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Titre :

Title :

Sound systems for emergency purposes – Part 2: Installation, commissioning and maintenance

Note d'introduction

Introductory note

This draft has been prepared in accordance with proposals submitted to the Project Team as a result of review of the proposed Edition 3 of 60849. This draft collates the installation requirements for systems, leaving the control and indicating equipment requirements to be published as a separate Standard.

The disaggregation of the requirements is proposed to make the equipment requirements more readily acceptable in countries where separate installation requirements or regulations prevent the adoption of Edition 2 of 60849.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOUND SYSTEMS FOR EMERGENCY PURPOSES

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard 60849 has been revised by the maintenance team of IEC technical committee 100: Audio video and multimedia systems and equipment.

This third edition cancels and replaces the second edition published in 1998 and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until June 2005. At this date, the publication will be:

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

SOUND SYSTEMS FOR EMERGENCY PURPOSES – PART 2: INSTALLATION AND MAINTENANCE

1 Scope

This International Standard specifies the installation and maintenance 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 commissioning of the system.

It 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 alert signals complying with ISO 7731 and evacuate signals complying with ISO 8201.

It does not apply to systems using sounders or bells.

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

NOTE 2 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 3 Sound systems for emergency purposes may be the subject of approval by relevant authorities.

2 Normative references

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

IEC 60065: *Safety requirements for mains operated electronic and related apparatus for household and similar use*

IEC 60079: *Electrical apparatus for explosive gas atmospheres*

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

IEC 60364: *Electrical installations of buildings*

IEC 60849: *Sound systems for emergency purposes – Part 2: Control and indicating equipment*

ISO/FDIS 7240-4: *Fire detection and fire alarm systems – Part 4: Power supply equipment*

ISO 7731: *Danger signals for work places – Auditory danger signals*

ISO 8201: *Acoustics – Audible emergency evacuation signal*

ISO 9921: 200X, *Ergonomics – Assessment of speech communication*

3 Definitions

For the purpose of this standard, the following definitions apply.

3.1

alarm

signal, or condition, warning of an emergency

3.2

alert signal

audible signal complying with ISO 7731 or visual signal or a combination of audible and visual signals that call attention to the possibility of a hazardous or dangerous situation

3.3

area of coverage

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

NOTE Certain parts of an area may be excluded, see 4.3

3.4

automatic mode

mode of operation of a sound system which is linked to a fire detection system, or other means of triggering the sound system to broadcast emergency messages without human intervention in a manner which is pre-set according to an agreed evacuation policy unique to that building

3.5

control station

the location from where the sound system is controlled during an emergency

3.6

critical signal path

all components and interconnections between every emergency broadcast initiation point and the input terminals on, or within, each loudspeaker enclosure

3.7

emergency

imminent risk or serious threat to persons or property

3.8**emergency mode**

mode of operation of the sound system in which sources are prioritised to ensure that the most important emergency signals take precedence over all others as necessary

NOTE This is required for systems, which are not solely for use in automatic mode. It is used for broadcasting coded or uncoded messages to the stewards, security, staff, police officers, fire officers etc., in terms of crowd control, as well as to the public at large in terms of life safety.

3.9**emergency zone**

subdivision of the premises such that the occurrence of an emergency within it will be indicated separately from any other subdivision

3.10**evacuate signal**

audible or visual signal or a combination of audible and visual signals complying with ISO 8201 that mean "evacuate the building immediately"

3.11**information**

any speech or intended audio signal

3.12**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.

3.13**loudspeaker zone**

any part of the area of coverage to which information can be given separately

3.14**manual mode**

mode of operation of a sound system whereby an operator is directly in control of the broadcast of any and all sounds, especially those of an emergency nature, be they live broadcasts or pre-recorded

3.15**warning**

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

3.16

warning signal

alert signal or evacuate signal or a combination of alert and evacuate signals

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 sound system shall use control and indicating equipment complying with IEC 60849-1.

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).

b) Unless damaged as a result of the emergency, or 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 maintenance, suitable provisions shall be made for alternative methods of communication under all prevailing circumstances until the system is restored to full functionality.

c) Except for initial switch-on, or during commissioning or maintenance, the system shall be capable of making an emergency broadcast within 60 seconds after the application of power or after a system reset, unless a different time period is indicated to be appropriate following a risk assessment.

d) Except during the condition described in 4.1c), the system shall be capable of broadcasting an alert signal within 3 s of being placed in an emergency mode by the operator, or automatically on receipt of a signal from a fire or other detection system. In the latter case, the period of 3 s includes the reaction time of the detection system from the time the emergency is first detected, to commanding the alert or evacuate broadcast.

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 of parts of the emergency system, that are in the critical signal path (see also 4.5 and 4.6).

g) The system shall be able to broadcast warning signals and speech messages to one or more areas simultaneously. There shall be at least one warning signal alternating with one or more speech messages for this purpose.

NOTE There is considerable variation in sites having emergency sound systems and consequently in the complexity of the sound systems.

h) All messages shall be clear, short, unambiguous and as far as practicable, pre-planned.

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

j) The system shall be divided into emergency loudspeaker zones if required by the evacuation procedure. Such zones need not be the same as other zones, for example emergency detection zones or non-emergency loudspeaker zones.

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 4.4 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.

4.2 Priorities

4.2.1 Classification of priorities

In automatic mode only, the order of priority for the message distribution shall be based upon:—

- a) any automatic programmed response;
- b) the perceived risk to occupants, which may require manual override of the programmed response.

In manual mode, the system shall be operated in accordance with an evacuation plan, including the live broadcasting of messages. The evacuation plan shall be defined by the purchaser in association with any relevant authority.

Events shall be given a level of priority according to their urgency.

NOTE The following primary levels are recommended but there may be advantages in adding further subgroups, depending on the operational strategies of the site:

1. evacuate – potentially life-threatening situation needing immediate evacuation;
2. alert – dangerous situation nearby requiring warning of impending evacuation;
3. 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.

4.2.2 Operational priorities

A manual mode control shall be installed at a central control point and also at remote control points specified by any relevant authority 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 (if any) via the emergency microphone.

NOTE These manual mode controls may form part of a fire or other detection system.

4.3 Safety requirements

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

To ensure the safe and effective operation of the sound system during an emergency, the following shall apply:—

- a) Ambient noise level at the control and indicating equipment shall be not greater than 70 dB(A).
- b) Access to the control and indicating equipment shall not be obstructed.
- c) Control and indicating equipment shall be located in an area that:
 - (i) presents a low risk to the equipment and personnel in an emergency; and
 - (ii) is free from ignition sources and stored combustible materials.
- d) Operation of the control and indicating equipment shall not obstruct the evacuation of the building.
- e) Visible indications shall remain readily distinguishable under all ambient lighting conditions.
- f) Controls and indicators shall be not less than 750 mm and not more than 1850 mm above the floor.
- g) Emergency lighting, sufficient to operate the equipment in the event of the loss of mains power, shall be provided.

4.4 Speech intelligibility

Unless otherwise specified, the following requirement shall be satisfied:

The speech intelligibility over all of an area of coverage (see 3.3) shall be greater than or equal to 0,7 on the common intelligibility scale (CIS).

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

The noise level (see B.5) 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.

NOTE 1 If the persons who are required to understand the messages are, or will be, reasonably familiar with them through regular system tests, the effective intelligibility tends to increase by approximately 0,05 on the CIS if the intelligibility is in the range 0,6 to 0,7. This may apply, for example, in an office building. However, in a sports ground, for example, most of the messages are likely to be relatively unfamiliar to the majority of persons present, and no relaxation of the above requirement should be considered.

NOTE 2 In the case of a large reverberant space, such as an exhibition centre where it is very difficult to meet the requirement of CIS 0,7, some relaxation may be given taking into account the different operational modes of "empty", "half build" and "use by the public".

The system specification may exclude from the area of coverage, defined areas rarely or never occupied by people.

4.5 Interface with emergency detection system

The communication link between the emergency detection system and the sound system shall be continuously monitored for faults.

NOTE In complex buildings in which actions, such as initiation of evacuation signals, silencing of alarm signals, etc., can be implemented at remote voice alarm equipment, consideration shall be given to whether there is a need for such actions to be indicated at any central fire detection and alarm control and indicating equipment.

4.6 Secondary power supply

Where a building is required to be evacuated because of primary power failure, a secondary 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 secondary power supply shall be capable of powering the system for a minimum of 30 min.

Where a building is not required to be evacuated because of primary power failure, the secondary 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 voice alarm system is capable of operation in emergency mode for 30 min when the building is re-occupied.

NOTE If the secondary power is supplied from a generator, it is necessary to ensure that no part of the sound system suffers either:

- partial or complete shut-down due to voltage fluctuations whilst the generator runs up to speed; or
- switching or other transients which can damage the power supply circuits within the sound system.

The use of a UPS (Uninterruptible Power Supply) to serve at least the sensitive equipment should be considered within the risk assessment process.

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

If batteries are used as a secondary 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 complying with IEC 60896-1 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 in order to achieve their specified life, which shall be not less than four years. The end of life shall be taken as the time when deterioration to less than 80 % of the rated ampere-hour capacity (at the one-hour rate) has occurred.

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. Annex C provides battery capacity, charging current and power source calculation examples.

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

4.7 Climatic and environmental conditions

When not otherwise specified, the system equipment shall be operate within the following environmental conditions:

a) Control and indicating equipment and associated power supply equipment:

- ambient temperature $-5\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$;
- relative humidity 25 % to 90 %;
- air pressure 86 kPa to 106 kPa.

b) All other equipment:

- ambient temperature $-20\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$;
- relative humidity 25 % to 99 %;

- air pressure 86 kPa to 106 kPa.

4.8 Marking and symbols for marking

The information left on site upon completion of the installation shall be such that a reasonably competent person who has never seen the site before can investigate faults and instigate repairs without any undue delay.

5 Installation requirements

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

NOTE If the emergency sound system forms part of an emergency detection and/or alarm system, it is likely that the cabling will be subject to mandatory national or local, emergency and/or alarm system standards.

Where the application specifically excludes detection and/or alarm, the cabling shall be of a standard suitable for the application.

Precautions shall be taken to prevent the spread of hazardous effects via the wiring routes.

When a sound system for emergency purposes is installed in combination with an emergency detection system, the installation standards for the sound system shall comply as far as is applicable with the standards required for that detection system.

In cases where additions and / or modifications are made to a system that does not conform to the requirements of this International Standard, such modifications shall not be deemed to conform to this International Standard unless the entire system is upgraded to conform to this International Standard.

6 System operation

6.1 Operational instructions

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 at each control station.

Operational instructions shall be provided in the form best suited to the environment in which they are to be used. This may take the form of a bound document, or laminated cards, or both, or some other means.

Operation instructions shall be updated after additions to or modifications of the system, or on the basis of practical experience, or revised procedures.

NOTE 1 In addition, contractual considerations may require the provision of manuals in a different form or of a different type.

NOTE 2 As far as possible, graphic illustrations should be used. Where text is necessary it should be clearly legible and in the preferred language(s).

NOTE 3 The number of copies of the operational instructions required varies, but as a guide, there should be one copy for every control position, one copy for every equipment rack location, one copy for the purchaser's archive, one copy for the contractor's archive, and one copy for the consulting engineer's archive.

6.2 Records to be kept

Installation, log 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 the following:—

a) Installation

1) Details of the locations of all items of equipment including "as installed" schematics showing the cable labelling of the interconnections, these having been certified as true, preferably by an independent reviewer.

2) "As installed" performance measurements of the system on a zone by zone and circuit by circuit basis, including:

- measured loudspeaker loading per circuit in emergency mode;
- settings of any adjustable items within the system, including equalization settings, relative level settings, signal delays settings, the output level of power amplifiers on a loudspeaker circuit by circuit basis;
- sound pressure levels on a loudspeaker zone by zone basis at locations designated by the system designer as being representative;
- intelligibility measurements on a loudspeaker zone by zone basis at representative locations agreed with the system purchaser.

b) Log

A means of recording and securely preserving the dates and times of routine and/or preventative maintenance and test activities, any remedial action taken, and by whom, and on whose authority shall be provided in a format which is appropriate to the building, its system installation and its operational use.

An automatic fault monitoring system shall be provided with means of recording every occurrence of status change complete with a time and date stamp and covering a period, which suits the purchaser's operational cycle. This cycle is to be a minimum of one week and a maximum of one year.

The purpose of such a log is:

- 1) to allow investigation of the incident should it be suggested that the system failed to broadcast in a particular area at the time of an incident,
- 2) to allow maintenance staff to monitor the pattern of faults arising, so aiding the diagnosis of system problems and the management of preventive maintenance.

As a guide, the log should include:

- dates and times of usage of the system;
- details of tests and routine checks carried out;
- time and date of each fault occurrence;
- details of the fault found and the circumstances of it being found (for example during routine maintenance);
- action taken to rectify or remedy;
- date, time and name of person in charge of the system;
- countersignature of the responsible person, if any faults have occurred or have been rectified.

6.3 Commissioning

On completion of the installation of the system, check for the following:—

- a) Check that all non-emergency functions are disabled during emergency operation.

- b) Measure the time required for the system to be capable of making an emergency broadcast after the application of power or after a reset.
- c) Measure the time required for the system to be capable of broadcasting in an emergency mode by the operator, or automatically on receipt of a signal from a fire or other detection system.
- d) Check that the system operator is able to receive indications of the correct functioning or otherwise of parts of the emergency system in the critical signal path.
- e) Check that the system is able to broadcast warning and speech signals in one or more areas simultaneously.
- f) Measure the ambient noise level of the control and indicating equipment.
- g) Check that access to the control and indicating equipment is not obstructed.
- h) Check that the location of the control and indicating equipment:
 - (i) presents a low risk to the equipment and personnel in an emergency; and
 - (ii) is free from ignition sources and combustible materials.
- i) Check that operation of the control and indicating equipment does not obstruct the evacuation of the building.
- j) Check that the visible indications remain readily distinguishable in ambient light conditions.
- k) Measure the mounting height of controls and indicators.
- l) Check that emergency lighting is sufficient to operate the equipment in the event of the loss of mains power.
- m) Check that speech intelligibility is greater than or equal to 0,7 on the common intelligibility scale.
- n) Check that the failure of the communication link between the emergency detection system and the sound system is reported as a fault.
- o) Check that the secondary power supply capacity is equal to or greater than the calculated requirements.
- p) Check that the environment does not exceed the requirements of 4.7.
- q) Check that information is available on site to enable the investigation of faults and initiation of repairs.
- r) Check that operating instructions are available on site.

NOTE An example of a commissioning test report as shown in Appendix D.

6.4 Maintenance

6.4.1 Precautions

Inspection, testing and maintenance of emergency warning systems shall be carried out after notifying building occupants.

6.4.2 Inspection

Inspection of the emergency warning system in accordance with table 6.1 shall be carried out at intervals not exceeding six months.

Table 6.1 Inspection schedule

Item	Action required	Result	Pass/Fail	Comment
a)	Check that access to the control and indicating equipment is not obstructed			
b)	Check that the location of the control and indicating equipment: (i) presents a low risk to the equipment and personnel in an emergency; and (ii) is free from ignition sources and combustible materials			
c)	Check that operation of the control and indicating equipment does not obstruct the evacuation of the building			
d)	Check that the visible indications remain readily distinguishable in ambient light conditions			
e)	Check that information is available on site to enable the investigation of faults and initiation of repairs			
f)	Check that operating instructions are available on site			

6.4.3 Tests

Tests of the emergency warning system in accordance with table 6.2 shall be carried out at intervals not exceeding twelve months.

Table 6.2 Test schedule

Item	Action required	Result	Pass/Fail	Comment
a)	Check that all non-emergency functions are disabled during emergency operation			
b)	Measure the time required for the system to be capable of making an emergency broadcast after the application of power or after a reset			
c)	Measure the time required for the system to be capable of broadcasting in an emergency mode by the operator, or automatically on receipt of a signal from a fire or other detection system			
d)	Check that the system operator is able to receive indications of the correct functioning or otherwise of parts of the emergency system in the critical signal path			
e)	Check that the system is able to broadcast warning and speech signals in one or more areas simultaneously			

Item	Action required	Result	Pass/Fail	Comment
f)	Measure the ambient noise level of the control and indicating equipment			
g)	Check that emergency lighting is sufficient to operate the equipment in the event of the loss of mains power			
h)	Check that speech intelligibility is greater than or equal to 0,7 on the common intelligibility scale			
i)	Check that the failure of the communication link between the emergency detection system and the sound system is reported as a fault			
j)	Check that the secondary power supply capacity is equal to or greater than the calculated requirements			
k)	Check that the environment does not exceed the requirements of 4.7			

6.4.4 Report

The report of the inspection and testing system shall be completed out in accordance with the Table 6.3.

Table 6.3 Report

Premises Name:		Date of Test:	
Address		Test Period:	
:			
The sound system passes all inspection requirements and does not require additional work? Y/N			
The sound system passes all test schedule requirements and does not require additional work? Y/N			
Comments:			
Owner/Agent: _____ Print		Service Person: _____ Print	
Signature: _____		Signature: _____	
Date: _____			

6.4.5 Maintenance instructions

Maintenance manuals shall give details of all work required to maintain the installation, including:

- 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 the addresses, telephone and facsimile numbers, e-mail and or web addresses of suppliers of materials and parts;
- d) at least one original set of equipment and materials catalogues (photocopies are acceptable for any further copies that may be required);
- e) list and location of spare parts;
- f) list and location of special tools;
- g) any test certificates that may be required to be examined by the relevant authority;
- h) a set of "as installed" drawings, these having been certified as true, preferably by an independent reviewer.

Maintenance manuals shall be provided in a form best suited to the environment in which they are to be used. They may take the form of bound documents, or data files, or both, or some other means.

Annex A (Informative)

Measurement of speech intelligibility

A.1 Introduction

Various methods of measuring speech intelligibility have been proposed, and several are mentioned in International and National Standards. Work on this subject is continuing, notably in ISO technical committees 43 and 159. Pending a completion of this work sufficient for the needs of this standard, this annex briefly describes several methods that are available. 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 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, STI has the greatest discrimination at high values of intelligibility, while 256 word phonetically balanced word scores has the greatest discrimination at low values.

A.2 Methods of measurement

A.2.1 Speech transmission index

The speech transmission index (STI) is derived by calculation from measurements of the modulation transfer function (MTF), and a number of computer-based measuring systems offer this facility. The details of the carrier and modulation frequencies to be used, together with their respective weightings, are standardized in IEC 60268-16 [1] ¹⁾.

A.2.2 RASTI – Rapid (or room) acoustics speech transmission index

The RASTI results from a simplified method of determining the STI, using two octave-band noise carriers and four or five modulation frequencies. The method is described in IEC 60268-16.

A.2.3 Phonetically-balanced word scores

The phonetically balanced (PB) word score method depends on the transmission of specially chosen words, selected from a known population, to a panel of listeners. General information is given in ISO/TR 4870 [2].

NOTE 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.

A.2.4 Modified rhyme test

The modified rhyme test (MRT) method also uses a panel of listeners.

A.2.5 Articulation index

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

¹⁾ The numbers in square brackets refer to the Bibliography.

A.2.6 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 [3]).

A.2.7 Articulation loss of consonants

The articulation loss of consonants, usually expressed as a percentage, with the symbol $\%AL_{\text{cons}}$, can be determined from the results of transmission tests, using specially chosen simple words. It is described in [4].

NOTE – AL_{cons} does not use test words in carrier phrases and omits vowels. This leads to erroneous results in the presence of reverberation or peak clipping.

A.3 Limitations of the methods

A.3.1 General

All of the methods listed in A.2 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. See also B.4.

A.3.2 Speech transmission index (STI)

Generally, STI methods are not suitable for testing systems introducing frequency shifts or frequency multiplication or using vocoders.

With some measuring versions (see IEC 60268-16), the results are meaningful only if:

- a) the system does not use any amplitude compression, expansion or non-stationary temporal processing;
- b) the total harmonic distortion of a sinusoidal signal giving the same sound pressure level at the measuring position as the STI test signal does not exceed 17 % (corresponding to approximately 1 dB of compression of a pink-noise signal due to peak clipping).

A.3.3 RASTI

The results are meaningful only if the requirements given in IEC 60268-16 are satisfied. In general, RASTI is suitable for room acoustics with direct sound transmission between speaker and listener. Only in specific conditions (i.e. substantially linear systems), can the method be applied to sound systems.

A.3.4 Phonetically balanced word scores (256 and 1 000 population)

The limitations are given in ISO/TR 4870. It should be noted that, because the method 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.

A.3.5 Modified rhyme test

The limitations are similar to those given in ISO/TR 4870. It should be noted that, because the method 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.

A.3.6 Speech intelligibility index

The limitations are given in [3].

A.3.7 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 these respects.

A.4 Correlation of the results of the various methods

In order to specify a single figure for the intelligibility requirements of a system, and to compare results of different measurements, much work has been done to determine relationships between the results of the various methods of measurement. In most cases, these relationships are now firmly established and accepted, despite being subject to a degree of uncertainty or statistical variation. For the purposes of this International Standard, it has been found necessary to correlate the results of each of the above methods to a new scale, termed the "common intelligibility scale" (CIS). An essential requirement, due to the above-mentioned uncertainty, is that the gradient of each correlation curve is neither too small nor too great, as each of these conditions exaggerates the uncertainty in the correlation (see [5]).

The correlations that have been determined are shown in Figure B.1.

Annex B (normative)

Measurement method

B.1 Choice of method of measurement

The intelligibility shall be measured by one or more of the methods listed in Annex B, for which the requirements for reliable results are satisfied. The results shall then be converted to the CIS according to the relevant curve(s) given in Figure B.1.

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

The measurements shall be made at a sufficient number (n) of representative points, which shall be detailed in the system specification, in each area of coverage. The arithmetical average I_{av} of the intelligibility values on the CIS, and the standard deviation σ of the results, shall be calculated. The quantity $I_{av} - \sigma$ shall exceed the limit value specified in 4.4.

If the result is within $\pm \sigma$ of the limit, the measurements should be repeated, preferably at a larger number of points.

The mean value of intelligibility, and its 95 % confidence interval, over the whole area of coverage shall be calculated, taking into account the shape of the statistical distribution of the results of the measurements.

B.4 Sound pressure level

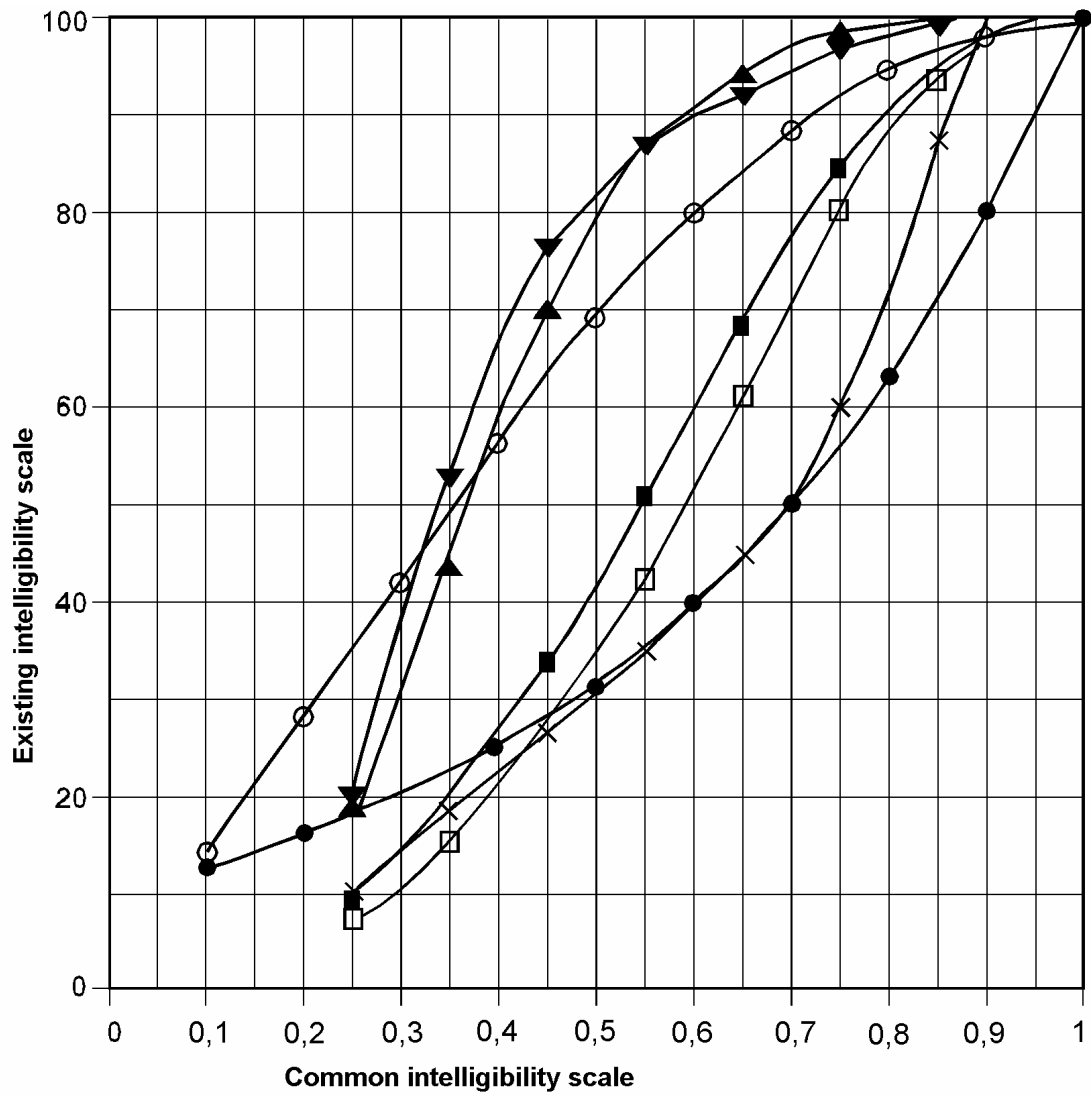
The C-weighted sound pressure level for the measurement shall be equal to the L_{Ceq} , measured for not less than 10 s at the measuring point when the system is in normal operation as an emergency sound system.

NOTE 1 If the RASTI method is used, A-weighting may be used for both measurements instead of C-weighting.

NOTE 2 Linear response may be used instead of C-weighting, only if the results are reliable.

B.5 Ambient noise level

The A-weighted ambient noise level (the residual noise level) in the absence of the test signal (the residual noise) shall be measured, in decibels re 20 μ Pa, over a period sufficient to reasonably represent the residual noise at the time of the intelligibility test. Measurements of the equivalent A-weighted sound pressure level shall be made at representative points over the area of coverage. The positions, duration and time of measurements shall be reported, together with a note of any unusual circumstances that might affect the validity of the measurements.



- ▼ Phonetically balanced word scores (256 words)
- ▲ Short sentences
- Percentage articulation of consonants (100-(% Alcons))
- Phonetically balanced word scores (1 000 words)
- 1 000 syllables
- × Articulation index (AI)
- Speech transmission index (STI x 100)

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NOTE The marked points on the curves indicate the correlation values which were derived from published sources. See [7].

Figure B.1 – Conversion of existing intelligibility scales to the common intelligibility scale

Annex C (informative)

Power source calculations

C.1 BATTERY CAPACITY

The battery capacity requirement should be determined as follows:

(a) Determine the quiescent load current I_Q . Where the load may vary, the worst case average over any 24 h period shall be used.

(b) Determine the full load current I_A .

(c) Determine the capacity de-rating factor F_C of the battery when discharged at the half hour rate, taking into account the minimum operating voltage of the connected the control and indicating equipment.

(d) The 20 h discharge battery capacity C_{20} at 15°C to 30°C shall be determined as follows:

$$C_{20} = 1.25 \left((I_Q \times T_Q) + F_C (I_A \times T_A) \right)$$

where:

1.25 is the uplift factor for expected battery deterioration;

I_Q is the total quiescent current;

T_Q is the quiescent stand-by power source time, (nominally 24 h);

F_C is the battery re-rating factor at half hour discharge rate;

I_A is the total current in alarm state;

T_A is the full load stand-by power source time, (nominally 0.5 h).

Where the average battery temperature is outside 15°C to 30°C the battery manufacturer's data shall be used to determine any further de-rating factor to be applied.

C.2 CHARGING CURRENT

The battery charging current should return a charge to a discharged battery, within 24 h, sufficient to maintain the system for 5 h on normal quiescent load followed by 30 min on full load.

A discharged battery is one that has reached the minimum control and indicating equipment operating voltage when discharged at the nominal quiescent current.

The minimum charging current I_C , is calculated as follows:

$$I_C = \frac{1.25 \left((I_Q \times 5) + F_C (I_A \times 0.5) \right)}{24}$$

where:

1.25 is the uplift factor to account for various losses during charging;

I_Q is the total quiescent current;

F_C is the battery re-rating factor at half hour discharge rate;

I_A is the total current in alarm state.

C.3 POWER SOURCE CALCULATIONS

The main power source capacity is required to meet the requirements of this Standard and a typical set of calculations may be as follows:

$$I_{PSE} = I_Q + I_C \quad \text{and}$$

$$I_Q = I_{QWS} + I_{QANC}$$

where:

I_{PSE} is the total current required to power the system in its quiescent state and to charge the battery;

I_Q is the total quiescent current;

I_C is the charging current;

I_Q is the total quiescent current;

I_{QWS} is the highest quiescent current of the warning system;

I_{QANC} is any quiescent ancillary load connected.

- m) Speech intelligibility is greater than or equal to 0,7 on the common intelligibility scale Y/N
- n) Failure of the communication link between the emergency detection system and the sound system is reported as a fault Y/N
- o) Secondary power supply capacity is equal to or greater than the calculated requirements Y/N
- p) Environment does not exceed the requirements of 4.7 Y/N
- q) Information is available on site to enable the investigation of faults and initiation of repairs Y/N
- r) Operating instructions are available on site Y/N

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