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Fire detection and fire alarm systems —
Part 32: Planning, design, installation, commissioning, use and maintenance of voice alarm systems

прийнято як національний стандарт
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Fire detection and fire alarm systems - Part 32: Planning, design, installation, commissioning, use and maintenance of voice alarm systems

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Foreword

This document (CEN/TS 54-32:2015) has been prepared by Technical Committee CEN/TC 72 “Fire detection and fire alarm systems”, the secretariat of which is held by BSI.

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

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Introduction

Guidelines covering sound systems for use during an emergency are published by different organizations within Europe. The intention of this Technical Specification is to draw together these documents and provide up-to-date guidelines for planning, design, installation, commissioning, use, maintenance and modification of emergency sound systems throughout Europe.

Sound systems for use in emergency, whether automatically triggered, manually triggered, or both, are commonly called voice alarm systems.

It is not intended that this Technical Specification should override existing local, regional or national regulations. It is expected for a considerable (and as yet unspecified) period that these guidelines will coexist with other codes. However, it is hoped that the availability of a common set of guidelines will assist in the harmonization of practice and standards for voice alarm systems throughout Europe.

This document gives recommendations. These recommendations can be made mandatory by being specified within other document(s). For example, an authority having jurisdiction empowered under local, regional or national legislation can require compliance with this document. Equally a contract between a purchaser and a supplier can specify compliance that may then become mandatory under contract law.

The purpose of a voice alarm system is to provide intelligible warning to person(s) within, or in the vicinity of, a building in which an emergency has occurred and to enable such person(s) to take appropriate measures according to an emergency management plan.

Voice alarm systems are often used instead of alarm sounders (see EN 54-3) because the meaning of an alarm signal may not be clear to untrained building occupants and so time may be spent deciding what it means and then further time may be spent deciding what to do.

This document contains specific recommendations for the design, installation, commissioning, use, and maintenance of voice alarm systems and is based on the format used in CEN/TS 54-14.

The main principles on which the guidelines are based are given in the body of this Technical Specification. Detailed recommendations by which these principles may be satisfied are given in annexes.

1 Scope

This Technical Specification provides guidelines for the planning, design, installation, commissioning, use, maintenance and modification of voice alarm systems in and around buildings that broadcast information for the protection of lives in a fire emergency. See EN 54-1:2011, Figure 1, item C and item M.

These guidelines cover voice alarm systems that are triggered automatically by a fire detection and fire alarm system or that are manually triggered, or both.

This Technical Specification does not apply to fire detection and fire alarm systems that only use voice sounders, bells or sounders or a combination of these.

NOTE 1 CEN/TS 54-14 provides guidelines for these systems.

This Technical Specification does not exclude the use of voice alarm systems for emergency purposes other than fire emergency.

NOTE 2 When used for emergencies other than those due to fire, it might be appropriate to modify the guidance in this Technical Specification.

This Technical Specification does not exclude the use of voice alarm systems for non-emergency purposes.

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 54-1:2011, *Fire detection and fire alarm systems - Part 1: Introduction*

3 Terms and definitions, symbols and abbreviations

For the purposes of this document, the definitions, symbols and abbreviations given in EN 54-1:2011 and the following apply.

3.1 Terms and definitions

3.1.1
acceptance
decision that the installed system meets the requirements of a previously agreed specification

3.1.2
acoustically different area
ADA
subdivision of a voice alarm zone, which may be an enclosed or otherwise physically defined space, characterized by an individual reverberation time and/or ambient noise level

Note 1 to entry: ADA is also known as an acoustically distinguishable area.

3.1.3
alarm signal
visual, audible or tactile indication of a fire or other emergency

EXAMPLES Fire, bomb alert, industrial accident, civil commotion, terrorist attack.

3.1.4
alarm load
maximum current required to operate the voice alarm system in the voice alarm condition

3.1.5
ambient noise level
ambient sound pressure normally present in an ADA in dB, normally measured using equivalent sound pressure level, L_{eqT} but may be measured using L_{10}, depending on the nature of the noise

Note 1 to entry: The level of ambient noise is measured across all the octave bands from 125 Hz to 8 kHz. The results can be used to correct STI calculations and to assist with electro-acoustic system design.

Note 2 to entry: L_{eqT} is the A-weighted sound pressure level of noise varying over a period of time, T (normally 10 min) expressed as the amount of average energy and is the measurement method normally used when there is long-term background noise, such as from extraction fans.

Note 3 to entry: L_{10} is the sound pressure level exceeded for 10 % of the measurement period calculated by statistical analysis over a specified time period, T and is the measurement method normally used when background noise varies significantly.

Note 4 to entry: Where the ambient noise level exceeds 90 dB, satisfactory speech intelligibility becomes increasingly difficult to achieve because of the auditory-masking effect.

3.1.6
approval
agreement by a third-party that the installed system satisfies the requirements of the third-party

3.1.7
approval body
body accepted by an authority having jurisdiction or other competent organization as having the expertise necessary to assess the compliance of the installed system with this Technical Specification

3.1.8
area of coverage
area inside or outside a building where the voice alarm system should meet the recommendations of this Technical Specification

3.1.9
arithmetic mean
l_{av}
value obtained by dividing the sum of a set of quantities by the number of quantities in the set

Note 1 to entry: The arithmetic mean l_{av} is given by the following formula:

$$l_{av} = \frac{1}{N}\left(a_1 + a_2 + a_3 + \ldots + a_N\right)$$

where

a_N is a real number (measurement value), and

N is the number of measurement values.

3.1.10
attention-drawing signal
tone that is broadcast 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_{AeqT}.

3.1.11
audibility
property of a sound that allows it to be heard among other sounds

Note 1 to entry: The fact that a message is audible does not mean that it is intelligible.

3.1.12
auditory masking
process by which the threshold of hearing (audibility) of one sound is increased by the presence of another (masking) sound

Note 1 to entry: In the STI method, auditory masking is also referred to as the upward spread of masking.

3.1.13
authority having jurisdiction
AHJ
body having powers to approve the voice alarm system provided under local, regional, national or European legislation

3.1.14
automatic mode
mode of operation of a voice alarm system such that it can be put into the voice alarm condition by a fire detection and fire alarm system without human intervention in a way that is pre-set according to an agreed emergency management plan

3.1.15
auxiliary mains power supply
locally provided mains power supply used to provide power to a VAS so that the quiescent condition can be maintained during a mains power supply failure without compromising the duration of operation of a VAS

EXAMPLE Uninterruptable power supply, automatically started generator.

Note 1 to entry: Auxiliary mains power supplies are also called essential power supplies.

3.1.16
cabinet
housing that affords a degree of mechanical protection and robustness to its constituent parts and subassemblies

3.1.17
coded message
emergency message intended to inform trained staff of an incident without alerting untrained occupants

Note 1 to entry: Messages that are not coded, and whose meaning is therefore clear, are known as clear messages.

3.1.18
PA/VA system
voice alarm system in which emergency audio functions are combined with non-emergency audio functions

3.1.19
commissioning
process for managing the delivery of a voice alarm system by verifying that it is designed, installed, and tested to meet the project specification

3.1.20
competent person
person who, in relation to the work undertaken, has the necessary knowledge, skill and experience to complete the work satisfactorily and safely

3.1.21
control centre
location containing an emergency microphone that is occupied by trained operators during periods of risk, such as during public access times in a shopping centre or during an event in a sports venue

Note 1 to entry: If access to a control centre is restricted, the emergency microphone may be considered to be at access level 2 as defined in EN 54-2.

3.1.22
control point
location containing an emergency microphone for the use of trained operators during an emergency

3.1.23
emergency message
broadcast comprising an attention-drawing signal followed by a pre-recorded or live emergency announcement

3.1.24
emergency microphone
microphone for use by the fire service or trained operators as part of a voice alarm system

Note 1 to entry: The emergency microphone may have status indicators and manual controls for the selection and broadcast of live and/or pre-recorded announcements.

Note 2 to entry: In order to achieve the best possible intelligibility, it is essential that operators of emergency microphones are trained to use microphones correctly.

3.1.25
emergency speech level
A-weighted sound pressure level of the speech signal that will be broadcast in the voice alarm condition measured in dB

Note 1 to entry: To determine the emergency speech level the A-weighted equivalent continuous sound pressure level L_{AeqT} is measured and 6 dB added to the result (see EN 60268-16).

3.1.26
equivalent continuous sound pressure level
L_{eqT}
twenty-fold decimal logarithm of the ratio of the RMS sound pressure level for a given time interval, T, to the reference sound pressure, where the RMS sound pressure may be determined with a standardized frequency weighting

Note 1 to entry: EN 61672 (all parts) gives further information regarding the requirements for sound pressure measurements.

3.1.27
fault
equipment failure within the voice alarm system that jeopardises the correct functioning of part or all of the system

3.1.28
fire compartment
building compartment whose boundaries have a defined fire resistance

3.1.29
functional condition
condition of the VACIE characterized by its indication at the VACIE

Note 1 to entry: The functional conditions recognized in this Technical Specification are:

— the voice alarm condition, when any emergency message or fire alarm signal, recorded or live, is broadcast in at least one voice alarm zone,

— the fault warning condition, when a fault is indicated,

— the disabled condition, when the disablement of a function is indicated,

— the quiescent condition, when no other functional condition listed above is indicated.

3.1.30
hierarchical VAS
voice alarm system comprising more than one VACIE in which one VACIE is designated as the main VACIE and in which the main VACIE is able to:

a) receive signals from and/or transmit signals to any subsidiary VACIE;

b) indicate the status of any subsidiary VACIE

Note 1 to entry: It may be necessary to ensure that the transmission paths between VACIE are able to continue to operate correctly in case of a single fault.

3.1.31
intelligibility
measure of the proportion of the content of a message that can be correctly understood by listeners

3.1.32
listener
person of normal hearing in the voice alarm system’s area of coverage who is able to understand the language used

3.1.33
loudspeaker transmission path
transmission path to one or more loudspeakers

Note 1 to entry: A loudspeaker transmission path may have more than one link to the VACIE, such as a loop connected at both ends.

Note 2 to entry: If two or more cables are directly linked without a method of isolation by a fuse, relay or similar device, they are part of the same loudspeaker transmission path.

Note 3 to entry: Loudspeaker transmission paths are often referred to as loudspeaker circuits – see EN 54-1.

3.1.34
maintenance
routine process of inspection, testing and work on the voice alarm system (including cleaning, re-alignment, adjustment and replacement) carried out at pre-determined intervals in order to maintain correct operation

Note 1 to entry: Maintenance may also be referred to as servicing.

3.1.35
manual mode
mode of operation where a trained operator is directly in control of the broadcast of live or pre-recorded emergency messages

3.1.36
multi-lingual emergency message
emergency message comprising multi-lingual content with the same meaning

3.1.37
distributed VAS
distributed VAS normally transports audio signals, control data and fault monitoring data over a transmission path and may comprise one or more VACIE that communicate with each other or may be one VACIE distributed over several locations

3.1.38
operator
person who is trained to an agreed level of proficiency in tasks relating to the operation and use of the voice alarm system

Note 1 to entry: Tasks relating to the operation and use of the voice alarm system include interpret indications and warnings, operating the VAS controls and microphones, reporting issues to the responsible person and recording relevant events in the logbook.

3.1.39
phased evacuation
system of evacuation in which different parts of the building are evacuated in a controlled sequence of phases, those parts of the building expected to be at greatest risk being evacuated first

EXAMPLE A typical two-phase system will be capable of broadcasting “alert” and “evacuate” signals in different parts of the building. A typical three-phase system will be capable of giving “staff alarm”, “alert” or “evacuate” signals in different parts of the building.

Note 1 to entry: Phased evacuation is normally used where evacuation routes are restricted, such as in high-rise buildings, or where total evacuation may be dangerous or unnecessary.

Note 2 to entry: The normal condition, under which no alarm is given in a voice alarm zone, is not counted as a phase of alarm.

3.1.40
pre-recorded message
pre-recorded emergency message stored in the VACIE

3.1.41
purchaser
person or organization or their appointed representative responsible for the contract to purchase a voice alarm system

Note 1 to entry: The purchaser is often referred to as the client, customer, end-user or owner.

Note 2 to entry: Representatives of the purchaser can include members of the design team or a contractor.

3.1.42
quiescent condition
condition of the voice alarm system characterized by the absence of the voice alarm condition, fault warning condition, or disabled conditions

Note 1 to entry: If the voice alarm system is also used for non-emergency purposes, these functions are considered to be part of the quiescent condition.

3.1.43
responsible person
person appointed by the user who is responsible for ensuring that the voice alarm system operates properly, that operators are trained and competent, and that the system is correctly maintained

Note 1 to entry: In buildings with large numbers of occupants this responsibility may also be delegated so that someone with appropriate knowledge is always present.

3.1.44
reverberation time
RT
time in seconds required for the average sound-energy to decay by 60 dB after the sound source has stopped broadcasting

3.1.45
speech transmission index
STI
Speech Transmission Index (STI) is an objective measure between 0 (no intelligibility) and 1 (perfect intelligibility) used to predict the intelligibility of speech transmitted to listeners via a transmission channel

Note 1 to entry: Guidance on STI is given in EN 60268-16.

3.1.46
speech transmission index for public address systems
STIPA
method obtained by using a condensed version of the STI method but still responsive to distortions found in room acoustics and/or public address systems

Note 1 to entry: Guidance on STIPA is given in EN 60268-16.

3.1.47
system designer
technically competent person or organization that takes responsibility for the specification and adequacy of the design of the voice alarm system

3.1.48
transmission path
physical connection, external to the cabinet(s) of the VACIE, for the transmission of information, emergency messages and/or power between the VACIE and other components of the voice alarm system and/or parts of the VACIE contained in different cabinets

3.1.49
user
person or organization having day-to-day responsibility for the building and for implementation of fire-safety procedures

3.1.50
verification
process by which the installer or other contractor satisfies the purchaser that the voice alarm system meets the defined requirements

3.1.51
voice alarm condition
condition of the VACIE when an emergency message, pre-recorded or live, or an alarm signal is broadcast in at least one voice alarm zone

3.1.52
voice alarm control and indicating equipment
VACIE
component of a voice alarm system that generates and transmits emergency messages or alarm signals to loudspeaker(s) when it receives alarm signal(s) from a fire detection and fire alarm system and/or from manual controls

Note 1 to entry: VACIE can vary in size and complexity from a single cabinet through to many cabinets distributed throughout a building or site.

3.1.53
voice alarm system
VAS
sound distribution system complying with EN 54 that provides means for broadcasting emergency messages or alarm signals in the event of a fire or other emergency, either automatically under control from a fire detection and alarm system, or manually, or both (see item M of EN 54-1)

3.1.54
voice alarm zone
defined area composed of one or more ADAs, to which emergency messages can be broadcast separately

Note 1 to entry: Voice alarm zones may be selected and controlled to broadcast emergency messages singly or in groups.

Note 2 to entry: When used for non-emergency purposes, such as public address announcements or music, the boundaries of loudspeaker zones may differ from the voice alarm zones, in which case they are commonly called public address or PA zones.

3.2 Symbols and abbreviations

CIE control and indicating equipment (item B of Figure 1 in EN 54-1: 2011)

GUI graphical user interface

PSE power supply equipment (item L of Figure 1 in EN 54-1: 2011)

RMS root mean square (e.g. of a signal)

SPL sound pressure level

4 General

4.1 Use of this Technical Specification

This Technical Specification provides recommendations for planning, design, installation, commissioning, verification, use, maintenance and modification of VAS. They are not mandatory, but are intended to provide a basis for the provision and use of effective systems and so specify what “should” be done, rather than giving requirements for what “shall” be done.

4.2 Guideline format

This Technical Specification cannot cover every case that might arise. For this reason, variations from these recommendations are possible, provided that they achieve the safety objectives of the VAS and have been agreed between all responsible parties (see 5.4) and that the variations are documented (see 8.3 c).

This Technical Specification has been drawn up so that the provision and use of an installed VAS will follow the pattern shown in Table 1.

4.3 Project phases

The project should be split into phases as shown in Table 1. This Technical Specification is written as though each of the phases is to be carried out by different organizations. Each organization will have its own expertise but will also need information derived from previous work and will need to pass information on to the parties responsible for the next phase in order to ensure a clear understanding of the VAS objectives.

This Technical Specification gives recommendations for qualifications of personnel or organizations, responsibility for the work, and for the documentation to be carried on from one phase to the next phase.

Table 1 — VAS: phases, content and ownership of the planning, design, installation, commissioning, use, maintenance and modification

Phase	Clause	Content	Ownership
Concept (Assessment of needs)	5	Purpose, risk-assessment, local, regional or national requirements, emergency management plan, subdivision of the building into voice alarm zones, interaction of the VAS with other systems	Purchaser
Planning and design	6	Selection of and intended locations of components, provision for VAS indications and controls, provision of power supplies, selection, routeing and protection of interconnection cables	VAS designer
Installation	7	Mounting, interconnecting and testing the equipment and cables	Installer
Commissioning	8	Commissioning the VAS and training of operators	Installer
Verification	9	Verification of correct operation of the VAS	Purchaser
Third-Party Approval	10	Verification and certification of correct operation of the VAS	AHJ
Acceptance	11	Acceptance of the performance of the VAS	Purchaser
Use	12	Operation of control and indicating equipment and emergency microphones	User
Maintenance	13	Routine testing Repair and/or replacement of defective components Identifying changes that may affect the performance of the VAS that may require modification or extension	Responsible person Maintenance contractor Maintenance contractor
Modification	14	Modification or extension of an installed VAS	Purchaser

4.4 Safety requirements

There may be local, regional or national or European requirements related to the safety of the VAS, such as requirements for electrical safety. These requirements are not covered in this Technical Specification.

4.5 Warranties and guarantees

In addition to any warranties required by legislation, manufacturers or suppliers will usually guarantee the components of installed VAS. The performance of the installed VAS may be guaranteed by one of the organizations responsible for supply, design or installation.

Any warranty should be in written form, and should at least specify the:

a) organization responsible for fulfilling the warranty;

b) date(s) from which the warranty will operate;

c) duration of the warranty;

d) extent of responsibility under the warranty.

Where possible, all warranties should operate from the same date.

4.6 Documentation

The person or organization taking responsibility for each phase should certify proper execution of that phase of the work.

Model certificates and logbook are shown in Annex A.

4.7 Responsibility

Responsibility for the planning, design, installation and the initial performance of the installed VAS should be clearly defined and documented by the purchaser in consultation with the AHJ. It is desirable that, from the installation phase, one organization should take overall responsibility for the project.

At acceptance (see Clause 11) a responsible person should be appointed and take responsibility for the

— availability of documentation giving instructions for use;

— training and assessment of operators;

— routine testing procedures and records;

— maintenance of the VAS;

— ensuring hand-over of their responsibilities to their successor.

4.8 Qualifications

Persons or organizations carrying out the tasks referred to in this Technical Specification should be appropriately competent and experienced and, where applicable, in conformity with local, regional or national requirements for qualifications.

5 Concept (Assessment of needs)

5.1 Responsibility

The purchaser is responsible for consulting with local, regional and national AHJs and for ensuring that the concept for the VAS including the safety level (see B.1) or category (see B.2) complies with their requirements.

5.2 Intention and purpose

VAS are installed for the protection of life and are normally used when any or all of the following apply:

— untrained occupants or members of the public are present in a building or on a site, for instance, in sports stadiums, transport terminals, shopping centres and places of entertainment;

— there are restrictions to escape routes that require occupants to be directed when and how to evacuate the building, such as in tall buildings with restricted capacity stairs;

— although occupants are trained, there are risks that require different warnings and/or instructions to those for fire, such as terrorist attacks and in some chemical processing facilities.

5.3 Risk-assessment

5.3.1 General

The purpose of risk-assessment is to evaluate the consequences of an emergency to personal safety, property and everyday activities and consists of a risk analysis followed by a risk evaluation.

A team representing the relevant disciplines should carry out the risk-assessment and should consist of at least two persons.

5.3.2 The risk-assessment should be carried out systematically. For example:

— split the building into functional groups and activity areas;

— identify the likely occupant groups;

— identify hazards and risk-increasing factors;

— identify which measures should be assessed at which level in the organization;

— conduct a risk analysis and evaluation for each identified risk, hazard and user group;

— determine what critical measures can reduce each risk;

— estimate residual risks and judge whether they can be tolerated;

— if a risk cannot be tolerated, reduce the risk until it becomes tolerable.

This information should be analysed in order to estimate the likelihood and seriousness of each risk and decisions made whether to prevent the risk, reduce the impact of the risk or accept the risk.

This process should be repeated as often is necessary for the risk-assessment team to be satisfied that the remaining risks are acceptable.

5.3.3 The risk-assessment will lead to proposals for VAS design to reduce the risks during an emergency such as:

— identification of areas needing coverage;

— identification of the boundaries of voice alarm zones;

— the content and language(s) of live or pre-recorded messages or both;

— whether coded or clear alert message(s) or both are needed;

— alternative methods of warning for ADAs that do not need to be covered by the VAS;

— supplementary or alternative methods of warning for the deaf;

— supplementary or alternative methods of warning in areas with high ambient noise;

— whether a phased evacuation VAS is needed;

— the extent of user and operator training;

— whether one or more emergency microphones are needed;

NOTE Local, regional or national regulations may require at least one emergency microphone.

5.3.4 The risk-assessment will also lead to proposals for VAS design to ensure the integrity of the VAS, such as:

— whether multiple and/or spare components such as amplifiers are needed;

— whether diverse routeing or protected or fire-resistant cables or both are needed;

— whether multiple loudspeaker transmission paths or interleaving of loudspeakers or both are needed;

— whether loop wiring of loudspeakers with or without isolators is needed.

The risk analysis should be reviewed regularly during the project and updated when new risks and hazards are identified.

When an existing building is modified the risk-assessment should be reviewed and updated.

5.3.5 If the purchaser wishes to reduce the standby time of the VAS below the normal minimum of 24 h, (see 6.10.1) the risk assessment should also consider the points in 6.11.

5.4 Consultation

The purchaser of the VAS should decide the requirements for the VAS after consultation with other responsible parties such as the:

— authority having jurisdiction (AHJ);

— emergency services;

— emergency risk insurer;

— designers and installers of emergency detection/protection alarm systems in the protected building or site;

— VAS equipment supplier(s);

— VAS installer.

If the design of the VAS depends on the requirements of an AHJ, it is important that this authority is identified at the earliest stage possible and its requirements established, including any need for third-party approval.

If approval is required from more than one AHJ and they have different requirements the VAS should be designed and installed to meet the most stringent of the requirements. In the event that the requirements are incompatible, then the incompatibility should be resolved by discussion and the results recorded in the design documentation.

5.5 Local, regional or national requirements

— The regulations of some countries recommend that the design of the VAS should be categorized in safety levels that specify the level of redundancy that should be built into systems (see B.1).

— The regulations of some countries recommend that the design of the VAS should be categorized on the basis of the degree of manual control and training of operators (see B.2).

— The designer should consider the need to define the security level and/or VAS category and ensure that an appropriate level and/or category are selected for the application.

5.6 Documentation

5.6.1 General

Documents should be prepared to cover the general requirements and objectives for the VAS, including the emergency management plan, security level, and category if required, taking into account the expected occupancy of the building. The amount of information given in these documents should be sufficient to allow detailed designs to be prepared.

The documents should also include where applicable;

a) requirements for third-party approval or acceptance;

b) information on any areas of the building with special risks (see 6.6);

c) requirements for options that are mandatory under local, regional or national regulations.

5.6.2 Emergency management plan

An emergency management plan for the building or site should be prepared by a suitably qualified person and should consider at least the following:

a) what kinds of emergencies are to be covered, what response is expected in case of an emergency and whether the response will depend on the position and nature of the emergency;

b) occupancy and use of the building or site, which may differ substantially at different times;

c) the time required to evacuate the building or site and therefore how long the VAS will need to be in the voice alarm condition;

d) the need for coded or clear alert messages and/or signals;

e) the need for alternative alarm signals for noisy areas such as plant rooms, where satisfactory intelligibility is unlikely to be achieved and occupants can be trained;

f) the need for alarm signals for the hearing-impaired;

g) the need for phased evacuation where exit routes have limited capacity or where complete evacuation of the building may be dangerous or unnecessary;

h) whether or not to override all non-emergency functions in a PA/VA system that is in the voice alarm condition;

EXAMPLE In a football stadium, where crowd control is a major concern, it may be sensible to continue to broadcast game commentary to most of the crowd while an evacuation is in progress in other areas.

i) the specification of live and pre-recorded emergency messages including scripts, language(s), dialect and gender of the talkers(s);

j) the extent of operator training, including the correct use of emergency microphones;

k) the location of equipment such as emergency microphones and VACIE cabinets including adequate temperature control, space and weight bearing ability;

l) the need to control the evacuation using manual controls;

m) if the VAS is to have manual controls, decide who will control it in the voice alarm condition, and what control priority they will have. Decide what arrangements need to be made to transfer control between control rooms or control points;

n) if the VAS is to have manual controls, who will decide the content and frequency of initial and on-going training and ensure that it takes place;

o) the voice alarm zone coverage areas and boundaries;

NOTE For non-emergency purposes, loudspeaker zones may differ from voice alarm zones.

p) the acoustic limits of each ADA and voice alarm zone, acoustic overlap from adjacent voice alarm zones and their effect on intelligibility;

q) the need to control other sound sources that may affect intelligibility, such as fire alarm sounders, paging systems and music systems;

r) the need to ensure that the emergency functionality of the VAS cannot be affected by unauthorized persons.

5.6.3 Documentation necessary to prepare design

The purchaser should ensure that the designer is provided with the documentation necessary to design the VAS in accordance with the requirements of this part of EN 54 including:

a) plans of the building showing voice alarm zone boundaries, boundaries of ADAs in each voice alarm zone, emergency microphone locations (control rooms and/or control points) and other VAS equipment locations;

b) the emergency management plan;

c) the acoustic report, including:

   1) a list of the ADA(s) in each voice alarm zone. The sum of the areas of the ADAs should equal the total area of the voice alarm zone;

2) the predicted or measured reverberation time of each ADA in octave bands from 125 Hz to 8 kHz;

3) the predicted or measured ambient noise level in each ADA in octave bands from 125 Hz to 8 kHz;

In existing buildings the data should be measured directly. In new buildings, the data should be derived from existing buildings with equivalent properties and purposes.

d) information on environmental conditions such as temperature, humidity, corrosive atmosphere, electromagnetic influences (e.g. areas subject to severe thunderstorms);

e) a description of the environments where equipment is to be installed (e.g. occupancy of the building and hazardous locations).

5.7 Parts of the building needing cover

5.7.1 Extent of coverage

5.7.1.1 General

The purchaser should specify the parts of the building to be covered but they may also be specified by a third-party, such as an AHJ or an insurance company.

Where the extent of the VAS coverage is not specified by a third-party, or where there is a desire to install a more extensive system than the minimum required by local, regional or national regulations, the extent of coverage should be defined as part of the risk-assessment (sees 5.3).

The extent of coverage should be specified as one of the following:

5.7.1.2 Total coverage

A VAS providing total coverage includes all occupied ADAs other than those specifically exempted by this Technical Specification.

5.7.1.3 Partial coverage

A VAS providing partial coverage includes occupied ADAs in specific areas of risk such as the public areas of a stadium or the malls of a shopping centre.

5.7.2 Areas not needing coverage

Some areas may have a sufficiently low risk to life during an emergency that they need not be covered by a VAS. However, alternative means of warning should still be provided in all areas that can be occupied (see 5.3.3).

Areas not normally needing coverage by a VAS include:

a) all normally unoccupied parts of the building;

b) unventilated frozen food stores with gross volume below 20 m^3;

c) areas of excessive ambient noise where other warning methods are used, such as equipment plant rooms;

d) areas where VAS broadcast is not appropriate, such as in patient areas of hospitals and nursing homes, where evacuation is managed by staff.

5.8 Extent of manual control

VAS may be designed to automatically or manually broadcast pre-recorded and/or live emergency messages or both.

The purchaser, in consultation with the AHJ, should carefully consider the extent of manual control. Manual controls should suit the application and should not be over-specified. Unnecessarily complex controls may lead to serious consequences if misused and so there will be more need for regular and thorough training of staff and exercising of the VAS, including regular evacuation drills.

NOTE 1 Guidance on VAS categories and the complexity and training recommendations for VAS is given in B.2.

NOTE 2 Some buildings, such as sports stadiums, may benefit from the provision of indications and controls that use topographical graphical user interfaces (GUIs) in order to reduce the risk of errors and misuse.

6 Planning and design

6.1 Responsibility of the designer

Responsibility for compliance of the VAS design with the specification and with local, regional or national regulations lies with the person or organization that signs the design certificate (see A.1).

The designer should list any assumptions made and provide written justification for selected solutions.

The designer should ensure that all components of the VAS are compatible with each other.

NOTE Where components are Construction Products as defined by the Construction Products Regulation, it may be possible to ensure compatibility by reference to the Declarations of Performance issued for each component.

6.2 Devices connected to the VAS

Components of, or devices connected to, the VAS should comply with the relevant parts of EN 54.

Devices to be connected to the VAS for which there is no relevant part of EN 54 should be demonstrated to have no detrimental effect on the performance of the VAS if they should fail, e.g. through compliance with other local, regional, national, European or International standards, or other documents that are acceptable to the responsible parties (see 5.4).

EXAMPLE Active loudspeakers, “local’ volume controls, PCs, music sources, printers.

Duplication of devices is not considered to be sufficient to achieve this since both devices are likely to be subject to from the same mode(s) of failure.

It is important to ensure that all devices connected to the VAS are compatible with each other and that fault monitoring is maintained where needed, such as where volume restoration devices are employed.

6.3 Faults

The design of the VAS should be such that the effects of faults in transmission paths, cables or connectors are minimized.

Fault warnings from the VAS should be transmitted to a connected fire detection and fire alarm system at least as a general voice alarm fault.

Fault warnings may also be transmitted to other equipment such as building management systems.

6.4 Modes and conditions of operation

6.4.1 General

When a fire emergency occurs the VAS should be put into the voice alarm condition manually or automatically following any pre-planned delay.

6.4.2 Phased evacuation

Where phased evacuation is required, the evacuation procedure should be specified in the emergency management plan and agreed with all responsible parties (see 5.4).

6.4.3 Audio channels

Where the emergency management plan requires simultaneous broadcast of different emergency messages, sufficient audio channels should be provided in the VACIE.

6.4.4 Automatic mode

In automatic mode the voice alarm condition is initiated by a fire detection and alarm system and subsequent signals and emergency messages should be continuously broadcast until they are either overridden manually or silenced by a signal from the fire detection and alarm system. Removal of the initiating signal should not result in cancellation of the voice alarm condition.

6.4.5 Manual mode

In manual mode, a trained operator in a control centre or at a control point manually selects the voice alarm condition.

Where manual controls are provided, the following indications should be given for each voice alarm zone or group of voice alarm zones that can be controlled from that location:

a) indication of the voice alarm condition,

b) indication of the fault condition,

c) indication of the disabled condition.

6.4.6 Quiescent condition

The VAS may be silent while in the quiescent condition or it may be used for non-emergency broadcasts such as information or entertainment, in which case, fault monitoring should operate normally.

In case of failure of the mains power supply, sound systems that are not part of the VAS should normally be muted to avoid interference and conserve the standby power supply.

If the user wishes to operate the VAS for non-emergency purposes during failure of the mains power supply this is considered to be part of the quiescent condition. However, significant power may be consumed and so additional power capacity should be provided, typically from an uninterruptible power supply (UPS) or generator, so that the recommendations of this Technical Specification are still met (see 6.10.2).

6.4.7 Voice alarm condition

The voice alarm condition is used to inform occupants of an emergency and then instruct them what action to take.

All emergency messages, whether live or pre-recorded, should take precedence over non-emergency broadcasts.

Fire emergency messages should be preceded by the same attention-drawing signal. However, emergency messages for different types of emergency may be preceded by different attention-drawing signals.

Where local, regional or national regulations specify the use of particular attention-drawing signals, these should be used.

An attention-drawing signal may be omitted before coded messages.

6.4.8 Order of priorities

The VAS design should ensure that the following order of priorities is adhered to:

a) live emergency messages via an emergency microphone;

b) manually activated pre-recorded emergency messages;

c) automatically activated pre-recorded emergency messages;

d) non-emergency broadcasts.

6.4.9 Emergency microphones

Emergency microphones should be located in quiet, low-reverberation areas so that the intelligibility of emergency messages is not compromised.

The following points should be considered:

— reverberation time of the location;

— normal ambient noise (e.g. from a busy road or noisy machinery);

— abnormal ambient noise (e.g. a control room where during an emergency there is an increase in the ambient noise due to warning devices, etc.);

— avoiding interference and feedback from VAS loudspeakers and other sound systems.

Emergency microphones should be operable at access level 2 (see EN 54-16). This can be achieved by locating the microphone in a secure area such as a control room, or by means of keys or codes.

In large and/or complex buildings there may be more than one emergency microphone, in which case it may be in a different part of the building so that a secondary location can be used if the primary location is compromised.

6.4.10 Emergency messages

Emergency messages may be pre-recorded or live or both. Where it is practical, pre-recorded messages are preferred because their content is controlled.

It is important that emergency messages are clear and intelligible, with sound levels normalized in relation to each other, and that they only contain information relevant to safe evacuation. Emergency messages should be short and as comprehensible as possible in order to aid understanding and should avoid the use of words that are likely to cause panic. If many occupants are not familiar with the chosen language the announcements should be given in more than one language as specified in the emergency management plan.

The delivery of emergency messages that are to be broadcast in reverberant ADAs may need to be slowed down to minimize the effects of reverberation on intelligibility.

The maximum length of a single language emergency message excluding attention-drawing signal should not exceed 10 s. The time between the beginning of one single-language or multi-lingual emergency message and the beginning of the next single-language or multi-lingual emergency message should not exceed 60 s.

In order to achieve the best possible intelligibility, pre-recorded messages should be recorded using trained talkers under controlled conditions such as a recording studio.

Where a risk is foreseeable, the content of live emergency messages should be planned and scripted.

Where an unforeseen emergency occurs and unplanned messages are needed, it is important that they are clear and unambiguous and can be repeated without causing confusion. Therefore, a procedure should be defined to deal with unplanned messages. For instance, ad hoc emergency messages may be written down prior to being broadcast.

Operators should be regularly trained in the correct use of controls and microphones and on how to follow the emergency management plan.

6.5 Intelligibility

6.5.1 General

6.5.1.1 Introduction

The primary purpose of the VAS is to provide intelligible pre-recorded and/or live emergency messages throughout the area of coverage. It is therefore essential that the achievement of acceptable levels of intelligibility is considered from the beginning of the planning and design process.

Apart from the electro-acoustic characteristics of the VAS, the achievable speech intelligibility in each ADA depends largely on the acoustic environment, particularly the reverberation time and ambient noise level during an emergency.

The emergency speech level needs to be sufficiently loud to overcome the ambient noise; however, if very high levels of ambient noise need to be overcome, additional deterioration of intelligibility may occur due to auditory masking. This should be identified as part of the risk assessment and other methods of warning may be appropriate (see 6.6.4).

Two methods of achieving adequate intelligibility in an ADA are described.

a) The prescriptive design method described in 6.5.3 is only suitable for acoustically simple ADAs.

b) The detailed design method described in 6.5.4 may be used in any ADA.

NOTE Annex C provides further information about methods of measuring intelligibility.

6.5.1.2 Acoustic characteristics needed for planning and design

Reverberation time and ambient noise can have a significant detrimental effect on achievable speech intelligibility. The expected reverberation time and ambient noise levels for each ADA should be predicted, or measured under comparable conditions in a similar ADA. These acoustic characteristics should be provided for each ADA by the building designer and agreed between the responsible parties (see 5.4) and the VAS designer during the planning phase.

During an emergency the ambient noise level may increase significantly, e.g. due to increased mechanical ventilation or increased human activity. The detrimental effect of this noise on intelligibility can be taken into account as part of the Speech Transmission Index method.

Reverberation time and ambient noise levels should either be applied to the predicted intelligibility during the planning and design phase or should be applied to the measurements taken after the installation, or both. The measurement method for ambient noise is described in C.2.4 and the recommendations for computer simulation are described in 6.5.4 b).

If changes from the acoustic characteristics agreed during the planning phase occur, the design should be re-evaluated. For instance, if an ADA is assessed by measurement after installation and the reverberation times or ambient noise levels are different under operational conditions (e.g. because the ADA is unoccupied, but the design assumed that it will be occupied) an appropriate correction should be applied to the measured STI values. Refer to EN 60268-16 for details.

Because of the importance of the emergency speech level in achieving acceptable speech intelligibility in relation to the signal-to-noise ratio and level-dependant auditory masking effects, the required emergency speech level should also be specified during the planning phase.

6.5.1.3 Emergency speech levels

Recommended equivalent continuous A-weighted emergency speech levels at the designed listening height (see 6.5.3 e) are as follows:

1) absolute minimum sound level: 65 dBA;

2) in sleeping areas, absolute minimum sound level at the bed-head: 75 dBA;

3) maximum sound level in all areas: 120 dBA at the listening height (see 6.5.3 e);

NOTE 1 Prolonged exposure to high acoustic levels can damage hearing.

4) The difference between the ambient noise level and the emergency speech signal should normally be at least 6 dB.

NOTE 2 Signal-to-noise ratios of 6 dB to 15 dB are normally sufficient but this is not always the case and, each ADA needs to be considered separately.

NOTE 3 Local, regional or national regulations may make different recommendations for minimum and maximum sound pressure levels.

6.5.2 Intelligibility and loudspeakers

The selection of the type, number, location and orientation of loudspeakers is a critical part of VAS design and different types and quantities of loudspeakers might be needed to give intelligible coverage of an ADA. Their selection is based on information including the:

— relationship between voice alarm zones and fire compartments;

— area of coverage, floor plans, building section drawings and surface finish specifications;

— climatic environment;

— practical mounting arrangements such as ceiling tile, wall, pole, etc.;

— structural limitations such as the load-bearing capability of the building structure;

— requirements for potentially explosive atmospheres;

— directional characteristics, sensitivity and frequency response of the chosen loudspeaker(s).

It is likely that the building designers will want to influence the choice and location of loudspeakers for aesthetic reasons. While these issues may be taken into account, it is essential that the required intelligibility levels can be achieved.

In acoustically simple ADAs such as offices and hotel bedrooms, the VAS designer may be able to estimate the types, quantities and locations of loudspeakers required using the prescriptive design method (see 6.5.3).

In acoustically difficult ADAs such as transport terminals and large entertainment spaces, a detailed design method should be used to help select the types and locations of loudspeakers (see 6.5.4).

Loudspeakers should be chosen for their ability to produce an intelligible result rather than for aesthetic considerations such as size or appearance.

It is also important that the type, orientation and location of loudspeakers are not compromised by equipment installed by others and so representatives of the involved trades should be consulted early in the design stage.

EXAMPLE Air conditioning plant might take up so much space that loudspeakers have to be relocated.

The response of loudspeakers should not be compromised by, for example:

— the use of loudspeakers having rear enclosures with insufficient volume or absorption;

— the use of loudspeaker grilles with insufficient acoustic transparency;

— obstructions or incorrect orientations that prevent them from radiating directly at the occupants.

6.5.3 Prescriptive design method

In order for the prescriptive method to be used in an ADA the ADA should be acoustically simple such that the following is predicted or achieved:

a) the average reverberation time in each of the 500 Hz, 1 kHz and 2 kHz octave bands is not greater than 1,3 s;

b) the reference ambient noise level is less than 65 dBA;

c) the sound pressure level of the alert tone(s) plus message(s) is greater than 75 dB L_{AeqT} where T is the duration of one pre-recorded or live emergency message;

d) the installation height of loudspeakers is limited to five metres above floor level;

e) the distance between the centres of adjacent loudspeakers is not greater than:

   1) 6 m for uni-directional loudspeakers;

   2) 12 m for bi-directional loudspeakers (on axis);

f) the unobstructed distance between a loudspeaker and any occupant of an ADA should not be greater than:

   1) 4,5 m for unidirectional loudspeakers (within the 2 kHz coverage angle of the loudspeaker);

2) 6,0 m for bidirectional loudspeakers (within the 2 kHz coverage angle of the loudspeaker);

When calculating the distance from loudspeakers, the listening height of seated listeners should be taken as being 1,2 m above the floor and the listening height of standing listeners should be taken as being 1,6 m above the floor.

NOTE See Annex D for guidance on the application of the prescriptive design method.

6.5.4 Detailed design method

A detailed design method should be used in all ADAs where the recommendations for the prescriptive method cannot be measured or predicted. Detailed designs should be carried out by suitably qualified personnel and should follow the requirements for use of STI as a design prediction tool as described in EN 60268-16.

The average speech intelligibility in 90 % of the ADA and in any other areas exceeding 10 m^2 within the ADA should be assessed in accordance with Annex C, and should not normally be less than 0,50 on the STI-scale. The absolute minimum STI-value should not be less than 0,45 except where agreed by the purchaser and the AHJ (see 4.7).

The STI recommendations are considered to be a reasonable minimum, although in some very reverberant ADAs with very high noise levels this can be impractical to achieve. In such cases, an acceptable level of intelligibility should be agreed and documented by the AHJ and other responsible parties (see 5.4).

Possible detailed design methods include:

a) Calculations based on statistically predicted parameters.

Prediction of STI performance should be based on the full modulation transfer function (MTF) matrix calculated from the predicted room-acoustic and electro-acoustic parameters and from the measured or estimated background noise levels for each octave-band that contributes to the STI. For further information and definitions, refer to EN 60268-16.

b) Computer simulation model based on simulated impulse responses.

The basis of a reliable computer simulation is the creation of a three-dimensional computer model of the ADA using software that is designed to accurately predict the acoustic behaviour of the ADA. The required detail of the modelled geometry should account for acoustically relevant surfaces rather than architectural details. Sound-diffusing properties of surfaces should be properly accounted for.

After the creation of the room geometry, the model should be adjusted for the expected reverberation time of the ADA. If the ADA already exists, measurements should be performed to determine the reverberation time and the model should be calibrated with the results. Different methods can be used to determine the reverberation time in the simulation model. If the ADA does not yet exist, the VAS designer should consult the building designer to enable the reverberation time to be predicted with reasonable accuracy (see 5.6.3 c) ii).

In order to properly incorporate loudspeakers within the simulation model, data sets describing the electro-acoustic parameters of proposed loudspeakers are necessary. These primarily consist of the frequency-dependent polar-radiation characteristics. These data files should be approved by the manufacturer and should reflect the actual properties of the loudspeaker. Where applicable, they should also match the specifications for sensitivity and power handling measured during assessment for compliance with EN 54-24.

NOTE The data gathered in EN 54-24 measurements is not sufficient for modelling purposes.

For the prediction of sound pressure levels, care needs to be taken that the loudspeakers in the simulation are driven at levels that can be achieved with the intended power amplifiers. The available power needs to be shared across the entire intended frequency range and not applied to individual frequency bands.

For the prediction of speech intelligibility by means of the STI, the following should be considered:

— the predictions should be carried out in accordance with EN 60268-16. The simulated impulse responses should have a minimum duration of 1,6 s;

— the absolute threshold of hearing, the effects of auditory masking and the spectrum of the expected ambient noise should be taken into account;

— for the calculation of signal-to-noise ratios, care should be taken to account for the frequency spectrum of speech (see EN 60268-16), including any project-specific equalization (see 6.13.2).

6.6 Special risks

6.6.1 General

Special risks require particular attention and knowledge of the design and choice of equipment, the location and spacing of loudspeakers and the arrangement of loudspeaker transmission paths.

Special risks include, for example:

6.6.2 Hazardous areas

Some buildings may contain hazards such as a high fire load, flammable liquid storage, or explosive, chemical, biological or nuclear risk that will have significant effects on the design of the VAS. In such cases very close cooperation is necessary between the purchaser (who should be aware of such hazards) and the designers and installers of VAS.

In areas with an explosive hazard, the requirements of the ATEX Directive (94/9/EC) apply. Voice alarm equipment used in such areas should comply with the ATEX Directive.

6.6.3 Outdoor and partially outdoor areas

Where all or part of a VAS is installed in an outdoor area, special attention should be paid to:

— how environmental conditions may affect durability of the equipment;

— the possible effects of natural growths and infestations;

— how atmospheric conditions may affect the propagation of sound;

— environmental noise pollution from the VAS during normal use;

— environmental noise pollution from the VAS during emergency message testing.

6.6.4 Other methods of warning

In special situations other methods of warning may be more effective as well as or instead of emergency messages.

Examples include:

— exhibition halls during the “build” phase of an exhibition where many occupants are untrained, but full safety and security measures are not usually in place,

— noisy plant rooms with occasional occupants who have received evacuation training, or

— high-risk industrial facilities with occupants who have received evacuation training.

Visual alarm devices should be installed in areas where the ambient noise level exceeds 85 dBA, or where the wearing of hearing protection devices is required, or where required by local, regional or national requirements for hearing-impaired persons.

The design may also require the provision of alarm signals for the hearing-impaired and for areas outside the VAS area of coverage, such as:

a) visual alarm devices (see EN 54-23);

b) alarm sounders (see EN 54-3);

c) audio-frequency induction-loop systems;

d) other sensory systems, such as vibrating radio pagers and vibrating pillow pads.

6.6.5 Responsibility

In addition to the purchaser's responsibility under 4.7 and 5.1, and the designer's responsibility under 6.1, the purchaser and designer should ensure that all necessary information needed for the assessment of special risks is made available. This will usually include an emergency management plan that takes the special risks into account.

6.7 VAS control and indicating equipment (VACIE)

Where the VAS is used for evacuation in case of fire, whether connected to a fire detection and alarm CIE or not, the VACIE should be certified to EN 54-16.

6.8 Interface between the fire detection and alarm system and the VAS

6.8.1 General

It is essential that transmission paths between the fire detection and alarm system and the VAS are reliable so that messages will be automatically broadcast where and when required and so that fault and status information is available where and when needed.

Where there is more than one interface between the fire detection and alarm system and the VAS, conflicting information transmitted by the FDAS should not cause conflicting or confusing messages to be broadcast by the VAS;

6.8.2 Monitoring of the transmission path between the fire detection and alarm system and the VAS

a) A fault in any transmission path between the fire detection and alarm system and the VAS should not prevent the correct reception of alarm signals by the VACIE;

b) A fault in any transmission path between the fire detection and alarm system and the VAS should not affect the correct functioning of the VACIE or of any other VAS transmission path;

c) A short-circuit or disconnection of the transmission path(s) between the fire detection and alarm system and the VAS should be indicated at the CIE of the fire detection and alarm system within 100 s of the occurrence of the fault;

d) Where a transmission path between the fire detection and alarm system and the VAS crosses fire compartments, interlinking cables should be protected against fire and mechanical damage and should be routed through areas of low fire risk;

NOTE Local, regional or national regulations may make different recommendations regarding the protection of cables from fire.

e) The transmission path between the fire detection and alarm system and the VAS should be arranged so that a single fault on the transmission path cannot disable any part of the interface between the fire detection and alarm system and the emergency VACIE;

6.9 Initiation of the voice alarm condition

The voice alarm condition should be initiated by a fire detection and alarm system, a manual call point, or at the VAS manual controls (if provided).

A timer may delay the broadcast of alarm signals in accordance with the emergency management plan and local, regional or national regulations, or both.

6.10 Power supply

6.10.1 General

VAS power supplies should comply with EN 54-4 as required by EN 54-16.

VAS often consume considerably more power than fire alarm sounders and large or multiple power supply equipment may be necessary.

Where VACIE are distributed, power supply equipment may also be distributed.

The output(s) of VAS power supplies need to be reliable and capable of supplying the largest load that can be placed on them under quiescent, voice alarm and fault conditions.

All parts of the VAS associated with emergency use should be powered so that they remain in reliable continuous service whether the power is derived from mains, standby batteries, or any combination of these.

If a mains power supply is not available and the standby batteries have been exhausted in all or part of the building, the affected part of the building should only be occupied if adequate alternative warning measures have been implemented.

If standby batteries have been exhausted and are being recharged, consideration should be given to limiting occupation of that part of the building until the standby batteries have reached at least 80 % capacity, unless adequate alternative warning measures have been implemented.

It is common to provide auxiliary mains power supplies such as UPS or generators that do not comply with EN 54-4 to keep important electrical systems operational during a mains power supply failure. If the VAS is connected to such a system this does not remove the requirement in EN 54-16 to provide EN 54-4 standby power supply(s) but it may be acceptable to reduce the standby time in 6.11 a), subject to risk-assessment (see 5.3.5) and agreement between the responsible parties (see 5.4).

If the emergency management plan requires the broadcast of non-emergency messages or music in some voice alarm zones during an emergency, as may be the case in sports stadiums for crowd management purposes, an auxiliary mains power supply is not considered to be sufficiently reliable and additional standby power supply capacity should be provided so that the recommendations of this Technical Specification are still met.

NOTE Where a power supply is only used to power a non-emergency component, such as a music source or non-emergency paging console, the failure of which will not disrupt the VAS, EN 54-4 compliance is not essential.

6.10.2 Mains power supply

For every mains power supply that forms part of the VAS:

a) In order to minimize the potential for failures, the design of the circuits supplying mains power to the VAS should not be affected by faults on other circuits or equipment, or by the isolation of mains supplies in the building.

b) Mains power supply(s) should be connected via an all-pole isolator that is not used for any other purpose. The isolator should be marked in the local language(s) “Fire/Voice Alarm– Do Not Switch Off” and be inaccessible to unauthorized persons or require the use of a special tool to gain access.

NOTE On large or distributed VAS more than one mains power supply and all-pole isolator may need to be provided.

6.11 Standby power supply

6.11.1 General

For every standby power supply that forms part of the VAS:

a) If the emergency management plan states that the building should be evacuated following mains power supply failure, the standby power supply should be capable of operating the VAS in the voice alarm condition for at least 30 min or twice the evacuation time specified in the emergency management plan, whichever is the longer.

b) If the emergency management plan does not state that the building is to be evacuated following failure of the mains power supply, the standby power supply should be capable of operating the VAS in the quiescent condition for at least 24 h and then powering the VAS in the voice alarm condition for at least 30 min.

NOTE 1 Local, regional or national regulations may make different recommendations regarding standby times.

c) Factors that should be considered when calculating the duration of standby power supplies include:

    1) whether an auxiliary mains power supply will automatically take over in the event of mains power supply failure;

    2) whether mains power supply failure status is only reported at specific locations on site and so may not be acted on quickly;

    3) whether mains power supply failure status is reported via communication system to trained staff who can take action;

    4) the likely time for mains power supply to be restored;

    5) where an auxiliary mains power supply is not provided, provisions to quickly replace the mains power supply such as plug-in points for generators;

    6) the likely time it will take for occupants to evacuate the building to:

        i) a place of safety where communication is necessary, such as the playing surface of a sports venue;

        ii) a place of safety where communication is not necessary such as an external car park;

    7) outside periods of normal occupancy, such as during evenings, or during events that occupy a small part of a large complex, the time it is likely to take for the occupants to evacuate the building to:

i) a place of safety where communication is necessary, such as a place of relative safety that is protected by fire protection measures;

ii) a place of safety where communication is not necessary, such as an external car park;

8) the likely time to evacuate the building when there are no untrained occupants on site;

d) the standby power supply calculations should be agreed with the responsible parties (see 5.4) and documented prior to design of the VAS and should form part of the emergency management plan for the building.

NOTE 2 Guidance on calculating battery capacity is given in Annex E.

6.11.2 Mains and standby power supplies

In case of a fault, or interruption of the mains supply, at least the affected part of the VAS should be maintained by a standby power supply.

a) Transitions between a mains power supply and a standby power supply, and vice versa, should not cause any interruption to the operation of the VAS or result in unwanted activation.

b) A fault in a mains power supply should not adversely affect a standby supply and vice-versa.

c) The operation of a single protective device should not result in failure of both a mains power supply and a standby power supply.

d) The presence of mains or standby power should be indicated by a green indicator(s), located in a position(s) that are obvious to staff responsible for monitoring VAS faults.

e) Mains and standby power supplies should be independently capable of supplying the maximum alarm load of the section of the VAS that they are intended to power, irrespective of the condition of other power supplies.

6.12 Power amplifiers

When properly installed and maintained, power amplifiers certified to EN 54-16 are expected to be reliable and so it is not always necessary to make provision for the consequences of amplifier failure.

However, if the risk assessment shows that it is necessary to mitigate the effect of amplifier failure, this can be achieved in a number of ways such as providing standby amplifiers that are automatically switched into service in the case of a fault, or providing additional power amplifiers each serving a smaller number of loudspeakers. The fault status of standby amplifiers should be monitored in accordance with EN 54-16.

NOTE It is good practice to design the VAS so that each amplifier has spare capacity to allow its loudspeaker load to be increased without modifying the VACIE.

6.13 Loudspeakers

6.13.1 General

Unless otherwise specified in local, regional or national regulations, or agreed as a variation, loudspeakers should be certified to EN 54-24 whether the VAS is connected to a fire detection and alarm CIE or not.

6.13.2 Audio equalization

Audio equalization may be applied to individual loudspeakers or groups of loudspeakers at any stage(s) in the audio path, and is normally used to improve intelligibility.

There are no restrictions to this equalization provided that it is within the limits declared by the loudspeaker manufacturer and provided that at least the minimum STI is achieved in the relevant ADA.

Consideration should be given to whether different types of loudspeaker need to use separately equalized transmission paths.

6.13.3 Loudspeaker transmission paths

A fault on one loudspeaker transmission path should not affect any other loudspeaker transmission path. This may be achieved by means such as protective devices or by the use of separate amplifiers.

Where a loudspeaker transmission path passes through one or more fire compartments, failure in that part of the loudspeaker transmission path should not prevent the broadcast of emergency messages in any other fire compartment.

Methods of achieving this include:

— use of fire-resisting cables;

— use of fire resisting conduit;

— routeing cables diversely via areas of low risk- see 7.5.6;

— redundant wiring (often known as A/B wiring) comprising two (or more) separate loudspeaker transmission paths covering an ADA;

— loop wiring with automatic isolators;

— limiting the number of loudspeakers that can fail due to a single fault.

The method used may be defined in local, regional or national regulations.

Where the risk analysis shows that two or more loudspeaker transmission paths need to serve an ADA, the loudspeakers should be interleaved and arranged so that failure of one loudspeaker transmission path will not reduce intelligibility below the minimum recommended by this Technical Specification for the ADA.

Refer to 7.5 for information about cable installation.

6.13.4 Ambient noise sensing and compensation controller (ANS)

If installed, ANS controller(s) should be fail-safe so that, in case of failure, emergency broadcasts revert to the commissioned Emergency Speech Level (see 3.1.25).

ANS sensor(s) should be clearly labelled with the words “Voice Alarm Audio Sensor” in the local language(s).

6.13.5 Voice alarm zones

If the emergency management plan requires that different emergency messages are to be broadcast in different parts of the building at the same time, the VAS should be divided into voice alarm zones.

In determining the boundaries of voice alarm zones, the following criteria should be applied:

a) a single fire detection zone should not contain more than one voice alarm zone;

NOTE 1 A number of fire detection zones can be contained within a single voice alarm zone.

NOTE 2 For non-emergency use, such as public address announcements or music, there does not need to be any relationship to the voice alarm zone boundaries.

b) the intelligibility of messages broadcast in one voice alarm zone should not be reduced below the recommendations of 6.5.4 by interference from the broadcasting of messages in other voice alarm zones or from more than one source.

Sound from loudspeakers should not inhibit or adversely affect the operation of the VAS. In particular, care should be taken that the proximity and power setting of loudspeakers does not cause feedback when an emergency microphone(s) is used.

Where it is important that occupants are not subject to stress caused by loud noises, such as patients in hospital wards, the sound pressure level and message content should be arranged to minimize trauma while providing warning to staff. This may be achieved by the use of coded messages.

A voice alarm zone should normally be restricted to a single storey except for vertical structures such as stairwells, light wells, lift shafts and atriums, which should normally be separate voice alarm zones.

The maximum coverage area of each voice alarm zone should be determined from the emergency management plan.

NOTE 3 Local, regional or national regulations may limit the maximum area of coverage or the maximum number of loudspeakers of a single loudspeaker transmission path.

6.13.6 Fire-resistant ceilings

If loudspeakers are installed into a classified fire-resistant ceiling, suitable measures should be taken to maintain the fire protection separation.

NOTE A loudspeaker with a “fire dome” does not normally provide adequate fire protection separation unless it has been certified by the relevant authorities.

When using loudspeakers in conjunction with “fire domes” or similar rear enclosures, the acoustic characteristics may be significantly affected. If these effects cannot be determined by calculation or by means of data sheets, then measurements should be taken to ensure that adequate intelligibility can be achieved.

6.13.7 Humid areas and corrosive atmospheres

In atmospheres that are humid or corrosive or both, such as swimming pools and ice (skating) rinks, components, loudspeakers and installation materials should be suitable for the atmosphere.

6.14 Hierarchical VAS

Where several VAS are connected in a hierarchy it is essential that the operation of automatic and manual emergency controls is prioritized. This may be achieved by designating one or more VAS and control centres as having control, or by the prioritization of controls, or a combination of both.

Hierarchical VAS are frequently used in places where a site is divided into a number of subsidiary parts; for instance in industrial sites, hospitals, campus sites and shopping centres.

Where there are several buildings on a site, each may require its own VAS, but with the facility to provide status information to a control centre.

In VAS where a control centre is fundamental to the evacuation strategy, failure of a single transmission path should not result in loss of indications from or control of a subsidiary VAS.

Where a control centre can broadcast or control emergency messages it is essential that failure of a transmission path is indicated at the control centre and at the affected subsidiary VAS.

Where such systems are to be installed the designer should:

a) ensure mutual compatibility;

b) define suitable working procedures (including procedures for resetting, silencing, isolation, etc.);

c) define and specify the interfaces between the parts of the hierarchical network;

d) define how message priorities will operate;

e) define which controls have priority over other controls, at what times or under what circumstances;

f) define which audio sources have priority over other audio sources, at what times or under what circumstances;

The equipment used and the transmission path integrity should be such that at least the following indications are given at the control centre:

g) identify any subsidiary VAS that is in the voice alarm condition;

h) identify any condition of a subsidiary VAS in which an emergency message could be prevented from being broadcast (such as fault or disabled conditions);

i) identify any failure of a link to a subsidiary VAS that might prevent a voice alarm condition from being displayed at the control centre or at the affected subsidiary VAS;

j) ensure that failure of any one VAS does not prevent the independent operation of any other VAS.

Requirements for other control and indication facilities should be determined from the consultations referred to in 5.4.

6.15 Distributed VAS

6.15.1 General

A single short-circuit or interruption in any transmission path between distributed cabinets of a VAS should not prevent the activation of a voice alarm output condition to more than one voice alarm zone for longer than 100 s following the occurrence of the fault.

Variations in the time taken to process emergency signals between VACIE should not adversely affect the intelligibility in any ADA.

Where Ethernet (or any other third-party physical layer) is used to connect a distributed VAS, the VAS designer should take responsibility for design and reliability including, but not limited to:

— Transmission path protection, (see 7.5);

— Power supplies (see 6.10);

— Checking that network routers and network switches have been tested and verified to operate correctly with the VACIE (see EN 54-16).

Consideration should be given to ensuring that transmission path latency will not adversely affect intelligibility in any ADA.

6.15.2 Interface of distributed VAS with a fire detection and alarm system or systems

The time from an emergency signal being received at the VACIE and the beginning of the emergency message broadcast or, if applicable, the start of any programmed delay should not exceed 3 s.

6.15.3 Operation of distributed VAS

If two or more locations have manual controls, the operating procedure and priorities of control should be clearly defined in the emergency management plan in order to avoid incorrect operation.

7 Installation

7.1 General

The VAS should be installed in accordance with documentation prepared during the planning and design phase (see Clause 6). If, for any reason, the design is found to be unsuitable during installation, any changes should be agreed by the original designer or by another suitably qualified person in consultation with the responsible parties (see 5.4) and agreed amendments made to the documentation, including the certificate of design.

7.2 Responsibility of the installer

Responsibility for installation of the VAS in compliance with the specification and the documentation from Clause 6 rests with the person or organization that signs the installation certificate (see A.2).

7.3 Location of equipment

The positioning of all VAS equipment should be checked against the VAS design documentation. Any conflict should be resolved by consultation with the responsible parties (see 5.4).

7.4 Installation of the VACIE

7.4.1 General

The VACIE should be installed in locations that provide:

— access limited to authorized staff only;

— light intensity between 100 lux and 500 lux;

— noise levels that do not mask acoustic warnings;

— adequate control of the ambient temperature to prevent overheating of the equipment;

— environmental conditions within the limits given in EN 54-16;

— environment with low risk of significant dust ingress;

— environment with low risk of mechanical damage;

— environment with low risk of fire;

— adequate support for the weight of the equipment;

— easy access to the equipment including allowing sufficient space for opening of covers and doors.

When the VACIE is installed in room(s) where fire detection is mandatory automatic smoke detection should be installed.

The operator interface(s) of the VACIE should be easily accessible to trained operators who need to operate the equipment during an emergency. Where a VACIE operator interface is situated in a locked room, the room should be marked “Voice Alarm Control” or equivalent, in the appropriate language(s), using lettering at least 50 mm tall. If the room is labelled to indicate the presence of fire alarm control equipment, this may be omitted.

7.4.2 Hazardous areas

The location of equipment should take into account special hazards that might exist when the building is occupied. In locations with a potentially explosive atmosphere the requirements of the ATEX Directive should be followed (see 6.6.2).

7.4.3 Separate locations

Where VACIE components are installed in different locations the integrity of the transmission paths should comply with the requirements of EN 54-16:

The transmission paths between operator controls, microphones and other components of the VAS should be protected against mechanical damage and fire in accordance with local, regional or national VAS regulations or, if these do not exist, the local, regional or national regulations for fire detection and alarm systems should be followed as far as possible.

7.5 Cable installation

7.5.1 General

Cables should be installed in accordance with local, regional or national regulations or, where these are not applicable or available; the recommendations of this clause should be followed.

Cable types should meet the specifications of the manufacturer of the VAS components to be connected and local, regional or national installation regulations.

The characteristics of all transmission paths should be specified at the design stage and should be suitable for the VAS. They should not be less than the minimum resistive load or more than the maximum capacitive load declared by the manufacturer.

The electrical characteristics of all cables, such as voltage drop, current carrying capacity, impedance, capacitance, breakdown voltage and insulation resistance, should be suitable for the system. The maximum voltage drop in any loudspeaker transmission path should not exceed 10 %.

NOTE 1 A 10 % voltage drop in a loudspeaker circuit approximates to a 1 dB loss of sound pressure level.

NOTE 2 Long cable runs may affect the frequency response and compromise intelligibility.

If agreed with the AHJ, more than 10 % voltage drop may be allowed, provided that the minimum intelligibility is achieved.

Where cross-talk or electromagnetic interference is likely to affect intelligibility, consideration should be given to increasing physical separation, or using twisted cables, shielded cables or co-axial cables.

Loudspeaker cables should be at least 0,8 mm diameter per conductor.

7.5.2 Cable routeing

Cables carrying power or signals for a VAS should be routed so as to avoid adverse effects on the system. Factors to be taken into account include:

a) electromagnetic interference at levels that might prevent correct operation;

b) the possibility of damage from fire;

c) the possibility of mechanical damage, including damage that could cause short-circuits between VAS cables and other cables;

d) damage due to maintenance work on other systems.

Where necessary, VAS cables may be segregated from other cables by the use of insulating or earthed conducting partitions or by separation by an adequate distance.

All cables and other metallic parts of the VAS should be well separated from any metalwork forming part of a lightning protective system. Precautions against damage from lightning should comply with local, regional or national regulations.

7.5.3 Cable installation

The cable support system should be selected and installed according to local, regional or national building regulations.

Cable supports, ducts and shafts should withstand at least the same temperature and water application as that of the VAS cable it supports while maintaining adequate support. The cable support should have a mechanical protection rating suitable for the hazard depending on where it is installed. Installation of cables should be such that damage due to mechanical tension is limited to a minimum.

Conduit and duct dimensions should be such as to permit easy drawing in and out of the cables. Access should be provided by means of removable or hinged covers.

Arrangements for safety earth connections should be in accordance with local, regional or national regulations and with the recommendations of the manufacturer of the VAS components.

Steps should be taken to avoid damage due to rodent attack, vandalism, lightning and chemical damage such as from paint, oils and ultraviolet light (see 7.5.8).

7.5.4 Precautions against spread of fire

Where cables penetrate a wall, floor or ceiling of a fire compartment, the penetration should be fire-stopped so that the fire resistance of the penetrated component is not reduced.

7.5.5 Cable joints

Cables should be installed without joints wherever practicable.

Where the use of a joint cannot be avoided, it should be housed in a junction box as described below:

a) all junction boxes, glands, seals, etc. should be suitable for the environment, number of cables and conductors and be installed in easily accessible locations;

b) each cable should be adequately supported and enter the junction box through a separate cable gland;

c) junction boxes, glands, seals etc. should withstand at least the same temperature and water application as the cable for which they are used;

d) junction boxes should be clearly labelled “Fire/Voice Alarm” in the local language(s);

e) opening of junction boxes should only be possible by use of a tool;

f) if a junction box is shared with other systems, the responsible parties (see 5.4) should agree this in writing and adequate mechanical and electrical segregation should be employed to ensure that correct operation of the VAS is not jeopardized.

7.5.6 Diversely routed cables

Cables that are diversely routed in order to reduce the risk of failure of the VAS in case of a fire should be installed so that a source of damage to one cable is unlikely to damage the other cable(s), for instance by installing them in separate building risers (e.g. A/B wiring, see 6.13.3).

7.5.7 Loop wired loudspeaker cables

In order to meet the recommendations of this Technical Specification, loudspeaker transmission paths may be wired in a loop. In this case, it may be necessary to provide methods of isolation to prevent a short-circuit fault on one part of a cable affecting another part of the cable.

7.5.8 Outdoor Cable installation

Where cables are installed outdoors it may be necessary to provide protection against:

a) lightning;

b) earth potential differences;

c) degradation of the protective sheath by sunlight.

When cable passes through an external wall or ceiling:

d) the hole should slope downwards to the outside to help prevent the entry of water and dust;

e) the hole should be sealed using a non-hygroscopic material.

7.5.9 Cable classifications for fire resistance

Unless required by local, regional or national regulations it may not be necessary to protect cables serving loudspeakers in the fire compartment where a fire is present because occupants will have already been alerted before the fire damages the cable. However, it is important to ensure that the VAS continues to operate in other parts of the building so that other occupants can receive emergency broadcasts.

Unless covered by local, regional or national regulations, where wiring systems pass from one fire compartment to another fire compartment, cables should be rated to withstand fire for at least 30 min accordance with EN 50200 (PH30).

7.6 Inspection and testing of wiring

On completion of wiring, or sections of wiring, the installer should carry out tests to ensure the integrity of cable insulation and adequacy of earthing. Usually, the tests on cables will be carried out with equipment disconnected and prior to completion of installation. Further tests should therefore be carried out on completion of installation as part of the commissioning process.

In some VAS, limits on circuit impedance or capacitance or both may be specified by the system manufacturer, in which case these measurements should also be carried out, either on completion of installation or at commissioning (see Clause 8).

The results of all tests should be recorded and made available to the organization responsible for commissioning the system.

7.7 Loudspeaker installation

Loudspeakers should be permanently mounted.

Each incoming and each outgoing conductor of the same potential should be connected to a separate securely fixed clamping facility. Tools or special equipment should be required to disconnect conductors.

NOTE Tools include screwdrivers and special equipment includes ladders but not chairs.

Conductors should be supported and connected so that there is no undue mechanical stress on the conductors or the terminations to which they are connected.

7.8 Inspection and testing of loudspeaker circuits

It is good practice to carry out tests and adjustments, especially to loudspeakers and other components mounted in inaccessible places, while access equipment is in place.

Loudspeaker transmission paths should be tested before and after connection of loudspeakers and adjustment of loudspeaker taps or settings, if provided. It should be ensured that the load of each loudspeaker transmission path does not exceed the amplifier power available and the final load should be recorded in order to assist with commissioning, fault-finding and system modifications.

The following tests should be carried out, unless there is specific agreement that they will form part of the commissioning process:

NOTE This process is commonly referred to as pre-commissioning.

— the 1 kHz impedance of every loudspeaker circuit;

— the consistent polarity of loudspeakers in the same ADA;

— any other tests specified by the designer of the system.

The results of all tests should be recorded and made available to the organization responsible for commissioning the system.

7.9 Documentation

The installer should provide as-installed drawings to the purchaser showing the position of the VAS components, cables, junction boxes, etc. (see 8.3 d)) Connection diagrams of components including junction boxes should be included. The records should be permanent and suitable for convenient reference.

The installer should supply the purchaser with an installation certificate (see A.2) and a logbook (see A.8).

8 Commissioning

8.1 General

The aim of the commissioning process is to bring the VAS into operation and demonstrate that it meets the requirements documented in 5.6.

Any person responsible for commissioning the VAS should be appropriately qualified and possess a thorough knowledge of this Technical Specification, especially Clauses 6, 7 and 8.

Commissioning may be observed by, and form the basis for approval by a third-party (see Clause 10).

8.2 Responsibility

Responsibility for compliance of the installed VAS with the specification and the documentation of Clause 6 rests with the person or organization that signs the commissioning certificate (see A.3).

If the compliance of the installed VAS with the specification and the documentation of Clause 6 is to be verified by a third-party, responsibility for ensuring that the commissioning is carried out correctly rests with the person or organization that signs the verification certificate (see A.4).

8.3 Prerequisite documentation

The following should be provided:

a) the original specification;

b) a schedule of agreed variations from the original specification and from the recommendations of this Technical Specification;

c) certificates for design (see A1) and installation (see A2);

d) as-installed drawings of the VAS showing locations of all equipment including, but not limited to:

   1) fire detection and alarm system interface(s);

   2) emergency microphone(s) (see 6.4.9) and ANS sensor(s) (see 6.13.4);

   3) a schedule of loudspeaker transmission paths showing loudspeaker model, tap settings, design load per loudspeaker transmission path, measured load per transmission path, end of line devices, short-circuit isolators and other equipment used for loudspeaker line monitoring or control;

   4) other audio inputs, manual controls and indicators;

   5) types, sizes and routes of cables including details of cable identification and mains distribution arrangements.

The cable routes shown should be sufficiently accurate to allow them to be found for the rectification of faults.

NOTE In some complex buildings a cabling schedule cross-referenced to the drawings may be necessary to explain the cable routes.

8.4 Commissioning

8.4.1 General

The commissioning engineer(s) should make a thorough visual inspection to ensure:

— that the installation has been carried out in a satisfactory manner;

— that the methods, materials and components used comply with this Technical Specification;

— that records, drawings and operating instructions match the installed VAS.

8.4.2 Design compliance and documentation

The commissioning engineer(s) should verify that the records, documents and instructions required in Clause 6 have been provided and are accurate.

The commissioning engineer(s) should verify that the installed VAS design and documentation complies with the specification (security level or category if applicable, intelligibility, number and extent of voice alarm zones, number and content of messages, provision of indicators and controls).

8.4.3 Installation verification

The commissioning engineer(s) should verify that installation complies with the requirements of Clause 6, in particular:

a) location of equipment;

b) transmission paths;

c) cabling, cable specifications and labelling.

8.4.4 VAS sound requirements

The commissioning engineer(s) should verify that VACIE operates according to the specification including:

a) all loudspeakers and loudspeaker cables are located correctly, are of the correct type and function correctly;

b) pre-recorded messages are installed and comply with the specification;

c) microphone(s) are of the correct type and function correctly;

d) for each emergency message or multi-lingual emergency message, the sound pressure level complies with the specification for each ADA;

e) adjustments to time-align broadcasts are carried out, if necessary, to achieve the required intelligibility.

f) for each emergency message or multi-lingual emergency message, the minimum speech intelligibility value for each ADA complies with the requirements of 6.5.

8.4.5 Measurement of intelligibility

Measurements should be performed according to the recommendations given in Annex C.

Speech intelligibility should be assessed at defined locations in each ADA (see C.2.2) and statistical analysis performed to calculate the STI rating according to the method described in C.2.3.

It is normally necessary to perform separate measurements in each ADA. However, where ADAs have identical acoustic characteristics (such as in hotel bedrooms), it may be acceptable to measure a single ADA of each type provided this is agreed by the responsible parties (see 5.4) and the AHJ.

NOTE 1 Where the measurement techniques specified in EN 60268–16 are not applicable, other methods may need to be used, subject to agreement of the AHJ.

The following recommendations should be satisfied for each ADA:

a) if the reverberation times at the time of measurement are different from those supplied for preparation of the design (e.g. because the building is empty but the design assumes that the building will be occupied), an appropriate correction needs to be applied to the measured STI values;

b) if the ambient noise levels at the time of intelligibility measurement are different from those supplied for preparation of the design (e.g. because the building is empty but the design assumes that the building will be occupied), an appropriate correction needs to be applied to the measured STI values;

c) if the emergency speech levels at the time of intelligibility measurement are different from those submitted for preparation of the design, (e.g. in order to minimize noise pollution) appropriate corrections need to be applied to the measured STI values.

NOTE 2 Items a) and b) above normally require advice from an expert in electro-acoustic design and may also need a calibrated simulation model to properly apply the necessary corrections.

8.4.6 VACIE

The commissioning engineer(s) should verify that the VACIE operating modes and settings are tested and comply with the specification, in particular the

a) functional controls and indicators;

b) automatic and manual controls;

c) interface with the fire detection and alarm system;

d) ancillary functions, inputs and outputs.

8.4.7 Hierarchical VAS commissioning

In addition to the tests listed in 8.4.6, demonstrate that all controls and indications operate as required by the system design.

In hierarchical VAS where a control centre is fundamental to the evacuation strategy, ensure that failure of a single transmission path does not result in loss of indications from or control of a subsidiary VAS.

8.4.8 Distributed VAS commissioning

In addition to the tests listed in 8.4.6, demonstrate that a single short circuit or interruption in any voice alarm transmission path between distributed cabinets of a VAS does not prevent the activation of a voice alarm condition for longer than 100 s following the occurrence of the fault

8.4.9 Tests and verification of correct operation

The commissioning engineer(s) should perform the following tests:

a) Perform functional tests for all emergency messages and alarm conditions and verify prioritizations.

b) In both quiescent and voice alarm conditions check that the mains and standby power supply capacity is large enough to meet the functional requirements.

Where the standby time has been reduced below the recommendations of 6.11 a) due to the provision of an auxiliary mains power supply(s), check that the auxiliary mains power supply is able to meet the functional requirements in both quiescent and voice alarm conditions.

Either:

a) Ensure that the standby batteries are fully charged.

Operate the VAS from standby power in quiescent mode for the duration specified, followed by the voice alarm condition for the duration specified. The VAS should operate correctly at all times.

Or:

b) Ensure that the standby batteries are sufficiently charged.

Measure the average current consumed in quiescent mode for at least 100 s, measure the average current in voice alarm mode for at least two cycles of the emergency message.

Calculate the standby battery capacity (see Annex E) and verify that the standby power supply capacity is adequate.

8.5 Documentation

Adequate instructions on use and routine testing of the installed system should be supplied to the responsible person. Advice on routine testing is given in 12.2.

The commissioning engineer should supply the purchaser with a signed commissioning certificate see A.3.

An operation and maintenance manual should be supplied that provides at least:

— a list of VAS components and diagram(s) showing their configuration;

— as-installed drawings of the VAS (see 8.3 d));

— documentation of the as-commissioned VAS to allow for comparison by maintenance staff;

— comparison of the original building design against the final building layout;

— Information on the intended use and operation of the VAS;

— detailed maintenance procedures including manufacturers' recommendations;

— copies of site-specific software and configuration files.

8.6 Operator instructions

Operator instructions should be located adjacent to emergency microphones and VACIE controls. These should be provided in the form best suited to the way in which they are to be used; for instance, a bound document, laminated cards, electronic display, equipment labelling or any combination of these.

The operator instructions should be updated after additions or modifications to the VAS, or on the basis of practical experience, or of revised procedures.

In order to remind operators how to use the microphones correctly, a pictogram may be placed immediately adjacent to the emergency microphone showing the optimum talker-to-microphone distance (see Figure 1 and Figure 2).

Dimensions in millimetres

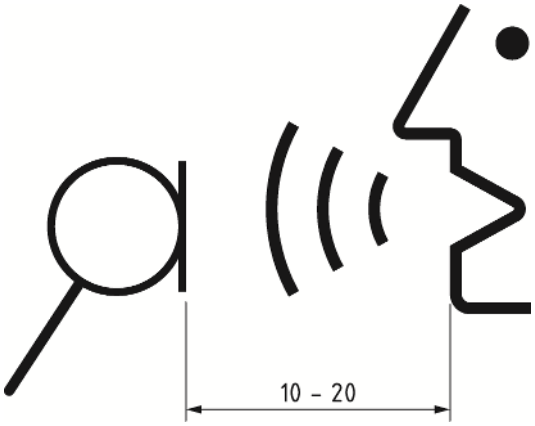

Figure 1 — Example of pictogram for a standard microphone to mouth distance

Dimensions in millimetres

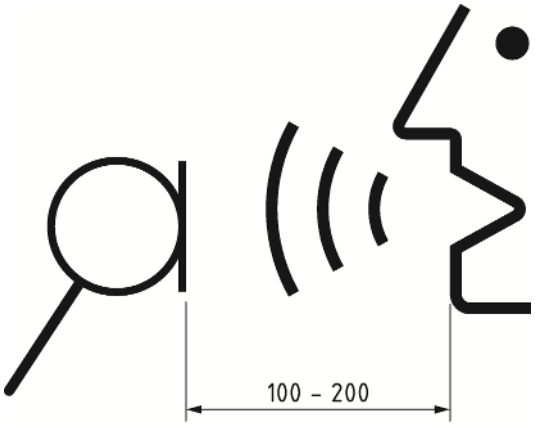

Figure 2 — Example of pictogram for a close-talking microphone to mouth distance

It should be noted that VAS operators are often non-technical and need appropriate operating instructions.

9 Verification

9.1 General

Where a purchaser considers that there is significant potential for the installed VAS to deviate from this Technical Specification, verification of conformity should be arranged.

The verifying organization may be one of those involved in the design, supply, installation or commissioning processes (e.g. the system supplier or the designer) or an independent third-party.

NOTE Verification may be observed by and form the basis approval by a third-party (see Clause 10).

9.2 Responsibility

It is important that any person assigned to carry out the verification process is competent and experienced in the design of VAS conforming to this Technical Specification and with local, regional or national regulations and installation practices.

NOTE In the event that the verification process identifies areas of non-conformity, the purchaser might request a further verification of the affected areas after correction.

The scope and extent of the verification process should be agreed between the purchaser and the organization responsible for verification.

9.3 Documentation

On completion, a verification certificate should be issued (see A.4). The verification certificate should also contain a report on the scope and extent of the verification carried out or identify where this information is available.

10 Third-party approval

10.1 General

If required, third-party approval will usually be based on an initial inspection; together with continuing periodic inspections to ensure that the VAS has been correctly used, maintained and, where necessary, modified.

10.2 Approval by authorities having jurisdiction and others

10.2.1 Authorities having jurisdiction - AHJ

Different local, regional or national regulations may exist. In general, VAS complying with this Technical Specification and using equipment approved by third-parties will meet the requirements of an AHJ, but it may also require its own inspection be carried out.

10.2.2 Insurance organizations

The requirements of fire insurance organizations or fire departments may have local, regional or national variations, which are usually laid down in their own documents. These requirements will specify any needs for direct involvement by insurance organizations or fire departments in the inspection of the installed VAS.

10.2.3 Approval by more than one body

In the event that the requirements of two approval bodies are incompatible, then consultation (see 5.4) should take place prior to installation in order to resolve and record the outcome.

10.3 Approval procedures

10.3.1 General

It is the responsibility of the AHJ to inform the installer of the various stages at which inspection and testing of the VAS being installed will be required. Particular note should be made of inspection or testing that for any reason cannot be carried out on the completed installed VAS. It is the responsibility of the installer to inform the approval body when each stage is reached.

10.3.2 Inspection and testing

The inspection may be carried out by the AHJ or by another approval body acceptable to the AHJ.

The approval organization should specify the parts of the installed VAS to be inspected or tested.

10.3.3 Testing of operation

The test schedule required for approval should be agreed between the purchaser or his representative, the installer, and the AHJ.

Where the testing will involve signals being sent to ancillary services or equipment, precautions should be taken to ensure that test signals do cause unintended results, such as the unwanted evacuation of building occupants.

The AHJ may require that the VAS has been in operation under normal conditions of use for a period agreed by the responsible parties (see 5.4) before final approval is given.

10.3.4 Intelligibility

Intelligibility should be assessed as described in 8.4.5.

10.3.5 Documentation

The approval body should provide a signed certificate of approval of the installed VAS, which may be based on the verification certificate (see A.4). Where variations from this Technical Specification have been agreed, the certificate should contain a list of the variations agreed by the responsible parties (see 5.4). A reference to this certificate should be given in the logbook (see A.8).

If the approval body decides that approval cannot be given, then a written notice of the deficiencies of the VAS should be given to the purchaser.

10.4 Periodic inspection by an approval body

10.4.1 General

The approval body may require periodic inspections to be made as a condition of continuing approval.

10.4.2 Documentation

A report of the periodic inspection should be given in writing to the responsible person. The inspection should be recorded in the logbook (see A.8).

Where changes are required as a result of an inspection, these should be notified in writing to the responsible person. The notification may specify a time limit for the completion of these changes, and may reserve the right to re-inspection after completion.

If the approval body decides that approval should be withdrawn because of deficiencies of the VAS, then a written notice of those deficiencies should be given to the responsible person.

11 Acceptance

Before accepting the VAS, the purchaser (or appropriate representative of the purchaser) should ensure, at least, that:

a) all installation work appears to be satisfactory;

b) the VAS is capable of giving intelligible broadcasts throughout the area of coverage;

c) the following documents have been provided to the purchaser:

   1) operation and maintenance manuals including “as installed” drawings (see 8.3 d));

   2) certificates of design, installation and commissioning (see A.1, A.2 and A.3);

   3) a logbook to record the periodic testing of the VAS (see A.8);

   4) a certificate of third-party approval (if required);

d) sufficient representatives of the purchaser or user have been adequately trained in the operation of the VAS, including, at least, all means of broadcasting emergency signals and the correct use of emergency microphones (if installed);

e) the purchaser's nominated responsible person has been advised of their responsibilities and how these might be discharged;

f) all tests defined in the purchase specification have been witnessed, where required;

As evidence of acceptance, the purchaser should complete an acceptance certificate (see A.5).

12 Use

12.1 Responsibility

The purchaser or user should appoint one or more responsible persons to ensure that the VAS is tested and maintained in accordance with this Technical Specification, that appropriate records are kept and that staff are aware of their roles and responsibilities. The name(s) of the responsible person(s) should be recorded in the logbook (see A.8) and kept up to date. Some or all of the functions may be delegated by contract to another organization (such as an installation or maintenance organization).

Responsibilities include:

— ensuring that the VACIE is checked at least once every 24 h to confirm that no faults are indicated;

— ensuring that faults are rectified promptly;

— ensuring that arrangements are in place for testing and maintenance in accordance with Clauses 12 and 13;

— ensuring that the logbook (see A.8) is kept up to date and is available for inspection;

— establishing liaison between those responsible for changes in, or maintenance of, the building (including redecoration, etc.) to ensure that work does not create faults or compromise the performance of the VAS. If structural or occupancy changes occur or are planned, the responsible person should ensure that any changes to the VAS are considered at an early stage;

— ensuring that, when changes are made to the VAS, operating instructions and as-installed drawings (see 8.3 d)) are updated;

— ensuring that any spare parts agreed between the purchaser and the organization responsible for the maintenance of the VAS are held securely within the building and that they are listed and their storage location is recorded in the logbook;

— ensuring that spare parts that are used are replaced and the logbook updated to record this;

— laying down procedures for dealing with alarms, warnings and other events originating from the VAS;

— training people who are authorized to use the VACIE controls;

NOTE The level of training necessary will depend on the degree of manual control that is provided.

— training people who are authorized to make emergency announcements, especially in microphone technique;

— providing and maintaining emergency microphone operator instructions such as scripted emergency messages, in a prominent position;

— ensuring there are no obstructions that might hinder the transmission of sound from loudspeakers;

— maintaining a clear space of at least 0,5 m around and below each loudspeaker;

— ensuring that access to emergency microphones is not obstructed;

— ensuring that the VAS is suitably modified if changes of use or configuration of the building occur;

— ensuring that maintenance is carried out at the correct intervals;

— ensuring that the VAS is properly serviced after the occurrence of a fault, fire or other event that might adversely affect the system.

12.2 Periodic tests

Every week the responsible person should ensure that a portion of the VAS is tested so that the whole VAS is tested at least once per year. The test should be carried out at approximately the same time every week and occupants instructed to report any instance of poor intelligibility.

NOTE 1 Local, regional or national regulations may make different recommendations regarding periodic tests.

It is advisable that routine testing of the VAS with the emergency messages takes place at times of low occupancy. During occupied times a test message may be used to allow people to report areas of low intelligibility. The VAS may also be tested at random times to test the emergency management plan.

Periodic tests should be carried out as follows:

a) VAS that can be triggered by a fire detection and alarm system should be tested by operating a manual call point associated with the fire detection and alarm system and ensuring that the correct emergency message is broadcast in the correct emergency loudspeaker zone(s) according to the cause and effect plan;

NOTE 2 It is not sufficient to test emergency messages from controls at the VACIE alone.

b) where installed, and depending on the extent of the controls provided, emergency microphone(s) should be checked for correct operation including tests of voice alarm zone selection and emergency message selection controls as follows:

    1) a message should be broadcast to advise occupants that a test is about to commence and that no action is necessary;

    2) check that a live emergency message is broadcast correctly in at least one voice alarm zone;

    3) check that a pre-recorded emergency message, where provided, can be selected and broadcast correctly in at least one voice alarm zone;

    4) after the test, another broadcast should advise that the test is over and that action should be taken on all future announcements.

NOTE 3 The “test over” announcement may also ask that any lack of intelligibility is reported to the building management.

c) Where the emergency management plan requires live scripted announcements to be made, the responsible person should ensure that all VAS operators practise making these announcements at least once a year.

NOTE 4 These exercises may form part of on-going training for operators as part of the emergency management plan. Operator shift patterns may need to be altered to accommodate training and practice announcements for every operator.

12.3 Repair

In the event of

a) any fault indication or malfunction of the VAS,

b) any suspicion of a malfunction of the VAS (for example after a fire),

c) damage to any part of the VAS,

d) any malfunction that has been identified during maintenance,

the responsible person should arrange for the repair of the VAS at the earliest opportunity. Depending on the nature of the fault or malfunction, it may be necessary to implement additional safety measures or restrict access to the building.

12.4 Logbook

The logbook should be kept in a place accessible to authorized persons (preferably at or near the controls of the VACIE). A record should be kept in this logbook of all events concerning the VAS including test results.

A suggested form of logbook is given in A.8.

13 Maintenance

13.1 General

Periodic inspection and servicing is essential to ensure that any unmonitored faults are identified; that preventive measures can be taken to ensure the continued reliability of the VAS, and that the responsible person is made aware of any changes that may affect the protection afforded by the system.

The VAS should be regularly maintained by an organization that is certified or authorized to carry out maintenance of the VAS. Maintenance should start immediately on completion of the installation whether the building is occupied or not.

13.2 Responsibility

The responsible person should ensure that maintenance is carried out and continues to be carried out correctly.

If any part of the VAS will be unable to enter the voice alarm condition due to maintenance or repair, the affected area should either be closed to untrained occupants and the remaining trained occupants given alternative means of warning such as secure radio. If the building remains open, alternative means of evacuation should be provided such as additional trained staff with secure radio and loud-hailers at strategic locations.

13.3 Documentation

A documented plan should be created for maintenance and retesting of the VAS as recommended by the VAS designer in conjunction with the equipment manufacturer. This should be carried out by a competent person or organization at least twice a year.

NOTE Local, regional or national regulations may make different recommendations regarding periodic maintenance and retesting.

The plan should give details of all work required to maintain the VAS in working order, consistent with the specified performance criteria and any other requirements of this Technical Specification and of local, regional or national regulations.

The plan should identify the components that require maintenance (see 12.4), referring to their locations on drawings, together with manufacturers' reference numbers and correspondence details of suppliers of materials and parts.

The plan should include:

a) instructions that the logbook (see A.8) should be examined and that any recorded faults should be investigated and repaired;

b) the method(s) of maintenance;

c) any sequence related to maintenance;

d) a set of as-fitted drawings (see 7.9).

e) at least one set of manuals for equipment and materials;

f) a list and locations of spare parts held on site;

g) a list and location of special tools held on site;

h) copies of certificates as required by the AHJ.

Work carried out on the VAS should be recorded in the logbook. Explanatory details should either be recorded in the logbook (see A.8) or recorded separately and held with the system documentation. A maintenance report should be provided to the responsible person and recorded in the logbook. Any identified deficiencies of the VAS or changes to the building that affect the effectiveness of the VAS should be notified to the responsible person.

13.4 Prevention of unwanted activation

It is important that maintenance work does not result in unwanted activation of fire protection equipment. If a link is provided to other fire protection equipment then either the link or the other equipment should be disabled for the duration of the test, unless the test is also intended to be a test of the other equipment.

Where the VAS will automatically operate other equipment, such as muting of other sound systems, occupants should be informed in advance.

13.5 Spare parts

Any spare parts that are held on site should be kept in good condition and replaced as necessary. The provision of spares on site is normally governed by the contract.

Components that have failed and cannot be repaired should normally be replaced with identical components. If this is not possible and alternative components have to be used, this should be agreed with the responsible person and third-party inspection body (if required) and after their installation the system should be subject to verification and/or testing as agreed with the responsible person and third-party inspection body (if required).

13.6 Maintenance at intervals not exceeding 6 months

NOTE 1 Local, regional or national regulations may make different recommendations regarding maintenance intervals.

a) a visual inspection should be made to check whether structural or occupancy changes have affected the siting or orientation of loudspeakers. In particular, verify whether:

   1) any new or relocated partitions have been erected that affect intelligibility and audibility;

   2) any changes to the use or occupancy of an area makes the existing loudspeaker design unsuitable, e.g. due to an increase in ambient noise;

   3) any building alterations or extensions may require the installation of additional loudspeakers and associated voice alarm equipment;

b) any structural or occupancy changes found should be reported to the responsible person so that corrective works can be commissioned;

c) the organization appointed to carry out corrective works should be competent in electro-acoustic design. Following modification, the VAS should be re-commissioned to the extent agreed by the responsible parties (see 5.4) and, all documentation brought up to date to reflect the new status and a modification certificate issued (see A.7);

NOTE 2 The organization carrying out maintenance of the VAS may not be competent to carry out electro-acoustic design required for corrective works that involve loudspeakers.

d) clean all cabinets and components, taking care to avoid injury due to dangerous measures (e.g. wet cloth). If moisture is found inside cabinets, the source should be identified and the problem rectified;

e) moving electro-mechanical parts such as fans should be cleaned and checked for proper operation. In the case of automatic cooling fans it may be necessary to heat a sensor to verify correct operation;

f) VAS equipment can generate significant amounts of heat, resulting in thermal changes that can cause movement and so internal cables and connectors should be checked for proper physical connections;

g) all emergency microphones should be visually examined for damage and tested to check that areas that are selected receive an intelligible broadcast;

h) at least one automatic fire alarm initiation input should be operated to check that the correct messages are broadcast to the correct voice alarm zones and they are audible and intelligible. Sound pressure levels should be recorded in the logbook (see A.8) and compared to previous test results carried out at the same locations;

i) apply a suitable audio signal to the loudspeaker transmission path(s) and check each loudspeaker for clear distortion-free sound of adequate loudness;

j) if installed, any associated ANS should be checked for correct operation;

k) the mains power supply should be disconnected to check that the VAS continues to operate correctly, when powered from the standby power supply, under full alarm load and that fault warnings are correctly indicated;

l) the standby power supply should be disconnected, checking that the VAS continues to operate correctly when powered from the mains power supply, under full alarm load and that fault warnings are correctly indicated;

m) the ambient battery temperature should be measured before battery cabinets are opened by use of a probe or other effective method and the average temperature to which each battery has been subjected since installation should be calculated;

n) the date of installation of batteries should be checked against the battery life recommended by the supplier and replacement batteries installed if appropriate;

o) batteries and their connections should be examined to check that they are in a serviceable condition and not likely to fail before the next inspection;

p) vented batteries, where used, should be examined and serviced to ensure that the specific gravity of each cell is correct. Electrolyte levels should be checked and topped up as necessary;

q) all controls and indicators at control and indicating equipment should be checked for correct operation;

r) all fault indicators and their circuits should be checked, where practicable, by simulation of short-circuit, open-circuit and, if applicable, earth fault conditions;

s) all ancillary functions of the control and indicating equipment should be tested;

t) all further checks and tests recommended by the manufacturer of the VAS and other components of the VAS should be carried out.

13.7 Maintenance at intervals not exceeding 12 months

NOTE 1 Local, regional or national regulations may make different recommendations regarding maintenance intervals.

All automatic fire alarm initialization inputs should be operated to check that the correct messages are broadcast to the correct areas and are intelligible. Sound pressure levels should be recorded in the logbook (see A.8) and compared to previous test results carried out at the same locations;

NOTE 2 The work described might be carried out over the course of two or more service visits during each 12-month period.

All loudspeakers should be checked for correct operation and, where appropriate, orientation;

a) if applicable, the cause and effect of the phased evacuation programme should be confirmed as being correct;

b) manual initialization of all pre-recorded emergency messages should be checked for correct operation in accordance with 6.4.10;

c) all loudspeakers should be visually examined for damage;

d) a visual inspection should be made to confirm that all readily-accessible cable fixings are secure and undamaged;

e) the impedance of each loudspeaker transmission path should be measured. The ambient noise at the loudspeakers should be low to ensure correct measurement. The results should be compared against the last recorded values and if the deviation exceeds 5 % check if loudspeakers have been added, removed, or tappings have been changed. Such changes should have already been recorded in the VAS documents;

NOTE 3 It is normal for impedances of newly installed loudspeakers to change.

The measurement should be carried out long enough after the last broadcast that the voice coil temperature has cooled to the environmental temperature. A typical 6 watt loudspeaker requires 5 min, and a high-power loudspeaker 30 min to cool down.

f) all further annual checks and tests recommended by the manufacturer of the VACIE and other components of the VAS should be carried out.

Any outstanding defects should be reported to the responsible person and entered in the logbook (see A.8).

On completion of the work, a signed maintenance certificate should be issued (see A.6).

13.8 On appointment of a new maintenance organization

The new maintenance organization should carry out an inspection of the VAS and its documentation and produce a plan for effective maintenance of the VAS for agreement with the responsible person and third-party inspection body (if required).

Faults and areas of non-compliance with this Technical Specification and with local, regional and national regulations should be documented and identified to the responsible parties (see 5.4) and remedial action agreed.

NOTE Not all non-compliances may need to be rectified; this is for the responsible person to determine, based on the advice of the maintenance organization, the third-party inspection body (if required), the insurer and any third-party advisers engaged by the responsible person.

13.9 After a fire

a) Every transmission path, voice alarm loudspeaker, emergency microphone and visual warning device that might have been affected by the fire should be inspected and tested in accordance with 13.7 and 13.8.

b) A visual examination and suitable tests should be carried out on any other part of the VAS that lies within the fire area and other areas affected by corrosive smoke from the fire and that might have been damaged by the fire (e.g. power supplies, VACIE and cables). Where there is evidence of damage, suitable action should be taken.

c) Circuits external to the VACIE that might have been affected by the fire should be tested for correct operation.

d) On completion of the work, any defects found should be recorded in the logbook (see A.8), and the responsible person notified accordingly.

14 Modification or extension

14.1 General

All modifications (whether extensions or alterations) to the installed VAS should be agreed with the responsible parties (see 5.4).

14.2 Responsibility

Responsibility for modification of the VAS in compliance with the specification and the documentation from Clause 14 rests with the person or organization that signs the modification certificate (see A.7).

14.3 Third-party approval

Where the installed VAS is the subject of approval by a third-party, they should specify the rules governing which types or extents of modification require further inspection. If a modification requires verification by the approval body they should be informed in writing.

14.4 Extent of compliance

Where the installed VAS is not the subject of approval by a third-party or local, regional or national regulations, the following should apply:

a) if the installed VAS was designed to this Technical Specification, any modification should be such that the resulting installed VAS still complies with this Technical Specification;

b) if the installed VAS was designed and installed to a different standard, modification should not increase the degree of non-compliance with this Technical Specification within the area initially covered, and the following should apply:

    1) modifications to field devices, such as adding or replacing loudspeakers that do not require modification of the VACIE, should comply with the requirements of the Technical Specification to which the VAS was originally installed;

    2) modifications that require changes to the VACIE, including end-of line devices, isolators and other equipment for loudspeaker line monitoring or control, should comply with the requirements of this Technical Specification (see 13.5).

14.5 Documentation

Modifications carried out on the installed VAS should be recorded in the logbook (see A.8) and the documentation should be updated.

Annex A
(informative)

Model documents

This annex gives models for:

— Design certificate;

— Installation certificate;

— Commissioning certificate;

— Verification certificate (optional) ;

— Acceptance certificate;

— Maintenance certificate;

— Modification certificate;

— Logbook.

Although the various certificates are shown separately, it is permissible (and may be desirable) for them to be combined into one or more documents, or to be bound into the logbook (see A.8).

A.1 Design certificate

Certificate of design of Voice Alarm System (VAS) at:

Address and post code: .....

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.....

I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the design of the VAS, particulars of which are set below, CERTIFY that the said design for which I/we have been responsible conforms to the best of my/our knowledge and belief with CEN/TS 54-32:2015, Clause 6 except for the variations, if any, stated in this certificate.

Name (in block letters): ..... Position: .....

Signature: ..... Date: .....

For and on behalf of: .....

Address and post code: .....

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Variations from the recommendations of CEN/TS 54-32:2015, Clause 6

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Extent of system covered by the certificate:

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Installation and commissioning

It is strongly recommended that installation and commissioning be undertaken in accordance with CEN/TS 54-32:2015, Clause 7 and 8

Verification

If required, verification that the system conforms to CEN/TS 54-32:2015 should be carried out, on completion, in accordance with CEN/TS 54-32:2015, Clause 9.

Yes ☐ No ☐ To be decided by the purchaser ☐

Maintenance

It is strongly recommended that, after completion, the system is maintained in accordance with CEN/TS 54-32:2015, Clause 13.

User responsibilities

The user should appoint a responsible person to supervise all matters pertaining to the system in accordance with CEN/TS 54-32:2015, Clause 12.

A.2 Installation certificate

Certificate of installation of the Voice Alarm System (VAS) at:

Address and post code: .....

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I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the installation of the VAS, particulars of which are set below, CERTIFY that the said installation for which I/we have been responsible conforms to the best of my/our knowledge and belief with CEN/TS 54-32:2015, Clause 7, except for the variations, if any, stated in this certificate.

Name (in block letters): ..... Position: .....

Signature: ..... Date: .....

For and on behalf of: .....

Address and post code: .....

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The extent of liability of the signatory is limited to the system described below.

Extent of system covered by the certificate:

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Specification against which the system was installed:

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Variations from the specification and/or CEN/TS 54-32:2015, Clause 7)

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Wiring has been installed and tested in accordance with CEN/TS 54-32:2015, 7.5. Test results have been recorded and are provided on the appended electrical installation certificate:

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Unless supplied by others, the as-installed drawings have been supplied to the person responsible for commissioning the system [see CEN/TS 54-32:2015, 7.9].

A.3 Commissioning certificate

Certificate of commissioning for the Voice Alarm System (VAS) at:

Address and post code: .....

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.....Postcode: .....

I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the commissioning of the VAS, particulars of which are set below, CERTIFY that the said installation for which I/we have been responsible conforms to the best of my/our knowledge and belief with CEN/TS 54-32:2015, 7.6 and 7.8, except for the variations, if any, stated in this certificate.

Name (in block letters): .....Position: .....

Signature:..... Date: .....

For and on behalf of:.....

Address and post code: .....

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The extent of liability of the signatory is limited to the system described below.

Extent of system covered by the certificate:

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Variations from CEN/TS 54-32:2015, 7.6 and 7.8

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☐ All equipment operates correctly.

☐ Installation work is, as far as can be reasonably ascertained, of an acceptable standard.

☐ The entire system has been inspected and tested in accordance with CEN/TS 54-32:2015, 7.6 and 7.8

The system performs as required by the specification prepared by:

.....

a copy of which I/we have given.

☐ The documentation described in CEN/TS 54-32:2015, Clause 8 has been provided to the user.

The following work should be completed before/after (delete as applicable) the system becomes operational:

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A.4 Verification certificate (optional)

Certificate of verification for the Voice Alarm System (VAS) at:

Address and post code: .....

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I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the verification of the VAS, particulars of which are set below, CERTIFY that the verification work for which I/we have been responsible conforms to the best of my/our knowledge and belief with CEN/TS 54-32:2015, Clause 9.

Name (in block letters): ..... Position: .....

Signature: ..... Date: .....

For and on behalf of: .....

Address and post code: .....

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The extent of liability of the signatory is limited to the system described below.

Extent of system covered by the certificate:

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Scope and extent of the verification work:

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☐ In my/our opinion, as far as can reasonably be ascertained from the scope of work described above, the system conforms to, and has been commissioned in accordance with CEN/TS 54-32:2015, other than in respect of variations already identified in the certificates of design, installation or commissioning.

The following non-conformities with CEN/TS 54-32:2015 have been identified (other than those recorded as variations in the certificates of design, installation or commissioning):

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A.5 Acceptance certificate

Certificate of acceptance for the Voice Alarm System (VAS) at:

Address and post code: .....

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.....Postcode: .....

I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the acceptance of the VAS, particulars of which are set below, ACCEPT the system on behalf of:

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Name (in block letters): .....Position: .....

Signature:..... Date: .....

For and on behalf of:.....

Address and post code: .....

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The extent of liability of the signatory is limited to the system described below.

Extent of system covered by the certificate:

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☐ All installation work appears to be satisfactory.

☐ The system is capable of providing an audible and intelligible voice communication.

The following documents have been provided to the purchaser or user:

☐ As-installed drawings.

☐ Operating and maintenance instructions.

☐ Certificate of design, installation and commissioning.

☐ A logbook (see A.8).

☐ Representatives of the user have been properly instructed in the use of the system, including, at least, operation of master stations and outstations and fault identification.

☐ All relevant tests, defined in the purchasing specification, have been witnessed. (Delete if not applicable.)

The following work is required before the system can be accepted:

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A.6 Maintenance certificate

Certificate of maintenance for the Voice Alarm System (VAS) at:

Address and post code: .....

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I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the maintenance of the VAS, particulars of which are set below, CERTIFY that the said installation for which I/we have been responsible conforms to the best of my/our knowledge and belief with CEN/TS 54-32:2015, Clause 13, except for the variations, if any, stated in this certificate.

Name (in block letters): ..... Position: .....

Signature: ..... Date: .....

For and on behalf of: .....

Address and post code: .....

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The extent of liability of the signatory is limited to the system described below.

Extent of system covered by the certificate:

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Variations from CEN/TS 54-32:2015, 7.6 and 7.8:

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☐ Relevant details of the work carried out and faults identified have been entered in the system logbook (see A.8).

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A.7 Modification certificate

Certificate of modification for the Voice Alarm System (VAS) at:

Address and post code: .....

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.....Postcode: .....

I/we being the competent person(s) responsible (as indicated by my/our signatures below) for the modification of the VAS, particulars of which are set below, CERTIFY that the said installation for which I/we have been responsible conforms to the best of my/our knowledge and belief with CEN/TS 54-32:2015, 7.6 and 7.8, except for the variations, if any, stated in this certificate.

Name (in block letters): .....Position: .....

Signature:..... Date: .....

For and on behalf of:.....

Address and post code: .....

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The extent of liability of the signatory is limited to the system described below.

Extent of system covered by the certificate:

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Variations from CEN/TS 54-32:2015, 7.6 and 7.8:

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☐ Following the modifications, the system has been tested in accordance with CEN/TS 54-32:2015, 7.6 and 7.8. Test results have been recorded and are provided on the appended electrical installation certificate.

☐ Following the modifications, as-installed drawings and other system records have been updated as appropriate.

I/we the undersigned confirm that the modifications have introduced no additional variations from CEN/TS 54-32:2015 other than those recorded above:

Signed: .....

Capacity: .....

(e.g. maintenance organization, system designer, consultant or user representative)

A.8 Logbook

A logbook should be kept to record the names of the responsible person and any delegates plus all events that occur in respect of the VAS, including, alarm signals, fault signals disablements, modifications and work on the system.

The logbook may be combined with the fire detection and alarm system logbook in which case this should be clearly indicated in the combined logbook.

The following information should be recorded in the logbook:

a) the name of the user's nominated responsible person;

b) any emergency broadcast not initialized by the fire detection and alarm system or manually from the VACIE;

c) details of the maintenance organization;

d) brief details of maintenance arrangements;

e) dates, times and types of all tests;

f) dates, times and types of all faults, disablements and defects;

g) dates and types of all maintenance (e.g. maintenance visit or non-routine attention).

The logbook may be prepared in a form of an easily-used check list.

Annex B
(informative)

VAS safety levels and categories

B.1 VAS safety levels

B.1.1 Reliability

If required by local, regional or national regulations, one of the following safety levels should be specified by the purchaser and the AHJ as part of the emergency management plan in order to ensure reliability of the VAS.

NOTE Reliability does not mean maintaining the functional integrity in the event of a fire.

The specification of a safety level is based on the possible hazard scenarios identified by the risk assessment such as the minimum and maximum number of trained and untrained occupants the building structure, number of floors, escape routes, escape route lengths, etc.

B.1.2 Safety level I

In the event of a fault in a transmission path (interruption, short-circuit or failure of equal effect) only the emergency message broadcast within one voice alarm zone in a single storey may fail.

This safety level permits the emergency message broadcast within a fire compartment to fail in the event of a fault in the transmission path. In practice, this means, that a loudspeaker transmission path has to be installed for each fire compartment and that suitable measures should be taken to ensure that failure of one transmission path does not affect another transmission path.

B.1.3 Safety level II

In the event of a fault in an amplifier or transmission path (open circuit, short circuit or failure of equal effect) the speech intelligibility according to the STI method in each voice alarm zone should not fall below 0,45.

In addition to the requirements for safety level I, this level requires the transmission paths to be arranged so that even in the event of a fault an intelligible emergency message will still be heard in the areas concerned. This may be achieved by means such as diversely routed cables (see 7.5.6) or loop wired loudspeaker cables (see 7.5.7). Thus, it is permissible for, e.g. one of two installed loudspeaker circuits to fail.

NOTE 1 If the voice alarm zone contains several rooms, these requirements apply to each room.

NOTE 2 Reliability of the transmission path may be achieved by, e.g. separate multicore cables for each circuit (e.g. A/B wiring, see 6.13.3) or by use of specially protected cables such as in conduits according to EN 61386-1 or underground cables connecting buildings.

B.1.4 Safety level III

In the event of a fault in the overall system the speech intelligibility according to the STI method in each voice alarm zone should not drop below 0,45.

In addition to the requirements for safety level II regarding the transmission paths, this level requires the installation of a fully redundant VACIE including emergency microphone.

NOTE 1 If the alarm area contains several rooms, these requirements apply to each room.

NOTE 2 Reliability of the transmission path may be achieved by, e.g. separate multicore cables for each circuit (e.g. A/B wiring, see 6.13.3) or by use of specially protected cables such as in conduits according to EN 61386-1 or underground cables to connect buildings.

B.2 Category of VAS

B.2.1 General

VAS can be used in a wide variety of applications, from small shops and places of assembly through to large stadiums, airports and industrial sites. Although it is important that the VAS is reliable, it is also important to ensure that the facilities provided are appropriate to the risk and are not unnecessarily complex or expensive to install or operate. In order to assist the designers in defining the specification a range of categories have been defined.

The categories are based on evacuation strategy, risk and level of staff competency and reflect the degree of manual control appropriate to the risk and to the availability of trained VAS operators. A category V4 system is not necessarily more effective than a category V1 system and may actually be dangerous if manual controls are used inappropriately.

B.2.2 Category V1: Automatic evacuation

The objective of a category V1 VAS is to offer automatic operation against a pre-programmed set of evacuation rules. The system may also have facilities for the manual selection and initiation of non-emergency messages, provided that these are automatically overridden by messages initiated from the fire detection and alarm system.

B.2.3 Category V2: Live emergency messages

A category V2 VAS provides the facility to broadcast live emergency messages by means of one or more all-call emergency microphone(s). It may also have the automatic facilities provided by a category V1 VAS.

The objective of a Category V2 VAS is to allow live announcements to be made.

B.2.4 Category V3: Zonal live emergency messages

A category V3 VAS provides, in addition to the functions of the category V2 VAS, the facility to broadcast live emergency messages in pre-determined voice alarm zones or groups of voice alarm zones. A category V3 VAS also has the ability to display the status of emergency broadcast messages that have been initiated by an emergency detection system(s).

The objective of a category V3 system is to permit evacuation control in specific areas of the building

B.2.5 Category V4: Manual pre-recorded message controls

In addition to the live emergency message control provided by a category V3 VAS, a category V4 VAS has the facility to select and direct pre-recorded emergency messages to individual voice alarm zones. A category V4 VAS also has the ability to disable or enable emergency broadcast messages that have been initiated by an emergency detection system(s) and display their status.

The objective of a category V4 system is to allow well-trained and disciplined staff to follow a pre-planned evacuation strategy when the automatic mode needs to be overridden.

B.2.6 Category V5: Engineered VAS

Category V5 applies where the application falls outside the scope of category V1 to V4, or wherever a prescriptive solution is either unsatisfactory or the designers believe that an alternative approach is more

suitable. It covers tailored solutions based on the assessment of special or changing risks and requires the responsible parties (see Clause 5.4) to accept full responsibility for their design.

B.2.7 Requirements of the AHJ

Where required by local, regional or national regulations any requirements imposed by the AHJ for the VAS should clearly state the category of system required.

B.2.8 Purchaser responsibilities

Where required by local, regional or national regulations the purchaser of the VAS should inform the designer of the VAS of the category of system that is required (e.g. in the purchase or tender specification).

If the designer has not been informed of the category of system required, the designer should make clear to the purchaser which category of system is proposed prior to an order for the system being placed.

In each of these situations the description of the system should be further clarified by adequate information on the areas of the building to be covered by the specific VAS category(s).

B.2.9 System design certificate

Where required by local, regional or national regulations the VAS design certificate (see A.1) should clearly state the category of VAS and provide a brief description of the areas of the building that are covered.

Annex C
(normative)

Measurement of speech intelligibility

C.1 Methods of measurement

C.1.1 General

The following methods of measuring speech intelligibility are considered in this Technical Specification.

NOTE Local, regional or national regulations may make different recommendations regarding requirements and measurement of speech intelligibility.

C.1.2 Speech Transmission Index (STI)

The speech transmission index, STI, is derived by calculation from measurements of the full modulation transfer function (MTF) standardized and described in EN 60268-16. A number of computer-based measuring systems offer this facility. The measurement of STI is based on gathering an impulse response of the system under test and is also termed the Schroeder method. The application of this method requires fundamental understanding of digital acoustic measurement technology

C.1.3 Speech Transmission Index for Public Address (STIPA)

The Speech Transmission Index for Public Address systems, STIPA, is an index obtained by using a condensed version of the MTF and is standardized and described in EN 60268-16. A number of hand-held measuring systems offer this facility. The measurement of STIPA is performed with modulated noise signals, and is also termed the direct method. It requires less skill than the Schroeder method.

C.1.4 Other methods

Other methods of assessing intelligibility, such as RASTI or STITEL, are not suitable for measuring the intelligibility of VAS.

C.2 Measurement procedure

C.2.1 Choice of measurement method

Select a method of measuring speech intelligibility as described in C.1.

The selection of the method should take into account its inherent limitations as given in EN 60268-16.

C.2.2 Measurement points

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 should be greater than or equal to the number required in Table C.1;

b) the distance between adjacent measurement points should reflect the evenness of the sound coverage;

c) the measurement points should be evenly distributed throughout the ADA with no preference for good or bad locations;

d) no more than one third of the points should be located on the axis of any loudspeaker;

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

f) take into account any points highlighted during the risk-assessment.

Table C.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
1 500 to less than 2 500	15
Greater than 2 500	15 per 2 500 m^2

C.2.3 Calculation of the STI rating

In order to determine the STI rating for an ADA, the following rules apply:

a) Any continuous areas of the ADA that are smaller than 10 m^2, such as alcoves, may be excluded from the analysis and need not to be assessed.

b) 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. For smaller ADAs with fewer than 10 measurement points, no samples should be discarded.

c) From the remaining samples, calculate the arithmetic mean and note the minimum value. Both should meet or exceed the respective requirements given in 6.5.4.

C.2.4 Ambient noise

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

If this is not possible, for instance, because the building is at the planning stage or because it is not yet occupied the STIPA signal should be at least 10 dB above the predicted level (see 5.6.3 c) iii). Guidance for post-processing the 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 should be measured as an L_{eq} over a representative time period.

C.2.5 VAS conditioning

Place the VAS into the voice alarm condition.

In order to ensure that the VAS is operating as it will during a real evacuation, ensure the whole VAS remains operational throughout the test.

Where phased evacuation is used, the VAS may not be configured to broadcast alarm signals to all voice alarm zones simultaneously, however for the purposes of measurement, the VAS loading should be that which will occur in an emergency. In an occupied building, where the operational functioning of the building would be compromised if the whole VAS was broadcasting for more than a short period, it may be more practical to use artificial loads in some voice alarm zones.

C.2.6 Test signal

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

Where it is not practical to apply a continuous 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 emergency speech level, the applied test signal spectrum needs to be determined in all octave bands from 125 Hz to 8 kHz for each measurement location so that the STI result can be post-processed to account for the differences in level. Guidance 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 voice alarm zones, the actual status of the VAS 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 voice alarm zones.

C.2.7 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 kHz in dB with reference to 20 µPa at each measurement point;

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

d) method of intelligibility measurement, STI or STIPA;

e) intelligibility value at each measurement point;

f) intelligibility result within the ADA as determined according to C.2.3;

g) unweighted test signal spectrum in octave bands from 125 Hz to 8 kHz 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 reference ambient noise level, 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 emergency speech level, 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 D
(informative)

Guidance for Prescriptive Loudspeaker Design

D.1 Decibels (dB)

The human ear can perceive a very wide range of loudness or sound-pressure variation. The quietest sound a normal human ear can detect has a pressure variation of 20 micro-pascals, (μPa) which is defined as the threshold of hearing. However, the pressure variation close to a very noisy event such as the launching of a space rocket can produce a large measurement of about 2 000 000 000 μPa.

In order to make measurement and calculation easier to manage, a logarithmic decibel scale is used instead of the linear pascal scale and the threshold of hearing (20 μPa) is defined as the reference level, 0 dB.

This is also convenient because human perception of the intensity of sound is more nearly proportional to the logarithm of sound pressure than to the sound pressure itself so the dB scale is useful to describe perceptual levels or level differences.

For the purposes of this Technical Specification it is important to know that in order to get a barely noticeable 3 dB increase in power output from a loudspeaker, it is necessary to put in twice as much power from an amplifier. In order to get a 10 dB increase in power output from a loudspeaker (which will sound approximately twice as loud) it is necessary to put in 10 times as much power from an amplifier.

Increasing amplifier power at low levels, such as from 5 watts to 10 watts may not be a problem. However, to get the same increase at high sound-pressure levels may require increasing amplifier power from, for example, 1000 watts to 2000 watts for the listener to discern an increase in sound level. This is likely to be expensive, especially as the mains and standby power supplies will have to be enlarged to suit.

D.2 Sensitivity

Sensitivity is a measure of efficiency similar to fuel consumption of a vehicle and describes how much sound energy a loudspeaker will produce for each watt of input power. In order to enable comparison, loudspeakers are rated in terms of how much SPL they produce at a distance of 1 metre when 1 watt is fed to them. Thus, if a loudspeaker is rated as 90 dB 1 W/1 m, putting a 1 watt signal in will result in a 90 dB measurement at 1 metre.

NOTE This is significantly more than a loudspeaker rated at 87 dB 1 W/1 m because this needs twice as much power to generate the same sound level.

D.3 Coverage angle

EN 54-24 defines the coverage angle of a loudspeaker as the smallest angle between two directions on either side of the reference axis [normally perpendicular to the loudspeaker] at which the sound pressure level is 6 dB less than the sound pressure level on the reference axis. This angle is measured in the vertical and horizontal planes and for many types of loudspeakers the figures will be the same.

D.4 Frequency Response

The frequencies reproduced by the loudspeaker measured in Hz (cycles per second). The human ear can hear between 20 Hz to 20 kHz with varying degrees of sensitivity but for intelligible speech, the useful range is from 125 Hz to 8 kHz.

D.5 Maximum Sound Pressure Level

The maximum SPL (SPL_{max}) a loudspeaker can produce at 1 metre is determined by the sensitivity and power handling of the loudspeaker.

SPL_{max} = sensitivity + 10 × log (max power handling)

EXAMPLE For a loudspeaker with a sensitivity of 90 dB per watt per metre and a power handling of 6 watts, the maximum SPL at 1 m = 90 dB + 10 × log 6 dB = 90 dB + 7,8 dB = 97,8 dB.

D.6 Loudspeaker Types

D.6.1 General

Although there are many types of loudspeakers, the following types are most suitable for use with the prescriptive design method:

— Ceiling loudspeaker;

— Surface mounted (box) loudspeaker;

— Bi-directional loudspeaker;

— Column loudspeaker;

— Horn loudspeaker.

D.6.2 Ceiling loudspeaker

Typical ceiling loudspeakers have a coverage angle that reduces with frequency, (typically 140° at 250 Hz dropping to 40° at 10 kHz).

Good coverage of an ADA can be obtained when ceiling loudspeakers are spaced on a square grid at a pitch of twice the ceiling height, up to a limit of 6 m apart. Using a pitch greater than 6 m will usually result in loss of intelligibility because the narrow coverage angle of higher frequencies results in gaps in coverage. For more even coverage, the square grid can be replaced by a hexagonal grid, which removes the overlap gaps in the square grid, but uses more loudspeakers.

D.6.3 Surface mounting loudspeaker

The performance of surface-mounting loudspeakers is similar to that of ceiling loudspeakers, and they are normally used on walls or where a ceiling cannot accept flush devices.

When used on a ceiling they should be treated in the same way as ceiling loudspeakers. When used on a wall and using the prescriptive design method, they should be mounted at a height of no more than 2,8 m and spaced no more than 6 m apart. Wall loudspeakers should not cover a corridor more than 3 m wide from one side of the corridor. Where A+B circuits are used in a corridor, it may be convenient to place the “A” loudspeakers at 12 m intervals on one wall and the “B” loudspeakers at 12 m intervals, offset by 6 m on the opposite wall.

In small rooms it is common to place a wall loudspeaker over the door, and a single loudspeaker will normally cover a room up-to 6 m by 6 m.

D.6.4 Bi-directional loudspeaker

This is a special type of surface mounting loudspeaker with drivers pointing 180 degrees away from each other designed for use in corridors. When used on a wall they should be mounted at a height of no more than

2,8 m and spaced no more than 12 m apart and should not cover a corridor more than 3 m wide from one side of the corridor.

D.6.5 Column loudspeaker

Column loudspeakers have a very useful property, the vertical coverage angle is very narrow, and the horizontal coverage angle is wide; which makes them ideal for use in large reverberant spaces such as churches and transportation halls. The narrow vertical coverage angle prevents the excitation of the unused reverberant space above the listeners, helping to reduce the reverberant sound in the space so improve intelligibility.

D.6.6 Horn loudspeaker

Horn loudspeakers are very efficient devices with a predictable coverage angle of which there are two main types, re-entrant and constant directivity (CD).

Horn-loaded loudspeakers often have different horizontal and vertical coverage angles such as 90° x 50° (Horizontal x Vertical) so that sound can be directed at listeners but not wasted or directed at surfaces that will reflect the sound and reduce intelligibility.

Re-entrant horns usually have a very narrow frequency response, which limits their intelligibility, and so are not suitable for VAS.

CD horns are usually part of loudspeaker arrays where they provide very closely controlled coverage angle at mid and high frequencies, and are usually augmented with additional low-frequency drivers to give wide frequency response.

Annex E
(informative)

Standby battery calculations

E.1 Formula for calculating battery capacity

E.1.1 Capacities calculated on the basis of operation of the VAS at maximum power for the whole evacuation period could result in excessive battery requirements. The following formula should be used for calculating the minimum total capacity of VLRA batteries:

$$C_{\min} = 1,25\left(\left[D_1 \times T_1 \times I_1\right] + \left[D_2 \times T_2 \times I_2\right]\right)$$

where:

$C_{\min}$ is the minimum capacity of the battery at 20 °C when new [in ampere hours (Ah)];

D_1 is a de-rating factor derived from the battery manufacturer's data, based upon the standby quiescent current I_1 and the discharge time T_1.

This factor is the de-rating from the 20 h rate, and:

a) for T_1 = 24 h (i.e. greater than 20 h), D_1 = 1, since the 20 h rate is directly applicable;

b) for T_1 = 6 h (i.e. less than 20 h), D_1 is the de-rating factor, read from the battery manufacturer's data, which takes into account that the discharge time is 6 h (and therefore not greater than 20 h);

T_1 is the battery standby period (in hours);

I_1 is the battery standby (quiescent) load current (in amperes), excluding load current in the alarm condition;

NOTE 1 I_1 is measured or calculated as the sum of the quiescent currents of all the components of the VAS, based upon operation at the nominal voltage (V), including contributions such as the current taken by the fault monitoring circuits.

D_2 is a de-rating factor derived from the manufacturer's data, based upon full alarm load current I_2 and the discharge time T_2. This factor is the de-rating from the 20 h rate and takes into account that the discharge time is normally 1/2 h, (and therefore not greater than 20 h).

T_2 is the alarm condition period (in hours) (normally 1/2 h but may need to be longer). A minimum period of 1/2 h should always be used, even where a shorter period is requested;

I_2 is the total battery load current with all voice alarm zones in full alarm condition (in amperes). See E.2 for an approximate method of calculation of I_2 and for a worked example of a calculation to determine the required capacity of a VRLA battery for a VAS automatically broadcasting speech messages;

NOTE 2 Local, regional or national regulations may make different recommendations regarding standby times.

E.1.2 The multiplying factor, 1,25, is included to allow for some ambient temperature variation and battery ageing.

NOTE 1 High ambient temperatures reduce battery service life dramatically; at extreme temperatures the battery may be destroyed. The service life quoted by the manufacturer is based upon battery operation within the range 20 °C to 25 °C. It is therefore recommended that the battery is located in an environment the temperature of which exceeds that range

only occasionally. If this is not possible, it will be necessary to replace the battery more frequently. For example, a VRLA battery operating in a continuous ambient temperature of 35 °C has an expected life of only 60 % of its specified life at 20 °C.

NOTE 2 De-rating factors D_1 and D_2 are not always available from manufacturer's data. A safe approximation to ($D_2 \times T_2 \times I_2$) may be obtained from a manufacturer's 20 h rate battery capacity selection chart, which gives a graph showing required discharge current versus required discharge time. Within the graph is a series of curves, each corresponding to a particular 20 h rate Ah battery size. After calculating I_2 (see E.2) and knowing T_2 (normally 1/2 h), the 20 h rate Ah value can be read from the graph. This figure may be taken to represent ($D_2 \times T_2 \times I_2$) in the expression for C_{min}. It may be a little higher in Ah value than ($D_2 \times T_2 \times I_2$) calculated using an available value for D.

E.2 Formula for calculating I_2

E.2.1 Where the VAS broadcasts speech messages, the exact calculation of I_2 is complicated because a typical emergency message is a composite of periods of silence, attention-drawing signals and voice. The periods of silence, however, should be considered as extensions to the "voice" element; this is a safeguard to allow, for example, for the use of an emergency microphone to override the emergency message. A method of calculating I_2 approximately is given in E.2.2.

E.2.2 First, it is necessary to know:

a) the nominal battery voltage, V (in volts);

b) the total duration of one message cycle, including the subsequent period of silence until the start of the next cycle, M (in seconds);

c) the total duration of the attention-drawing signal(s) within the message cycle, X (in seconds);

d) the total duration of the speech section of the message, together with all periods of silence, including the subsequent period of silence until the start of the next message cycle, Y (in seconds);

e) the sum of the required maximum output powers to all loudspeakers, based upon a sinusoidal input, L (in watts); and

f) the efficiency of the power amplifiers used as a percentage, η (100 × output power/input power).

NOTE 1 The total loudspeaker power required from an amplifier is often significantly less than the rated power output of the amplifier.

When the VAS specification calls for spare capacity, i.e. a reserve of power, to meet possible future requirements for increased loudspeaker coverage, this should be taken into account at the design stage, resulting in an increased value for L.

NOTE 2 Where the exact efficiency of the power amplifiers is not known, η can be assumed to be about 50 % for class AB or 80 % - 90 % for a class D amplifier.

E.2.3 To derive from the output power requirement the associated input power from the battery, an allowance has to be made for amplifier efficiency. The maximum input power for a sinusoidal signal is $100L/\eta$ watts. This figure can be used directly for calculating the power associated with the attention-drawing signal (which is assumed to be sinusoidal). For speech, however, the average power is considerably less than for the "sinusoidal" attention-drawing signal. A very approximate reduction factor of 2 may be used to estimate its input power requirement (a small amount of compression of the speech signal is allowed for within this factor); i.e. the maximum input power for speech signals is $50L/\eta$ watts. I_2 can then be calculated from the following formula:

$$I_2 = \frac{100L(X/M)/\eta + 50L(Y/M)/\eta}{V} = \frac{50L(2X+Y)/\eta}{MV}$$

E.2.4 The calculated value of I_2 can now be used to determine the de-rating factor D_2 from the battery manufacturer's information.

EXAMPLE: Calculation of the standby battery capacity required, in ampere hours, for a VLRA battery to satisfy the following requirements for a VAS broadcasting speech messages (reference being made to E.1):

V	= 24 V	(standby battery voltage)
T_1	= 24 h	(standby period)
T_2	= 1/2 h	(period on full alarm load)
I_1	= 2 A	(total quiescent current, including any monitoring current)
L	= 1 000 W	(output power required for all loudspeakers)
M	= 32 s	(total duration of one message cycle, including periods of silence)
X	= 8 s	(total duration of the attention drawing-signal within one message cycle)
Y	= M – X	(the total duration of the speech section of the message, together with all
	= (32 – 8)	periods of silence, including the subsequent period of silence until
	= 24 s	the start of the next message cycle)
η	= 90 %	(power amplifier efficiency of class D amplifiers)

$$I_2 = \frac{50L(2X+Y)}{\eta MV}$$

$$= \frac{50\,000 \times (2 \times 8 + 24)}{90 \times 32 \times 24}$$

$$= \frac{50\,000 \times (16 + 24)}{69\,120}$$

$$= \frac{200\,000\,0}{69\,120}$$

= 28,94 A

= 28,9 A (approximately).

The minimum battery capacity, C_{min}, required can now be calculated as follows (E.1):

D_1 = 1

D_2 = 1,9 (from the manufacturer's data relating to a 52,1 A discharge rate for 1/2 h, for example, but see also E.2.2, Note 2)

$$C_{\min} = 1,25\left(\left[D_1 \times T_1 \times I_1\right] + \left[D_2 \times T_2 \times I_2\right]\right)$$

$$C_{\min} = 1,25\left(\left[1 \times 24 \times 2\right] + \left[1,9 \times 0,5 \times 28,9\right]\right)$$

$$C_{\min} = 1,25(48 + 27,5)$$

$$C_{\min} = 1,25 \times 75,5$$

$$C_{\min} = 94,375 \text{ Ah}$$

A combination of the manufacturer's standard batteries should be used to give a total capacity at the 20 h rate (C_{20}) of at least 95 Ah.

Where the VAS broadcasts tones only (except for possible use of an emergency microphone for speech broadcast), it is suggested that:

a) Where the VAS broadcasts only coded alarm signals and/or live emergency messages, I_2 can be calculated as follows:

$I_2 = 100LX/\eta MV$

NOTE Use of the emergency microphone will normally override coded alarm signals.

b) Where the VAS broadcasts emergency signals that simulate bells or sounders and represent "Evacuate" or "Alert" signals, I_2 should be calculated on the basis of the broadcast of a continuous "Evacuate" signal. i.e.:

$I_2 = 100L/\eta$

Bibliography

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

[2] EN 54-2, *Fire detection and fire alarm systems - Part 2: Control and indicating equipment*

[3] EN 54-3, *Fire detection and fire alarm systems - Part 3: Fire alarm devices - Sounders*

[4] EN 54-4, *Fire detection and fire alarm systems - Part 4: Power supply equipment*

[5] CEN/TS 54-14, *Fire detection and fire alarm systems - Part 14: Guidelines for planning, design, installation, commissioning, use and maintenance*

[6] EN 54-16, *Fire detection and fire alarm systems - Part 16: Voice alarm control and indicating equipment*

[7] EN 54-23, *Fire detection and fire alarm systems - Part 23: Fire alarm devices - Visual alarm devices*

[8] EN 54-24, *Fire detection and fire alarm systems - Part 24: Components of voice alarm systems - Loudspeakers*

[9] EN 60268-16, *Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index (IEC 60268-16)*

[10] EN 61672 (all parts), *Electroacoustics - Sound level meters (IEC 61672)*

[11] IEC 60331, *Tests for electric cables under fire conditions*

[12] Directive 94/9/EC on equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)