STRENGTH

Brand Partners Products

31ST ANNUAL LEADERSHIP CONFERENCE

Refresher Low Frequency and Speaker Intelligibility

John Holba
Product Manager
System Sensor

NOTIFIER® by Honeywell

Honeywell Internal

Agenda

Overview of L-Series Speaker and Speaker Strobe Hold

Why Low Frequency?

Standards

Product Options

Case Studies and Applications

Speaker Design Best Practices for improved Intelligibility

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Low Frequency
Regulation and Standards

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Importance of Smoke Detection

- **Statistics show that smoke detectors and fire alarm systems save lives**
- **Commercial fire deaths have decreased almost 80%**
- **Hotel and motel fire deaths have decreased from 74% since 1980**
- **Home fire deaths have decreased 55% over the last 40 years**
  - Detection: 22% in 1977, now 96%

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Challenges for further Improvement

Factors that limit an occupant's ability to safely exit the dwelling or building during a fire.

- **Escape Time = RSET and ASET**
  - Required Safe Egress Time (RSET) = Notification + Activities + Exit
  - Available Safe Egress Time (ASET) = Visibility + High Temp + High CO

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Challenges for further Improvement

Available Safe Egress Times has greatly decreased

- **ASET Change 1975 = 17minutes compared to 2007 3.5 minutes**

- **Houses are bigger**
  - 1973: 1660 ft^2
  - 2010: 2392 ft^2

- **New Materials**
  - Construction: Real wood to engineered wood
  - Furnishing: Natural materials replaced with Synthetics



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Comparison of Room Furnishings
Legac
Comparison of Room Furnishings
Legacy Roo
Comparison of Room Furnishings
Legacy Room
Modern Room
03:30
Underwriters Laboratories

Areas for further Improvement

Waking Effectiveness

- **50%** of fire fatalities in residential buildings between 10 p.m. and 6 a.m.

Research (2008 Thomas and Bruck)

Standard tone, Low Frequency, bed/pillow shakers, strobe lights

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Waking Effectiveness Study (Thomas and Bruck)

Typical adults awaken quickly to the Standard fire alarm tone [2]

- Most fire alarm **horns** produce a 2KHz-4KHz audile alarm signal
- Most **smoke alarm sounders** produce a 3KHz audible alarm signal

High Risk Groups are a problem (Civilian Residential):

- **Young Children**: 13% under the age of 10 [1]
- **Elderly**: 45% between the ages of 40 and 69 [1]
- **People with Hearing Loss:** More than 34.5 million people in the US are hard of hearing [3]

520Hz
6-10 Times More Effective

520Hz
64% More Effective

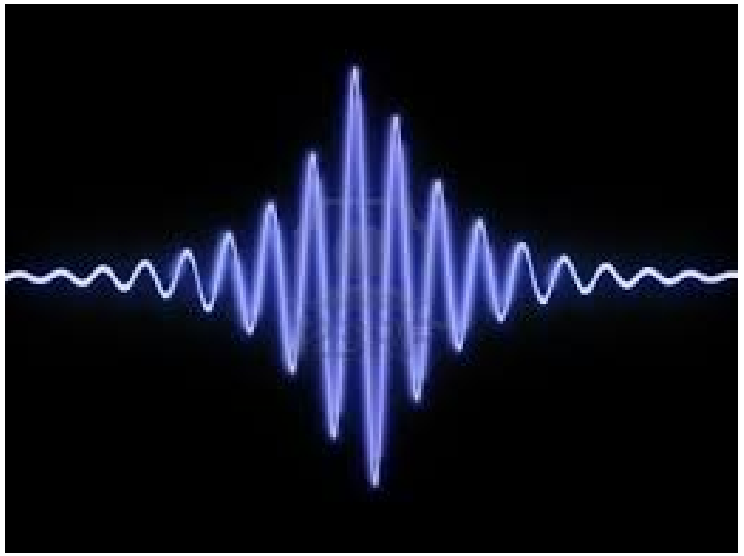
Source: :

1. *USFA, Civilian Fire Fatalities in Residential Buildings 2008-2010 Report*
2. Awakening of Sleeping People – a Decade of Research, Ian Thomas and Dorothy Bruck July 2008
3. *Waking Effectiveness of alarms for adults who are hard of hearing, NFPA Dorothy Bruck, Ian Thomas June 2007*

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Demo

3.1KHz EM Tone versus the Low Frequency Tone



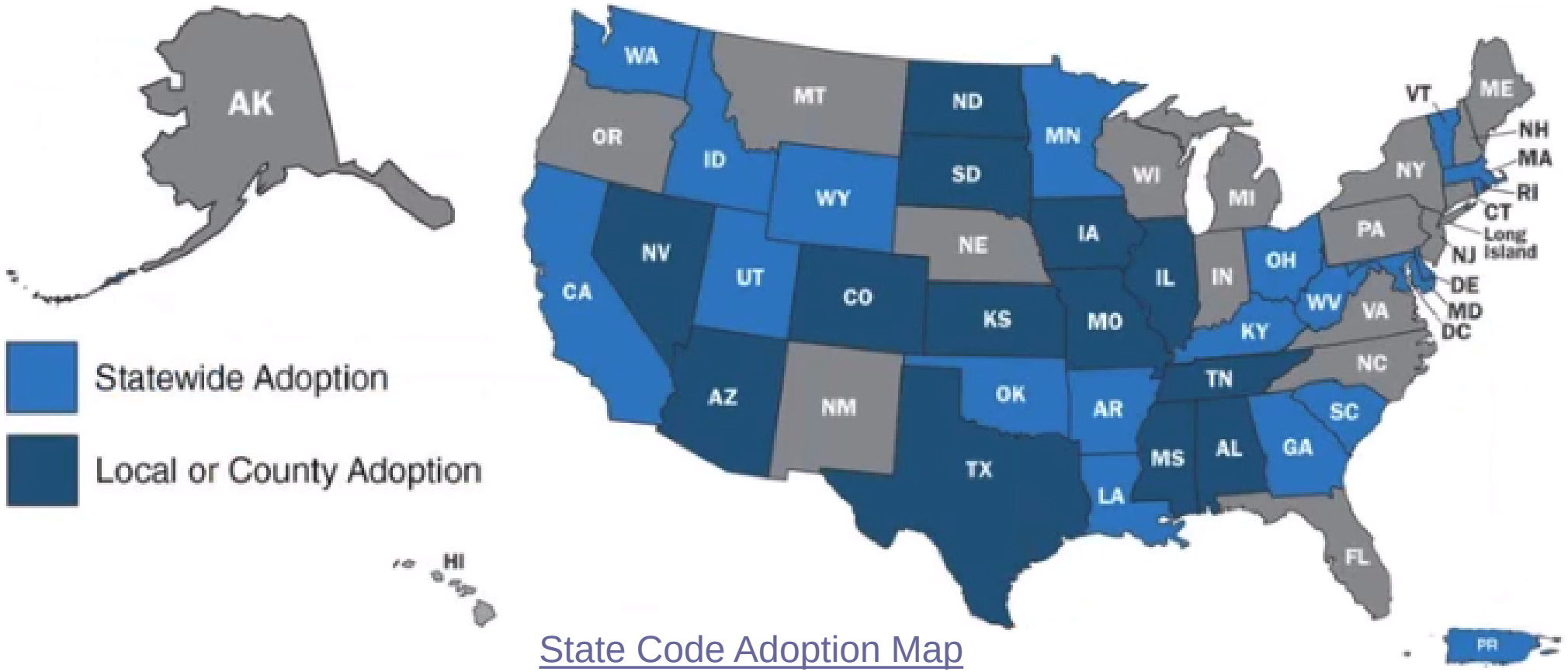
3Khz



520Hz

Why Low Frequency? Standards

2012 IBC/IFC Adoptions



State Code Adoption Map
Matrix for each state

Why Low Frequency? Standards

Required by Code: coming if not already required

- NFPA 72: New Construction Chapter 18, 24, 29

  (First Compliance 2014)
- NFPA 720: LF for CO Chapter 6 and 9 (Compliance 2015)
- UL 2012: 464 and 217, Compatibility listed in FACP literature

- AHJ may require for retrofits





LOW FREQUENCY SOUNDER

Why Low Frequency? Occupancy Impacts

Group R-1 Hotels and Motels, 907.2.8.1

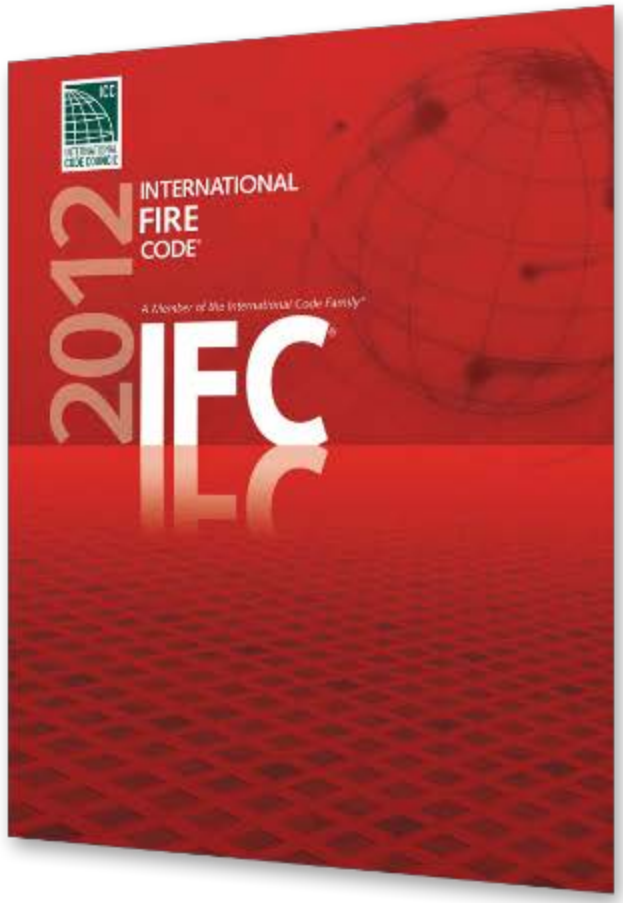
Exceptions:

1. A manual fire alarm system is not required in buildings if less than two stories where sleeping units have an exit directly to a public way, egress court, or yard.
2. Permits the fire alarm system to be activated by a sprinkler system and provide occupant notification

Group R-2 College and Universities, 907.2.9.2

Group E: Daycare and Assisted Living

- Not Required due to Trained Staff



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Low Frequency, Common Questions

Are the low frequency sounds required for retrofit applications?

- No, per NFPA 72, only in new buildings.
- Although, depending on the level of retrofit, AHJ may require low frequency sounders

Will LF sounders sync horns?

- Yes, both products use the same sync protocol

Commercial or Residential?

- Both, Ch18 all occupants with protected premise fire system, including multi family, sleeping area
- Chapter 29 cover household fire alarm detections systems, specifically with some hearing loss.

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Additional Resources

Archived Webinars

- **Posted on System Sensor web page**
- **More details on the code**
  - Low Frequency Alarms Requirements
    - Richard Roberts, Industry Affairs Manager
    - Studies and Requirements
  - Low Frequency Sounders
  - Low Frequency _CO design

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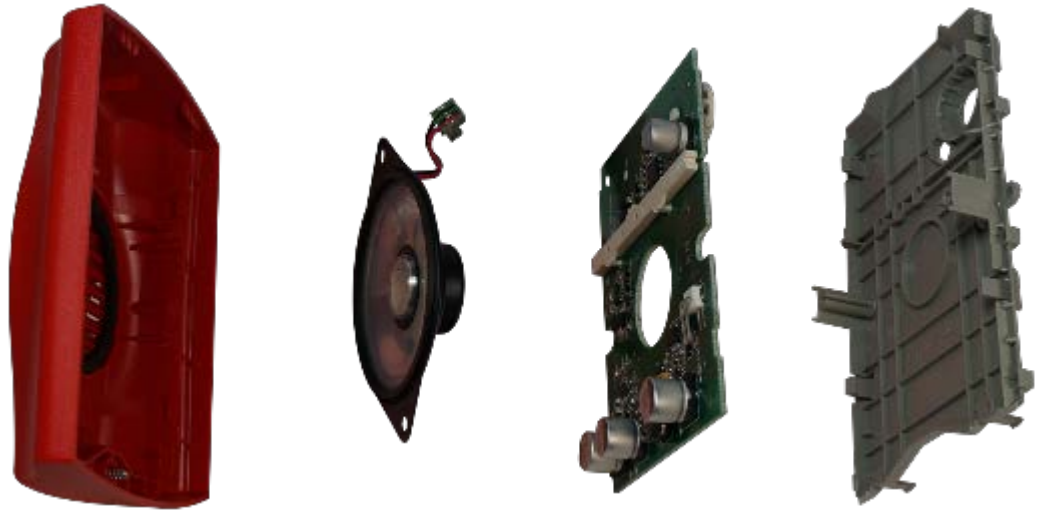
Product Options

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520 Hz Low Frequency Product Design

The custom product was designed to:

- Resonate around 520 hz
- Produce maximum sound output
- Utilize an efficient circuit design
- Keep a small footprint





Piezo



Speaker



520 Hz

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System Sensor Product Options: Sounder or Sound Strobe



P2RH-LF



P2WH-LF


HR-LF


HW-LF

Low Frequency (520 Hz) Sounder Strobes:

- Multi-Candela: 135, 150, 177 & 185
- 2 Selectable Tones: Temporal 3, Continuous
- Regulated 24 VDC/FWR

Low Frequency (520 Hz) Sounders:

- 3 Selectable Tones: Temporal 3, Continuous, and Coded
- Regulated 12 or 24 VDC/FWR

Applications:

- Hotels/Motels
- Dormitories
- Military Barracks
- Assisted Living Facilities
- Apartments/Condominiums

Can be used on Wall and Ceiling

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System Sensor Product Options: Sounder Base with Detector



Use Sounder Base with 200 Series sensor heads

Continuous, Temp 3 or Temp 4 output. Two Sound levels

Takes address of the Detector

System Sensor Sync Protocol

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System Sensor Product Options: Speaker and Speaker Strobe

Voice Requirements:

- System compatibility – FACP, amplifier, signal, and speakers
- Comply with Section 24.3 of ANSI-UL 464



L-Series Speaker and Speaker Strobes

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L- Series Standardization
Less = More

Less SKUs

Lower Carrying Costs

More Tones

Speaker Strobe



Standard Candela

High Candela

High Fidelity

High Volume

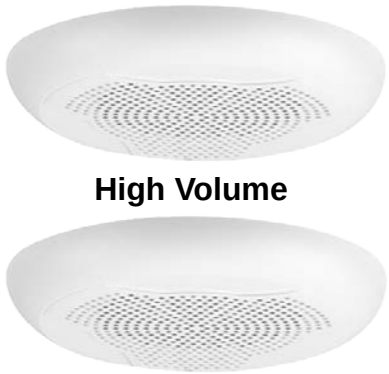
L-Series



Full Candela Range, Volume & Fidelity SPSWL

More Versatility

Speaker



High Volume

High Fidelity

Mini-Horn



3.1KHz

LF Sounder



520Hz

L-Series



Low Frequency CERTIFIED!

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Design Considerations



Power Supply Considerations

- Current Draw
- Voltage Drop
- More NAC circuits

Mini-Horn	Horn	LF Sounder	Speaker
14mA	SAA: 38mA L: 32 mA	138 mA	1/4W

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When to use each option



Dedicated Sounder or Sounder Strobe

Sounder Base

Speaker or Speaker Strobe

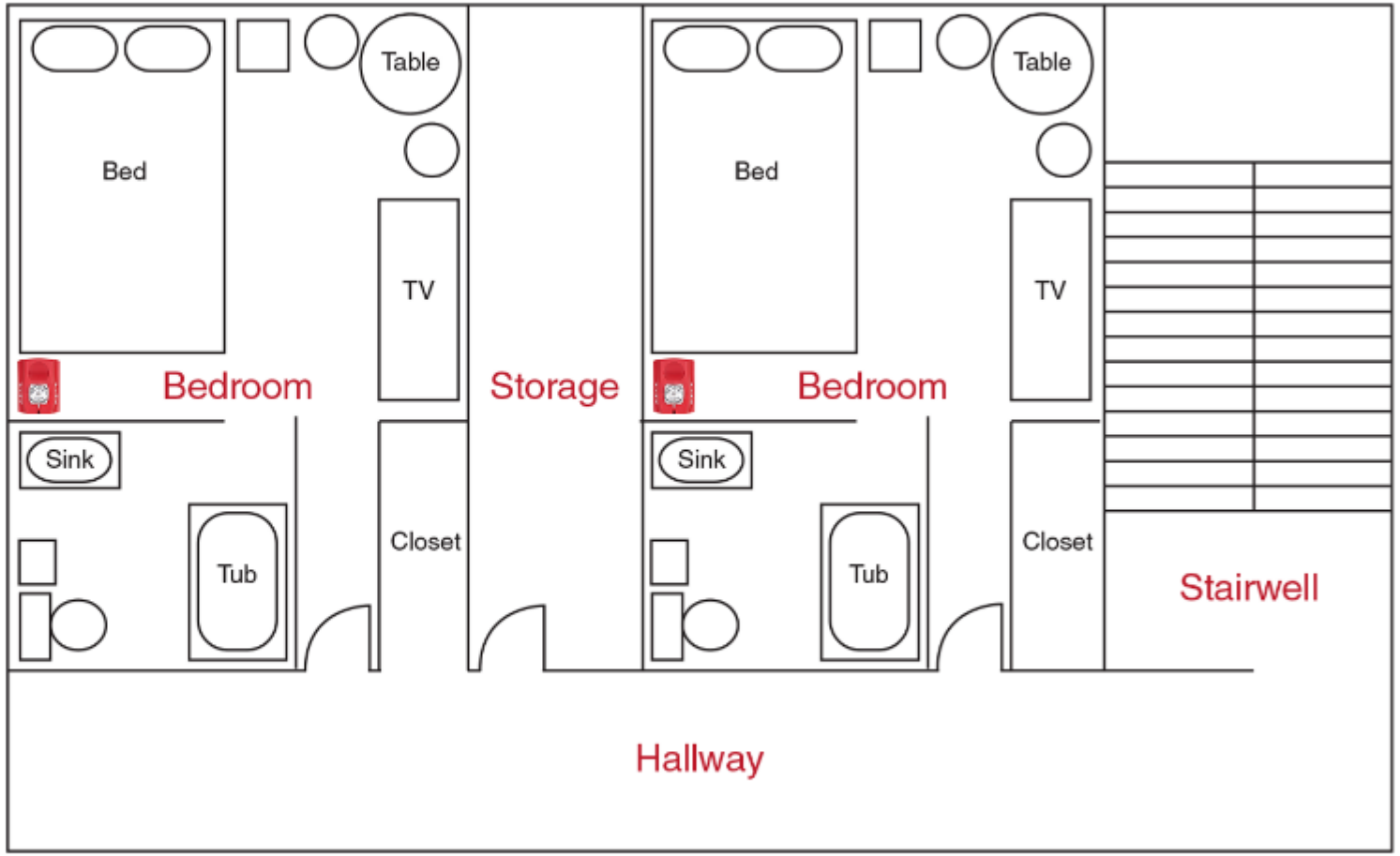
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Low Frequency Design Considerations

Different Tones

- Standard (3 Khz vs. 520 Hz square wave)
- Requirements for sleeping spaces:
  - Commercial every sleeping room

NOT required
Janitor closets, hallways, & stairwell



A.18.4.2.5 Coordination or synchronization of the audible signal within a notification zone is needed to preserve the temporal pattern.

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LOW FREQUENCY APPLICATIONS

- Examples
  - “Holiday Inn Express”
    - Local alarm only. System alarm based on hallway detector
    - Multiple Devices
    - 110v and 9 Volt battery replacement



Horn Strobe

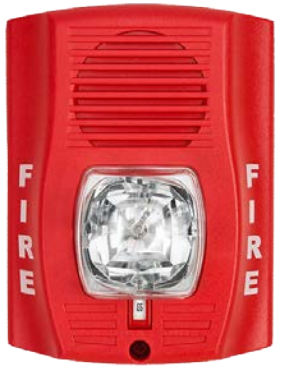
Detector





Corridor

Room

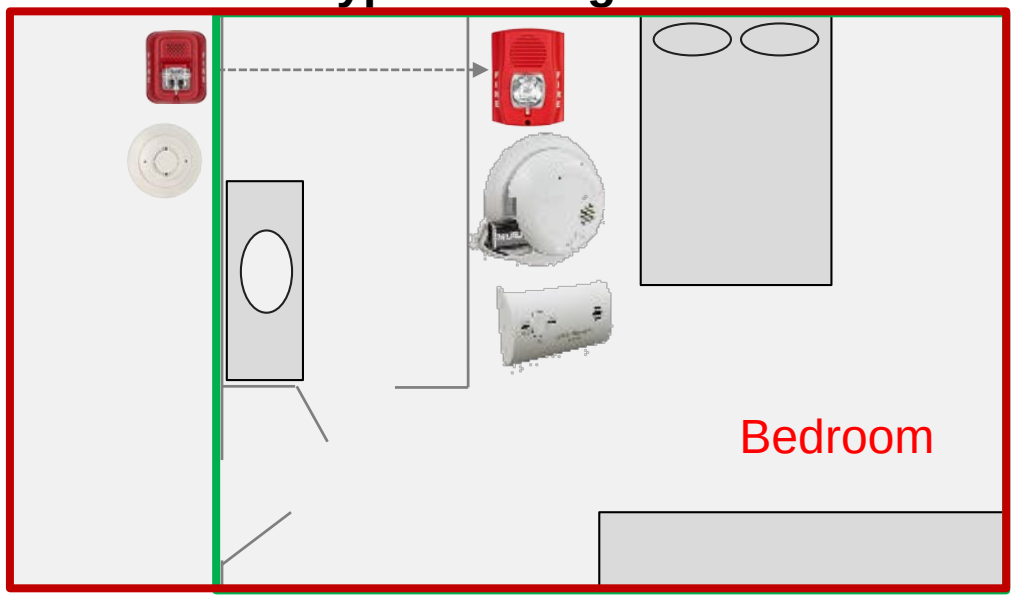




LF Sounder or
Sounder Strobe

Smoke and
CO Alarm

Typical Design



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LOW FREQUENCY APPLICATIONS

- Examples

  - “Holiday Inn Express”
    - Local alarm only. System alarm based on hallway detector
    - Multiple Devices
    - 110v and 9 Volt battery replacement

  - ALTERNATIVE
    - System alarm, in room and hallway
    - ~150 Room is breakeven
      - Speaker vs Sound
      - Less power supplies vs Amps
    - Upgradeable to voice



Horn Strobe



Detector



Corridor

Room



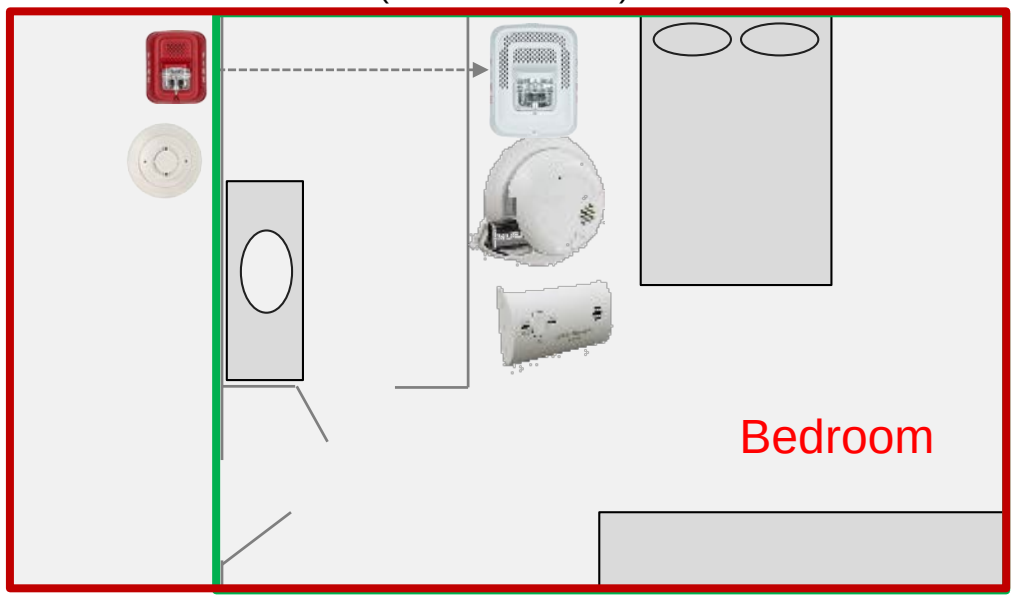
Replace LF Sounder with Speaker



Smoke and CO Alarm

Alternative Design

(~150 breakeven)



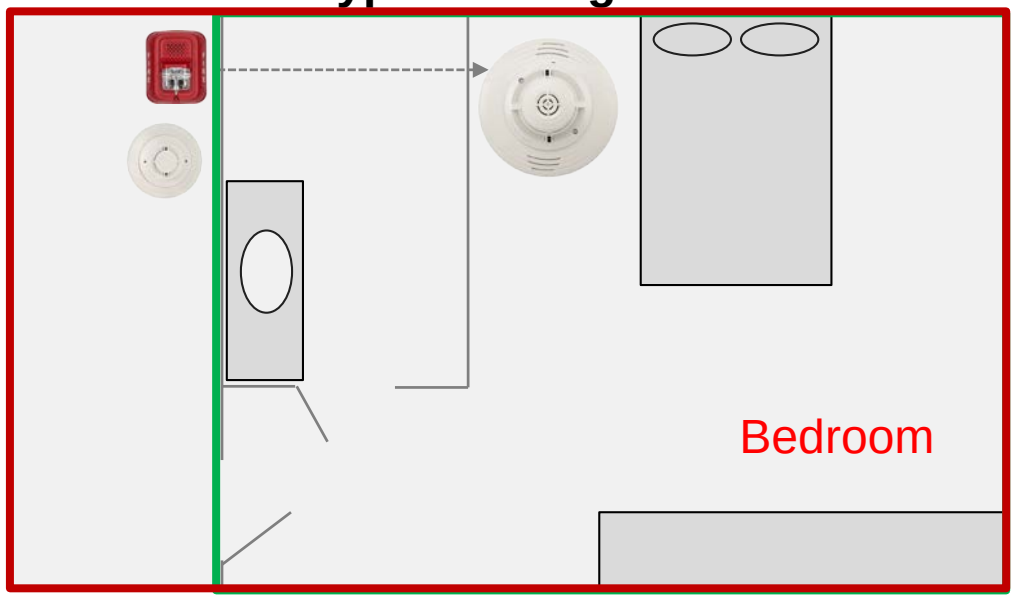
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LOW FREQUENCY APPLICATIONS

- Examples

- “Marriott”
  - Addressable System, Sounder Base
    - Local or General Alarm
    - System Detector in room
  - More Expensive
  - Single Device

Typical Design





Horn Strobe

Detector





Corridor

Room



Sounder Base



CO/Smoke Detector

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LOW FREQUENCY APPLICATIONS

- Examples

  - “High Rise”
    - Need Voice by Code
    - Local or General Alarm
    - System Detector in room
    - More Expensive



Speaker Strobe

Detector





Corridor

Room

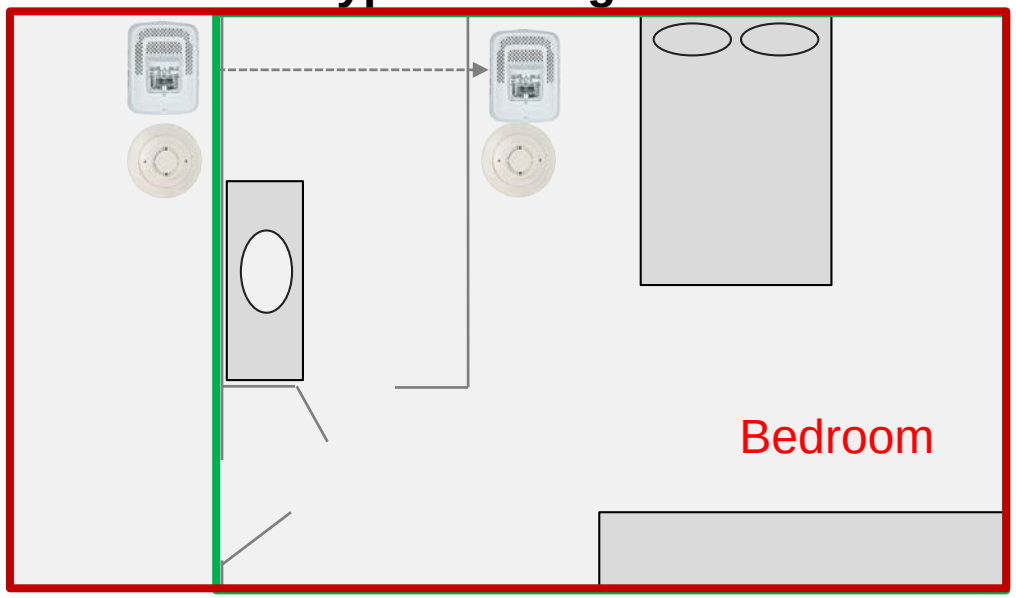


Speaker Strobe



CO/Smoke Detector

Typical Design



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Design Principles

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Voice Evacuation Systems

What's the driving factor?

- Code: Military Mass notification, high rise, large assembly areas
- Specificity: more flexibility when communicating with occupants

Key Requirements

- Public Mode = 15dB above ambient or 5dB above max, whichever is greater, 5 ft above floor
- Private Mode = 10dB above ambient or 5 dB max, whichever is greater
- Sleeping Areas = 75dB, 15dB above ambient or 5dB above max, whichever is greater, measured at the pillow

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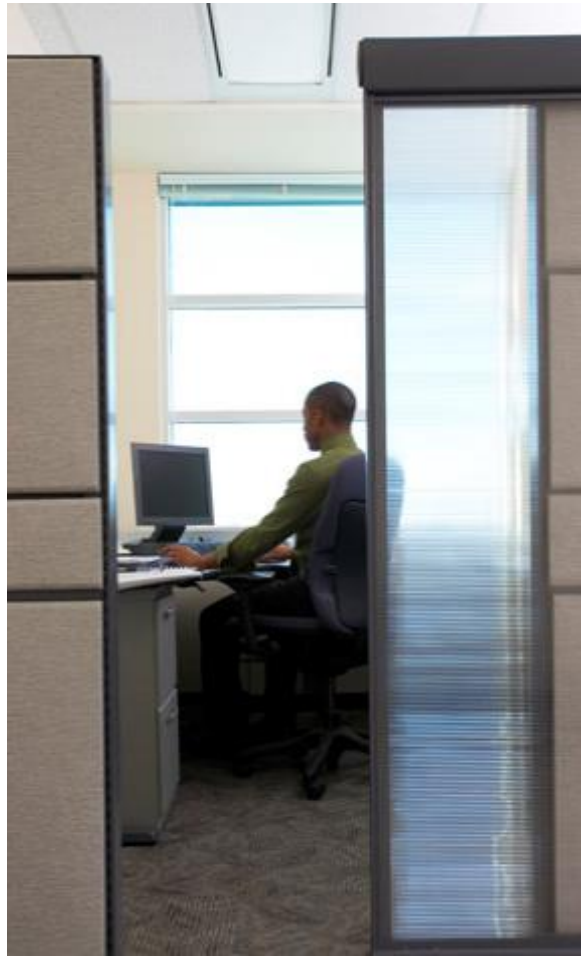
What is Intelligibility?

Intelligibility, Current Definition

- The quality or condition of being intelligible (NFPA 72, 3.3.124)
  - Intelligible
    Capable of being understood; comprehensible; clear
    (NFPA 72, 3.3.126)

Speech intelligibility is the measure of the effectiveness of speech

The measurement is usually expressed as a percentage of a message that is understood correctly



Can the building occupants understand the message accurately?

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Intelligibility in an Acoustically Distinguishably Space (ADS)

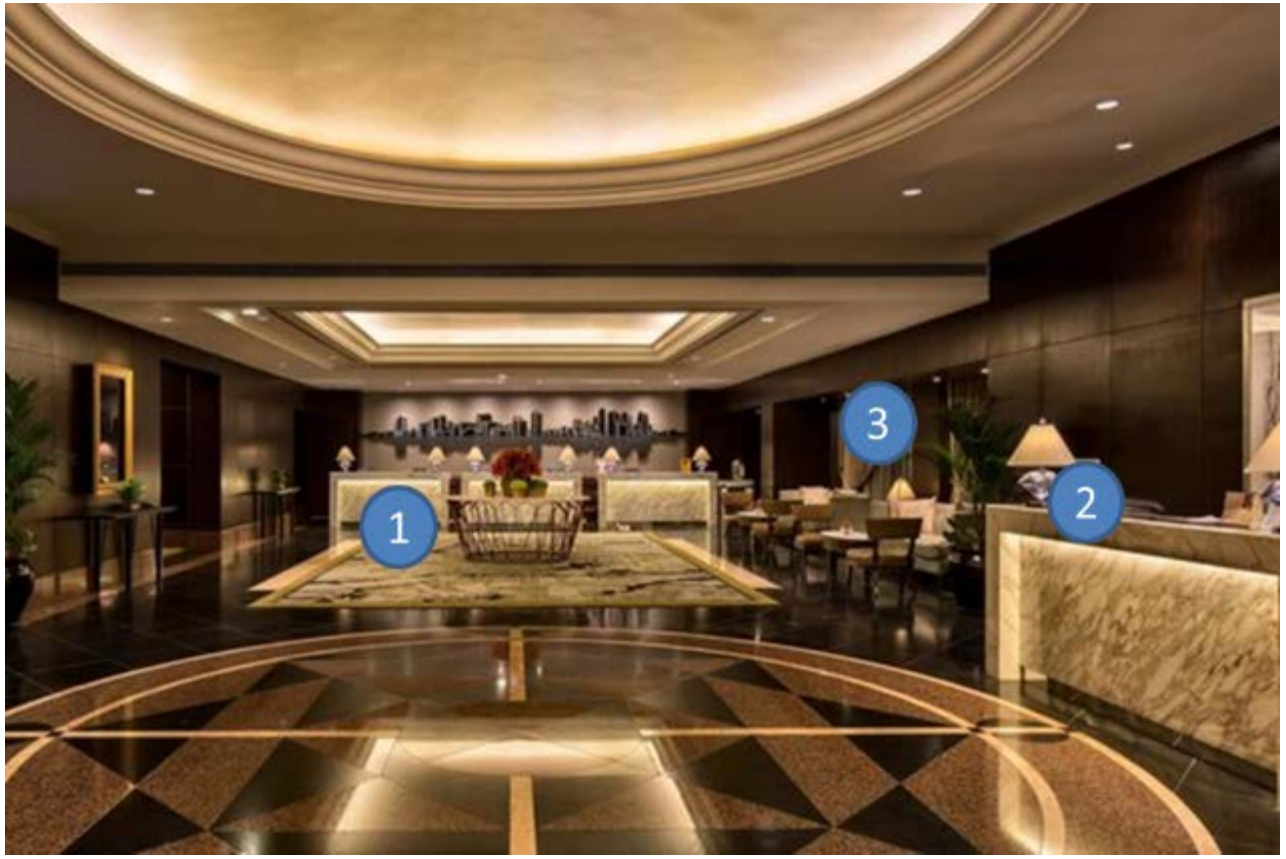
Agreed to at the beginning of the project (Chapter 18)

- Distinguished by physical barriers
- Distinguished by material changes
- Different ambient sound levels

Intelligible versus non-intelligible

- Define spaces with AHJ
- Avoid testing in areas that are “impossible”

The intention of code language:
AVOID OVER-DESIGN



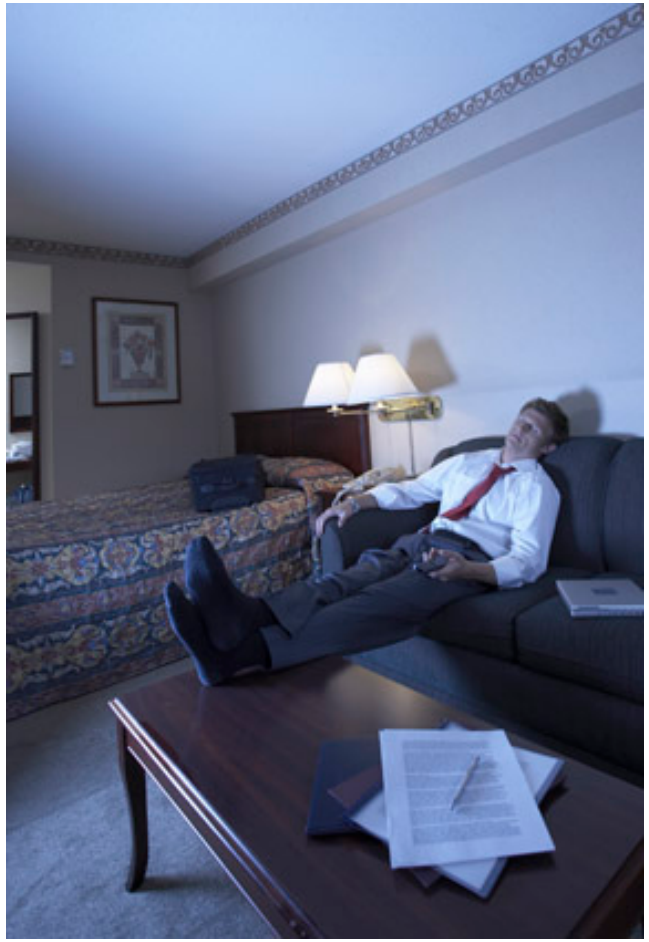
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Required But Not Measured

- **Intelligibility in certain small spaces**

- **Examples**
  - Hotel room
  - Certain office environments
  - Audibility requirements must be met

- **Meet audibility requirements only**



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Factors That Affect Intelligibility

Not an item on a Data Sheet, many variables affect Intelligibility

Factor	Key Drivers
Frequency response	Speakers, audio equipment
Harmonic distortion	Speakers, audio equipment
Signal-to-noise level	Speakers, spacing, speaker volume, ambient sound level, etc.
Echoes and reflections	Materials used in room or area, obstructions, speaker placement, etc.
Talker ability	Accents, dialects, diction, frequency of voice, etc.
Listener ability	Sensitivity of listener's hearing



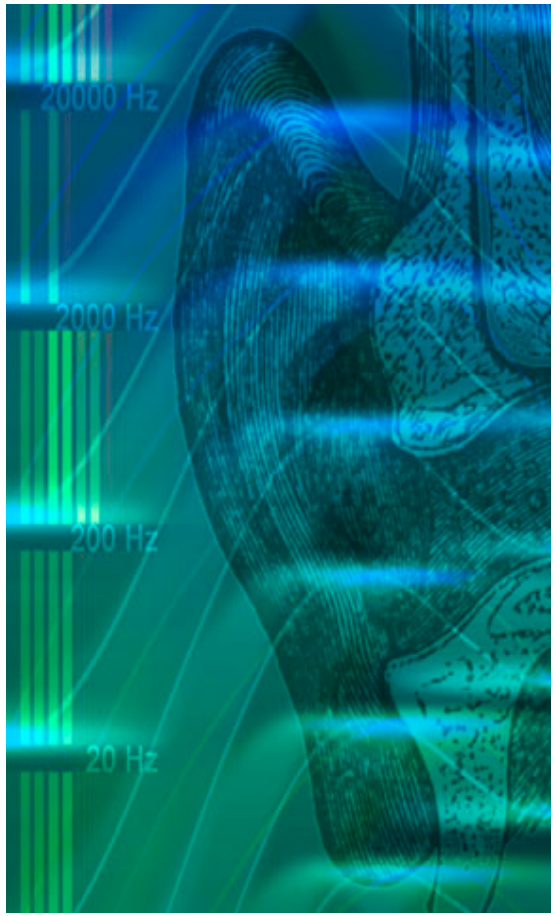


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Frequency Response

What's the driving factor?

- Ideal range: 150 – 11000 Hz
- UL 1480 requires 400 – 4000 Hz
- Average human listening range: 200 – 5000 Hz
- Frequency response should be as flat as possible for the most intelligible sound



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Harmonic Distortion

The average listener can detect 2% total harmonic distortion (THD)

15% distortion is considered to be non-intelligible

Contributing Factors

- Tolerance of the message generator and amplifier
- Loading of the audio amplifiers (load vs. available power)
- Mechanical factors
  - Wires touching the cone of the speaker
  - Excessive voltage drop in speaker line
  - Damaged speakers, excessive vibration

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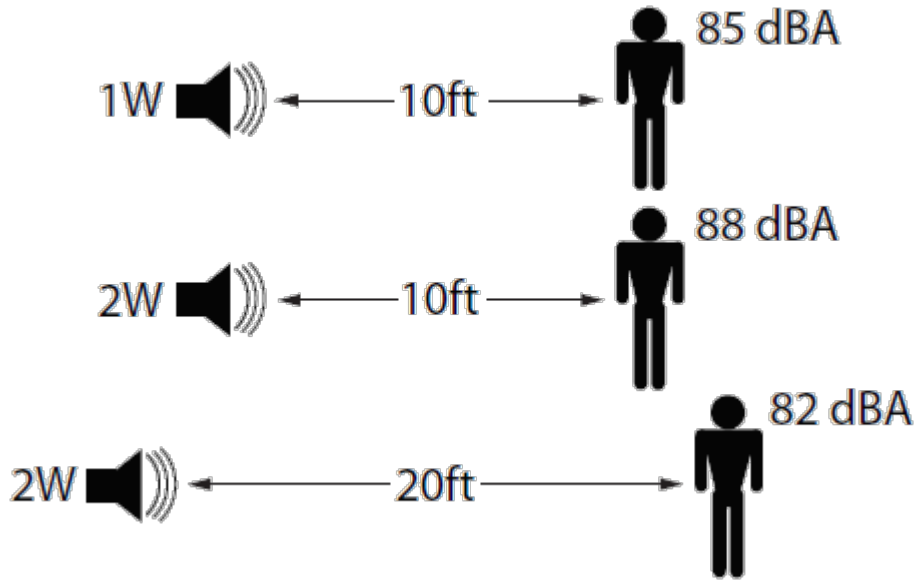
Signal-to-Noise Ratio

Initial sound signal (in dB) compared to the background (or ambient) sounds

Basics of Sound

- Decibel and Sound Pressure are based on logarithmic equations
- Number of Speakers and Distance are critical variables

	Case A	Case B	Case C	Case D	Case E
Speaker 1	85dB	85db	85db	80db	80dB
Speaker 2	-	85db	85db	10x	90dB
Speaker 3	-	-	85db		-
Total	85dB	88dB	89.8dB	90dB	90dB



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Design Applications

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Reverberation

Closely spaced echoes that cannot be distinguished

Minimizing reverberation is key to achieving acceptable intelligibility

Factors influencing reverberation

- Room size (volume and surface area)
- Reflective properties of room surfaces
  - Materials
  - Obstructions
- Speaker orientation (minimize reflections)
- Decibel output



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Tips for Achieving Intelligibility

Avoid installing wall-mounted speakers in large rooms with ceilings up to 15 ft. in height

Avoid installing 2W fire alarm speakers on ceilings that are greater than 20 ft. in height.

- L-Series 8W, 8” speakers is new option



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Speaker Placement

In general, use the same design rules for speaker placement as fo for *audible* Notification Appliances.

Be sure to cover small, isolated areas and pockets.

NFPA requires at least two speakers be installed in each “notification zone” within the facility.

While code requires speaker to be installed in areas of assembly, it is recommended that the entire facility have speakers.



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Speaker Settings

Loudness

- Needs to be loud enough to be heard, after that, diminishing returns or worse
- System Sensor speakers have selectable tap settings at ¼, ½ , 1 & 2 watts

Other Considerations to remember

- Building occupant activities
- HVAC systems noise
- Vehicular traffic noise
- The listener



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Speaker Coverage Example 1

Design Details:

- Ambient Noise Level = 52 dB
- Target Measurement = 67dB
  - 15 db Above Ambient

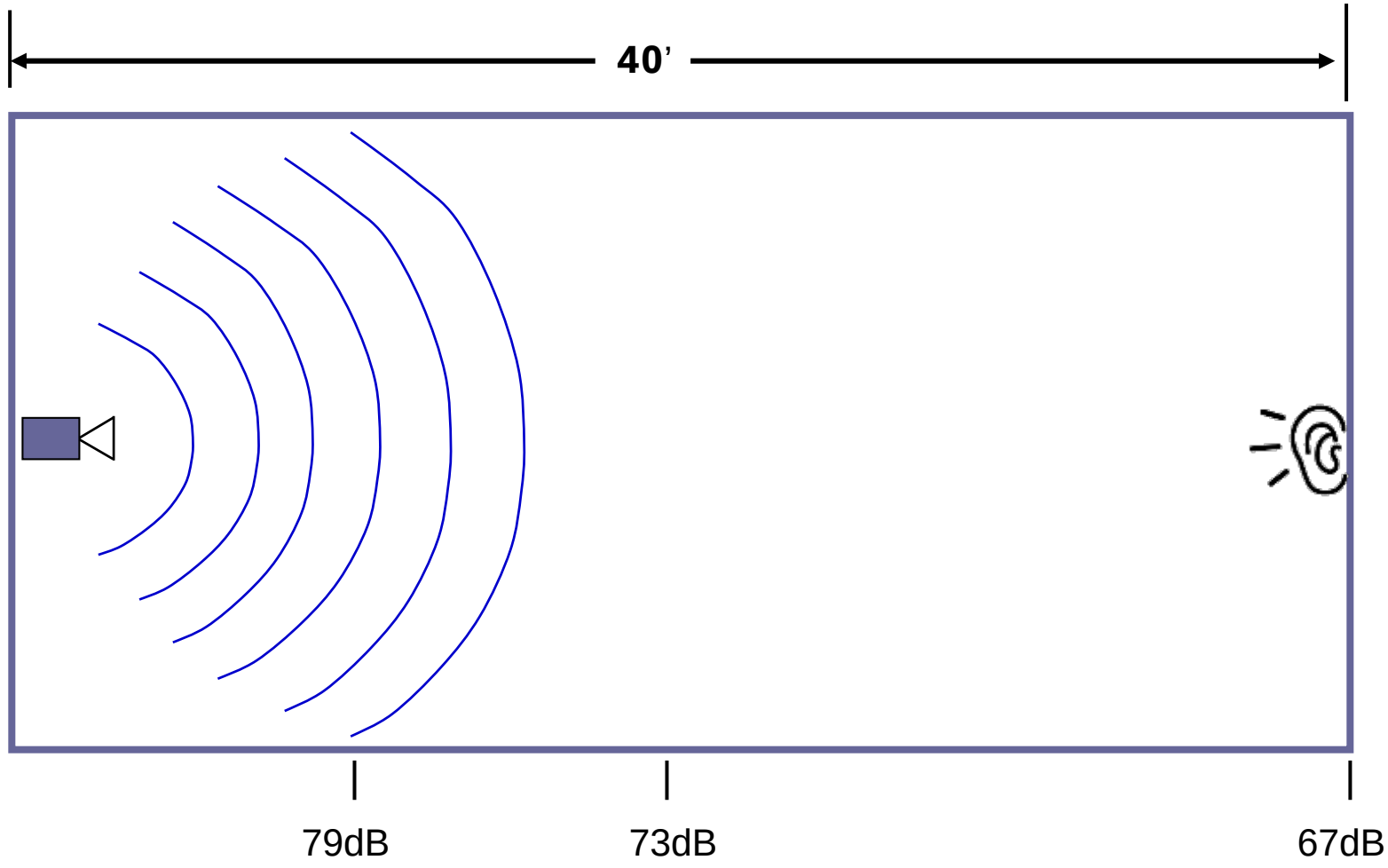
Implementation:

- Single Speaker

79 db @ 10 ft

73 db @ 20 ft

67db @ 40 ft



Lose 6 dB every double distance

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Speaker Coverage Example 1

Design Details:

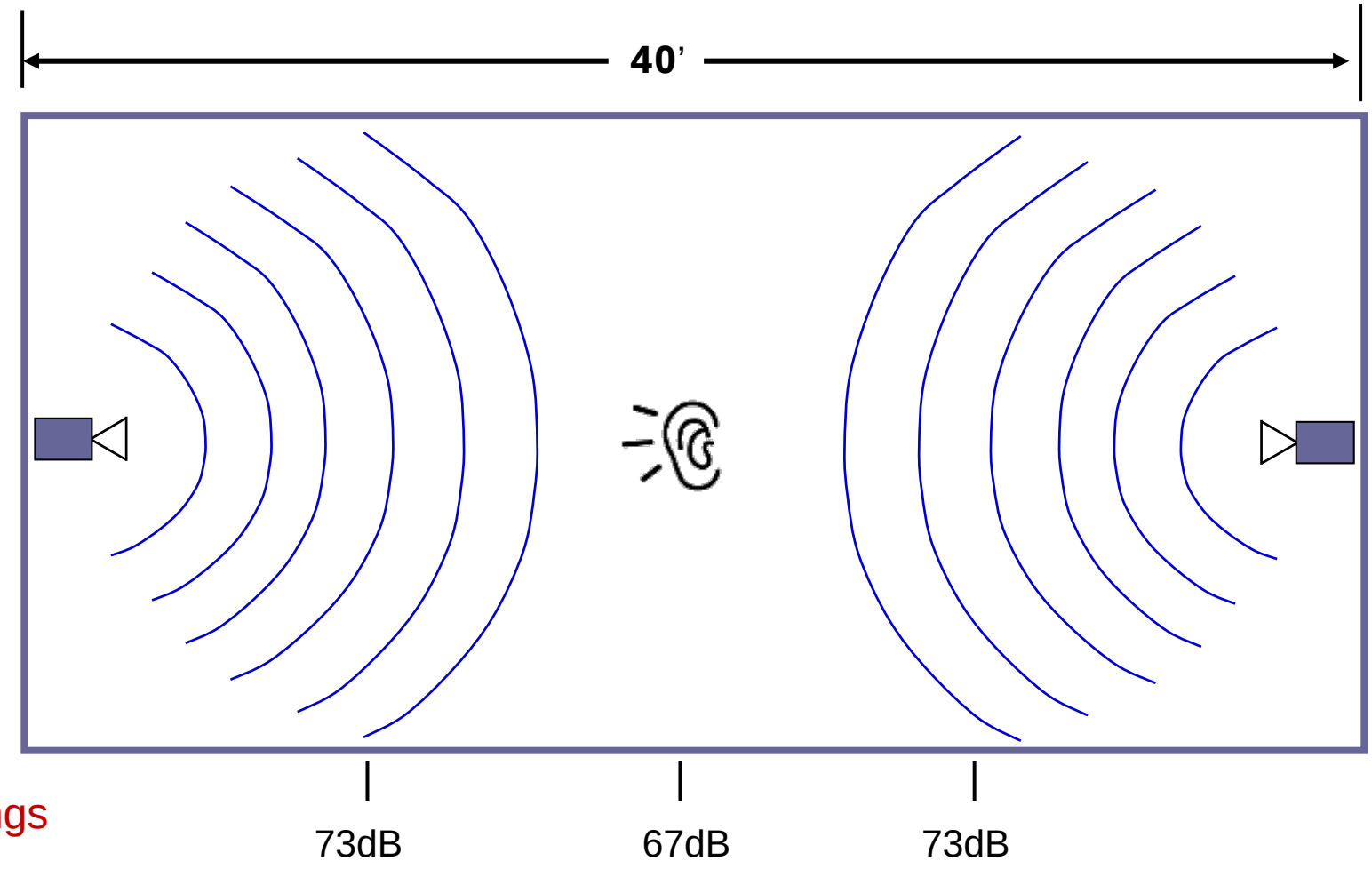
- Ambient Noise Level = 52 dB
- Target Measurement = 67dB
  - 15 db Above Ambient

Implementation:

- Two Speakers

  73 db @ 10 ft

  67 db @ 20 ft

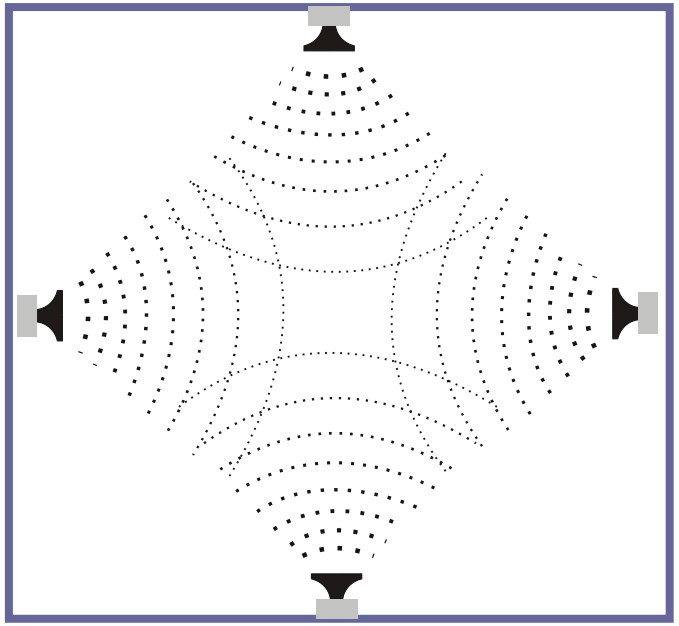


Lose 6 dB every double distance

Improved Intelligibility, Lower volume settings

Speaker Coverage Example 2

Clusters of speakers set at lower taps and mounted on columns in large areas such as in manufacturing or warehouses provide better fidelity and distribution of sound.



1 watt

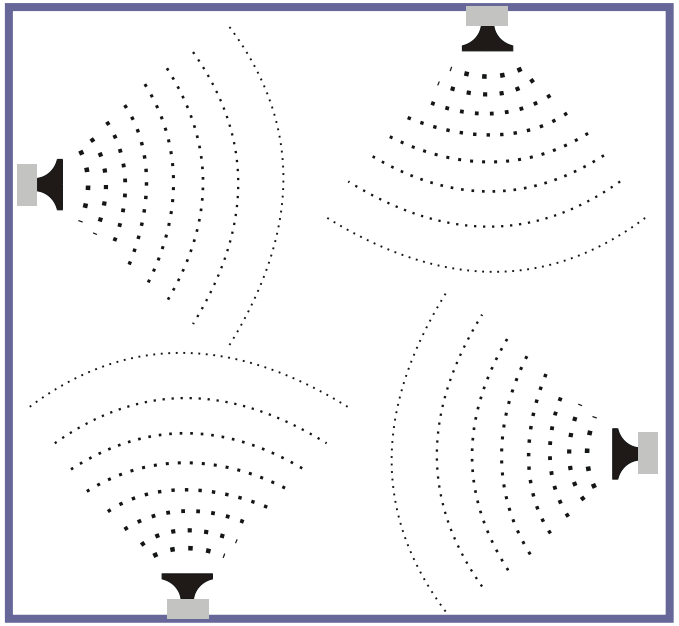
Four ¼-watt Speakers

Significant Reverberation

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Speaker Coverage Example 2

Clusters of speakers set at lower taps and mounted on columns in large areas such as in manufacturing or warehouses provide better fidelity and distribution of sound.

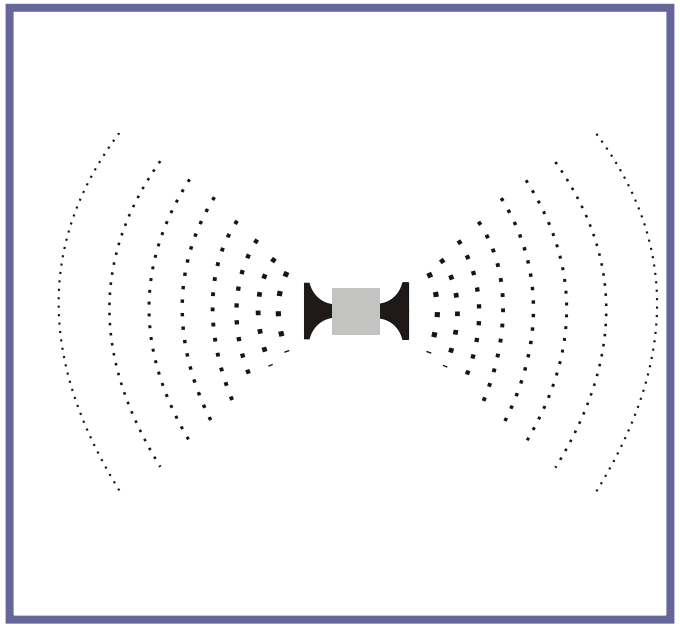


1 watt

Four ¼-watt Speakers

Better Coverage

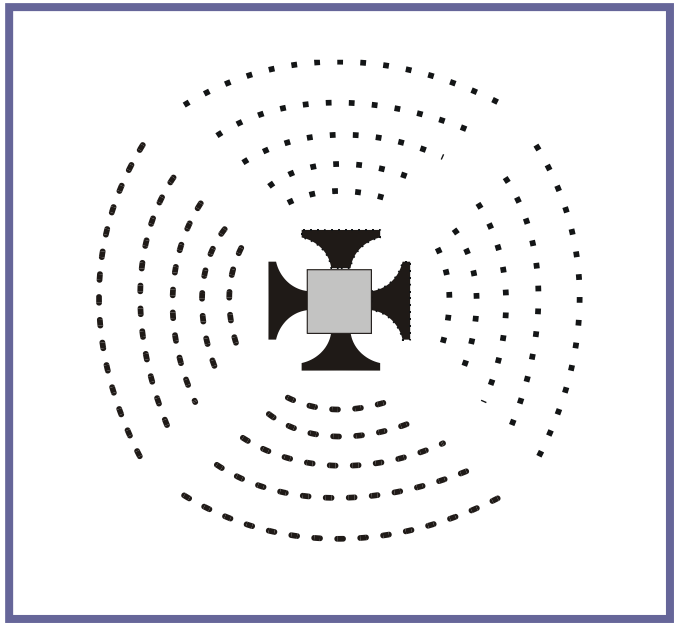
similar to strobe spacing



2 watts

Two 1-watt Speakers

Better Option



1 watt

Four ¼-watt Speakers

Improved Intelligibility

System Sensor Speakers:

Expanded Offering - Speaker



We now offer an 8” Speaker and Tile Bridge

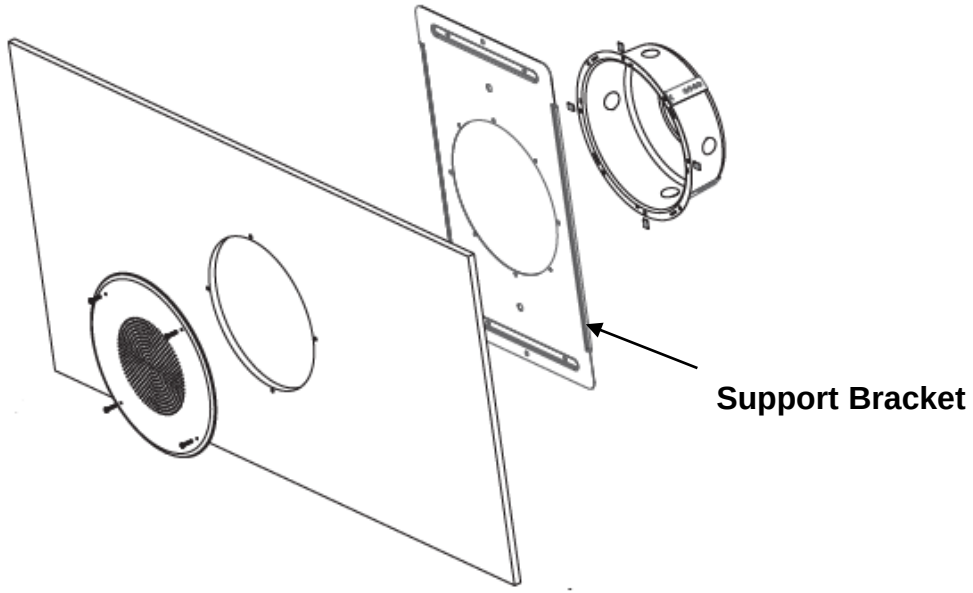
SPCW8 – 8” Speaker with Back Can

- Tap setting: 1/8W, ¼W, ½W, 1W, 2W, 4W, 8W
- Dual Voltage: 25 and 70 V
- Tap setting and voltage selected by use of jumper connection

Ships with a Back Can for surface mounting

SB-SPC8 Tile Bridge for ceiling tile application

- Purchased separately
- Packaged 4 per



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L-Series Standardization
Less = More

- Standard based product with new bezels make customization even easier

- ECS and MNS - Bezels are faster and cleaner
  - Saves time and money as compared to decals

- Bezel Offering: (Wall and Ceiling)
  ALERT, EVAC, AGENT, FUEGO, FOGO

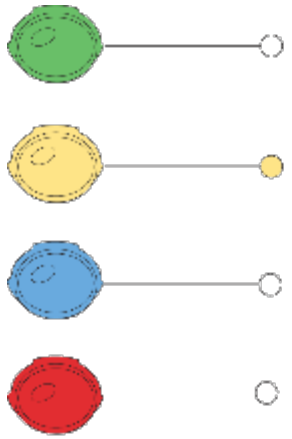


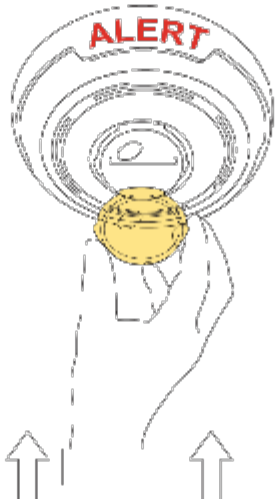














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Roadmap: System Sensor AV

L-Series Design Enhancements

2017	2018	2019



L-Series Indoor



L-Series 4-Wire



Expansion Plate



Low Frequency



Outdoor

Thank You

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