Training Presentation

Public Address and Voice Alarm
Contents

• Introduction
  • What is Voice Alarm?
  • What are the benefits?
  • What standards apply?
  • Intelligibility requirements
  • Issues when designing VA

• PA overview
  • Inputs
  • Amplifiers
  • Noise sensing

• VA Overview
  • Fire alarm interface
  • Fault monitoring
  • Battery backup

• Acoustic design
  • Speakers
  • Sound pressure level
  • Intelligibility
  • Loudspeaker Selection

• System Check List

• System Examples
What is a Voice Alarm?

- Provides a secure method of voice reproduction
- Deliver emergency recorded messages instead of bells.
- Deliver emergency live announcements (i.e. Fire Officer).
Benefits of voice alarm?

- Public take more notice of spoken word than bells or sounders.
- A spoken message identifies the nature of the problem and provides clear instruction.
- Specific and detailed information can be provided (phased evacuation).
- Can be used by emergency services for directing staff or the public.
- Can provide a public address/music system.
What does it consist of?

- Interface to the fire detection system
- Pre-recorded messages
- Amplifiers
- Loudspeakers
- Fault monitoring
- Battery back-up (allows the system to operate when mains fails)
What standards apply?

- Primarily regulated by BS5839 (Fire Detection & Alarm Systems for Buildings) part 8 in the UK
- EN60849 (Sound Systems for Emergency Purposes) throughout Europe
- BS7827 (Designing, Specifying, Maintaining & Operating Emergency Sound Systems at Sports Venues)
What standards apply?

- The Standards cover;
  - The original design of the voice alarm hardware, both central equipment and loudspeakers
  - The planning of the system
  - The performance of the **installed** system
  - The maintenance of the system
What are the loudspeaker, selection, placement and intelligibility requirements?

- the messages must be intelligible (clearly heard and *understood*)

- Speakers need safety features in order to comply with the standard
  - Ceramic terminal block
  - Thermal fuse

- Cabling requirements same as fire alarm sounders.

- Intelligibility defined within BS5839 as meeting CIS (Common Intelligibility Scale) of 0.7 (STI of 0.5) or greater
Intelligibility in a measurement of how easily understood the INSTALLED system is.

- Can be measured using real people (word scores)

- Can be measured using electronic test equipment (Rapid Assessment of Speech Transmission Index RASTI)
**Common Intelligibility Scale (CIS).** Unifies the most common intelligibility measures into one scale

- **CIS**
  - 0.0
  - 0.1
  - 0.2
  - 0.3
  - 0.4
  - 0.5
  - 0.6
  - 0.7
  - 0.8
  - 0.9
  - 1.0
  - Colors indicate:
    - Bad
    - Poor
    - Fair
    - Good
    - Excellent

**Speech Transmission Index (STI)** still referred to often in specifications

- **STI**
  - 0.0
  - 0.1
  - 0.2
  - 0.3
  - 0.4
  - 0.5
  - 0.6
  - 0.7
  - 0.8
  - 0.9
  - 1.0
  - Colors indicate:
    - Bad
    - Poor
    - Fair
    - Good
    - Excellent
What are the issues when designing a voice alarm?

- Sound pressure level (SPL) & intelligibility
- Number of inputs.
  - Fire mic
  - Fire Alarm
  - Paging mic
  - Music
- Number of Outputs (Zones)
- Single or phased evacuation
- Distributed (racks located *around* the site) or centralised (one central rack)
Public Address Overview
Typical Small Public Address

- Zone selection
- Paging mic
- Matrix/Amplifier
- Multidisk CD Player
- Z1 Stock
- Z2 Canteen
- Z3 Supermarket
Purpose of a PA

- To switch or ‘route’ audio signals from an announcement station i.e. a microphone to a speaker zone or zones
- Interface various announcement stations and other line level audio inputs such as a CD or cassette player
- Requests for a ‘route’ from the announcement stations are made to the central processor. The processor manages these requests with regard to their priority.
The core of a PA system is the Audio Switching Matrix

- The matrix routes the input sources (mic, music etc) to output destinations (speaker zones)

- The matrix can also incorporate message cards for alarms or announcements.

- All parameters (including microphone controls, signal routing, priority settings and fault monitoring) are programmable

- Activating an input controller makes a request to the matrix. The matrix manages the request (source/priority/destination) according to the configuration.
Input Controllers

- Microphones
  - Desk, wall or equipment rack mounting
  - Single or multiple selection buttons
  - Single button unit (PTT press to talk)
  - Control of microphone or audio source such as a CD player

- Controllers
  - Control of audio source such as a CD player
  - Pre recorded messages within the system
Microphones

- Typically comprise;
  - Goose neck or fist microphone
  - Zone selectors with busy and confirm LED indication
  - PTT button and speak indicator
  - Microphone to line level pre amplifier. Microphone signals are too small to be transmitted over distance. Need to amplify at the microphone.
  - Audio limiter (boosts quiet voice, reduces loud voice), digital chime and 20KHz-surveillance.
  - All these elements would be housed within the microphone unit.
Amplifiers

- Grouped together to meet the specific power requirements of each zone.

- Efficient use of output power and reduces the mechanical size of the power racks.

- Protected from short circuit speaker lines.

- The amplifiers are protected from being over-driven by thermal cut-out.
Noise sensing

- Typically used in Airports, Exhibition Halls and Convention Centres or where background noise levels vary

- Provides automatic adjustment of system sound pressure level to compensate for fluctuations in background noise.

- Background noise picked up by microphones in the zone
Typical Public Address

Audio Matrix

Security mic

Reception mic

CD Player

4 x 60W Power Amp

1 x 60W Power Amp

Z1

Z2

Z3

Z4

Z5

Z6

Z7

Z8

Z9
Voice Alarm Overview
Voice Alarm

- Voice alarm is basically *Public Address Plus*
  - + *Fire Interface*
  - + *Fault Monitoring*
  - + *Battery Back-up*
  - + *Voice message storage*
  - + *Fire protected equipment (ie cable, speaker fire domes, ceramic terminals)*
Fire alarm Interface

- Either;
  - Dry contact relays in the fire panel selecting zones for evacuation>alert
  - The voice alarm can be an addressable Node on a fire alarm’s digital bus reducing wiring and programming

- When fire alarm activates, fire alarm interface sends data to matrix, triggers emergency message.

- Any voice and/or alarm message can be recorded and stored
Typical Voice Alarm

- Fire Alarm
- Reception mic
- Fire mic
- CD Player
- Audio Matrix
- 4 x 60W Power Amp
- 1 x 60W Power Amp
- Batteries
- Fault Monitoring
- Z1A, Z1B
- Z2A, Z2B
- Z3A, Z3B
- Z4A, Z4B
- Z5
Fault Monitoring

- Required by BSEN60849

- Must be monitored on critical paths and components (paths through the voice alarm system that rely on equipment and the connections between them to achieve a voice alarm broadcast)
  - Audio paths
  - Data links
  - Control contacts
  - Amplifiers
  - Mains and battery supplies
Audio surveillance

- Surveillance tone (20kHz) is injected into the audio path via the microphone pre-amplifier or message card.

- This tone follows the same audio path as the microphone signal, through the matrix, amplifier, speaker lines and back to the surveillance detector at the rack.

- If the tone level falls a fault is indicated on the Fault Monitoring Panel on the rack.

- The switching matrix receives up to three sources carrying the surveillance tone and has a number of destination channels requiring surveillance.
Sound Engineering for 60 Years

Monitored Sources

- Fire Alarm
- Fire mic
- Reception mic
- CD Player
- Fault Monitoring
- Audio Matrix

Non-Monitored Sources

- Monitored message card

Monitored Zones

- Z1A
- Z1B
- Z2A
- Z2B
- Z3A
- Z3B
- Z4A
- Z4B
- Z5

End of Line Monitor unit

EOL
Data Path Surveillance

- Controller microphones or serial interfaces continually polled by matrix.

- On failing to receive a valid response from a serial input, the matrix will report a fault.

- The Matrix provides Fault indications for; Power supply, Battery Supply, and Battery Charger Supply.

- Fault indications for Program and configuration errors in compliance with BS5839.

- The matrix has watchdog circuits (identifies processor errors) on it’s CPU and message cards.
Battery Backup

- Voice Alarm Systems require battery Backup to comply with BS 5839 pt 8 or local standards

- Standby battery units provide a self-contained 24V DC supply. Sized to provide the standby supply capability required (more kit = more batteries).

- Typically 24 hours standby (no calls) followed by 0.5 hour Full Alarm
Network Voice Alarm Overview
Voice Alarm Network

• Voice Alarm standards apply to a network if the network is used for Emergency communication.

• Each rack operates as a stand alone equipment.

• Each audio and data line is monitored

• Dual redundancy allows broken lines to be bypassed by automatically switching to the working line

• Each microphone or fire interface on the system can be programmed to access any zone (or group) on the system.

• The whole network can be programmed from any network node

• Network interface unit operates as a physical bypass unit in event of equipment failure or for maintenance.
- Dual redundant Audio lines

Network Interfaces

Two Audios Clockwise

Two Audios Anti-clockwise
Dual redundant Data lines

- Main Bi-directional databus
- Backup Bi-directional databus

Data In/Out

Data In/Out

Data In/Out

Data In/Out
Acoustic Design
Loudspeakers

- There are 5 main types of loudspeaker:
  - Ceiling mounted.
  - Surface mounted (Cabinet).
  - Column.
  - Projection.
  - Horn
ACOUSTIC DESIGN

When selecting loudspeakers for a particular application, there are two basic requirements to take into account.

1) Sound Level

2) Intelligibility

Output level should be such that messages can be comfortably heard by all people with normal hearing in 95% of the area.

The information must be intelligible (understood)
**SOUND PRESSURE LEVEL (SPL)**

- Sound pressure level (loudness) measured in decibels (dB).

- “Sensitivity” of speaker is a measure of it’s efficiency.

- Sensitivity = SPL at a distance of 1 metre with a speaker input level of 1 watt.
SOUND PRESSURE LEVEL (SPL). How loud it is

- **Power**
  - Each time the power input to loudspeaker is doubled the output level increases by 3 dB. E.g., a loudspeaker having a sensitivity of 90 dB 1W/1m;
    - 1W = 90dB (@1m)
    - 2W = 93dB (@1m)
    - 4W = 96dB (@1m)

- **Distance**
  - Each time the distance from the speaker is doubled, sound level will decrease by 6 dB. E.g., a loudspeaker having a sensitivity of 90 dB 1W/1m tapped at 1W;
    - 90dB @1m
    - 84dB @2m
    - 78dB @4m
Intelligibility

- Voice Alarms should meet the requirements of British Standard BSEN60849
- Meet or exceed a CIS of 0.7; Speech Transmission Index (STI) of 0.5
- STI is a measure of how well a broadcast can be understood. 1 = best, 0.1 = worst
- RASTI (Rapid Assessment of Speech Transmission Index) Computer based programme using coded digital “noise”
- Affected by signal to noise, reverberation, time delays (echo)
Loudspeaker positioning

- Loudspeakers should be distributed evenly over the site to avoid local areas of excessive output (too loud) or blind spots (too quiet).
Loudspeaker selection

- Loudspeakers may be:
  - omni-directional; flush mounting ceiling, cabinet and sphere speakers
  - bi-directional; sound omitted from each end of, typically, a horizontal cylinder
  - uni-directional; horn speakers, columns, phased arrays
**Loudspeaker selection**

- **Ceiling Speakers**
  - flush mounted in suspended ceiling panels
  - spring clips or screws
  - provide good wide coverage

- **Typical applications**
  - Offices, schools, hospitals, shops, airport lounges
Loudspeaker selection

- **Cabinet Speakers**;
  - Wall/surface mount

- **Typical applications**;
  - Escape stairs, store rooms, kitchens

- **Column Speakers**
  - More than one cone speaker mounted in an enclosure
  - Typically 4 to 10 cones mounted vertically
  - Creates very directional beam of sound

- **Typical applications**;
  - Airport check-in halls, sports halls, churches
Loudspeaker selection

- Horn Speakers
  - Directional beam
  - Higher sound pressure levels as they are more efficient
  - Ideal for outdoor and industrial use.
  - Explosion proof available suitable for hazardous area installation.
  - The frequency range small therefore not suitable for high quality music broadcast (except “music horns”!)

- Typical applications;
  - Factories, power stations, car parks
System Check List

- **Type of System**
  - Public address
  - Voice Alarm

- **Site Conditions**
  - Industrial;
  - Factory
  - Warehouse
  - Intrinsically Safe
  - IP rated
  - Marine;
  - Cruise liner
  - Offshore industrial
  - Merchant ship
  - Office
  - MOD/Military
  - Leisure Centre
  - Shopping Centre
  - Airport

- **Type of Job**
  - New system
  - Upgrade to existing system
  - Replacement of existing system

- **Information provided**
  - Detailed specification
  - Drawings of site including speaker locations
  - Zone and loudspeaker tapping schedule
  - Drawings of site without speaker locations
  - No specification
  - Rough specification, no detail
  - Bill of quantities
System Check List

- System inputs
  - Messages:
    - Evacuate
    - Alert
    - Test
    - Bomb Alert
    - Security
    - Other
  - Microphones:
    - Multiple button microphone
    - Single button microphone
    - Fireman’s emergency microphone
    - Rack mounted microphone
    - Custom microphone (ie panel mount)

- Background music
  - CD Player
  - Tuner
  - Cassette player
  - Other music source

- Background music zone controller
- Fire alarm interface
- Digital loop Interface
- Closing contacts
- Telephone interface
- Telephone interface with zone selection
- Telephone interface without zone selection
System Check List

- **System outputs**
  - Number of Zones
  - A & B Circuits?
  - Volume controls
  - Zone loading
  - Induction Loops;
  - Desk top
  - Small area
  - Medium area
  - Large Area
  - Infra-red

- **Loudspeakers**
  - Ceiling speaker quantity
  - Cabinet speaker quantity
  - Horn speaker quantity
  - Music horn speaker quantity
  - Projector speaker quantity
  - Explosion proof speaker quantity
  - Clean room speaker quantity
  - Swimming pool speaker quantity
  - Xenon beacon quantity

- **Other considerations**
  - BS5839/BSEN60849 compliant
  - Battery backup
  - Percentage spare capacity
  - Percentage future capacity
  - Ambient Noise sensing
  - Graphic equalisation
  - Background noise levels
  - Required SPL
  - Required RASTI
System example; Factory

Requirements;

- Voice alarm in all internal areas plus some external
- Fireman’s microphone
- Security microphones
- Time signal generator
- Reception microphone
- Background music
- CCTV Message (“You are on camera”)
System example

- Requirements;
  - Warehouse, assembly & picking areas; background music, time alarm calls, fire alarm calls and general paging
  - Offices; fire alarm and general paging
  - Restaurant; background music, time signals, fire alarm and paging
  - Reception; Paging microphone, fire alarm and paging
  - Gatehouses; Paging microphone, fire alarm and paging
  - Entrance; Fireman’s microphone
System example

- Offices, reception, canteen; Quiet, suspended ceilings. Ceiling speakers (0.75W)
- Computer room; Noisier, solid roof. Cabinet speaker (1.5W)
- Assembly; Noisy (machines), large spaces, open ceiling. Projector speakers mounted on pillars (7.5W)
- Garage, goods in, despatch; Noisy (vehicles), open ceiling. Horn speakers mounted on walls (7.5W)
- External areas (despatch, car park); Large spaces, weather. Horn speakers on walls and pillars (15W)
Hardware

The system requires:

- Audio matrix with messages
- Amplifiers
- Fire alarm interface
- Batteries
- Fault monitoring system
- Speakers
- Microphones (paging and fireman’s)
- Music source
Example; Small supermarket

SIMILAR APPLICATIONS
- Small department stores.
- Works canteens

REQUIREMENTS
- Speech and music installation.
- Background music with interrupt for announcements and advertisements.
- Calls must have priority.
- Selectable live announcement routing.
- Mic in office must have priority over cashier.
Sound Engineering for 60 Years

- Z1 Stock
- Z2 Canteen
- Z3 Supermarket

Zone selection Paging mics

Amplifier/Matrix

Multidisk CD Player
Example: Department Store

- SIMILAR APPLICATIONS
  - Factories.
  - Industrial sites
  - Sport complexes
  - Hotels
  - Museums
  - Small airports
  - Mic in office must have priority over cashier.
**Example; Department Store**

### REQUIREMENTS

- Voice alarm
- Speech and music installation.
- Background music with interrupt for announcements and advertisements.
- Calls must have priority.
- Selectable live announcement routing.
- Mic in office must have priority over cashier.
Example; Research campus

- REQUIREMENTS
  - Voice alarm over a large site
  - Paging between buildings
  - Networked matrices providing coverage over all site
  - All microphones able to call any building and any zone