Introduction

Jack Poole, PE, FSFPE

- Graduate from Univ. of Md., BS in FPE
- Poole Fire Protection – Est. in 1991
- Licensed PE in FPE (52 states & territories)
- Member of ICC, NFPA, SFPE and ABPA
- Member of multiple NFPA Technical Committees, including NFPA 72 - Chairman of SIG-PRO TC & Alternate of NAC
- Fellow, Director & Secretary-Treasurer of SFPE
- 30 Years of Fire Protection Experience

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?

Unfortunate Historic Events

Weather Events
- Joplin Tornado
- Hurricane Katrina
- Japan Flood




Terroristic Attacks
- World Trade Center 93' & '01
- Yale University (Unabomber)
- Murrah Building

Unfortunate Historic Events

Nuclear & Chemical Attacks, Spills & Contamination
- Bhopal Gas Tragedy, India
- Three Mile Island

Base/Campus Shooters and Snipers
- Virginia Tech
- Fort Hood

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)

Industry Changes
NFPA 72 – 2010 Edition: Chapter 18 *Notification Appliances*

- **Significant Chapter 18 changes (old Chapter 7)**
- **Intelligibility Designed and Measured in accordance with ISO 7240-19**
- **Established minimum indoor Intelligibility Values**

METHOD	Average Value Minimum	Single Point Minimum
STI or STIPA	0.50	0.45
PB 256 words	94	91
PB 1000 words	77	68
MRT, %	94	90
SII	0.50	0.45

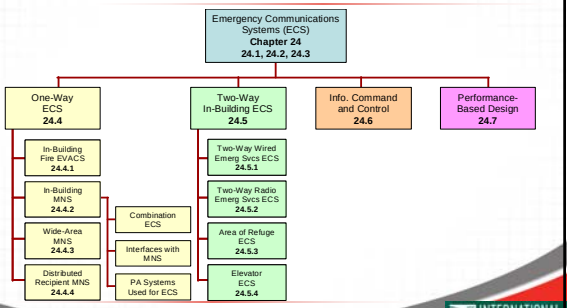
- **AHJ has authority to change minimum values**

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**

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 outdoors**
- **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**

Industry Changes

NFPA 72 – 2010 Edition: Chapter 24 *ECS*

- **24.3 Intelligible Voice Messages**
  - **Capable of reproducing messages with voice intelligibility**
- **24.4 One-Way ECS**
  - **Evacuation message shall be preceded and followed by three-pulse temporal pattern emergency evacuation signal**
  - **The message shall be repeated at least three times**
  - **Speaker layout shall be designed to ensure audibility and intelligibility**
  - **When the fire alarm system has been activated, and mass notification has been given priority, an audible and visible indication shall be provided at the building fire alarm control unit**

Industry Changes

NFPA 72 – 2010 Edition: Chapter 24 *ECS*

- **24.4 One-Way ECS**
  - **The fire alarm system shall not automatically override emergency mass notification messages**
  - **Mass notification messages can override fire alarm if evaluated by stakeholders**
  - **Visual notification to be completed through strobes, textual, graphic or video displays**
  - **Strobes used for dual purposes shall not be marked 'FIRE', strobes to be blank or 'ALERT'**
  - **Operation of MNS system is based on the emergency response plan / risk analysis**
  - **High powered speaker arrays (HPSA) for outdoor areas**

Industry Changes

UL 2572

- ***Standard for Safety for Mass Notification Systems***
- **Equivalent to UL 864**

Industry Changes

UL 2572: Main Evaluation Points

- **Construction**
- **Protection Against Injury to Persons**
- **Performance**
  - **General**
  - **Operation Tests**
  - **Common Requirements**
  - **Other tests**
- **Performance Tests – HPSA**
- **Manufacturing and Production Line Tests**
- **Marking and Instructions**

Industry Changes
UL 2572: Scope

- Requirements cover discrete electrical control units, communication units, transport products which manipulate the data packets, interfaces, and accessories for mass notification systems
- Products covered by this standard are intended to be used in combination with other appliances and devices to form an ECS
- Products are intended to communicate critical information within buildings and/or outdoor areas during an emergency

Industry Changes
UL 2572: Scope

- Communication is through voice and visual instructions, as well as alert and evacuation signals
- Installation documents describe various products needed to form an emergency communication and/or mass notification system and their intended use
- Address emergency service personnel communication system interfaces

Industry Changes
UL 2572: Why is it needed?

- ECS is different than Fire Alarm
  - Different functions
  - Different purpose
  - Different equipment

VS.

Industry Changes
Clery Act

- The Jeanne Clery Disclosure of Campus Security Policy and Campus Crime Statistics Act (20 USC § 1092(f))
- Originally known as the Crime Awareness and Campus Security Act of 1990
- Federal law that requires colleges and universities to disclose information about crime on and around their campus
- Tied to participation in federal student financial aid programs and applies to most institutions of higher education both public and private

Industry Changes
Clery Act

- Amended in 1992 for schools to afford victims of campus sexual assault certain basic rights
- Amended in 1998 to expand reporting requirements and formally change the name the law in memory of Jeanne Clery
- Amendments in 2000 and 2008 added provisions for dealing with registered sex offender notification and campus emergency response
- 2008 amendments also added a provision to protect crime victims, "whistleblowers", and others from retaliation

Industry Changes
Clery Act: History

- The "Clery Act" is named in memory of 19 year old university freshman Jeanne Ann Clery who was raped and murdered while asleep in her residence hall room on April 5, 1986
- Jeanne's parents, Connie and Howard, discovered students hadn't been told about 38 violent crimes on their daughter's campus in the three years before her murder

Industry Changes
Clery Act: Connection to ECS

- **(J) A statement of current campus policies regarding immediate emergency response and evacuation procedures, including the use of electronic and cellular communication (if appropriate)**

Industry Changes
Clery Act: Connection to ECS

- **Policies shall include procedures to:**
  - **Immediately notify the campus community upon the confirmation of a significant emergency or dangerous situation involving an immediate threat to the health or safety of students or staff occurring on the campus, as defined in paragraph (6), unless issuing a notification will compromise efforts to contain the emergency**
  - **Publicize emergency response and evacuation procedures on an annual basis in a manner designed to reach students and staff**
  - **Test emergency response and evacuation procedures on an annual basis**

Industry Changes
Clery Act: What does that mean?

- **Notify campus community immediately**
  - **College campuses turn to ECS to meet this requirement**

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

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
Two Types of ECS

- One-Way System – recipient doesn't have ability to provide information to sender (e.g., speakers that sound a tone, pre-recorded, or live voice message)
- Two-Way System – allows sender and recipient to communicate with each other (e.g., radios and telephones used by police & fire agencies)

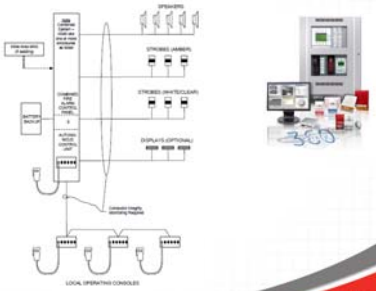
Emergency Communication System
What Drives it?

- Owners
- IBC Section 907
- NFPA 72 – Chapter 24
- UFC 4-010-01
- UFC 4-021-01 intelligibility performance standards
- Clery Act (kind of)

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

In-Building ECS
Typical Arrangement



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

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)

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)

In-Building ECS
Components: Displays

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

HPSA Zones
(High Power Speaker Arrays)

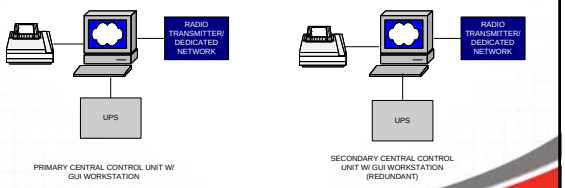
- Inform people outside of buildings
  - Can send a voice message to individual HPSA's or to all outdoor zones
- Strategically locate throughout campus or facility
- Each location should be at a height to be unobstructed by buildings and trees

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

Wide Area ECS
Typical Arrangement

WIDE AREA MASS NOTIFICATION SYSTEM (TYPICAL)



Wide Area ECS
Interface with HPSA and In-Building ECS

- **Primary and Secondary Pathways:**
  - **Fiber Optics**
  - **Radio (Military's preference)**
  - **Satellite**
  - **IP**
  - **Mesh Network**
  - **Microwave**

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**

Emergency Communication System
ECS Integration and Interoperability

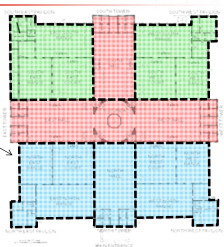
- Design and installation of fire alarm systems is highly regulated and dictated by codes and standards because system reliability is critical
- ECS reliability is also critical, and they are starting to be required by AHJs, or by governing law, codes, or standards
- Care must be taken that interconnectivity ECS with fire alarm systems does not violate any listings or approvals

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

Emergency Communication System
Multiple Channels Available

- Utilize multiple audio circuits to announce different messages simultaneously to multiple areas
- For example:
  - Message A, "Evacuate the building using the South entrance"
  - Message B, "Evacuate the building using the North entrance"
  - Message C, "Do not evacuate the building, wait for further instruction"



Emergency Communication System
Who needs it or is using it?

- Medical Centers
- College campuses
- Universities
- High-Rise Building
- Military bases
- Corporate campuses
- Large manufacturing facilities

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

Emergency Communication System
Military Projects

- UFC 4-021-01 Requirements for System Designers
  - ECS / MNS shall be designed under the supervision of a registered fire protection engineer (FPE), a registered fire protection engineer (FPE) having at least four years of current experience in the design of fire protection and detection systems, or by an engineering technologist qualified at NICET Level IV in fire alarm systems

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
  - Shelter in Place
  - Notify / Inform

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

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
- Understand Risks of an Emergency Event

Risk Analysis
What is it?

- The design of the emergency communication system shall be specific to the nature and anticipated risks of each facility for which it is designed
- The design of the emergency communication 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?

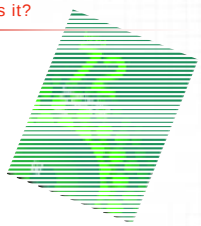
- **NFPA 72, Chapter 24 (2016)**

"a risk analysis shall be performed and approved by the AHJ."

- Section 24.3.5.4.1

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

- Section 24.3.11.10



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**

Risk Analysis
Stakeholders: Interests

- **What are their interests?**
- **Combining / reconciling interests?**
- **Consensus among the group?**

Risk Analysis
Process of Performing A Risk Analysis

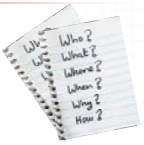
1. **Identify the range of hazards, threats, or perils:**
   - Identify the hazards, threats, or perils that impact or might impact your organization, infrastructure and/or surrounding area
2. **Determine the potential impact of each hazard, threat, or peril by:**
   - Estimating the relative severity, 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 how severe it is, how frequently it occurs, and how vulnerable 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

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 performance or reliability of the system?
- Is a voice system the best to convey the message or desired actions? Intelligible?

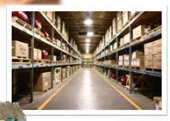
Remember, when an emergency event occurs, the response must be immediate and deliberate, and there is no time for indecision. Therefore, keep it SIMPLE.

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**

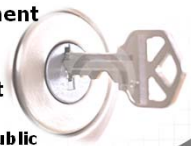
In-Building ECS Design
Things to Consider: Voice vs. Non-Voice

- **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**


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)**



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

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.
- Chimes
  - Used where qualified personnel are continuously in attendance.
- 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

- Technology designed as a cost-effective method for making emergency messages heard in high-noise factories and other industrial areas
- Based on the principle that for a signal to be audible, it need only exceed the background noise in a small frequency band
- Example: Equipment producing 100 dBA

In-Building ECS Design

Narrow Band Signaling: How It Works

- Issuing signals and voice messages at pre-determined frequencies that ride above the average ambient noise
- Uses narrow (1/3) octave bands instead of dBA to measure sound levels and ensure signals exceed background noise by at least 10 dB in one of the octave bands
- This method is sound from an engineering standpoint
- Clear, audible messages can be heard in loud environments

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, 30, 75, 110, 135, 177 and 185)

- 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: Audibility

- Measured in decibels (dBA)
- Public Mode Audibility
  - Sound level at least 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of 60 seconds
- Private Mode Audibility
  - Sound level at least 10 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of 60 seconds

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

In-Building ECS Design
Effectiveness: Messages

- Evacuation message is required to be preceded and followed by three-pulse temporal pattern emergency evacuation signal
- The message shall be repeated at least three times

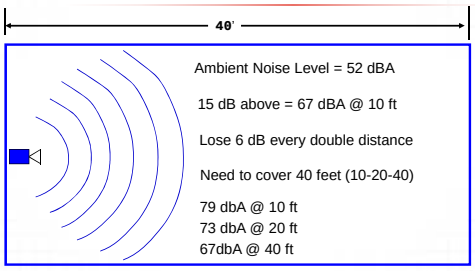
In-Building ECS Design
Notification Location

- Public Area
  - Areas open to the public or used for gathering are required to have audible and visual notification appliances
- Employee Areas
  - Staff rooms or office areas where non-accessible to the public are permitted to have audible notification appliances

In-Building ECS Design
Notification Spacing

- Ceiling mounted speaker spacing should be 2x the ceiling height
- Provide strobes per ADA requirements and located in accordance with NPFA 72 spacing
- Amber strobes may need to have candela rating de-rated 20% to allow for the light reduction of the amber lens (varies by Manufacturer)

In-Building ECS Design
Speaker Coverage Example



In-Building ECS Design
Notification Zones

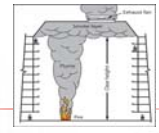
- Separate alarm annunciation by zone
- Evacuation by Floor
  - Each floor is to be annunciated separately
- Annunciation by subdivision of floor
  - Each area subdivided by fire or smoke barriers are annunciated separately
  - Floor areas exceeding 22,500 SF should be subdivided into zones 22,5000 SF or less
- Multiple buildings
  - System serving more than one building shall be annunciated separately as well as exterior areas

In-Building ECS Design
Power Requirements

- **Primary Power Supply**
  - Supplied by a dedicated branch circuit of commercial light and power, engine-driven generator, or engine-driven generator arranged for cogeneration with commercial light and power
- **Secondary Power Supply**
  - Supplied by a dedicated storage battery or automatic-starting, engine-driven generator
- **Uninterruptible Power Supply (UPS)**
  - Supplied by a dedicated branch circuit and UPS failure will results in a system trouble signal

In-Building ECS Design
Control Requirements

- **System Interlocks and Control Features**
  - HVAC Shutdown
  - Damper Control
  - Shutdown of Process Equipment
  - Door Release
  - Loud Noise Shutdown
  - Smoke Exhaust/Control System



In-Building ECS Design
System Architecture: Capabilities

- **Preserves fire protection goals:**
  - Life safety
  - Property protection
  - Mission protection
  - Heritage preservation
  - Environmental protection
- **Means of response to events:**
  - Monitor
  - Notify
  - Assist

In-Building ECS Design
System Architecture: Limitations

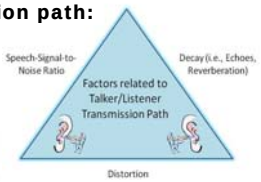
- Ceiling height and obstructions
- Air flow
- Ambient environment and noise levels
- Detector type
- Water supply
- Fire department response time and capabilities
- Occupancy
- Egress design
- Construction type
- Capabilities of occupants

NFPA 72 Design Considerations
Intelligibility

- Intelligibility - The capability of being understood or comprehended (distinguishable and understandable)
- In simple terms – intelligibility is an evaluation of changes that occur to speech that impact comprehension
- If you can't understand a voice message you cannot be made aware of the emergency event or special instructions
- Poor example of intelligibility

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

Factor	Key Drivers
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
Frequency response	*speakers, audio equipment*
Harmonic distortion	*speakers, audio equipment*

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.

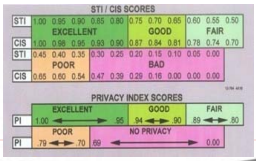
ADS is important new terminology to understand and apply when both designing and testing voice systems.

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.**

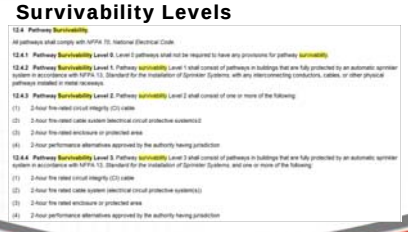
NFPA 72 Design Considerations
Intelligibility: Audio Intelligibility

- **When designing to meet intelligibility requirements, it is better to use lower wattage settings and add additional speakers. Higher wattage settings will create more reverberation and distortion.**
- **Suggested Scores – CIS=0.7 or STI=0.5**



NFPA 72 Design Considerations
Survivability

- **Survivability is the ability of any means for transmitting system information to remain operational during fire conditions**
- **Survivability Levels**



NFPA 72 Design Considerations

Survivability: Notification, Communication, and Other Circuits

- **In-Building Fire Emergency Voice/Alarm**
  - **Systems employing relocation or partial evacuation shall be Level 2 or Level 3**
  - **Systems not employing relocation or partial evacuation shall be Level 0, Level 1, Level 2, or Level 3**
- **In-Building ECS**
  - **Level 0 or greater if determined by risk analysis**
- **Wide-Area**
  - **Level 0 or greater if determined by risk analysis**

NFPA 72 Design Considerations

Circuit Integrity

- **Circuit Integrity - All means of interconnecting equipment, devices, and appliances and wiring connections are intact without occurrence of open or ground-fault conditions**
- **Circuit pathways are designated as Class A, Class B, Class C, Class D, Class E, Class X, or Class N depending on their performance**
- **See NFPA 72, Section 12.3 for details of each Class type and performance criteria**

Additional Design Considerations

Building Code Requirements

- **Type of fire alarm systems**
  - **Automatic**
  - **Manual**
  - **Conventional**
  - **Addressable**
- **Location of fire command control unit**
  - **In the fire command center of high-rise buildings (IBC)**

Additional Design Considerations
Fire Safety Functions

- **Elevator Control**
  - Initiating devices are to be used to initiate fire fighters' service recall to a designated and alternate levels
  - Occupant use elevators are to be shutdown upon activation of a heat detector or sprinkler
- **HVAC Control**
  - Detection devices used to cause the operation of HVAC systems smoke dampers, fire dampers, fan control, smoke doors, and fire doors are monitored for integrity
  - Smoke detectors mounted in the air ducts of initiate either an alarm signal at the control panel or a supervisory signal at a constantly attended location or supervising station
  - Air handling units serving the ducts where smoke detectors are actuated are shutdown to prevent transfer of smoke

Additional Design Considerations
Fire Safety Functions

- **Smoke Control**
  - The automatic alarm-initiating zones are to be coordinated with the smoke control system fans they actuate
- **Remote signaling to supervising station**
  - Alarm signals are to be immediately retransmitted to the communications center
  - Upon receipt of an alarm, a supervisory, or a trouble signal, the operator on duty is responsible for notifying the owner or the owner's designated representative immediately
  - All operator controls are to be operated at the beginning of each shift or change in personnel, and the status of all alarm, supervisory, and trouble signals is to be noted and recorded

Additional Design Considerations
Fire Safety Functions

- **Door Control**
  - Initiating devices used for doors held open are to be released upon activation of the device and needs to be monitored for integrity
  - Electrically locked doors in a required means of egress are required to unlock in the direction of egress
  - Means of egress doors unlocked by the fire alarm system, are to be unlocked prior to or concurrent with activation of any public-mode notification appliances in the area served by the normally locked means of egress doors and should remain unlocked until the fire alarm condition is manually reset

ECS Testing & Commissioning

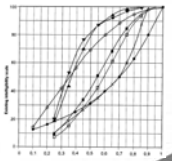
- Initial Acceptance Testing
  - All new systems are to be inspected and tested
  - The AHJ is to be notified prior to the initial acceptance test
- Reacceptance Testing
  - When an initiating device, notification appliance, or control relay is added, should be functionally tested
  - When an initiating 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

ECS Testing

- Reacceptance Testing
  - Changes made to site-specific software
    - All functions known to be affected by the change are 100 percent tested
    - 10 percent of initiating devices that are not directly affected by the change, up to a maximum of 50 devices, are tested and correct system operation is to be verified
    - A revised record of completion is to be prepared
- Changes to all control units controlled by the system executive software requires a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify critical system functions

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



ECS Testing

Intelligibility: Methods of Measurement

- Phonetically Balanced Word Scores – panel of listeners.
- Modified Rhyme Test – panel of listeners.
- Speech Transmission Index – (modeling).
- Speech Transmission Index for Public Address – STIPA signal and meter.
- Speech Intelligibility Index – noise spectra levels.

ECS Testing

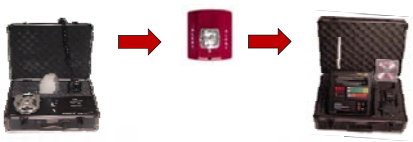
Intelligibility: Acceptability Criteria

- The intelligibility of an emergency communication system is considered acceptable if at least 90 percent of the measurement locations within each Acoustically Distinguishable Space (ADS) have a measured STI of not less than 0.45 STI (0.65 CIS) and an average STI of not less than 0.50 STI (0.70 CIS)
- 90% Pass Rate

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



ECS Testing

Intelligibility: Limitations of Test Method

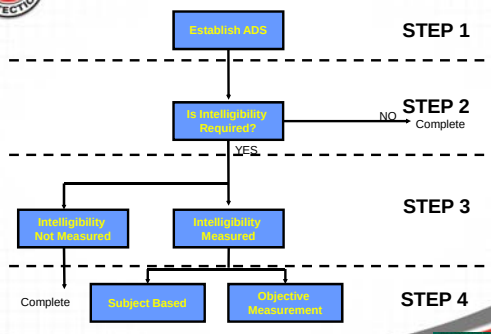
- Areas of high ambient sound pressure levels ("noise") may be incapable of meeting the Acceptability Criteria.
- Impulse sounds made during measurements may impact measurement accuracy or cause instrument error. (Example: door or file drawer closing).
- Natural variation in ambient noise levels may affect the results.

ECS Testing

Intelligibility: Pre-Planning for Testing

- Occupancy and Use Type coordination
- Determine Operational Time Periods – "Occupied" verses "Unoccupied".
- Testing before Building Completion – partial use before final acoustic configuration. Intelligibility testing may be different once completed.
- Facility Construction/Condition – completion of fire command center (use of microphone)
- System Under Test – FA/MNS must be complete
- Power Supply – Test will full power
- Develop a Test Plan

Review of the Process



Overview of Topics Covered

- 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?

Questions

Thank You