The design, installation and maintenance of voice alarm systems

A guide to BS 5839-8
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Douglas F. Mason and Colin S. Todd
To my dear wife, Elizabeth.

Douglas F. Mason

To my three loving children, Keith, Jayne and Fiona (Little Boo), because of whom I am blessed. And to Karen for her everlasting love and support. And to the cats of Hutton Roof (past and present), for their loyal company as I write in the dead of night.

Colin S. Todd
## Contents

*About the authors*  ix  
1. Introduction  1  
2. Voice alarm systems and standards – a short history  9  
3. The role of voice alarm systems in fire warning  15  
4. Scope of BS 5839-8  21  
5. Contents of the Code  25  
6. Defining the terms  39  
7. Types of systems and the evacuation plan  47  
8. System planning considerations, including exchange of information and responsibilities and variations  53  
9. Interface between the voice alarm system and the fire detection and fire alarm system  57  
10. Fault monitoring, integrity and reliability of circuits external to the VACIE  65  
11. Typical arrangements of voice alarm systems  77  
12. Voice alarm control and indicating equipment (VACIE)  93  
13. Power supplies  99  
14. Use of voice alarm systems for purposes other than warning of fire  111  
15. Loudspeakers, loudspeaker zones and loudspeaker circuits  117  
16. Power amplifiers  133  

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The design and installation of voice alarm systems

17. Ambient noise sensing and compensation 139
18. Emergency and non-emergency messages 143
19. Audibility and intelligibility 153
20. Emergency message generators 165
21. Emergency microphones 169
22. Wiring 177
23. Radio-linked systems 183
24. Voice sounders 189
25. Climatic and environmental conditions, radio and electrical interference and electrical safety 193
26. Installation 195
27. Commissioning and handover 199
28. Maintenance 203
29. User responsibilities 209
About the authors

Colin Todd graduated from Edinburgh University in 1974 with an honours degree in physics. He then became one of the first four students in the United Kingdom to undertake a postgraduate Masters degree in fire safety engineering, thereby shaping his future career in fire protection.

After fire protection experience in industry, the Fire Offices’ Committee (which was later incorporated into the Loss Prevention Council) and a leading insurance broker, he founded the leading fire consultancy practice, C.S. Todd & Associates, in 1982. The practice, of which Colin is managing director, provides consultancy services in all aspects of fire safety and fire engineering, but has always been able to offer specialist advice on fire detection and fire alarm matters, an area in which Colin specialized during his time with the Fire Offices’ Committee (FOC).

Colin served for two years as a member of the Board of the Institution of Fire Engineers (IFE), and was the director responsible for technical matters. He also served on the Board of the Engineering Council Division of the Institution, and, for many years chaired the Division’s Membership Committee. He is, at the time of writing, Chairman of the Fire Risk Assessment Council of the Fire Industry Association.

Colin Todd is a chartered engineer, a Fellow of the Institution of Electrical Engineers, a Fellow of the Association of Building Engineers, a Fellow of the Institution of Engineering and Technology, a Fellow of the Institute of Physics, and a corporate member of the Society of Fire Protection Engineers and the Institute of Risk Management. He is also a standards associate of the British Standards Society.

For many years, Colin has served on national standards making committees, particularly those of BSI. He is a member of the BSI Technical Committee that was responsible for the production of BS 5839-8, and he served on the BSI working group that prepared the final draft of the 1998 version of the standard.
Douglas Mason graduated from Glasgow University with a degree in mathematics and physics. His career spanned industrial electronics, defence electronics and research before he entered the field of fire protection in 1983 as Engineering Manager of Planned Equipment Ltd, a fire detection system manufacturer and installer. He became technical director of the company, and designed a new generation of conventional (but microprocessor-based) fire alarm panels.

The company also majored in sound systems, and Douglas led the company into the voice alarm field. He was responsible for the introduction of a range of sophisticated, electronic voice alarm control equipment.

Recognizing the need for standardization, Douglas lobbied the British Fire Protection Systems Association (BFPSA) (now the Fire Industry Association) to develop a voice alarm standard. He subsequently chaired the BFPSA working group that generated the first UK standard for voice alarms in 1994. He then served as a member of the BSI working group that, in effect, converted the BFPSA Code into BS 5839-8.

He joined C.S. Todd & Associates in 1998 as a senior consultant specialising in fire detection and voice alarm consultancy work, and until 2008 designed many fire detection and fire alarm systems and voice alarm systems.

Also, since 1998, he has drafted a number of British Standards, including BS 5839-9, and most recently has served on the BSI working group that created the revised version of BS 5839-8.

Douglas is a chartered engineer and a corporate member of the Institution of Engineering and Technology. He retired from full-time employment with the practice in 2008, but continues to work as a part-time consultant in this field.
1. Introduction

This is the third edition of *The design and installation of voice alarm systems*. The book remains a guide to BS 5839-8,¹ the first code of practice in the UK for the design, installation and maintenance of voice alarm (VA) systems, but has been brought up to date to reflect the changes to that document. The Code is one part of the BS 5839 suite of codes, all of which now bear the generic title *Fire detection and fire alarm systems for buildings*.

Since the publication of the original version of BS 5839-8 in 1998, VA systems have become more prevalent, particularly in buildings in which substantial numbers of members of the public assemble, but also in medium and large multi-storey office buildings. Accordingly, there is an even greater need for the Code, and for it to be as appropriate and up to date as possible. This book refers to the latest (2013) version of the Code but covers all the extensions of the scope introduced in BS 5839-8:2008, as well as those now included in BS 5839-8:2013, such as allowance for an increasing need for fire-resistant data cable. New concepts, such as types of VA systems, have been introduced to help those specifying VA systems.

In the first edition of this Guide, the question ‘Why is there a need for a “guide to the guide”?’ was asked. The answer is probably still ‘interpretation’. As in its first published form, this book gives further guidance on issues that were previously contentious or surrounded by ambiguity. However, the Code has now been in force for 15 years and a number of changes have been found to be needed; few, if any, of these changes were made to the Code (in 2008, and now in 2013) because the Code, in its original form, was ‘wrong’. However, as well as the extension to the scope,

¹ BS 5839-8:2008 *Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of voice alarm systems.*
account has had to be taken of newly published standards and codes of practice, particularly BS EN 54-16,\(^2\) which obviates the need for many of the previously included detailed recommendations relating to control and indicating equipment for VA systems and BS EN 54-25,\(^3\) which refers to radio-linked VA systems.

Codes of practice do not give detailed guidance on implementation, nor is it possible, in a code of practice, to explain in any detail the reason behind the various recommendations made. The main purpose of this Guide is, therefore, to increase understanding of the Code by, for example:

- explaining the reasons for the recommendations in the Code;
- outlining the consequences of failures to satisfy the recommendations;
- providing more detailed guidance on the manner in which the recommendations may be satisfied;

using numerous examples to aid interpretation. Also, the Guide is not as formal a document as the Code, permitting it to include background and other associated information. For example, the opportunity is taken to consider the use of VA systems for purposes other than emergency warning. The authors hope that this approach will make the Guide interesting to read, as, they hope, was the case with previous editions.

Although the Code has been used primarily for VA systems associated with fire detection systems in buildings, these systems have sometimes included facilities for broadcasting messages relevant to other emergency situations such as bomb or other security alerts. To take this into account, ‘fire microphones’ are now referred to as ‘emergency microphones’. It is important that the Code deals with emergencies other than fire emergencies, because BS EN 60849,\(^4\) another VA system standard dealing with such emergencies, has been withdrawn. It should, however, be noted that there are also other relevant codes or standards that may be specified in particular circumstances, for example BS 7827\(^5\) if the voice alarm is intended for use in a sports ground or stadium.

It is strange how long it has taken for voice messages to become established as credible alarms of fire – or, indeed, any other emergency. In the

\(^2\) BS EN 54-16:2008 Voice alarm control and indicating equipment.
\(^3\) BS EN 54-25:2008 Fire detection and fire alarm systems — Components using radio links.
\(^4\) BS EN 60849:1998 (edition 2) Sound systems for emergency purposes.
\(^5\) BS 7827:1996 Code of practice for designing, specifying, maintaining and operating emergency sound systems at sports venues.
17th century, a handbell was used to draw people’s attention, but the warning was usually supplemented by a voice message, if only comprising the word ‘Fire’! Even in those early days, the use of voice messages must have assisted in evacuation.

In recent times, however, bells or electronic sounders, without any voice messages, have been established as fire alarm warning signals. The very word ‘alarm’ conjures up loud bells or sirens and, to those of us in the fire safety profession, it seems obvious that these warnings should be taken seriously. We all know, however, that the sound of ringing bells is really useful only to those who have been trained to recognize them as warnings of fire and to respond appropriately.

Those unfamiliar with a building may not recognize the warning from an audible alarm device as a fire warning. Moreover, there is a tendency for members of the public to disbelieve the warning, even if they do recognize it, on the assumption that it might be a test or a false alarm. (Unfortunately, statistically, this assumption is correct!) This means that there is often reluctance on the part of occupants to evacuate a building when the fire alarm system is operated, resulting in a ‘pre-movement time’, between the initial sounding of the alarm and the initiation of evacuation, that can greatly exceed the evacuation time itself.

Research has shown that the reluctance arises, in part, because of a desire for further information. This information can be provided by broadcasting an appropriately worded speech message, thereby resulting in a much more appropriate response; practical research and anecdotal information both confirm this.

There is now, however, some evidence that emergency voice messages, although in themselves giving clear information on action to be taken in the event of fire, can sometimes be ignored in a real fire condition, if occupants of a building have been exposed excessively to repetitive broadcasts of the actual emergency messages for test purposes (despite messages before and after the tests, advising listeners to take no emergency action). To counter this, emphasis is put, in the latest version of the Code, on minimizing this exposure to the actual emergency message during weekly test periods, by broadcasting the message out of normal working hours.

That aside, the replacement of bells or electronic sounders by voice messages dramatically reduces the occupants’ pre-movement time and, therefore, the overall evacuation time. There are not yet enough statistics to determine whether lives have been saved by the use of voice messages, but there can be no doubt that, in many types of building, life safety is enhanced by the use of these systems. The voice alarm is here to stay and its use will grow.
BS 5839-1\(^6\) refers its readers to BS 5839-8 for systems ‘where audible alarms comprise speech messages generated by a VA system’, and the design of VA systems is therefore established as a separate discipline in its own right. Although the design principles can, and should, be based on the principles developed for fire alarm systems, there are many special considerations in the design of VA systems. They involve audio technology and acoustics, and the system must be able to broadcast emergency messages that can be easily understood. Thus, there is a major difference between a conventional alarm sounder system and a VA system. For example, an alarm sounder system requires only adequate audibility for optimum perception of the warning, whereas a VA system requires intelligibility, of which audibility is only one component.

As discussed in more detail in the next chapter, the absence, for a considerable time, of specific codes of practice or standards for VA systems resulted in many design shortcomings, bad practices and, ultimately, installations that did not even meet the basic principles of fire alarm design as embodied in, for example, BS 5839-1. Inadequately intelligible and not easily understood broadcasts were one of the common shortcomings. Without the discipline now applied by the recommendations of BS 5839-8, many VA systems would still exhibit problems such as:

- unsuitable and non-fire rated cabling for loudspeaker circuits;
- unsuitable loudspeakers;
- ineffective fault monitoring arrangements for loudspeaker circuits;
- totally unmonitored sections of the alarm path, including the crucial link between the fire detection system and the VA system.

These shortcomings arose not merely through ignorance of system requirements (although the sound systems industry was initially slow to appreciate the principles of fire alarm design), but in order to reduce costs and win orders – a very unsatisfactory state of affairs! Accordingly, the publication of BS 5839-8 was an important step in rationalizing, standardizing and providing a tool for the control of design standards. These important factors have now been enhanced by the publication of this revised version of the Code. Nevertheless, the authors of the

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\(^6\) BS 5839-1:2013 Fire detection and fire alarm systems for buildings — Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises.
1. Introduction

Code have once again been conscious of the need to avoid ‘going over the top’ in making recommendations or placing onerous requirements upon system designers that would inevitably lead to excessively high costs and drive purchasers back to conventional alarm sounder systems. In the original version of the Code, particular care was taken to avoid recommendations for VA systems that went beyond the analogous recommendations for conventional alarm sounder systems. The revised Code further emphasizes this need by introducing the concept of VA system types, which assists in providing a ‘horses for courses’ approach to VA system design.

Attempts have also been made to ensure that the Code is flexible where appropriate. For example, with the advent of BS EN 54-16, which *inter alia* gives performance requirements for power amplifiers, it may now not be necessary to include automatically switched standby amplifiers because of the inherent reliability of power amplifiers conforming to that British Standard.

Even after the great care taken in the original version of the Code to consider the views of all parties, and to develop recommendations that were logical and justifiable, there has been some misunderstanding on certain issues, such as the use of ‘dual’ loudspeaker circuits. Particular attention is therefore given to these issues in this Guide.

In BS 5839-8:2008, a significant number of alterations and additions to the content were made, because of changes in technology, custom and practice. The principal changes (taken from the text of the revised Code) were as follows:

a) ‘Types’ of VA systems have been introduced to recognize and identify the different configurations of systems that can be used and their specific operational needs;
b) the need is clearly identified for the building evacuation plan to be based on a risk assessment by a competent person;
c) recommendations in the use of voice sounders have been included as a clause in the main part of the Code as opposed to an annex, thus recognizing their increased acceptability in simpler VA systems where manual control is not required;
d) recommendations for VA control and indicating equipment and power supply equipment have been rewritten taking into account that the new harmonized European standards, BS EN 54-16 and BS EN 54-4, give the applicable product requirements;
e) the information on standby battery calculation has been consolidated into one informative annex;
f) two different levels of fire resistance of cables are recognized, and recommendations given for application of each type;
g) recommendations for networked systems, for example in respect of cable types, are included;
h) the use of radio to link parts of the VA system is recognized and recommendations for the implementation of such radio links included;
i) recommendations for the maintenance of systems, including the periods at which routine servicing should be carried out, have been revised;
j) the single ‘commissioning and installation’ certificate has been replaced by a modular certification scheme separately covering: design, installation, commissioning, acceptance, verification, inspection and servicing, and modification;
k) the code of practice has been simplified by the use of practice specification format, in which commentary on relevant principles is followed by short, succinct recommendations. This is intended to make the code of practice less ambiguous and simpler for the non-specialist to apply and compliance of installations more straightforward to audit;
l) the term ‘deviation’ has been replaced with the term ‘variation’, to avoid any negative connotation associated with the term used to describe an aspect of system design that, for good reasons, does not conform to this standard.

Since then, at least the following alterations and additions have been made in BS 5839-8:2013:

a) the text on radio-linked systems has been modified to remove conflicts with BS EN 54-25:2008;
b) new recommendations for measurement of audibility of background noise have been added;
c) the text on cables and wiring has been updated;
d) Annex C has been modified to allow for alternative amplifier efficiencies;
e) practical guidance is now included on placement of loudspeakers in simple acoustic environments;
f) the term ‘responsible person’ has been removed and replaced with references to ‘premises management’ to avoid confusion with the term defined in legislation;
g) changes have been made to recommended regular system test procedures.
VA systems must be properly designed if they are to operate continuously and reliably. However, the philosophy behind the recommendations of BS 5839-8 does not involve the creation of systems that cannot fail. (Indeed, not only is 100 per cent reliability impossible, but it would be unaffordable even if it did exist.) The Code does stress the need for measures that will minimize failures and downtime, but also stresses the need for comprehensive monitoring of all critical system elements. This need for comprehensive fault monitoring is one of the main features that distinguish a VA system from a traditional public address system.

As in the case of any code of practice, BS 5839-8 provides recommendations, rather than requirements. In practice, of course, the Code forms the basis for purchase specifications and requirements by enforcing authorities. Nevertheless, variations from the recommendations may be acceptable in particular circumstances. Such variations should be subject to agreement between all interested parties, including the purchaser, any relevant enforcing authority and, possibly, the fire insurer.

VA systems are particularly appropriate for medium- and large-sized buildings that house significant numbers of members of the public. The ability of these systems to broadcast specific messages for particular areas of the building and real time speech make them very suitable for buildings in which phased evacuation is used. However, the principle of using voice messages to give fire warning is appropriate for virtually any size of building, and, as the cost of systems decreases and there is greater integration of VA systems and fire detection systems, the size of buildings for which VA systems are used will continue to decrease. The enhanced guidance contained in the revised version of BS 5839-8 should assist this growth in VA systems, while ensuring that the systems installed meet the needs of fire safety.

Even though the revised Code addresses the few ambiguities and imperfections found in the original version, further such issues may arise, as experience in the use of the Code continues to grow. Users should note that BSI technical committees always welcome feedback. The technical committee responsible for BS 5839-8 would, no doubt, be prepared to consider further comments from users and would, obviously, continue to be in a position to respond to enquiries in the event of serious problems of interpretation.
4. Scope of BS 5839-8

The Code has been written to guide all interested parties involved in any stage of a VA installation project, both technically and in terms of project management. Coverage extends therefore from microphones to loudspeakers via amplifiers, but also from initial planning to system maintenance via design and handover.

The recommendations of BS 5839-8 basically apply to any VA system that is automatically triggered by, and therefore effectively forms an integral part of, a fire alarm system. Normally, VA systems are used in buildings in which there is a significant amount of automatic fire detection, but the recommendations of the Code would apply even if the fire alarm system were purely a manual (break glass call point) system. In this respect, the Code interfaces perfectly with BS 5839-1, advising on the connections between the fire detection and fire alarm system and the VA system, as well as on the information that must be fed back from the VA system to the fire detection and fire alarm system. (The previous sentence presupposes that the two systems are entirely separate; this need not, of course, be the case, and the availability of fully integrated fire detection/voice alarm systems has grown, as predicted, since the first edition of this book was published.)

VA systems other than those of Type V1 (see Chapter 7) incorporate a facility for live speech broadcast. VA systems within the scope of the Code must, however, always have a facility for automatic transmission of pre-recorded messages. A system that requires manual intervention by an operator in order to transmit either pre-recorded or live messages would not come within the scope of the Code, nor would such a system generally be regarded as acceptable for fire warning purposes. Thus, the simplest VA system to which the Code would apply would be one in which, for example, there was only a single message (and thus a single stage alarm arrangement) that was automatically triggered by an associated fire detection and fire alarm system (whether incorporating
The design and installation of voice alarm systems

automatic fire detectors or not). Systems used in large complexes will, of course, be much more sophisticated, typically involving tens of loudspeaker zones, several emergency microphones, multiple evacuate/alert and test messages, several different types of loudspeaker and often various manual controls to start and stop messages.

The Code applies equally to centralized systems, in which all power amplifiers are installed at a single location, and distributed systems, where power amplifiers, etc., are located in groups at strategic points around a building. The choice between the two types of system is basically a matter of economics and engineering ‘taste’, but exactly the same recommendations apply to both types of systems. Some recommendations of the Code may appear quite onerous for small systems but the view taken was that system format was an engineering issue to which absolutely consistent recommendations should apply.

Fire telephones are specifically excluded since they make up an entirely separate form of communication system, now referred to as an emergency voice communication system. A VA system is intended to inform the occupants of a building collectively of the existence of a fire. Fire telephones, on the other hand, are provided for operational use by the fire and rescue service during the fire, and for use by fire wardens in an emergency or, much more commonly, disabled persons requiring assistance with evacuation. A code of practice covering such systems, BS 5839-9, was published in 2003.

Voice alarms used for fire warning, and conforming to BS 5839-8, may be used for warning of other types of emergency, such as bomb warnings, etc. The potential use of VA systems for this purpose is fully acknowledged in BS 5839-8, which provides relevant recommendations in respect of, for example, prioritization. This continues to represent a distinct difference from recognized practice in the USA, where use of a VA system for purposes other than fire warning would need special approval. The acceptance of VA systems for multiple emergency situations and for non-emergency broadcasts, such as paging, background music, etc., is extremely important, as it often makes the VA system economically viable in situations in which a public address system is required for other purposes. This is considered further in Chapter 14. If one were designing a VA system for purposes other than fire warning, although this would not lie within the scope of the Code, its

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12 BS 5839-9:2003 Fire detection and fire alarm systems for buildings — Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems.
recommendations would nevertheless be appropriate if there were a need for high reliability and integrity of the warning system.

Originally, BS 5839-8 did not apply to VA systems used in sports stadia because of the existence of the code of practice, BS 7827, which provides recommendations for the installation, maintenance and operation of permanently installed sound systems used for emergency purposes at sports venues. However, most of the recommendations of the Code apply to such systems and this was recognized in an Amendment to the Code, introduced in 2005. The revised version of BS 5839-8 now includes more information relevant to sports venues, but, in the Scope, still refers the reader also to BS 7827.

The first version of the Code, although an installation code of practice, contained a number of recommendations for the design of hardware. This arose because of the absence of product standards for components of VA systems. With the advent of BS EN 54-16, a product standard for control and indicating equipment for VA systems (including microphones), it has been possible to remove much of that information. Recommendations for appropriate loudspeakers, however, have had to be retained in the revised Code because the new standard BS EN 54-24 for VA system loudspeakers does not (at the time of this edition going to press) include requirements for fire-related mechanical and electrical integrity of loudspeakers and their connections.

The Code continues to apply only to VA systems that are used in a temperate climate such as that of the UK.

In the original Code, recommendations for the use of voice sounders (stand-alone devices connected to fire alarm systems, containing the components necessary to generate and broadcast their own digitally recorded messages) were included in an annex. In recognition of their increasing use, voice sounders are now dealt with in a separate clause of the revised Code.

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13 BS EN 54-24:2008 Fire detection and fire alarm systems. Components of voice alarm systems. Loudspeakers.