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BSI Standards Publication

Sound systems for emergency purposes

bsi.

National foreword

This British Standard is the UK implementation of EN 50849:2017. It supersedes BS EN 60849:1998 which will be withdrawn 30 September 2017.

The UK participation in its preparation was entrusted to Technical Committee EPL/100, Audio, video and multimedia systems and equipment.

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English Version

Sound systems for emergency purposes

Systèmes électroacoustiques pour situations d'urgence

Elektroakustische Notfallwarnsysteme

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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European foreword

This document (EN 50849:2017) has been prepared by CLC/BTTF 133-1 “Sound systems for emergency purposes which are not part of fire detection and alarm systems”.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) [2018-03-03]
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) [2020-03-03]

This document supersedes EN 60849:1998.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

EN 50849:2017 includes the following significant technical changes with respect to EN 60849:1998:

— Annex A, Measurement of speech intelligibility, has been brought up to date in line with EN 60268-16;

— emergency sound systems for use in case of a fire emergency are excluded from the scope of this standard.

Emergency sound systems for use in case of fire emergency are covered by CEN/TS 54-32 [1], EN 54-16 and by national, regional or local regulations [2].

Components that have been certified to EN 54-16 [2] and EN 54-24 [3] can be expected to be suitable for use in a sound system for emergency purposes that complies with this standard.

CEN/TS 54-32 provides guidance for sound systems for emergency purposes which are to be used for evacuation in case of a fire emergency.

Introduction

This European Standard introduces a new approach to the assessment of system intelligibility compared with EN 60849, the standard on which it is based.

Over recent years, the Speech Transmission Index STI has been the most commonly used method for determining intelligibility of emergency sound systems. Other methods have rarely been applied. For this reason, it was decided to express the required intelligibility score by using the STI scale. The intelligibility requirements in 5.1 and Annex A have been changed in line with this.

Furthermore, the RASTI measurement method has been removed from this standard because it does not give accurate results.

This residual standard based on EN 60849 is intended to remove any requirements that conflict with the EN 54 series of fire detection and fire alarm standards, including EN 54-16 for voice alarm systems control and indicating equipment and EN 54-24 for voice alarm systems loudspeakers.

1 Scope

This European Standard specifies the performance requirements for sound systems which are primarily intended to broadcast information for the protection of lives within one or more specified areas in an emergency. It also gives the characteristics and the methods of test necessary for the specification of the system.

This European Standard applies to sound reinforcement and distribution systems to be used to effect a rapid and orderly mobilization of occupants in an indoor or outdoor area in an emergency, including systems using loudspeakers to broadcast voice announcements for emergency purposes and attention-drawing or alarm tone signals.

This European Standard does not apply to emergency sound systems used for evacuation in case of fire emergency, whether connected to a fire detection and fire alarm system or not.

NOTE 1 The use of the system for normal sound reinforcement and distribution systems purposes under non-hazardous circumstances is not excluded.

It is recommended that the system, when used for emergency purposes, should form part of a complete facility (equipment, operating procedures and training programmes) for the control of emergencies.

NOTE 2 Sound systems for emergency purposes may be the subject of approval by relevant authorities.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 60065, *Audio, video and similar electronic apparatus — Safety requirements (IEC 60065)*

EN 60068-1, *Environmental testing - Part 1: General and guidance*

EN 60079 (all parts), *Explosive atmospheres (IEC 60079 series)*

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

IEC 60364 (all parts), *Low-voltage electrical installations*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1
alarm
signal, or condition, warning of an emergency

3.2
area of coverage
area, inside and/or outside a building, where the system meets the requirements laid down in this standard

Note 1 to entry: Certain parts of an area of coverage may be excluded, see 5.1.

3.3
audibility
property of sound which allows it to be heard among other sounds

Note 1 to entry: At present for objective analysis, for example when using the STI equation (see EN 60268–16), the concept of audibility takes account of the relative loudness and frequency content of the sound in comparison with other sounds present at the same time.

3.4
clarity
property of a sound which allows its information-bearing components to be distinguished by a listener

Note 1 to entry: It is related to the freedom of the sound from distortion of all kinds. There are three kinds of distortion involved in the reduction of clarity of a speech signal in an electro acoustic system:

a) amplitude distortion, due to nonlinearity in electronic equipment and transducers;

b) frequency distortion, due to non-uniform frequency response of transducers and selective absorption of high frequencies in acoustic transmission;

c) time domain distortion, due to reflection and reverberation in the acoustic domain.

3.5
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

3.6
danger
risk of harm or damage

3.7
emergency
imminent risk or serious threat to persons or property

3.8
emergency loudspeaker zone
part of the area of coverage to which emergency information can be given separately

3.9
information
speech or intended audio signal

3.10
intelligibility
measure of the proportion of the content of a speech message that can be correctly understood

Note 1 to entry: Satisfactory intelligibility requires adequate audibility and adequate clarity.

3.11
loudspeaker zone
part of the area of coverage to which information can be given separately

3.12
acoustically different area
ADA
subdivision of an emergency loudspeaker zone, that may be an enclosed or otherwise physically defined space, characterised by an individual reverberation time and/or ambient noise level

3.13
warning
important notice concerning any change of status which demands attention or activity

3.14
attention–drawing-signal
tone that is broadcasted to attract attention at the start of an emergency message

Note 1 to entry: The level of the attention-drawing-signal is measured using the A-weighted equivalent continuous sound pressure level method, $L_{A,egT}$.

4 General system requirements

4.1 Principal features

A sound system for emergency purposes shall permit the broadcasting of intelligible information of measures to be taken for the protection of lives within one or more specified areas of coverage.

The following criteria shall be fulfilled:

a) When any alarm occurs, the system shall immediately disable or override any functions not connected with its emergency role (such as paging, music or general pre-recorded announcements being broadcast to the loudspeaker zones requiring emergency broadcasts), except where specifically required, and agreed by the interested parties.

b) Unless damaged as a result of the emergency or undergoing repair or maintenance, the system shall be available for operation at all times (or as required by the system specification). In the event of unavailability due to repair or maintenance, suitable provisions shall be made for alternative methods of communication under all prevailing circumstances until the system is restored to full functionality.

c) The system shall be capable of broadcasting a first attention-drawing signal within 3 s of being placed in an emergency mode by the operator, or automatically on receipt of a signal from an emergency detection system. In the latter case, the period of 3 s does not include the reaction time of the detection system from the time the emergency is first detected, to commanding the alarm broadcast.

d) The system shall be able to broadcast attention-drawing signals and speech messages to one or more areas simultaneously. There shall be at least one appropriate attention-drawing signal alternating with one or more speech messages for this purpose.

e) At any time the system operator shall be able to receive, by means of a monitoring system, indications of the correct functioning or, otherwise, indications of failures in the critical signal path (see also 5.2 and 5.3).The monitoring system shall indicate the failure of an amplifier or of a loudspeaker circuit.

f) Failure of a single amplifier or loudspeaker circuit shall not result in loss of coverage in more than one loudspeaker zone.

g) An attention-drawing signal shall precede the first message for 4 s to 10 s. Successive signals and messages shall then continue until either changed in accordance with the evacuation procedure, or until manually silenced. The interval between successive messages shall not exceed 30 s and attention-drawing signals shall be broadcast whenever periods of silence might otherwise exceed 10 s. Where more than one attention-drawing signal is used, such as those used for different types of emergency, each signal shall be clearly distinguishable in character.

h) All messages shall be clear, short, unambiguous and as far as practicable, pre-planned. Where pre-recorded messages are used, they shall be held in a non-volatile solid-state store, and be continuously monitored for availability. The system design shall make it inherently impossible for an external source to corrupt or derange the store or its contents.

i) The content of all messages and the language(s) used shall be specified and/or approved by the purchaser or his representatives or the relevant authorities or both.

j) The system shall be capable of being divided into emergency loudspeaker zones if required by the evacuation procedure.

k) In determining loudspeaker zones, the following criteria shall apply:

   1) the intelligibility of messages broadcast in one zone shall not be reduced below the requirement of 5.1 by the broadcasting of messages in other zones or from more than one source;

   2) no emergency detection zone shall contain more than one emergency loudspeaker zone. For non-emergency use, a loudspeaker zone may be subdivided.

l) A secondary power source shall be available (see 5.6).

4.2 Responsible person

The person or body having control of the premises shall nominate a “responsible person”, identified by name or job title, who shall be responsible for ensuring that the system is properly maintained and repaired such that it continues to operate as specified.

The responsible person shall be appropriately trained and have the authority and resources to carry out the task effectively.

4.3 Priorities

4.3.1 Classification of priorities

It is necessary to decide upon an order of priority for the message distribution based upon:

— any automatic programmed response;

— the perceived risk to occupants, which may require manual override of the programmed response.

Events shall be given a level of priority according to their urgency. The following primary levels are recommended but there may be advantages in adding further subgroups, depending on the operational strategies of the site:

a) evacuate – potentially life-threatening situation needing immediate evacuation;

b) alert – dangerous situation nearby requiring warning of impending evacuation;

c) non-emergency – operational messages, e.g. system test, etc.

The use of these levels in descending order of priority will ensure that appropriate alarm signals and messages are provided first to the zones immediately at risk.

4.3.2 Operational priorities

If the sound system is capable of operation in fully automatic mode, a facility shall be available to control:

— the type of pre-recorded message being broadcast;

— the distribution of messages to different zones;

— real-time instructions or information to occupants via the emergency microphone (if any is provided).

Means may be provided for manual intervention to override any automatically programmed functions. This may apply both to the nature of the message being broadcast and to the distribution paths of the message. Thus, manual controls may be provided at the central control point (and also at specified remote control points) to allow:

a) starting or stopping of pre-recorded alarm messages;

b) selection of appropriate pre-recorded alarm messages;

c) switching on or off of selected loudspeaker zones;

d) broadcasting of live messages via the emergency microphone (if any).

NOTE These manual controls may form part of an emergency control panel.

It is essential to provide continuing operator and staff training in the use of all manual controls.

The emergency control microphone shall have the highest level of priority for access to the sound system, with provision to allow it to override all other broadcasts.

4.4 Safety requirements

The safety requirements applying to emergency sound systems of EN 60065 shall apply.

The mechanical construction of the system shall be such that under the influence of internally generated heat, explosion or implosion, however caused, no part shall cause injury to any person.

Where any part of the system is installed in areas with hazardous or explosive atmospheres, the relevant safety requirements of the EN 60079 series shall be met.

5 System technical requirements

5.1 Speech intelligibility

The average speech intelligibility in 90 % of each ADA and in any other areas exceeding 10 m^2 within the ADA, shall be assessed in accordance with the methods described in Annexes A and B, and shall be not less than 0,50 on the STI-scale, while the minimum STI-value shall not be lower than 0,45.

The speech intelligibility requirements are considered to be a reasonable minimum, although in some very reverberant spaces and areas with very high noise levels this can be impractical to achieve. In such cases, an acceptable level of intelligibility should be agreed by the relevant authorities and other interested parties and then documented.

NOTE See Annexes A and B for the conversion between the STI and various other scales of intelligibility.

The ambient noise level (see Annex B) at the time of measurement (but in the absence of the test signal) and the test signal level shall be stated with the test result.

5.2 Automatic status indication

For automatic status indication for emergency sound systems, the following requirements shall apply:

A clear indication shall automatically be given at the designated control locations of:

a) system availability;

b) power supply availability;

c) any fault condition;

d) for systems having more than one loudspeaker zone, which loudspeaker zones are selected and the mode of operation of the zone, i.e. “evacuate” or “alert” and pre-selection of an emergency microphone;

e) where different emergency messages are provided, which are dependent on the evacuation requirements, indication of which messages being broadcast and into which zone may be displayed by a suitable method. If provided, this information shall be continuously displayed and kept up to date.

5.3 Automatic fault monitoring

For automatic fault monitoring for emergency sound systems, the following requirements shall apply:

A clear indication shall automatically be given at specified locations, for example at main equipment locations, of:

a) short-circuit or disconnection or failure of the main power source;

b) short-circuit or disconnection or failure of the standby power source;

c) short-circuit or disconnection or failure of any battery charging equipment associated with the main or standby power sources;

d) rupture of any fuse or operation of any circuit breaker, isolator or protective device that may prevent an emergency broadcast;

e) failure of the transmission path from an emergency microphone capsule to the preamplifier, and the transmission path from the preamplifier to the emergency sound system, if provided;

f) short circuit or interruption in the transmission path(s) to the loudspeaker(s);

g) amplifiers or modules missing which are necessary for the correct functioning of the emergency sound system in an emergency;

h) failure of any standby amplifier, if applicable;

i) failure of emergency signal generators, including emergency pre-recorded message stores;

j) short-circuit or disconnection of visual alarm devices;

k) failure of a processor to correctly execute its software program;

l) detection of any error during memory checking;

m) cessation of any scanning or interrogation process;

n) failure of the interconnecting data or voice communication links between parts of a distributed system.

In addition to individual fault identification at these locations, a common audible warning shall sound for a minimum of 0,5 s every 5 s. A fault shall cause the audible warning to operate in a latched mode and a visual indicator to light, either steadily, or in a flashing mode. Manual acceptance and reset controls shall be included. When accepted, the audible warning shall be silenced and the indicator shall change to, or remain in, steady illumination. The occurrence of a further fault condition shall reactivate the audible warning and the visual indicator. When all the faults have been cleared, the indicator shall be switched off, either automatically or by operating a fault reset control.

The fault indication shall be given within 100 s of the occurrence of the fault, regardless of whether the sound system is being used for non-emergency purposes, such as the transmission of background music.

5.4 Monitoring of software controlled equipment

For software-controlled equipment for emergency sound systems, the following requirements shall apply:

The correct execution of the system software by any microprocessor shall be monitored by internal self-checking procedures and by an appropriate monitoring circuit (e.g. “watch dog” circuit) that conforms to the following requirements:

a) the monitoring circuit and its associated indication and signalling circuits shall not be prevented from determining and signalling a fault condition by the failure of any microprocessor or associated clock circuits;

b) the monitoring circuit shall monitor the execution of routines associated with the main program elements (i.e. it shall not be solely associated with “waiting” or other “housekeeping” routines);

c) in the event of a failure by a microprocessor to execute its software correctly, the monitoring circuit shall (in addition to initiating an audible and visual fault warning) perform as follows:

    1) re-initialise the processor and attempt to restart the program at a suitable point within 10 s of the occurrence of the failure. The re-initialisation procedure shall verify that the contents of memory, both program and data, are not corrupted, and

    2) either:

        i) record that a failure has occurred (using a system capable of recording a minimum of 99 failures and re-settable only by an operation restricted to authorized servicing personnel); or

        ii) automatically reset the equipment and give an audible and visual warning that an automatic reset has occurred. Once acknowledged, this occurrence should be logged in accordance with 7.2 b).

5.5 Interface with an emergency detection system

For the interface between the emergency sound system and an emergency detection system, the following requirements shall apply:

The communication link between the emergency detection system and the emergency sound system shall be continuously monitored for faults. This is normally performed by the control equipment for the emergency detection system, which gives an audible and visual indication of a fault in the link between the two systems.

The emergency detection system shall also be capable of receiving information regarding faults in the emergency sound system and shall include a provision, usually at its control and indicating equipment, for appropriate audible and visual indication of such faults. As a minimum, the emergency sound system shall be capable of transmitting to the emergency detection system one general “emergency sound system fault” for any fault condition, listed in 5.3, that may occur within the emergency sound system.

The link between an emergency detection system and the emergency sound system is of crucial importance in maintaining the integrity of overall operation. If any emergency sound system is distributed between several enclosures then each transmission path between enclosures shall be monitored. Each link shall be monitored for faults. The emergency sound system shall be capable of continuing to broadcast emergency messages that have been initiated by the emergency detection system, even in the event of a subsequent fault in the interconnecting link between the two systems (i.e. the emergency sound system shall “latch” on receipt of a signal from the emergency detection system). Interruption by higher priority broadcasts shall still be possible.

5.6 Power supplies

The provision of main and standby power supplies shall be such that failure or rupture of a single protective device removes coverage from no more than one emergency loudspeaker zone.

If the building is to be evacuated following main power failure, a standby power supply shall be provided. This shall be capable of operating the system in the emergency mode for a period equal to twice the evacuation time determined by the appropriate authority for the building. In any event, the standby power supply shall be capable of powering the system for a minimum of 30 min.

If a building is not to be evacuated following failure of the main power supply, a standby power supply shall be provided. The standby power supply shall be capable of operating the system for at least 24 h, or 6 h if an emergency generator is available, and then powering the system in emergency mode for a minimum of 30 min. If a building remains unoccupied for several days, provision should be made to ensure that the sound system is capable of operation in emergency mode for 30 min when the building is re-occupied.

Non-emergency functions within the system, such as background music, shall not operate from the standby power supply if this will reduce the capacity below the minimum required for emergency operation.

If batteries are used as a standby power supply they shall be of the secondary type, complete with automatic charging facilities. Where lead-acid batteries are used they shall be of the valve-regulated type unless otherwise specified, and the charging system shall incorporate charging current compensation for changes in the ambient temperature, where this is necessary to achieve the specified battery life.

Batteries shall be used in accordance with the manufacturer's recommendations. Automatic charging shall ensure that the batteries are fully recharged from the fully discharged state to 80 % of their maximum rated capacity in a period of not more than 24 h.

Adequate ventilation and protection against corrosion and dangers resulting from gases emitted by the batteries shall be provided.

5.7 Climatic and environmental conditions

For the performance of system components under climatic and environmental conditions, the following requirements shall apply.

As all or part of the system components may be installed inside or outside buildings, under various climatic and environmental conditions, and exposed to possible mechanical damage, it is essential that the full information on the conditions under which the system is required to operate shall be included in the system specification. For tests, refer to EN 60068-1.

When not otherwise specified, the system shall operate satisfactorily within the system specification under the following conditions:

a) Control and amplification equipment and associated battery power supplies:

   1) ambient temperature −5 °C to +40 °C;

   2) relative humidity 25 % to 90 %;

   3) air pressure 86 kPa to 106 kPa.

b) All other equipment:

1) ambient temperature −20 °C to +55 °C;

2) relative humidity 25 % to 99 %;

3) air pressure 86 kPa to 106 kPa.

5.8 Marking and symbols for marking

Equipment shall be permanently marked with information regarding its function.

NOTE Where regulatory marking covers the same information as this clause, e.g. mandatory marking required by an EU Directive, the requirements of this clause are met.

Terminals and controls shall be permanently marked with information regarding their function, characteristics and polarity.

The marking shall be such that it shall be possible to adjust the user controls and to confirm their positions accurately in conformity with the information given in the user instructions.

Marking shall preferably include letter symbols, signs, numbers and colours that are internationally comprehensible.

6 Installation requirements

The system shall be installed in accordance with the IEC 60364 series, unless otherwise required by mandatory national or local standards.

If the emergency sound system is connected to an emergency detection system, interconnecting cables may be subject to local regulations. In any case, cables should be robust enough to ensure correct operation of the emergency system before and for the duration of an emergency. Precautions shall be taken to prevent the spread of hazardous effects via the wiring routes.

When a sound system for emergency purposes is connected to and used with an emergency detection system, the installation standards for the emergency sound system shall comply as far as is applicable with the standards required for that detection system.

When additions and/or modifications are made to an existing system, which may not comply with this standard, the complete system shall be upgraded to meet this standard.

7 System operation

7.1 Instructions for operation

Instructions for the operation of the system, including actions to be taken in accordance with established and well-rehearsed procedures, shall be available for rapid reference, preferably prominently and permanently displayed, at each control station.

As far as possible, graphic illustrations should be used. Where text is necessary it should be clearly legible and in the preferred language(s).

Updating of the instructions for operation shall be carried out after additions or modifications of the system, or on the basis of practical experience, or revised procedures.

Instructions shall include:

— the functional operation of the system;

— action to be taken in the event of a system failure.

A bound copy of the operational instructions shall be provided.

7.2 Records to be kept

Installation, logbook and maintenance records shall be kept by the end user and/or maintenance company contracted by the end user, in accordance with relevant international and national standards. These shall comprise as a minimum:

a) installation:

   1) details of the locations of all items of equipment;

   2) performance measurements of the system including:

      i) measured loudspeaker loading per circuit;

      ii) settings of any adjustable items within the system, including the output level of power amplifiers;

      iii) sound pressure levels;

      iv) intelligibility measurements;

   3) record of stored messages for emergency voice announcement and configuration data as hard copy and/or data record.

b) Log book:

   A log book shall be kept, in which all usage of the system and all fault occurrences should be recorded, together with all available automatically produced records, to include:

   1) dates and times of usage of the system;

   2) details of tests and routine checks carried out;

   3) time and date of each fault occurrence;

   4) details of the fault found and the circumstances of it being found (for example during routine maintenance);

   5) action taken to rectify or remedy;

   6) date, time and name of person in charge of the system;

   7) counter-signature of the responsible person, if any faults have occurred or have been rectified.

7.3 Maintenance

7.3.1 General

There shall be an established and documented procedure for the scheduled maintenance and retesting of the emergency sound system and equipment as recommended by the system designer in conjunction with the equipment manufacturer, and in accordance with relevant international and national standards. The complete system shall be verified at least once a year by a competent person and can be verified in one or more inspections. A responsible person (see 4.2) shall be nominated to ensure that the procedure continues to be carried out correctly.

This provision may subject to more stringent local, regional or national regulations.

7.3.2 Maintenance instructions

A maintenance manual shall be available giving details of all work required to maintain the installation and equipment in proper working order, consistent with specified performance criteria and any other requirements of this European Standard and other relevant international or national standards. This shall state clearly:

a) the method of maintenance;

b) any sequence related to maintenance;

c) identification of parts requiring maintenance, giving reference to the location of items on drawings, together with manufacturers' reference numbers, and full correspondence details of suppliers of materials and parts;

d) at least one original set of equipment and materials catalogues:

   Catalogues may be supplied in electronic format;

e) list and location of spare parts;

f) list and location of special tools;

g) test certificates as required to be examined by the relevant authority;

h) a set of drawings that describes the location and interconnections of all components of the emergency sound system.

Annex A
(informative)

Measurement of speech intelligibility

A.1 Introduction

This annex describes several methods that are available for the measurement of speech intelligibility. It gives information on the correlations between them, and their limitations, either directly or by references to relevant standards. Annex B specifies the procedures to be used for the purposes of this European Standard.

It is recommended to choose, if possible, the method of measurement, which gives the greatest discrimination in the range of intelligibility being investigated, taking into account the standard deviation to be achieved and the gradients of the relevant curves. For example, the STI (Speech Transmission Index) has the greatest discrimination at high values of intelligibility, while 256-word phonetically balanced word scores has the greatest discrimination at low values.

The Speech Transmission Index STI has become the most commonly used method to determine the intelligibility of emergency sound systems. In the context of this standard, STIPA is regarded as being a subset of STI and being equivalent to STI within the limitations given in EN 60268-16. Other methods of assessing intelligibility are not suitable for measuring the intelligibility of emergency sound systems." In the context of this standard, STIPA is regarded as being a subset of STI and being equivalent to STI within the limitations given in EN 60268-16.

A.2 Methods of measurement

A.2.1 Speech transmission index

The STI is derived by calculation from measurements of the modulation transfer function (MTF), and a number of computer-based measuring systems and hand-held instruments offer this facility. The details of the carrier and modulation frequencies to be used, together with their respective weightings, are standardized in EN 60268-16. EN 60268-16 also offers valuable information about the limitations of the method, practical measurement procedures as well as comparisons with other methods.

A.2.2 Phonetically-balanced word scores

The phonetically balanced (PB) word score method depends on the broadcast of specially chosen words, selected from a known population, to a panel of listeners. General information is given in ISO/TR 4870 [5].

For all types of subjective test involving room acoustics, the test words should be embedded in carrier phrases as this produces representative reflections and reverberation during the presentation of the test word.

NOTE An STI score of 0,5 is equivalent to a PB word score of 94 %.

A.2.3 Modified rhyme test

The modified rhyme test (MRT) method also uses a panel of listeners and a broadcast of specially chosen words.

NOTE An STI score of 0,5 is equivalent to a MRT score of 94 %.

A.2.4 Speech Intelligibility Index

The Speech Intelligibility Index (SII) is determined from the equivalent speech and noise spectra levels together with the equivalent hearing threshold level (see [6]).

NOTE An STI score of 0,5 is equivalent to a SII score of 0,5.

A.2.5 Articulation Index

The Articulation Index (AI) has been revised and renamed the Speech Intelligibility Index (SII).

A.2.6 Articulation loss of consonants

The articulation loss of consonants, usually expressed as a percentage, with the symbol %ALcons, can be determined from the results of transmission tests, using specially chosen simple words. It is described in [6].

NOTE 1 ALcons does not use test words in carrier phrases and omits vowels. This leads to erroneous results in the presence of reverberation or peak clipping.

NOTE 2 An STI score of 0,5 is equivalent to an ALcons of 12 %.

A.3 Limitations of the methods

A.3.1 General

All of the above methods can give misleading results unless the measurement procedure is carried out very carefully and in strict accordance with the relevant standard. Furthermore, it is essential that either the ambient noise level at the time of measurement is very similar to that which occurs under normal operating conditions, or that an appropriate correction is made to the raw data of the test results.

NOTE General information on intelligibility testing is given in ISO/TR 4870.

A.3.2 Speech Transmission Index (STI)

Generally, STI methods are not suitable for testing systems introducing frequency shifts or frequency multiplication or using voice encoders. Reference is made to EN 60268-16 for further information, test methods and their limitations.

A.3.3 Phonetically balanced word scores (256 and 1 000 population)

The limitations of this method are given in ISO/TR 4870. It should be noted that, because it is based on how well words are understood by listeners, there are no limitations in respect of the characteristics of the sound system or those of the environment.

A.3.4 Modified rhyme test

The limitations of this method are similar to those given in ISO/TR 4870. It should be noted that, because the method is based on how well words are understood by listeners, there are no limitations in respect of the characteristics of the sound system or those of the environment.

A.3.5 Speech intelligibility index

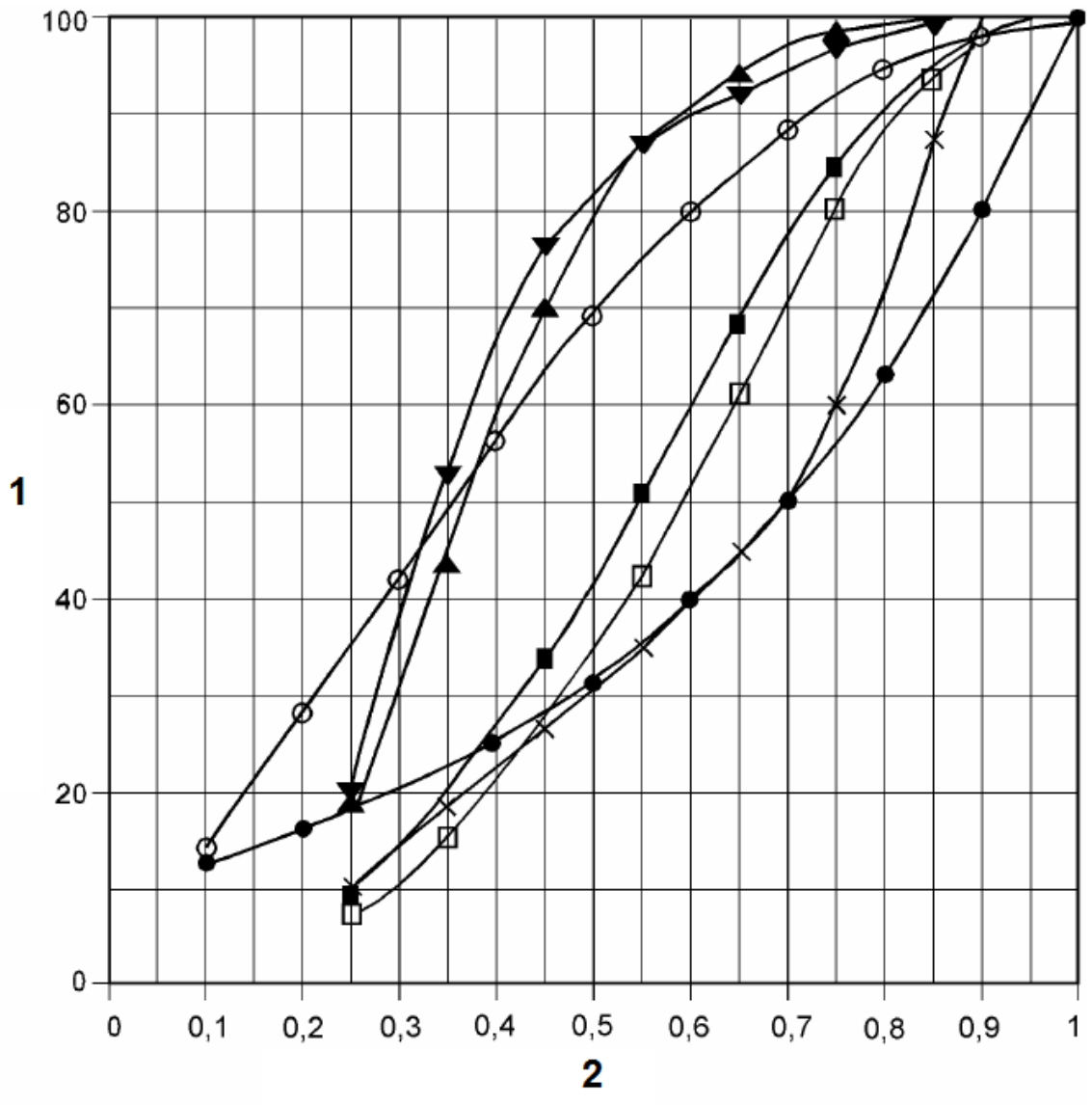
The limitations of this method are given in [6].

A.3.6 Articulation loss of consonants

The limitations are similar to those given in ISO/TR 4870. It should be noted that, if the measurement procedure is based on the reception of words by listeners, there are no limitations in respect of the characteristics of the sound system or those of the environment. If, however, another method of measurement is used, there may be limitations in respect to those aspects.

A.4 Correlation of the results of the various methods

Figure A.1 gives the correlation between the various intelligibility scales.



Key

1 existing Intelligibility Scale

2 common Intelligibility Scale

curve ▼ phonetically balanced word scores (256 words)

curve ▲ Short Sentences

curve ○ Percentage articulation of consonants (100 - % Alcons)

curve ■ phonetically balanced word scores (1 000 words)

curve □ 1 000 syllables

curve X Articulation Index

curve ● Speech Transmission Index (STI x 100 or STIPA x 100)

NOTE The marked points on the curves indicate the correlation values which were derived from published sources.

Figure A.1 — Conversion of existing intelligibility scales

Annex B
(normative)

Intelligibility measurement methods

B.1 General

The intelligibility shall be measured by one or more of the methods listed in Annex A, for which the requirements for reliable results are satisfied. If a different method than the STI method is chosen, the individual results shall first be converted to the STI-scale (see Annex A) and subsequently evaluated according to B.3.

Properly assessing speech intelligibility by measurement often requires careful adjustment of measurement parameters. Especially when the reverberation time and the background noise in the ADA or the sound pressure level of the sound system at the time of the measurement do not match the values that occur in emergency situations, appropriate corrections need to be applied to the results of the measurement. Important information regarding measurements of and necessary corrections for the STI method is given in EN 60268-16, it is thus cited here as general reference.

B.2 Status of the sound system

Usually, the whole sound system should be in operation for all measurements. If measurements are carried out with the sound system in a special status, this shall be stated with the results.

B.3 Number of measurements and calculation of the result

Measure the speech intelligibility within each ADA at several measurement points chosen according to the following requirements:

a) The number of measurement points for each ADA shall be greater than or equal to the number required in Table B.1.

b) The distance between adjacent measurement points shall reflect the evenness of the sound coverage.

c) The measurement points shall be evenly distributed throughout the ADA with no preference for good or bad locations.

d) No more than one third of the points shall be located on the axis of any loudspeaker.

e) Unless otherwise specified, the height of the measurement points shall be 1,2 m above finished floor level for seated positions and 1,6 m above finished floor for standing positions.

Table B.1 — Minimum number of measurement points

Area of the ADA (m^2)	Minimum number of measurement points
Less than 25	1
25 to less than 100	3
100 to less than 500	6
500 to less than 1 500	10
1500 to less than 2 500	15
Greater than 2 500	15 per 2 500 m^2

In order to determine the single-number intelligibility rating for any ADA, the following rules apply:

f) Any continuous areas with poor intelligibility that are smaller than 10 m^2 may be excluded from the analysis and need not to be assessed.

g) From all measurements taken in all remaining areas of the ADA, discard the samples with the worst intelligibility, but not exceeding 10 % of the area of ADA or 10 % of the measurement points. In practice, this will mean that at least 10 measurements have been taken in the ADA. For smaller ADAs with fewer measurement points, no samples shall be discarded.

h) From the remaining samples, calculate the arithmetic mean and note the minimum value. Both shall meet or exceed the respective requirements given in 5.1.

B.4 Ambient noise

Measure the ambient noise level within each ADA at representative points across the ADA for long enough to represent the ambient noise in the ADA at the time of the speech intelligibility test.

In order to allow for a proper correction of the measured STI values, the ambient noise spectrum needs to be determined in all octave bands from 125 Hz to 8 000 Hz. Guidelines for post-processing measured data are given in EN 60268-16.

Ambient noise is rarely constant. Typical usage ambient noise is the best measure and the required spectrum shall be measured as an L_{EQ} over a representative time period.

B.5 Test signal

Where an emergency microphone(s) is used, simulate a normal talker by acoustically applying the test signal to the emergency microphone(s). For other sound sources, electronically inject the signal at a suitable input(s) of the emergency sound system, ensuring that the controls are set so that the signal level is representative.

Where it is not practical to continuously apply an acoustic test signal to the emergency microphone, direct injection may be used, provided that the sound pressure level is equal to that of normal emergency microphone announcement and that the microphone is subjectively checked for correct operation. It is also important to take into account the frequency response of the microphone and to equalize the test signal accordingly.

Adjust the test signal such that the continuous A-weighted sound pressure level of the test signal is 3 dB more than the continuous A-weighted sound pressure level, measured for not less than 40 s (unless the announcement is of shorter duration), when the VAS is broadcasting speech at the emergency speech level.

NOTE For further information on adjusting levels of speech and test signals refer to EN 60268–16.

Where it is not possible or not practical to continuously broadcast the test signal at levels equivalent to the speech level in emergency situations, the applied test signal spectrum needs to be determined in all octave bands from 125 Hz to 8 000 Hz for each measurement location so that the STI result can be post-processed to account for the differences in level. Guidelines for post-processing measured data are given in EN 60268-16.

Where it is not possible or not practical to broadcast the test signal to all configured emergency loudspeaker zones, the actual status of the emergency sound system should be recorded on the test report and justification provided to show that the partial broadcast does not affect the minimum requirements for all configured emergency loudspeaker zones.

B.6 Records

For the noise and intelligibility measurements, record the following:

a) locations of measurement points;

b) unweighted ambient noise level spectrum in octave bands from 125 Hz to 8 000 Hz in dB with reference to 20 µPa at each measurement point;

c) duration of measurement period of the ambient noise measurement;

d) method of STI measurement (see EN 60268-16);

e) STI value at each measurement point;

f) STI result within the ADA as determined according to B.3;

g) unweighted test signal spectrum in octave bands from 125 Hz to 8 000 Hz in dB with reference to 20 µPa at each measurement point;

h) any unusual circumstances that may affect the validity of the measurements;

i) If the ambient noise level is not equal to the ambient noise level in emergency situations, apply an appropriate correction to the raw data of the test results to obtain speech intelligibility values taking into account the reference ambient noise within the ADA. Record the adjusted speech intelligibility result;

j) If the test signal level is not adjusted to reflect the speech level in emergency situations, apply an appropriate correction to the raw data of the test results to obtain speech intelligibility values taking into account the emergency speech level. Record the adjusted speech intelligibility result.

Annex C
(normative)

Attention-drawing audible signals

C.1 Introduction

Sound signals may be used to warn of an imminent announcement. To be effective they shall be sufficiently audible. This annex recommends appropriate sound levels and measurement methods. This annex is intended to only refer to the attention-drawing signals, not the voice announcement. The impact of the sound pressure level of the voice announcement on intelligibility is assessed using the intelligibility measurement method.

C.2 Audibility of attention-drawing signals

Attention-drawing signals over the whole an area of coverage (see 3.2) shall meet the following criteria:

a) absolute minimum sound level: 65 dB; A-weighted;

b) absolute minimum sound level at the bed-head: 75 dB; A-weighted;

c) A-weighted sound pressure level of the alarm is between 6 dB and 20 dB above the A-weighted background noise level (or 9 dB to 23 dB in relevant alarm frequency bands):

   1) the method of measuring background noise shall be consistent with the nature of the noise;

   2) short duration background noise (<30 s) shall be measured using $L_{A,}$eq;

   3) longer period background noise shall be measured using L_A10;

d) the maximum alarm sound level, at any listener position, shall not exceed 120 dB; A-weighted, to limit exposure.

C.3 Attention-drawing signal level measurement method

In order to determine the sound pressure level of the attention-drawing signal, the A-weighted equivalent sound pressure level, $L_{A,}$eq, shall be measured for not less than 10 s at the measuring point when the system is in normal operation as an emergency sound system, if the attention-drawing signal can be played continuously. For attention-drawing signals shorter than 10 s, the measurements shall be made over at least five repetitions.

The measurements shall be made at a number of representative points, which shall be detailed in the system specification, in each area of coverage.

C.4 Ambient noise level measurement method

In order to determine the ambient noise level (the residual noise level in the absence of the test signal), the A-weighted equivalent sound pressure level, $L_{A,}$eq, shall be measured, in decibels over a period sufficient to reasonably represent the residual noise at the time of the intelligibility test.

Measurements shall be made at representative points, which shall be detailed in the system specification, in each area of coverage. The duration and time of measurements shall be reported, together with a note of any unusual circumstances that might affect the validity of the measurements.

C.5 Assessment

The flowchart in Figure C.1 may be used for the assessment of the attention drawing signal level.

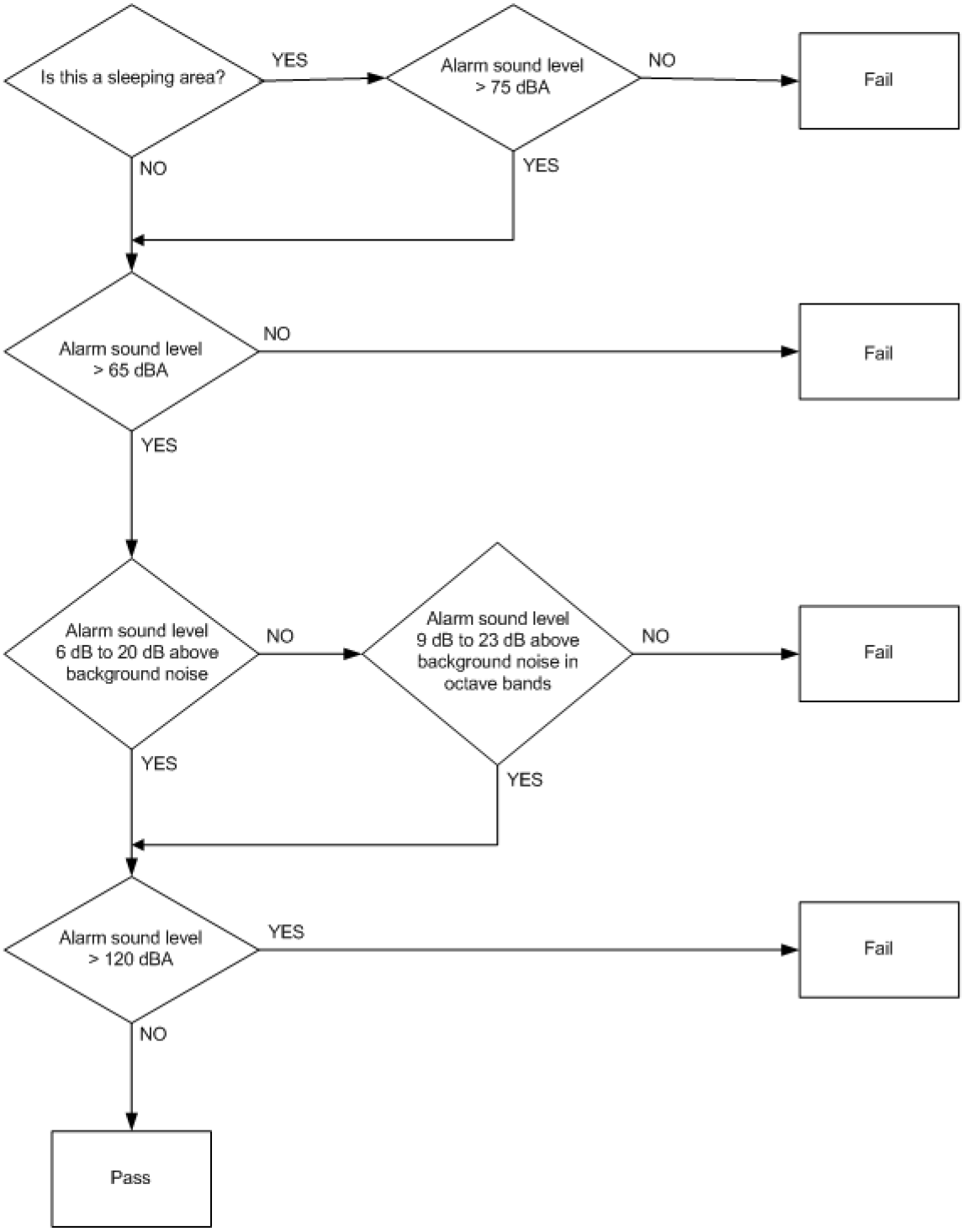


Figure C.1 — Flowchart for the assessment of attention-drawing signals

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[1] Withdrawn

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