POOLE FIRE PROTECTION

Understanding Emergency Communication Systems, Risk Analysis, and Voice Intelligibility

Jack Poole, PE, FSFPE

May 5, 2015

Introduction

Jack Poole, PE

- Graduate from Univ. of Md., BS in FPE
- Poole Fire Protection – Est. in 1991
- Licensed PE in FPE (52 states & territories)
- Member of NFPA, SFPE, ICC and ABPA
- Member of multiple NFPA Technical Committees, including NFPA 72, NAC
- NFPA Board of Directors, Aviation Section
- 29 Years of Fire Protection Experience

U.S. DEPARTMENT OF ENERGY

Topics to Be Covered

Emergency Communication Systems (ECS)

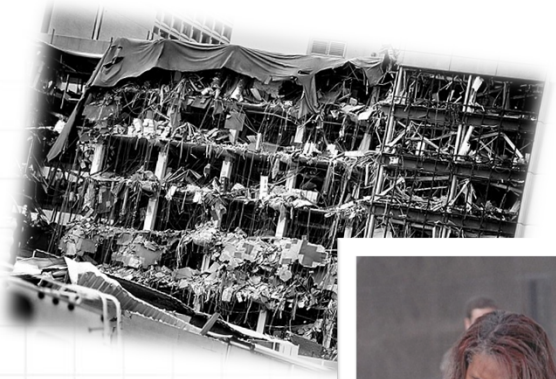
- **Paradigm Shift and Industry Changes**
- **What is an Emergency Communication (Mass Notification) System?**
- **Who is qualified to design these systems?**
- **What is a "Risk Analysis", and Why?**
- **What are some system design considerations?**
- **How are these systems tested?**

U.S. DEPARTMENT OF ENERGY

Unfortunate Historic Events

Weather Events

- Joplin Tornado
- Hurricane Katrina
- Japan Flood



Terroristic Attacks

- World Trade Center 93’ & ‘01
- Yale University (Unabomber)
- Murrah Building

U.S. DEPARTMENT OF ENERGY

Unfortunate Historic Events

Nuclear & Chemical Attacks, Spills & Contamination

- Bhopal Gas Tragedy, India
- Three Mile Island

Base/Campus Shooters and Snipers

- Virginia Tech
- Fort Hood

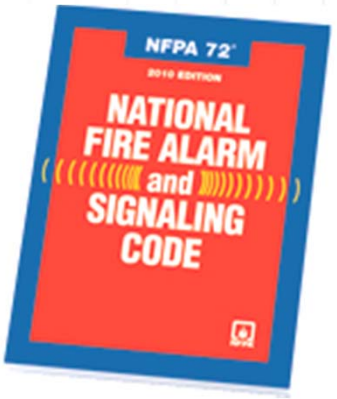
U.S. DEPARTMENT OF ENERGY

Paradigm Shift

- September 11, 2001 was a major driver
- Forced Fire Departments to rethink the way they operate and respond to incidents
- Re-evaluation by Owners and Designers of how to make buildings safer
- Being prepared for the Emergency Event
- NFPA 1600, Disaster/Emergency Management & Business Continuity Programs
- Adequate Communication Capabilities

Industry Changes

NFPA 72 – 2010 Edition



- **Significant NFPA 72 changes, now called…**

  National Fire Alarm and Signaling Code

- **Major Changes in format and addition of 3 new chapters (from 11 chapter to 29 chapters – 15 not used)**
  - **Circuits and Pathways**
  - **Emergency Control Functions & Interfaces**
  - **Emergency Communications Systems (ECS)**

U.S. DEPARTMENT OF ENERGY

Industry Changes

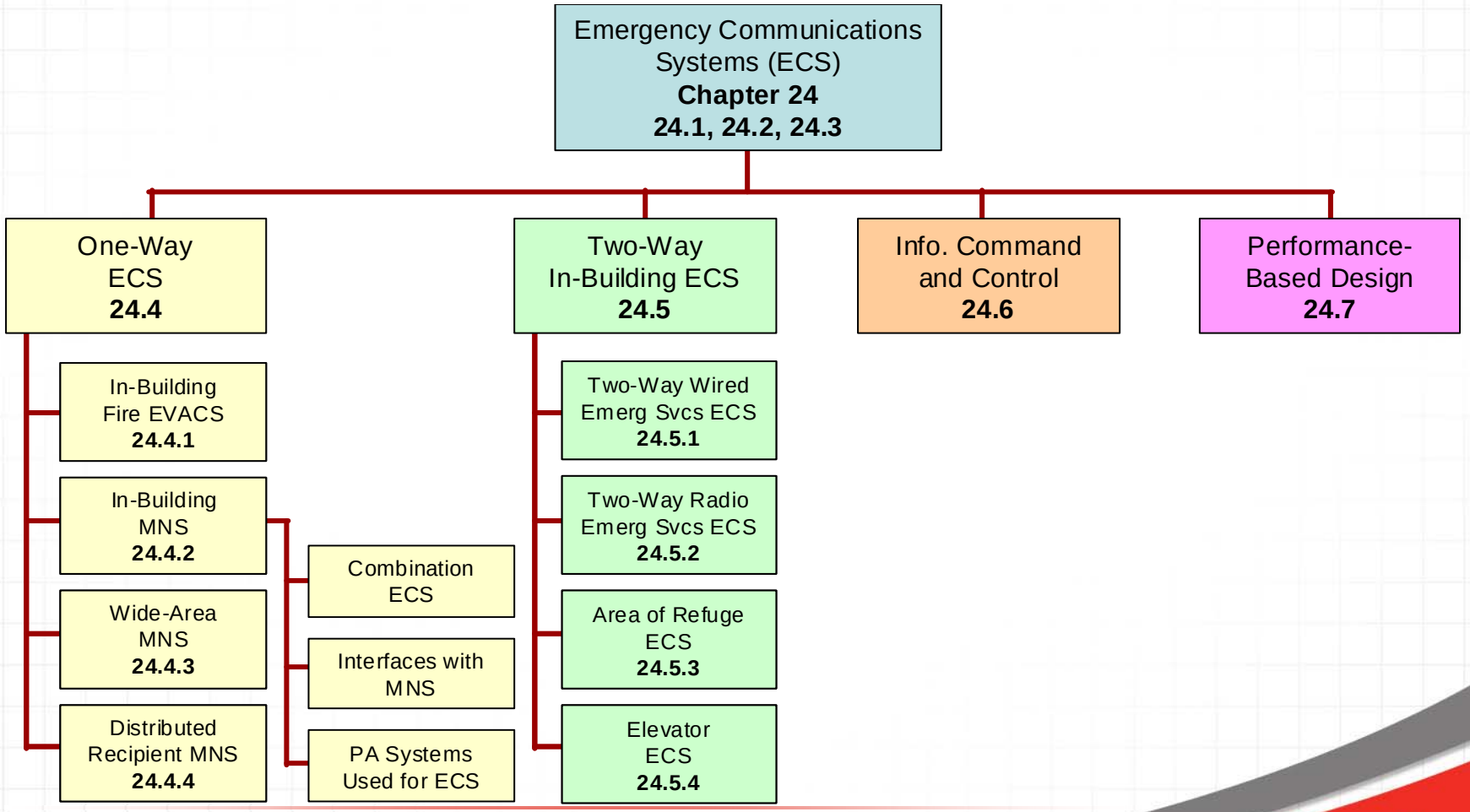
NFPA 72 – 2010 Edition: Chapter 24 *ECS*

- **2007 NFPA 72 Annex E, *Mass Notification Systems* Replaced by Chapter 24 Emergency Communications Systems**
- **Content from Chapter 6, Protected Premises Fire Alarm Systems**
- **Emergency Voice Alarm Communications**
- **One- and Two-Way Communication Service**
- **Chapter 24 is a complete set of requirements for emergency communications systems – including requirements from other chapters by reference**

U.S. DEPARTMENT OF ENERGY

Industry Changes

NFPA 72 – 2010 Edition: Chapter 24 *ECS*



Industry Changes

NFPA 72 – 2010 Edition: Chapter 24 *ECS*

- **24.1 Application / Introduction**
  - **Applies to Emergency Communications Systems (ECS) indoors and <u>outdoors</u>**
- **24.2 Purpose**
  - **To protect life by indicating the existence of an emergency situation and communicating information necessary to facilitate a response or action**
  - **Establishes the minimum level of performance, reliability and quality of installation – but not the only method to be achieved**

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

What is it?

- **A Emergency Communication System (ECS), also known as Mass Notification (MNS), is a system designed to provide "real time" instructions and information to a large number of people spread out over a large complex, campus or multi-building facility in the event of an emergency**
- **May use voice communications, visible signals, text, graphics, tactile or other communications methods**

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

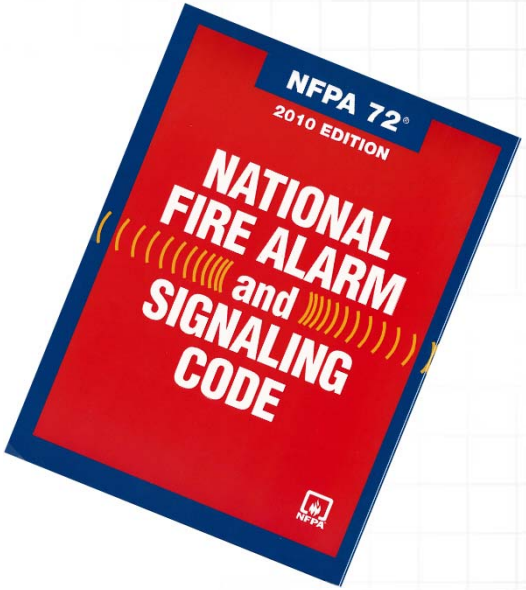
Purpose

- **Provide communication capability in the event of any type of emergency**
- **Initiate evacuation, relocation, or to provide information on fire, weather, terrorist events, biological, chemical or nuclear emergencies to occupants**
- **Assist emergency responders to deal with real time conditions during an emergency**

Emergency Communication System

What Drives it?

- **Owners**
- **NFPA 72 – Chapter 24 (2010)**
- **UFC 4-010-01**
- **UFC 4-021-01 intelligibility performance standards**
- **Clery Act (kind of)**




UFC 4-021-01
9 April 2008
Change 1, January 2010

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN AND O&M:
MASS NOTIFICATION SYSTEMS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

Key Elements of ECS

- **In-Building ECS**
  - **Functions**
  - **Integration with other systems**
- **HPSA Zones**
  - **High Power Speaker Array**
  - **Addressable Controller**
- **Wide Area ECS**
  - **Also called Campus or City**
  - **Functions**

U.S. DEPARTMENT OF ENERGY

In-Building ECS

Components: Control Panel

- **Often combined with FA system**
- **Sends digital voice messages to building occupants**
- **Send and receive digital messages and live page from the Campus or Base Wide System**
- **Has the ability to activate strobes and displays**

U.S. DEPARTMENT OF ENERGY

In-Building ECS

Components: Local Operating Console

- **Perform “live” paging to meet the specific emergencies**
- **Minimum of eight (8) switches for activating messages and a microphone**
- **Protected in a small wall mounted enclosure (non-lockable)**

U.S. DEPARTMENT OF ENERGY

In-Building ECS

Components: Notification

- **Provide a “clear” strobe for fire alarm events and an “amber” strobe for mass notification events**

(Military Requirement for Army and Air Force only)

U.S. DEPARTMENT OF ENERGY

In-Building ECS

Components: Displays

- **Service people with hearing disabilities by providing a method of sending the Emergency Communication Alert messages**

U.S. DEPARTMENT OF ENERGY

HPSA Zones

(High Power Speaker Arrays)

- **Inform people outside of buildings**
  - **Can send a voice message to individual HPSA's or to all outdoor zones**
- **Strategically locate throughout campus or facility**
- **Each location should be at a height to be unobstructed by buildings and trees**

U.S. DEPARTMENT OF ENERGY

Wide Area ECS

(also called Campus Wide ECS)

- **Send Digital Voice Messages to any HPSA or In-Building ECS**
- **Receive emergency info (e.g. fire alarm data) from any In-Building ECS**
- **Have a Graphical Interface to display the campus and information for the operator**
- **Send live messages to any HPSA or In-Building ECS**
- **Print out all system events**

U.S. DEPARTMENT OF ENERGY

Wide Area ECS

Interface with other Systems/Functions

- **Systems / Functions include:**
  - **CCTV**
  - **Security Systems**
  - **Access Control**
  - **Pager Interface**
  - **Electronic Signage**
  - **Fax**
  - **Email Server**
  - **SMS Text Messaging to Cell Phones**
  - **VoiP Telephone Systems to Voice Mail**

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

Benefits of Combination Fire Alarm/ECS

- **Built-in compatibility**
  - **Easier to program**
  - **Easier to interact properly**
- **Survivable**
  - **Paging systems are not built**
  - **Distributed messaging and a survivability**
- **Expandable / flexible**
  - **Scalable**
  - **Ease of reconfigure**

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

Who needs it or is using it?

- College campuses
- Universities
- Military bases
- Corporate campuses
- Large manufacturing facilities

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

Owner Responsibilities

- **Safety to life and property**
- **Per NFPA 72 (2010), hire a qualified System Designer who is…**
  - **Registered, licensed, or certified by a state / local authority**
  - **Certified by a nationally recognized certification organization acceptable to the AHJ**
  - **Factory trained and certified for fire alarm system design and ECS design of the specific type / brand of the system and who are acceptable to the AHJ**

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

I think I need it, … now what?

- **Where do I start?**
- **What do I need?**
- **Who am I trying to protect?**
- **What is my objective?**
  - **Evacuate**
  - **Stay in place**
  - **Notify**

Don't plan for the emergency situation (there are too many possibilities.) Plan for protecting the people in your charge.

U.S. DEPARTMENT OF ENERGY

Emergency Communication System

Understanding An Emergency Event

- **Understand and consider how:**
  - **An event may progress**
  - **An event may change**
- **Example: Sep. 11, 2011**
  - **Prepared for an emergency event in one building, not both**
  - **Fire Department directed occupants to remain in the South Tower**

U.S. DEPARTMENT OF ENERGY

Risk Analysis

What is it?

- **The design of the emergency communication / mass notification system shall be specific to the nature and anticipated risks of each facility for which it is designed**
- **The design of the mass notification system shall include the preparation of a design brief that is prepared utilizing recognized performance-based design practices**
- **The Risk Analysis process should include all applicable Stakeholders (team approach)**

Risk Analysis

What drives it?

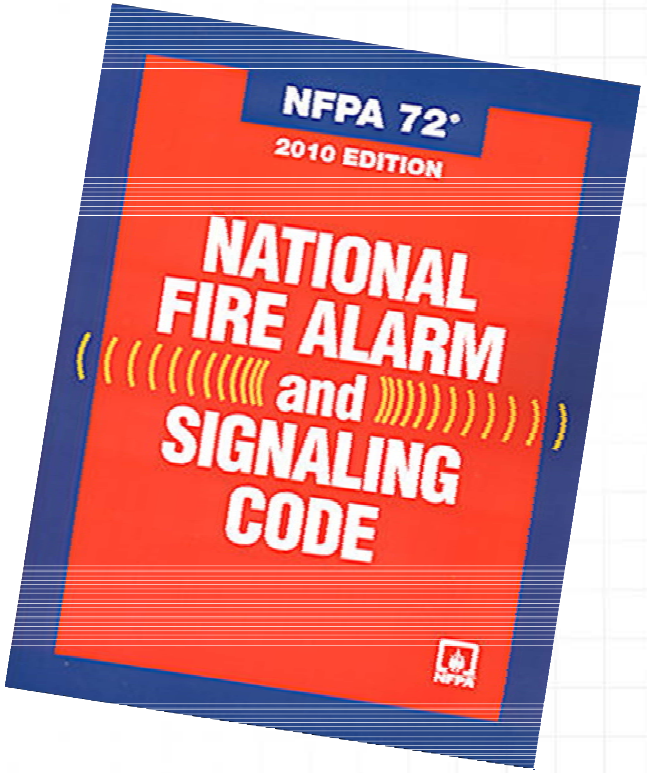
- **NFPA 72, Chapter 24**

*"Performance-based design and the **risk analysis** shall be applied in accordance with Section 24.7."*

- Section 24.4.2.2.3

*"A **risk analysis** shall be used as the basis for development of the emergency response plan."*

- Section 24.4.2.2.3



U.S. DEPARTMENT OF ENERGY

Risk Analysis

Stakeholders

- **Any individual, group, or organization that might affect, be affected by, or perceive itself to be affected by the risk, such as:**
  - **Authority Having Jurisdiction**
  - **Facility Owner / Users / Employees**
  - **Facility Maintenance Staff (I-T-M)**
  - **Emergency Responders**
  - **Insurance Company or Insurers**
  - **Fire Protection Design Professional (FPE)**
  - **Design & Construction Team**

U.S. DEPARTMENT OF ENERGY

Risk Analysis

Process of Performing A Risk Analysis

1. **Identify the range of hazards, threats, or perils:**
   - **Identify the hazards, threats, or perils that impact or might impact your organization, infrastructure and/or surrounding area**

2. **Determine the potential impact of each hazard, threat, or peril by:**
   - **Estimating the relative severity, frequency, and vulnerability of each hazard, threat, or peril**
   - **Estimate how vulnerable your people, operations, property and/or environment are to each hazard, threat, or peril**

Risk Analysis

Process of Performing A Risk Analysis

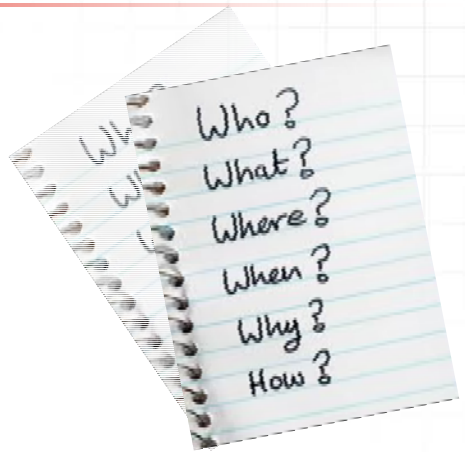
3. **Categorize each hazard, threat, or peril according to <u>how severe it is, how frequently it occurs, and how vulnerable</u> you are**

4. **Develop strategies to deal with the most significant hazards, threats, or perils**
   - **Develop strategies to prevent, mitigate, prepare, respond and recover hazards, threats, or perils that impact or might impact your organization and its people, operations, property, and environment**

U.S. DEPARTMENT OF ENERGY

Risk Analysis

Assessing the Risk



- **To fully understand the risk(s) that you are attempting to be addressed, you should develop some questions to ask. The answers should then be evaluated by a licensed professional that is familiar with Risk Assessments. The following slides provide a list of questions that might help assess the level of risk and type of system desired.**

Risk Analysis

Assessing the Risk: The Questions

- **What is the type of emergency event?**
- **What is the urgency of the emergency event?**
- **What is the anticipated or expected severity of the emergency event?**
- **What is the certainty of the emergency event, is it happening now?**
- **What types of natural disasters, accidental hazards, or human-caused events could provide life threatening scenarios?**

Risk Analysis

Assessing the Risk: The Questions

- **What is the location of the event or from what direction is the event approaching?**
- **Based on the potential hazards or incident, which occupants and personnel should be notified?**
- **What zone or areas of the complex or building should receive the emergency message(s)?**
- **What instructions or message should we send to the personnel we are notifying?**

Risk Analysis

Assessing the Risk: The Questions

- **What is the expected <u>performance or reliability</u> of the system?**
- **Is a <u>voice system</u> the best to convey the message or desired actions? Intelligible?**

Risk Analysis

Sample Outline

RISK ANALYSIS OUTLINE

1. General Content
   - a. Purpose
   - b. Scope
2. Project Description
   - a. Summary
3. Risk Assessment
   - a. Accessing the Risk
   - b. Contingency Planning
   - c. Risk Assessment Benefits
4. Number of Persons
5. Occupancy Characteristics
6. Anticipated Threats
7. Extent of Notification
8. Operational Status and System Effectiveness
9. Staff Assistance
10. Emergency Response Personnel
11. Risk Prevention
    - a. Type of Risk
    - b. Risk Impact
    - c. Program Constraints
    - d. Potential Prevention
12. Cost and Effectiveness of Prevention(s)
    - a. Potential Prevention(s)
13. Risk Reduction Recommendations
14. Summary/Design Brief
    - a. Clear Statement
    - b. Testing

SAMPLE

U.S. DEPARTMENT OF ENERGY

Risk Analysis

Outcome

- **Protection of life by indicating the existence of an emergency situation and communicating information that is necessary and delivered in a manner that is understood to facilitate the appropriate building occupant response and action**

Questions

In-Building ECS Design

Things to Consider: Voice vs. Non-Voice

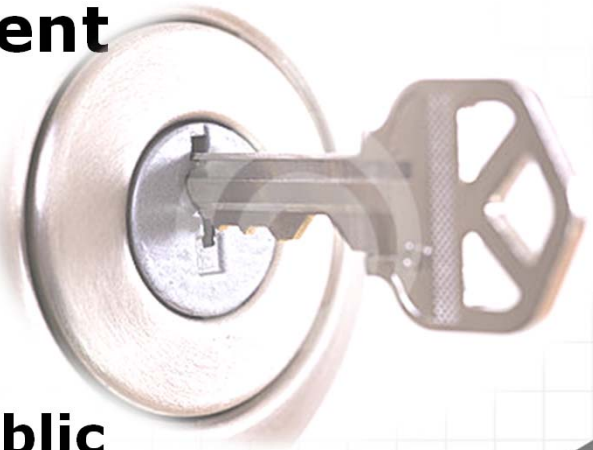
- **Type of Occupants to Notify**
  - **Hearing Impaired**
  - **Multiple Languages**
- **Number of Occupants**
  - **Inhabited Building**
- **Building Size**
  - **High-rise Building**
- **Type of Building**
  - **Hard Surfaces**
  - **Large Open Areas**

U.S. DEPARTMENT OF ENERGY

In-Building ECS Design

Things to Consider: Local and Remote Control

- **Access to Control Equipment**
  - **Staff only**
  - **Staff and Visitors**
  - **Emergency Responders**
- **Capabilities of Control Equipment**
  - **Initiate Messages**
  - **Live voice announcements**
- **Location of Control Equipment**
  - **Security, Manager Office**
  - **Areas/rooms accessible to the Public**
  - **Secure rooms (located Electrical room)**

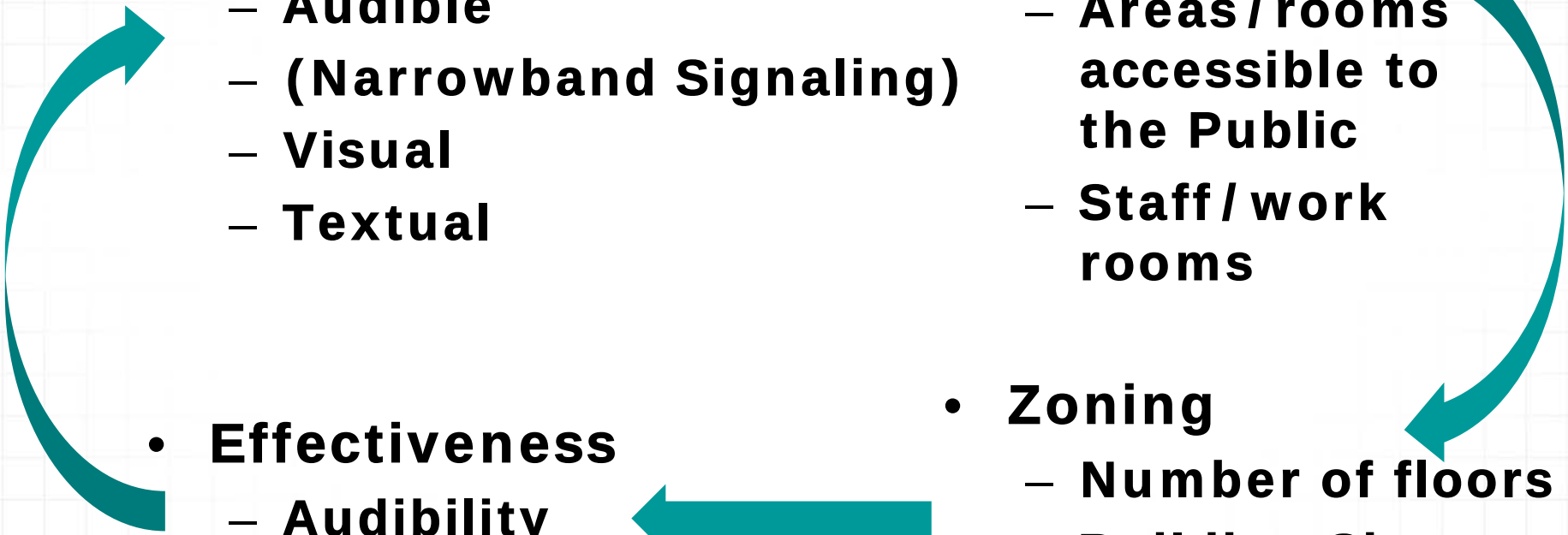


U.S. DEPARTMENT OF ENERGY

In-Building ECS Design

Things to Consider: Notification

- **Types**
  - Audible
  - (Narrowband Signaling)
  - Visual
  - Textual
- **Locations**
  - Areas/rooms accessible to the Public
  - Staff/work rooms
- **Zoning**
  - Number of floors
  - Building Size
- **Effectiveness**
  - Audibility
  - Intelligibility
  - Messages



U.S. DEPARTMENT OF ENERGY

In-Building ECS Design

Audible Notification Appliances

- **Bells**
  - **Often used as an external gong to indicate the flow of water in the sprinkler system.**
- **Horns**
  - **Often used in high-noise environments.**
- **Sounders**
- **Chimes**
  - **Used where qualified personnel are continuously in attendance.**

In-Building ECS Design

Audible Notification Appliances

- **Sirens**
  - **Loud appliances limited in use to outdoor or heavy industrial areas.**
- **Speakers**
  - **Used to relay real-time voice messages or instructions.**

In-Building ECS Design

Narrow Band Signaling: Benefits

- **This method is sound from an engineering standpoint**
- **Clear, audible messages can be heard in loud environments**
- **Allows notification communication to areas where it was not feasible under previous NFPA provisions**
- **Utilizes less speakers and power**

U.S. DEPARTMENT OF ENERGY

In-Building ECS Design

Visual Notification Appliances

- **Strobes**
  - **Used in high-noise environments, in areas occupied by hearing impaired individuals, or in areas where audible may not be desired (i.e. hospital operating rooms)**
- **Selectable Candela Output (15, 15/75, 30, 75, 110)**

In-Building ECS Design

Textual Appliances

- **Text display that provides audible, visual, or tactile output, or any combination thereof**
- **Only be used to supplement audible or visible notification appliances**

In-Building ECS Design

Effectiveness: Intelligibility

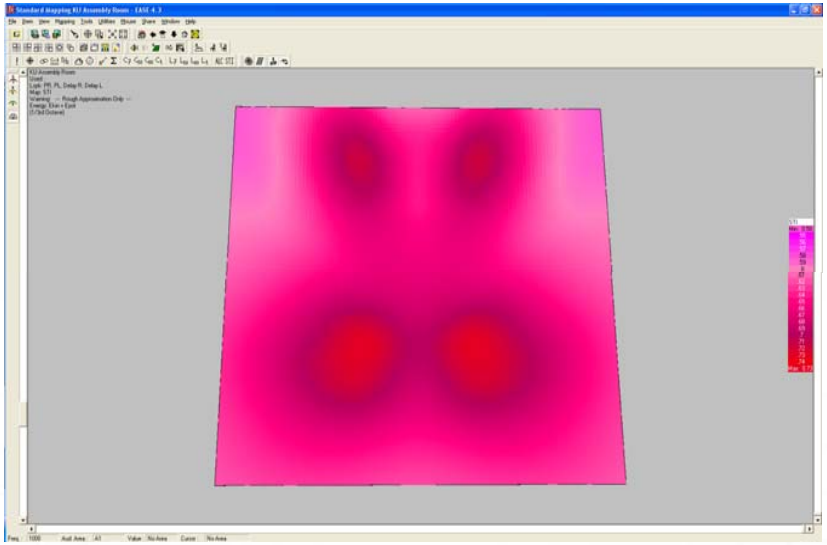
- **The capability of being understood or comprehended (distinguishable and understandable)**
- **Predicted according to "Standardized Transmission Index (STI) or "Common Intelligibility Score" (CIS)**
- **Better to use lower wattage settings and add additional speakers**
- **Higher wattage settings will create more reverberation and distortion**

U.S. DEPARTMENT OF ENERGY

NFPA 72 Design Considerations

Intelligibility: Technical Concepts

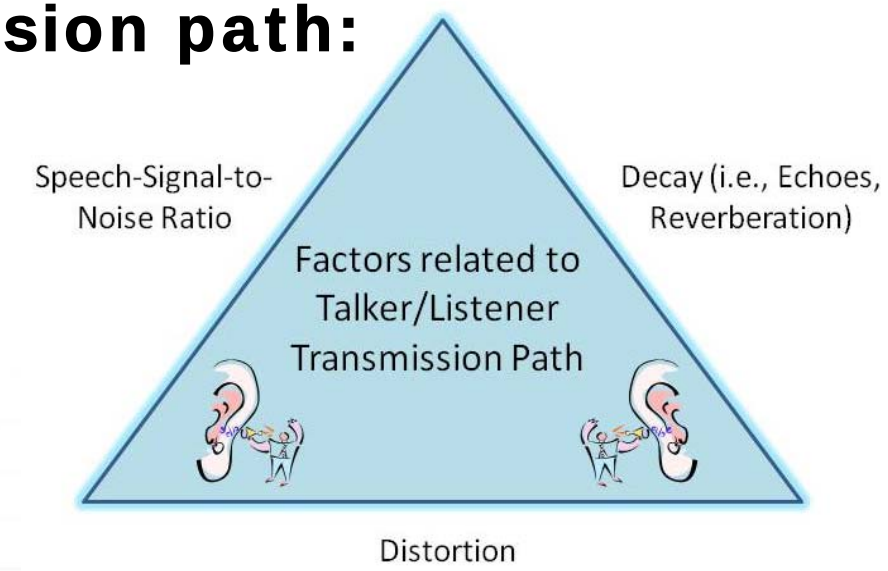
- **Audibility: Measured in decibels (dBA)**
- **Intelligibility: Predicted according to "Standardized Transmission Index (STI) or "Common Intelligibility Score" (CIS)**



NFPA 72 Design Considerations

Intelligibility: Technical Concepts

- **Important building characteristics: occupancy type, ceiling height, surface features, etc.**
- **Factors related to talker/listener transmission path:**



NFPA 72 Design Considerations

Intelligibility: Intelligibility Factors - Frequency Response

- **UL 1480 requires that voice alarm loudspeakers produce frequencies from 400 Hz to 4000 Hz**
- **The adult male & female voice produce frequencies from 150 Hz to 11 KHz**
- **The average listener is naturally more efficient at hearing sounds in the 200Hz to 5000Hz frequency range**

NFPA 72 Design Considerations

Intelligibility: Definitions and Annex Text

- **Acoustically Distinguishable Space (ADS).** **An emergency communication system notification zone, or subdivision thereof, that might be an enclosed or otherwise physically defined space, or that may be distinguished from other spaces because of different acoustical, environmental or use characteristics such as reverberation time and ambient sound pressure level.**

ADS is important new terminology to understand and apply when both designing and testing voice systems.

U.S. DEPARTMENT OF ENERGY

NFPA 72 Design Considerations

Intelligibility: Chapter 18

- **18.4.10 *Voice Intelligibility.**
  - **18.4.10.1* Acoustically Distinguishable Spaces (ADS) shall be determined by the system designer during the planning and design of all emergency communications systems.**
  - **18.4.10.2 Each ADS shall be identified as requiring or not requiring voice intelligibility.**
  - **18.4.10.3* Where required by the authority having jurisdiction, ADS assignments shall be submitted for review and approval.**

U.S. DEPARTMENT OF ENERGY

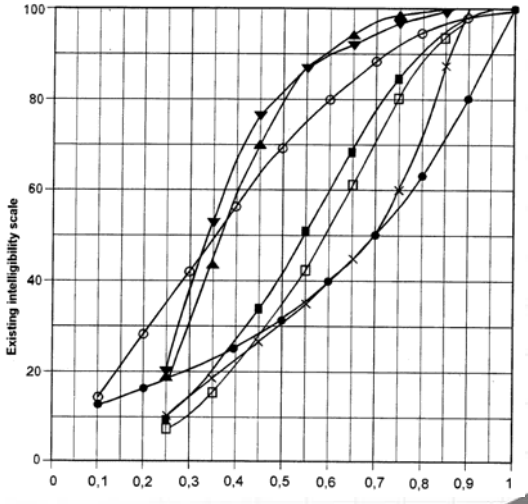
ECS Testing

- **Initial Acceptance Testing**
  - **All new systems are to be inspected and tested**
  - **The AHJ is to be notified prior to the initial acceptance test**
- **Reacceptance Testing**
  - **When an initiating device, notification appliance, or control relay is added, should be functionally tested**
  - **When an initiating device, notification appliance, or control relay is deleted, another device, appliance, or control relay on the circuit is to be operated.**
  - **Modifications or repairs to control equipment hardware warrant re-test of control equipment**

U.S. DEPARTMENT OF ENERGY

ECS Testing
Intelligibility

- **Two basic categories of intelligibility testing:**
  - **Subject (human) based testing; and**
  - **Instrument based test methods (used in this project)**
- **Well documented in literature**
- **Relationships established**



U.S. DEPARTMENT OF ENERGY

ECS Testing

Intelligibility: Acceptability Criteria

- **Minimum of 0.45 STI (0.65 CIS)**
- **Average of 0.50 STI (0.70 CIS)**
- **Designed to Test the System Design/Components – not input signal**

U.S. DEPARTMENT OF ENERGY

ECS Testing

Intelligibility: Where to Test

- **In situations where there are several ADSs that have the exact same physical and system configuration, it may be possible to test only a representative sample and then just check the others to confirm system and appliance operation. For example hotel rooms with similar layouts or offices of similar size and furnishings where each has a speaker appliance. In these cases there would be no expected difference in system intelligibility. The only possible problem would be one where an appliance was not operational or tapped at the incorrect wattage.**

ECS Testing

Intelligibility: Where NOT to Test

- **Testing of intelligibility shall not be required in buildings and areas of buildings that are acoustically challenging and that meet the audibility requirements of this code. Spaces that are not considered to be acoustically challenging include, traditional office environments, hotel guestrooms, dwelling units, and spaces with carpeting and furnishings.**
- **Acoustically challenging spaces are locker rooms, rest rooms, storage areas, kitchens – those spaces with lots of hard and reflective surfaces.**
- **Like or similar ADSs**

U.S. DEPARTMENT OF ENERGY

Questions

Thank You

Jack Poole, PE, FSFPE
Poole Fire Protection
913-747-2050
jpoole@poolefire.com