



BSI Standards Publication

**Designing, specifying, maintaining and
operating emergency sound systems for
sports grounds, large public buildings,
and venues — Code of Practice**

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Summary of pages

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Foreword

Publishing information

This British Standard published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 October 2019. It was prepared by Technical Committee EPL/100, *Audio, video and multimedia systems and equipment*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes [BS 7827:2011](#), which is withdrawn.

Relationship with other publications

This British Standard has been drafted to complement and avoid conflict with other standards with similar scopes, but which are of a more generic nature, i.e. not specifically giving recommendations for large public buildings, venues and sports grounds, notably [BS 5839-8](#), [BS 5839-9](#), BS EN 50849 and PD CEN/TS 54-32.

These standards allow for variations from their normal provisions. BS 7827 provides guidance when some of those variations are necessary. BS 7827 indicates where its recommendations can be followed in combination with the provisions of the other standards.

This code of practice is applicable to a wide range of buildings including airports, rail and metro/underground stations and transportation terminae which may have their own specific standards and guidance. Whilst the standards listed above take precedence, this code of practice provides additional information where no specific standard or codes of practice exists.

See the introduction and [Clause 4](#) where references to related standards are addressed in more detail.

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- references to speech intelligibility have been updated to reflect advances in technology and practical experience;
- information has been provided to help the purchaser understand the need to allow sufficient funding to enable a properly functioning system to be engineered; and
- cross references to other standards have been updated.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Section 1: General

Introduction

This Code of Practice for designing, specifying, maintaining and operating emergency sound systems can be applied to sports grounds, as well as venues and other large, complex sites that have similar electroacoustic systems, occupancy and occupant-generated sound levels. These can include rail termini, airports, convention and exhibition centres, shopping centres and entertainment complexes. Large venues can consist of enclosed, covered and open spaces within the same complex.

This standard does not categorize the type of building, as it is increasingly difficult to define what some buildings are. For example, stadiums also hold concerts, arenas also stage sports events and shopping malls host live acts. Instead, use of this standard is based on the requirements of the building.

Contained within many, but not all, large venues are buildings and spaces that warrant special attention with regard to the most effective way to inform and manage spectators and other members of the public through the safe and clear use of the emergency sound system. Important factors and characteristics include the following.

- Large venues often contain spaces designed to hold members of the public who do not know any pre-planned evacuation procedures.
- Large venues often contain spaces designed to hold spectators and visitors in high numbers and densities, which introduces the requirement for effective general crowd control as well as control during dangerous situations, such as terrorism, civil commotion and fire.
- Large venues often contain large open-air areas, such as the external piazza of a shopping mall or exhibition centre, pitch of a cricket ground or the track-side of a racetrack. Although these spaces do not pose a high fire risk, this does not preclude them from crowd-related risks such as that of people returning to a building which is in an evacuation status; a reliable and effective means of communicating with occupants is still essential for such areas.
- Effective and intelligible emergency sound systems can be used, not only to provide clear and useful commentary to spectators and information to visitors/customers, but also to provide entertainment quality music, audio for video replay, advertising, etc. It is these non-emergency enhancements which can be usefully integrated with the emergency requirements and thus give added value to the system.
- Large venues may be put to a range of uses beyond the primary use, in some cases outnumbering the occasions of primary usage in the annual event schedule; the emergency sound system may therefore have multiple modes of operation, including that of a voice alarm or sound system for emergency purposes.

This British Standard also introduces parameters and requirements which are not usually found in smaller built spaces and thus where other generic standards might not offer sufficient guidance.

For sports projects, useful guidance can also be found in the *Guide to Safety at Sports Grounds* published by The Sports Ground Safety Authority on behalf of the Department for Digital, Culture, Media and Sport (commonly referred to as the “Green Guide”) [1], and, for music concerts, *The Purple Guide to Health, Safety and Welfare at Music and Other Events* [2].

1 Scope

This British Standard gives recommendations and guidance for the design, specification, maintenance and operation of permanently installed sound systems used for emergency purposes at sports grounds, venues and other large buildings/sites that have similar electroacoustic systems, occupancy and occupant-generated sound levels, to convey specific instructions to the public to manage their behaviour in a variety of situations.

The standard is applicable to emergencies that require full or partial evacuation and those for which there is a need to keep people inside a building, safe from danger outside.

Emergency sound systems in large public buildings, venues and sports grounds are covered by this British Standard as a specific case because these form a class of building or complex which has certain parameters which define a particular need in terms of life safety.

These include, but are not restricted to:

- a) one centralized or several focused performance spaces or activity areas;
- b) “back of house” areas for operational and administrative purposes;
- c) large areas of internal circulation;
- d) large external areas of collection and dispersal, e.g. car and coach parks, railway stations;
- e) occasional high crowd density; or
- f) a fully engineered V5 system as defined in [BS 5839-8:2013](#).

In addition to the different types of area, a project is likely to fall under the scope of this British Standard when the venue has the following characteristics:

- 1) has higher sound pressure level (SPL) requirements than a conventional public address or voice alarm system, typically above 90 dB(A);
- 2) has several distributed equipment rack locations and/or multiple call/paging points;
- 3) has complex operational requirements, such as the ability to run simultaneous activities;
- 4) is a sports stadium or arena;
- 5) is frequented by large members of the public unfamiliar with the building;
- 6) has varying operational requirements depending on use, typically event and non-event mode or public and non-public days;
- 7) has a combination of large open spaces and smaller enclosed areas; or
- 8) has substantial periods of minimal or partial use.

This British Standard aims to ensure that, in an emergency, voiced messages are intelligible in all parts of the venue to which the public have access, no matter what type of event is taking place, as well as those areas outside the venue that the system is intended to serve. Emergency messages to cover staff areas are also covered.

This British Standard applies irrespective of whether a special sound system is installed for an event.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document.¹⁾ For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BS 5839-8:2013](#), *Fire detection and fire alarm systems for buildings – Part 8: Code of practice for the design, installation, commissioning and maintenance of voice alarm systems*

[BS 5839-9](#), *Fire detection and fire alarm systems for buildings – Part 9: Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems*

[BS 7671](#), *Requirements for electrical installations – IET Wiring Regulations*

BS EN 50171, *Central power supply systems*

BS EN 50200, *Method of test for resistance to fire of unprotected small cables for use in emergency circuits*

BS EN 50849, *Sound systems for emergency purposes*

BS EN 60268-16:2011, *Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index*

BS EN IEC 62040-1, *Uninterruptible power systems (UPS) – Part 1: Safety requirements*

BS EN IEC 62040-2, *Uninterruptible power systems (UPS) – Part 2: Electromagnetic compatibility (EMC) requirements*

BS EN 62040-3, *Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements*

BS EN 62040-4, *Uninterruptible power systems (UPS) – Part 4: Environmental aspects – Requirements and reporting*

PD CEN/TS 54-32: 2015, *Fire detection and fire alarm systems – Part 32: Planning, design, installation, commissioning, use and maintenance of voice alarm systems*

3 Terms and definitions

For the purposes of this standard the following terms and definitions apply.

3.1 ambient noise measurement metric

metric used to describe the ambient noise level that the sound system has to overcome

NOTE This metric relates to system operating level and specifically the signal to noise ratio that is required as a result of the ambient noise level.

3.2 ambient noise sensing (ANS)

system that measures the ambient noise in a zone and automatically adjusts the audio output level appropriate to the current ambient noise in the zone

3.3 area of circulation

area where the public can move freely from one compartment to another, such as a concourse, stairway or pathway

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

3.4 area of congregation

area of a venue which causes a restriction to the natural flow of people such as a turnstile, gate or, to a lesser extent, a merchandizing or catering booth within the confines of a compartment

3.5 area of coverage

area, inside and/or outside a building to be covered by the sound system

3.6 area of dispersal

area outside the main structure of the venue which has a minimum of restrictions to the flow of people, such as a car park, grassed area, roadway which is not public highway.

3.7 audibility

property of a sound which allows it to be heard among other sounds

3.8 audio network

communication system that allows multiple devices to exchange digital audio and control signals

3.9 automatic mode

mode of operation of a voice alarm system which does not require manual intervention

3.10 certificate holder

person or legal entity to whom a current safety certificate has been granted

3.11 clarity

property of a sound which allows its information-bearing components to be distinguished by a listener, related to the freedom of the sound from all types of distortion

NOTE There are three types of distortion involved in the reduction of clarity of a speech signal in an electro-acoustic system:

- a) time domain distortion, due to reflection and reverberation in the acoustic domain;*
- b) frequency distortion, due to non-uniform frequency response of transducers and selective absorption of high frequencies in acoustic transmission; and*
- c) amplitude distortion, due to non-linearity in electronic equipment and transducers.*

3.12 clipping

situation in which the signal level exceeds the capabilities of an amplifier or digital audio path which in turn leads to waveform amplitude distortion

3.13 compartment

part of a structure separated from all other parts of the same structure by walls, ceilings or floors

3.14 control point/control room

area which contains an announcement microphone (with or without a zone control panel) or an area which contains a control panel for any part of a sound system

NOTE A control room is also known as a control point.

3.15 critical signal path

physical connection, external to the cabinet of the emergency sound system, for the transmission of information and/or power between parts of an emergency sound system contained in different cabinets

3.16 dBA

sound pressure level, expressed in dB, referred to 20 μ Pa, measured with a defined frequency weighting, known as A-weighting

NOTE 1 See BS EN 61672-2.

NOTE 2 It is normally "weighted" to better agree with human perception. The most usual weighting is the "A" weighting – expressed as dBA. Although "C" weighting is sometimes used, the A weighting method has become the universal method of measuring the overall level of a sound.

3.17 digital signal processor (DSP)

processor dedicated to the real-time processing of audio signals

NOTE DSPs perform various audio equalization, signal delay, compression, limiting and routing operations and frequently integrate with a digital audio network. A DSP may be a dedicated component or its functions may be integrated into other components such as a power amplifier.

3.18 emergency loudspeaker zone

part of the area of coverage to which emergency information can be given

3.19 emergency microphone

microphone dedicated for use by the emergency services or other responsible persons as part of the sound system

3.20 emergency mode

status of a system whereby emergency messages (either live or pre-recorded) are broadcast

NOTE 1 In manual mode, all emergency messages are preceded by a pre-announcement tone; in automatic mode, all messages have intervening tones between the messages

NOTE 2 If the system is used for broadcasting sounds other than live messages, these sounds have to be disabled for some or all of the period of the state of emergency, in controlled zones or across the whole venue.

3.21 emergency sound system

sound system used for emergencies, either a voice alarm system or sound system for emergency purposes

3.22 equalization

process of adjusting the gain or attenuation of certain frequencies within a signal

3.23 equipment room

area which contains equipment associated with the fundamental processes of the sound system

3.24 equivalent continuous A-weighted sound pressure level, $L_{Aeq, T}$

value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within a specified time interval, T , has the same mean-squared sound pressure as the sound under consideration that varies with time.

NOTE This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period.

3.25 headroom

ratio (usually expressed in decibels) which refers to the amount a signal can exceed a designated nominal value allowing transient audio peaks to exceed this nominal level without distortion

3.26 installer

person or organization whose duty is to install and possibly maintain the emergency sound system

NOTE 1 Often a third party contractor employed by the building operator or construction company.

NOTE 2 The installer might also provide some operational support and might also be the system designer.

3.27 intelligibility

measure of the proportion of the content of a speech message that can be correctly understood

NOTE Satisfactory intelligibility requires adequate audibility and adequate clarity.

3.28 listener

person who is within the area of coverage

3.29 loudspeaker

device used to emit speech and other audio content or signals

NOTE This might be driven from external amplifiers located in an equipment rack or might include amplifiers local to or built into the device.

3.30 loudspeaker circuit

audio transmission path to an assembly of loudspeakers supplied from the same control equipment and protected against over-current by the same protective device(s) or current limitation arrangements and surveillance

3.31 loudspeaker zone

part of the area of coverage to which speech, information and/or music can be separately routed

NOTE A loudspeaker zone might be the same as an emergency loudspeaker zone, or might be a sub-division of an emergency loudspeaker zone.

3.32 manual mode

mode of operation where an operator is directly in control of the broadcast of live or pre-recorded sounds

3.33 normal mode

status of a system whereby either music, other entertainment or operational messages (either live or pre-recorded) are broadcast, sometimes with intervening tones or pre-announcement tones

NOTE Typical messages are for people management, such as warnings not to leave bags unattended, or to wear personal protective equipment while on site.

3.34 percentile level, $L_{A10,T}$

A-weighted sound pressure level obtained using time-weighting “F”, which is exceeded for N% of a specified time interval

NOTE 1 $L_{A90,1h}$ is the A-weighted level exceeded for 90% of 1 h.

NOTE 2 $L_{A10,10min}$ is the A-weighted level exceeded for 10% of 10 min.

3.35 $p_A(t)$

instantaneous A-weighted sound pressure (μPa)

3.36 p_0

reference sound pressure ($20 \mu\text{Pa}$)

3.37 pink noise

steady state sound that contains every frequency within the range of human hearing that has been filtered to have equal energy in every fractional octave.

NOTE Pink noise is useful for testing equipment performance in the electrical domain as it can be bandwidth adjusted to suit the measurement but is not representative of the acoustic content of real-world sounds. However, where a base SPL is required to be achieved, a steady state source is easier to measure than a dynamic one, such as speech.

3.38 pre-announcement tone

short tone, or series of tones, normally broadcast before each message when a state of emergency exists and the system is in manual and emergency modes

3.39 private areas with a view of the event

compartments to which the public have restricted access, such as executive suites, private boxes or press viewing areas

NOTE The difference between these areas and public audience areas is that the view of the event is often through windows or within a segregated area with more limited access / egress.

3.40 (the) public

visitors to a venue who might be unfamiliar with its layout and emergency procedures

3.41 public address system (PA system)

sound system intended to distribute signals from one or more locations to a number of other locations through a multiplicity of loudspeakers

3.42 public address (PA) voice alarm (VA) – PA/VA system

sound system, interfaced with the fire detection and alarm system, designed to be used for both PA (non-emergency) and VA (emergency) purposes

NOTE This includes parts of the system which are dedicated for use as either PA or VA only, as well as parts of the system which are used for both PA and VA.

3.43 public area

area provided for the express purpose of accommodating members of the public

3.44 purchaser

person or organization responsible for the purchase of a sound system or their appointed representative

NOTE Representatives can include members of the design team or a contractor.

3.45 quality of service (QoS)

digital network's ability to achieve maximum bandwidth and deal with other network performance elements like latency, error rate and uptime, ensuring that time-critical signals are given priority

NOTE This also involves controlling and managing network resources by setting priorities for specific types of data (video, audio, files) on the network.

3.46 responsible person

person, identified by name or job specification, who is responsible for ensuring that a sound system is properly maintained and repaired, so as to continue to operate as specified, and for ensuring that operators are adequately trained

3.47 reverberation time (RT)

time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped

NOTE 1 Reverberation time is usually measured in octave or third octave bands. It is not necessary to measure the decay over the full 60 dB range. The decay measured over the range 5 dB to 35 dB below the initial level is denoted by T_{30} and over the range 5 dB to 25 dB below the initial level by T_{20} .

NOTE 2 Reverberation time is an important indicator of the subjective perceived acoustic of a space.

3.48 signal delay

electronic delay of the signal to time align sound arrivals from loudspeaker(s) placed at distant locations from a primary loudspeaker or to synchronise the arrival of speech signals for ancillary systems, for example, Assistive Listening Systems and visual displays

3.49 signal to noise ratio

comparing the level of a desired signal to the level of background noise, often expressed in decibels

3.50 sound system

equipment and resources necessary to reinforce original sound or to reproduce recorded sound, in appropriate parts of the venue with adequate intelligibility

3.51 sound system for emergency purposes

sound system that provides means for broadcasting speech messages in an emergency

3.52 speech intelligibility

ease with which the words in broadcast speech can be received and potentially understood; the quality of the overall transport mechanism from the talker's mouth to the listener's ear

3.53 speech transmission index for public address (STIPA)

measure of potential speech intelligibility over a public address system using a condensed Speech Transmission Index (STI) measurement format

3.54 sound pressure level (SPL, L_p)

ten times the logarithm to the base 10 of the ratio of the time-mean-square of a sound pressure signal to the square of the reference value.

NOTE 1 Sound pressure level is expressed in decibels (dB).

NOTE 2 The reference value is 20 μ Pa.

3.55 system designer

technically competent person who takes responsibility for the technical specification and adequacy of the design for the system

3.56 target coverage

percentage of the area where the designer considers the system can exceed or at least meet the performance parameters stated

NOTE For periphery or masked areas, the performance would at best be slightly reduced as a result of being merely off-axis to a primary sound source (loudspeaker).

3.57 target frequency response

frequency response considered to be appropriate for each sub-division of the venue

NOTE Typical characteristics for a given frequency response are given in Table [A.2](#).

3.58 target SPL

sound pressure level requirement derived from the design noise level and the required signal to noise ratio

3.59 target STI

required intelligibility category of the design

NOTE For example, category F, G, or H. See Table [A.1](#) and [13](#).

3.60 transmission path

connection between sound system components used for the transmission of information, including audio, data and control

3.61 user

person or organization responsible for the operation of a sound system or their appointed representative

3.62 voice alarm system (VA)

sound system that provides means for broadcasting speech messages and/or warning signals in the event of an emergency in case of fire and which may be interfaced to the fire detection and alarm system

4 Standards guidance based on performance requirements*COMMENTARY ON CLAUSE 4*

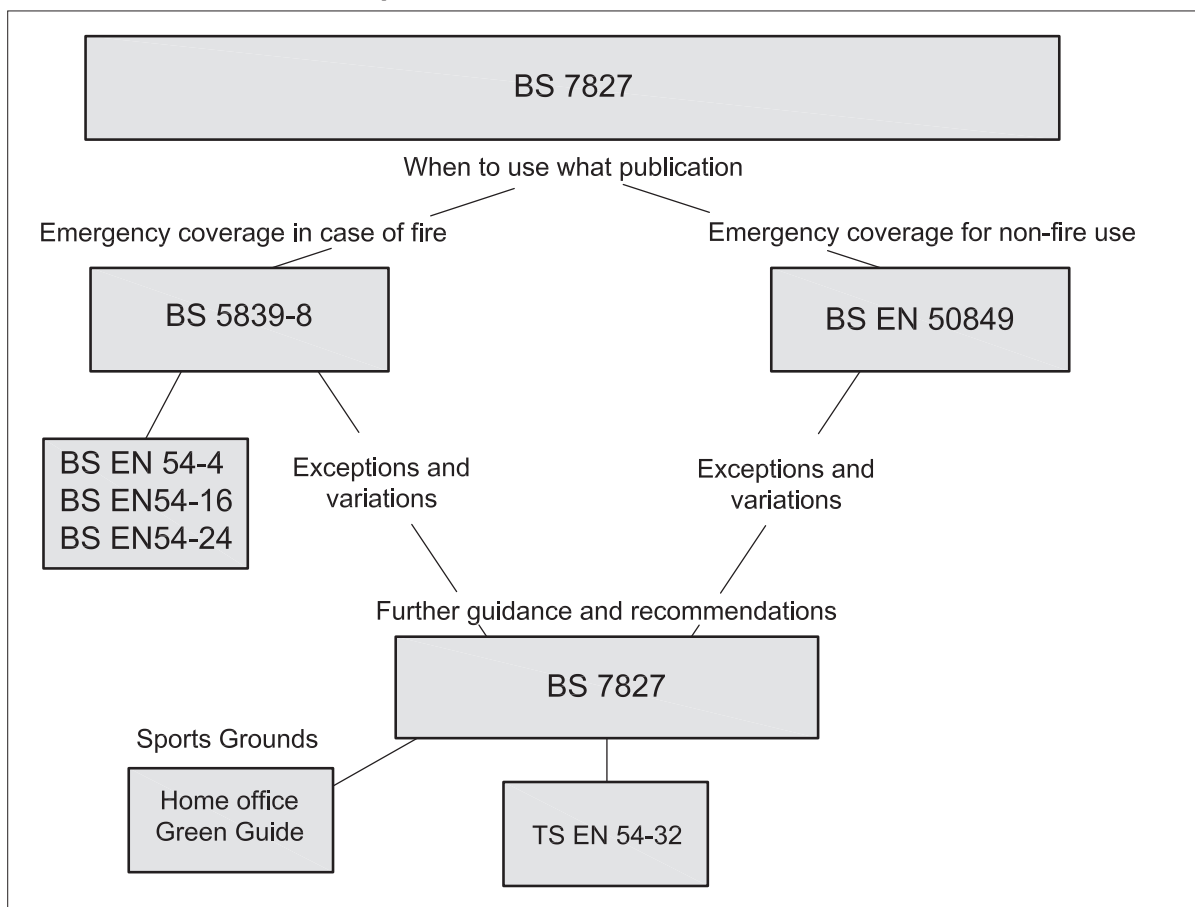
Due to differences in emphasis, there might be conflict between the specific guidance of national fire and emergency standards, the Green Guide [\[1\]](#), and fire standards.

Many standards concerning emergency evacuation, notably fire-related standards, are, of necessity, generic. While they might allow for categorization on grounds of size or complexity of building, they are nevertheless aimed at use in standard buildings types, such as offices, shopping centres, factories, schools.

For fire-related emergencies in public and non-public areas, fire standards might apply. With some venues, non-public areas might use fire alarm sounders to alert staff of fire. However, it may be necessary to provide speech coverage in those areas to inform staff of other types of emergency; for example, a terrorist incident.

When used for sports venues, this standard supports the Green Guide [\[1\]](#), which gives wider guidance from planning through construction to operation. Within the latter there are specific requirements in relation to crowd control, staff and management, and communications between them.

[Figure 1](#) shows the relationship that this British Standard has with other publications.

Figure 1 — Guidance on when to use related publications

4.1 General

Based on the scope set out in [Clause 1](#), and [Figure 1](#), a risk assessment should be carried out to divide the venue into voice alarm zones and sound system for emergency purposes zones.

Internal areas or areas where emergency messaging is required in case of fire, should be designated to be voice alarm. External areas and areas where paging is required in case of non-fire emergency should be designated sound system for emergency purposes.

NOTE 1 In some areas, the relevant standard might be difficult to apply, in which case this British Standard gives further guidance.

For any non-public area that requires emergency messages, an assessment should be made as to whether a simple fire sounder circuit is appropriate or if it is required to be covered by an emergency sound system.

NOTE 2 Sounders might adequately provide alert and evacuate notification to trained staff for a fire-related emergency, but it might be necessary to determine whether a sound system for emergency purposes is also required in those areas to inform the staff of other types of emergency such as a terrorist incident.

The most appropriate method should be determined for communicating with the public using wide staircases as many hundreds of people might be occupying them during an evacuation or end of an event.

NOTE 3 This might introduce a conflict between the recommendations for stairways given in [BS 5839-8:2013](#).

Disabled refuge systems, as defined in [BS 5839-9:2011](#), should also be taken into account as they are frequently located on or near stairwells.

Stairways in a large venue should be assessed for VA coverage and a risk assessment should be carried out to avoid conflict between the recommendations in this standard and those in [BS 5839-9:2011](#) for disabled refuges.

Any audio reproduction outside the speech range (octave bands 125Hz thru 8KHz inclusive) are not part of the emergency system and therefore should not be utilized during emergency paging. This equipment should be band-limited or muted during an emergency to preserve speech intelligibility.

NOTE 4 There is no need for a secondary power supply for any low frequency equipment.

NOTE 5 Areas that require sound for entertainment and general information as well as an emergency sound system are classified as PAVA. Performance specifications (such as frequency response) of the system might be extended into these areas so that the reproduction of music is of appropriate quality for the entertainment purposes intended.

Indeed, in some venues, the PAVA system might be used to augment a pop concert. Such systems would include the use of bass, or even sub-bass, speakers.

4.2 Application of standards

Given the potential likelihood of conflict between different emergency standards, the designers, together with the purchaser, should agree an appropriate solution subject to the following:

- a) the solution and its rationale should be published and agreed with all relevant interested parties prior to commitment of a design; and
- b) the efficacy of the solution should be reviewed on a regular basis by the operator and/or the purchaser and adjusted accordingly if possible. Any change to any part of the building or to the planned use and procedures associated with the facility should also prompt a review.

The recommendations of [BS 5839-8:2013](#) should be followed for areas designated as VA.

The recommendations of BS EN 50849:2017 should be followed for areas designated as Sound Systems for Emergency Purposes.

Whilst different parts of the system might have been designed, installed, commissioned, etc., in accordance with [BS 5839-8:2013](#) and BS EN 50849:2017, they should be treated as one complete system for operational purposes.

The recommendations for all parts of the system should be followed to meet agreed speech intelligibility targets in [Annex E](#).

A traditional "bowl" area of a stadium should be categorized as VA if its evacuation requires the public to pass through an enclosed or restrictive space.

NOTE This might also include the pitch if the public might be evacuated to this area or if it is used as a holding area.

Open areas such as car parks and areas outside the turnstiles should usually be categorized Sound Systems for Emergency Purposes though they can be required for emergency communication purposes and so should be adequately designed and monitored for this purpose.

Where non-public areas are covered by fire alarm sounders, a risk assessment should be carried out to determine whether a Sound System for Emergency purposes needs to be installed to allow communication to staff in the event of a non-fire related emergency. If the building has both systems installed in an area, the emergency messages should be given priority such that the sounders are muted in the event of an emergency speech broadcast. For a building that deploys both sounders in the non-public areas and emergency messages in the public areas, a risk assessment should be carried out to ensure that the two systems are acoustically isolated.

4.3 System integrity

In areas designated as voice alarm, the recommendations for system integrity in [BS 5839-8:2013](#) should be followed.

In areas designated sound system for emergency purposes, this standard is intended for large sites and venues with more complex evacuation requirements.

A risk assessment should include an assessment as to whether redundant amplifiers or secondary loudspeaker circuits for each zone are required for the following scenarios:

- a) in areas that are of very low occupancy, normally less than 500;
- b) small spaces such as disabled toilets or where it would be impractical to try and fit two loudspeakers in very close proximity;
- c) where there are secondary measures in place to communicate with the public or staff;
- d) external areas or walkways where public and staff gain access to or egress from the venue/building;
- e) perimeter of the venue; and
- f) car parks or other large external areas.

Section 2: Planning and assessment

5 Procurement

COMMENTARY ON CLAUSE 5

The cost of sound systems for large venues is substantial. Associated costs are often significantly underestimated by cost consultants.

The inherent costs of these systems are largely due to:

- a) extensive areas of coverage;*
- b) use of high-powered systems that meet strict intelligibility criteria;*
- c) significant numbers of paging zones;*
- d) complex operational requirements (e.g. high levels of flexibility); and*
- e) difficult acoustic conditions including high noise and/or reverberation.*

Appropriate provisional costings should be made at the earliest opportunity to ensure that the effectiveness of the system for emergency purposes is not compromised due to the lack of an assigned budget.

Where a sound system specialist has not been appointed at the early stages of a project, the cost consultant should take account of costs of comparable systems from other recent projects when assigning a provisional budget.

Following suitable provisional costing, the cost consultant should liaise closely with the sound system specialist to develop and finalize the budget for the system, ensuring that the following are included, where relevant:

- a) custom architectural requirements (e.g. enclosure colour);
- b) related architectural integration requirements;
- c) licensing; and
- d) any phasing over time of the proposed installation.

The designer, installer or project engineer should be deemed a competent person.

NOTE 1 For example, in the UK, such a person might have corporate or full membership of one or more recognized and relevant institutions such as the Institute of Sound and Communications Engineers (ISCE), the Audio Engineering Society (AES), or the Institute of Acoustics (IOA), or be a chartered engineer.

NOTE 2 Whilst the ability of a contractor to demonstrate previous successful installations conforming to this standard is desirable, this does not preclude whether the contractor has designed, specified, maintained and operated a system in compliance with this standard.

Those responsible for design, installation, commissioning and maintenance should be able to demonstrate their ability to deliver large, complex projects where sound quality and speech intelligibility are critical requirements.

Care should be taken in choosing a suitable installer for a compliant installation.

The person responsible for the design and its implementation should have relevant qualifications and experience.

The purchaser should ensure that the person responsible for the design is adequately informed of the objectives of the system and any relevant requirements of enforcing authorities.

6 Planning

6.1 General

At the planning stage of any new large venue or refurbishment project, and especially at the planning of any refit or upgrade of public safety and information systems, due account should be taken of the various factors critical to the achievement of a sound system for public safety and emergency use; e.g. the size and acoustic properties/conditions of spaces and structural support, e.g. loudspeakers.

A safety management plan should be supplied to the sound system designer.

Professional advice should be sought at the planning stage to assist the purchaser in satisfying the recommendations of this code of practice.

The purchaser should consult with the operator of the venue before progressing to the design phase.

NOTE Where the purchaser has been designated responsible for any particular action, they may delegate the task to an appropriate member of the design team, such as the system designer, architect, structural engineer.

6.2 Scope of the project

The purchaser should arrange for the scope of the project to be evaluated by a sound system designer to ensure compatibility with the recommendations of this British Standard.

6.3 Safety management plans

The purchaser should define all safety management plans, including evacuation methodologies, the roles of officials and marshals and the provision or proposal of complimentary emergency and essential information systems, such as fixed and variable signage, in order that the sound system can be designed in accordance with these plans.

NOTE A sound system design typically contains an evaluation and verifies that all planning considerations have been made.

6.4 Acoustic properties

The purchaser should seek advice to ensure that the acoustic properties of the various spaces are compatible or can be made to be compatible with achieving the speech intelligibility and sound quality recommendations in [Annex E](#). The sound system designer in particular should advise if such spaces are acoustically suitable. In new buildings or major refurbishment projects, the architect should also ensure that the spaces are acoustically well equipped and capable of supporting adequate intelligibility.

NOTE Any space where the reverberation time is greater than approximately 1.5 to 2 seconds requires careful design and might result in reduced intelligibility.

6.5 Roof-mounted speakers

Roof-mounted loudspeakers likely to be required for large public areas such as the main circulation in a shopping mall, large transportation concourses, bowl of a stadium or arena or large span space, can have weight loading implications on the structure that should be taken into account by the sound system designer, the design team and purchaser. In the case of mounting loudspeakers from the roof, planning should be in place for the possible failure of the primary loudspeaker fixings and for the use of secondary safety fixings to secure all parts of the loudspeakers to the structure.

NOTE Bass loudspeakers can be particularly heavy.

7 Variations from the recommendations of this document and related standards

COMMENTARY ON CLAUSE 7

The recommendations of this standard are not designed to exclude or restrict new or innovative methods of producing a suitable sound system that is “fit for purpose”.

A large, complex venue is unlikely to be able to conform to the exact requirements of the normal voice alarm and sound systems for emergency purposes standards.

The voice alarm control and indicating equipment (VACIE) used for the emergency sound system might not be able to conform with the requirements of BS EN 54-16:2008. This might be due to the lack of a suitable power supply that conforms with BS EN 54-4. Furthermore, a large, modular audio system might not be procured or constructed in a manner that conforms with the usual requirements of the Construction Product Regulation.

Appropriate loudspeakers, tested to conform to BS EN 54-24:2008, especially for long throw, high SPL applications, might not be available. In such an eventuality this might be classified as a “special application” as set out in the scope of BS EN 54-24:2008. Furthermore, loudspeakers with active components, particularly active column arrays, might provide the optimum solution for some applications but loudspeakers with active components might not be covered by a Harmonised European standard such as BS EN 54-24:2008.

Where a method proposed deviates from the recommendations of this standard and related standards, any potential risks of adopting the approach should be shown to be acceptable and to achieve the intended outcomes of this standard. This should form part of the risk assessment for the project and should be agreed with the relevant parties.

Where products are used that have not been tested to a Harmonised European standard or a European Technical Assessment, the designer should explain this in the risk assessment, giving reasons why the products chosen provide the optimum solution.

NOTE Attention is drawn to the Construction Product Regulation.

8 Performance specification

COMMENTARY ON CLAUSE 8

The principal purpose of providing an effective emergency sound system at a large venue is to allow clear speech communications to be delivered to the occupants.

The most critical application of this provision is the delivery of instructions to evacuate the building in a timely manner, without unnecessary confusion or anxiety caused, in the event of an emergency. Such instructions vary in complexity from an explicit evacuation to a detailed set of actions directed at the staff or specific areas of the crowd in response to an emerging situation.

The achievement of sufficient levels of speech intelligibility directly implies minimum requirements for signal levels, frequency and temporal distortion.

The system should be designed (planned and specified) and implemented (installed, commissioned, operated, demonstrated and maintained) to achieve the speech intelligibility requirements and all other performance requirements recommended in [Annex E](#). Project-specific requirements should be agreed by all interested parties as part of a defined and recorded emergency management plan.

NOTE These might include, but are not limited to, relaxation of intelligibility requirements for certain specific areas mitigated by alternative methods of achieving a safe environment.

Section 3: Engineering

9 Location and environment of emergency microphones

COMMENTARY ON CLAUSE 9

It is important to ensure that messages broadcast from emergency microphones are of adequate intelligibility, and not unduly affected by interference from background noise, reverberation, feedback, etc.

The prime location for initiating emergency messages when the building is occupied by the public is the security or control room. However, in venues where the control room is unmanned, except on event days, the next logical place would be at the site “security” post which is where the fire and rescue service would expect to find the fire detection and fire alarm system control panel intended for their use.

The proposed location of emergency microphones should be assessed to optimize the intelligibility of the broadcast. This assessment should include:

- a) typical ambient noise, e.g. avoid a security post near a busy road or an area close to noisy machinery;
- b) atypical ambient noise, e.g. a control room where during an emergency there is an increase in the ambient noise due to direct communication between other people or indirect communication such as the base station of a radio system; and
- c) the acoustic properties of the space.

NOTE The adverse effects of ambient noise and reverberation may be minimized by introducing acoustic absorption in the immediate environment of an emergency microphone, for example by means of an acoustic hood, booth or similar device.

The acoustic conditions of the emergency microphone position should have, where practicable:

- 1) reverberation time (average of 500 Hz, 1 kHz, 2 kHz octave bands) not greater than 0.7 s; and
- 2) background noise conditions due to noise ingress, building services or equipment within the room not greater than 40 dBA for 30 s or more, and not greater than 55 dBA at any time from equipment likely to operate during an emergency microphone announcement (e.g. telephones, fire panel warnings).

The sound system should always have more than one emergency microphone located in different parts of the venue so that a secondary location can be used should the primary location be compromised.

10 Electro-acoustic modelling

COMMENTARY ON CLAUSE 10

The ability to demonstrate that the proposed electro-acoustic system is likely to meet the performance requirements, not only for life safety applications but also other purposes, is desirable especially for challenging and/or complex spaces. The electro-acoustic design, preferably modelled in a proprietary computer software programme, is also a useful benchmark for any future verification process (see [Clause 21](#), [22](#) and [23](#)).

However, not all spaces require modelling. An experienced sound system designer can make a judgement on which spaces can be modelled to assist with the design and which do not require modelling and can

be reliably designed by experience/rules of thumb, including whether this requires agreement with the relevant body responsible for sign-off of the system.

Specialist computer modelling programmes allow the virtual space to be built, room surfaces attributed with absorption coefficients and the loudspeakers located with their specific performance characteristics. Potential SPL and speech intelligibility (STI) can then be predicted.

Such computer programmes generally employ a simplified geometry to represent the space. Rarely can an architectural 3D model be directly used for modelling due to the inherent complexity. Consequently, a new simplified model has to be created specifically for the sound system design. The resultant model is usually a fair approximation of the likely result which will be achieved if a particular electro-acoustic design were implemented. This modelling provides the following benefits to the design process:

- a) prediction of statistical variation in STI across the area of coverage that can then be directly compared to statistical STI criteria requirements;*
- b) prediction of SPL across the area of coverage;*
- c) different loudspeaker locations, types and quantities can be compared;*
- d) different amounts and locations of acoustic absorption can be compared; and*
- e) results can take the form of graphical representations which are easier to understand for a layperson.*

Modelling is only as good as the input data used so the designer should check the adequacy of the data available before building the model. The acoustic data should be carefully reviewed to check that they are realistic and will not lead to misleading results.. Performance data for the absorption of sound by a material should be based on laboratory test data wherever possible rather than predicted performance.

NOTE Given that the final performance of any sound system is a combination of the system design and architectural acoustics for which the space serves, this process is collaborative between the architect and electro-acoustic designer to arrive at a solution that works.

In order to obtain results which are a fair approximation of the likely outcome, the user of the modelling software should be able to demonstrate an understanding of sound and system design, as well as a degree of understanding of room acoustics. If a verification process is to be carried out (see [Clause 22](#)) caution should be taken in respect of the difference in data available at the time of the modelling and design versus the built environment.

The modelling should take account of occupational noise within the space, including occupied noise as well as the noise levels expected during an evacuation, including crowd noise where relevant.

The effect of the additional absorption added by the occupants should also be taken into account as this can have a significant impact on some types of venue e.g. stadium or arena bowl, concourses and enclosed station platforms.

The electro-acoustic design for major areas within a venue should be modelled, preferably with the aid of a proprietary computer software programme.

Care should be taken in the interpretation of predictions and the overall electro-acoustic design process should only be entrusted to a competent person.