RISK ASSESSMENT OF VOICE ALARM SYSTEMS

This document forms the beyerdynamic company guidelines for technical and sales staff quoting public address (PA), voice alarm (VA) and voice evacuation (VE) systems to adhere to the British standards and European standards required for voice evacuation system designs. This document must be considered in advance of any design or quotation being supplied for a project.

1.1 Introduction:

This document has been produced to provide further detail to the requirements of the various published Standards relating to sound systems used for emergency purposes, whether those be linked to fire detection and alarm systems or not and whether the sound systems provide for automatic evacuation routines, or are for manual evacuation routines, or a combination of these.

This document also identifies the areas where equipment and materials not available or proven at the time of the authoring of the Standards can be used, provided adequate safety measures are taken, in the design and installation of the system.

The process of designing a sound system for emergency purposes must start with a risk assessment of the building concerned, related to its use and method of operation in real terms.

The guiding principles for a design relate to that risk assessment.

1.2 Guiding Principles:

1.2.1 G1 - Diversity:

When designing a system, the assessment of risk of failure must be analysed. All single points of failure must be minimised and preferably removed. The more diversity designed into a system, the more likely it is that a larger part of the system will operate when required, and to a higher standard. However, care should be taken to avoid unnecessary complication which might lead to unreliability or difficulty of maintenance.

1.2.2 G2 - Intelligibility:

A system should be designed such that for an intelligible input there is an intelligible output. The coverage of the building with such an intelligible output must include all areas where people might need to escape from, including the escape routes, to safety.

The risk of a person not hearing an intelligible message in an emergency must be assessed and compared to the likelihood of that space being occupied. e.g. a corridor or an office is a likely place to be occupied, but the ceiling of an atrium is not.

What is usually the nub of the problem areas which are either small, or rarely occupied, or both, e.g. store rooms electrical plant rooms, grid-top plant areas etc., where the assessment needs to be reasoned between pragmatism and percentage risk in a consistent manner.

1.2.3 G3 - Proving that it still works:

A system should be monitored to so as to prove that for an acoustic input there can be an acoustic output when required. This monitoring must be automatic except for the loudspeaker itself which must be manually checked by testing the system on a regular basis. The monitoring must be continuous i.e. it is not acceptable to remove the monitoring at any time.

Do we need mic in speaker.

1.2.4 G4 - Value engineering:

A system used to provide non-Voice Alarms services such as general paging or entertainment is far more likely to operate in Voice Alarm mode when required because it is "monitored" far more often in its non-Voice Alarm mode by staff and the Public. The only stipulation required is that Voice Alarm takes priority without compromise.

1.2.5 G5 – Intuitive & easy operation, but safer due to reducing all areas of risk:

A system will not fulfil its role if the unfamiliar user cannot operate it easily and intuitively, nor will it fulfil its role if materials or equipment are chosen which do not address all the risks, not just those of fire, (e.g. vandalism, accidental damage etc.).

1.3 Considerations And Cross-References:

The following codes have been used to provide logical indicators of subject matter:

A Amplification
C Cabling
F Fault Monitoring
G Guiding Principles
L Loudspeakers
M Microphone
S Audio Signal Processing
U Batteries or UPS
X Control

Guide Principles & Legal Requirements

In order to design a system with beyerdynamic manufactured or distributed products, the following standards must be met:

BS 5839-1 1988
BS 5839-4 1988
BS 5839-8 1988
BS EN 60849
BS 7827

Summary of Legal Requirements

This is outlined to meet standards plus personal and company due diligence when designing systems:

1. It should be noted that the Emergency Microphone forms a single point of failure unless it is duplicated and diversified. I.e. more than one area where emergency messages can be given.

2. If the microphone electronics is mounted locally, it could be phantom powered from the central equipment. In the case that it is locally powered (and there is no reason not to do so) then there needs to be a secondary power supply. This secondary power could take the form of a re-chargeable battery or a (small) UPS.

3. The integrity of the microphone used for emergency purposes must be continuously monitored. Whatever method of achieving this must provide a continuous system of monitoring through to the loudspeakers. E.g. if 20Hz is used to monitor the microphone, and 20kHz is used to monitor the remainder of the system, then the 20kHz must be injected into the audio signal before the 20Hz is filtered out. This implies that the 20Hz is detected prior to the filter and after the 20kHz is injected.

4. If the microphone electronics is mounted locally, then the status signal should be sent to the central fault monitoring system as well as the audio signal to the central equipment.

5. For larger buildings, and especially those used by the Public, there should be more than one place where an emergency microphone can be used on the basis that a fire or terrorism alert in the primary location may preclude the message being originated from that primary location.

6. Zone selection panels for selecting zones for Voice Alarm messages should be ergonomically laid out, intuitive to use, and preferably topologically representative.

7. Zone selection panels should also utilise topological touchscreens on larger systems, but it is important that these are duplicated and their connection cables diversely routed in order to avoid the risk of a single point of failure.

8. In the case of large systems, and especially in complicated buildings to which the Public have access, the control panel may take the form of a touch-screen. This provides more relevant detail of a fault status than mere indicating lamps (e.g. critical or non-critical faults) provided that it is designed properly and takes into account the unique requirements of the building. Where touchscreens are used, the secondary power is preferably given by means of a UPS, and the status of the touch-screen, the UPS and the microphone all need to be sent to the central fault monitoring system as well as the audio signal to the central equipment.

9. Where large sites require the control and amplification equipment to be distributed around the site (e.g. Stadia, shopping malls, educational establishment etc.) not only to reduce loudspeakers cable runs, but also to diversify the risk of a single site failure, the inter-connecting signal and data cable shall be selected for their ability to carry the relevant type of signal and routed in such a fashion to minimise the risk of being affected by fire or electromagnetic interference as well as being protected from fire and mechanical damage as far as possible by means of cable containment.

10. If any of the following functions are carried out by a digital signal processor, the risk of a failure constitutes a single point of failure, therefore the sources and outputs should be interleaved and routed via a pair of processors such that if one fails, only half the system is in failure mode: 20kHz Injection and Mix Routing of priority/emergency sources to outputs Room Equalisation Delay for the relative location of loudspeakers. Detection of 20kHz on an emergency source.

Are we covered when each group of 8 has its own DSP?

11. In the case of a multiple driver loudspeaker assembly using an active crossover, the speech range driver circuit must be monitored. If this uses a mixed tone (e.g. 20kHz) then the crossover must be arranged to have a suitable (High Q) notch band-pass at the appropriate frequency.

12. If signal processing is carried out using discreet equipment which is totally analogue (or discreet units which have analogue inputs and outputs, yet process in the digital domain), care should be taken regarding warranties and overall reliability if it is proposed to modify these to provide secondary power directly from batteries. Similarly, the selection of such products should also take into account the risks associated with a single point of failure and the ability to successfully monitor the signal path in the event of dynamic level changes which affect the monitoring signal. e.g. automatic level control or active crossover monitoring by 20kHz tones.

This means column of 16 or more. Only? We can't bypass the DSP.

13. The concept of allowing the emergency message – be it from a microphone or a message generator – to by-pass the signal processing in the event of a failure of that processor belies the importance of intelligibility. The solution should be to duplicate and diversify the signal path through two (or more) processors in an inter-leaved fashion.

14. The concept of allowing the emergency message – be it from a microphone or a message generator – to by-pass the routing as an "all call" in the event of a failure of a processor may be satisfactory in smaller installations, or those installations which only use routing for non-VA purposes. However, where a building is to be evacuated in phases (e.g. hotels, multi-storey offices etc.) or buildings open to the Public (e.g. shopping malls, stadia, arenas, theatres etc.) which should be manually evacuated, the principle of an "all call" may actually cause personal damage or fatalities due to stampeding and clogging of exits by people who, having left a relatively safe area, mix with those from an endangered area. The solution should be to duplicate and

15. The use of digital signal processors (DSPs) for routing and signal processing is considered to be prudent for many VA designs. However, the processor must be able to operate in audio terms without direct connection to any other device which relies on the use of moving parts (e.g. a computer) due to the higher risk of failure of the moving parts than the solid state parts.

Does this mean we need to interface with other devices too - Besides the PC?

16. Computers may be used to carry out non-critical activities such as programming of DSPs, detailed monitoring of status, remote control of non-VA applications etc., provided that the basic functions of VA audio, basic fault indication, and audible warning can be carried out independently.

17. Computer-based systems may also be used for control of VA routing (e.g. touchscreens) provided that they are duplicated and diversified and monitored. I.e. there is more than one place to generate the emergency message.

18. If any amplifier feeds more than one loudspeaker it constitutes a single point of failure, so that circuit should be split to two amplifiers which feed alternate, interleaved loudspeakers.

19. If loudspeaker zone circuits are very large, then these should be broken down into smaller circuits fed by smaller amplifiers with the source distributed at line level, thus providing more diversity in the event of an amplifier failure. Alternatively a spare amplifier of the largest common denominator shall be provided (together with status monitoring) which shall be arranged to be automatically cut in circuit in the event of a failure of one of the amplifiers in the same rack (i.e. one spare per rack). The same degree of protection may be achieved by parallel banking amplifiers on constant voltage systems. Other means of minimising the risk attributable to amplifier failure may be appropriate.

Having a separate P/S for each 8 covers this

20. Where dual or multiple channel amplifier units are served by common sections (such as power supplies or fuses) the output section shall provide sufficient short circuit protection so as not to affect the operation of the rest of the unit. The allocation of such amplifier channels shall be such that interleaved loudspeaker circuits are not fed from common sections, and thus avoid a single point of failure.

21. If an amplifier has the ability to be powered by more than one type of supply (e.g. mains and battery) the status of both the supply fuses must be monitored so as to ensure that when the alternative supply is used that it is able to operate correctly or flagged as a fault. If an amplifier has only one fuse (e.g. mains only) then no such monitoring is required since if it were to rupture this constitutes an equipment failure anyway.

22. Considering that the majority of circuit faults arise not from amplifier failure, but by line shorts (nails through loudspeaker cables re-configuration of the building causing loudspeakers to be removed and their cables shorted together) the use of standby amplifiers and parallel banking does not actually solve the problem. The diversity into more smaller load amplifiers is therefore preferred.

23. Modern amplifiers are much more reliable than in the past and therefore the risk of an amplifier failure is much lower then other risk in the system. Nevertheless, if the hot standby amplifier arrangement is chosen, then this standby amplifier must also be monitored for its ability to work when put into circuit.

24. All amplifiers should be chosen for their ability to withstand short circuits (and open circuits) on their outputs (and inputs). Though modern amplifier designs generally have no problem in working with constant voltage transmission lines where the cabling can be highly capacitive, care should be taken to ensure that this actually the case when selecting amplifiers for this type of application.