume flow rates through the extract duct(s) correct? ❑ Yes ❑ No

[See Procedure 3C.4]

Comments:

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3C.5 Are the standby generators correctly installed and operational? ❑ Yes ❑ No

Comments:

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Hot smoke tests

3C.6 Has consideration been given to the need for a full scale hot smoke test? ❑ Yes ❑ No

[See Procedure 3C.5]

Comments:

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Procedure 3C
Final acceptance

Procedures

Natural ventilation systems

Guidance is provided in BS 5588-10:1991, Appendix C.1.3.

Procedure 3C.1: Vent and inlet areas

The area of vents needs to be measured to ensure that these match the design requirements. The inlets need to be checked to ensure that there is an adequate area provided, with doors, vents and other openings that open automatically.

Procedure 3C.2: Test certificates

Test certificates need to be provided to show the aerodynamic area of ventilators.

Procedure 3C.3: Operational sequence of the system

The hand over procedure should include operation of the system by activation of the system in each smoke control zone. All elements of the system should operate correctly.

Mechanical extraction systems

Guidance is provided in BS 5588-10:1991, Appendix C.1.2.

Procedure 3C.4: Extract volumes

The extract volume flow rates can be measured at ambient conditions. The air velocity should be measured at the outlet from the reservoir. This allows for leakage into the ductwork.

Ideally, the extract ductwork should include tapping points for pitot measurements for commissioning purposes, to the requirements of CIBSE Commissioning Code A.

Commissioning data sheets should be provided.

NOTE: This is not a design code, but a guide for a structured assessment of a smoke control system.

Procedure 3C.5: Full scale hot smoke tests

Full scale hot smoke tests may be needed to confirm the performance of the smoke control system where there is insufficient confidence in the design scenario and the design calculations. Thus, in unusually complex buildings or where novel smoke control designs have been developed, such a test may be warranted. (See BR 386 for guidance on the methodology of such tests.)

Procedure 4

Assessment of a voice alarm system

Procedure 4: Introduction

NOTE: This is not a design code, but a guide for a structured assessment of a voice alarm system.

This procedure relates to the assessment of a voice alarm system (i.e. a sound distribution system that has been specially designed for automatically broadcasting speech messages in the event of operation of an associated fire detection system). Voice alarm systems are the preferred method of giving fire warnings in large buildings to which large numbers of the public resort (e.g. airport and railway terminals, shopping complexes, exhibition halls, etc.). They may, however, also be used in general industrial and commercial buildings, such as factories and offices.

The British Standard for voice alarm (VA) systems is BS 5839-8. Accordingly, the assessment of voice alarm systems described in this procedure is based on conformity to this Standard. However, it should be noted that BS 5839-8 is a code of practice and, as such, it may not be necessary to meet all of its recommendations in every case. Nevertheless, any intention to deviate from a recommendation of the code would need to be agreed with the approving authority (and other interested parties – see 4.3).

A voice alarm system may be used in lieu of conventional alarm sounders, such as bells or electronic sounders; in practice, where a voice alarm system is installed, these conventional alarm sounders are generally unnecessary and should be used only where voice message intelligibility is not thereby affected. Likewise, it is undesirable to add voice messages to a system using conventional alarm sounders (except for the provision of supplementary information).

The operation of the voice alarm system in response to operation of a manual call point or an automatic detector should be entirely automatic, requiring no manual intervention whatsoever. The messages should be recorded on a non-volatile, solid state medium and transmission should not involve the use of moving parts (e.g. magnetic tape or compact disk should not be used). However, a fireman's microphone may be provided to enable live speech to be broadcast by a responsible person, such as a fire officer. The fireman's microphone will normally override the pre-recorded messages.

As well as being sufficiently audible, voice alarm messages must be clear, unambiguous and intelligible. It will, therefore, be necessary for the messages to be demonstrated to the assessor in situ, with any other fire protection systems that will be started up in the event of fire operational during this demonstration.

The use of voice sounders (stand-alone devices that can broadcast recorded voice messages) is addressed in BS 5839-8:1998, Annex E. These devices may be appropriate in specific circumstances, but cannot be considered as equivalent to a voice alarm system – there is no facility for live speech from a fire microphone. Nevertheless, they are often a more economic means of providing some of the benefits of voice message fire warnings where the full functionality of a voice alarm system is not strictly necessary.

BS 5839-8 does not preclude the use of voice alarm systems to provide other audio services, e.g. general paging and background music. However, the system would need to be configured so that emergency use takes priority.

References in brackets to a clause number are references to subclauses of BS 5839-8.

Procedure 4A
Assessment of specification and design drawings

Checklist

Assessment of a specification and design drawings for a voice alarm system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

4A.1* **Does the voice alarm system extend throughout all relevant areas?** ❑ Yes ❑ No

[See Procedure 4A.1]

Comments:

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4A.2* **Is there any possibility of a clash between voice messages and conventional alarm sounders?** ❑ Yes ❑ No ❑ N/A

[See Procedure 4A.1]

Comments:

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4A.3* **In buildings with staged alarm arrangements, is the zoning of the voice alarm system appropriate?** ❑ Yes ❑ No ❑ N/A

[See Procedure 4A.2]

Comments:

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4A.4* **Does the loudspeaker layout appear suitable for the sound levels and intelligibility required?** ❑ Yes ❑ No

[See Procedure 4A.3]

Comments:

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4A.5* **Is the proposed location of control equipment and of any fireman's microphone(s) satisfactory?** ❑ Yes ❑ No

[See Procedure 4A.4]

Comments:

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4A.6* **Has the correct standby battery duration been specified?** ❑ Yes ❑ No

[See Procedure 4A.5]

Comments:

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4A.7* **Have the correct cable types been specified?** ❑ Yes ❑ No

[See Procedure 4A.6]

Comments:

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4A.8* **Will any interconnecting cables between the fire alarm control equipment and the voice alarm control equipment be monitored?** ❑ Yes ❑ No

[See Procedure 4A.7]

Comments:

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4A.9* **Will there be suitable monitoring of all loudspeaker circuits?** ❑ Yes ❑ No

[See Procedure 4A.8]

Comments:

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4A.10 Is there a need for standby power amplifiers and, if so, are they provided? ❑ Yes ❑ No ❑ N/A

[See Procedure 4A.9]

Comments:

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4A.11 Is there a need for additional loudspeaker circuits and, if so, have they been provided? ❑ Yes ❑ No ❑ N/A

[See Procedure 4A.10]

Comments:

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4A.12 Are the messages satisfactory? ❑ Yes ❑ No ❑ N/A

[See Procedure 4A.11]

Comments:

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Procedure 4A
Assessment of specification and design drawings

Procedures

Procedure 4A.1: Area of coverage

(Refer to BS 5839-8:2002, 6.10.)

If it has been decided to provide a VA system in the premises, it is likely to be appropriate for sole use as the fire warning system throughout the entire premises. It is not good practice, in general terms, to mix voice messages with conventional alarm sounders.

There may, however, be circumstances in which such an arrangement could be acceptable. For example, it might be acceptable to use voice alarm in the public areas of a large building complex, but use conventional alarm sounders in plant areas to which the public has no access. Alternatively, it may be the case that the conventional alarm sounders are silenced while supplementary information is provided via voice messages.

Where it is permitted to use a voice alarm system in the same building as conventional fire alarm sounders, it should be ensured that the operation of fire alarm sounders does not prevent voice messages from being intelligible to the relevant building occupants. Great care should be taken to avoid any confusion. Ideally, members of the public should be able to hear only the voice alarm messages.

Specific recommendations of BS 5839-8 relating to combined use of a voice alarm system with conventional fire alarm sounders include:

- Attention drawing signals used to introduce voice messages should be the same as those produced by the sounders.
- Restarting of sounders, that have been silenced in order to broadcast messages over the VA system, should be automatic – no period of silence should exceed 10 seconds.

Procedure 4A.2: Zoning

(Refer to BS 5839-8:2002 Clause 9.)

If the building has a staged alarm arrangement (e.g. for phased evacuation), it should be ensured that the zoning of the VA system is such that all areas are always, at any stage of the emergency, to simultaneously receive the same message (e.g. an evacuation message) from a single voice alarm zone.

Loudspeaker zone boundaries should, where possible, coincide with walls or partitions in order to aid acoustic separation between zones. This is especially important if different messages are to be broadcast into adjacent zones simultaneously.

Loudspeaker zone boundaries should not conflict with the boundaries of fire detection zones. It is acceptable for the area covered by a loudspeaker zone to be covered by more than one fire detection zone, but not vice versa.

Procedure 4A.3: Review of loudspeaker siting

(Refer to BS 5839-8:2002, Clause 15.)

It is not possible to determine from design drawings whether the sound levels recommended in the British Standard will be achieved. This should be confirmed at final acceptance (see Procedure 4C.3).

However, a quick review of loudspeaker layout may enable any major shortfalls in loudspeaker provision to be identified. In particular, the following points should be noted:

- In rooms where people sleep, a sound level of 75dB(A) is unlikely to be achieved unless there is a loudspeaker within the room. Normally, hotel bedrooms are likely to require a loudspeaker in every bedroom. Refer to site inspection procedures.
- If there is more than one door between any point and the nearest loudspeaker, a sound level of 65dB(A) may not be achieved at that point (see Procedure 4C.3). Refer to site inspection procedures.
- Where conventional alarm sounders are used, it is necessary simply to ensure that an adequate sound pressure level is achieved in all areas, taking into account the attenuation of partitions and doors. This is also relevant in the case of a voice alarm system, but, in this case, there is also a need to consider intelligibility.

In this connection, it should be noted that materials of construction, such as partitions, doors, etc., not only attenuate sound but also filter out higher frequencies, on which intelligibility may depend. Accordingly, in the case of a voice alarm system, there may be a need for loudspeakers in many large rooms in order to achieve intelligibility, even though a loudspeaker outside a room (e.g. in an adjacent corridor) would achieve sufficient audibility.

Guidance on typical background noise levels in buildings is contained in BS 5839-8:1998, Annex B.

Procedure 4A.4: Siting of control equipment and any fireman's microphone(s)

(Refer to BS 5839-8:1998, 12.3 and 17.4.)

Control and indicating facilities that may be required to be used during the course of an emergency, and any fireman's microphone(s) provided, should be located close to a main access point to the building. They may be combined with the fire detection and alarm system control and indicating equipment.

If the controls are located in a security control room or a similar location, it should be ensured that there is ready access to this location for the fire brigade if it is considered that they may require access to the facilities during the course of a fire.

Procedure 4A.5: Required battery duration

(Refer to BS 5839-8:1998, Clause 18.)

Since the voice alarm system forms a part of the fire alarm system, the standby battery duration for the voice alarm system should be at least equivalent to the standby battery duration required for the fire detection and alarm system. Guidance on this is contained in Procedure 1A.10.

In the event of power failure, any non-fire uses to which the voice alarm system is put should be disabled.

Procedure 4A.6: Cable types

(Refer to BS 5839-8:1998, Clause 19.)

Since the voice alarm system must be capable of prolonged operation during the course of a fire, all associated wiring should be fire-resisting. This includes all wiring to loudspeakers, interconnecting wiring between any separate racks that constitute part of the voice alarm system and wiring that interconnects the voice alarm system with the fire detection and alarm system.

If, nevertheless, the standby batteries are located close to the voice alarm control equipment, and both are in an area of low fire risk that is protected by automatic fire detection, it may be possible to relax this requirement. Similarly, if the fire detection and alarm control equipment and the voice alarm control equipment effectively form a single enclosure, interconnecting wiring need not be fire-resisting.

Procedure 4A.7: Monitoring of interconnection between the voice alarm system and the fire detection and alarm system

(Refer to BS 5839-8:1998, 6.4 and 7.1.)

The interconnecting cables between the fire alarm control equipment and the voice alarm control equipment form part of the critical path within the fire warning system for the premises. Unfortunately, in the past, this connection has sometimes been left unmonitored, particularly where one contractor had provided the fire detection and alarm system while another had provided the voice alarm system; each had assumed the other would monitor the interconnections.

It is essential that this cable is monitored. In the event of an open or short circuit fault on this cable, a fault warning must be given within 100 seconds, at the fire detection and alarm system control equipment.

Procedure 4A.8: Monitoring of loudspeaker circuits

(Refer to BS 5839-8:1998, 7.2.)

It is essential that the loudspeaker circuits are fully monitored, so that a single open or short circuit fault or earth fault on any part of the loudspeaker wiring results in a fault warning within 100 seconds. There are various methods by which loudspeaker wiring may be monitored. Some are able to satisfy this objective, while others may not always operate successfully.

It should be made clear to the designer, at the design stage, that at acceptance stage, the effectiveness of the monitoring will be tested by, for example, disconnecting a single connection to a single loudspeaker to ensure that a fault warning is given.

Procedure 4A.9: Standby power amplifiers

(Refer to BS 5839-8:1998, Clause 8.)

In BS 5839-8, it is stated that the voice alarm system should continue to operate correctly in the event of the failure of any single power amplifier.

In practice, this is usually achieved by either of two methods:

- Having spare capacity in a bank of parallel amplifiers so that, with the failed amplifier disconnected, the remaining amplifiers can meet full loudspeaker load on all circuits.
- Duplication of the amplifiers so that, for each amplifier, there is an equivalent sized amplifier acting as a spare ready to take over the loudspeaker load.

The use of separately powered loudspeaker circuits interleaved within the same area will not normally meet this requirement. Although the fire alarm warning can still be sounded in all areas when there is a failure of an amplifier, the audibility and intelligibility criteria will not be met.

Procedure 4A.10: Additional loudspeaker circuits

(Refer to BS 5839-8:1998, 6.6.3.)

The number of loudspeaker circuits will usually be determined by the zoning of the system or by circuit loading in relation to amplifier sizing. As with conventional sounder circuits, it is not normally intended that loudspeaker circuits be duplicated so that in the event of loss of a circuit there should still be audible and intelligible speech, albeit it at a reduced level. However, there may be circumstances where this is justified. In particular, this could apply to large public buildings such as shopping centres, cinemas and transport terminals.

BS 5839-8 recommends that additional loudspeaker circuits be provided in public spaces in these buildings, if the space is greater than 4,000m^2 in area or designed to accommodate more than 500 members of the public. In these circumstances, the two (or more) loudspeaker circuits should be interleaved so that adjacent speakers are on different circuits.

Procedure 4A.11: Messages

(Refer to BS 5839-8:1998, Clause 14.)

Message formats should include an attention drawing signal, brief silence, the message and another period of brief silence. The sequence should then be repeated continuously until manually silenced. Examples of messages are given in BS 5839-8, but the exact wording would need to be agreed with all interested parties. Any intention to use coded messages should be carefully considered as these can often be misinterpreted or ignored.

Procedure 4B
Assessment of work in progress

Checklist

Assessment of work in progress for a voice alarm system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

4B.1* **Is the voice alarm system being installed throughout the relevant areas?** ❑ Yes ❑ No

[See Procedure 4A.1]

Comments:

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4B.2* **Does the loudspeaker layout appear suitable for the sound levels and intelligibility required?** ❑ Yes ❑ No

[See Procedure 4A.3]

Comments:

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4B.3* **Is the location of control equipment and any fireman's microphone(s) satisfactory?** ❑ Yes ❑ No

[See Procedure 4A.4]

Comments:

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4B.4* **Are the correct cable types being installed?** ❑ Yes ❑ No

[See Procedure 4A.6]

Comments:

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4B.5 Is mechanical protection being provided for cables where appropriate? ❑ Yes ❑ No ❑ N/A

[See Procedure 4B.1]

Comments:

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4B.6* Is the method of connection to loudspeakers satisfactory? ❑ Yes ❑ No

[See Procedure 4B.2]

Comments:

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4B.7 Are voice alarm cables being segregated from all other cables? ❑ Yes ❑ No

[See Procedure 4B.3]

Comments:

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4B.8* Is the standard of cable installation satisfactory? ❑ Yes ❑ No

[See Procedure 4B.4]

Comments:

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4B.9* Has a suitable mains supply been provided? ❑ Yes ❑ No

[See Procedure 4B.5]

Comments:

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Procedure 4B
Assessment of work in progress

Procedures

Procedure 4B.1: Checking the adequacy of the mechanical protection of cables

(Refer to BS 5839-8:1998, 19.3.)

Steel wire armoured and mineral insulated copper sheathed cables do not normally require any additional mechanical protection. PVC 'singles' are only ever run in conduit or trunking and therefore always have additional mechanical protection.

All other cables should be provided with additional mechanical protection in the circumstances described in BS 5839-1:2002 (see Procedure 1B.3).

Any cable may need additional mechanical protection if it is exposed to particularly arduous conditions, such as impact by forklift trucks.

Suitable means of providing mechanical protection comprises enclosure in conduit, trunking or ducts. Alternatively, the cable may be chased into plaster finishes.

Procedure 4B.2: Method of connection to loudspeakers

(Refer to BS 5839-8:1998, 6.6.2.)

It is common practice for contractors to terminate the main fire-resisting loudspeaker circuits at a junction box close to each loudspeaker; a flexible cable then leads from the junction box to the loudspeaker. This arrangement leads to an additional junction for each loudspeaker on the system, which may be accepted if there is no other practicable installation technique, provided that:

- the connection between the junction box and the loudspeaker is fire-resisting;
- the connection between the junction box and the loudspeaker is monitored (so that an open circuit fault on this single interconnection would result in a fault warning);
- the flexible cable is protected against mechanical damage if this is necessary (see Procedure 4B.1).

It is often found that contractors simply use the flying lead attached to the loudspeaker at its time of purchase to make the connection to the junction box. This is unacceptable as the flying lead is not normally fire-resisting, nor, under these circumstances, is it normally monitored.

Procedure 4B.3: Checking segregation of wiring

(Refer to BS 5839-8:1998, 19.3.)

Since the voice alarm system forms part of the fire warning system in the premises, the cables of the voice alarm system should be segregated from the cables of other services, in the same way as fire alarm cables. (See Procedure 1B.4).

Procedure 4B.4: Checking the standard of cable installation

(Refer to BS 5839-8:1998, Clause 26.)

The cable installation for the voice alarm system should conform to the same standards as the cable installation for the fire detection and alarm system. (See Procedure 1B.5.)

Procedure 4B.5: Checking the voice alarm mains supplies

(Refer to BS 5839-8:1998, 18.1.)

The mains supplies for the voice alarm system should satisfy the same requirements as the mains supply for the fire detection and alarm system. (See Procedure 1B.6.)

Procedure 4C
Final acceptance

Checklist

Final acceptance of a voice alarm system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

4C.0* **Has the control equipment been examined and tests at the control equipment been witnessed?** ❑ Yes ❑ No

[See Procedure 4C.0]

List tests and results:

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4C.1* **Are the batteries provided of sufficient capacity to power the system for the duration required?** ❑ Yes ❑ No

[See Procedure 4C.1]

Comments:

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4C.2 Is the rating of the power supply sufficient? ❑ Yes ❑ No

[See Procedure 4C.2]

Comments:

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4C.3* **Has a suitable mains supply been provided?** ❑ Yes ❑ No

[See Procedure 4B.5]

Comments:

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4C.4* **Have loudspeakers been provided throughout all relevant areas?** ❑ Yes ❑ No

[See Procedure 4A.1]

Comments:

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4C.5* **Has the correct zoning been adopted?** ❑ Yes ❑ No ❑ N/A

[See Procedure 4A.2]

Comments:

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4C.6* **Is the system sufficiently audible and intelligible throughout all areas?** ❑ Yes ❑ No

[See Procedure 4C.3]

Comments:

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4C.7* **Is the location of control equipment and any fireman's microphone(s) satisfactory?** ❑ Yes ❑ No

[See Procedure 4A.4]

Comments:

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4C.8* **Have the correct cable types been used?** ❑ Yes ❑ No

[See Procedure 4A.6]

Comments:

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4C.9 Has mechanical protection been provided for cables where appropriate? ❑ Yes ❑ No ❑ N/A

[See Procedure 4B.1]

Comments:

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4C.10* Is the method of connection to loudspeakers satisfactory? ❑ Yes ❑ No

[See Procedure 4B.2]

Comments:

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4C.11 Are voice alarm cables segregated from all other cables? ❑ Yes ❑ No

[See Procedure 4B.3]

Comments:

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4C.12* Is the standard of cable installation satisfactory? ❑ Yes ❑ No

[See Procedure 4B.4]

Comments:

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4C.13* Have all voice alarm service penetrations been fire stopped? ❑ Yes ❑ No

[See Procedure 4C.4]

Comments:

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4C.14 Has adequate documentation been provided to the user? ❑ Yes ❑ No

[See Procedure 4C.5]

Comments:

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Procedure 4C
Final acceptance

Procedures

Procedure 4C.0: Witnessing tests at the voice alarm control equipment

There is a variety of tests that may be carried out on the voice alarm control and indicating equipment to confirm that it conforms to the relevant clauses of BS 5839-8, and that it enables the voice alarm system, in conjunction with the automatic fire detection and alarm system, to conform to both Part 1 and Part 8 of BS 5839. It may not be appropriate to carry out every test in every case.

However, while at the control and indicating equipment for the voice alarm system, the following points should always be confirmed:

- that there are at least two independent loudspeaker circuits (to conform to BS 5839-8:1998, 6.6.1); only one loudspeaker need be fitted to the second circuit, unless it has been previously agreed by all interested parties that further loudspeaker zones are required (see subclause 6.6.3);
- that the interconnection between the voice alarm system and the fire detection and alarm system is monitored (subclause 7.1);
- that, on operation of a break glass call point in any area, the voice alarm message is started within that area within a maximum of 3 seconds (subclause 6.4); and
- that all controls operate correctly, resulting in the correct response of the voice alarm system.

The following 'menu' of system tests should at least be considered and it should be agreed between the assessor, the contractor and the user as to which tests are to be carried out.

- **Battery removal test:** disconnection of the standby power supply should result in a fault warning within 100 seconds; the system should be capable of operating normally and initiating a voice alarm message under these conditions;
- **Simulated mains failure test:** disconnection of the mains supply should result in a fault warning within 100 seconds; the system should be capable of operating normally and initiating a voice alarm message under these conditions;
- **Loudspeaker monitoring test:** disconnection of a single conductor at a single loudspeaker at any point in the installation should result in a fault warning being given within 100 seconds. This test should be carried out if there is any doubt regarding the effectiveness of loudspeaker circuit monitoring.

Procedure 4C.1: Checking adequacy of battery capacity

(Refer to BS 5839-8:1998, 18.5.)

Procedure 1C.1 provides guidance on checking the battery capacity of a fire alarm system. A similar principle should be adopted for checking the battery capacity of a voice alarm system, except that a modified value needs to be used for the alarm current, to take into account that voice alarm messages incorporate periods of silence.

The procedure for calculating standby battery capacities for VA systems is outlined in BS 5839-8:1998, 18.5. This refers to Annex C, which provides a methodology for determining the alarm current and the load when the system is in an alarm condition.

Procedure 4C.2: Verification of adequacy of power supply

(Refer to BS 5839-8:1998, clause 18.)

It should be confirmed that the power supply is capable of providing the maximum alarm load measured during operation of the system. It should also be confirmed that the rating of the power supply is sufficient to charge flat batteries within 24 hours, while providing the quiescent load of the system.

Procedure 4C.3: Verification of sound levels and intelligibility

(Refer to BS 5839-8:1998, 28.5.2–28.5.3.)

The assessor should witness measurements of sound levels in at least a sample of areas. Particular consideration should be given to suspect areas that, from an inspection of the building or a study of the drawings, may suffer from low sound levels or high background noise levels. There is usually little point in measuring sound levels in normal-sized rooms in which loudspeakers are located. Measurements should always be carried out in cases where there is more than one door between any point and the nearest loudspeaker or, in the case of sleeping risks, if there are no loudspeakers within the rooms in which people sleep. Wherever measurements are made, it should be ensured that all doors in the area are closed at the time of the test.

Care should also be taken in the case of buildings with acoustic partitioning, as the attenuation characteristics of the partitioning may be such as to reduce sound levels to well below those recommended in the British Standard.

It should also be confirmed that the sound level in any area in which an emergency call will be made to the fire brigade in the event of a fire is not so loud as to interfere with telephone communications. This recommendation will often apply, for example, in the case of a telephone switchboard.

While measuring sound levels, it should be ensured that the voice alarm messages are intelligible on a subjective basis. This test should be carried out with any associated fire protection measures in operation. For example, in a shopping complex with a mechanical smoke extraction system, smoke extract fans should be running during the course of the test to ensure that the voice alarm messages are of sufficient sound pressure level and intelligibility to be heard readily over the background noise of the extract fans. In case of dispute, objective measurements of intelligibility can be carried out by specialists.

Message content and broadcast sequence should follow the recommendations in BS 5839-8: 1998, 14.4. It should be ensured that messages are repeated at appropriate intervals. The time interval between repeats of the message should not exceed 30 seconds. Periods of complete silence should be brief and typically up to 5 seconds. However, longer silence periods may be necessary, e.g. in spaces with long reverberation times. However, the overall time interval between repeats of the message should still not exceed 30 seconds.

Procedure 4C.4: Fire stopping

(Refer to BS 5839-8:1998, Clause 26.)

All penetrations for conduits, ducts, trunking and cables should be fire stopped to the full thickness of the barrier that is penetrated. Within ducts, trunking, etc., it may also be necessary to install appropriate barriers to prevent the spread of fire. It should be noted that this may not, contractually, be the responsibility of the voice alarm contractor. However, conformity to the relevant clauses of BS 5839-8 cannot be claimed until this work is completed.

Procedure 4C.5: Documentation

(Refer to BS 5839-8:1998, Clause 28.)

It should be confirmed that the installer of the voice alarm system has provided a certificate of conformity (either of the type shown in BS 5839-1:2002, Annex G, covering both the fire detection system and the VA system or alternatively, of the type shown in BS 5839-8:1998, Annex D). The certificate should unambiguously confirm full conformity to the relevant clauses of BS 5839 or clearly state all deviations from the recommendations of that code.

In addition, it is desirable for the following documents to be provided to the user:

- Commissioning records.
- An operating manual.
- As fitted drawings. [These should show the locations of all equipment, such as loudspeakers, control and indicating equipment, fireman's microphone(s) and junction boxes. The drawings should also show cable types and sizes and wiring routes; drawings should be carefully checked to show that they do indicate wiring routes, as these are often omitted from drawings.]
- A log book in which the user should record all faults, alarm conditions, service visits, etc.

NOTE: This is not a design code, but a guide for a structured assessment of a voice alarm system.

Procedure 5

Assessment of a gaseous fire extinguishing system

Procedure 5: Introduction

NOTE: This is not a design guide, but a guide for a structured assessment of a gaseous fire extinguishing system.

This procedure relates to the assessment of a total flooding gaseous fire extinguishing system. Such systems involve the discharge of a specific quantity of extinguishant so as to produce a uniform concentration throughout the protected space that is sufficient to extinguish the fire.

Following the demise of halon (in particular, halon 1301), on environmental grounds, new gaseous extinguishants have been introduced. The new agents may be subdivided into two groups, known generically as either halocarbons or inert gases. These agents, along with carbon dioxide (CO_2) are often employed where there is a need for an electrically non-conducting agent that does not cause secondary damage. Typically, they are used to protect computer rooms, telecommunications facilities, electrical plant rooms, flammable liquids hazards and archives.

The British Standard for CO_2 systems is BS 5306-4. All of the new agents are covered by an international standard, BS ISO 14520. In view of this, references are made to either BS 5306-4 or BS ISO 14520 as appropriate.

BS ISO 14520 is divided into 15 parts. Part 1 covers general requirements applicable to all systems. Each of the subsequent 14 parts covers a specific extinguishing agent. It is therefore necessary to refer to two parts of BS ISO 14520 in relation to a system – for example, for FM 200, this would be BS ISO 14520 Parts 1 and 9 and for IG-541, this would be BS ISO 14520 Parts 1 and 15.

The use of halon is now controlled by legislation. In accordance with EC Regulation 2037/2000 approving authorities should not approve any submissions that include installation of a new halon system, and all such systems predating the legislation must have been decommissioned.

With one exception, none of the new extinguishants are subject to control under current environmental legislation. The exception is NAF S-III (HCFC Blend A), the use of which is currently prohibited by the EC Regulation. Other halocarbon agents are subject to a voluntary agreement between Government and industry to minimize emissions. This, for instance, precludes discharge testing.

A gaseous fire extinguishing system will usually be actuated automatically by a fire detection and alarm system. Assessment of the latter is covered under Procedure 1 and this Procedure refers only to those electrical aspects that are specific to automatic gaseous fire extinguishing systems. The British Standard that addresses these matters is BS 7273-1.

Procedure 5A
Assessment of specification and design drawings

Checklist

Assessment of specification and design drawings for a gaseous extinguishing system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

5A.1* **Has sufficient information been provided on the room being protected, its contents and the nature of the hazard?** ❑ Yes ❑ No

[See Procedure 5A.1]

Comments:

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5A.2* **Has the correct design concentration been used?** ❑ Yes ❑ No

[See Procedure 5A.2]

Comments:

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5A.3* **Is the quantity of gas sufficient?** ❑ Yes ❑ No

[See Procedure 5A.3]

Comments:

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5A.4* **Is the design/construction of the protected room suitable for containing and holding a gas discharge?** ❑ Yes ❑ No

[See Procedure 5A.4]

Comments:

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5A.5 Is there provision for over-pressure relief venting? ❑ Yes ❑ No

[See Procedure 5A.5]

Comments:

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5A.6 Is there provision for ventilation after a discharge? ❑ Yes ❑ No

[See Procedure 5A.6]

Comments:

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5A.7 Are the types of detector used appropriate? ❑ Yes ❑ No

[See Procedure 5A.7]

Comments:

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5A.8* Is the spacing of detectors adequate? ❑ Yes ❑ No

[See Procedure 5A.8]

Comments:

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5A.9* Have manual controls been provided? ❑ Yes ❑ No

[See Procedure 5A.9]

Comments:

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5A.10* **Are appropriate safety measures planned?** ❑ Yes ❑ No

[See Procedure 5A.10]

Comments:

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5A.11 Are the containers/components/pipework of the correct specification? ❑ Yes ❑ No

[See Procedure 5A.11]

Comments:

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5A.12 Are the interfaces, between the fire detection system and the ventilation plant, etc., clearly specified? ❑ Yes ❑ No

[See Procedure 5A.12]

Comments:

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5A.13 Is the siting of containers satisfactory? ❑ Yes ❑ No

[See Procedure 5A.13]

Comments:

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5A.14 Have sufficient nozzles been provided? ❑ Yes ❑ No

[See Procedure 5A.14]

Comments:

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Procedure 5A
Assessment of specification and design drawings

Procedures

Procedure 5A.1: Specification and plans

(Refer to BS ISO 14520-1:2006, 7.2 and Annex A/BS 5306-4:2001, Clause 6 as appropriate.)

It is important that the basis for the design of a total flooding gaseous extinguishing system is established and recorded. It is normal, therefore, for specifications and drawings to be produced that not only outline the engineering details, such as pipe sizes and specification, but also clearly describe the nature of the hazard and any known or assumed design parameters, e.g. minimum and maximum temperatures and altitude.

In approving systems, approving authorities should request to see working documents, that should include the following:

- Description of the room, the hazards being protected and the extent to which the room is occupied.
- Minimum and maximum ambient temperatures.
- Location of the protected room within the building and whether it is above or below ground.
- Height above/below sea level.
- Wall, floor and ceiling construction.
- Scaled layout drawings and cross-sections that clearly show the extent of any raised floors and suspended ceilings.
- Description of the ventilation system.
- Type of extinguishant being used.
- Design concentration.
- Quantity of extinguishant and supporting calculations.
- Specification of containers used, including capacity, storage pressure and weight (including extinguishant).
- Description of pipe, fittings and nozzles, including material specifications.
- Scale drawings showing extinguishant distribution system, including containers, piping and nozzles.
- Isometric with node references and corresponding flow calculations to support pipe and nozzles sizing.

Procedure 5A.2: Design concentration

(Refer to BS ISO 14520-1:2006, 7.5/BS 5306-4:2001, Clauses 13–14 as appropriate)

It is vital to the effective performance of a gaseous fire extinguishing system that the correct design concentration is chosen. Design concentrations normally include a safety factor (typically 30 per cent), that is added to the extinguishing concentration derived from tests.

Some data on extinguishing concentrations is currently listed in published standards, but it may be necessary to rely upon the manufacturers' design manual for some design concentrations. It is important to understand that design concentrations vary, depending on the fuel and its configuration.

Flammable liquids (Class B fires) will often require different design concentrations. For example:

	Minimum CO_2 design concentration
Acetone	31 per cent
Ethanol	43 per cent
Kerosene	34 per cent

In the case of Class A fires (e.g. paper, wood and cellulosic-based materials), the design concentration required will depend on the nature of burning. Deep-seated fires will often require considerably higher concentrations to reliably extinguish the fire. However, most gaseous extinguishing systems are designed to extinguish surface flaming at a stage before the fire becomes deep-seated. Typical design concentrations for Class A surface flaming are as follows:

Halon 1301	5 per cent (for comparison)
FM 200 (HFC 227ea)	7.5 per cent
FE 13 (HFC 23)	19.5 per cent
Inert gases (such as IG-541, IG-55 and IG-01)	38–40 per cent

For the purposes of design, electrical hazards such as switchgear rooms and computer rooms are treated as Class A surface flaming fire risks. However, BS ISO 14520-1:2006, 7.5.1.3 draws attention to the limitations of tests in determining a suitable concentration for hazards involving plastics. It recommends that a higher concentration is used. This equates to 7.72 per cent for FM 200.

Procedure 5A.3: Quantity of gas

(Refer to BS ISO 14520-1:2006, 7.6/BS 5306-4:2001, Clauses 13–14 as appropriate.)

The amount of agent required to achieve the design concentration is derived from the following equation:

$$W = \frac{V}{S}\left(\frac{C}{100 - C}\right)$$

where W = mass of extinguishant (kg);

V = net volume of hazard (m^3);

C = extinguishant design concentration (per cent by volume);

S = specific volume of vapour at the minimum ambient temperature (m^3/kg).

For non-liquefiable extinguishants (i.e. the inert gases), the equation is:

$$W = \frac{V}{S} \ln\left(\frac{100}{100\ C}\right)$$

or:

$$W = 2.3026 \frac{V}{S} \log_{10}\left(\frac{100}{100 - C}\right)$$

These equations have been used to create tables of flooding factors, that are values representing the mass of agent (kg) per cubic metre of volume for a specified design concentration and at a specified temperature. The quantity of agent is, therefore, very simply calculated by multiplying the volume of the room by the appropriate flooding factor, that should be selected on the basis of the minimum temperature of the room.

Example:

- The room to be protected is 10m wide by 3m long and 3m high, giving a volume of 90m^3.
- The fire risk is Class A surface flaming.
- The minimum ambient temperature is 20ºC.
- The agent used is FM 200.

Assuming the design concentration required is 7.5 per cent, the flooding factor from BS ISO 14520-9:2006, Table 3 is 0.5909kg/m^3 at 20ºC. The quantity of agent required is 0.5909 x 90, equalling 53.2kg.

In the case of CO_2 systems, BS 5306-4:2001 again provides flooding factors (e.g. Table 3). For example, for a computer room, a design concentration of 53 per cent is required, the flooding factor for which is 1.5 kg/m^3. These flooding factors are generally not temperature dependent.

Quantities of the new inert gas agents can generally be calculated in the same way, although often the quantity of agent will be expressed as a volume rather than a weight, and the flooding factor as a percentage of the room volume. It is important, therefore, to understand the distinction between design concentration and flooding factor. The design concentration is the concentration of agent that must be achieved in the room. The flooding factor is usually higher than this, to take account of the fact that some agent is lost through holes while the gas is being discharged. Hence, for IG-541, to achieve a 40 per cent design concentration, a flooding factor of 51 per cent is required.

Procedure 5A.4: Room enclosure

(Refer to BS ISO 14520-1:2006, 7.4, 7.8 and Annex E/BS 5306-4:2001, Clause 12 as appropriate.)

Total flooding systems work by achieving a concentration of agent that is sufficient to extinguish the fire. In order to prevent the fire reigniting, it is important to hold the extinguishing agent at the critical concentration for a certain period of time, the 'hold time'. Typically, hold times of 10 minutes are considered the minimum for Class A surface flaming fires.

The hold time is dependent on the degree to which the room is gas tight. It is often necessary to ensure a very high standard of sealing of holes and gaps in the construction of the room. Doors need to be self-closing and fitted with draught seals, and gaps around pipes need to be fire stopped. Fans in air conditioning/ventilation systems, unless self-contained and recirculating the air within the room, need to be stopped automatically prior to discharge of the agent, and dampers need to be closed to seal off the volume of the room. Even if recirculating units continue to run, fresh air make-up fans should stop and the dampers close.

The normal way of establishing that the room is sufficiently well-sealed is by conducting an enclosure integrity test (see BS ISO 14520-1:2006, Annex E and also Procedure 5C.4 of this manual). In some circumstances, a full discharge test may be used for this purpose, but not in the case of systems using halon 1301 or the new halocarbon agents.

Enclosure integrity is often not the contractual responsibility of the system installer. Similarly, issues relating to the construction of the protected room enclosure are usually not the contractual responsibility of the system installer.

Approving authorities and assessors should, nevertheless, ensure that satisfactory answers to the following questions are provided in the information submitted:

- Is the protected room enclosure to be built of fire-resisting construction (at least 30 minutes when tested in accordance with the relevant part of BS 476)?
- Is the glazing (if any) suitable for the pressures likely to be generated?
- Are there arrangements to ensure that all closeable openings will be sealed shut prior to discharge?
- Have any unencloseable openings been compensated for in the design of the system (e.g. extended discharge with extra agent)?

Procedure 5A.5: Pressure relief venting

(Refer to BS ISO 14520-1:2006, 7.4.1 and BS 5306-4:2001, Clause 12.)

The discharge of a gas into the protected room will increase the pressure in the room. It is theoretically possible, in a well-sealed room, that pressures capable of causing structural damage could be created. The only guaranteed way of avoiding such a possibility is to incorporate pressure relief venting in the room. This applies to halocarbon agents as well as CO_2 and the inert gases, although, because of the rapid cooling in the room when a halocarbon is discharged, negative pressure as well as positive pressure is generated.

This is an issue that has not always been considered in gas extinguishing system design and is not fully addressed in current standards. It can easily be overlooked, as the contractual responsibility for addressing it does not often reside with the system installer.

Procedure 5A.6: Post-fire ventilation

[Refer to BS ISO 14520-1:2006, 5.3 h).]

In addition to the products of combustion from the fire itself, the action of an extinguishing agent in suppressing a fire can result in the generation of thermal decomposition products. These are usually acidic and give rise to corrosion if not removed quickly after the fire is extinguished. They are also a health hazard.

A means of ventilating the room after a discharge should therefore be provided. This should normally comprise a dedicated mechanical extract system that is separate from the normal ventilation system. It should incorporate low-level grilles and should discharge directly to open air. However, if external doors and windows are available natural ventilation can be considered acceptable.

This is again an issue that is not normally within the contractual responsibility of the system installer.

Procedure 5A.7: Detector type

(Refer to BS 7273-1:2000, 4.2.3.)

BS 7273 recommends that, where smoke detectors are used to automatically initiate a gas discharge, there should normally be one of each type (i.e. optical and ionization chamber) on each circuit. As a minimum of two circuits are usually provided in order to give coincidence connection (i.e. confirmation of fire by the operation of two separate detectors/zones before the system is actuated), the minimum number of detectors required for any size of room will be four, except in the case of small rooms in which two detectors of the same type may be acceptable.

Procedure 5A.8: Detector spacing

(Refer to BS 7273-1:2000, 4.2.4)

As ‘coincidence connection’ requires that a second detector operates, thus confirming the presence of a fire, before the gas extinguishing system is actuated, it is necessary to reduce the spacing/area coverage of detectors to avoid an excessive delay before a second detector is operated.

As a minimum, the area coverage is reduced by half (i.e. from $100m^2$ per detector to $50m^2$ per detector), resulting in the doubling of the number of detectors required. Special considerations apply in the case of computer rooms (refer to BS 6266).

Procedure 5A.9: Manual operation

(Refer to BS 7273-1:2000, 6.1.2.)

Although approving authorities and assessors will normally require that total flooding gaseous extinguishing systems are designed for automatic operation, the facility for manual operation should also be provided. This will necessitate the provision of manual release controls. These should normally be sited outside entrances/exits, but, in circumstances where they would be subject to malicious or inadvertent operation, they should be sited inside the protected areas, adjacent to the door.

Procedure 5A.10: Safety

(Refer to BS ISO 14520-1:2006, 5.2/BS 5306-4:2001, Clause 34 as appropriate.)

Current guidance and recommendations on the safety precautions required for a gaseous fire extinguishing system can be found in a report produced by the Halon Alternatives Group (HAG). Previous guidance, in the form of the HSE's guidance note GS16, has been withdrawn.

Depending on the extinguishant and the achieved gas concentration, it is permissible for some systems to be in the automatic mode of operation (i.e. ready to operate automatically) while people are present. However, it is not intended that people should remain in the room while the extinguishant is discharged.

Approving authorities should ensure that, as a *minimum*, the following safety precautions are incorporated into the design of the system and the protected room enclosure:

- Doors that open outwards and fastenings that do not require the use of a key.
- A pre-discharge time delay, to allow people to escape prior to discharge.
- An audible warning during the time delay period.
- Illuminated status indicator lamps at entrances.
- Warning signs on entrances.

Hold switches may be provided at exits to allow people escaping to temporarily delay the discharge (if it is intended that the system may remain in the automatic mode when the room is occupied) but these are not mandatory.

In some cases, lock-off controls will be necessary to change over from automatic mode to 'manual only' mode on entry to the protected room. In the case of CO_2, in particular, an additional mechanical means of isolation, such as a valve, may be warranted.

Procedure 5A.11: Hardware specifications

Both BS ISO 14520 and BS 5306-4 give guidance on the specifications for pipework, fittings and containers for gaseous fire extinguishing systems, although BS ISO 14520 does not refer to relevant British Standards. It is important that the correct specifications are used, as these are related to the required pressure rating. For example, seamless steel containers conforming to BS 5045-7 and BS EN 1964-1 are required for high pressure CO_2 storage containers, whereas lower strength welded steel containers conforming to BS 5045-2 are permissible for, say, FM 200 stored at 25 bar.

Procedure 5A.12: Interfaces

(Refer to BS ISO 14520-1:2006, 7.4.3/BS 7273-1, Clause 5 as appropriate.)

As stated in Procedure 5A.4 of this manual, it is vital that ventilation fans are stopped and dampers closed prior to discharge of the extinguishant. Other important electrical interfaces are often required in order to stop machinery, to power down equipment and to signal to other alarm systems, such as the main building fire alarm system. The gas itself is usually released by an actuator that is either directly or indirectly operated by an electrical signal from the fire detection system.

It is vital, in view of the interdependency of the various electrical and mechanical systems, that interfaces are clearly specified. A relatively simple cause and effect chart or a diagram showing the sequence of events, is usually the clearest way of describing how the system should respond (see BS 7273-1, Annex A).

Procedure 5A.13: Container siting

(Refer to BS ISO 14520-1:2006, 6.2.3/BS 5306-4:2001, Clause 37 as appropriate.)

Containers should normally be sited outside the protected room, in a position where they are easily accessible for maintenance but where they are not vulnerable to tampering. If they are stored in small rooms or cupboards, vents should be provided to prevent the build-up of a high concentration of gas from, say, a leaking valve.

Containers should only be sited inside the protected room if there is no alternative location for them. If the containers are stored in the protected room, the system cannot be discharged manually from the mechanical release that is usually provided at the container head. It is, however, possible to provide a mechanical manual release outside the protected room, although this may not always be considered necessary.

Procedure 5A.14: Nozzles

(Refer to BS 5306-4:2001, 6.3.6/16.2 as appropriate.)

The number of nozzles required is largely dictated by the size of the room and the limitations of the nozzle. Height and area coverage limits for nozzles are usually specified in manufacturers' design manuals.

Computer calculations are used to determine the size of the orifices in the nozzle necessary to give a flow rate that will ensure the discharge is completed within 10 seconds for halocarbon agents, within 60 seconds for inert gases and between 60 seconds and 7 minutes in the case of CO_2 systems (depending on the fire risk).

Procedure 5B
Assessment of work in progress

Checklist

Assessment of work in progress for a gaseous extinguishing system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

5B.1 Have all electrical and mechanical components been installed in accordance with the working drawings? ❑ Yes ❑ No

[See Procedure 5A.1]

Comments:

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5B.2 Do the pipework and fittings meet the appropriate specifications? ❑ Yes ❑ No

[See Procedure 5A.11]

Comments:

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5B.3* Is the standard of pipework installation satisfactory? ❑ Yes ❑ No

[See Procedure 5B.1]

Comments:

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5B.4 Is there adequate earthing/ electrical clearance? ❑ Yes ❑ No ❑ N/A

[See Procedure 5B.1]

Comments:

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5B.5 Are nozzles sited appropriately and marked to indicate orifice size? ❑ Yes ❑ No

[See Procedure 5B.2]

Comments:

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5B.6* Are detectors appropriately sited? ❑ Yes ❑ No

[See Procedure 1B.1]

Comments:

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5B.7 Are containers appropriately sited and securely fixed? ❑ Yes ❑ No

[See Procedure 5B.3]

Comments:

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Procedure 5B
Assessment of work in progress

Procedures

Procedure 5B.1: Checking the standard of pipework installation

(Refer to BS ISO 14520-1:2006, 6.3/BS 5306-4:2001, Clause 41 as appropriate.)

Pipework should be rigidly fixed by pipework supports securely fastened to the structure of the room. Nozzles should also be adequately supported against the force of the discharge. The maximum distance between pipe supports is given in BS ISO 14520-1:2006, Table 4. For example, for 15mm diameter pipe the maximum distance between supports is 1.5m. This increases to 5.8m for 200mm diameter pipe. The distance from a nozzle to the last pipe support should not exceed 100mm for pipe diameters of 25mm or less and 250mm for pipe diameters above 25mm.

Pipework should be painted red or otherwise suitably marked to show it is part of a fire fighting system.

If the system is being installed in an electrical substation or switchroom, the pipework should be earthed. It is also important that the pipework is installed so that there is adequate clearance between electrical conductors and all parts of the system. Safety clearances are specified in the standards.

Procedure 5B.2: Checking the siting of nozzles

(Refer to BS ISO 14520-1:2006, 6.3.6/BS 5306-4:2001, Clause 41 as appropriate.)

Nozzles should be sited so that the discharge is not deflected or otherwise obstructed by pipes, ducts, equipment, etc.

The nozzles should be stamped or marked with a part number or other means of identification, that should be checked against the working drawings.

Procedure 5B.3: Checking container siting

(Refer to BS ISO 14520-1:2006, 6.2.3/BS 5306-4:2001, Clause 37 as appropriate.)

The containers should be securely fixed to the wall in the vertical position by straps and should be mounted on a flat surface capable of withstanding the weight of the filled container.

Containers should only be fixed horizontally if they are designed for this purpose and the arrangement is permitted by the terms of the manufacturers' design manual. Refer also to Procedure 5A.13 of this manual.

Procedure 5C
Final acceptance

Checklist

Final acceptance of a gaseous extinguishing system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

5C.1* **Is there adequate documentary evidence of testing and commissioning?** ❑ Yes ❑ No

[See Procedure 5C.1]

Comments:

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5C.2* **Are the room dimensions, ventilation arrangements and hazard details the same as those upon which the design was based?** ❑ Yes ❑ No

[See Procedure 5C.2]

Comments:

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5C.3* **Have all electrical and mechanical components been installed in accordance with the working drawings?** ❑ Yes ❑ No

[See Procedure 5A.1]

Comments:

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5C.4* **Is the siting of detectors, controls, nozzles, etc., satisfactory?** ❑ Yes ❑ No

[See Procedures 5B.2, 5B.5 and 5B.6]

Comments:

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5C.5 Does the container(s) contain the correct fill of agent? ❑ Yes ❑ No

[See Procedure 5C.3]

Comments:

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5C.6 Have all interfaces with ancillary services been completed? ❑ Yes ❑ No

[See Procedure 5A.12]

Comments:

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5C.7 Has a successful integrity test been carried out? ❑ Yes ❑ No

[See Procedure 5C.4]

Comments:

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5C.8 Has overpressure relief been provided? ❑ Yes ❑ No

[See Procedure 5A.5]

Comments:

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5C.9 Is there a means for ventilation after a discharge? ❑ Yes ❑ No

[See Procedure 5A.6]

Comments:

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5C.10* **Is the *achieved* concentration within acceptable safety limits?** ❑ Yes ❑ No

[See Procedure 5C.5]

Comments:

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Procedure 5C
Final acceptance

Procedures

Procedure 5C.1: Documentation

(Refer to BS ISO 14520-1:2006, 8.3.)

It should be confirmed that the installer of the gaseous fire extinguishing system has provided a completion certificate stating conformity to BS ISO 14520/BS 5306-4, as appropriate.

The installer's commissioning records should be inspected to confirm that:

- All mechanical and electrical components have been tested/inspected and are in working order.
- All detectors and manual controls have been tested to ensure that the system operates according to the operational sequence (see Procedure 5A.12 of this manual).
- All interfaces with ventilation plant, etc., have been completed and tested (see Procedure 5A.12 of this manual).
- The pipework has been blown through with, for example, air, to ensure that there are no blockages.
- The pipework has been pressure tested.

Procedure 5C.2: Confirming the basis of the design

(Refer to BS ISO 14520-1:2006, 8.2.2 and 8.2.3.11.)

It is vital that a check is made to confirm that the dimensions of the protected room enclosure are the same as those used to determine the quantity of agent. If there is any variation, the implications of this should be assessed by recalculating the quantity of gas required. If the room volume is greater than originally anticipated, the effect could be a shortfall in the quantity of agent and hence a lower achieved gas concentration. If the room volume is smaller than originally anticipated, the resultant gas concentration may exceed the agent's safety limits.

It is also important to check other aspects of the protected risk about which assumptions may have been made at the design stage. These are as follows:

- **Minimum temperature.** Any significant variation could result in the system having either too little or too much gas.

- **Hazard details.** If the type of fire expected or the nature of the fuel is different to that for which the system was designed, the effect could again be that the quantity of gas is incorrect.
- **Ventilation arrangements.** It may have been assumed that all ventilation systems will be stopped and sealed by dampers prior to discharge. However, it is important to check the actual ventilation arrangements to ensure that, for example, there are no fresh air louvres or transfer grilles that have not been taken into account.

Procedure 5C.3: Checking the quantity of agent

(Refer to BS ISO 14520-1:2006, 7.6/BS 5306-4:2001, clauses 13–14 as appropriate.)

The agent fill stamped on the labels of the containers should be checked to ensure that it is correct.

Procedure 5C.4: Enclosure integrity

(Refer to BS ISO 14520-1:2006, 8.2.4.)

The report on the enclosure integrity test should be inspected to determine that the minimum hold time was achieved. If the room failed the test, evidence should be sought to confirm that remedial sealing works were carried out and that the integrity of the room was subsequently retested.

Procedure 5C.5: Achieved concentration

(Refer to BS ISO 14520-1:2006, 7.6/BS 5306-4:2001, clauses 13–14 as appropriate.)

Approving authorities should ensure that the installer makes a documented statement as to the extinguishant concentration that will be achieved should the system be discharged.

While the quantity of agent is determined by establishing the *minimum* ambient temperature and the *gross* volume of the protected room, the achieved concentration should be based on the *maximum* ambient temperature and the *net* volume of the room (i.e. less any fixed, impermeable objects such as beams and columns, sealed ductwork, etc.). Thus, the achieved concentration represents a worst case check that is used to confirm that, if people were inadvertently exposed to a discharge, the maximum safe limits would not be exceeded.

NOTE: This is not a design guide, but a guide for a structured assessment of a gaseous fire extinguishing system.

Procedure 6

Assessment of an emergency escape lighting system

Procedure 6: Introduction

NOTE: This is not a design guide, but a guide for a structured assessment of an emergency escape lighting system.

This procedure relates to the assessment of an emergency escape lighting system (i.e. that part of the emergency lighting that provides illumination for the safety of people leaving a location). In practice, the terms emergency lighting and emergency escape lighting are often regarded as synonymous, although, strictly, assessors will be dealing only with what would correctly be termed escape route lighting and open area lighting. These are provided for illumination in the event of power failure, so that people can reach, identify and safely use escape routes. Emergency escape lighting may be only one part of the emergency lighting in the premises; in large buildings, there may be a (non-legislatively required) need for standby lighting [normally provided by an emergency generator(s)], that is provided to enable normal activities to continue in the event of failure of the mains supply to a building. Safety legislation may also require high risk task area lighting that provides for the safety of people involved in a potentially dangerous process.

It should be borne in mind that, just as emergency escape lighting will normally be wholly inadequate to satisfy standby lighting requirements (e.g. because of illuminance level and extent of coverage), standby lighting is likely to be inadequate to satisfy requirements for emergency escape lighting (e.g. because of inability to cater for failure of local lighting in one area of the premises).

The objective of the emergency escape lighting to which this procedure refers is to enable safe exit for occupants in the event of fire and consequent failure of normal safety, such that:

- Escape routes are clearly and unambiguously indicated.
- Illumination is provided along escape routes to allow safe movement towards, and through, the exits provided.
- Fire alarm call points and firefighting equipment provided along escape routes can be readily located.

Approval of escape lighting is based on compliance with BS 5266-1, the relevant clauses of BS 5266-7 and with BS 5266-8. In this manual, references in italics to a clause number are references to clauses or subclauses in BS 5266-1. However, it should be noted that BS 5266-1 is a code of practice and, as such, it may not be appropriate to meet all of its recommendations in every case. Deviations from any recommendation should, however, be subject to agreement with the approving authority (and any other interested parties) and they should be recorded in the completion certificate (see Procedure 6C.3 of this manual).

Reference should also be made to guidance that supports The Building Regulations 2000 (e.g. Approved Document B), particularly in determining whether escape lighting is necessary and, if so, whether the entire building is to be provided with a system that conforms to BS 5266-1 or whether only certain areas of the building need to have escape lighting. In this section of the manual, it is assumed that escape lighting has already been determined as a requirement under The Building Regulations 2000, but it should be noted that this assumption would not apply to all premises.

Six different categories of escape lighting are defined in BS 5266-1, according to whether the systems are:

- **maintained**, designated as category **M** (i.e. with lamps illuminated at all material times, under normal conditions by means of power from the normal mains supply but by means of a standby supply at other times); or
- **non-maintained**, designated as category **NM** (i.e. lamps illuminated only when the supply to the normal lighting fails);

and whether the duration for which the system will provide escape lighting is:

- one hour; or
- two hours; or
- three hours.

Thus, a non-maintained system of one hour's duration is designated NM/1.

Guidance on the category of escape lighting that is appropriate for different occupancies is contained in BS 5266-1:2005, Clause 10.

In general, maintained mode of operation is used in premises in which the normal lighting may be reduced below the level required for escape route identification and illumination when the premises are occupied (e.g. places of public entertainment) and, at least, have illuminated 'EXIT' signs in public assembly buildings (such as public houses). In other premises, a non-maintained mode may be adequate.

A duration of one hour will be the minimum requirement, even for the smallest premises in which escape lighting is required. In premises where people sleep, a category NM/3 or M/3 should normally be required.

Escape lighting may be provided by:

- **Self-contained** luminaires (incorporating a battery, charger, changeover device and mains monitoring device within each luminaire); or
- A **central battery** system (comprising one or more centralized battery banks supplying 'slave' luminaires); or
- In theory, a standby generator but, in practice, a normal standby generator will not usually be a satisfactory source of supply for escape lighting because, in the event of failure of local normal lighting circuit(s) as a result of fire, the emergency generator will not start up to resupply lighting in the area(s) in question; it will normally be designed to cater only for complete loss of the mains supply to the entire building. Moreover, if the local normal lighting circuit is damaged, there is not normally an alternative circuit to supply lighting. However, special and unusual configurations could be arranged, such as a system in which a proportion of the normal lighting circuits are supplied via fire-resisting cable, and in which failure of any one of these circuits results in supply of all such circuits by means of a standby generator.

The means by which escape lighting is provided is irrelevant to the approving authority and assessor, provided that it caters for failure of any critical normal lighting circuit (i.e. those on escape routes, etc.); choice of system depends largely on considerations such as cost, efficiency, flexibility and maintenance requirements. However, great caution should be exercised in the case of any proposal that depends solely on a standby generator; it will be necessary to verify that, in the event of failure of a single critical normal lighting circuit, lighting will be restored.

In the case of self-contained systems, the potential design fault that should be borne in mind is the provision of non-maintained escape lighting circuits at local distribution boards; in this case, there is no protection against failure of any normal lighting circuit on the distribution board. Another potential design fault could be connection of escape lighting circuits in one area to normal lighting circuit(s) in another area. Self-contained escape lighting should always be connected to the normal lighting circuit in the area served by the escape lighting. These faults do not arise in the case of maintained escape lighting.

In the case of central battery escape lighting, the most common design fault is to supply the central battery unit of a non-maintained system by means of a local circuit in the area in which the unit is located, without any facilities for monitoring of critical normal lighting circuits throughout the premises. Again, failure of these circuits will not restore lighting in the areas they serve. This can be avoided by using a maintained system or alternatively by monitoring all critical normal lighting circuits at the central battery unit, that switches on the escape lighting in the event of any critical normal lighting circuit failure. Another potential design fault is the use of non-fire-resisting cables to wire the escape lighting circuits, making them as vulnerable to failure as the normal lighting circuits.

Procedure 6A
Assessment of specification and design drawings

Checklist

Assessment of specification and design drawings for an emergency escape lighting system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

Category of system acceptable to the approving authority or assessor.

❑ NM/1 ❑ NM/2 ❑ NM/3

❑ M/1 ❑ M/2 ❑ M/3

Proposed form of power supply.

❑ Self-contained batteries ❑ Central battery ❑ Standby generator

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6A.1* **Are the plans submitted adequate to enable evaluation of the proposal?** ❑ Yes ❑ No

[See Procedure 6A.1]

Comments:

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6A.2* **Does the proposal clearly indicate that the category of system is as described above?** ❑ Yes ❑ No

Comments:

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6A.3* **Are the areas of coverage in accordance with the requirements imposed under The Building Regulations 2000?** ❑ Yes ❑ No

[See Procedure 6A.2]

Comments:

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6A.4* **Does the number and distribution of fittings appear to be reasonable?** ❑ Yes ❑ No

[See Procedure 6A.3]

Comments:

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6A.5* **Has the correct cable type been specified? (Not applicable to connections between a self-contained emergency luminaire and the normal mains supply.)** ❑ Yes ❑ No ❑ N/A

[See Procedure 6A.4]

Comments:

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Procedure 6A
Assessment of specification and design drawings

Procedures

Procedure 6A.1: Plans

(Refer to BS 5266-1:2005, 3.2.)

Clients or their representatives should provide plans of the proposed installation to approving authorities or assessors as part of their submission.

BS 5266-8 recommends that such plans should show the following:

- The layout of the building.
- The layout of all existing or proposed escape routes.
- The locations of fire alarm call points.
- Likely locations of firefighting equipment.
- All items, structural or otherwise, that may offer obstruction to escape.

Procedure 6A.2: Areas of coverage

(Refer to BS 5266-7:1999, 4.1–4.3)

There is an inherent implication in Parts 1 and 7 of BS 5266 that all premises that are provided with escape lighting will have such provision throughout the premises. Guidance on those premises that should, and those that need not, be provided with emergency escape lighting can be found in guidance documents that support The Building Regulations 2000 (e.g. Approved Document B). Although this section of the manual is obviously only relevant in cases where it has already been determined that escape lighting is to be required under The Building Regulations 2000, it should not be assumed that emergency escape lighting is required in all areas in every building.

For example, in the case of a school, emergency escape lighting may not be necessary in parts of the building that have natural light and are used only during school hours. However, emergency escape lighting may be required in certain areas that are used for evening activities, such as night classes. Similarly, BS 5266-1 recommends that consideration be given to the provision of escape lighting in all motor generator rooms, control rooms, switch rooms, plant rooms, and mains/emergency lighting control equipment areas.

In view of the situation outlined in the previous two paragraphs, in order to identify the areas in which a requirement for the provision of emergency escape lighting is appropriate in the circumstances of the case under consideration, there should be careful reference to guidance that supports The Building Regulations 2000 (e.g. Approved Document B) and BS 5266-1. There may, for example, be areas of the building in which it is perfectly clear from guidance that supports The Building Regulations 2000 that a requirement for escape lighting in a particular area(s) of the premises is unnecessary. Equally, in the particular circumstances of the case, there may be a case for adopting the more detailed recommendations of the British Standards in certain areas; an example might be a lobby that is provided with escape lighting and from which escape routes discharge directly into a potentially unlit external area, in which case BS 5266-1 recommends that emergency escape lighting luminaires are installed in external areas in the immediate vicinity of the exits.

Procedure 6A.3: Illuminance level and distribution of fittings

(Refer to BS 5266-1:2005, clause 5, 6.1–6.8; also BS 5266-7:1999, 4.1–4.3.)

BS 5266-1 recommends that for routes that are *permanently clear and unobstructed* and up to 2m wide, the horizontal illuminance at floor level on the centre line of the escape route should be not less than 0.2 lux but preferably 1 lux. If the 0.2 lux is adopted, all potential hazards on an escape route should be light in colour with contrasting surround. Such hazards include the nosings of stair treads, barriers and walls at right angles to the direction of movement. Also, this level is not regarded as sufficient if the escape route will be used by older people.

BS 5266-7 (which is also a European standard) recommends that a figure of 1 lux be adopted for the level of illuminance along the centre line of the escape route. The Fire Safety Panel recommends that it is this recommendation that is adopted for *all* new emergency escape lighting installations and that the possible relaxation to 0.2 lux, to which BS 5266-1 refers, should not be accepted. In addition, BS 5266-7 recommends that a central band of the escape route, consisting of not less than half of the width of the route be illuminated to a minimum of 0.5 lux. Escape routes wider than 2m can be treated as a number of 2m wide strips or be provided with open area lighting (see next two paragraphs).

In the case of undefined escape routes through open areas, the horizontal illuminance should be at least 0.5 lux across the floor level of the entire area, including a border of 0.5m around the perimeter of the area.

The aforementioned illuminance levels should be regarded as the lowest value acceptable during the rated discharge period or due to the effects of the system ageing. In defined escape routes, these illuminance levels should be provided within 5 seconds of the failure of the normal lighting supply, but, at the discretion of the approving authority, this period may be extended to a maximum of 15 seconds in premises likely to be occupied for the most part by persons who are familiar with the premises and the escape routes. In open areas with undefined escape routes, 50 per cent of the required illuminance should be achieved within 5 seconds and full required illuminance within 60 seconds.

The system design should take into account all relevant factors that may reduce illuminance, including reduction in voltage during the rated period, voltage drop in the system wiring, lamp ageing and the accumulation of dirt and dust. Photometric data available from the manufacturer of the equipment will have taken such factors into account. The installer should not take reflectance from walls into account in designing the installation, although this will, in practice, improve illuminance levels, particularly in the case of light wall surfaces.

Account must also be taken of the need for control over the uniformity of illuminance and the avoidance of glare. There should be no abrupt changes between very dark and very light areas of illumination on the floor of the escape route. The recommended illuminance should be achieved with a uniformity of not less than 0.025 (i.e. a 40:1 ratio between the dark and light areas), particularly on the centre line of defined escape routes. Limitation of contrast between dark and light areas is particularly important in the case of premises in which people with visual impairment may use the escape routes.

High contrast between a luminaire and its background may produce glare. The most common problem is the inappropriate use of a small number of high-powered luminaires in premises such as warehouses. Since such glare may dazzle occupants and prevent obstructions from being seen, it should be avoided.

The distribution of luminaires should also be such that there is an escape lighting luminaire near each exit door and emergency exit door and at points where it is necessary to emphasize the position of safety equipment and potential hazards. BS 5266-7 specifically recommends that escape lighting luminaires are located in the following positions:

a) At each intersection of corridors.
b) At each exit door intended to be used in an emergency.
c) At each change of direction.
d) Near each stairway, so that each tread receives direct light.
e) Near (normally within 2m of) any other change of floor level.
f) Outside and near to each final exit. (This is not essential if local authority lighting on a public thoroughfare provides adequate illumination.)
g) Near (normally within 2m of) each fire alarm call point, piece of firefighting equipment and first aid post.
h) To illuminate exit and safety signs required by the approving authority.

In the case of g), if the locations in question are not on the escape route or in an open area, they should be illuminated to 5 lux minimum on the floor.

In addition, BS 5266-1 recommends that consideration should be given to the provision of additional escape lighting at the following locations:

a) Lift cars (preferably comprising a self-contained luminaire); this is essential in the case of firefighting lifts and lifts for evacuation of disabled people.
b) Moving stairways and walkways.
c) Toilets, lobbies and closets exceeding $8m^2$ in gross area and smaller facilities that are devoid of ‘borrowed’ lighting.
d) Motor generator, control and plant rooms and switch rooms, as well as areas adjacent to main control equipment associated with the provision of normal and emergency lighting.
e) Covered car parks. The pedestrian escape routes from covered and multistorey car park areas should be easily identifiable and should be provided with emergency escape lighting.

An illuminance of 1 lux is a low level of illumination. It may be difficult for visually impaired people to navigate escape routes easily if the level of illuminance is as low as this. On the basis of research that they carried out, the Building Research Establishment recommended that, for people with poor vision, a system that provides a minimum of 3 lux along the centre line on the floor or stair of an escape route should be provided. This should be borne in mind in premises intended specifically for people with visual impairment.

The designers of emergency lighting installations base their designs on photometric data produced by the manufacturer of the luminaires. In the case of fittings approved under the ICEL scheme, this data will have been independently confirmed by the approval body. If reflectance is ignored, the illuminance on the escape route will be determined by the mounting height of the luminaires and the spacing between fittings. All manufacturers produce data sheets that specify the spacing between fittings, according to the illuminance required, the mounting height of the luminaires and whether they are mounted in the transverse or axial orientation. (See Figure 5)

Table 1: Typical spacing table for a 8w fluorescent self-contained luminaire to be installed in a defined escape route for 1 lux minimum illuminance

Mounting height (m)	Spacing (m) for 8w tubular fluorescent lamps for orientations as defined in Figure 5.				
	A T–W	B T–T	C T–A	D A–A	E A–W
2	1.3	4.7	4.2	3.7	0.9
2.5	1.5	5.0	4.5	4.0	1.0
3	1.3	4.8	4.3	3.8	0.8

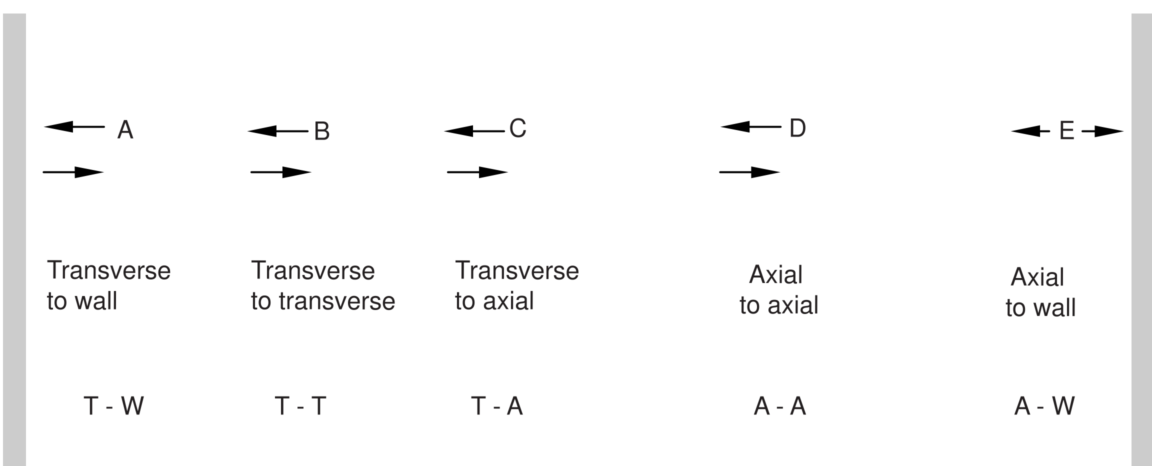

Figure 5: Definition of distances between luminaires for different orientations (see Table 1)

[Table 1 and Figure 5 reproduced from ICEL 1008:2001, Emergency Lighting Risk Assessment Guide (third edition).]

Where doubt exists regarding the spacing between fittings or the number of fittings in an area, the manufacturers' data sheets, which are readily available, may be consulted. As an example, the following table and associated figure provide information in relation to a typical 8w fluorescent self-contained luminaire to be installed on a defined escape route, such as a corridor, in which an illuminance of 1 lux is required.

In view of the number of factors that the manufacturer has taken into account in formulating the photometric data, such as allowance for dust, lamp and battery ageing, deterioration of output during the rated duration, etc., there is usually little point in attempting to measure the level of illuminance in an installed system (e.g. at acceptance testing). In a new installation, the luminaires will be clean, batteries at maximum capacity, etc. and, in practice, reflectance from walls and ceilings will increase the illuminance at floor level.

Accordingly, when the normal lighting is isolated in a building with escape lighting designed to provide 1 lux on defined escape routes, the illuminance measured may well be around 3 lux. Very often, borrowed light from the street also makes such measurements of little value. However, light meters that can accurately measure such low levels of illuminance are available and may be of value in the event of serious doubts about the illuminance achieved during acceptance testing. The use of such meters may also be of value in determining the uniformity of illumination.

Further information on design procedures can be found in CIBSE technical memorandum TM12 'Emergency Lighting', published by the Chartered Institute of Building Service Engineers.

Procedure 6A.4: Cable type

(Refer to BS 5266-1:2005, 8.2.1–8.2.2.)

Wiring that must maintain circuit integrity during the course of a fire (primarily wiring between a central battery unit and the associated slave luminaires) must either be inherently fire-resisting [e.g. mineral insulated copper sheathed (MICS) cable] or be protected against fire by burial in the structure of the building or by being situated in a negligible fire risk area and separated from any significant fire risk by a wall, partition or floor having a fire resistance of at least 1 hour.

It is essential that this requirement is checked during site inspections, as failure to use a fire-resisting cable could jeopardize the entire escape lighting installation in the event of fire.

Procedure 6B
Assessment of work in progress

Checklist

Assessment of work in progress for an emergency escape lighting system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

6B.1* **Are the areas of coverage in accordance with the requirements imposed under The Building Regulations 2000?** ❑ Yes ❑ No

[See Procedure 6A.2]

Comments:

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6B.2* **Is the correct cable type being installed? (Not applicable to connections between a self-contained emergency luminaire and the normal mains supply.)** ❑ Yes ❑ No ❑ N/A

[See Procedure 6A.4]

Comments:

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6B.3* **Does the number and distribution of fittings appear to be reasonable?** ❑ Yes ❑ No

[See Procedure 6A.3]

Comments:

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6B.4 Are escape lighting cables being segregated from all other cables? ❑ Yes ❑ No

[See Procedure 6B.1]

Comments:

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6B.5 Is the standard of cable installation satisfactory? ❑ Yes ❑ No

[See Procedure 6B.2]

Comments:

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6B.6 Are all isolators, switches and protective devices kept to a minimum and appropriately sited? ❑ Yes ❑ No

[See Procedure 6B.3]

Comments:

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6B.7 Are suitable test facilities being installed? ❑ Yes ❑ No

[See Procedure 6B.4]

Comments:

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Procedure 6B
Assessment of work in progress

Procedures

Procedure 6B.1: Checking segregation of wiring

(Refer to BS 5266-1:2005, 8.2.6.)

The purpose of segregation in a central system is to minimize any potential for other circuits to result in malfunction of the escape lighting system arising from, for example:

a) Breakdown of the cable insulation of the other circuit(s) and/or the escape lighting system circuit(s).
b) A fire caused by a fault on another circuit.

Mineral insulated copper sheathed cables and fire-resisting cables conforming to BS 7629 do not need further segregation from the cables of other services. Other cables should be segregated by one of the following means:

- Installation in conduit, ducting, trunking, etc. reserved for escape lighting wiring. (Ducting or trunking that is reserved for escape lighting circuits should be marked to indicate this reservation.)
- Installation in a separate compartment of trunking, separated by a strong, rigid, non-combustible, continuous partition from other services.
- Mounting at a distance of at least 300mm from conductors of other systems.

Procedure 6B.2: Checking the standard of cable installation

(Refer to BS 5266-1:2005, 8.2.1–8.2.2.)

It should be ensured that surface run cables are neatly run and securely fixed at suitable intervals (e.g. if MICS cables are used, clips should be fitted every 600mm in the case of horizontal runs and 800mm in the case of vertical runs). Checks should be carried out to ensure that, within any false ceilings, escape lighting cables are securely supported to permanent construction (and are not, for example, lying on top of the false ceiling tiles).

Where a cable passes through an internal wall, a smooth clearance hole should be provided. If additional mechanical protection is necessary, a smooth bore sleeve should be sealed into the wall. It should be ensured that the ends of the sleeve are free from sharp edges to guard against damage to cables during installation.

Joints in cables should be avoided. Where joints are necessary, they should be terminated in a suitable junction box, that should be marked 'ESCAPE LIGHTING' and 'MAY BE LIVE'.

Procedure 6B.3: Isolators, switches and protective devices

(Refer to BS 5266-1:2005, 8.3.2.)

The number of isolators, switches and protective devices that cause failure of the emergency lighting standby power source should be kept to the minimum required to satisfy BS 7671. Any isolator, switch or protective device associated with an escape lighting system should be situated in a position inaccessible to unauthorized persons and be protected against unauthorized operation.

Each isolator switch, protective device and key-in operating device should be marked 'ESCAPE LIGHTING'.

Procedure 6B.4: Test facilities

(Refer to BS 5266-1:2005, 8.3.3.)

Each escape lighting system should have suitable means for simulating failure of the normal supply for test purposes. Normally, these comprise key switches that isolate the mains supply to the escape lighting system without interrupting the normal lighting in the premises.

Procedure 6C
Final acceptance

Checklist

Final acceptance of an emergency escape lighting system at:

Name/address of premises: ....

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Name of assessor: ....

Date of assessment: ....

Application number: ....

Action required: ....

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*** It is essential that items marked thus, and in bold type, are checked.**

6C.1* **Are the areas of coverage in accordance with the requirements imposed under The Building Regulations 2000?** ❑ Yes ❑ No

[See Procedure 6A.2]

Comments:

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6C.2* **Has the correct cable type been installed? (Not applicable to connections between a self-contained emergency luminaire and the normal mains supply.)** ❑ Yes ❑ No ❑ N/A

[See Procedure 6A.4]

Comments:

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6C.3* **Does the number and distribution of fittings appear to be reasonable?** ❑ Yes ❑ No

[See Procedure 6A.3]

Comments:

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6C.4 Have escape lighting cables been segregated from all other cables? ❑ Yes ❑ No

[See Procedure 6B.1]

Comments:

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6C.5 Is the standard of cable installation satisfactory? ❑ Yes ❑ No

[See Procedure 6B.2]

Comments:

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6C.6 Are all isolators, switches and protective devices kept to a minimum and appropriately sited? ❑ Yes ❑ No

[See Procedure 6B.3]

Comments:

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6C.7 Have suitable test facilities been installed? ❑ Yes ❑ No

[See Procedure 6B.4]

Comments:

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6C.8 Have all escape lighting cable penetrations been fire stopped? ❑ Yes ❑ No

[See Procedure 6C.1]

Comments:

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6C.9 Does the system operate correctly when tested? ❑ Yes ❑ No

[See Procedure 6C.2]

Comments:

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6C.10 Has adequate documentation been provided to the user? ❑ Yes ❑ No

[See Procedure 6C.3]

Comments:

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Procedure 6C
Final acceptance

Procedures

Procedure 6C.1: Fire stopping

(Refer to BS 5266-1:2005, 8.2.1–8.2.2.)

All penetrations for conduits, ducts, trunking and cables should be fire stopped to the full thickness of the barrier that is penetrated. Within ducts, trunking, etc., it may also be necessary to install appropriate barriers to prevent the spread of fire. It should be noted that this may not, contractually, be the responsibility of the escape lighting contractor. However, the system should not be fully accepted until this work is completed.

Procedure 6C.2: Functional testing

(Refer to BS 5266-1:2005, 8.3.3.)

The system should be functionally tested to ensure that it operates correctly in the event of a mains failure that affects the normal lighting. It is recommended that a qualified electrician from the installer should be available to the assessor throughout this test work.

Within each area in which escape lighting has been required under The Building Regulations 2000, normal lighting should be totally isolated by removal of fuses or operation of circuit breakers at the appropriate normal lighting distribution boards. It should be verified that, in these circumstances, there is adequate provision of escape lighting. During normal working hours, it may be difficult to obtain an impression of illuminance levels and reliance may need to be placed on a subjective assessment as to whether the number and distribution of luminaires appears reasonable (see Procedure 6A.3). Particular attention should be paid to windowless accommodation.

Thereafter, it should be confirmed that the configuration of the escape lighting system is such that, within areas in which escape lighting has been required under The Building Regulations 2000, failure of any single normal lighting circuit that would leave the area with insufficient illumination for escape results in operation of adequate escape lighting. The purpose of this test is to ensure that the means of detecting mains failure is adequate. Therefore, in the case of a system of self-contained escape lighting, it may be adequate to carry out observations that confirm that, when the electrician removes any one normal lighting fuse or operates the relevant circuit breaker, the correct escape lighting operates. Labelling on distribution boards should also be of assistance in confirming that escape lighting has been connected to the normal lighting circuits; on opening any distribution board, it should never be found that non-maintained emergency escape lighting is connected to its own dedicated circuit.

In the case of central battery systems, verification of adequate final lighting circuit monitoring may prove more time-consuming. However, it should, again, be verified (perhaps by sampling and confirmation by the contractor) that non-maintained escape lighting does operate on failure of any single normal lighting circuit within an area in which escape lighting has been required.

During these tests, it should be confirmed that self-contained escape lighting is actually connected to the normal lighting circuit(s) within the same area as the escape lighting, i.e. it should be ensured that the escape lighting is not connected to a normal lighting circuit in another area.

It is also desirable that any test facilities are test operated, particularly to determine that, after the test, the system returns to its normal quiescent mode.

Procedure 6C.3: Documentation

(Refer to BS 5266-1:2005, 10.6 and clause 11.)

Before final handover, the user should be provided with instructions on the operation and maintenance of the system. The instructions should preferably be in the form of a manual for retention by the occupier.

A log book should also be provided to the occupier and the following information should be recorded in it:

a) Date of any completion certificate, including any certificate relating to alterations.
b) Date and brief details of each service, inspection or test carried out.
c) Dates and brief details of any defects and of remedial action taken.
d) Date and brief details of any alterations to the emergency escape lighting installation.

On completion of the work of installing the system or of a major alteration to the system, a completion certificate should be supplied to the occupier/owner of the premises. A model completion certificate is contained in BS 5266-1:2005, Annex C.

On completion of the work, drawings of the emergency escape lighting installation should be provided and retained on the premises.

NOTE: This is not a design guide, but a guide for a structured assessment of an emergency escape lighting system.

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BS 7807:1995, *Code of practice for design, installation and servicing of integrated systems incorporating fire detection and alarm systems and/or other security systems for buildings.*

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