

Plans Review of Fire Alarm Systems

PRFAS-Student Manual

2nd Edition, 1st Printing-November 2023



FEMA

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November 2023
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Acronyms

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ACKNOWLEDGMENTS

The development of any National Fire Academy (NFA) course is a complex process aimed at providing students the best possible learning opportunity we can deliver.

There are many players in the course development, each of whom plays an equally important part in its success. We want to acknowledge their participation and contribution to this effort and extend our heartfelt thanks for making this quality product.

The following people participated in the creation of this course:

Stacey Harmon, Instructional Systems Specialist
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Subject Matter Expert

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Subject Matter Expert

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Subject Matter Expert

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COURSE DESCRIPTION

This five-day course will enable students to describe the plans review process and conduct a plans review in a rigorous, systematic approach.

COURSE GOAL

The course will examine the fundamentals of fire alarm systems, their individual components, and subsequent preparations for comprehensive plans reviews. Nationally recognized standards for the design, installation and evaluation of fire alarm devices will be considered. Practical application of the concepts and relevant standards will be employed throughout the course.

AUDIENCE, SCOPE AND COURSE PURPOSE

The target audience for this course includes individuals presently assigned to review fire alarm shop drawings.

The scope of this course spans instruction in the knowledge and skill necessary to evaluate the soundness and code compliance of engineering and architectural plans for fire alarm systems proposed as part of facility and occupancy construction plans. The course will enable students to perform a plans review to evaluate the suitability of the fire alarm system in accordance with nationally recognized standards for design and installation. Course content covers fire protection standards, plans reading, parts of a submittal package, classifying hazards, battery and voltage drop calculations, and fire alarm system components.

While there is no prerequisite coursework needed, students will be assigned pre-course activities they must complete prior to the first day of the course.

GRADING METHODOLOGY

The students' final grades will be computed using the final exam. The final exam will include 56 multiple-choice questions. The exam covers all information in the Student Manual (SM), as well as the concepts presented during presentations and class discussions. In addition, certain activities in the course will be evaluated using points (i.e., 60 points total for 60% of the total grade).

Grading rubrics are provided for all graded assignments. Grading rubrics can be accessed at the end of the Course Syllabus and within the SM. Each rubric is labeled according to the activity name.

A minimum grade of 70% is required to pass the course. The complete grading scale is provided here:

Letter grade	Point range
A	90-100
B	80-89
C	70-79
F	69 or lower

Students who do not obtain an end-of-course passing score face possible sanctions for up to 12 months regarding acceptance or placement in future NFA course offerings.

PLANS REVIEW OF FIRE ALARM SYSTEMS

Students who do not complete the entire course will be awarded an Incomplete (I) grade. In accordance with NFA academic policies, an Incomplete (I) grade must be removed by the end of the next semester following the course, or it automatically becomes a Failing (F) grade.

The final course grade will be comprised of these elements:

Element	Completion/ formal grade	Grade points	Percent of final course grade
Activities			
• Pre-course Activity 1	Grade	7	5%
• Pre-course Activity 2	Grade	5	5%
• Activity 3.1	Grade	10	10%
• Activity 4.1	Grade	10	10%
• Activity 6.2	Grade	10	10%
• Activity 7.1	Grade	15	30%
Final exam	Grade	56	30%
		Total	100%

GRADING RUBRICS

PRE-COURSE ACTIVITY 2: CONSEQUENCES OF IMPROPER FIRE ALARM SYSTEM DESIGN AND INSTALLATION

Assignment: Students will research two fire incidents that have resulted from an error(s) in fire alarm system installation and/or design.

The table below details the point distribution for the pre-course activity 2. (Maximum points: 5.)

Element of performance	Submission of the research.	No submission: 0 points	No attempt made at completing the research.	Deficient: 0.5 point	One fire incident researched and submitted.	Exemplary: 1 point	Two fire incidents researched and submitted.
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Element of performance	Research quality and analysis (evaluated for each fire incident researched).	Acceptable: 1 point	Fire incident research needs more detailed information or includes inaccurate information. The cause of the incident has vague or no correlation to fire alarm design and/or installation.	Exemplary: 2 points	Fire incident research includes sufficient and accurate background details. The cause of the incident is identified and correlated to fire alarm design and/or installation.
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ACTIVITY 3.1

SMOKE AND HEAT DETECTOR SPACING

Assignment: Students will be provided with a set of plans with which they will review spacings for smoke and heat detection and the duct smoke detection placements.

The table below details the point distribution for Activity 3.1. (Maximum points: 10.)

Element of performance	No submission: 0 points	Deficient: 1 point	Acceptable: 2 points	Exemplary: 3 points
Verification of areas protected with area smoke detection.	No response provided.	Incorrect verification of compliance made.	Correct verification of compliance made but with incorrect or lack of supporting details.	Correct verification of compliance made with supporting details.
Verification of areas protected with area heat detection.	No response provided.	Incorrect verification of compliance made.	Correct verification of compliance made but with incorrect or lack of supporting details.	Correct verification of compliance made with supporting details.

Element of performance	No submission: 0 points	Deficient: 1 point	Acceptable: 2-3 points	Exemplary: 4 points
Verification of areas protected with duct smoke detection.	No response provided.	Incorrect verification of compliance made.	Correct verification of compliance made but with incorrect or lack of supporting details.	Correct verification of compliance made for all required systems.

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ACTIVITY 4.1

VERIFICATION OF NOTIFICATION LAYOUT

Assignment: Students will use a set of plans that they will review and determine if audibility and visibility requirements are met.

The table below details the point distribution for Activity 4.1. (Maximum points: 10.)

Element of performance	Determination of code compliance for visual coverage.	Determination and justification are incorrect.	Correct determination for code compliance is made, but insufficient justification is provided.	Sufficient justification is provided, but final determination for code compliance is incorrectly determined.	Correct determination for code compliance is made, and sufficient justification is provided.	Exemplary: 4 points
	No attempt made at determining code compliance.	Determination and justification are incorrect.	Correct determination for code compliance is made, but insufficient justification is provided.	Sufficient justification is provided, but final determination for code compliance is incorrectly determined.	Correct determination for code compliance is made, and sufficient justification is provided.	
	Determination of code compliance for audible coverage.	Determination and justification are incorrect.	Correct determination for code compliance is made, but insufficient justification is provided.	Sufficient justification is provided, but final determination for code compliance is incorrectly determined.	Correct determination for code compliance is made, and sufficient justification is provided.	
Element of performance	Identify the difference for residential occupancy alarm notification.		No submission: 0 points	Deficient: 1 point	No submission: 0 points	Exemplary: 2 points
			No attempt made at identifying difference.	No attempt or incorrect information is provided.		Correct information is provided.

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ACTIVITY 6.2

VERIFY VOLTAGE DROP CALCULATIONS

Assignment: Students will analyze the voltage drop to determine if devices will function correctly given a sample circuit.

The table below details the point distribution for Activity 6.2. (Maximum points: 10.)

<p>Element of performance</p> <p>Determination for maximum number of devices in an assigned scenario.</p>	<p>No submission: 0 points</p> <p>No attempt made at determining the maximum number of devices, or calculation provided is less than 10% correct.</p>	<p>Deficient: 1-5 points</p> <p>Incorrect determination for maximum number of devices is made, but calculation provided is partially correct (10%-50%).</p>	<p>Acceptable: 6-9 points</p> <p>Incorrect determination for maximum number of devices is made, but calculation provided (more than 50%).</p>	<p>Exemplary: 10 points</p> <p>Correct determination for maximum number of devices is made along with correct calculations.</p>
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ACTIVITY 7.1

WRITING THE DEFICIENCY LETTER

Assignment: Students will prepare a written deficiency letter to the designer stating issues of concern and appropriate code sections.

The table below details the point distribution for Activity 7.1. (Maximum points: 15.)

Element of performance	No submission: 0 point	Deficient: 1 point	Standard: 2 points	Exemplary: 3 points
Sender and receiver information.	Sender and receiver information are missing in the letter.	Sender and receiver information is presented incorrectly in the letter.	Only a portion of the sender and receiver information is presented correctly in the letter.	Detailed sender and receiver information are presented correctly in the letter.
Identification of the deficiencies.	None of the correct deficiencies are identified in the letter.	At least one correct deficiency is identified in the letter.	At least 50% of the deficiencies are identified in the letter.	All correct deficiencies are identified in the letter.
Location of the deficiencies.	Locations of the deficiencies are not identified in the letter.	At least one correct location of a deficiency is identified in the letter.	At least 50% of the deficiency locations are identified in the letter.	All correct locations of the deficiencies are identified in the letter.
Supporting codes or standards.	None of the correct codes or standards related to the deficiencies are provided in the letter.	At least one correct supporting code or standard relevant to a deficiency is provided in the letter.	At least 50% of the deficiencies are supported by relevant code(s) or standard(s).	All correct codes or standards relevant to the deficiencies are provided in the letter.
Recommended action.	No recommendation for action is provided in the letter.	An incorrect recommendation is made in the letter.	A recommendation is made in the letter, but it is not actionable or vague.	A clear and actionable recommendation is made in the letter.

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PLANS REVIEW OF FIRE ALARM SYSTEMS

SCHEDULE

TIME	DAY 1	DAY 2
8:00 – 9:00	Introduction, Welcome, and Administrative	Unit 2: Fire Alarm System Fundamentals
9:00 – 9:10	<i>Break</i>	<i>Break</i>
9:10 – 10:40	Unit 1: Preparing for Plans Review	Unit 2: Fire Alarm System Fundamentals (cont'd)
10:40 – 10:50	<i>Break</i>	<i>Break</i>
10:50 – 11:55	Unit 1: Preparing for Plans Review (cont'd)	Unit 2: Fire Alarm System Fundamentals (cont'd) Activity 2.1: Determining Fire Alarm System Requirements
11:55 – 12:55	<i>Lunch Break</i>	<i>Lunch Break</i>
12:55 – 2:20	Unit 1: Preparing for Plans Review (cont'd) Activity 1.1: National Fire Protection Association 72 [®] , <i>National Fire Alarm and Signaling Code</i> [®] , Design and Installation Documentation	Unit 2: Fire Alarm System Fundamentals (cont'd) Activity 2.2: Evaluating Input/Output Matrix
2:20 – 2:35	<i>Break</i>	<i>Break</i>
2:35 – 5:00	Unit 1: Preparing for Plans Review (cont'd) Unit 2: Fire Alarm System Fundamentals	Unit 2: Fire Alarm System Fundamentals (cont'd) Activity 2.3: Reviewing Fundamentals for Fire Alarm System Information Unit 3: Initiating Devices

Note: This schedule is subject to modification by the instructors and approved by the training specialist.

PLANS REVIEW OF FIRE ALARM SYSTEMS

TIME	DAY 3	DAY 4
8:00 – 9:00	Unit 3: Initiating Devices (cont'd)	Unit 4: Notification Appliances (cont'd)
9:00 – 9:10	<i>Break</i>	<i>Break</i>
9:10 – 10:40	Activity 3.1: Smoke and Heat Detector Spacing Unit 3: Initiating Devices (cont'd)	Unit 4: Notification Appliances (cont'd) Activity 4.1: Verification of Notification Layout
10:40 – 10:50	<i>Break</i>	<i>Break</i>
10:50 – 11:55	Unit 3: Initiating Devices (cont'd)	Unit 4: Notification Appliances (cont'd) Activity 4.1: Verification of Notification Layout (cont'd) Unit 5: Ancillary Interconnection
11:55 – 12:55	<i>Lunch Break</i>	<i>Lunch Break</i>
12:55 – 2:20	Unit 3: Initiating Devices (cont'd) Activity 3.2: Device Placement	Unit 5: Ancillary Interconnection (cont'd)
2:20 – 2:35	<i>Break</i>	<i>Break</i>
2:35 – 5:00	Unit 3: Initiating Devices (cont'd) Unit 4: Notification Appliances	Unit 5: Ancillary Interconnection (cont'd) Activity 5.1: Reviewing for Interface Requirements Unit 6: Battery and Voltage Drop Calculations

PLANS REVIEW OF FIRE ALARM SYSTEMS

TIME	DAY 5
8:00 – 9:00	Unit 6: Battery and Voltage Drop Calculations (cont'd) Activity 6.1: Battery Backup Calculations
9:00 – 9:10	<i>Break</i>
9:10 – 10:40	Unit 6: Battery and Voltage Drop Calculations (cont'd) Activity 6.2: Verify Voltage Drop Calculations
10:40 – 10:50	<i>Break</i>
10:50 – 11:55	Activity 6.2: Verify Voltage Drop Calculations (cont'd) Unit 7: Deficiency Letter
11:55 – 12:55	<i>Lunch Break</i>
12:55 – 2:20	Unit 7: Deficiency Letter (cont'd) Activity 7.1: Writing the Deficiency Letter
2:20 – 2:35	<i>Break</i>
2:35 – 5:00	Unit 7: Deficiency Letter (cont'd) Final Exam Course Evaluation Course Graduation

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FIREFIGHTER CODE OF ETHICS

Background

The Fire Service is a noble calling, one which is founded on mutual respect and trust between firefighters and the citizens they serve. To ensure the continuing integrity of the Fire Service, the highest standards of ethical conduct must be maintained at all times.

Developed in response to the publication of the Fire Service Reputation Management White Paper, the purpose of this National Firefighter Code of Ethics is to establish criteria that encourages fire service personnel to promote a culture of ethical integrity and high standards of professionalism in our field. The broad scope of this recommended Code of Ethics is intended to mitigate and negate situations that may result in embarrassment and waning of public support for what has historically been a highly respected profession.

Ethics comes from the Greek word ethos, meaning character. Character is not necessarily defined by how a person behaves when conditions are optimal and life is good. It is easy to take the high road when the path is paved and obstacles are few or non-existent. Character is also defined by decisions made under pressure, when no one is looking, when the road contains land mines, and the way is obscured. As members of the Fire Service, we share a responsibility to project an ethical character of professionalism, integrity, compassion, loyalty and honesty in all that we do, all of the time.

We need to accept this ethics challenge and be truly willing to maintain a culture that is consistent with the expectations outlined in this document. By doing so, we can create a legacy that validates and sustains the distinguished Fire Service institution, and at the same time ensure that we leave the Fire Service in better condition than when we arrived.



FIREFIGHTER CODE OF ETHICS

I understand that I have the responsibility to conduct myself in a manner that reflects proper ethical behavior and integrity. In so doing, I will help foster a continuing positive public perception of the fire service. Therefore, I pledge the following...

- Always conduct myself, on and off duty, in a manner that reflects positively on myself, my department and the fire service in general.
- Accept responsibility for my actions and for the consequences of my actions.
- Support the concept of fairness and the value of diverse thoughts and opinions.
- Avoid situations that would adversely affect the credibility or public perception of the fire service profession.
- Be truthful and honest at all times and report instances of cheating or other dishonest acts that compromise the integrity of the fire service.
- Conduct my personal affairs in a manner that does not improperly influence the performance of my duties, or bring discredit to my organization.
- Be respectful and conscious of each member's safety and welfare.
- Recognize that I serve in a position of public trust that requires stewardship in the honest and efficient use of publicly owned resources, including uniforms, facilities, vehicles and equipment and that these are protected from misuse and theft.
- Exercise professionalism, competence, respect and loyalty in the performance of my duties and use information, confidential or otherwise, gained by virtue of my position, only to benefit those I am entrusted to serve.
- Avoid financial investments, outside employment, outside business interests or activities that conflict with or are enhanced by my official position or have the potential to create the perception of impropriety.
- Never propose or accept personal rewards, special privileges, benefits, advancement, honors or gifts that may create a conflict of interest, or the appearance thereof.
- Never engage in activities involving alcohol or other substance use or abuse that can impair my mental state or the performance of my duties and compromise safety.
- Never discriminate on the basis of race, religion, color, creed, age, marital status, national origin, ancestry, gender, sexual preference, medical condition or handicap.
- Never harass, intimidate or threaten fellow members of the service or the public and stop or report the actions of other firefighters who engage in such behaviors.
- Responsibly use social networking, electronic communications, or other media technology opportunities in a manner that does not discredit, dishonor or embarrass my organization, the fire service and the public. I also understand that failure to resolve or report inappropriate use of this media equates to condoning this behavior.

Developed by the National Society of Executive Fire Officers

A Student Guide to End-of-course Evaluations

Say What You Mean ...

Ten Things You Can Do to Improve the National Fire Academy

The National Fire Academy takes its course evaluations very seriously. Your comments and suggestions enable us to improve your learning experience.

Unfortunately, we often get end-of-course comments like these that are vague and, therefore, not actionable. We know you are trying to keep your answers short, but the more specific you can be, the better we can respond.



Actual quotes from student evaluations:	Examples of specific, actionable comments that would help us improve the course:
1 "Update the materials."	<ul style="list-style-type: none"> The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices. The student manual references building codes that are 12 years old.
2 "We want an advanced class in (fill in the blank)."	<ul style="list-style-type: none"> We would like a class that enables us to calculate energy transfer rates resulting from exposure fires. We would like a class that provides one-on-one workplace harassment counseling practice exercises.
3 "More activities."	<ul style="list-style-type: none"> An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept. Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.
4 "A longer course."	<ul style="list-style-type: none"> The class should be increased by one hour per day to enable all students to participate in exercises. The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.
5 "Readable plans."	<ul style="list-style-type: none"> The plans should be enlarged to 11 by 17 and provided with an accurate scale. My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.
6 "Better student guide organization," "manual did not coincide with slides."	<ul style="list-style-type: none"> The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21. The instructor added slides in Unit 4 that were not in my student manual.
7 "Dry in spots."	<ul style="list-style-type: none"> The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy. Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.
8 "More visual aids."	<ul style="list-style-type: none"> The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern. There was a video clip on NBC News (date) that summarized the topic very well.
9 "Re-evaluate pre-course assignments."	<ul style="list-style-type: none"> The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them. The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.
10 "A better understanding of NIMS."	<ul style="list-style-type: none"> The instructor did not explain the connection between NIMS and ICS. The student manual needs an illustrated guide to NIMS.

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UNIT 1: PREPARING FOR PLANS REVIEW

TERMINAL OBJECTIVE

The students will be able to:

- 1.1 *Evaluate the materials for completeness and compliance with locally and nationally recognized design standards, given a sample fire alarm plan submittal package.*

ENABLING OBJECTIVES

The students will be able to:

- 1.1 *Verify the appropriate sections of the International Code Council (ICC) and National Fire Protection Association (NFPA) codes relating to fire alarm submittals are selected.*
 - 1.2 *Identify plan symbols, notes and details found on the shop drawings.*
 - 1.3 *Validate the basic submittal package for compliance with locally adopted rules and standards or special rulings.*
 - 1.4 *Identify special supplemental information that may be required.*
 - 1.5 *Evaluate the basic submittal package completeness to accept or reject the submittal for review.*
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ENABLING OBJECTIVES (cont'd)

- Validate the basic submittal package for compliance with locally adopted rules and standards or special rulings.
- Identify special supplemental information that may be required.
- Evaluate the basic submittal package completeness to accept or reject the submittal for review.

Slide 1-4

What is the responsibility of the submitter of fire alarm plans?

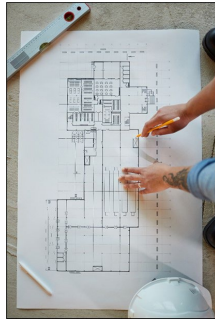


Photo courtesy of iStock.

Slide 1-5

What is the role of the plans reviewer?



Photo courtesy of iStock.

Slide 1-6

I. STAKEHOLDERS

STAKEHOLDERS

- Building owner.
- System designer.
- Authority having jurisdiction (AHJ).




Photo courtesy of iStock.

Slide 1-7

- A. Building owner: responsible for setting goals that they want to achieve for their building. They are also responsible for future inspection, testing and maintenance, so device choice and location will be important for the life of the system.
- B. System designer: responsible for designing a system that meets the minimum requirements of the codes and standards that are applicable to the project. They are also responsible for coordinating with other systems that may require interface with the fire alarm system. This may also be a licensed engineer.
- C. Authority having jurisdiction (AHJ): responsible for verifying that the design meets the minimum requirements of the codes and standards.

II. STANDARDS AND CODES

INTERNATIONAL CODE COUNCIL

- Established in 1994.
- Provides codes, tools and resources for building safety professionals.
 - International Building Code (IBC).
 - International Mechanical Code (IMC).
 - International Fire Code (IFC).


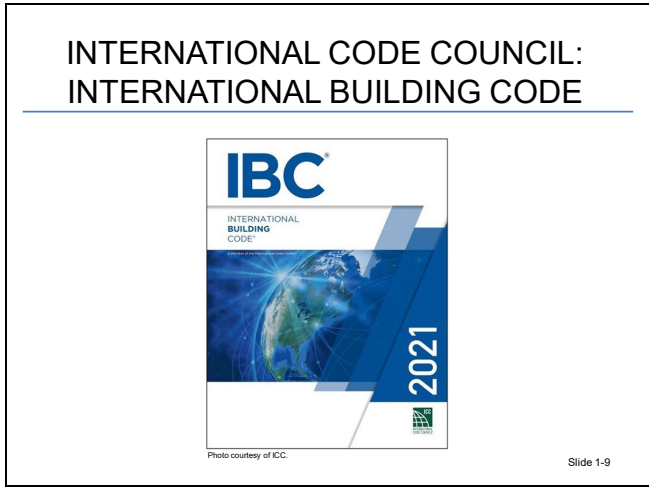


Photo courtesy of ICC.

Slide 1-8

- A. International Code Council (ICC): Established in 1994, the ICC standardized multiple organizations and varying codes into a single set of national model construction codes (ICC, n.d.).





1. International Building Code (IBC).
 - a. The IBC is based on nationally developed consensus standards.
 - b. The first edition of the IBC was published in 2000.
 - c. The IBC publication is updated every 3 years and has been published in 2000, 2003, 2006, 2009, 2012, 2015, 2018 and 2021 (Kelechava, 2021).
 - d. Major changes from the 2015 edition to the 2018 edition include (Kelechava, 2021):
 - Use of fire walls to create separate buildings was limited to only the determination of permissible types of construction based on allowable building area and height.

INTERNATIONAL CODE COUNCIL:
INTERNATIONAL MECHANICAL CODE (cont'd)



Photo courtesy of Keith Hecker.

Slide 1-12

- 2. International Mechanical Code (IMC).
 - a. The IMC publication is updated every 3 years and has been published in 2000, 2003, 2006, 2009, 2012, 2015, 2018 and 2021 (ICC, 2021b).
 - b. Major changes from the 2015 edition to the 2018 edition include (ICC, 2018):
 - Added coverage of pollution control units.
 - A new exception was added to recognize Type I kitchen hoods listed for clearances to combustibles of less than 18 in.
 - Added coverage for a newer type of non-metallic (NM) duct, phenolic duct.
 - New coverage for high-volume, large-diameter fans (HVLD), also referred to as high-volume, low-speed (HVLS) fans.
 - c. Major changes from the 2018 edition to the 2021 edition include (ICC, 2021):
 - Polyurethane spray-applied foam on the exterior of ducts in attics and crawl spaces is now required to meet specific smoke and flame index limits.
 - Fire and smoke dampers must now be provided with approved access for inspection and maintenance.






3. International Fire Code (IFC).
 - a. The IFC publication is updated every 3 years and has been published in 2000, 2003, 2006, 2009, 2012, 2015, 2018 and 2021 (ICC, 2021).
 - b. Major changes from the 2018 edition to the 2021 edition include (ICC, 2021):
 - Provisions for emergency responder communication were revised to reflect the expansion of such systems beyond radios and the need for increased performance of such systems.
 - The requirements for energy storage systems (ESS) were further refined to reflect the variety of new technologies and applications (in building and stand-alone) and the need for proper commissioning and decommissioning of such systems.

- The provisions for construction fire safety were reorganized and expanded with an emphasis on the owner’s responsibilities. The new language requires a site safety plan and designation of a site safety director.

NATIONAL FIRE PROTECTION ASSOCIATION

- Established in 1896.
- Provides codes and standards related to building, processing, design, service and installations to minimize risks and effects of fire.

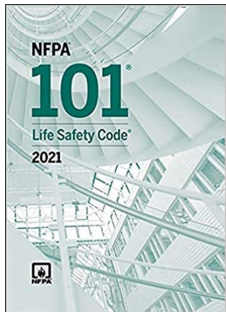


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Slide 1-15

- B. National Fire Protection Association (NFPA): Established in 1896, the NFPA provides codes and standards related to building, processing, design, service and installations to minimize risks and effects of fire (NFPA, n.d.-b).

NATIONAL FIRE PROTECTION ASSOCIATION 101

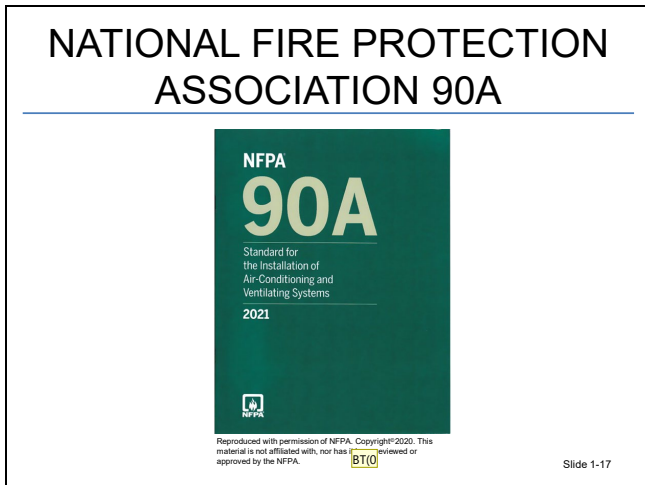


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Slide 1-16

1. NFPA 101[®], *Life Safety Code*[®].
 - a. NFPA 101 was originally published in 1927 and has been updated in a 3-year cycle since 2000 (Hugo & Hartenbach, 2017).
 - b. Major changes from the 2018 edition to the 2021 edition include (Roman et al., n.d.):
 - Special amusement requirements were divided into three classifications.

- Existing classroom door locks and latches, which were previously only permitted one releasing operation, were updated to allow up to two releasing motions to open.
- Changes were made to alleviate some of the unforeseen noncompliance issues that occurred in the health care sector.
- Inspection, testing and maintenance requirements for extraneous fire doors that are not required by code in health care and other occupancies were eliminated.
- Requirements for existing hotels and dormitories to be outfitted with carbon monoxide detection, as well as new requirements for low-frequency alarm signals to be installed in sleeping rooms of new hotels, dorms and new apartment buildings, were added.
- The option of forgoing sprinklers in most types of high-rise buildings that do not already have what are known as “approved engineered life safety systems” (ELSS) was eliminated.



2. NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.
 - a. This document is a referenced standard to NFPA 101 and governs the installation of the systems covered in the scope.
 - b. Regulates duct smoke detection and equipment shutdown, similar to the IMC.

CENTERS FOR MEDICARE & MEDICAID SERVICES

- The federal government has adopted NFPA 101®, *Life Safety Code*®, as the basis for fire protection requirements in their licensed facilities.
- Centers for Medicare & Medicaid Services (CMS) partners with state agencies for enforcement may or may not include your jurisdiction.




Photo courtesy of CMS.




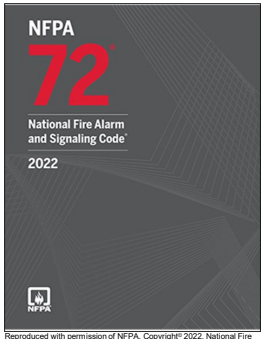
Photo courtesy of iStock.

Slide 1-18

3. Centers for Medicare & Medicaid Services (CMS).

- a. The federal government has adopted NFPA 101 (2012 edition) as the basis for fire protection requirements in their licensed facilities.
- b. CMS partners with state agencies for enforcement may or may not include your jurisdiction. In some cases, state health department inspectors, rather than fire inspectors, may be responsible for enforcement.

NATIONAL FIRE PROTECTION ASSOCIATION 72



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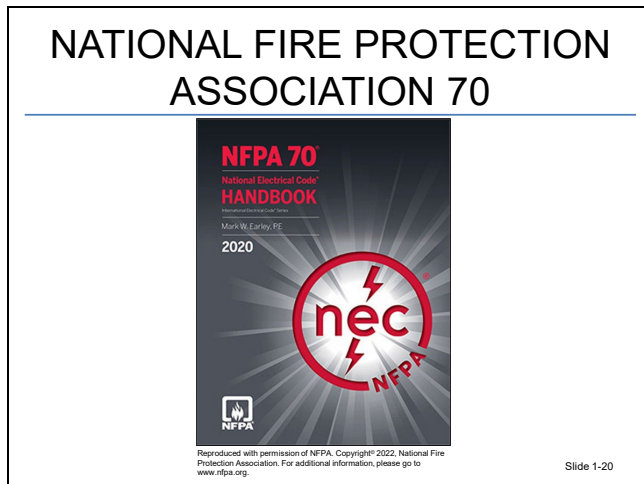
Slide 1-19

4. NFPA 72®, *National Fire Alarm and Signaling Code*®.

- a. NFPA 72 is updated in a 3-year cycle.
- b. Major changes from the 2019 edition to the 2022 edition include (Hammerberg, 2022):
 - The term and definition of “certified” was added to Chapter 3, “Definitions.”

- Other terms and definitions added included “cybersecurity,” “minimum hearing distance,” and “observation.”
 - Minimum hearing distance is defined as “the closest distance that an occupant’s ear can be to an audible appliance” (NFPA, 2022, Section 3.3.176).
 - Observation is defined as “a suggested correction, improvement, or enhancement to the fire alarm or signaling system that is not considered to be an impairment or deficiency” (NFPA, 2022, Section 3.3.193).
- Chapter 7, “Documentation,” was updated to state that design documents must indicate the pathway class and survivability level designations as part of the requirements, and must also be added to floor plan drawings and system riser diagrams. Another new design documentation requirement was added for carbon monoxide detectors, where applicable.
- Changes were made to Chapter 10, “Fundamentals,” to state that a risk analysis should be performed to eliminate the detector over the fire alarm control unit (FACU), notification appliance circuit extenders and supervising station transmitting equipment.
- A new Chapter 11, “Cybersecurity,” was added.
- In Chapter 12, “Circuits and Pathways,” a new survivability level (Level 4) was added, which describes alternatives for 1-hour ratings rather than 2-hour ratings used in Levels 2 and 3.
- In Chapter 14, “Inspection, Testing and Maintenance,” there was a section added regarding the new term “observations,” clarifying that owners are not required to address observations that are not impairments or deficiencies.
- In Chapter 17, “Initiating Devices,” language used to describe when remote indicators are required has changed. Annex material was also added for language that was revised to provide better guidance for carbon monoxide detector placement. New language states that carbon monoxide detectors installed in air ducts cannot be used as a substitute for open area protection.

- Changes in Chapter 18, “Notification Appliances,” were made to allow existing strobe lights with the label “FIRE” to be used for other purposes.
- A new section on obstructions was also added to Chapter 18 to address obstructions of visual notification appliances.
- In Chapter 21, “Emergency Control Function Interfaces,” a change was made to eliminate not allowing time-delay capability for water flow devices for sprinklers installed in elevator pits.
- In Chapter 23, “Protected Premises,” a change was made to allow manual pull stations to operate using positive alarm sequence where approved by the AHJ.
- Also in Chapter 23, a new section on remote access was added to establish minimum requirements for new technology that allows remote access to equipment.
- In Chapter 24, “Emergency Control Systems,” language was changed to include the new Level 4 pathway survivability option.
- In Chapter 26, “Supervising Station Alarm Systems,” language for retransmission of subsequent signals from the protected premises to the communications center was modified.



5. NFPA 70[®], *National Electrical Code*[®].
 - a. NFPA 70 is updated in a 3-year cycle.

- b. Plans reviewers for fire alarm systems must have a basic understanding of the National Electrical Code (NEC), as it is the basis for the materials that are used and the installation methods for electrical systems in general, of which the fire alarm is one.
- c. Major changes from the 2017 edition to the 2020 edition include (NFPA, n.d.-a):
 - Improvements were made to eliminate exterior emergency disconnects to enhance electrical safety for emergency responders at one- and two-family dwelling installations.
 - Service disconnect rules were revised to help increase electrical worker safety.
 - Updates were made to ground-fault protection and leakage-current measurement device requirements.
 - Requirements for power over ethernet were updated to meet the installation practices of new and evolving technologies.
 - Tables used for conducting load calculations were updated to reflect improvements in energy efficiency.
 - Article 310 was reorganized to include new user-friendly numbering for important ampacity tables.
 - A new requirement was added about covering exposed cables installed on ceiling surfaces and sidewalls.

**AMERICAN SOCIETY OF
MECHANICAL ENGINEERS**

- Established in 1880.
- Provides knowledge-sharing and collaboration within the engineering field.




Photo courtesy of American Society of Mechanical Engineers (ASME).

Slide 1-21

C. American Society of Mechanical Engineers (ASME).

1. The ASME was established in 1880 and aims to provide knowledge-sharing and collaboration within the engineering field (ASME, n.d.). With its mission to “advance engineering for the benefit of humanity,” the organization provides codes and standards, as well as certification and accreditation, training, publications, and conferences (ASME, n.d.).

**AMERICAN SOCIETY OF
MECHANICAL ENGINEERS — A17.1**

- Standard code related to elevators and escalators.
- Contains information about interfacing elevators to fire alarm systems and detection device requirements.




Photo courtesy of ASME.

Slide 1-22

2. *A17.1, Safety Code for Elevators and Escalators.*
 - a. ASME’s A17.1/CSA B44 is the standard code throughout North America for the design, construction, installation, operation, inspection, testing, maintenance, alteration and repair regarding elevators and escalators.
 - b. This document contains information about interfacing elevators to fire alarm systems, as well as specific detection device requirements for hoistway, machine rooms and elevator lobbies.

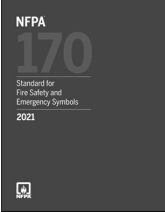
Which codes and editions are adopted in your jurisdiction for building code and fire code?

Slide 1-23

III. SYMBOLS, NOTES AND DETAILS ON SHOP DRAWINGS

NATIONAL FIRE PROTECTION ASSOCIATION 170

Any symbols used on a fire alarm plan submission must follow NFPA 170, *Standard for Fire Safety and Emergency Symbols*.



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FACU	Fire alarm control unit
AIM	Addressable input module
H F	Heat detector – fixed temp
⊗	Remote alarm indicator and test switch (RTS)

Slide 1-24

- A. NFPA 170, *Standard for Fire Safety and Emergency Symbols*.
1. Any symbols used on a fire alarm plan submission must follow NFPA 170. This is a requirement of NFPA 72 and an attempt to standardize how items are called out on drawings. As an alternative to that prescriptive requirement, symbols acceptable to the AHJ would be allowed by NFPA 72.
 2. NFPA 72 is the only document that mandates the use of NFPA 170, and therefore, symbols from that document will not likely be used by designers of other systems that do not use NFPA 72.

SYMBOLS

A way for the layout designer to show specific components of the system graphically.

- DEVICE SYMBOL LEGEND -

<ul style="list-style-type: none"> FACU FIRE ALARM CONTROL PANEL LCD FIRE ALARM ALPHANUMERIC ANNUNCIATOR PANEL (LCD) GD GRAPHIC DISPLAY F FIRE ALARM MANUAL PULL STATION S PHOTOELECTRIC SMOKE DETECTOR 	<ul style="list-style-type: none"> CDS CEILING-MOUNT HORN/STROBE-HIGH LOUDNESS SETTING (UNLESS OTHERWISE NOTED) -F- DENOTES CANDELA RATING CS CEILING-MOUNT STROBE; -F- DENOTES CANDELA RATING T VALVE TAMPER CONNECTION F SPRINKLER FLOW CONNECTION
--	--

Photo courtesy of ADT.

Slide 1-25

- B. Symbols are a way for the layout designer to show specific components of the system graphically.

NOTES

Explain things about the installation materials in textual format rather than graphical.

GENERAL NOTES:

1. REFER TO MANUFACTURER'S INSTALLATION SHEET (INCLUDED WITH EACH DEVICE) FOR REQUIRED BOX MOUNTING AND PROPER WIRE TERMINATION.
2. DASHED LINES INDICATE EXISTING EQUIPMENT TO REMAIN UNLESS OTHERWISE NOTED.
2. SUBSCRIPT "ER" INDICATES EXISTING EQUIPMENT TO BE REPLACED.

Photo courtesy of ADT.

Slide 1-26

- C. Notes explain things about the installation materials in textual format rather than graphical.

DETAILS

Present a zoomed-in visual to a specific area or component to show details.

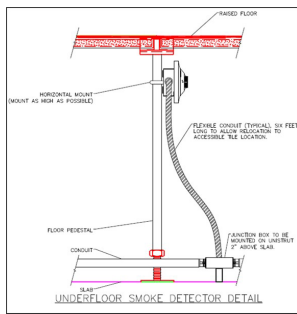


Photo courtesy of ADT.

Slide 1-27

- D. Details present a zoomed-in visual to a specific area or component to show specific information so that a reviewer can determine compliance to code(s). While details are not necessarily required in the submittal, it is a good practice to include them in order to visually show components in greater detail.

IV. SUBMITTAL BOOKLET

A. Requirements for submittal booklet.

BATTERY CALCULATIONS

- Standby batteries generally provide the secondary power for a fire alarm system.
- Starting point for battery calculations is the required time that battery power is needed.

Slide 1-28

1. Battery calculations.
 - a. Standby batteries generally provide the secondary power for a fire alarm system. In buildings where an engine-driven generator is installed, the required amount of battery storage can be reduced.
 - b. The starting point for battery calculations is the required time that battery power needs to be provided for. The time specified for battery storage is broken down into standby time and alarm condition time.
 - The standby time is when the system is in a non-alarm condition. The loads are much less often in standby than they are in an alarm condition when the notification appliances have to be powered.
 - Standby time must be 24 hours for all system types and can be reduced to 4 hours when an engine-driven generator is installed.
 - The amount of time that standby power needs to operate all notification devices depends on the type of system monitoring, whether carbon monoxide detection is integrated into the alarm system, and whether notification uses emergency voice alarm communication (EVAC) or mass notification.

System type	Alarm time required
EVAC	15 min.
In-building mass notification	15 min.
Carbon monoxide systems	12 hr./5 min.
All others	5 min.

BATTERY CALCULATIONS (cont'd)

- For systems integrating carbon monoxide detection, the 12-hour alarm time is reduced to 5 minutes.
- Loads are multiplied by the required time frames for total amp-hours of standby power.



Photo courtesy of Merton Bunker & Associates.

Slide 1-29

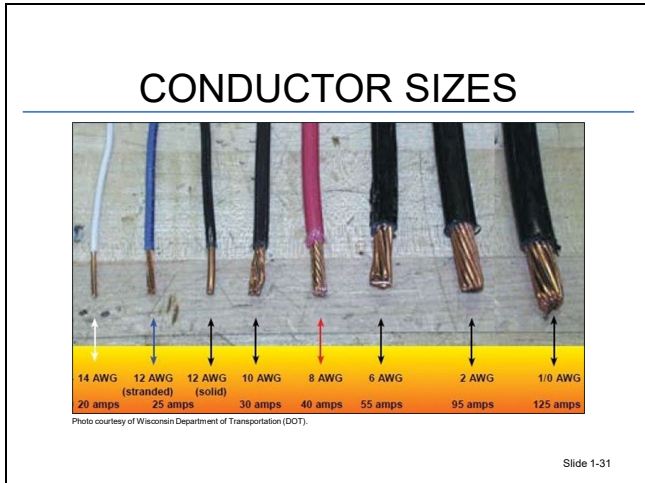
BATTERY CALCULATIONS (cont'd)

ITEM	DESCRIPTION	STANDBY CURRENT PER UNIT (AMPS)	QTY	TOTAL STANDBY CURRENT PER ITEM	ALARM CURRENT PER UNIT (AMPS)	QTY	TOTAL ALARM CURRENT PER ITEM	
	Basic system module 7100	0.08500	X 1	= 0.0850	0.0850	X 1	= 0.0850	
	Silent Knight DACT 9129	0.08400	X 1	= 0.0840	0.1840	X 1	= 0.1840	
	addressable sensors max load	0.00033	X 99	= 0.0327	0.0700	X 1	= 0.0700	
	addressable modules max load	0.00020	X 98	= 0.0196	0.0700	X 1	= 0.0700	
	LCD display annunciator LCD-7100	0.01200	X 1	= 0.0120	0.0230	X 1	= 0.0230	
	max current draw on NAC circuits	0.00000	X 2	= 0.0000	1.5000	X 2	= 3.0000	
		0.0000	X 0	= 0.0000	0.0000	X 5	= 0.0000	
		0.0000	X 0	= 0.0000	0.0000	X 4	= 0.0000	
		0.0000	X 0	= 0.0000	0.0000	X 4	= 0.0000	
		0.0000	X 0	= 0.0000	0.0000	X 0	= 0.0000	
		0.0000	X 0	= 0.0000	0.0000	X 0	= 0.0000	
TOTAL SYSTEM				0.2133	TOTAL SYSTEM			
STANDBY CURRENT (AMPS)				0.2133	ALARM CURRENT (AMPS)			
				0.2133				
Prepared for:		REQUIRED STANDBY TIME (HRS) NFPA 72-2002 4.4.1.5.3.1	TOTAL SYSTEM STANDBY CURRENT (AMPS)	REQUIRED STANDBY CAPACITY (AMP-HOURS)	REQUIRED ALARM TIME (HOURS) NFPA 72-2002 4.4.1.5.3.1	TOTAL SYSTEM ALARM CURRENT (AMPS)	REQUIRED ALARM CAPACITY (AMP-HOURS)	
		24	X 0.2133 =	5.1192	3.000	X 3.4020 =	3.2855	
Prepared by:		REQUIRED STANDBY CAPACITY (AMP-HOURS)	REQUIRED ALARM CAPACITY (AMP-HOURS)	TOTAL CAPACITY (AMP-HOURS)	TOTAL CAPACITY (AMP-HOURS)	CORRECTION FACTOR	ADJUSTED BATTERY CAPACITY (AMP-HOURS)	
		5.1192	X 0.2858 =	5.4042	5.4042	X 125% =	6.7553	

Photo courtesy of ADT.

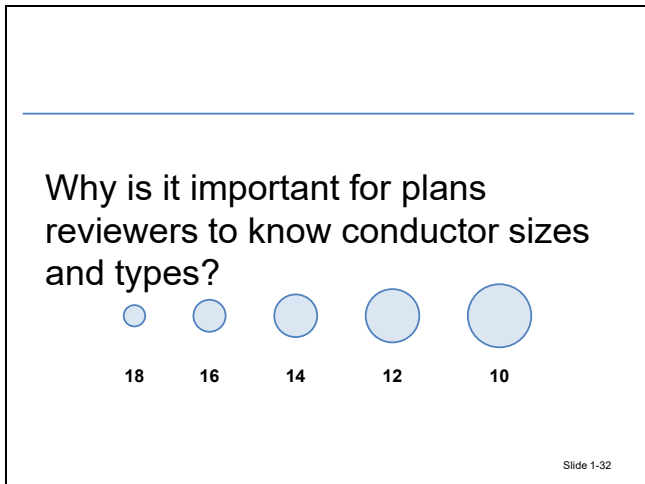
Slide 1-30

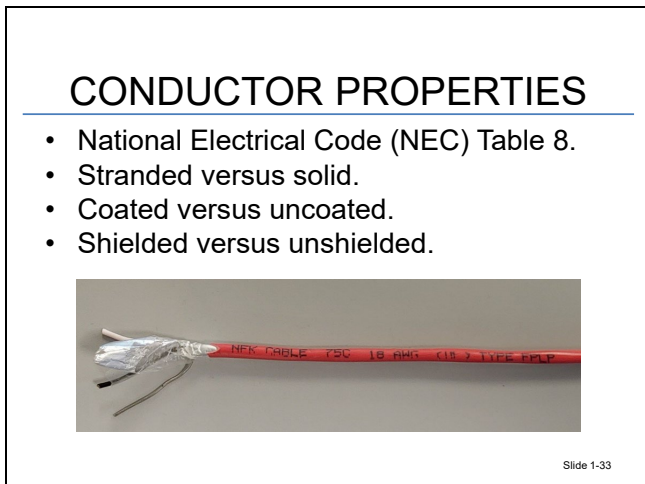
- c. For systems integrating carbon monoxide detection, the 12-hour alarm time is reduced to 5 minutes when the system is monitored by a supervising station.
- d. Once the loads are calculated for both standby and alarm conditions of the system, those loads are multiplied by the required time frames to come up with total amp-hours of standby power. A 1.25 correction factor is added to the calculation to account for battery degradation over time or future expansion of the notification circuits.



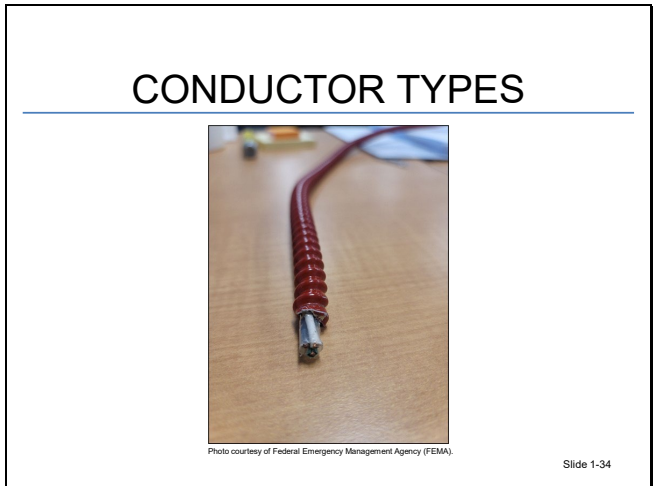
2. Conductor sizes and types.

Conductors used for fire alarm cabling can be copper, aluminum or copper-clad aluminum. Each type of material has different properties regarding resistance and current-carrying capacity.





- 3. Conductor properties.
 - a. Table 8 from the NEC shows solid wire under the stranding column but with the quantity of conductors being “1.” True stranded wire is shown in the same column with the number of conductors being “7.” The diameter of each conductor in the strand is much smaller than solid, but when multiplied by the seven conductors that are bundled together in the strand, the overall area is actually larger than a single solid conductor of the same gauge wire.
 - b. The table also breaks out coated and uncoated wire, as they have slightly different resistance at the same gauge. Uncoated wire is bare copper with or without insulation. Coated wire is tinned copper conductors with or without insulation. This is typically done to enhance corrosion resistance of the copper wire when used in atmospheres where corrosion may be accelerated.
 - c. While not a property that is included in the table or one that affects resistance, cabling used for fire alarm wiring can be shielded or unshielded. Shielding is when the wires in the cable are wrapped with a material such as foil to prevent interference from electromagnetic radiation or electrical noise.
 - d. The decision on what specific type of wire to use is up to the design professional. We can use the information on the plans, in the submittal package, and from the NEC to ensure that we understand what is being used and whether it is being designed and installed correctly.



Are roles and responsibilities (swim lanes) clearly divided when working with an electrical inspector? Do you need to cross the lanes?

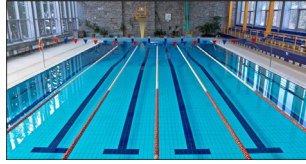


Photo courtesy of iStock.

Slide 1-35

VOLTAGE DROP CALCULATIONS

VOLTAGE DROP CALCULATION

Circuit Number	Serves	1500 Shore (corking mount) 1000 Amps	3000 Shore (corking mount) 600 Amps	1500 Shore Shore (corking mount) 300 Amps	3000 Shore (corking mount) 600 Amps	7500 Shore Shore (corking mount) 140 Amps	% Spare Capacity	Load (in amps)	Approximate Total Circuit Length Using #14 AWG (in feet)	Maximum Circuit Length Using #14 AWG (in feet)	Calculated Final Voltage at Load device based on circuit length & conductor (100°F)
ELECTRIC ROOM											
FA07/ NAC 1	FIRST NATIONAL BANK	2	1	4	1	1	87%	0.882	250	984	19.38
FA07/ NAC 2	SPARE						100%	0.000	0		
A/V Device Total This Panel		2	1	4	1	1	Total load	0.882			

Photo courtesy of ADT.

Slide 1-36

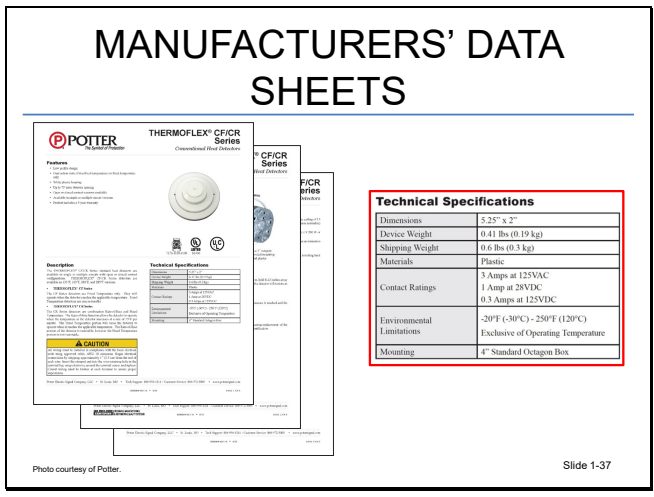
4. Voltage drop calculations.

a. Each circuit should be shown with wire type, gauge and length to determine the voltage drop. The number and type of devices on the circuit will dictate the load that will be applied. This should be done for all circuits with a significant current draw, but is most important for notification circuits, as they have the largest load. In addition, with reduced voltage the devices will either not function at all or will function at a reduced capacity.

b. There are two main calculation methods used for voltage drop:

- **End-of-line method:** Using the end-of-line method, the total number of devices and their loads are added together. That total load is added at the end of the circuit, meaning the entire length of the conductors is used to calculate the voltage drop with the entire load being placed at the end-of-line.

- While this is not specific to how the loads are actually added, it is a more conservative and quicker calculation than the other method, point-to-point.
- **Point-to-point method:** examines each section of conductors and adds the load from each individual device to the system at the point where it occurs. This means that wire can be sized smaller and more precisely to the actual load that occurs at a specific point in the circuit.
- While this calculation is more precise and can potentially save wire size, it takes more time and may need to be recalculated if changes are made in the field.



5. Manufacturers' data sheets indicating model numbers and listing information for equipment, devices and materials.

The data sheets for equipment are essential information to have as a portion of the document submittal process. Data sheets or cut sheets will tell us how a product is listed, how it is intended to be installed, and any functional limitations that we may need to be aware of to determine that the product is being used correctly.

SCOPE OF WORK

- SCOPE OF WORK -

THE INTENT OF THIS PROJECT IS TO REPLACE THE EXISTING SPRINKLER MONITORING PANEL AT THIS FACILITY TO INCLUDE THE NEW TENANT RENOVATION ON THE 1ST FLOOR. IN ORDER TO ACCOMPLISH THIS TASK, NEW NOTIFICATION AND INITIATING DEVICES WILL BE ADDED THROUGHOUT IN ALL LOCATIONS REQUIRED. ALL DEVICES TO BE TIED INTO NEW CIRCUITING PROVIDED UNDER THIS CONTRACT.

Photo courtesy of ADT.

Slide 1-38

6. Scope of work sets the boundaries of what the design professional is responsible for according to their contract with the building or business owner. While this may limit what is shown on the plans or what that specific design professional is responsible for, it does not alleviate the design and installation requirements under the applicable codes, standards and regulations.

PROGRAM PRINTOUT

Program printout shows all of the devices and the intended action.

Complete Panel Report

Device ID	Device Name	Device Type	Device Location	Device Status	Device Action	Device Notes
101	Smoke Detector	Smoke	101-101	Normal	Alert	
102	Smoke Detector	Smoke	101-102	Normal	Alert	
103	Smoke Detector	Smoke	101-103	Normal	Alert	
104	Smoke Detector	Smoke	101-104	Normal	Alert	
105	Smoke Detector	Smoke	101-105	Normal	Alert	
106	Smoke Detector	Smoke	101-106	Normal	Alert	
107	Smoke Detector	Smoke	101-107	Normal	Alert	
108	Smoke Detector	Smoke	101-108	Normal	Alert	
109	Smoke Detector	Smoke	101-109	Normal	Alert	
110	Smoke Detector	Smoke	101-110	Normal	Alert	
111	Smoke Detector	Smoke	101-111	Normal	Alert	
112	Smoke Detector	Smoke	101-112	Normal	Alert	
113	Smoke Detector	Smoke	101-113	Normal	Alert	
114	Smoke Detector	Smoke	101-114	Normal	Alert	
115	Smoke Detector	Smoke	101-115	Normal	Alert	
116	Smoke Detector	Smoke	101-116	Normal	Alert	
117	Smoke Detector	Smoke	101-117	Normal	Alert	
118	Smoke Detector	Smoke	101-118	Normal	Alert	
119	Smoke Detector	Smoke	101-119	Normal	Alert	
120	Smoke Detector	Smoke	101-120	Normal	Alert	

Photo courtesy of ADT.

Slide 1-39

7. Program printout shows all of the devices and the intended action.

ANY OTHER JURISDICTION REQUIREMENTS

If the jurisdiction requires a certain number of plans or a certain level of licensure or certification for the design professional, the plans should comply with them.

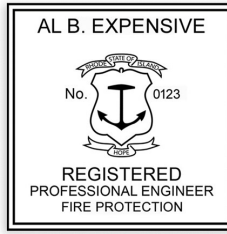


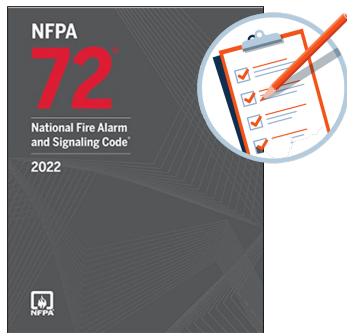
Photo courtesy of Rhode Island State Building Office Design Professionals

Slide 1-40

8. Any other jurisdiction requirements.

If the jurisdiction requires a certain number of plans or a certain level of licensure or certification for the design professional, the plans should comply with them.

NATIONAL FIRE PROTECTION ASSOCIATION 72 REQUIREMENTS FOR SUBMITTAL



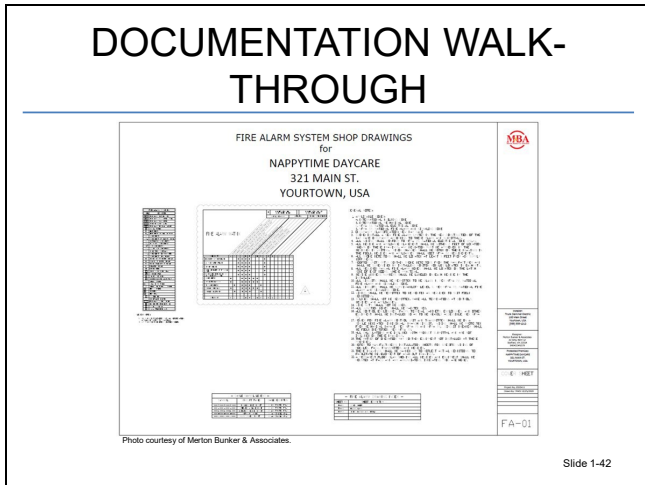
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Slide 1-41

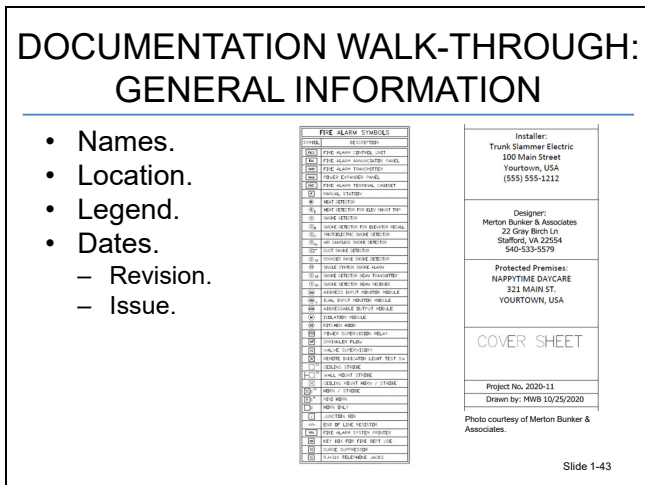
B. NFPA 72 requirements for submittal.

1. Specific requirements for a submittal were not required until NFPA 72's 2013 edition.
2. Requirements for documentation are outlined in Chapter 7 of NFPA 72.

V. DOCUMENTATION WALK-THROUGH

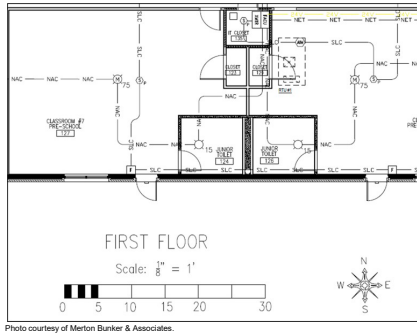


- A. This walk-through of sample plans and submittal packet will prepare you for the upcoming activity on design and installation documentation.
- B. This walk-through will follow NFPA 72's documentation requirements for design documentation and shop drawings.



- 1. General information: Ensure that all necessary information is present, including names, location, legend and dates.

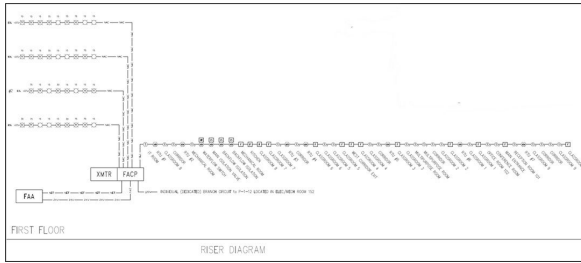
DOCUMENTATION WALK-THROUGH: FLOOR PLANS



Slide 1-44

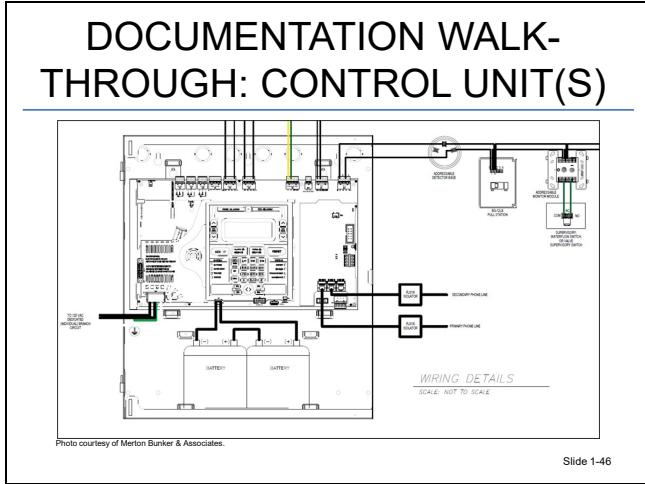
2. Floor plans: Ensure that floor plans are drawn to indicated scale and include necessary information, such as floor or level identification and system riser locations.

DOCUMENTATION WALK-THROUGH: RISER DIAGRAM

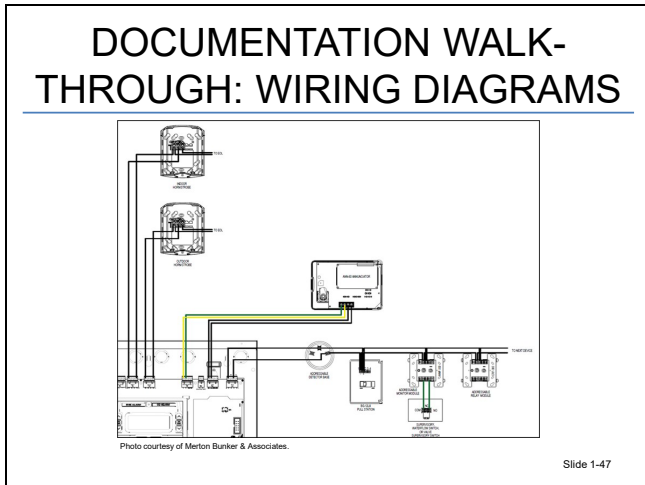


Slide 1-45

3. Riser diagram: Ensure that the riser diagram is coordinated with the floor plans and includes necessary information, such as number of risers and type and number of circuits in a riser.



4. Control unit(s): Ensure that diagrams are provided for all control unit equipment or control unit accessory.

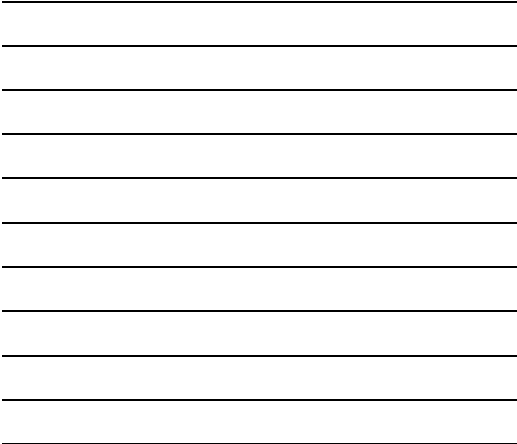


5. Wiring diagrams: Ensure that wiring diagrams are provided for all necessary devices, such as initiating devices, notification appliances and remote indicators.

DOCUMENTATION WALK-THROUGH: NARRATIVE OR INPUT/OUTPUT MATRIX

Photo courtesy of Merton Bunker & Associates.

Slide 1-48



6. Narrative or input/output (I/O) matrix: Ensure that a narrative description or I/O matrix of operation that describes the sequence of operation is provided.

DOCUMENTATION WALK-THROUGH: SYSTEM CALCULATIONS

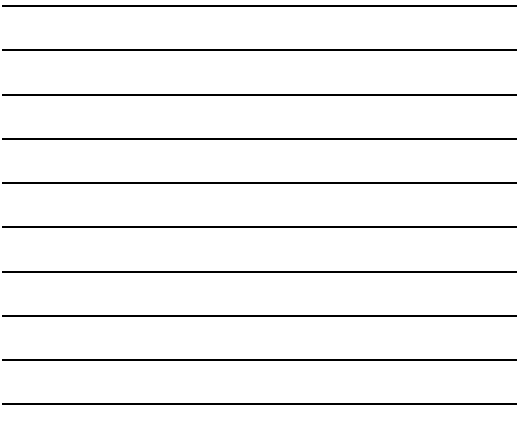
Fire Alarm System Secondary Battery-set Calculation Worksheet

ITEM	DESCRIPTION	STANDBY CURRENT PER UNIT (AMPS)	QTY	TOTAL STANDBY CURRENT PER ITEM	ALARM CURRENT PER UNIT (AMPS)	QTY	TOTAL ALARM CURRENT PER ITEM		
ACU	Control Unit	0.1410 X	1 =	0.1410	0.2570 X	1 =	0.2570		
NI	Annunciator	0.9150 X	1 =	0.9150	0.0400 X	1 =	0.0400		
D	Stroke Detector	0.0040 X	25 =	0.0995	0.0065 X	25 =	0.1625		
IS	Manual Station	0.0040 X	13 =	0.0048	0.0050 X	13 =	0.0650		
IM	Monitor Module	0.0038 X	7 =	0.0266	0.0000 X	7 =	0.0000		
M	Door Monitor Module	0.0038 X	2 =	0.0076	0.0000 X	2 =	0.0000		
ST	Horn Strobe 15c	0.0000 X	11 =	0.0000	0.0440 X	11 =	0.4840		
ST	Stroke 15c	0.0000 X	11 =	0.0000	0.0410 X	11 =	0.4510		
SD	Horn Strobe 30c	0.0000 X	3 =	0.0000	0.0710 X	3 =	0.2130		
ST	Horn Strobe 15c	0.0000 X	10 =	0.0000	0.1210 X	10 =	1.2100		
TOTAL SYSTEM STANDBY CURRENT (AMPS)				0.1913	TOTAL SYSTEM ALARM CURRENT (AMPS)				2.138

DESCRIPTION	REQUIRED STANDBY TIME (HRS)	TOTAL SYSTEM STANDBY CAPACITY (AMP-HOURS)	REQUIRED ALARM TIME (HOURS)	REQUIRED SYSTEM ALARM CAPACITY (AMP-HOURS)	SAFETY FACTOR	ADJUSTED BATTERY CAPACITY (AMP-HOURS)
APPLYTIME DAYCARE 21 MAIN STREET CORTOWN, USA	NFPA 72-2010 4.4.1.6.3.1	24	0.1913	4.6506	0.062 X	0.286

Photo courtesy of Merton Bunker & Associates.

Slide 1-49



7. System calculations: Ensure that system calculations are provided.

DOCUMENTATION WALK-THROUGH: SYSTEM CALCULATIONS (cont'd)

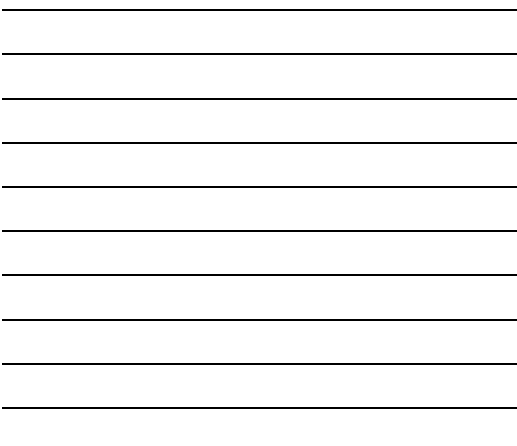
This calculator provides voltage drop calculations in three formats (Point to Point, End of Line, and Load Centering). Make sure that you know what method is accepted by, and the results do not exceed the limits set by the respective jurisdiction.

Point to Point Method End of Line Method Load Centering Method

CIRCUIT IS WITHIN LIMITS				CIRCUIT IS WITHIN LIMITS				CIRCUIT IS WITHIN LIMITS					
Device #	Device Name	Current (Amps)	Distance (Feet)	Device #	Device Name	Current (Amps)	Distance (Feet)	Device #	Device Name	Current (Amps)	Distance (Feet)		
1	Device 1	0.581	20	2	Device 2	0.137	28	3	Device 3	0.081	30		
4	Device 4	0.054	8	5	Device 5	0.041	8	6	Device 6	0.041	8		
7	Device 7	0.041	11	8	Device 8	0.137	12	9	Device 9	0.071	18		
11	Device 11	20.09	0.319									20.09	0.319
12	Device 12	20.09	0.319									20.09	0.319

Photo courtesy of Merton Bunker & Associates.

Slide 1-50



ACTIVITY 1.1

National Fire Protection Association 72[®], *National Fire Alarm and Signaling Code*[®], Design and Installation Documentation

Purpose

Determine the compliance with applicable standards and codes using the provided sample submittal package.

Directions

1. In your small group, use the Central City High School plans and the checklist on the following page to determine if information submitted is complete. Note where the information can be found. If missing, document “not shown.”
2. Be prepared to share your responses with the larger group.

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ACTIVITY 1.1 (cont'd)

Central City High School Checklist

	Item	Location
1	Name of protected premises, owner and occupant (where applicable)	
2	Name of installer or contractor	
3	Location of protected premises	
4	Device legend and symbols in accordance with NFPA 170, or other symbols acceptable to the AHJ	
5	Date of issue and any revision dates	
6	Floor or level identification	
7	Point of compass (indication of north)	
8	Graphic scale	
9	All walls and doors	
10	All partitions extending to within 15% of the ceiling height (where applicable and when known)	
11	Room and area descriptions	
12	System devices/component locations	
13	Locations of fire alarm primary power disconnecting means	
14	Locations of monitor/control interfaces to other systems	
15	System riser locations	
16	Type and number of system components/devices on each circuit, on each floor or level	
17	Type and quantity of conductors and conduit (if used) for each circuit	
18	Identification of any ceiling over 10 feet (3.0 meters) in height where automatic fire detection is being proposed	
19	Details of ceiling geometries, including beams and solid joists, where automatic fire detection is being proposed	
20	Where known, acoustic properties of spaces	
21	General arrangement of the system in building cross-section	
22	Number of risers	
23	Type and number of circuits in each riser	
24	Type and number of system components/devices on each circuit, on each floor or level	
25	Number of conductors for each circuit	
26	Identification of the control equipment depicted	
27	Location(s) of control equipment	
28	All field wiring terminals and terminal identifications	

PREPARING FOR PLANS REVIEW

29	All circuits connected to field wiring terminals and circuit identifications	
30	All indicators and manual controls	
31	Field connections to supervising station signaling equipment, releasing equipment or emergency safety control interfaces, where provided	
32	Typical wiring diagrams shall be provided for all: <ul style="list-style-type: none">• Initiating devices• Notification appliances• Remote indicators• Annunciators• Remote test stations• End-of-line and power supervisory devices	
33	A narrative description or I/O matrix of operation shall be provided to describe the sequence of operation	
34	Battery calculations	
35	Notification appliance circuit voltage drop calculations	
36	Other required calculations, such as line resistance calculations, where required	

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REFERENCES

- American Society of Mechanical Engineers. (n.d.). *About ASME*. <https://www.asme.org/about-asme#:~:text=Founded%20in%201880%20as%20the>
- Hammerberg, T. P. (2022, January 15). What's new in the 2022 NFPA 72: An overview of the important changes. *Electrical Contractor*. <https://www.ecmag.com/magazine/articles/article-detail/integrated-systems-whats-new-2022-nfpa-72-overview-important-changes>
- Hugo, J., & Hartenbach, A. (2017, August 31). #72-The history of life safety code: NFPA 101, NFPA 13, NFPA 13R, and NFPA 13D. *Quick Response Fire Supply*. <https://blog.qrfs.com/72-the-history-of-life-safety-code-nfpa-101-nfpa-13-nfpa-13r-and-nfpa-13d/>
- International Code Council. (2018). *International mechanical code* (IMC Section No. 506.1). <https://codes.iccsafe.org/s/IMC2018/chapter-5-exhaust-systems/IMC2018-Ch05-Sec506.1>
- International Code Council. (2021a). *International fire code*. <https://codes.iccsafe.org/content/IFC2021P2>
- International Code Council. (2021b). *International mechanical code*. <https://codes.iccsafe.org/content/IMC2021P3/preface>
- International Code Council. (n.d.). *Who we are*. <https://www.iccsafe.org/about/who-we-are/>
- Kelechava, B. (2021, April 27). 2021 International building code (ICC IBC-2021). *American National Standards Institute*. <https://blog.ansi.org/2021-international-building-code-icc-ibc/#gref>
- National Fire Protection Association. (2022). *National fire alarm and signaling code*® [Standard no. 72]. <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=72>
- National Fire Protection Association. (n.d.-a). *Changes to the NEC*. <https://www.nfpa.org/NEC/About-the-NEC/Changes-to-the-NEC>
- National Fire Protection Association. (n.d.-b). *NFPA overview*. <https://www.nfpa.org/About-NFPA/NFPA-overview>
- Roman, J., Verzoni, A., & Watson, R. (n.d.). Important NFPA code changes for 2021. *Precision Fire Protection*. <https://pfpinc.com/important-nfpa-code-changes-for-2021/>

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APPENDIX

CONDUCTOR PROPERTIES

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Table 8 Conductor Properties

Size (AWG or kcmil)		Conductors										Direct-Current Resistance at 75°C (167°F)					
		Stranding					Overall					Copper			Aluminum		
		Quantity	mm	in.	Diameter	mm	in.	Diameter	mm ²	in. ²	Area	ohm/km	ohm/kFT	ohm/km	ohm/kFT	ohm/km	ohm/kFT
18	0.823	1620	1	—	—	1.02	0.040	0.823	0.001	25.5	7.77	26.5	8.08	42.0	12.8		
18	0.823	1620	7	0.39	0.015	1.16	0.046	1.06	0.002	26.1	7.95	27.7	8.45	42.8	13.1		
16	1.31	2580	1	—	—	1.29	0.051	1.31	0.002	16.0	4.89	16.7	5.08	26.4	8.05		
16	1.31	2580	7	0.49	0.019	1.46	0.058	1.68	0.003	16.4	4.99	17.3	5.29	26.9	8.21		
14	2.08	4110	1	—	—	1.63	0.064	2.08	0.003	10.1	3.07	10.4	3.19	16.6	5.06		
14	2.08	4110	7	0.62	0.024	1.85	0.073	2.68	0.004	10.3	3.14	10.7	3.26	16.9	5.17		
12	3.31	6530	1	—	—	2.05	0.081	3.31	0.005	6.34	1.93	6.57	2.01	10.45	3.18		
12	3.31	6530	7	0.78	0.030	2.32	0.092	4.25	0.006	6.50	1.98	6.73	2.05	10.69	3.25		
10	5.261	10380	1	—	—	2.588	0.102	5.26	0.008	3.984	1.21	4.148	1.26	6.561	2.00		
10	5.261	10380	7	0.98	0.038	2.95	0.116	6.76	0.011	4.070	1.24	4.226	1.29	6.679	2.04		

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UNIT 2: FIRE ALARM SYSTEM FUNDAMENTALS

TERMINAL OBJECTIVE

The students will be able to:



- 2.1 *Compare the materials used with the appropriate codes and standards and manufacturers' data sheets to determine if the system is suitable for the building, given fire alarm shop drawings.*

ENABLING OBJECTIVES

The students will be able to:

- 2.1 *Describe the required elements that establish a fire alarm system.*
 - 2.2 *Determine if the system provided is appropriate for use and occupancy.*
 - 2.3 *Describe the operations of a fire alarm control unit (FACU).*
 - 2.4 *Verify that FACU location is acceptable.*
 - 2.5 *Determine if the primary and secondary power sources provided are allowed for the system.*
 - 2.6 *Analyze circuit and pathway arrangements for code compliance.*
 - 2.7 *Determine if the fire alarm is monitored and the type of monitoring provided.*
-

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**UNIT 2:
FIRE ALARM SYSTEM
FUNDAMENTALS**

Slide 2-1

TERMINAL OBJECTIVE

Compare the materials used with the appropriate codes and standards and manufacturers' data sheets to determine if the system is suitable for the building, given fire alarm shop drawings.

Slide 2-2

ENABLING OBJECTIVES

- Describe the required elements that establish a fire alarm system.
- Determine if the system provided is appropriate for use and occupancy.
- Describe the operations of a fire alarm control unit (FACU).
- Verify that FACU location is acceptable.

Slide 2-3

ENABLING OBJECTIVES (cont'd)

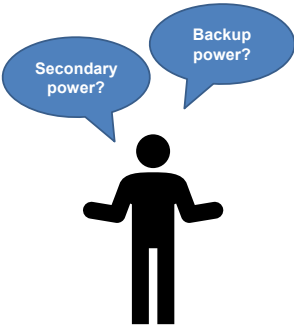
- Determine if the primary and secondary power sources provided are allowed for the system.
- Analyze circuit and pathway arrangements for code compliance.
- Determine if the fire alarm is monitored and the type of monitoring provided.

Slide 2-4

I. TERMINOLOGY

TERMINOLOGY

- Secondary power.
- Correction factor.
- FACU.
- Module.
- Floor versus zone.
- Plans versus shop drawings.
- Quiescent.



Slide 2-5

Following are terms that will be discussed throughout the course, and considerations for interchangeable or incorrect terms.

A. **Secondary power:** the alternate source of power when the building utility is not available. This is the term formally used in National Fire Protection Association (NFPA) 72[®], *National Fire Alarm and Signaling Code*[®].

Not to be confused with:

1. “Emergency generator/power” is often used incorrectly as a blanket phrase to cover all backup power. NFPA 110, *Standard for Emergency and Standby Power Systems* refers to emergency power when it is specifically used to power a fire and/or life safety system.

2. A “standby power” system may also be legally required but wouldn't provide power to those types of systems; standby power would instead power things like heating, ventilating and air conditioning (HVAC) that may be inconvenient if they are not operating.

Terms like standby power and emergency power are not used in the standard.

- B. **Correction factor:** the term “safety margin” has been updated to “correction factor” in the 2022 edition of NFPA 72. Since the term “safety margin” has been in use for several years and editions, both terms will likely be used interchangeably for some time.

- C. **Fire alarm control unit (FACU):** a central unit of the fire alarm system that receives signals from initiating devices, and based on the signal and device, determines what actions to take. This is the term used and defined in NFPA 72.

1. Sometimes referred to as:
 - a. Fire alarm panel.
 - b. Fire alarm control panel (FACP).
2. The definition has been modified over editions and previously did include the word “panel.”
3. There are also subclassifications of the FACU depending upon what they control. There are:

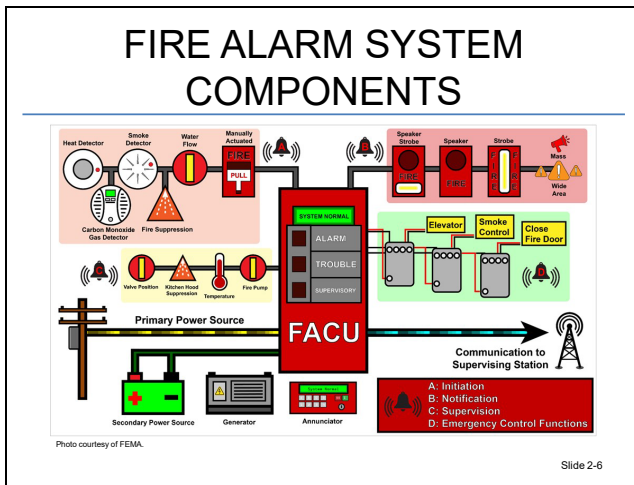
The subclassifications are meant to highlight what equipment is being controlled and how that individual control unit may fit together when connected to other control units.

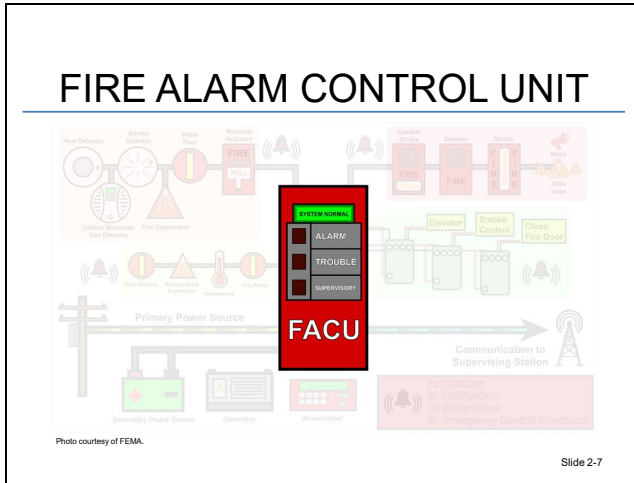
- a. Releasing service FACUs.
 - b. Dedicated function FACUs.
 - c. Protected premises (local) control units.
 - d. Master FACUs.
- D. **Module:** At its most basic, it is essentially an on/off switch. It can be an input or an output where the FACU either sends a signal to or receives a signal from the module as part of the sequence of operations. Modules will be discussed in greater detail in a later section.

Sometimes referred to as:

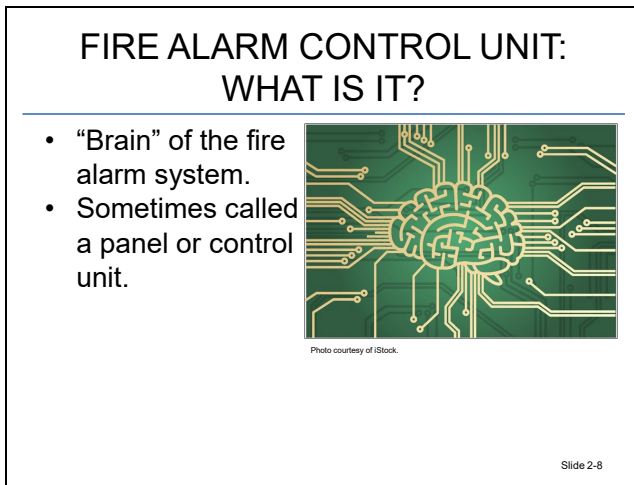
1. Addressable input module (AIM).
 2. Monitor module.
 3. Zone activating module.
- E. **Floor versus zone:** Systems may be divided into smaller areas. This can be done by floor or by zone. The system designer will decide how they want to break the system up into smaller areas on the same floor or by floor. When talking about the system division, it is more accurate to refer to zoning.
- F. **Plans versus shop drawings:** The word “plans” is used as a generic term for drawings of a building or system. “Shop drawings” are more specifically plans that are used to fabricate, manufacture and install the specific system. These are what will be used during the construction process and what we need to review for code compliance.
- G. **Quiescent:** This term is used in NFPA 72 when discussing battery capacity and calculation. It is referring to the alarm system in a non-alarm condition. We also refer to this as “standby.”

II. FIRE ALARM SYSTEM COMPONENTS





A. FACU.



1. What is a FACU?
 - a. The FACU is the “brain” of a fire alarm system.
 - b. It may also be referred to as a panel or simply a control unit.

**FIRE ALARM CONTROL UNIT:
WHAT IS IT? (cont'd)**

- Receives signals from initiating devices and determines what action to take.
- More than one FACU per system is possible, with one being the master FACU.

```
graph TD; Master[Master FACU] --- Sub1[FACU Subpanel]; Master --- Sub2[FACU Subpanel]; Master --- Sub3[FACU Subpanel];
```

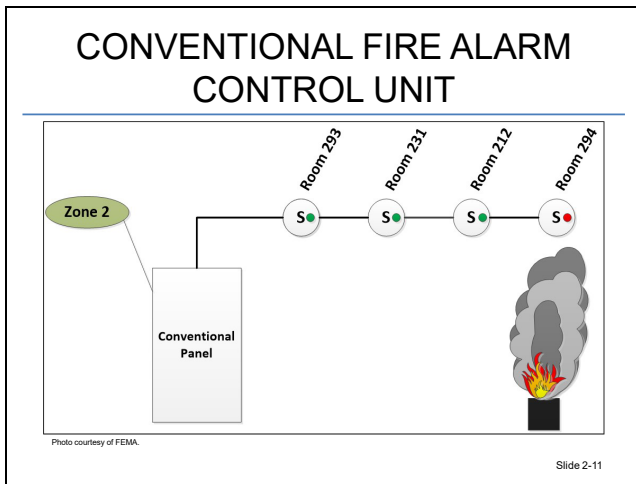
Slide 2-9

- c. It receives signals from initiating devices, and based on the signal and device, determines what actions to take, such as:
 - Activating notification appliances.
 - Retransmitting alarm.
 - Notifying audibly/visibly at FACU.
 - Turning HVAC on/off.

- d. There can be more than one FACU per system, with one being dedicated as the master FACU. FACUs can be provided for a specific function, such as recalling elevators or releasing a sprinkler system as in the case of a pre-action system.

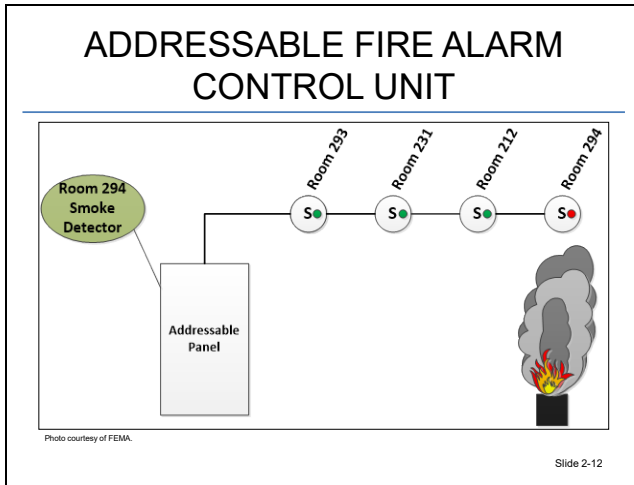
- e. The image shows multiple FACUs connected together. The system designer may include multiple FACUs as part of the design. There will be one FACU designated as the master FACU that will accept inputs from the other control units.





- 2. Two main types of FACU.
 - a. Conventional (wiring-based).
 - A conventional FACU has devices wired to zones.
 - For example, if all 10 smoke detectors on the first floor are wired to a single zone on the FACU, and if one device activated, the FACU would indicate first floor. In addition, a second alarm on the same zone would not be indicated, as the zone itself is already in alarm.
 - Starting in 2015, the International Building Code (IBC) only allows conventional, zone-type alarm systems for new installations on smaller systems or those performing a specific control function.

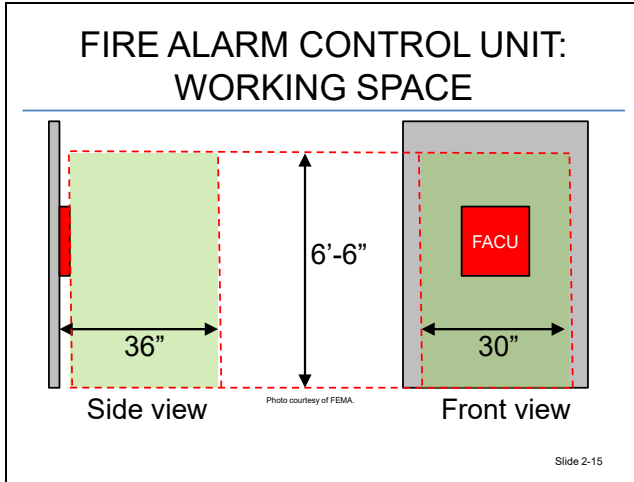
- The image shows a conventional FACU and how it responds to a device when activated, here using Room 294 as an example. The FACU simply sees that Zone 2 has a device in alarm, not knowing which one. If subsequent devices in Zone 2 go into alarm, there will be no further indication on the FACU.



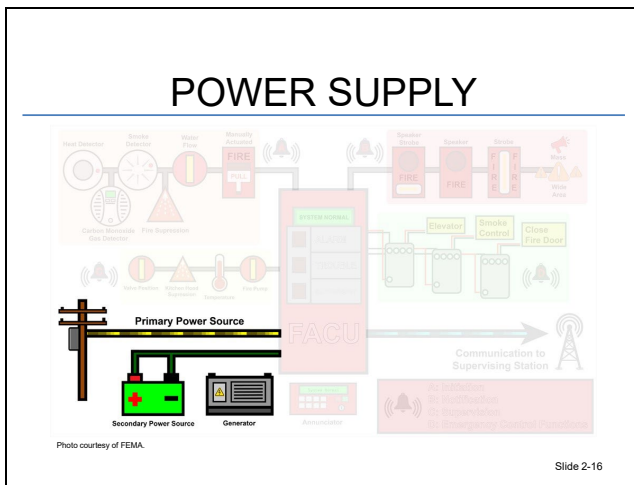
b. Addressable (programming/software-based).

- Addressable fire alarm systems predominantly use digital technology. Each device has a programmed address and would be indicated as such on the FACU.
- Using the same example as the conventional FACU, the 10 smoke alarms on the first floor would each have a unique address, so that if one detector goes into alarm, the FACU would indicate which one. For instance, the FACU may read “First floor rear hall smoke.” In addition, any subsequent device that goes into alarm would be separately indicated on the FACU.
- The image shows an addressable FACU and how it responds to a device when activated, here using Room 294 as an example. The FACU specifically sees that the device with the ID “Room 294” is in alarm. If subsequent devices go into alarm, there will be further indication on the FACU of all devices in alarm.

- d. The plans reviewer may need to look at the electrical/mechanical drawings to determine if heat will be provided in the area where the FACU is being installed, especially in the case of an installation in an entryway.



- 4. FACU working space.
 - a. A FACU is electrical equipment and therefore governed by NFPA 70®, *National Electrical Code*® (NEC). That document dictates the safe space in front of the equipment to facilitate work that may need to be done.
 - b. The image shows the required working space of 30-inch width, 36-inch depth and 6-foot-6-inch height. The width and height are prescriptive minimums, and if the equipment itself is higher or wider, the working space will be dictated by the footprint of the equipment.



B. Power supplies.

POWER SUPPLY: WHAT IS IT?

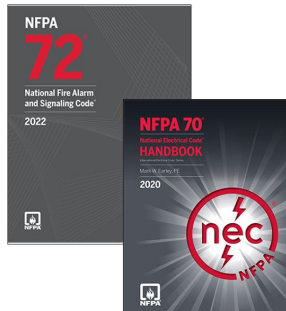
- A source of electrical operating power.
- Primary and secondary sources of power ensure redundancy to power the fire alarm system.

Slide 2-17

1. What is a power supply?
 - a. NFPA 72 defines the power supply as “a source of electrical operating power, including the circuits and terminations connecting it to the dependent system components” (NFPA, Section 3.3.214, 2022).
 - b. Fire alarm systems need to have redundancy when it comes to powering the system. We refer to primary and secondary sources of power to address this issue.

POWER SUPPLY INSTALLATION RULES

- NFPA 72®, *National Fire Alarm and Signaling Code*®.
- NFPA 70®, *National Electrical Code (NEC)*®.



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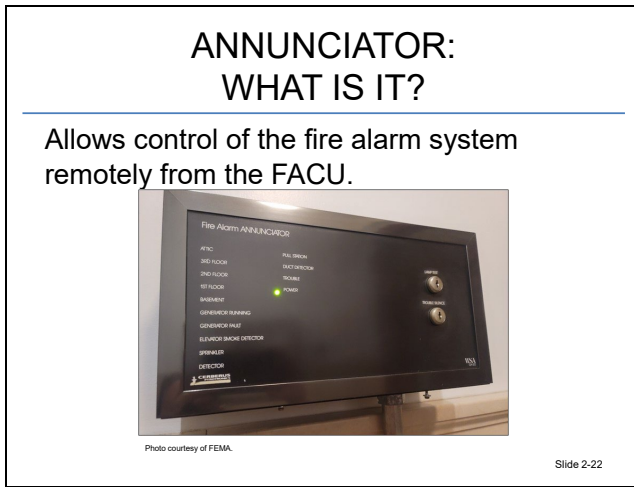
Slide 2-18

2. Power supply installation rules.
 - a. While NFPA 72 governs the installation methods and materials of the fire alarm system, NFPA 70 will also be a document that will need to be used to ensure a compliant installation.

- d. Batteries are governed by NFPA 72, which states that batteries need to be marked with month and year of manufacture for future inspection and replacement.



C. Annunciators.



- 1. What is an annunciator?
 - a. An annunciator is the component of the fire alarm system that allows the user to control the fire alarm system remotely from the FACU.
 - b. Annunciators can also include controls so that alarms can be acknowledged, silenced and reset.

ANNUNCIATOR: TYPES

- **Graphic.**
 - Shows a floor plan and specific location of the signal received.
- **Remote.**
 - Displays the status of the system and allows some functionality controls.

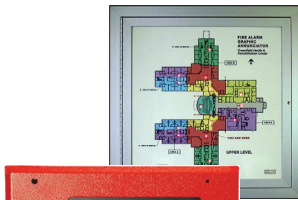


Photo courtesy of Potter.

Slide 2-23

Photo courtesy of Graphics National.

2. Types of annunciators.

- A graphic annunciator shows a floor plan and specific location of the signal received.
- A remote annunciator displays the status of the fire alarm system and allows for the control of some functions.

ANNUNCIATOR: TYPES (cont'd)

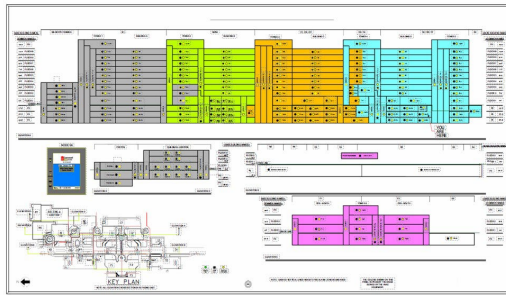


Photo courtesy of ADT.

EXISTING GRAPHIC IN ENGINEERING OPERATIONS CENTER

Slide 2-24

ANNUNCIATOR INSTALLATION RULES

- Follow manufacturer's installation instructions.
- Installation must be in a conditioned space.
- Follow any jurisdiction-specific requirements on location.



Photo courtesy of Brad Cronin.

Slide 2-25

3. Annunciator installation rules.

- a. Follow manufacturer's installation instructions.
- b. Installation must be in a conditioned space that is within listing limitations for temperature.
- c. There is no specific location required by NFPA 72. However, a local jurisdiction may have requirements regarding installation location.

INITIATING DEVICES

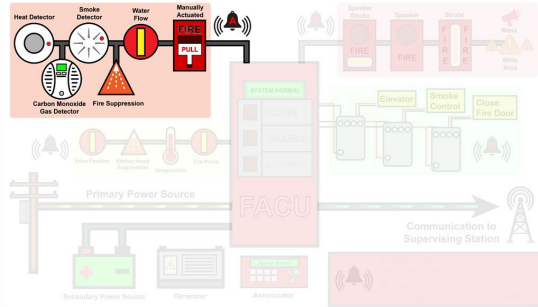


Photo courtesy of FEMA.

Slide 2-26

D. Initiating devices.

INITIATING DEVICE: WHAT IS IT?

- A device that will report a condition or signal to the FACU.
- Inputs of the system that inform the FACU.

— SLC — SLC — SLC —
Signaling line circuit (SLC)

— IDC — IDC — IDC —
Initiating device circuit (IDC)

Slide 2-27

1. What is an initiating device?
 - a. Initiating device is a generic term for any device that will report a condition or signal to the FACU. There are many different types of initiating devices, depending on what their specific function is. These are the inputs of the system that will inform the FACU about what is going on in certain areas of the system.
 - b. Devices are connected on a circuit known as either a signaling line circuit (SLC) for addressable systems or an initiating device circuit (IDC) for conventional systems.

INITIATING DEVICE: TYPES

- Heat detection.
- Smoke detection.
- Flame detection.
- Gas detection.
- Carbon monoxide detection.
- Sprinkler water flow.



Photo courtesy of iStock.

Slide 2-28

2. Types of initiating devices include:
 - a. Heat detection.
 - b. Smoke detection.

- c. Flame detection.
- d. Gas detection.
- e. Carbon monoxide detection.
- f. Sprinkler water flow.
- g. Other types of system of device monitoring.

**INITIATING DEVICE
INSTALLATION RULES**

- Each device will have its own specific limitations and installation rules. Refer to the manufacturer's published instructions.


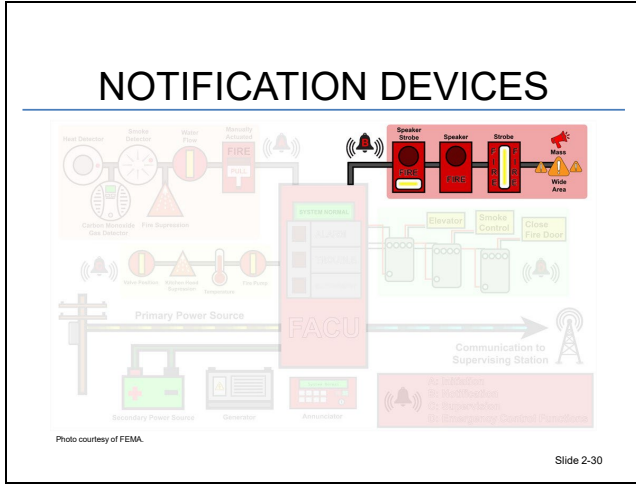


Photo courtesy of Merton Bunker & Associates.

Slide 2-29

- 3. Initiating device installation rules.
 - a. Each device will have its own specific limitations and installation rules, which can be found in the manufacturer's published instructions.
 - b. Plans reviewers should ensure the following:
 - Avoiding sources of unintended activation.
 - Placing devices so that they are easily accessible for future inspection, testing and maintenance.
 - Installing in areas that are within the listing limitations for temperature, humidity and other conditions.



E. Notification devices.

NOTIFICATION DEVICE: WHAT IS IT?

- Output of the fire alarm system.
- FACU takes input from the initiating device and activates the notification device if needed.

Photo courtesy of Potter.

Slide 2-31

1. What is a notification device?

A notification device is the output of the system. Based on the specific input received from the initiating devices, the FACU will take that signal and determine whether to activate the notification device.

NOTIFICATION DEVICE: TYPES

- Audible.
- Visual.
- Tactile.
- Combination.

— NAC — NAC — NAC —
Notification appliance circuit (NAC)




Photo courtesy of Potter.

Slide 2-32

2. Types of notifications.
 - a. Notification devices will produce notifications in audible, visual, tactile or combined formats.
 - b. Devices are connected on a circuit known as a notification appliance circuit (NAC).

**NOTIFICATION DEVICE
INSTALLATION RULES**

- Each device will have its own specific limitations and installation rules. Refer to the manufacturer's published instructions.

L- Series Dimensions
Figure 3 illustrates the dimensions for the ceiling backbox surface mount backbox

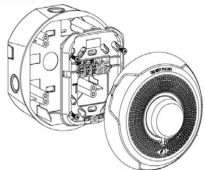


Figure 3 2-Wire Ceiling Mount Horn Strobes with Ceiling Surface Mount Backbox

Photo courtesy of Honeywell.

Slide 2-33

3. Notification device limitations.
 - a. Each project will have its own specific limitations and installation rules, which can be found in the manufacturer's published instructions.
 - b. The image shows an example of installation details from a cut sheet for a ceiling-mount horn strobe.

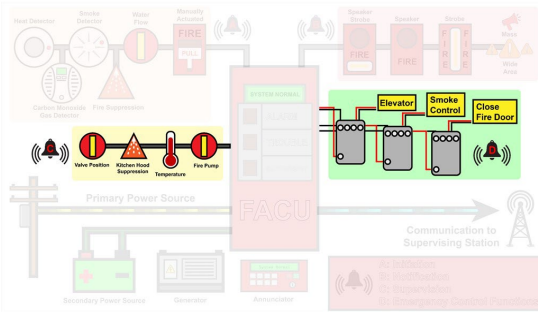
NOTIFICATION DEVICE INSTALLATION RULES (cont'd)

- Considerations for each space's intended use.
 - Audible factors.
 - Visual factors.
 - Large open areas that will be subject to future furnishings and fixtures.

Slide 2-34

- c. Plans reviewers should be aware of each space's intended use, taking the following into consideration:
- Audible factors: For example, there may be high ambient noise in industrial occupancies.
 - Visual factors: Ensure there is no obstruction of visibility by items (e.g., rack storage or library stacks) or due to the geometry of the space.
 - Pay close attention to large open areas that will be subject to future furnishings and fixtures, which may require a closer inspection during construction or at time of occupancy.

INTERFACE DEVICES



Slide 2-35

F. Interface devices.

INTERFACE DEVICE: WHAT IS IT?

- Connects the fire alarm system to another device or system.
- Could be an output or input in the system.

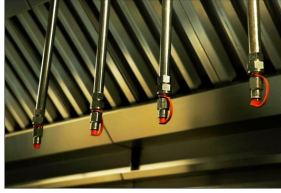


Photo courtesy of iStock.

Slide 2-36

1. What is an interface device?
 - a. A fire alarm interface device connects the fire alarm system to another device or system.
 - b. The interface could be an output, in the case of connecting to nonlisted devices such as sign boards and light-emitting diode (LED) displays.
 - c. The interface can also be an input, connecting some of the types of initiating devices mentioned previously.

INTERFACE DEVICE INSTALLATION RULES

Devices may not be listed for the application they interface to.




Photo courtesy of Donite Nance.

Slide 2-37

2. Interface device installation rules.
 - a. Plans reviewers need to be aware of devices that may not be listed for the application they interface to.

USE OUTSIDE OF LISTING



WARNING
As Stipulated By Factory Mutual And Underwriters Laboratories

This unit is not intended or designed for ordinary use. It is a special application device to be used for unusual conditions such as non-rising stem gate valves where no other approved or listed method of protection is available or practical. As this unit does not meet NFPA codes and standards, requiring restoration signal when the valve is positioned to normal, special attention should be given by the responsible parties to assure that the proper operation of this device is maintained. This device should only be restored to normal when the valve is in the normal condition.

Photo courtesy of Donte Nance. Slide 2-38

- b. Plans reviewers need to ensure that devices are listed for the application they interface to and ensure the correct location of the specific interface module in relation to what it is connecting.

III. DESIGN CHOICES SPECIFIC TO OCCUPANCY CLASSIFICATION

INTENT AND CLIMATE OF THE SYSTEM

When a fire alarm system is required by the building code or NFPA 101[®], *Life Safety Code*[®], the specific requirements are based on the occupancy.




Photo courtesy of iStock. Slide 2-39

- A. Intent and climate of the system.

When a fire alarm system is required by the building code or NFPA 101[®], *Life Safety Code*[®], the specific requirements are based on the occupancy.

FIRE HAZARD SPECIFIC TO OCCUPANCY

- Determining the requirements of fire alarm system and devices:
 - What is going to burn in this building, and how much heat will be released?
 - What will smoke propagation be?
 - How fast will the fire spread in the building?



Photo courtesy of iStock Slide 2-40

B. Fire hazard specific to occupancy.

1. The following questions are the basis for determining the devices and system that will be required:
 - a. What is going to burn in this building, and how much heat will be released?
 - b. What will smoke propagation be?
 - c. How fast will the fire spread in the building?
2. The codes take a prescriptive approach to addressing building and occupancy protection.

FIRE HAZARD SPECIFIC TO OCCUPANCY (cont'd)



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- 3. While the fire alarm requirements are occupancy-specific, the building has to be examined as a whole to determine if there are multiple occupancies with differing fire alarm requirements. If there are multiple occupancies, you must determine if the occupancies are separated or intermingled. If the building is subdivided into different fire areas and there is occupancy separation, the fire alarm requirements would only apply in each space.

FIRE HAZARD SPECIFIC TO OCCUPANCY (cont'd)

- Nature of the occupants:
 - Are there sleeping areas that may delay evacuation?
 - Are occupants confined to an area (e.g., prisons)?
 - Are occupants knowledgeable about the building?
 - Are there occupants who require guidance or assistance to evacuate?




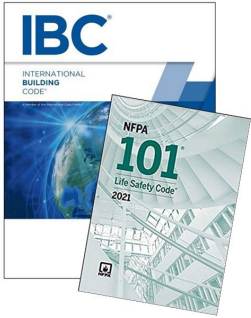
Photo courtesy of iStock

Slide 2-42

- 4. The nature of the occupants in a space also contributes as a factor in the fire alarm system design. Questions for consideration include:
 - a. Are there sleeping areas that may delay evacuation?
 - b. Are occupants confined to an area (e.g., prisons)?
 - c. Are occupants knowledgeable about the building?
 - d. Are there occupants who require guidance or assistance to evacuate?

OCCUPANCY CLASSIFICATION

- Code driven.
 - International Building Code (IBC).
 - NFPA 101.



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OCCUPANCY CLASSIFICATION (cont'd)

- Same concepts but different nomenclature between International Code Council (ICC) and NFPA.

Occupancy Category	NFPA 101/2000 (Occupancy Type)	IBC (Group)	Examples
Assembly	Assembly	A-1	Fixed seating production/theater
		A-2	Restaurants, nightclubs
		A-3	Other assembly (gyms, museums)
		A-4	Arenas, pools
		A-5	Stadiums, grandstands
Business	Business	B	Offices, dentists' offices, city halls
Educational	Educational	E	Schools, grade 12
Industrial	Industrial	F-1	Factories with moderate hazards
		F-2	Factories with low hazard (bricks, glass)
Storage	Storage	S-1	Storage with moderate hazard (flammable)
		S-2	Storage with low hazard (canned goods)
		S-3	Detonation hazard (explosives)
High hazard	Occupancy Type + hazardous contents requirements	H-1	Accidental burning hazard (flammable gases)
		H-2	Supported combustion hazard (flammable solids)
		H-3	Health hazards
		H-4	Health hazards
Medical Care/Institutional	Healthcare (4+ patients)	H-5	Semiconductor fabrication
Board & Care	Residential Board & Care (24 persons)	I-2 (16 patients)	Inpatient (24 hr) care, nursing homes
Day Care	Day Care (4+ clients)	I-3 (16 persons)	Personal care services & lodging
Detention & Correctional	Detention & Correctional (14+ persons)	I-4 (16 persons)	Care & Supervision (24 hr)
Mercantile	Mercantile	M	Occupants under restraint or security
		M-1	Display, sale of goods (retail)
Residential	Hotel & Dormitories	R-1	Hotels, motels (transient use)
	Hotel & Dormitories	R-2	Dormitories
	Apartment	R-3	Apartment
Special Structures	Lodging and Boarding	S-4 (16 persons)	Boarding
	Board & Care	S-4 (16 persons)	Board & Care, rehab facilities
	Occupancy Type + Special Structure provisions	Group U	Towers, tanks

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C. Occupancy classification.

1. Classification of occupancy is driven by codes.

a. International Code Council's (ICC's) IBC.

b. NFPA 101.

2. ICC and NFPA 101 convey the same concepts but use different nomenclature.

D. Types of occupancies and fire alarm requirements.

1. The IBC has the requirements for fire protection systems in Chapter 9. The fire alarm requirements are found in Section 907. This section will also include additional requirements for detection devices to address other hazards that are not occupancy-specific.

2. NFPA 101 is broken into chapters by occupancy, often with a separate chapter for a new occupancy versus an existing occupancy. Fire alarm requirements are located in each occupancy chapter.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS

- Assembly occupancies.



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Slide 2-45

3. Assembly occupancies (Groups A-1, A-2, A-3, A-4, A-5).
 - a. The fire alarm requirements for assembly occupancies are based on the number of occupants. A manual fire alarm is required for an assembly use occupant load of 300 or more.
 - b. If the assembly use is above or below the level of exit discharge, that number drops to 100 people. If the building contains multiple occupancies that are not separated, the occupant load for the entire building will be used.
 - c. Where the occupant load is at or above 1,000 people, the alarm needs to use emergency voice alarm communication (EVAC) with messaging for the purpose of notification versus a general evacuation tone.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Business occupancies.



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Slide 2-46

4. Business occupancies (Group B).

- a. The fire alarm requirements for business occupancies are based on the number of occupants.
- b. A manual fire alarm system is required for a business use occupant load on all floors of 500 or more.
- c. If the business use has an occupant load of 100 above or below the level of exit discharge, a manual fire alarm will be required.
- d. If the fire area contains an ambulatory care facility, supervised smoke detection needs to be installed in that area, as well as public use areas outside the space including corridors and elevator lobbies.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Educational occupancies.




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Slide 2-47

- 5. Educational occupancies (Group E).
 - a. Almost all educational occupancies require a fire alarm system. There is an exception for small schools with an occupant load of 50 or fewer. Once the occupant load gets above 100, the fire alarm needs to be an EVAC system.
 - b. In lieu of installing a manual fire alarm system throughout the school, automatic detection or automatic sprinklers can be provided.
 - c. If detection is used, smoke detection needs to be provided in corridors, and heat detection needs to be provided in auditoriums, cafeterias, gymnasiums and similar areas.
 - d. If the school contains shops or labs that involve dusts or vapors, those spaces also need heat detection.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Factory industrial occupancies.



Photo courtesy of iStock.

Slide 2-48

6. Factory industrial occupancies (Groups F-1, F-2).
 - a. The fire alarm requirements for industrial occupancies are driven by size and number of occupants.
 - b. A manual fire alarm is only required in an industrial occupancy where it is two or more stories in height and the combined occupant load is 500 or more above or below the level of exit discharge.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- High hazard occupancies.



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Slide 2-49

7. High-hazard occupancies (Groups H-1, H-2, H-3, H-4, H-5).
 - a. The fire alarm requirements for high-hazard occupancies are driven by the chemicals that are stored, used or handled in the facility.
 - b. A manual fire alarm is required where organic coatings are manufactured.

- c. Automatic smoke detection is required for highly toxic gases, organic peroxides and oxidizers.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Institutional occupancies.



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- 8. Institutional occupancies (Groups I-1, I-2, I-3, I-4).
 - a. The fire alarm requirements for institutional occupancies are specific to the subclassification, as each one has a different reason the occupants are incapable of self-preservation.
 - b. The Centers for Medicare & Medicaid Services (CMS), which administer and regulate Medicare and Medicaid services under the U.S. Department of Health and Human Services (HHS), adopted NFPA 101 as the fire protection requirements in health care. Depending on the state, the enforcing authority for NFPA 101 under CMS may be the fire code official.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Group I-1.



Photo courtesy of iStock. Slide 2-51

- Group I-1.
 - These facilities include sleeping and custodial care provided by staff.

- A fire alarm is required with smoke detection in corridors, waiting areas open to corridors, and habitable spaces other than sleeping units and kitchens.
- Since this occupancy has sleeping areas, single- and multiple-station smoke alarms are also required.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Group I-2.



Slide 2-52

- Group I-2.
 - These are hospital-type facilities, and the fire alarm requirements are broken into Condition 1 or Condition 2 facilities, depending upon whether the facility has emergency care, surgery, obstetrics or in-patient stabilization units for psychiatric care or detoxification.
 - In Condition 1, smoke detection is required in corridors and spaces that open into corridors.
 - There is an exception for smoke compartments that contain sleeping units that are protected with smoke detection. That smoke detection has to visibly signal in the corridor, as well as provide an audible and visible signal at the care providers' station in each unit.
 - Another exemption for corridor smoke detection exists if the sleeping unit doors are automatic-closing on smoke detection in the sleeping unit and it provides the alerting function listed previously.

- In Condition 2, smoke detection is a function of construction and design options, and multiple options for compliance exist, as described in Section 407.2 of the IBC. In these cases, the fire alarm design options will need to be part of a bigger picture of compartmentation and suppression for the building.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Group I-3.




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Slide 2-53

- Group I-3.
 - These are detention and correctional facilities and are broken into five different occupancy conditions based on the level of confinement.
 - All of these facilities require manual fire alarm systems and automatic smoke detection, for the purpose of alerting staff.
 - Smoke detection needs to be installed in residential housing areas, to include contiguous spaces such as day rooms and activity rooms.
 - For tampering and security concerns, the smoke detection can be placed in exhaust ducts or behind listed guards.
 - There are exemptions for sleeping units in Conditions 2 and 3, as well as small sleeping units in sprinkler-protected smoke compartments.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Group I-4.



Photo courtesy of iStock.

Slide 2-54

- Group I-4.
 - These are facilities that provide custodial care for children or adults for less than 24 hours a day.
 - A manual fire alarm system is required, but there are no specific fire alarm requirements for I-4 use groups.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Mercantile occupancies.



Photo courtesy of Integra Code Consultants.

Slide 2-55

- 9. Mercantile occupancies (Group M).
 - a. For retail-type establishments, the fire alarm requirements are once again driven by occupant load and location in the building.
 - b. A manual fire alarm is required when the occupant load combined on all floors is 500 or more and also if the occupant load is more than 100 above or below the level of exit discharge.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Residential occupancies.



Photos courtesy of iStock.

Slide 2-56

- 10. Residential occupancies (Groups R-1, R-2, R-3, R-4).
 - a. The fire alarm requirements for residential occupancies are specific to each of the subclassifications.
 - b. The subclassifications are driven by the number of occupants or dwelling units, as well as whether the occupants are transient or permanent in nature.
 - c. All Group R occupancies require single- and multiple-station smoke alarms.
 - Group R-1.
 - A manual fire alarm is required, but there are exceptions for buildings not more than two stories with each unit being a one-hour rated compartment, and each unit having egress directly to a public way. Smoke detection is required throughout all interior corridors that serve sleeping units.
 - Group R-2.

A manual fire alarm is required when any of the following exist:

 - Any dwelling unit or sleeping unit is three or more stories above the level of exit discharge.
 - Any dwelling unit or sleeping unit is more than one story below the highest level of exit discharge.

- The building contains more than 16 dwelling units or sleeping units.
- There are exceptions similar to what we discussed for R-1.
- Groups R-3 and R-4.
 - No fire alarm requirements other than single- and multiple-station smoke alarms.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Storage occupancies.



Photos courtesy of iStock.

Slide 2-57

11. Storage occupancies (Groups S-1, S-2).

A manual fire alarm is required in public- and self-storage occupancies three or more stories in height.

TYPES OF OCCUPANCIES AND FIRE ALARM REQUIREMENTS (cont'd)

- Special uses and occupancies.



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Slide 2-58

- 12. Special uses and occupancies.
 - a. There are other fire alarm requirements for special occupancies listed in Chapter 4, such as high-rise, covered mall buildings, underground buildings and others.
 - b. In addition, the IBC will generally allow a heat detection system to be replaced by automatic sprinkler protection.
 - c. A manual fire alarm system can usually also be omitted when the building is sprinkler-protected. If the manual fire alarm system is omitted, one manual fire alarm box is still required.
 - d. The specific rules for detector replacement or omission are occupancy- and building-specific and need to be consulted for each individual scenario.
 - e. The occupancy-specific rules will also tell you any occupancy-specific rules regarding notification when a fire alarm is activated.
 - f. There are specialized standards that address very specific concerns unique to their topics, such as NFPA 150, *Fire and Life Safety in Animal Housing Facilities Code*, which takes into account the health and safety of the animal occupants of a building. Elements like loud noises from a fire alarm horn causing the animals to harm themselves are taken into account.

SYSTEM GOALS/OUTCOMES

- Early detection of a fire or other hazardous condition for safe evacuation (public mode notification).
- In some occupancies, staff is notified and utilized (private mode notification).
- Non-required systems.




Photo courtesy of iStock.

Slide 2-59

E. System goals/outcomes.

1. The basic premise of a fire alarm system is early detection of a fire or other hazardous conditions such as carbon monoxide and occupant notification with the outcome being safe evacuation of the building or area. The fire alarm code refers to this premise as public mode notification.
2. In some buildings and occupancies, this is not always possible. In health care or other institutional uses, occupants are often unable to take self-preserving action. In such buildings, staff is notified and utilized for implementing the emergency plan rather than a total evacuation.
3. An owner of a building may also choose to put in a non-required system or devices. These would still need to go through the plans review process and follow NFPA 72 for their design and installation.

ACTIVITY 2.1

Determining Fire Alarm System Requirements

Purpose

Determine the required fire alarm system for the building based on appropriate standards and codes using the provided building descriptions.

Directions

1. In your small group, determine the building code requirements for fire alarm systems based on the provided examples of occupancies or hazards of each newly constructed building. Each table group will use the building code adopted by their jurisdiction (or if not available, use the most current version of the IBC).

- a. High school for 250 students.

- b. Two-story restaurant with an occupant load of 125 people per floor.

- c. 12-story apartment-style building used by a college for student housing.

2. Be prepared to share your responses with the larger group, citing specific standards, editions and sections, where appropriate.

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IV. FIRE ALARM CONTROL UNIT OPERATIONS

INPUT/OUTPUT MATRIX

- Part of a submission of shop drawings for plans review.
- A way to show all devices and off-normal conditions.
- Addressable fire alarm system: input/output (I/O) matrix becomes the basis of the FACU programming.

Slide 2-61

INPUT/OUTPUT MATRIX (cont'd)

FIRE ALARM SYSTEM OPERATIONAL MATRIX	RESULTING ACTION	LOCATION IN BUILDING	FACU FUNCTIONS						ANNUNCIATION	NOTIFICATION	AUXILIARY CONTROL
			Alarm Initiation	Supervisory	Trouble	Control	Relay	Output			
Alarm Initiation Signals											
Manual Station	Alarm	Alarm	X	X				X	X	X	X
Smoke Detector	Common/Alarm	Common/Alarm	X	X				X	X	X	X
Heat Detector	Common/Alarm	Common/Alarm	X	X				X	X	X	X
Smoke/Flow Switch	Common/Alarm	Common/Alarm	X	X				X	X	X	X
Supervisory Initiation Signals											
Drift Detector	Common/Alarm	Common/Alarm		X	X			X	X		X
Common Alarm Receiver	Common/Alarm	Common/Alarm		X	X			X	X		
Fixed Switch (not "NORM") position			X	X				X	X		
Trouble Initiation Signals											
Equipment Component Failure					X	X	X	X			
AC Power Supply Failure					X	X	X	X			
Control Panel Failure					X	X	X	X			
Addressable Device Malfunction (Indicative of Trouble)					X	X	X	X			
Externally-Only Smoke Detector					X	X	X	X			
Two addressable smoke detectors (connected to the same I/O) with same device address					X	X	X	X			

Photo courtesy of ADT.

Slide 2-62

A. Input/output (I/O) matrix.

1. An I/O matrix is part of a typical submission of shop drawings for plans review.
2. The I/O matrix is a way to show all devices, as well as off-normal conditions, such as a wiring or power issue on the fire alarm system, and what actions the FACU will take in terms of annunciation, notification, and/or any other fire safety controls when that specific input is received.
3. In the case of an addressable fire alarm system, the I/O matrix becomes the basis of the programming of the FACU.

PROGRAMMING

- The way the system will be configured within the hardware of the FACU.
- Changes in programming should be reflected in the I/O matrix.

Project Name:	Building A Addition	Date:	April 21, 2017
Panel Location:	P3 Electric Room	Panel Type:	ILI-MB-E3
Sensor Address	Device Type	Description	
N85-L1-S001	Photo Detector	Floor P3 Zone 2 Electric Rm AA354	
N85-L1-S002	Photo Detector	Floor P3 Zone 2 South @ Fire Doors	
N85-L1-S003	Photo Detector	Floor P3 Zone 4 South @ Fire Doors	
N85-L1-S004	Photo Duct Spv	Floor P3 Zr 4 TE Damper Corridor AA222	
N85-L1-S005	Thermal Det	Floor P3 Zone 4 Elevator Machine Room	
N85-L1-S006	Thermal Det	Floor P3 Zone 4 Elevator Machine Room	
N85-L1-S007	Photo Detector	Floor P3 Zone 4 Elevator Machine Room	
N85-L1-S008	Thermal Det	Floor P3 Zone 4 Elevator Machine Room	
N85-L1-S009	Photo Detector	Floor P3 Zone 4 EDF Room AA327	
N85-L1-S010	Photo Detector	Floor P3 Zone 4 IDF Room AA326	
N85-L1-S011	Photo Detector	Floor P3 Zone 4 Freight Elevator Lobby	
N85-L1-S012	Photo Duct Spv	Floor P3 Zone 4 EMR Damper	

Photo courtesy of ADT.

Slide 2-63

B. Programming.

1. The programming is the way the system will be configured within the hardware of the FACU.
2. The programming is based on the I/O matrix. If changes are made to the programming, the I/O matrix should be updated to reflect the changes.

V. INPUT/OUTPUT MATRIX WALK-THROUGH

INPUT/OUTPUT MATRIX WALK-THROUGH

FIRE ALARM SYSTEM SHOP DRAWINGS
for
NAPPYTIME DAYCARE
321 MAIN ST.
YOURTOWN, USA

Photo courtesy of Merton Bunker & Associates.

Slide 2-64

This walk-through of sample plans and submittal packet will prepare you for the upcoming activity on I/O matrix review.

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ACTIVITY 2.2

Evaluating Input/Output Matrix

Purpose

Review the I/O matrix for intended operation of the system, based on a given scenario.

Directions

1. Using the I/O matrix found on page F003 of the Central City High School plans, answer the following questions:

a. List the five devices that, upon activation, will register an alarm signal at the FACU.

b. Will a carbon monoxide (CO) detector activation set off the notification appliances?

c. Will all smoke detectors shut down air handling units (AHUs)? If not, which devices will?

d. If a heat detector is removed from its base, what signal will be received on the FACU? Will removal of a CO detector result in the same signal?

- e. When a duct smoke detector activates, what signal will be received on the FACU? Will the notification appliances activate?

- f. What audible signal will the CO detectors provide?

- g. Which signals will be transmitted to the supervising station?

- 2. Be prepared to share your responses with the larger group, citing specific standards, editions and sections, where appropriate.

VI. SYSTEM POWER

SYSTEM POWER

- Primary power.
 - How a fire alarm is powered under normal conditions.
 - Majority of primary power uses electric utility.

42 CIRCUIT 3 PHASE PANEL SCHEDULE

PANEL: L (866.1) LOCATION: RM 112 MOUNT: SURFACE

MAIN: 225A MAIN LOCATION: BOTTOM BUS SIZE: 225A

VOLTAGE: 120V/208V PHASE: 3W WIRE: 4 CONDUIT: 2 1/2"

CABLE: 4#2/0 CU/AL 1P/0/0/0 MIN. C.B. 1C

NO.	DESCRIPTION	VA	A	W	VA	DESCRIPTION	VA	A	W	VA	DESCRIPTION	VA	A	W	VA
1	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
2	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
3	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
4	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
5	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
6	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
7	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
8	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
9	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
10	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
11	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
12	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
13	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
14	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
15	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
16	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
17	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
18	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
19	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
20	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
21	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
22	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
23	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
24	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
25	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
26	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
27	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
28	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
29	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
30	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
31	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
32	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
33	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
34	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
35	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
36	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
37	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
38	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
39	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
40	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
41	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000
42	1 2P X	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000	RM 100 110, 111, 112	1000	4.5	1	1000

Photo courtesy of FEMA.

Slide 2-67

- A. Primary power.
1. Primary power is how a fire alarm is powered under normal conditions.
 2. The vast majority of primary power uses electric utility. Engine-driven generation is allowed, since there are some remote facilities that generate their own power. This would require approval from the authority having jurisdiction (AHJ), in addition to someone trained on-duty at all times to ensure reliability.

SYSTEM POWER (cont'd)

- Secondary power.
 - How the fire alarm is powered when the primary power is not available.
 - Can be storage batteries or a combination of an automatic-starting, engine-driven generator and storage batteries.



Photo courtesy of PowerSonic.

Slide 2-68

- B. Secondary power.
1. Secondary power is how the fire alarm is powered when the primary power is not available.
 2. Secondary power can be storage batteries or a combination of an automatic-starting, engine-driven generator and storage batteries.

SYSTEM POWER (cont'd)

- Needs to be able to provide the system with 24 hours of power in a non-alarm condition.
- Could be using an uninterruptible power supply (UPS).
- Battery calculations are required.



Slide 2-69

3. The secondary power source needs to be able to provide the system with 24 hours of power in a non-alarm condition. At the end of the 24-hour period, there needs to be sufficient capacity to operate the system in an alarm condition for either 5 minutes or 15 minutes, depending upon system type.
4. Secondary power could be using an uninterruptible power supply (UPS). This type of power supply was historically used for computer or network equipment. In recent years, the technology has allowed for much larger UPS systems that can power a wider range of electrical equipment including fire alarm systems. Plans reviewers need to be aware that if a UPS is being used as secondary power for the fire alarm system, it has to meet all of the requirements for reliability specified in NFPA 72 for any secondary source of power.
5. Battery calculations, which will be discussed later in this course, are required to show that storage batteries are sufficient for the loads described above. There is also a correction factor of 25% required to account for battery degradation and future expansion of the system.

VII. CIRCUITS AND PATHWAYS

CIRCUITS VERSUS PATHWAYS

- A circuit is a pathway, but not all pathways are circuits.
- Pathways may include:
 - Optical fiber cable.
 - Radio frequency.
- Traditional circuits are wired, while pathways do not have to be wired.

Slide 2-70

A. Circuits versus pathways.

1. A circuit is a pathway, but not all pathways are circuits.
2. Pathways may include optical fiber cable and radio frequency, but are not circuits in the traditional sense.

WIRING METHODOLOGIES

- Allowable methods of wiring take the reliability of the circuits, redundancy, and when possible, fail-safe conditions into consideration.
- Governed by:
 - NFPA 72.
 - NFPA 70.

Slide 2-71

B. Wiring methodologies.

1. Considering that a fire alarm system will need to work, at least for a certain period while the building is on fire, the wiring for devices will need to have some survivability built in. The allowable methods of wiring take the reliability of the circuits, redundancy, and when possible, fail-safe conditions into consideration.

2. Types of wires: NEC Article 760 specifies which type of cable and rating is allowed to be used in certain areas. For example, cable being used for a riser is not allowed to be Fire Power Limited (FPL); it must be Fire Power Limited Plenum (FPLP) or Fire Power Limited Riser (FPLR). The protection of the cable in terms of non-metallic (NM) or metal-clad (MC) has to do with the survivability and ties back to NFPA 72.
 - a. NM.
 - b. MC.
 - c. FPL.
 - d. FPLP.
 - e. FPLR.
3. Thermoplastic high heat-resistant, nylon-coated (THHN). The wiring methods are not only governed by NFPA 72, but also NFPA 70.

WIRING CLASSES

- Class A.
- Class B.
- Class C.
- Class D.
- Class E.
- Class N.
- Class X.




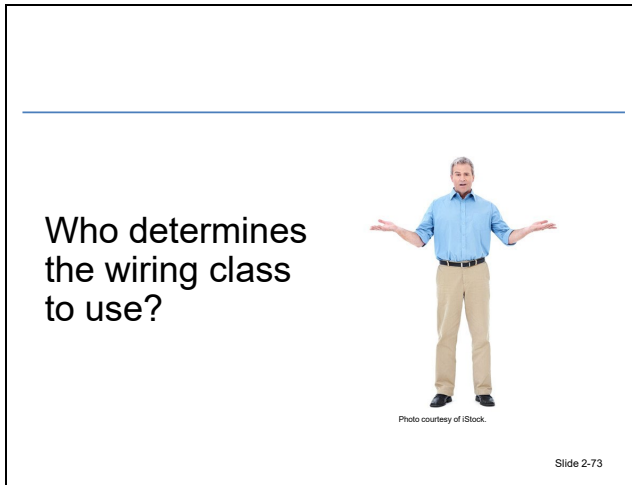
Photo courtesy of iStock.

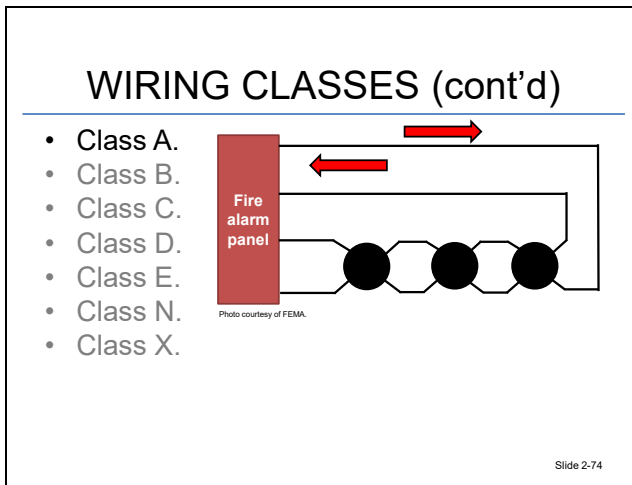
Slide 2-72

C. Wiring classes.

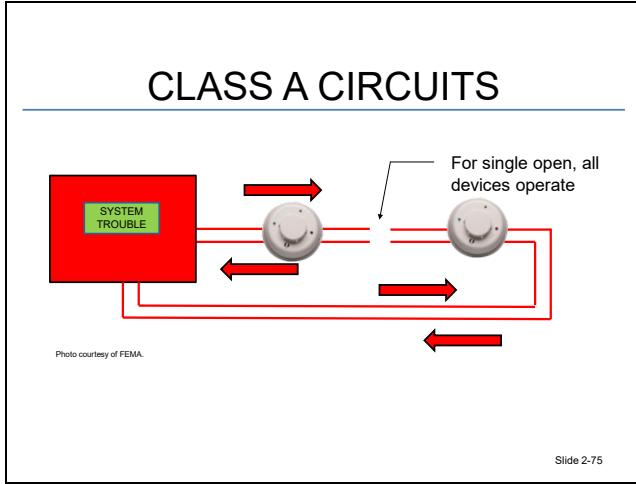
1. In the last 10-plus years, NFPA 72 has deviated from class and style of wiring to now discussing classes and survivability.

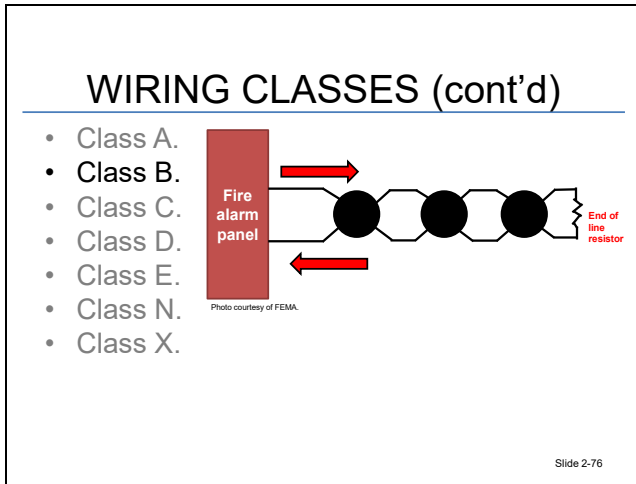
2. The classes of wiring are:



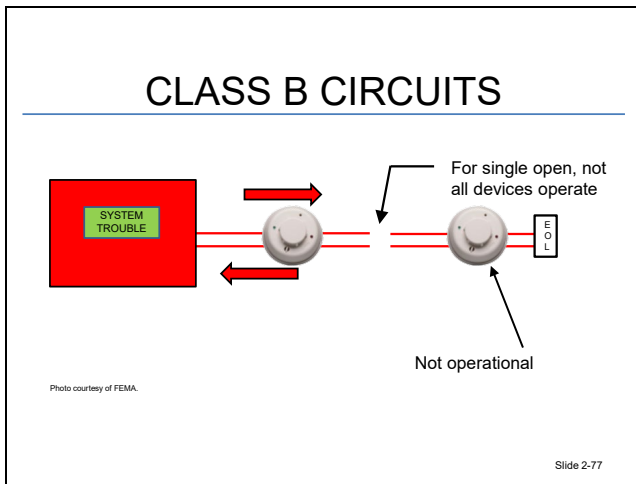


- a. Class A wiring would be a redundant path and allow operation past a single open in the circuit. In Class A wiring, there can be a single break or open in the circuit and not lose any devices because of the redundant pathway.





b. Class B wiring does not include a redundant path, and a single open would prevent operation of devices beyond the open circuit. In Class B wiring, a break in the circuit would result in a loss of communication with all devices that are downstream of the break or open.



WIRING CLASSES (cont'd)

- Class A.
- Class B.
- **Class C.**
- Class D.
- Class E.
- Class N.
- Class X.

Photo courtesy of FEMA.

Slide 2-78

c. Class C has an end-to-end verification of operational status, but the integrity of individual paths is not monitored.

WIRING CLASSES (cont'd)

- Class A.
- Class B.
- Class C.
- **Class D.**
- Class E.
- Class N.
- Class X.

Photo courtesy of FEMA.

Slide 2-79

d. Class D wiring is a fail-safe operating path that is not required to be monitored for integrity. In Class D, a fault of the circuit is not annunciated on the FACU.

WIRING CLASSES (cont'd)

- Class A.
- Class B.
- Class C.
- Class D.
- **Class E.**
- Class N.
- Class X.

Fire alarm panel

Normal

End of line resistor

Photo courtesy of FEMA.

Photo courtesy of Stock.

Slide 2-80

e. Class E: Class D and Class E are the only pathways that would not be monitored for integrity.

WIRING CLASSES (cont'd)

- Class A.
- Class B.
- Class C.
- Class D.
- Class E.
- **Class N.**
- Class X.

Fire alarm panel

Switch

Switch

Endpoint devices

Photo courtesy of FEMA.

Slide 2-81

f. Class N wiring is a redundant pathway verified through end-to-end communication. It is a newer method of wiring that was introduced into NFPA 72 in 2016. It allows for the use of Ethernet for communication. It is similar to wiring Class C with communication being monitored rather than the pathway, but it is handled through network devices.

WIRING CLASSES (cont'd)

- Class A.
- Class B.
- Class C.
- Class D.
- Class E.
- Class N.
- Class X.

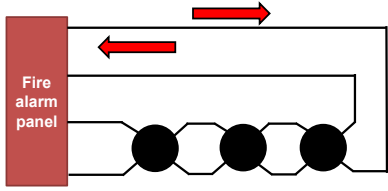


Photo courtesy of FEMA.

Slide 2-82

g. Class X circuits are redundant and allow for communication past a single open or a single short-circuit or a single ground fault. "IM" indicates an isolation module at each device.

PATHWAY SURVIVABILITY

Level	Description
Level 0	No survivability.
Level 1	Building protected by NFPA 13, <i>Standard for the Installation of Sprinkler Systems</i> automatic sprinkler system/installed in metal raceways.
Level 2	Two-hour rating to the cable itself or the enclosure the cable is in.
Level 3	Requires both sprinkler system of Level 1 and two-hour rating of Level 2.
Level 4	Would have a one-hour rating to the cable itself or the enclosure the cable is in.

Slide 2-83

PATHWAY SURVIVABILITY (cont'd)

Building A Addition **Fire Alarm System**

SIGNALING LINE CIRCUIT (SLC) SCHEDULE

There are four signaling line circuit (SLC) paths from the alarm transfer panel as configured for this project. An SLC serves a maximum of 100 signaling appliances (sensors and/or annunciators, vocoders or relays, speaker or field-mounted remote detectors). Each SLC also serves a maximum of 150 trouble addresses (trouble monitor).

The first signaling line circuit shall be Class "X" (no isolation module or detector with 72, 2010 Edition paragraph 12.2.2 and the pathway survivability level shall be 1 as defined by NFPA 72, 2010 Edition paragraph 12.4.4).

The signaling line circuit and building network shall be wired Class "X" (no isolation module with isolators) as defined in NFPA 72, 2010 Edition paragraph 12.2, and the pathway survivability level shall be 3 as defined by NFPA 72, 2010 Edition paragraph 12.4.4.

All pathways shall comply with NFPA 70, National Electrical Code.

Pathway Survivability Level 3 as defined in NFPA 72, 2010 Edition paragraph 12.4.4 are as follows:

Pathway Survivability Level 1 - (12.4.2) Level 1 pathways shall consist of pathways in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, with any interconnecting conductors, cables, or other physical pathways subject to listed protection.

Pathway Survivability Level 2 - (12.4.3) Level 2 pathways shall consist of pathways in buildings that are fully protected by an automatic sprinkler system in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and one or more of the following:

1. 2-hour fire-rated rigidly (UL) cable
2. 2-hour fire-rated cable system (electrical circuit protective systems)
3. 2-hour fire-rated enclosure or protective case
4. 2-hour performance alternative approved by authority having jurisdiction.

The wire shall be a 16 AWG (listed per 2010 codebook table). The signaling cable is based on two different manufacturers (2010 NFPA 720). If other cables are to be used the specifications shall be reviewed with the Authority. The performance of the signaling cable are based on a maximum resistance of 40 ohms and a maximum capacitance of 5 micro farads.

Cable Manufacturer	Cable Model Number	Resistance per 1000 feet	Capacitance per 1000 feet	Minimum Distance	Typical applications
Manufacturer	Model	4.1	10.0	1000	resistance
Supplier	Model	4	45	1000.00	resistance

Slide 2-84

D. Pathway survivability.

1. There are different levels of pathway survivability that are discussed for the fire alarm circuits.
 - a. Level 0 would have no survivability.
 - b. Level 1 would be in a building protected by an NFPA 13, *Standard for the Installation of Sprinkler Systems* automatic sprinkler system and installed in metal raceways.
 - c. Level 2 would have a two-hour rating to the cable itself or the enclosure the cable is in. Level 2 also allows for other alternatives that are approved by the AHJ.
 - d. Level 3 requires both the sprinkler system of Level 1 and the two-hour rating of Level 2.
 - e. Level 4 would have a one-hour rating to the cable itself or the enclosure the cable is in.
2. In order to determine pathway survivability being correctly applied on the fire alarm plans, the building construction type, fire resistance rating of building elements, and the presence of a sprinkler system must be identified.

**NATIONAL ELECTRICAL CODE
RULES FOR FIRE ALARMS**

NFPA 70, NEC Article 760 governs the wiring size, insulation, materials and other specifications.

Slide 2-85

E. NEC rules for fire alarms.

The NEC governs the wiring, including size, insulation and materials, among many other things. These requirements are located in the NEC in Article 760, which is specifically for fire alarm systems.

VIII. CONTROL UNIT SUPERVISION

LOCAL

- Formally known as “protected premises” fire alarm systems.
- Systems are local to the building itself and do not signal an alarm anywhere else.




Photo courtesy of iStock.

Slide 2-86

A. Local.

1. These are otherwise known as “protected premises” fire alarm systems.
2. Systems are local to the building itself and do not signal an alarm anywhere else.

PROPRIETARY

- The owner of a facility monitors the system on site or at another facility under the same ownership.
- Often used at multiple-building complexes.




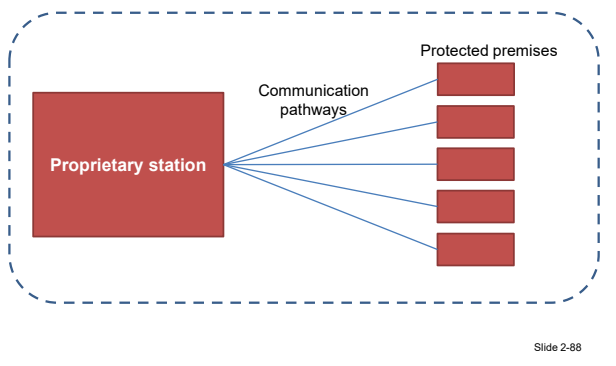
Photo courtesy of iStock.

Slide 2-87

B. Proprietary.

1. This method of supervision is when the owner of a facility monitors the system on site or at another facility under the same ownership.
2. This type of supervision is often used at multiple-building complexes, such as industrial facilities, government or military cluster facilities, amusement parks, or colleges and universities.

PROPRIETARY (cont'd)



Slide 2-88

PROPRIETARY (cont'd)

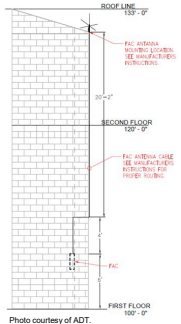


Photo courtesy of ADT.

Slide 2-89

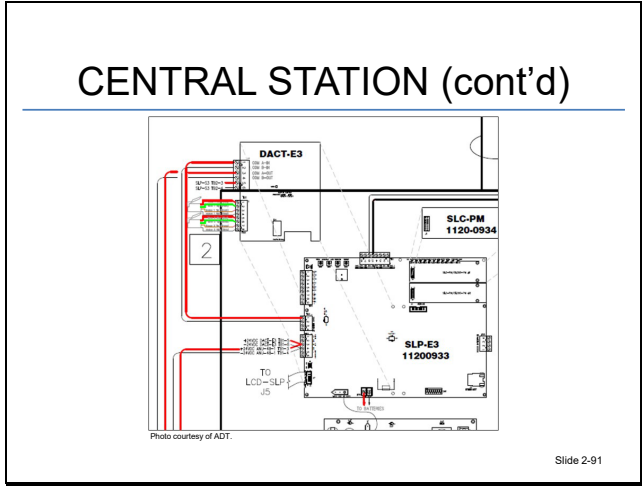
CENTRAL STATION

- Conducted by a facility that has been listed to a standard that sets out the parameters.
- There are additional requirements other than simply monitoring the fire alarm.
- Also responsible for record keeping, testing and maintenance.



Photo courtesy of Wikimedia Commons.

Slide 2-90



- C. Central station.
1. Central station monitoring is conducted by a facility that has been listed to a standard, such as Underwriters Laboratories (UL) 827, which sets out the parameters that a central station facility must meet in order to be listed as such.
 2. There are additional requirements other than simply monitoring the fire alarm. It is considered a central station service, and the service provided includes a runner service to respond to the facility for trouble signals, etc.
 3. The service is also responsible for record keeping, as well as testing and maintenance.

Should the monitoring company be already selected before or during the plans review stage? What are the benefits and downsides?

Photo courtesy of iStock.

Slide 2-92

REMOTE SUPERVISING STATION

- Unlike the central station, there are no listing criteria to be considered.
- Used where a listed central station is not required or available for the facility.



Photo courtesy of iStock.

Slide 2-93

REMOTE SUPERVISING STATION (cont'd)

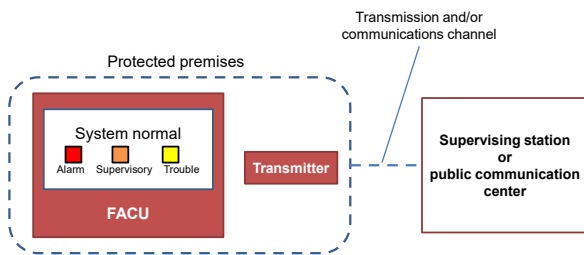


Photo courtesy of FEMA.

Slide 2-94

D. Remote supervising station.

1. A remote supervising station is not a service in the way that a central station is, and there are no listing criteria to be considered a remote supervising station.
2. This type of monitoring may be used where a listed central station is not required or available for the facility.

PUBLIC EMERGENCY ALARM REPORTING

- A public agency controls the infrastructure for the reporting of alarms.
- Can be hardwired or wireless in the case of radio frequency transmitting systems.



Photo courtesy of Keith Heckler.

Slide 2-95

E. Public emergency alarm reporting.

1. This method of supervising a fire alarm system is when a public agency, such as a municipal fire department, controls the infrastructure for the reporting of alarms.
2. These can be hardwired, in the case of Gamewell-type call boxes, or wireless, in the case of radio frequency transmitting systems.

IX. SYSTEM INFORMATION WALK-THROUGH

SYSTEM INFORMATION WALK-THROUGH

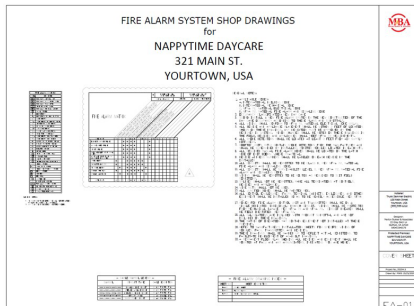


Photo courtesy of Merton Bunker & Associates.

Slide 2-96

This walk-through of sample plans and submittal packet will prepare you for the upcoming activity on reviewing fundamentals for fire alarm system information.

SYSTEM INFORMATION WALK-THROUGH (cont'd)

- In what room is the FACU located?
- What circuit powers the FACU, and where is the disconnect located?
- How many notification circuits are in the system?
- Which notification circuit has the longest length, and what is the length in feet? What is the wire gauge of that circuit?

Photos courtesy of Merton Bunker & Associates. Slide 2-97

- A. In what room is the FACU located?
- B. What circuit powers the FACU, and where is the disconnect located?
- C. How many notification circuits are in the system?
- D. Which notification circuit has the longest length, and what is the length in feet? What is the wire gauge of that circuit?

SYSTEM INFORMATION WALK-THROUGH (cont'd)

- What type of equipment is used to transmit to the remote station, and where is it located?
- What method for primary communication is used to the remote station? What is the secondary method?
- Are there any annunciator panels? If so, where are they located, and what type are they?
- Does the number of devices shown in the legend match the number shown on the floor plans?

Photos courtesy of Merton Bunker & Associates. Slide 2-98

- E. What type of equipment is used to transmit to the remote station, and where is it located?
- F. What method for primary communication is used to the remote station? What is the secondary method?
- G. Are there any annunciator panels? If so, where are they located, and what type are they?

H. Does the number of devices shown in the legend match the number shown on the floor plans?

**SYSTEM INFORMATION
WALK-THROUGH (cont'd)**

- Does the number of devices from the previous question also match the number shown on the circuits?
- What are some other considerations when it comes to the physical locations and paths that the circuits take in the building?
- Is any information required for a review not provided?

Slide 2-99

I. Does the number of devices from the previous question also match the number shown on the circuits?

J. What are some other considerations when it comes to the physical locations and paths that the circuits take in the building?

K. Is any information required for a review not provided?

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ACTIVITY 2.3

Reviewing Fundamentals for Fire Alarm System Information

Purpose

Review the provided plans to identify fundamental information about the fire alarm system.

Directions

1. In your small group, use the Central City High School plans to answer the following questions. Also document the page number where the information can be found.

a. In what room is the FACU located?

b. What circuit powers the FACU, and where is the disconnect located?

c. How many notification circuits are in the system?

d. Which notification circuit has the longest length, and what is the length in feet?
What is the wire gauge of that circuit?

- e. What type of equipment is used to transmit to the remote station, and where is it located?

- f. What method for primary communication is used to the remote station? What is the secondary method?


- g. Are there any annunciator panels? If so, where are they located, and what type are they?


- h. What are some other considerations when it comes to the physical locations and paths that the circuits take in the building?

- i. Is any information required for a review not provided?

- 2. Be prepared to share your responses with the larger group.

X. SUMMARY

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 U.S. Fire Administration

SUMMARY

- Terminology.
- Fire alarm system components.
- Design choices specific to occupancy classification.
- Fire alarm control unit operations.
- Input/output matrix walk-through.
- System power.
- Circuits and pathways.
- Control unit supervision.
- System information walk-through.

Slide 2-101

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REFERENCE

National Fire Protection Association. (2022). *National fire alarm and signaling code* [Standard no. 72]. <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=72>

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APPENDIX

OCCUPANCY CLASSIFICATION

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Occupancy Classification

Occupancy Category	NFPA 101/5000 (Occupancy Type)	IBC (Group)	Examples
Assembly	Assembly	A-1	Fixed seating, production/viewing
		A-2	Restaurants, nightclubs
		A-3	Other assembly (gyms, museums)
		A-4	Arenas, pools
		A-5	Bleachers, grandstands
Business	Business	B	Offices, dentists' offices, city halls
Educational	Educational	E	Schools ≤ grade 12
Industrial	Industrial	F-1	Factories with moderate hazards
		F-2	Factories with low hazard (bricks, glass)
Storage	Storage	S-1	Storage with moderate hazards (furniture)
		S-2	Storage with low hazards (canned goods)
High Hazard	Occupancy Type + hazardous contents requirements	H-1	Detonation hazard (explosives)
		H-2	Accelerated burning hazard (flammable gasses)
		H-3	Supported combustion hazard (flammable solids)
		H-4	Health hazards
		H-5	Semiconductor fabrications
Medical Care/Institutional	Healthcare (4+ patients)	I-2 (>5 patients)	Inpatient (24 hr) care, nursing homes
Board & Care	Residential Board & Care (4+ persons)	I-1 (>16 persons)	Personal care services & lodging
Daycare	Daycare (4+ clients)	I-4 (>5 persons)	Care & supervision (>24 hr)
Detention & Correctional	Detention & Correctional (1+ persons)	I-3 (>5 persons)	Occupants under restraint or security
Mercantile	Mercantile	M	Display, sale of goods (retail)
Residential	Hotel & Dormitories	R-1	Hotels, motels (transient use)
	Hotel & Dormitories	R-2	Dormitories
	Apartments		Apartments
	Lodging and Rooming	R-3	Boarding
	Board & Care	R-4 (5-16 persons)	Board & Care, rehab facilities
Special Structures	Occupancy Type + Special Structure provisions	Group U	Towers, tanks

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UNIT 3: INITIATING DEVICES

TERMINAL OBJECTIVE

The students will be able to:


- 3.1 *Assess the proper placement of initiating devices for the occupancy and hazard based on the knowledge of initiating device functions, given a set of fire alarm shop drawings.*


ENABLING OBJECTIVES

The students will be able to:

- 3.1 *Describe the functions of initiating devices.*
 - 3.2 *Identify if the detection technology is suitable for the application.*
 - 3.3 *Identify correct and incorrect methods of detector spacing in a given application.*
 - 3.4 *Identify possible sources of unintended activation of detection devices.*
-

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 **FEMA**

 U.S. Fire Administration

**UNIT 3:
INITIATING DEVICES**

Slide 3-1

TERMINAL OBJECTIVE

Assess the proper placement of initiating devices for the occupancy and hazard based on the knowledge of initiating device functions, given a set of fire alarm shop drawings.

Slide 3-2

ENABLING OBJECTIVES

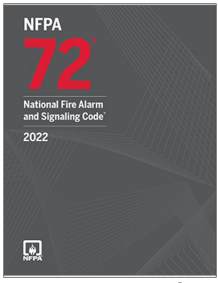
- Describe the functions of initiating devices.
- Identify if the detection technology is suitable for the application.
- Identify correct and incorrect methods of detector spacing in a given application.
- Identify possible sources of unintended activation of detection devices.

Slide 3-3

- D. The application of automatic or manual initiating devices shall comply with NFPA 72, Section 17.1.

CODES FOR AUTOMATIC DETECTION (cont'd)

- NFPA 72, sections 17.4 and 17.5 — general requirements for all initiating devices.
- NFPA 72, Section 17.5.3.3 — mounting and coverage requirements for smoke and heat detectors.



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Slide 3-6

- E. The general requirements for all initiating devices, when required, are found in NFPA 72, sections 17.4 and 17.5 (specifically, sections 17.4.2 through 17.4.5, 17.5.1, 17.5.2 and 17.5.3.1).
- F. The mounting and coverage requirements for smoke and heat detectors, when required, are found in NFPA 72, Section 17.5.3.3 (specifically, sections 17.5.3.3.1 and 17.5.3.3.2).

II. HEAT DETECTION

HEAT DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY

- Not affected by smoke.
- Types of heat detectors:
 - Fixed temperature.
 - Rate-of-rise.
 - Rate compensated.
 - Combination of fixed/rate-of-rise.
 - Addressable.
 - Linear.




Photo courtesy of Johnson Controls.

Slide 3-7

- A. Device functions and technology.
 - 1. Not affected by smoke.

- 2. Types of heat detectors include:
 - a. Fixed temperature: activated when the air temperature reaches a predetermined level, typically starting at 135 F and increasing. Common temperatures for devices are 135 F and 190 F.
 - b. Rate-of-rise: activated when the temperature change rate exceeds the device's set value. Devices are typically designed for 12 F to 15 F per minute.
 - c. Rate compensated: takes the best qualities of the previous two types and combines them into one unit. While these devices have to reach a set temperature before they activate, the entire sensing mechanism does not need to reach that temperature. Therefore, a fast heat release will activate a rate compensating device faster than a traditional fixed temperature.
 - d. Combination of fixed/rate-of-rise: includes both technologies.
 - e. Addressable heat detectors: available in each heat detector type and capable of measuring the temperature in a space and providing different responses for different temperatures, such as emergency response elevator lobbies.
 - f. Linear heat detectors: cables that detect heat along their entire length. When connected to a controller, they will identify the exact point on the cable sensing heat.
 - g. Each type of detector will need to be reviewed.
 - h. Symbols are utilized to show devices on the plans. Ensure the symbol for each type of heat detector is identified on the plans.

Who determines the type of heat detector to use?


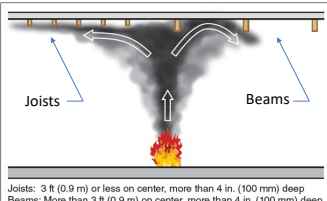


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HEAT DETECTION: SPACING CRITERIA

- Typically approved by Underwriters Laboratories (UL) for 50 feet x 50 feet spacing.
- UL Solutions of Canada (ULC) cross listing may be 75 feet x 75 feet spacing.
- Specific requirements for:
 - Beam construction.



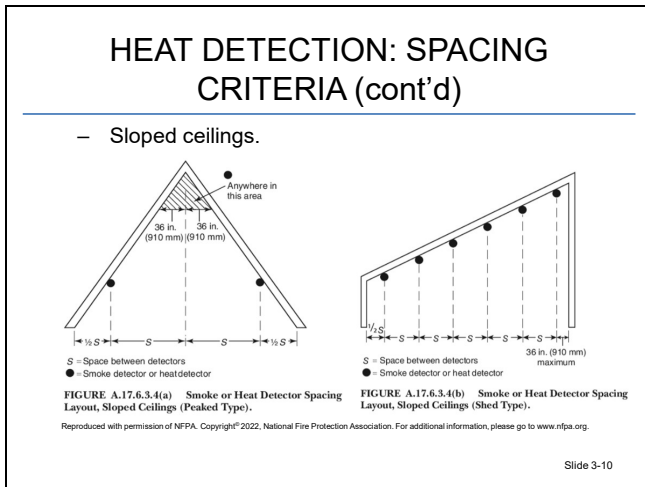
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Slide 3-9

B. Spacing criteria.

1. Heat detectors are typically classified by Underwriters Laboratories (UL) for 50 feet x 50 feet spacing. This is usually shown on the datasheet for the device.
 - a. Example: Detector spacing: UL classified for 50 feet (15.24 meters) center-to-center, FM approved for 25 feet x 25 feet (7.62 meters x 7.62 meters) spacing.
 - b. Spot-type heat detectors need to be installed on the ceiling, no less than 4 inches from the wall, or on the wall, no less than 4 inches or more than 12 inches from the ceiling.
 - c. Heat detectors have a listed spacing (S) for coverage in square feet. Detectors are spaced to cover an area so that there is a detector within 0.7S. Spacing to walls is measured at right angles and is 0.5S.
 - d. The listed spacing is only valid on a smooth, flat ceiling up to 10 feet in height. When the ceiling height increases above 10 feet, there is a delay in getting heat to the detector on the ceiling. In addition, construction features such as beams or ceiling slope will change how heat disperses on the ceiling and necessitate a reduction in spacing.
2. Specific requirements for:
 - a. Beam construction.
 - When beams project more than 4 inches down from the ceiling, you have to reduce spacing. The spacing is reduced to two-thirds S, measured at right angles.

- In the case of large beams greater than 18 inches and more than 8 feet apart, each pocket is treated as its own area for the purpose of coverage.
- For beams less than 12 inches in depth and less than 8 feet apart, the heat detectors can be installed on the bottom of the beams.



b. Sloped ceilings.

- Ceilings are considered leveled if the pitch does not exceed “1 in 8.” This is also expressed as 7.13 degrees or 12.5%. The spacing reduction is determined by the degree of slope and height.
- The first row of detectors needs to be placed within 36 inches of the peak. Where the slope is less than 30 degrees, the height at the peak is used for reducing S. When the slope is 30 degrees or more, the height at the peak can be used, but the average height over the slope can also be used as a less conservative option.

HEAT DETECTION: SPACING CRITERIA (cont'd)

- Ceiling height.
- Other considerations.

Table 17.6.3.5.1 Heat Detector Spacing Reduction Based on Ceiling Height

Ceiling Height Greater than (>)		Up to and Including		Multiply Listed Spacing by
ft	m	ft	m	
0	0	10	3.0	1.00
10	3.0	12	3.7	0.91
12	3.7	14	4.3	0.84
14	4.3	16	4.9	0.77
16	4.9	18	5.5	0.71
18	5.5	20	6.1	0.64
20	6.1	22	6.7	0.58
22	6.7	24	7.3	0.52
24	7.3	26	7.9	0.46
26	7.9	28	8.5	0.40
28	8.5	30	9.1	0.34

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c. Ceiling height.

- As previously stated, the listed spacing is valid up to 10 feet. Once the ceiling height goes above 10 feet, the listed spacing gets reduced.

d. Other considerations.

- There can be other ceiling heights and construction features. In these cases, an engineering analysis would be conducted using Annex B of NFPA 72 to determine the appropriate spacing, based on the system's goals and expected fire.

HEAT DETECTION: SPACING CRITERIA (cont'd)

- Example 1: What is the reduced spacing for a heat detector with a 50 feet listed spacing on a 19 feet high smooth ceiling?
- Answer: From Table 17.6.3.5.1, we multiply the listed spacing (50 feet) by the reduction factor of 0.64. This results in a design spacing of 32 feet.

Table 17.6.3.5.1 Heat Detector Spacing Reduction Based on Ceiling Height

Ceiling Height Greater than (>)		Up to and Including		Multiply Listed Spacing by
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16	4.9	18	5.5	0.71
18	5.5	20	6.1	0.64
20	6.1	22	6.7	0.58
22	6.7	24	7.3	0.52
24	7.3	26	7.9	0.46
26	7.9	28	8.5	0.40
28	8.5	30	9.1	0.34

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Slide 3-12

e. Example 1: What is the reduced spacing for a heat detector with a 50 feet listed spacing on a 19 feet high smooth ceiling?

HEAT DETECTION: SPACING CRITERIA (cont'd)

- Example 2: What is the reduced spacing for a heat detector with a 50 feet listed spacing on a 19 feet high joisted ceiling?
- Answer: From Table 17.6.3.5.1, we multiply the listed spacing (50 feet) by the reduction factor of 0.64. This results in a design spacing of 32 feet parallel to the joists. Further reduce spacing perpendicular to joists by 1/2 to 16 feet.

Slide 3-13

f. Example 2: What is the reduced spacing for a heat detector with 50 feet listed spacing on a 19-foot-high joisted ceiling?

HEAT DETECTION: COMMON PITFALLS

- No ceiling heights shown on plans with heat detection.
- Response time index (RTI) for heat detectors must be less than the RTI for sprinkler heads in elevator machine rooms and shafts.



Photo courtesy of iStock.

↓

Heat Detector Selection Chart (compatible with bases listed below)

Model	Fixed Temperature Operation at	Rate-of-Rise Operation	Maximum Spacing	FM Ratings RTI (Response Time Index)	UL & ULC Maximum Spacing
4099-9610E	135° F (57° C)	Not applicable	20 ft x 20 ft (6.1 m x 6.1 m)	Quick	70 ft x 70 ft (21.3 m x 21.3 m)
4099-9611E	200° F (93° C)		Quick		
4099-9613E	135° F (57° C)	Between 15° & 25° F/min (8.33° & 13.89° C/min)	20 ft x 20 ft (6.1 m x 6.1 m)	Quick	70 ft x 70 ft (21.3 m x 21.3 m)
4099-9615E	200° F (93° C)		20 ft x 20 ft (6.1 m x 6.1 m)	Ultra Fast	

Slide 3-14

C. Common pitfalls.

1. No details for ceiling slope, flat or beam construction, or ceiling heights shown on plans with heat detection.
2. Response time index (RTI) for heat detectors must be less than the RTI for sprinkler heads in elevator machine rooms and shafts to ensure power is removed before the water is released.

HEAT DETECTION: COMMON PITFALLS (cont'd)

- Not considering the expected ambient temperature on the ceiling.
- Failing to avoid rate-of-rise detection in areas where equipment or weather may cause a temperature rise.



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Slide 3-15

3. Not considering the expected ambient temperature on the ceiling for heat detector operating temperature.

For example, a 135 F heat detector cannot be installed on a ceiling where the expected ambient temperature will exceed 115 F.

4. Rate-of-rise detection should be avoided in areas where equipment or weather may cause a temperature rise that will activate the detector. This could include attics, commercial kitchens, air diffusers and an exterior door opening to an air-conditioned building.

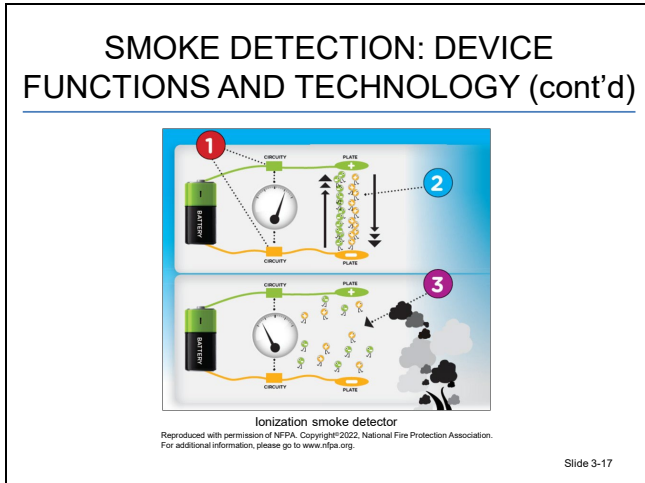
III. SMOKE DETECTION

SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY

- Two types:
 - Ionization.
 - Photoelectric, or optical, smoke detectors.



Slide 3-16

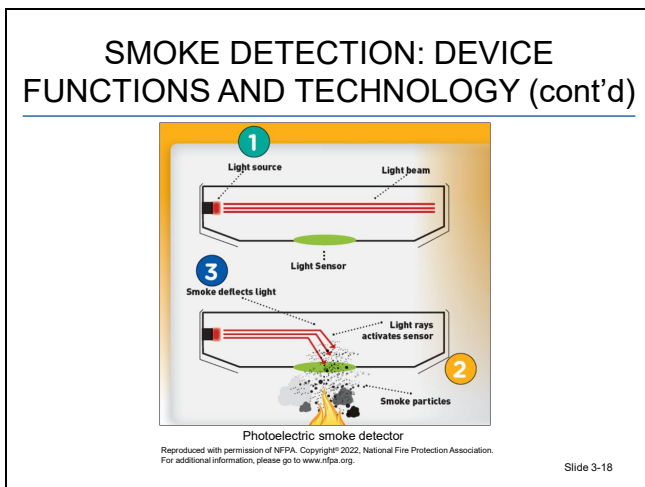


A. Device functions and technology.

1. There are two types of smoke detection:

a. Ionization smoke detection.

- Ionization smoke detectors use a radioisotope, typically americium-241, to ionize air causing a small amount of current to flow between two electrically charged plates. Smoke entering the chamber scatters the ions, decreasing the current flow, and activating an alarm.
- Ionization detectors are more sensitive to the flaming stage of fires than optical detectors, while optical detectors are more sensitive to fires in the early smoldering stage.



b. Photoelectric, or optical, smoke detection.

- Photoelectric/optical smoke detectors contain a source of infrared, visible or ultraviolet light — typically an incandescent light bulb or light-emitting diode (LED) — a lens, and a photoelectric receiver.
- In spot-type detectors, these components are arranged inside a chamber where air flows. This air may contain smoke from a nearby fire.
- In large open areas such as atriums and auditoriums, optical beam or projected-beam smoke detectors are used instead of a chamber within the unit. A wall-mounted unit emits a beam of infrared or ultraviolet light, either received and processed by a separate device or reflected by the receiver. In some types, particularly optical beam types, the light emitted by the light source passes through the air being tested and reaches the photosensor. The received light intensity will be reduced due to scattering from particulates of smoke, airborne dust or other substances; the circuitry detects the light intensity and generates the alarm if it is below a specified threshold, potentially due to smoke. In other types, typically chamber-types, the light is not directed at the sensor, which is not illuminated in the absence of particles. If the air in the chamber contains particles (smoke or dust), the light is scattered and some of it reaches the sensor, triggering the alarm.

Why is a plans review important when it comes to both types of detectors?




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Slide 3-19

SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY (cont'd)

- Smoke detectors used to control smoke spread:
 - Duct smoke detectors.
 - In combination with door hold-open magnets.
 - Required at stair entrances in high-rise buildings.



Photo courtesy of Merton Bunker & Associates.

Slide 3-20

2. Smoke detectors used to control smoke spread:

- a. Duct smoke detectors are used to shut down air handling units (AHUs) in the event of a fire, limiting the spread of smoke.

SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY (cont'd)



Photo courtesy of Keith Heckler.

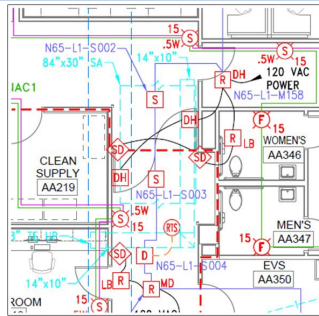


Photo courtesy of Andrew Roe.

Slide 3-21

- b. Smoke detectors combined with door hold-open magnets may also be used to control smoke spread across a floor.
- c. Smoke detectors are required at stair entrances in high-rise buildings to start stair pressurization fans to keep smoke from entering the stairs. They will also close the stair doors if being held open.

SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY (cont'd)

- High-sensitivity smoke detectors:
 - Early warning spot-type smoke detectors offer multiple levels of sensitivity.
 - Even higher sensitivities are possible with air sampling smoke detectors (ASSDs).




Photo courtesy of Johnson Controls.

Slide 3-22

3. High-sensitivity smoke detectors:
 - a. Very early warning spot-type smoke detectors offer multiple sensitivity levels for sensitive environments that cannot tolerate even small amounts of smoke.
 - b. Even higher sensitivities are possible with air sampling smoke detectors (ASSDs), which use a pipe network to draw air through a photoelectric detection chamber. ASSD models are used in data centers and clean rooms for very early warning. There are ASSD models suitable for harsh environments that use filters to eliminate dust from the air sample.

ENVIRONMENTAL CONSIDERATIONS

Table A.17.7.1.8 Environmental Conditions that Influence Smoke Detector Response

Detection Protection	Air Velocity >300 ft./min (>91.44 m/min)	Altitude >3000 ft (>914.4 m)	Humidity >93% RH	Temperature <32°F >100°F (<0°C >37.8°C)	Color of Smoke
Ion	X	X	X	X	O
Photo	O	O	X	X	X
Beam	O	O	X	X	O
Air sampling	O	O	X	X	O

X: Can affect detector response. O: Generally does not affect detector response.

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- B. Environmental considerations.
 1. Smoke detectors need to be installed in areas that do not fall below 32 F or rise above 100 F and have humidity that does not exceed 93%.

2. In addition, the air velocity in the space cannot exceed 300 feet per minute. This is due to the sensitive nature of the electronics and the sensing mechanisms of the detectors. If installed before finished construction, they either need to be cleaned or replaced prior to the acceptance test. As an alternative, they may be left inoperable and covered.
3. Smoke detectors are installed on ceilings or walls not more than 12 inches down from the ceiling. The minimum distance of 4 inches from the wall/ceiling intersection that exists for heat detectors no longer exists for smoke detectors, except for a peaked ceiling.

**SMOKE DETECTION:
SPACING CRITERIA**

- There are specific requirements for spot-type detectors:
 - Smooth ceilings.
 - Beam construction.
 - Sloped ceilings.

Slide 3-24

4. Specific requirements for:
 - a. Smooth ceilings.

**SMOKE DETECTION:
SPACING CRITERIA (cont'd)**

Photo courtesy of Merton Bunker & Associates. Slide 3-25

**SMOKE DETECTION:
SPACING CRITERIA (cont'd)**

Using Pythagorean Theorem:
 $a^2 + b^2 = c^2$
 Where c is the hypotenuse.
 $(0.5)^2 + (0.5)^2 = c^2 = 0.5$
 $c = \sqrt{0.5} = 0.707$

This results in a radius of protection of 0.7 times the design spacing.

Photo courtesy of Merton Bunker & Associates.

Slide 3-26

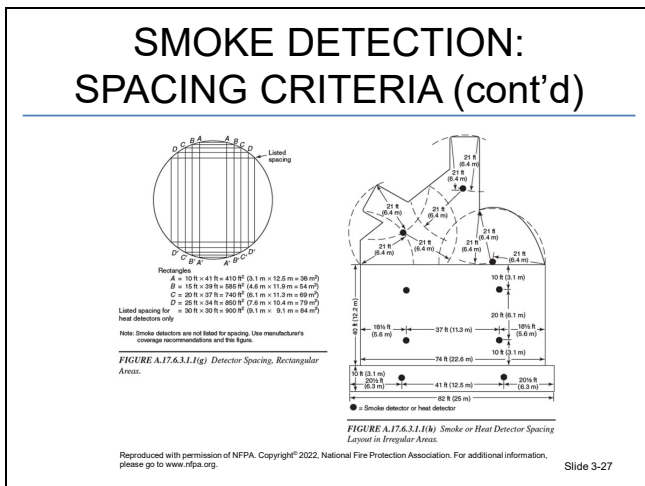
- Spacing should not exceed 30 feet x 30 feet with a maximum distance of 0.5S to the walls. This includes partial walls and partitions if they extend to within the top 15% of the ceiling height. All points of the ceiling in the area being covered must be within 0.7S.

b. Beam construction.

- In level ceiling construction with beams, the smoke detector spacing criteria have five separate compliance methods based on the space or beam size.
- If beam depth is < 10% of ceiling height (0.1H):
 - Smooth spacing allowed S.
 - Detectors located on the ceiling or bottom of beams.
- If beam depths are \geq 10% of ceiling height:
 - Where beams are spaced \geq 40% of the ceiling height, detectors are placed on the ceiling in each beam pocket.
 - Where beams are spaced < 40% of the ceiling height: smooth spacing parallel to beams, 0.5S perpendicular. Detectors located on the ceiling or bottom of beams.
- Where beams intersect, such as waffle or pan ceilings, the same rules as above are used based on beam depth.

INITIATING DEVICES

- In corridors that do not exceed 15 feet in width where beams run perpendicular to corridor length:
 - Smooth spacing permitted S.
 - Detectors are placed on ceilings, walls or the bottom of beams.
 - For rooms that do not exceed 900 square feet.
 - Smooth spacing allowed S.
 - Detectors placed on ceilings or bottom of beams.
- c. Sloped ceilings.
- The spacing for sloped ceilings is based on the normal horizontal distance between detectors but requires the first row to be within 36 inches horizontally from the peak.



d. Example.

- Detector spacing for rectangular areas.
- Smoke/heat detector spacing layout for irregular areas.

SMOKE DETECTION: SPACING CRITERIA (cont'd)

- There are specific requirements for:
 - Sloped ceilings with beam construction.
 - Ceiling height.



Photo courtesy of Merton Bunker & Associates.

Photo courtesy of APA.

Slide 3-28

- e. Sloped ceilings with beam construction.
 - Beams running parallel up slope:
 - Detectors on ceiling.
 - Ceiling height taken as average.
 - Spacing measured along horizontal projection of the ceiling.
 - Spacing measured parallel to beams. Smooth ceiling spacing S.
 - Spacing measured perpendicular to beams. For beam spacing $\leq 10\%$ of the ceiling height.
Smooth ceiling spacing S.
 - For beam spacing $> 10\%$ to $< 40\%$ of the ceiling height.
Spacing not to exceed $0.5S$.
 - For beam spacing $\geq 40\%$, detectors in every beam pocket.
 - Beams running perpendicular across slope.
 - Detectors on bottom of beams.
 - Ceiling height taken as average.

INITIATING DEVICES

- Spacing measured along horizontal projection of the ceiling.
- Smooth spacing permitted in beam pockets.
- Beam depth $\leq 10\%$ of the ceiling height, use smooth ceiling spacing.
- Beam depth $> 10\%$ of the ceiling height, not closer than $0.4S$, but not exceeding $0.5S$.
- Intersecting beams.
 - Detectors on bottom of beams.
 - Ceiling height taken as average.
 - Spacing measured along horizontal projection of the ceiling.
 - Beam depth $\leq 10\%$ of the ceiling height, not more than three beams between detectors, and not to exceed smooth ceiling spacing.
 - Beam depth $> 10\%$ of the ceiling height, not more than two beams between detectors, and not closer than $0.4S$, but not exceeding $0.5S$.
- f. Ceiling height.
 - There is no prescriptive requirement in NFPA 72 to reduce the smoke detector spacing based on excessive ceiling heights.
 - While not a prescriptive requirement, the effect that the height of a ceiling will have on the smoke stratification, as well as the detector response, should be considered by the designer.
 - NFPA's Fire Protection Research Foundation has a study on smoke detector spacing in high ceilings (<https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Detection-and-signaling/RFSpacingHighCeilings.pdf>).

LOCATION CRITERIA

There are specific requirements for proximity to diffusers.



Photo courtesy of Merton Bunker & Associates.

Slide 3-29

5. Location considerations.

SMOKE DETECTION: LISTING RULES

Smoke detectors — UL 268.

- Bases for 2-wire or 4-wire operation
- Auxiliary alarm relay output
- Remote alarm-indicating LED

Designed for EMI compatibility
UL listed to Standard 268

Description

Autocall TrueAlarm photoelectric detectors provide many of the pr

Features	Specifications	Model
• 2-wire or 4-wire operation	• 2-wire or 4-wire operation	• 2-wire or 4-wire operation
• Auxiliary alarm relay output	• Auxiliary alarm relay output	• Auxiliary alarm relay output
• Remote alarm-indicating LED	• Remote alarm-indicating LED	• Remote alarm-indicating LED
• Designed for EMI compatibility	• Designed for EMI compatibility	• Designed for EMI compatibility
• UL listed to Standard 268	• UL listed to Standard 268	• UL listed to Standard 268
• Description	• Description	• Description
Autocall TrueAlarm photoelectric detectors provide many of the pr	Autocall TrueAlarm photoelectric detectors provide many of the pr	Autocall TrueAlarm photoelectric detectors provide many of the pr

Photo courtesy of Johnson Controls.

Slide 3-30

C. Listing rules. Smoke detectors shall be listed to UL 268.

OTHER TYPES OF SMOKE DETECTION

- Air-sampling smoke detection. S_{AS}
- Projected beam-type smoke detection. S_{BT}



Photo courtesy of Brad Cronin.



Photo courtesy of Johnson Controls.

Slide 3-31

D. Other types of smoke detection.

1. Air sampling smoke detection: uses a network of pipes or tubes and draws air from the protected area. NFPA 72 does not have many rules relating to these types of systems as they are typically driven by the intended outcome and manufacturers' instructions. There is a limit in NFPA 72 of not more than 120 seconds of transport time from the furthest sampling port to the detector. During plan review, we will check the proposed installation against the manufacturer's information.
2. Projected beam-type smoke detection: can be useful for smoke detection in large open areas such as an atrium or a church. As with air sampling smoke detection, the prescriptive rules are typically found in the manufacturers' instructions versus the fire alarm code. Since these are activated by something obscuring the beam, we need to ensure that there is nothing in the area that may cause this obscuration that is not smoke.

**SMOKE DETECTION:
COMMON PITFALLS**

- Incorrect application for a smoke detector.
- Failing to ensure that the space where detection is installed is within the required environmental specifications.

Slide 3-32

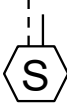
E. Common pitfalls.

1. Incorrect application for a smoke detector.
2. Failing to ensure that the space where detection is installed is within the environmental specifications for the device: 32 F to 100 F, humidity not above 93%.

IV. DUCT SMOKE DETECTION

DUCT SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY

- Detects hazardous levels of smoke in heating, ventilating and air conditioning (HVAC) ducts.
- Mounted inside a duct, at the duct opening or outside of a duct with air-sampling tubes projecting into the duct.



Slide 3-33

DUCT SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY (cont'd)

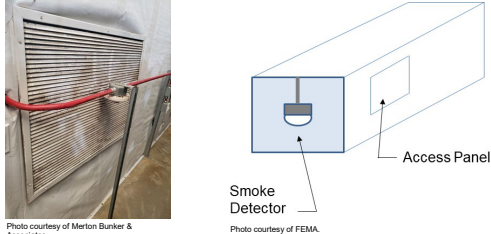


Photo courtesy of Merton Bunker & Associates.

Photo courtesy of FEMA.

Slide 3-34

- A. Device functions and technology.
1. Duct smoke detectors detect hazardous levels of smoke in heating, ventilating and air conditioning (HVAC) ducts.
 2. Duct smoke detectors are mounted inside a duct, at the duct opening or outside a duct with air-sampling tubes projecting into the duct. These detectors can protect HVAC equipment, ducting systems and rooms served by the ducts but are not intended to replace ceiling smoke detection systems.

DUCT SMOKE DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY (cont'd)

- May be listed as either photoelectric or ionization type with specific listing up to a maximum velocity of air movement within the duct.
- Usually requires a higher level of smoke for activation and not allowed to replace required open area smoke detection.

Slide 3-35

3. Duct detectors may be listed as either photoelectric-type or ionization-type with specific listing up to a maximum velocity of air movement within the duct.
4. Air velocity in a duct can be considerable, and air ducts dilute the smoke within them. Therefore, duct smoke detectors usually require a higher level of smoke for activation, and they are not allowed to replace required open area smoke detection. However, an area smoke detection may replace duct smoke detection.

DUCT SMOKE DETECTION: SPACING CRITERIA

- Placed four duct widths from any bend in the ductwork and prior to any branch lines.
- NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems* and International Mechanical Code (IMC) reference NFPA 72 for the installation of the devices and mandate a connection to a fire alarm system.

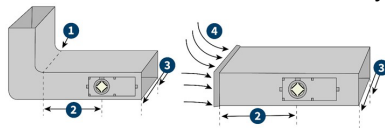


Photo courtesy of FEMA.

Slide 3-36

B. Spacing criteria.

1. Per the manufacturers' instructions, duct detectors shall be placed four duct widths from any bend in the ductwork (to avoid the turbulence created at the bend) and before any branch lines.

- Return can be omitted with area smoke detection.

**INTERNATIONAL MECHANICAL
CODE SPACING CRITERIA**

Scenario	Does Unit Have a Fan?	Does Unit Only Serve One Space?	Fan Capacity?	Connected System Capacity?	Area Smoke Detection Provided?	Duct-Detection Required for Each Unit?	Shutdown of Line Required?	Reasoning	Where?	Basis
1	No	N/A	N/A			No	No	There is no fan to shutdown.		IMC 606.2 Exception
2	Yes	Yes	Any	Any	Any	No	No	Fan only serves a single space; not required where system cannot spread smoke beyond enclosing walls, floors, and ceilings from where smoke is generated.		IMC 606.2 Exception
3	Yes	No	≤ 2,000 CFM	≤ 2,000 CFM	No	No	No	Fan is too small to require shutdown.		IMC 606.2.1, 606.2.2
4	Yes	No	≥ 2,000 CFM	> 2,000 CFM	No	Yes, in duct or in common return serving unit	Yes	System is large enough to warrant smoke detection.		IMC 606.2.1
5	Yes	No	> 2,000 CFM	Any	Yes	No; may use area detectors for shutdown	Yes	Area smoke detection can be used in lieu of duct-detection.		IMC 606.2.1 Exception
6	Yes	No	> 2,000 CFM	Any	No	Yes	Yes	Large enough fan to necessitate shutdown.		IMC 606.2.1



Slide 3-39

b. IMC.

- Does not apply to large open areas such as big-box stores.
- Detection is required in the return air of systems with a capacity of greater than 2,000 cfm.
- In multistory returns, air risers at each story before connection of common returns and before any air duct or plenum for a capacity over 15,000 cfm and greater than one story.
- Return can be omitted with area smoke detection.

DUCT SMOKE DETECTION: LISTING RULES

- Duct detectors are listed to UL 268A.
- Remote alarm indicators and test switches (RTSs) may be required.

Photos courtesy of Andrew Roe.

Listings
UL 268A

Slide 3-40

C. Listing rules.

1. Duct detectors are listed to UL 268A.
2. NFPA 72 code reference: Section 17.7.6.5.1.
3. Remote alarm indicators and test switches (RTSs) are required for duct detectors when their alarm LEDs are not visible from the floor (e.g., above the ceiling or in a closet).

DUCT SMOKE DETECTION: COMMON PITFALLS

- Installation completed without following the manufacturer’s instructions.
- No remote alarm light-emitting diodes (LEDs) shown for detectors above the ceiling.
- In some cases, duct detectors must be provided on both the supply and return of all air handlers over 2,000 cubic feet per minute (cfm).

Slide 3-41

D. Common pitfalls.

1. Installation completed without following the manufacturer’s instructions.
2. No remote alarm LEDs are shown for detectors above the ceiling.
3. In jurisdictions enforcing NFPA 90A and the IMC, duct detectors must be provided on the supply and return of all AHUs over 2,000 cfm.

V. DETECTOR SPACING WALK-THROUGH

DETECTOR SPACING WALK-THROUGH

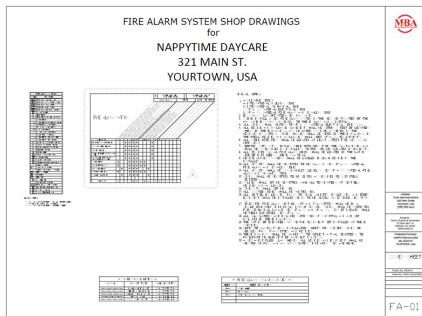


Photo courtesy of Merton Bunker & Associates.

Slide 3-42

This walk-through of sample plans and submittal packet will prepare you for the upcoming activity on determining smoke detector spacing.

DETECTOR SPACING WALK-THROUGH (cont'd)

- Room 113 spacing.

Photo courtesy of Merton Bunker & Associates. Slide 3-43

A. Room 113 spacing.

DETECTOR SPACING WALK-THROUGH (cont'd)

- Corridor spacing.

Photo courtesy of Merton Bunker & Associates. Slide 3-44

B. Corridor spacing.

ACTIVITY 3.1

Smoke and Heat Detector Spacing

Purpose

Review spacings for smoke and heat detection and the duct smoke detection placements based on the provided set of plans.

Directions

1. In your small group, use the Central City High School plans to determine the device spacing for the following:
 - a. For areas that are protected with area smoke detection, verify that 30 feet x 30 feet spacing is correct. Identify any areas of deficiency or information missing to determine if spacing is correct.

 - b. For areas that are protected with area heat detection, verify that 50 feet x 50 feet spacing is correct. Identify any areas of deficiency or information missing to determine if spacing is correct.

 - c. Using the referenced standard for duct detection from your adopted codes, determine if duct smoke detection is provided for all required systems. Verify that the location of duct smoke detection meets the requirements of the referenced standard (IMC or NFPA 90A).

2. Be prepared to share your responses with the larger group.

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VI. MANUAL PULL STATION

MANUAL PULL STATION: DEVICE FUNCTIONS AND TECHNOLOGY

- Activates an alarm system manually.
- At a minimum, one manual station is required for fully sprinklered buildings.

F

Slide 3-46

- A. Device functions and technology.
1. Manual pull stations activate an alarm system manually.
 2. The building code requires a minimum of one manual pull station for fully sprinklered buildings.
 3. NFPA 72 code reference: Section 17.15 (sections 17.15.1 through 17.15.9).

MANUAL PULL STATION: SPACING CRITERIA

- Operable portion needs to be between 42 inches and 48 inches above finished floor.


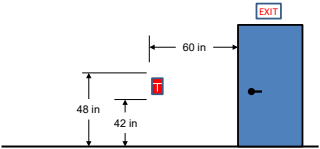


Photo courtesy of iStock
Slide 3-47

- B. Spacing criteria.
1. Manual pull stations must be installed so that the operable portion is between 42 inches and 48 inches above the finished floor.

MANUAL PULL STATION: SPACING CRITERIA (cont'd)

- Where the building code or NFPA 101®, *Life Safety Code*® requires a manual fire alarm system, and they don't meet the exemption for having a sprinkler system.
- Depending on the location, listed protective covers may be installed.

Slide 3-48

MANUAL PULL STATION: SPACING CRITERIA (cont'd)

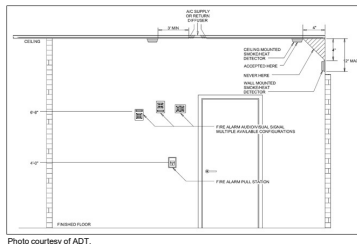


Photo courtesy of ADT.



Photo courtesy of iStock.

Slide 3-49

2. Where the building code requires a manual fire alarm system to be installed, and they do not meet the exemption for having a sprinkler system, NFPA 72 gives the requirements as follows:
 - a. Installed within 5 feet of each exit doorway on each floor.
 - b. With large, grouped openings over 40 feet in width, such as in the case of the main entrance of a sports stadium, boxes are installed within 5 feet on both sides.
 - c. Travel distance cannot exceed 200 feet to a pull station, measured on a single floor.
3. Manual pull stations are required at horizontal exits.

MANUAL PULL STATION: LISTING RULES

- Devices may be indoor only.
- May be subject to the same environmental concerns as smoke detectors for temperature and humidity.
- If placed on the exterior, they need to be specifically listed for the location.

Slide 3-50

C. Listing rules.

1. Devices may be indoor only.
2. May be subject to the same environmental concerns as smoke detectors for temperature and humidity.
3. If pull stations are placed on the exterior, they need to be specifically listed for this type of location. A device installed outside that is not weatherproof will fail early on. This can also be prevented with a weatherproof cover.

MANUAL PULL STATION: COMMON PITFALLS

- Placed near exit access doors rather than exit doors.
- Placed at the end of exit access and entering exits.
- Red in color and have same labeling even when used for other emergency notification.



Photo courtesy of iStock.

Slide 3-51

PULL STATION COVERS



Photo courtesy of iStock.

Slide 3-52

D. Common pitfalls.

1. Placed near exit access doors. They must be placed near exit doors as prescribed in the code.
2. Placed at the end of exit access and entering exits.
3. Red in color and have same labeling used for other emergency notification. If manual devices are used for other emergency notifications (e.g., medical, chemical release, weather emergency), they cannot be red in color and must have different labeling.
4. In areas where pull stations may be subject to malicious activation, specifically listed covers can be installed over the pull station. This cover will have an audible alarm, local to the cover, which will get the attention of those in the area prior to the pull station being activated. It is an additional action to using the pull station, but is specifically allowed by NFPA 72.

VII. WATER FLOW ALARM INITIATING DEVICES

WATER FLOW ALARM INITIATING DEVICES: DEVICE FUNCTIONS AND TECHNOLOGY

Paddle-type water flow switches are only allowed in wet pipe sprinkler systems.



Photo courtesy of Potter.

WF

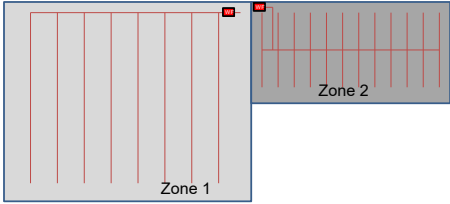
Slide 3-53

A. Paddle.

- 1. Device functions and technology. Paddle-type water flow switches are only allowed in wet pipe sprinkler systems.
- 2. Spacing criteria. There may be multiple sprinkler systems in a building or a single system that is broken into different zones. These zones might be based on area of the building or floor level. Each zone of a system is provided with a water flow switch.

PADDLE: SPACING CRITERIA

Each zone of a building provided with a water flow switch.



Slide 3-54

PADDLE: LISTING RULES

Water flow switches shall be listed for use.



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Slide 3-55

- 3. Listing rules. Water flow switches shall be listed for use.

PADDLE: COMMON PITFALLS

- Time delay not being set properly.
- Applying the 90-second time frame to activating alarm notification.

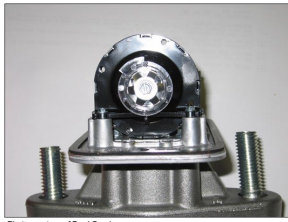


Photo courtesy of Brad Cronin.

Slide 3-56

4. Common pitfalls.

- a. Time delay not being set correctly: The time delay must be set correctly to avoid alarms from water surges.
- b. Applying the 90-second time frame to activate alarm notification versus activating the water flow device.

PRESSURE: DEVICE FUNCTIONS AND TECHNOLOGY

Pressure-type water flow switches used for dry sprinkler systems.

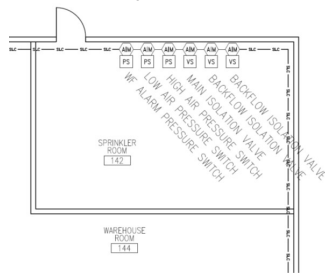


Photo courtesy of Merton Bunker & Associates.



Photo courtesy of Potter.

Slide 3-57

B. Pressure.

- 1. Device functions and technology.
 - a. Pressure-type water flow switches are used for dry sprinkler systems.
 - b. High- and low-pressure switches.

- A low-pressure switch is used to monitor a dry sprinkler system or potentially activate a pre-action system. When the air pressure in the system drops, the pressure in the water supply on the bottom side of the dry valve will eventually overcome the pressure in the system, and the valve will trip admitting water into the system. In a dry system, a low air pressure switch will monitor the normal air pressure in the system and operate if a drop in pressure occurs, prior to the valve tripping. This is generally a supervisory signal that should let someone know about the low air so that they can investigate the reason and correct it prior to the valve tripping. If the air pressure is too low, the valve may trip open and allow water to enter the dry pipe system.
- A high-pressure switch is used as a water flow device for a dry or pre-action sprinkler system. When a sprinkler opens, the air in the system drains and the valve trips as previously mentioned. The high water pressure enters the system and sets off the high-pressure switch. This should be an alarm, as water is flowing in the system. If the air pressure is too high, the higher pressure takes longer to bleed off, resulting in a delayed response.

PRESSURE: INSTALLATION CRITERIA

Dry sprinkler systems used in unconditioned or exposed spaces.

Photo courtesy of Summit Fire Sprinkler Design Services. Slide 3-58

PRESSURE: INSTALLATION CRITERIA (cont'd)

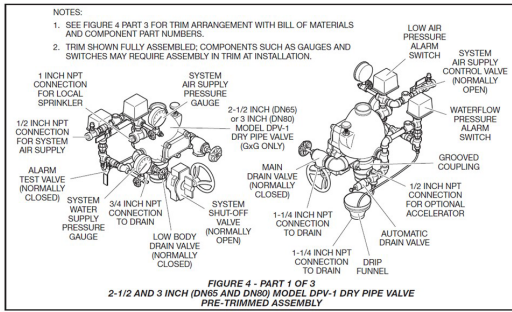


Photo courtesy of Tyco.

Slide 3-59

- Locations used. Dry sprinkler systems are used in unconditioned or exposed spaces like parking garages and loading docks.

PRESSURE: LISTING RULES

Pressure-type flow switches shall be listed for use.



Photo courtesy of Potter.

Slide 3-60

- Listing rules. Pressure-type flow switches shall be listed for use.

PRESSURE: COMMON PITFALLS

Not being properly plumbed.



Photo courtesy of Jim Monto.

Slide 3-61

4. Common pitfalls. Not being properly pitched: Dry systems need to be pitched properly in order to drain the condensate from the pipe. Improperly plumbed sprinkler piping fills with water and freezes, causing false trips.

VIII. CARBON MONOXIDE AND GAS DETECTION

What are the characteristics of a carbon monoxide gas?

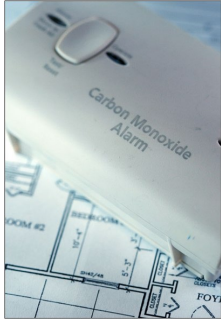


Photo courtesy of iStock. Slide 3-62

CARBON MONOXIDE AND GAS DETECTION: DEVICE FUNCTIONS AND TECHNOLOGY

- Required wherever fuel-burning appliances are installed.
- Also used in other-than-open garages to start garage supply and exhaust fans when high levels of carbon monoxide are detected.




Photo courtesy of iStock. Slide 3-63

- A. Device functions and technology.
 1. Carbon monoxide detectors are required wherever fuel-burning appliances are installed.
 2. They are also used in parking garages, which the codes do not consider to be open, to start garage supply and exhaust fans when high levels of carbon monoxide are detected. There are differences between carbon monoxide detection devices located in occupied areas of residential occupancies and those placed in parking garages. The devices will have different sensitivities and thresholds for activation. The sensitivities for protecting occupants are set forth in the product listing standard from UL. UL 2034, *Single and Multiple Station Carbon Monoxide Alarms* is used for these devices.

3. NFPA 72 code reference: Section 17.12.1.

**CARBON MONOXIDE AND GAS DETECTION:
DEVICE FUNCTIONS AND TECHNOLOGY**
(cont'd)

- NFPA code reference: NFPA 72, Section 17.12.1.
- NFPA code reference for gas detectors other than carbon monoxide: NFPA 72, Section 17.10 (17.10.2.1 through 17.10.2.4).

Slide 3-64

4. The selection, installation and operation of gas detectors other than carbon monoxide are governed by NFPA 72, Section 17.10 (17.10.2.1 through 17.10.2.4).
5. The NFPA Research Foundation Group has various research studies focusing on carbon monoxide, such as those described in the report “Carbon Monoxide Diffusion Through Porous Walls: A Critical Review of Literature and Incidents.”

**CARBON MONOXIDE AND GAS
DETECTION: SPACING CRITERIA**

Follow the manufacturers' instructions for spacing carbon monoxide detectors.



Photo courtesy of Honeywell.

Slide 3-65

- B. Spacing criteria. Follow the manufacturers' instructions and NFPA 72 for spacing carbon monoxide detectors.

DETECTION OF OTHER GASES

- Used at facilities where substances being handled or stored may have potential risk.
- Detection systems may be connected into the fire alarm.



Photo courtesy of iStock

Slide 3-68

F. Detection of other gases.

1. Gas detection may be used at a facility where there are substances being handled or stored that may create a potential risk to the occupants.
2. In many cases, the detection systems may be connected into the fire alarm for the purpose of notifying personnel or emergency responders that a hazardous condition may exist.

GAS DETECTION

- Toxic, ignitable or oxygen-displacing gases may have a detection system.
- Not required to be industrial.

Slide 3-69

3. Toxic, ignitable or oxygen-displacing gases may have a detection system. However, it doesn't have to be industrial.

IX. SPECIAL FIRE SUPPRESSION SYSTEMS

**SPECIAL FIRE SUPPRESSION SYSTEMS:
DEVICE FUNCTIONS AND TECHNOLOGY**

- Fixed extinguishing systems, sprinkler system fire pumps, valves and water supplies: monitored for status by the fire alarm system.
- Supervisory monitoring point examples:
 - Valves.
 - Pressure.
 - Trouble contacts.

RSFACU_{CO₂} RSFACU_{CA} RSFACU_{DC} RSFACU_{FO}

Slide 3-70

- A. Device functions and technology.
1. Fixed extinguishing systems (e.g., clean agent, pre-action, etc.) and sprinkler system fire pumps, valves and water supplies shall be monitored for status by the fire alarm system. An extinguishing system alarm shall cause notice on the fire alarm system.
 2. There are many things that can be monitored by the fire alarm system as a supervisory. These can include but are not limited to:
 - a. Extinguishing systems.
 - b. Fire pump off-normal condition.
 - c. Water tank level or close to freezing temperature.
 - d. Air pressure in a dry sprinkler system.
 - e. Valves for water supply to sprinklers, standpipes or other water-based systems.

SYSTEM MONITORING



Photo courtesy of iStock.



Photo courtesy of iStock.

Slide 3-71

- B. System monitoring. The fire alarm system will be interconnected to suppression systems installed in the building.

SPECIAL FIRE SUPPRESSION SYSTEMS: COMMON PITFALLS

- Not monitoring all parts of the fire protection system.
- Signals monitored incorrectly.

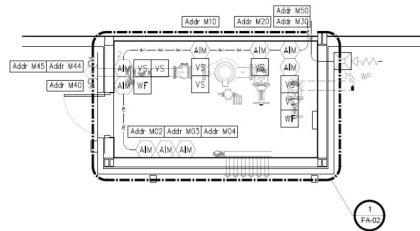


Photo courtesy of Merton Bunker & Associates.

Slide 3-72

- C. Common pitfalls. Not monitoring all parts of the fire protection system.

X. SUPERVISORY

Why should sprinkler control valves be monitored by the fire alarm system?




Photo courtesy of Brad Cronin.

Slide 3-73

SUPERVISORY: DEVICE FUNCTIONS AND TECHNOLOGY

- Connected to valves and pipes, monitored by the fire alarm system to ensure that the sprinkler system will operate when called upon.
- NFPA code reference: NFPA 72, Section 17.17.

PS LS LT HT VS

Slide 3-74

A. Device functions and technology.

1. Supervisory switches are simply hardwired contact devices connected to valves and pipes, monitored by the fire alarm system to ensure that the sprinkler system will operate when called upon. Any off-normal condition will cause a supervisory condition on the fire alarm system.
2. NFPA 72 code reference: Section 17.17.

SUPERVISORY DEVICES

- Can monitor temperature.
 - Water tank.
 - Fire pump room.
- Monitor pressure.
 - Pressure tank.
 - Dry system pressure.



Photo courtesy of Slock.

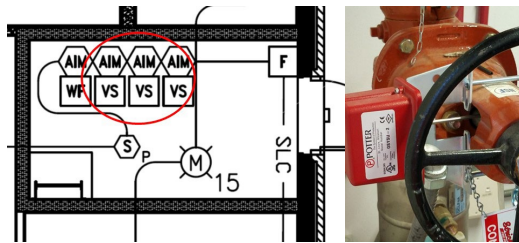
Slide 3-75

B. Supervisory devices.

1. Supervisory devices can monitor fire pump room temperature and water tank temperature.
2. Fire pump controllers will be interfaced into the fire alarm to initiate certain signals on the fire alarm system.

SUPERVISORY: SPACING CRITERIA

Switches are mounted on sprinkler valves or included as part of a sprinkler valve assembly.



Photos courtesy of Merton Bunker & Associates.

Slide 3-76

C. Spacing criteria. Switches are mounted on sprinkler valves or included as part of a sprinkler valve assembly.

SUPERVISORY: LISTING RULES

All sprinkler-related devices must be listed for use.



Photos courtesy of Potter.

VSR-CR CORROSION RESISTANT VANE TYPE WATERFLOW ALARM SWITCH WITH RETARD

UL, CUL and CSFM Listed, CE Marked
Service Pressure: 450 PSI (31 BAR)-UL
Flow Sensitivity Range for Signal: 4-10GPM (15-38 LPM)-UL
Maximum Surge: 18 FPS (5.5 m/s)
Contact Ratings: Two sets of SPDT (Form C)
10.0 Amps at 125/250VAC
2.0 Amps at 30VDC Resistive
100 Amps min. at 24VDC
Conduit Entrances: Two knockouts provided for 1/2" conduit.
Individual switch compartments suitable for dissimilar voltages.
Environmental Specifications:
• NEMA 4X/DIP6 Rated Enclosure suitable for indoor or outdoor use with factory installed gasket and die-cast housing when used with appropriate conduit fitting.

Slide 3-77

D. Listing rules. All sprinkler-related devices must be listed for use.

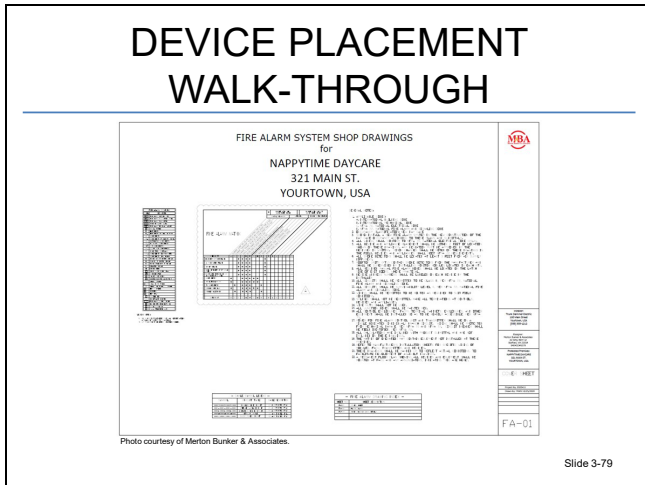
SUPERVISORY: COMMON PITFALLS

- Not monitoring all parts of the fire protection system.
- Using non-listed equipment.

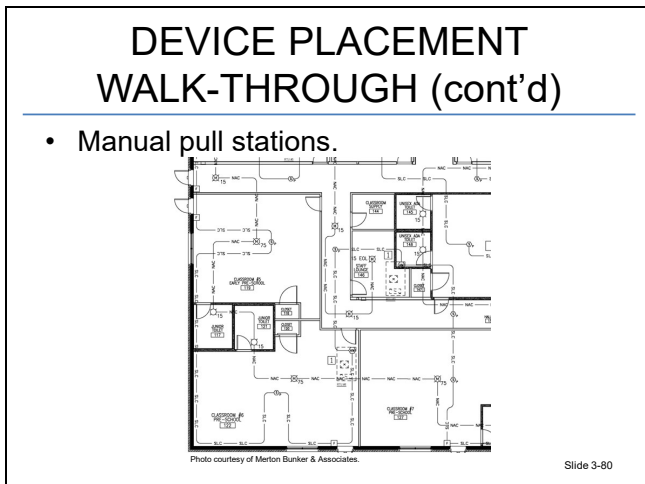
Slide 3-78

E. Common pitfalls. Not monitoring all parts of the fire protection system.

XI. DEVICE PLACEMENT WALK-THROUGH



This walk-through of sample plans and submittal packet will prepare you for the upcoming activity on determining device placement.



A. Manual pull stations.

DEVICE PLACEMENT WALK-THROUGH (cont'd)

- Supervisory devices.

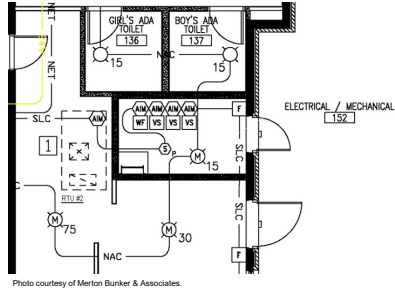


Photo courtesy of Merton Bunker & Associates.

Slide 3-81

- B. Supervisory devices.

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ACTIVITY 3.2

Device Placement

Purpose

Review manual pull station and supervisory device placements on the provided set of plans.

Directions

1. In your small group, use the Central City High School plans to answer the following questions regarding the code requirements for manual fire alarm devices.

a. When required, where are manual pull stations to be located?

b. How many additional pull stations are required in an unsprinklered building?

c. What is the mounting height of a manual pull station?

d. Could pull stations be eliminated since the building is fully sprinklered?

INITIATING DEVICES

2. Answer the following questions using the Central City High School plans.

a. Are pull stations located correctly on the plans?



b. Is the mounting height of the manual pull stations shown correctly?

c. Examine the plans and identify all supervisory devices.

d. Identify all special extinguishing systems on the plans and confirm the base building system is monitoring them.

3. Be prepared to share your responses with the larger group.



XII. SUMMARY

 **FEMA**  **U.S. Fire Administration**

SUMMARY

- Automatic detection.
- Heat detection.
- Smoke detection.
- Duct smoke detection.
- Detector spacing walk-through.
- Manual pull station.
- Water flow alarm initiating devices.

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 **FEMA**  **U.S. Fire Administration**

SUMMARY (cont'd)

- Carbon monoxide and gas detection.
- Special fire suppression systems.
- Supervisory.
- Device placement walk-through.

Slide 3-84

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APPENDIX

DUCT DETECTOR UNIT REQUIREMENTS — NATIONAL FIRE PROTECTION ASSOCIATION 90A

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DUCT DETECTOR UNIT REQUIREMENTS — NATIONAL FIRE PROTECTION ASSOCIATION 90A

Where a supply-side duct detection is required:

Scenario	Does Unit Have a Fan?	Does Unit Exhaust Only?	Connected System Capacity?	Duct-Detection Required for Unit?	Shutdown of Unit Required?	Reasoning	Where?	Basis
1	No	-	-	No	No	There is no fan to shut down; system does not have an “air distribution system.”	-	NFPA 90A 6.4.2.1 ¹
2	Yes	Yes	Any	No	No	Not required for fan units whose sole function is to remove air from inside building.	-	NFPA 90A 6.4.2.1
3	Yes	No	≤2,000 CFM	No	No	Fan is too small to require shutdown.	-	NFPA 6.4.2.1(1), (2)
4	Yes	No	≥2,000 CFM	Yes	Yes	System is large enough to warrant smoke detection.	Supply ²	NFPA 90A 6.4.2.1(1)

(MeyerFire, 2020)

¹ NFPA 90A 2012 and later editions.

² Installed “downstream of the air filters and ahead of any branch connections in air supply systems.”

INITIATING DEVICES

Where a return-side duct detection is required:

Scenario	Multi-Story, Common Return?	Return System Capacity	Exhaust Only?	Entire Area Covered by Area Smoke Detection?	Duct-Detection Required for Each Unit?	Shutdown of Unit Required?	Reasoning	Where?	Basis
1	No	-	-	-	No	No	Return-side detection not required for single story or separate floor returns.	-	NFPA 90A 6.4.2.1(2)
2	Yes	≤2,000 CFM	-	-	No	No	Return is too small to justify shutdown.	-	NFPA 90A 6.4.2.1(2)
3	Yes	>2,000 CFM	Yes	-	No	Yes	Not required for fan units whose sole function is to remove air from inside building.	-	NFPA 90A 5.4.2.3
4	Yes	>2,000 CFM	No	Yes	No	Yes	Area detection can be used to shutdown units.	Area	
5	Yes	>2,000 CFM	No	No	Yes	Yes	Common return size justifies shutdown.	Return ³	NFPA 90A 6.4.2.1(2)

³ Installed “at each story, prior to the connection to a common return and prior to any recirculation or fresh air inlet connections.”

UNIT 4: NOTIFICATION APPLIANCES

TERMINAL OBJECTIVE

The students will be able to:



- 4.1 *Assess the proper placement of notification appliances for the occupancy and hazard based on the knowledge of notification appliance functions, given a set of fire alarm shop drawings.*

ENABLING OBJECTIVES

The students will be able to:

- 4.1 *Describe the basic functions of notification appliances.*
 - 4.2 *Identify if the notification device technology is suitable for the application.*
 - 4.3 *Determine the method of notification used for system design.*
 - 4.4 *Determine proper audibility of fire alarm notification appliances.*
 - 4.5 *Determine proper sizing and placement of visible notification appliances.*
 - 4.6 *Identify correct and incorrect methods of notification device spacing in a given application.*
 - 4.7 *Describe other means for notification.*
-

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 FEMA  U.S. Fire Administration

UNIT 4: NOTIFICATION APPLIANCES

Slide 4-1

TERMINAL OBJECTIVE

Assess the proper placement of notification appliances for the occupancy and hazard based on the knowledge of notification appliance functions, given a set of fire alarm shop drawings.

Slide 4-2

ENABLING OBJECTIVES

- Describe the basic functions of notification appliances.
- Identify if the notification device technology is suitable for the application.
- Determine the method of notification used for system design.
- Determine proper audibility of fire alarm notification appliances.

Slide 4-3

ENABLING OBJECTIVES (cont'd)

- Determine proper sizing and placement of visible notification appliances.
- Identify correct and incorrect methods of notification device spacing in a given application.
- Describe other means for notification.

Slide 4-4

I. GENERAL CONSIDERATIONS FOR NOTIFICATION

**MODES OF NOTIFICATION:
PUBLIC VERSUS PRIVATE**

- Public mode notification.
- Private mode notification.




Photo courtesy of iStock.




Photo courtesy of iStock.

Slide 4-5

- A. Modes of notification: public versus private.
1. Public mode notification systems are intended to alert and evacuate the occupants of an entire building. This type of system is most common in publicly accessible buildings. Public mode notification systems require more notification appliances than private mode notification systems. However, there is no ongoing training of response personnel required.
 2. Private mode notification.
 - a. For those who cannot evacuate based on the typical public mode of notification, an alternative method is to use private mode notification. With private operating mode of notification, the alarm is only notifying trained staff that are part of the emergency plan for the facility, rather than providing a general evacuation signal targeted for all occupants.

- b. With private mode notification systems, fewer audible notification appliances are required, or they may be eliminated altogether by using strobe notification if allowed by the authority having jurisdiction (AHJ). However, private mode notification systems require trained personnel who will be responsible for receiving notification signals and expected to take appropriate action per the preestablished plan.
- c. The choice to use private mode notification needs to be in accordance with the building code for the occupancy, the National Fire Protection Association (NFPA) 101[®], *Life Safety Code*[®], and the AHJ.

IMPLICATIONS FOR PLANS REVIEWERS

- Determine if the notification is appropriate for the type of construction and meets minimum requirements.
- Design and approval by a professional fire protection engineer and/or risk analysis may be required.
- Requirements of National Fire Protection Association (NFPA) are followed and confirmed in the field.

Slide 4-6

- 3. Implications for plans reviewers.
 - a. The plans reviewer must determine if the occupant notification is appropriate for the type of construction and designed per code, at a minimum.
 - b. Anything above minimum code requirements, or a mass notification system that needs to be intelligible, is typically designed and stamped by a professional fire protection engineer, and would include a risk analysis and/or a detailed audible analysis of each space.
 - c. The prescriptive requirements of the NFPA are usually followed and then confirmed in the field with minimal changes, given a proper design.
 - d. Horns are louder than loudspeakers, therefore a voice system will have more loudspeakers provided to obtain the same dB level above ambient sound.

HAZARDOUS AREA SIGNALING

- Classification and division of hazardous areas should be identified on the plans.

Division 1	Division 2
Hazardous gases, vapors or liquids are routinely present under normal operating conditions.	Hazard gases, vapors or liquids are only present when a problem or failure occurs.

Slide 4-7

B. Hazardous area signaling.

1. Classification and division of hazardous areas should be identified on the plans. All signaling devices located in classified areas should be wired in accordance with the National Electrical Code (NEC).
2. Hazardous areas identified by the NEC are broken into three different classes and two divisions.

Division 1: Hazardous gases, vapors or liquids are routinely present in area under normal operating conditions.

HAZARDOUS AREA SIGNALING (cont'd)

- Class I, Division 1: Ignitable concentrations of **flammable gases, vapors or liquids** are present continuously or frequently under **normal** conditions.



Slide 4-8

- a. Class I, Division 1: where ignitable concentrations of flammable gases, vapors or liquids are present continuously or frequently within the atmosphere under normal operating conditions.

HAZARDOUS AREA SIGNALING (cont'd)

- Class I, Division 2: Ignitable concentrations of **flammable gases/vapors/liquids** are present within the atmosphere under **abnormal** conditions.



Photo courtesy of iStock.

Slide 4-9

- b. Class I, Division 2: where ignitable concentrations of flammable gases, vapors or liquids are present within the atmosphere under abnormal operating conditions.

HAZARDOUS AREA SIGNALING (cont'd)

- Class II, Division 1: Ignitable concentrations of **combustible dusts** are present within the atmosphere under **normal** conditions.



Photo courtesy of iStock.

Slide 4-10

- c. Class II, Division 1: where ignitable concentrations of combustible dusts are present within the atmosphere under normal operating conditions.

HAZARDOUS AREA SIGNALING
(cont'd)

- Class II, Division 2: Ignitable concentrations of **combustible dust** are present within the atmosphere under **abnormal** conditions.




Photo courtesy of iStock.

Slide 4-11

d. Class II, Division 2: where ignitable concentrations of combustible dust are present within the atmosphere under abnormal operating conditions.

HAZARDOUS AREA SIGNALING
(cont'd)

- Class III, Division 1: Ignitable fibers or materials producing **combustible flyings** are present within the atmosphere under **normal** conditions.




Photo courtesy of iStock.

Slide 4-12

e. Class III, Division 1: where easily ignitable fibers or materials producing combustible flyings are present within the atmosphere under normal operating conditions.

HAZARDOUS AREA SIGNALING (cont'd)

- Class III, Division 2: Ignitable fibers or materials producing **combustible flyings** are present within the atmosphere under **abnormal** conditions.

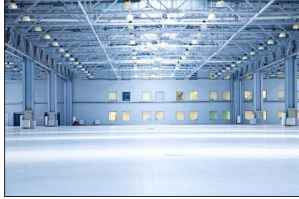


Photo courtesy of iStock.

Slide 4-13

- f. Class III, Division 2: where easily ignitable fibers or materials producing combustible flyings are present within the atmosphere under abnormal operating conditions.

HAZARDOUS AREA DEVICES



Photos courtesy of Rick Wood.

Slide 4-14

3. Since the notification appliances are electrically powered devices that are governed by the NEC, they must follow the rules for hazardous areas so that they do not become an ignition source.

UNIQUE CONSTRUCTION AND OCCUPANCY CONSIDERATIONS

- Complexity and size of an occupancy.
- Adopted building and fire codes.
- Layout of the building or area.



Photo courtesy of iStock.

Slide 4-15


C. Unique construction and occupancy considerations.

1. The complexity and size of an occupancy will determine the type of notification required. The fire alarm requirements for a particular building are based on the adopted building and fire codes.
 - a. Any building over 75 feet in height (from the fire department access point) is considered a high-rise and would require voice notification.
 - b. Buildings with large assembly areas, even those that are only a single story, may be required to have voice notification (e.g., places of worship).
 - c. The International Building Code (IBC) requires voice notification for occupancies over 1,000 people, and NFPA 101 requires voice notification for over 300 people in an assembly occupancy. This is just one of the many reasons why you need to know which code you are enforcing.
2. The layout of the building or area can have an effect on how sound will travel and how visible notification appliances will be seen.

II. AUDIBLE NOTIFICATION

AUDIBLE NOTIFICATION: DEVICE FUNCTIONS AND CHARACTERISTICS

- Voice and non-voice.
 - Voice: loudspeakers.
 - Non-voice: chimes, bells, horns.

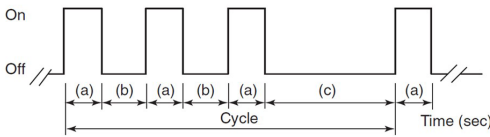


Photos courtesy of iStock. Slide 4-16

- A. Device functions and characteristics.
1. There are loudspeakers (small and large) for voice notification systems and several types of notification appliances for non-voice systems, including chimes, bells and horns, which can be single- or multitonned.
 2. All fire alarm and mass notification systems provide a temporal three-alarm signal, otherwise known as “code-3” or “T-3.” This temporal-three pattern is 0.5 seconds of “on,” followed by 0.5 seconds of “off” for three consecutive “on” periods. This is then followed by 1.5 seconds “off” and then repeated. In a voice notification system, the tone is followed by voice instructions.
 3. Many systems will also provide a code-4 notification tone for carbon monoxide detection. It looks and sounds exactly like code-3 notification, except that there are four “on” signals, each lasting for 100 milliseconds.

AUDIBLE NOTIFICATION: DEVICE FUNCTIONS AND CHARACTERISTICS (cont'd)

Temporal 3 Pattern: Alarm Evacuation Signal



Key:
 Phase (a) signal is on for 0.5 sec ±10%
 Phase (b) signal is off for 0.5 sec ±10%
 Phase (c) signal is off for 1.5 sec ±10% [(c) = (a) + 2(b)]
 Total cycle lasts for 4 sec ±10%

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AUDIBLE NOTIFICATION: DEVICE FUNCTIONS AND CHARACTERISTICS (cont'd)

Temporal 4 Pattern: Carbon Monoxide Signal

On

Off

Phase a: signal is on for 100 ms ± 10 ms.
Phase b: signal is off for 100 ms ± 10 ms.
Phase c: signal is off for 5 sec ± 0.5 sec for initial 4 minutes.
After the initial 4 minutes Phase c: signal is permitted to be changed to 60 s ± 6 s off.

Although the diagram shows a square waveform, the wave can have other shapes that produce a similar effect.

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Slide 4-18

AUDIBLE NOTIFICATION: DEVICE FUNCTIONS AND CHARACTERISTICS (cont'd)

- Sleeping areas: 520-hertz low frequency tone.

Photo courtesy of iStock.

Slide 4-19

4. Sleeping areas are required to be outfitted with a 520-hertz low frequency tone, which has been proven effective at waking people, including those with hearing loss and those who are impaired by alcohol.

PRESIGNAL SYSTEMS

Sounds alarm signal in a constantly attended location when the initial fire alarm signal is received.

Photo courtesy of iStock.

Slide 4-20

- 5. Presignal systems.
 - a. Presignal systems sound an alarm signal in a constantly attended location (e.g., control room, fire brigade station, etc.) when the initial fire alarm signal is received to allow trained personnel to investigate the incident and to manually operate the evacuation signal if necessary.
 - b. Where the system is connected to a remote location or supervising station, the alarm signal is sent immediately upon activation of the initial alarm signal.

EMERGENCY VOICE ALARM COMMUNICATION

- If emergency voice alarm communication (EVAC) is required, examine:
 - Sound pressure levels.
 - Voice intelligibility.
- Acoustically distinguishable spaces (ADSs) can be defined by walls, environmental considerations or characteristics of the space.
- Refer to NFPA 72®, *National Fire Alarm and Signaling Code*®, Annex D.




Photo courtesy of iStock.

Slide 4-21

- B. Emergency voice alarm communication (EVAC).
 - 1. Where the building’s fire codes require the audible signal to be an EVAC, the designer of the system needs to not only examine the sound pressure levels but also voice intelligibility.
 - 2. The system gets divided into zones, called acoustically distinguishable spaces (ADSs). These spaces can be defined by walls, environmental considerations or characteristics of the space itself.
 - 3. NFPA 72®, *National Fire Alarm and Signaling Code*® Annex D is a valuable resource for the designer of the EVAC system and the plans reviewer. It also covers how to properly test the system at acceptance.

SOUND LEVELS

- Needs to be high enough in decibels.
- Needs to overcome ambient sound levels.
- Visual signaling may need to be used if ambient sound level is high.

Table A.18.4.4 Average Ambient Sound Level According to Location

Location	Average Ambient Sound Level (dBA)
Business occupancies	54
Educational occupancies	45
Industrial occupancies	88
Institutional occupancies	59
Mercantile occupancies	40
Mechanical rooms	91
Piers and watersurrounded structures	40
Places of assembly	60
Residential occupancies	35
Storage occupancies	30
Thoroughfares, high-density urban	70
Thoroughfares, medium-density urban	55
Thoroughfares, rural and suburban	40
Tower occupancies	35
Underground structures and windowless buildings	40
Vehicles and vessels	50

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Slide 4-22

C. Sound levels.

1. The object of audible notification is to be heard during an emergency. This means that it needs to be loud enough to overcome the ambient sound levels of the occupancy. Audibility is usually measured in decibels (i.e., dB, dBA).

2. The sound level of a notification device needs to be high enough to overcome the ambient sound levels of the occupancy. While this can be a difficult task to achieve during the plans review phase of a project, there are guidelines from NFPA 72 that can be used to estimate the ambient noise for different occupancies. It becomes a balance between not having the audible signal be louder than 110 dBA when you are close to a device, but still maintaining 15 dBA above ambient. A sleeping area will need to have 75 dBA at the pillow, and as mentioned previously, be a low frequency signal. In addition to the requirement for the signal to be 15 dBA above average ambient sound level, the signal should be 5 dBA above maximum sound level that lasts for at least 60 seconds.

Normal calculations for fire alarm professionals for audibility are fairly straightforward:

- a. 15 dBA over ambient, doubling the distance from the source and subtracting 6 dBA.
 - Example: A rating of 100 dBA at 10 feet will yield 94 dBA at 20 feet, 88 dBA at 40 feet, and so on.

 - The annex gives the average ambient for a business occupancy at 54 dBA. With the goal of 15 dBA above ambient, we are looking for 69 dBA throughout the space.

- If we take a wall-mounted notification appliance that is rated at 88 dBA, that rating is at 10 feet. At 20 feet, we would drop to 82 dBA, 76 dBA at 40 feet, and so on.
- Between 80 and 120 feet away from the appliance, our sound pressure level would be below the 69 dBA, which is what we were looking to attain. This would mean we would need additional audible notification appliances in the space to maintain the required sound pressure level at 15 dBA above ambient.

b. Audibility can be measured with a Type II sound level meter.

3. Where the ambient noise level is very high, visual signaling should be used or noise level reduced by shutting down equipment.

SOUND LEVELS (cont'd)

- The listed decibel rating for a notification appliance is measured at 10 feet.
- As we move away from the device, the sound decreases at a rate of 6 dB for each doubled distance.


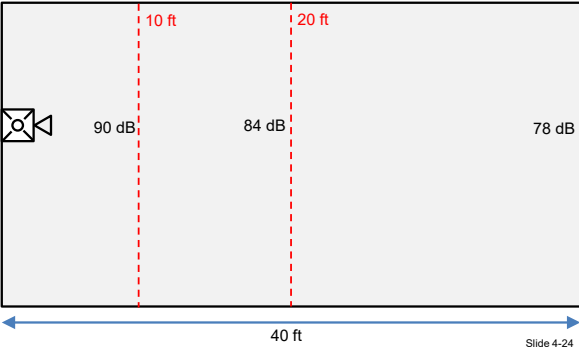


Photo courtesy of iStock.

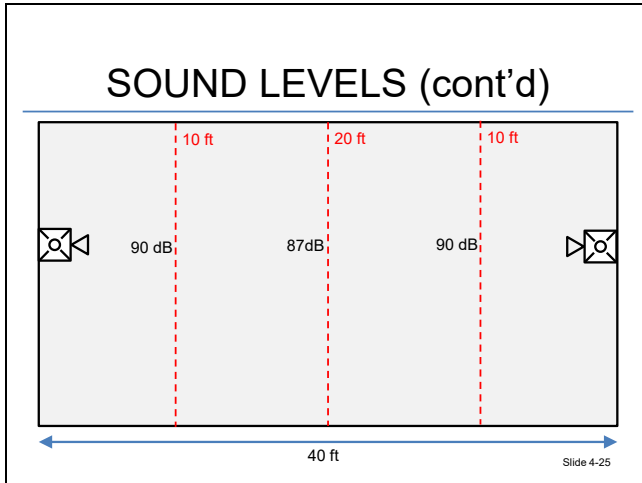
Slide 4-23

SOUND LEVELS (cont'd)



The diagram shows a rectangular area representing a room. On the left side, there is a speaker icon. A blue double-headed arrow at the bottom indicates a total width of 40 ft. Two vertical dashed red lines mark distances of 10 ft and 20 ft from the speaker. The sound level is labeled as 90 dB at 10 ft, 84 dB at 20 ft, and 78 dB at the right edge of the room.

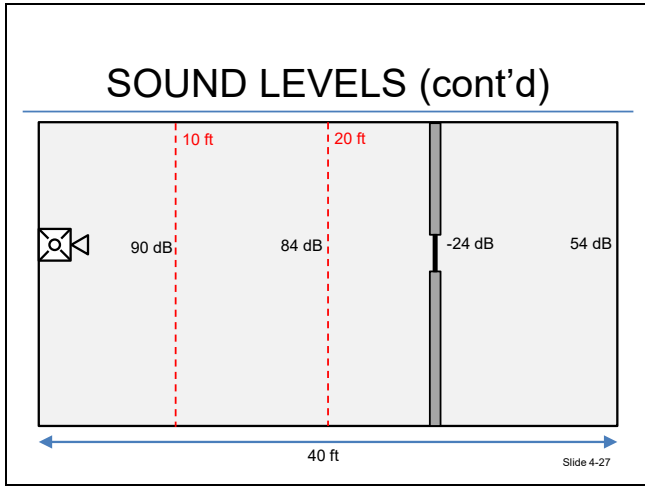
Slide 4-24

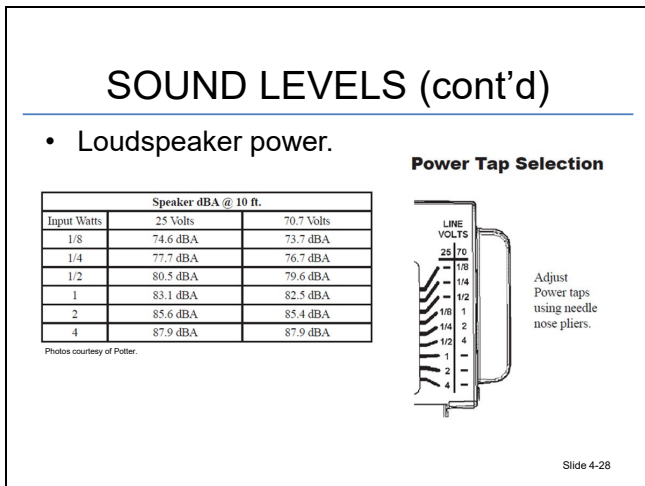


4. The listed decibel rating for a notification appliance is measured at 10 feet. As you move away from the device, the sound decreases. This occurs at a rate of 6 dB every time the distance is doubled.

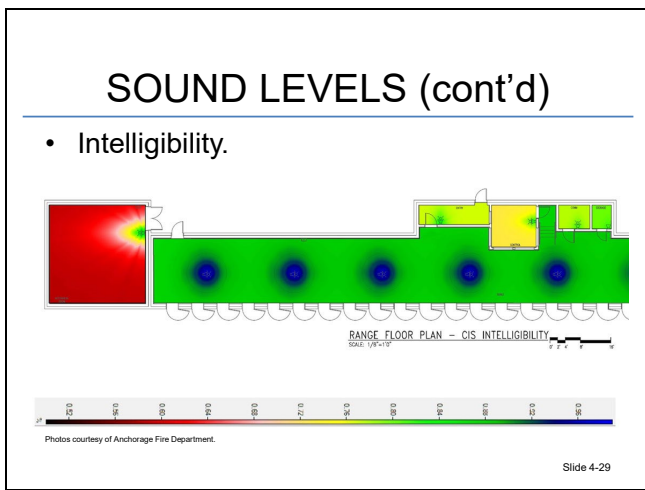
For example, a horn listed at 71 dBA would give that sound pressure level at 10 feet. At 20 feet, you would get 65 dBA, and at 40 ft, the sound would drop to 59 dBA. A slight increase, 3 dBA, is gained when multiple devices are used to cover a space.

5. Sound pressure levels decrease when sound penetrates objects such as walls and doors. According to the Society of Fire Protection Engineers (SFPE) “Handbook of Fire Protection Engineering,” the sound loss through a solid core door is an average of 24 dB, while a wood stud wall with plasterboard is an average of 35 dB. The sealing of the doors, insulation in walls, and thickness of materials will all affect this number.





6. As wattage doubles, sound level increases by approximately 3 dBA.



7. Common intelligibility scale (CIS) allows code and standards to require a certain level of performance in sound intelligibility while allowing for various measurement methods for speech intelligibility to be used (Grant, 2008).

**AUDIBLE NOTIFICATION:
INSTALLATION RULES**

- Needs to be placed where the signal can be heard.
- In accordance with NFPA 70®, *National Electrical Code*®, NFPA 72, and manufacturers' instructions.

Slide 4-30

D. Installation rules.

1. Devices need to be placed so that if public mode notification and general evacuation are used, the signal can be heard at the sound levels (as specified previously) throughout the building. Wall-mounted audible devices need to be installed not less than 90 inches above finished floor (AFF).
2. Fire alarm systems should be installed in accordance with both the NEC (i.e., NFPA 70®, *National Electrical Code*®) and the NFPA (i.e., NFPA 72), along with the instructions from the manufacturer. When it comes to mounting height and location for audible notification appliances, there is no prescriptive criteria in the codes other than sufficient audibility throughout the occupied areas.
3. If the audible appliance is also a visual appliance, the rules for installation of visible appliances will govern the location.

AUDIBLE NOTIFICATION: COMMON PITFALLS

- Inadequate audible signal through closed doors in occupied area.
- Not enough loudspeakers for voice system to be audible or intelligible.
- Loss of more than one notification zone on a single fault in a high-rise.
- Expected ambient conditions or insulation of rooms/areas not considered.

Slide 4-31

AUDIBLE NOTIFICATION: COMMON PITFALLS (cont'd)

- Wrong selection of audible characteristic chosen from cut sheet.

Horn Strobe Tones and Sound Output Data
Table 3 lists the horn strobe tones and sound output data.

Switch Position	Sound Pattern	dB	8-17.5 Volts		16-33 Volts	FWR
			DC	DC		
1	Temporal	High	84	89	89	
2	Temporal	Low	75	83	83	
3	Non-Temporal	High	85	90	90	
4	Non-Temporal	Low	76	84	84	
5	3.1 KHz Temporal	High	83	88	88	
6	3.1 KHz Temporal	Low	76	82	82	
7	3.1 KHz Non-Temporal	High	84	89	89	
8	3.1 KHz Non-Temporal	Low	77	83	83	

Table 3: Horn Strobe Tones and Sound Output Data

Photo courtesy of Potter.

Slide 4-32

E. Common pitfalls.

The designer of the system should make an attempt to consider the following items. However, the actual audibility of the system will ultimately need to be evaluated for compliance during system acceptance.

1. Inadequate audible signal through closed doors in occupied area.
2. Not enough loudspeakers for voice system to be audible or intelligible.
3. Loss of more than one notification zone on a single fault in a high-rise.
4. Not taking into account the expected ambient conditions or insulation of rooms or areas.

III. VISUAL NOTIFICATION

VISUAL NOTIFICATION: DEVICE FUNCTIONS AND CHARACTERISTICS

- Strobes.
- Billboards.
- Rolling text signs.
- Emergency text messaging.




Photo courtesy of Johnson Controls.

Photos courtesy of iStock.

Slide 4-33

A. Device functions and characteristics.

1. The primary method of visual notification for a fire alarm system is strobes. However, with the advent of mass notification systems, the selection of visual warning equipment has expanded to include large billboards, rolling text signs, emergency text messaging and others.
2. The location of visible devices is dictated by the building code. Visual devices that are listed as fire alarm notification appliances will meet the specific rules for visibility at certain distances.

VISIBILITY REQUIREMENTS

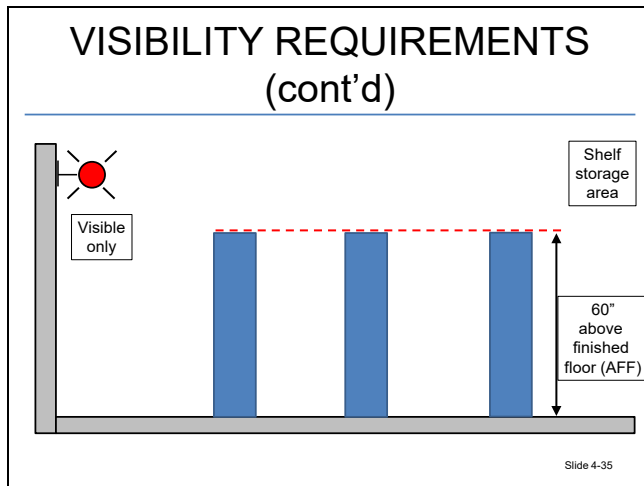
- Location mandated by the building code, fire code and the Americans with Disabilities Act Accessibility Guidelines (ADAAG).
- Required in any spaces that could be occupied by those with hearing impairment.
- Number of devices needed depends on the size and layout of the space.

Slide 4-34

B. Visibility requirements.

1. The building code, fire code and Americans with Disabilities Act Accessibility Guidelines (ADAAG) will mandate the locations of visual notification in all public buildings.

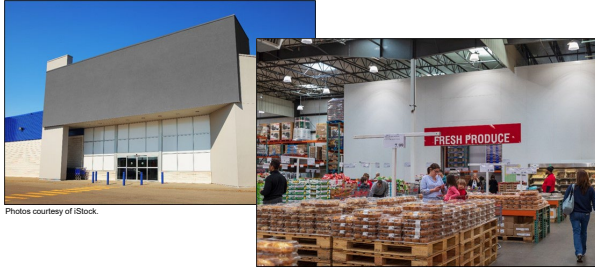
- 2. If using public mode notification, codes will require visibility in any spaces that could be occupied by those with hearing impairment.
 - a. This would be any area open to the public in a building.
 - b. It would also include a certain percentage of the rooms in a hotel or transient residential occupancy.
 - c. There also needs to be infrastructure to add visible notification in nontransient residential occupancies, such as apartment buildings, should someone with a hearing impairment move into the building.
 - d. Often a state's code for accessibility will mandate that a certain number of apartment units have visible notification.



- 3. The exact number of visual devices required depends on the size and layout of the space. A proper review of visual notification requires that furniture, storage room shelving height and locations of same be clearly shown on the plans. Any shelf over 60 inches will require visual notification between the shelves. Large pieces of furniture can obstruct visuals, which is why annual inspections are important.
 - a. The National Fire Alarm and Signaling Code provides guidance to determine if a certain candela rating of a visual notification appliance will cover a certain square footage of space.
 - b. Lowering the candela rating and increasing the number of devices to meet the minimum visibility is another option.
 - c. The layout of the space will also alter how visible notification appliances can be installed.

VISIBILITY REQUIREMENTS (cont'd)

- Example: big-box store.



Photos courtesy of iStock.

Slide 4-36

- d. During a plans review, you will need to know as much about the intended use and layout of the space as possible to verify the visibility of notification appliances.

VISUAL NOTIFICATION: INSTALLATION RULES

- Can be installed on walls or ceilings or suspended from high ceilings.
- Wall-mounted: 80 inches to 96 inches AFF.



Photo courtesy of iStock.

Slide 4-37

C. Installation rules.

1. Appliances can be installed on walls or ceilings or suspended from high ceilings.
2. Wall-mounted devices need to be between 80 inches and 96 inches AFF. This measurement is taken to the lens where the visible signal will originate.

VISUAL NOTIFICATION: INSTALLATION RULES (cont'd)

- Ceiling-mounted with ceiling over 30 feet in height must be suspended to 30 feet or lower AFF.



Photo courtesy of iStock.

Slide 4-38

3. In rooms with a ceiling over 30 feet in height, if ceiling-mount notification appliances are selected, they will need to be suspended to be 30 feet or lower AFF.

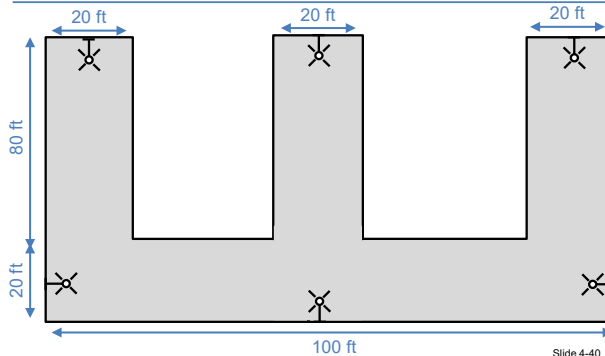
VISUAL NOTIFICATION: INSTALLATION RULES (cont'd)

- Corridors (less than 20 feet in width): within 15 feet of the end of the corridor and spaced no greater than 100 feet between devices.



Slide 4-39

VISUAL NOTIFICATION: INSTALLATION RULES (cont'd)



Slide 4-40

4. Since corridors are generally narrow in width, we treat them differently than a regular room. This is unless the corridor is greater than 20 feet in width. In the case of corridors that are not greater than 20 feet in width, we place a device within 15 feet of the end of the corridor and space them at not greater than 100 feet between the devices for the length of the corridor.

**VISUAL NOTIFICATION:
COMMON PITFALLS**

- Additions after a fire alarm system is designed.
- Changes made without consulting the fire alarm system designer.
- Failure to synchronize multiple signals.
- Incorrect mounting height.

Slide 4-41

D. Common pitfalls.

1. Additions of partitions, walls, shelves or racks after a fire alarm system is designed can alter the visibility of the fire alarm notification appliances.
2. Changes made by the architect without consulting the fire alarm system designer: architects must ensure that modifications and their effects on visibility of the signals are taken into account.
3. When more than one visible appliance is located in a room or within the same field of view, the visible signals must be synchronized. Synchronization of strobes must comply with NFPA 72, sections 18.5.5.5.2 and 18.5.5.6.7.

IV. OTHER MEANS OF NOTIFICATION

OTHER MEANS OF NOTIFICATION

- Text.
 - Textual audible.
 - Text and graphical visual.
- Directional signaling.




Photo courtesy of Honeywell.

Slide 4-42

- A. Text.
 - 1. Textual audible appliances.
 - a. Loudspeakers and loudspeaker strobes.
 - b. Large loudspeaker arrays.
 - c. Reference: NFPA 72, Chapter 18, Section 18.8.
 - 2. Text and graphical visual appliances.
 - a. Format: static, flashing or scrolling.
 - b. Reference: NFPA 72, Chapter 18, Section 18.9.

- B. Directional signaling.
 - 1. Used by large, complex buildings to assist in the evacuation of occupants that are not familiar with the building.
 - 2. Reference: NFPA 72, Chapter 18, Section 18.4.8.

OTHER MEANS OF NOTIFICATION (cont'd)

- Tactile.




Photo courtesy of Federal Emergency Management Agency (FEMA) Slide 4-43

C. Tactile.

1. Used for the hearing impaired, as a visible device will not be sufficient to awaken them while sleeping.
2. Example: bed or pillow shakers.
3. Reference: NFPA 72, Chapter 18, Section 18.10.

OTHER MEANS OF NOTIFICATION (cont'd)

- Wide area notification.




Photo courtesy of iStock. Slide 4-44

D. Wide area notification.

1. Not specifically a fire alarm notification appliance, but can be used on premises (e.g., college campuses) as part of the overall alerting to emergencies, natural or human-made, that may need certain responses.
2. Reference: NFPA 72, Chapter 18, Section 18.4.

OTHER MEANS OF NOTIFICATION (cont'd)

- Exit sign illumination.



Photo courtesy of iStock.

Slide 4-45

- E. Exit sign illumination: There are fire alarm systems designed to flash exit signs in addition to standard signaling in the event of an alarm.

OTHER MEANS OF NOTIFICATION (cont'd)

- Other visual notification device.



Photo courtesy of Alertus.

Slide 4-46

- F. Other visual notification device.
 1. Used in mass notification systems.
 2. Reference: NFPA 72, Chapter 24.

SPECIAL CONSIDERATIONS

- NPFA 72 allows for a performance-based option for visible notification layout.
- Minimum requirements need to be met for visibility and gain approval of the authority having jurisdiction (AHJ).

Slide 4-47

G. Special considerations.

1. NPFA 72 allows for a performance-based option in designing the visible notification layout for the building.
2. The designer needs to meet minimum requirements for visibility to gain approval of the AHJ for the intended design.

V. NOTIFICATION WALK-THROUGH

NOTIFICATION WALK-THROUGH

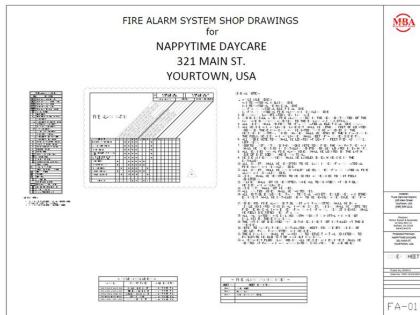


Photo courtesy of Merton Bunker & Associates.

Slide 4-48

- A. This walk-through of sample plans and submittal packet will prepare you for the upcoming activity on verifying notification layout.

NOTIFICATION WALK-THROUGH (cont'd)

- Notification appliances.

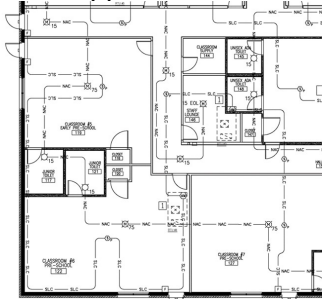


Photo courtesy of Merton Bunker & Associates.

Slide 4-49

- B. Notification appliances.

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ACTIVITY 4.1

Verification of Notification Layout

Purpose

Determine if audibility and visibility requirements are met, given a set of plans.

Directions

1. In your small group, examine the Central City High School plans to:

a. Determine if visual coverage is code compliant.



b. Determine if audible coverage is code compliant.

c. Determine the difference between the audible characteristics of business/ educational occupancy alarm notification and residential occupancy alarm notification.

2. Be prepared to share your responses with the larger group.

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VI. SUMMARY



SUMMARY

- General considerations for notification.
- Audible notification.
- Visual notification.
- Other means of notification.
- Notification walk-through.

Slide 4-51

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REFERENCE

Grant, C. C. (2008). *Intelligibility of fire alarm and emergency communication systems*. The Fire Protection Research Foundation. https://cdn2.hubspot.net/hubfs/359395/Midches_Aug2016/Docs/intelligibilityfirealarm.pdf

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UNIT 5: ANCILLARY INTERCONNECTION

TERMINAL OBJECTIVE

The students will be able to:

- 5.1 *Assess if the interface to supplemental systems is compliant with the code, given fire alarm shop drawings.*

ENABLING OBJECTIVES

The students will be able to:

- 5.1 *Evaluate where an interface is required for different types of system interconnection with fire alarm systems.*
 - 5.2 *Analyze the wiring methods for fire alarm control functions.*
 - 5.3 *Determine that a layout for smoke detection is correct for fire-rated doors.*
 - 5.4 *Conclude that code requirements for system interconnection have been met.*
-

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I. ELEVATORS

- A. One of the required features of an elevator is Firefighters' Emergency Operation. As part of this feature, elevators need to provide a Phase I Emergency Recall Operation, controlled by smoke or heat detectors installed in certain areas within the proximity of an elevator or its associated equipment.
- B. These detection devices, required by the American Society of Mechanical Engineers ASME A17.1, *Safety Code for Elevators and Escalators*, need to be installed in accordance with the building code, as well as National Fire Protection Association (NFPA) 72®, *National Fire Alarm and Signaling Code*®.

**WHERE INTERFACE IS REQUIRED:
ELEVATORS**

- Required for buildings with elevators that also have fire alarm systems.
- A dedicated fire alarm control unit (FACU) for elevator recall control and supervisory installed.


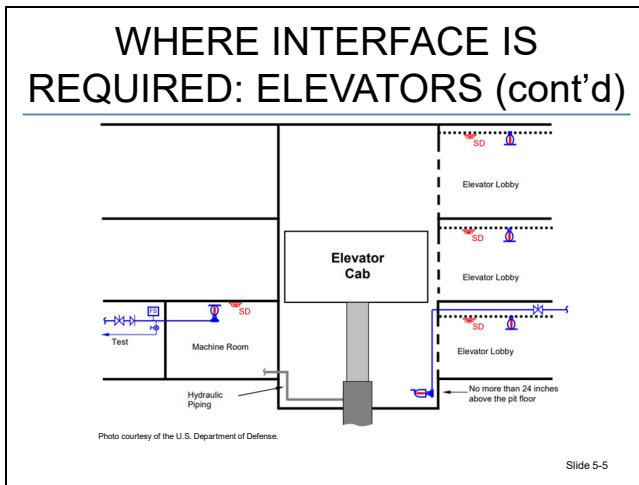


Photo courtesy of iStock.

Slide 5-4

1. Where interface is required.



WHERE INTERFACE IS REQUIRED: ELEVATORS (cont'd)

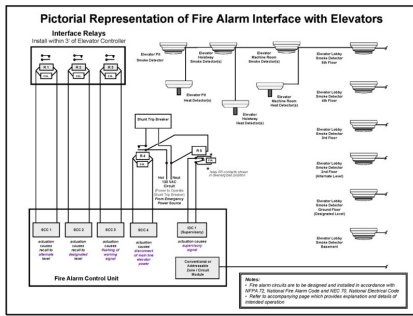


Photo courtesy of U.S. Department of Veterans Affairs.

Slide 5-6

- a. If the building where the elevator is installed has a fire alarm system, the detection devices mandated by ASME A17.1 need to be connected to that fire alarm system. This connection not only allows the emergency control function to be performed and the elevator to be recalled, but also activates the building's notification appliances or a signal at an attended location.
- b. If there is a fire alarm system installed in the building, then a dedicated fire alarm control unit (FACU) for elevator recall control and supervisory will be installed.

WIRING METHODS: ELEVATORS

- Same for all emergency control function interfaces.
- Class A, B, D, N or X.



Photo courtesy of Honeywell.

Slide 5-7

**WIRING METHODS:
ELEVATORS (cont'd)**

- AIM
- IM
- AOM
- AIO #




Photo courtesy of Merton Bunker & Associates.

Slide 5-8

- 2. Wiring methods.
 - a. The wiring methods for all emergency control function interfaces are allowed to be Class A, B, D, N or X.
 - b. The distance between the interface device and the component that controls the emergency control function is limited to 3 feet, unless the wiring method is Class D.

**REQUIRED CONTROL
FUNCTIONS: ELEVATORS**

- Elevator lobbies within 21 feet of the centerline of each elevator door.
 - Smoke detection required.


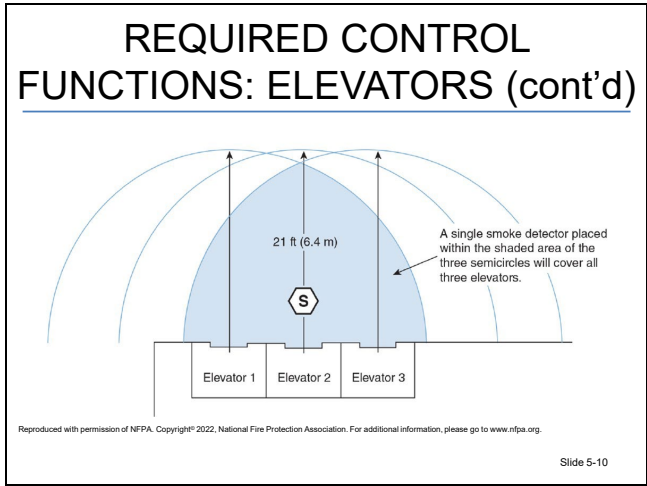
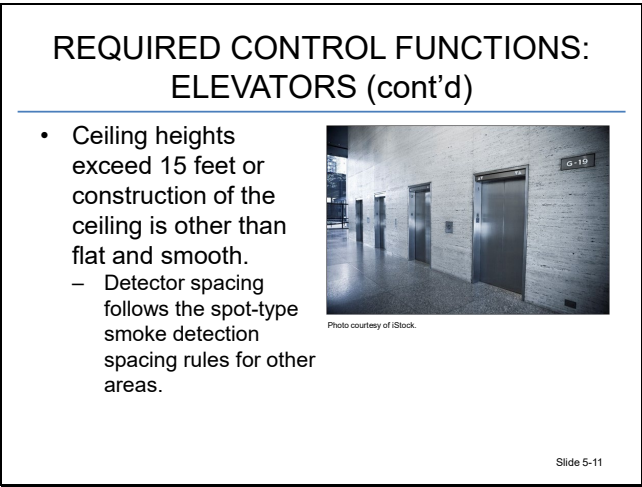


Photo courtesy of iStock.

Slide 5-9



- 3. Required control functions.
 - a. Smoke detection is required in elevator lobbies within 21 feet of the centerline of each elevator door.
 - b. One smoke detector may be appropriate for multiple elevators if the detector is located within the overlapping radiuses.



- c. When ceiling heights exceed 15 feet or construction of the ceiling is other than flat and smooth, detector spacing would follow the spot-type smoke detection spacing rules for other areas.

**REQUIRED CONTROL FUNCTIONS:
ELEVATORS (cont'd)**

- Sprinklers located in the elevator hoistway (top or bottom).
 - Detection required in the same area.
 - Detection required in the machine room.

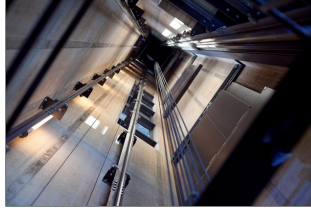


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Slide 5-12

- d. When sprinklers are located in the elevator hoistway at the top or bottom, detection is required in the same area to recall the elevator before water discharges from the sprinklers. Detection is also required in the machine room to recall the elevator.

II. HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

**WHERE INTERFACE IS REQUIRED:
HVAC EQUIPMENT**

Smoke detectors on systems with capacity that exceeds 2,000 cubic feet per minute (cfm).

FURNACE SCHEDULE

TAG	MANUFACTURER AND MODEL #	HEAT CAPACITY (BTU/H)	HEAT INPUT (BTU/H)	HEAT OUTPUT (BTU/H)	HEAT LOSS (BTU/H)	PA (IN)	VOLTAGE	AFUE	MODE #	WIRE #	REMARKS
F-1	LUX-AIRE 69T12020JPD13	120,000	112,000	5 TONS	2,000	150	120/60/1	92.0%	AC-1	WIRE-1	
F-2	LUX-AIRE 69T10014UPC13	100,000	93,000	3 TONS	1,200	150	120/60/1	92.2%	AC-2	WIRE-1	
F-3	LUX-AIRE 69T10014UPC13	100,000	93,000	3 TONS	1,200	200	120/60/1	92.2%	AC-3	WIRE-1	

REMARKS:
1- TO BE CONTROLLED BY T-BFF HEAT/COOL THERMOSTAT.
2- TO BE CONTROLLED BY SUPPLY DUCT SENSORS WITH REMOTE CONTROLLER LOCATED IN MANAGERS OFFICE.

CONDENSING UNIT SCHEDULE

TAG	MANUFACTURER AND MODEL #	HEAT CAPACITY (BTU/H)	VOLTAGE	MCA	SEER/EER	MODE #	REMARKS
AC-1	LUX-AIRE HABA-0605	5 TONS	208-230/1P	37.4	10.0/---	F-1	
AC-2	LUX-AIRE HABA-0365	3 TONS	208-230/1P	19.7	10.0/---	F-2	
AC-3	LUX-AIRE HABA-0365	3 TONS	208-230/1P	19.7	10.0/---	F-3	

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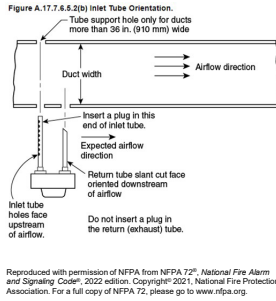
Slide 5-13

- A. Where interface is required.
1. The International Mechanical Code (IMC) and NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems* are the two documents that will normally govern the installation of ventilation for heating and cooling.
 2. Both the IMC and NFPA 90A require smoke detectors on systems with a capacity that exceeds 2,000 cubic feet per minute (cfm).

1 ton = 400 cfm.

REQUIRED CONTROL FUNCTIONS: HVAC EQUIPMENT

- Detection devices turn off the devices and fans that may be the source of the smoke or spreading smoke through the building.
- Specific location of the device or devices varies between the International Mechanical Code (IMC) and National Fire Protection Association (NFPA) 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.



Slide 5-14

B. Required control functions.

Smoke detection turns off the heating, ventilating and air conditioning (HVAC) devices and fans that may be the source of the smoke or may be spreading smoke through the building. The specific location of the smoke detectors varies between the IMC and NFPA 90A.

1. IMC specifications.

- a. Smoke detectors must be installed in the return air systems upstream of any filters, exhaust air connections, outdoor air connects, or decontamination equipment and appliances.

REQUIRED CONTROL FUNCTIONS: HVAC EQUIPMENT (cont'd)

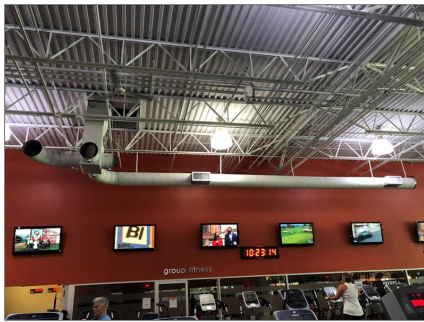


Photo courtesy of Keith Heckler.

Slide 5-15

- b. If the building has an area smoke detection system installed, the duct smoke detectors are not required.
- c. If multiple systems that are under the 2,000 cfm threshold for detectors share a common supply or return, and collectively are over the 2,000 cfm threshold, they also require the return air detector.

ANCILLARY INTERCONNECTION

- d. Return air risers that serve two or more stories and have a design capacity over 15,000 cfm require detectors installed at each story.
 - e. If the building has a fire alarm system, the duct smoke detectors need to be tied into the fire alarm to actuate a supervisory signal at an attended location.
2. NFPA 90A specifications.
- a. The same 2,000 cfm threshold exists for systems governed by NFPA 90A. The location of smoke detection is in the supply downstream of filters and ahead of any branch connections.
 - b. As with the IMC, systems that have a capacity of more than 15,000 cfm and serve more than one story need detection at each story prior to the connection to a common return of fresh air inlet.
 - c. There is also an exemption for systems where the entire area served has area smoke detection.



III. SMOKE MANAGEMENT/CONTROL

WHERE INTERFACE IS REQUIRED:
SMOKE MANAGEMENT/CONTROL

- Design of the smoke management system drives how it will interface with fire alarm system.
- Interface with fire alarm required in buildings where detection and control are used to operate mechanical control systems.

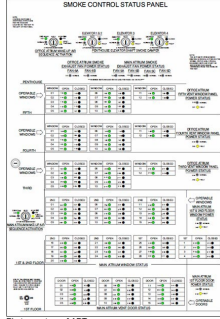


Photo courtesy of ADT.

Slide 5-17

A. Where interface is required.

1. The design of the smoke management system will be the driving factor, specifically in how it will interface with the fire alarm system.
2. In buildings where detection and control are used to operate mechanical smoke control systems, they will have to interface with the fire alarm.

REQUIRED CONTROL FUNCTIONS:
SMOKE MANAGEMENT/CONTROL

- Test scenario fires during the design phase will determine which zones turn on or off based on detection activated.



Photo courtesy of NIST.

Slide 5-18

B. Required control functions.

1. Determining which zones turn on or off, depending on what detection is activated, is a complex concept based upon test scenario fires during the design phase.

2. This is a highly technical life safety system and may be a time when the authority having jurisdiction (AHJ) wants to have technical assistance from a third-party fire protection engineer.

VIDEO PRESENTATION

“SMOKE EVACUATION TESTING”

<https://www.youtube.com/watch?v=IEXfPwfpzqA>

Slide 5-19

IV. DOOR FUNCTIONS

TYPES OF DOOR FUNCTIONS

- Door release.
- Example.
- Electrically locked doors.

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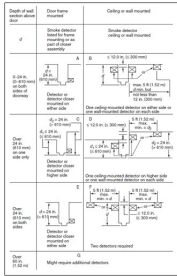
Slide 5-20

A. Door hold release.

1. Door release: NFPA includes specific smoke detector placement when they are used for door releasing service.
2. Electrically locked doors: commonly referred to as “delayed egress” by the building and life safety codes. These are doors that, for security reasons, will be kept locked during normal business hours. They will be arranged so that sprinkler system activation or automatic fire detection will unlock the doors, allowing for free egress.

WHERE INTERFACE IS REQUIRED: DOOR FUNCTIONS

- Automatic hold-open devices can be installed in place of self-closing doors.
 - Commonly, spot-type smoke detection is used, controlled with a magnetic hold that is powered by the fire alarm system.



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Slide 5-21

B. Where interface is required.

1. As an alternative to self-closing doors, some facilities choose to install automatic hold-open devices. These can be independent of the fire alarm system with an integrated smoke detection and releasing mechanism or, more commonly, spot-type smoke detection on either side of the door being controlled with a magnetic hold-open that is controlled by the fire alarm system.

DETECTOR PLAN VIEW

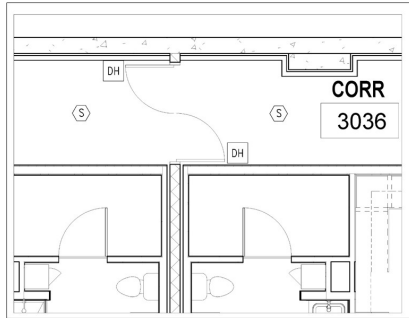
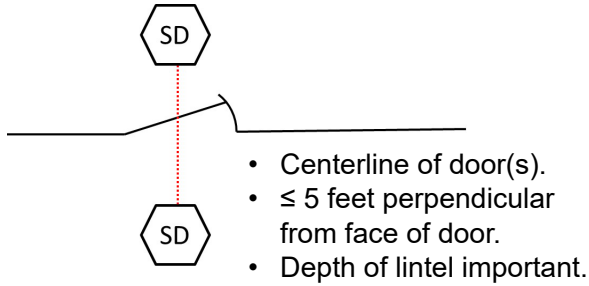


Photo courtesy of Merton Bunker & Associates.

Slide 5-22

DETECTOR LOCATION



Slide 5-23

INTEGRATED DETECTION



Slide 5-24

2. Automatic door closing can also be accomplished with smoke detection integrated into the door closer hardware. These devices can be standalone devices that are powered by either 120 volts of alternating current (VAC) or 24 volts of direct current (VDC). These devices can also send a signal to the fire alarm system upon activation of the integrated smoke detector.

WIRING METHODS: DOOR FUNCTIONS

A failsafe method is commonly used with doors closing upon loss of power, typically Class D.

Slide 5-25

C. Wiring methods.

Most commonly, wiring in egress doors uses a failsafe method with doors closing upon loss of power, typically Class D.

V. MONITORING

MONITORING

- Status can be monitored through the FACU.
- If the generator provides secondary power, it needs to be monitored as part of the power supply.

Slide 5-26

- A. When an emergency power supply is installed in accordance with National Fire Protection Association (NFPA) 110, *Standard for Emergency and Standby Power Systems*, its status can be monitored through the FACU.
- B. In addition, if the generator is providing secondary power to the fire alarm system, it would need to be monitored as part of the power supply for that system.

VI. OTHER CONTROL FUNCTIONS

**WHERE INTERFACE IS REQUIRED:
OTHER CONTROL FUNCTIONS**

Fire alarm system may control other functions based on the building, occupancy or hazards.




Photo courtesy of Keith Heckler. Slide 5-27

Where interface is required.

- A. The fire alarm system may control many other functions, depending upon the building, occupancy or hazards present. Examples include:
 - 1. Turning on lights and shutting down music or loud noises in the case of some assembly occupancies.

**WHERE INTERFACE IS REQUIRED:
OTHER CONTROL FUNCTIONS (cont'd)**

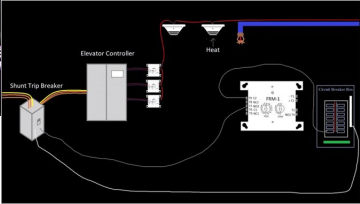



Photo courtesy of iStock. Photo courtesy of Joe Kiochan. Slide 5-28

- 2. Shutting down power or gas to cooking appliances in commercial kitchens.
- B. NFPA 13, *Standard for the Installation of Sprinkler Systems* now requires that high-volume, low-speed (HVLS) fans, such as those found in warehouses, need to turn off upon activation of water flow from the sprinkler system. This will be accomplished with an interface to the branch circuit powering the fans.

VII. FIRE-EXTINGUISHING SYSTEMS

**WHERE INTERFACE IS REQUIRED:
FIRE-EXTINGUISHING SYSTEMS**

- Alternative automatic fire-extinguishing systems are required to be interfaced with the building fire alarm.
- The type of system could be wet or dry chemical, water mist, clean-agent, carbon dioxide, or halon.
 - Each type has a specific NFPA installation standard.

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ACTIVITY 5.1

Reviewing for Interface Requirements

Purpose

Determine whether the interface requirement and what actions from the fire alarm should trigger a response in the interface system using the provided descriptions and associated plans of different conditions in a building.

Directions

1. In your small group, using the Central City High School plans, answer the following prompts.
 - a. Identify any interface devices that are shown by device ID and page.



 - b. Using the answers from the previous prompt, determine what other types of systems or equipment in the building are interfaced to the fire alarm.

 - c. Are there any systems or equipment that are not shown interfaced to the fire alarm system that should be?

2. Be prepared to share your responses with the larger group.

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IX. SUMMARY



SUMMARY

- Elevators.
- Heating, ventilating and air conditioning Equipment.
- Smoke management/control.
- Door functions.
- Monitoring.
- Other control functions.
- Fire-extinguishing systems.
- Interface walk-through.

Slide 5-33

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UNIT 6: BATTERY AND VOLTAGE DROP CALCULATIONS

TERMINAL OBJECTIVE

The students will be able to:



- 6.1 *Evaluate if the calculation inputs and outputs, as well as assumptions, are accurate given a set of battery and voltage drop calculations.*

ENABLING OBJECTIVES

The students will be able to:

- 6.1 *Determine that the required battery storage for system type is appropriate.*
 - 6.2 *Validate the accuracy of battery calculations using spreadsheets or other methods.*
 - 6.3 *Validate the accuracy of voltage drop calculations using spreadsheets or other methods.*
-

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**UNIT 6:
BATTERY AND VOLTAGE
DROP CALCULATIONS**

Slide 6-1

TERMINAL OBJECTIVE

Evaluate if the calculation inputs and outputs, as well as assumptions, are accurate given a set of battery and voltage drop calculations.

Slide 6-2

ENABLING OBJECTIVES

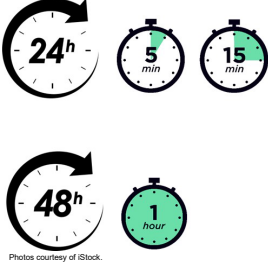
- Determine that the required battery storage for system type is appropriate.
- Validate the accuracy of battery calculations using spreadsheets or other methods.
- Validate the accuracy of voltage drop calculations using spreadsheets or other methods.

Slide 6-3

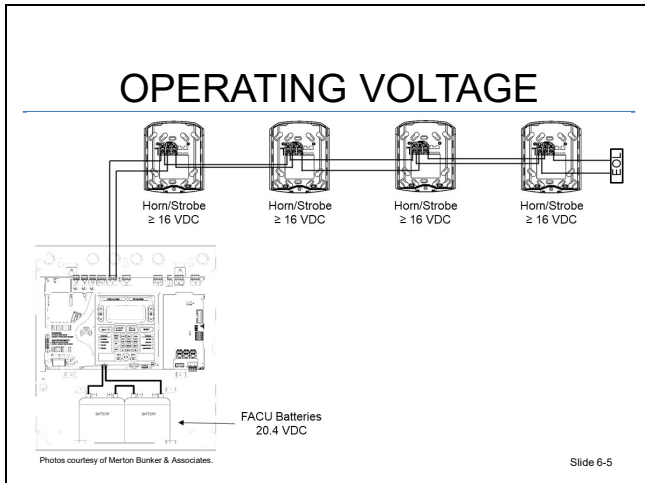
I. BATTERY CALCULATIONS

SECONDARY POWER REQUIREMENTS

- Standby batteries are always required on a fire alarm system.
- Government installations of mass notification systems require 48 hours of battery backup and 1 hour of alarm time.



Slide 6-4



A. Secondary power requirements.

1. Standby batteries are always required on both traditional fire alarm systems and emergency voice alarm communication (EVAC) systems. Many buildings, especially large ones with voice systems, are provided with an emergency generator for powering critical systems in the event of a normal power loss, and the fire alarm system may be connected to it. Traditional systems are designed with batteries capable of operating the system for 24 hours in quiescent load, followed by five minutes of alarm load. If the fire alarm system is connected to emergency power, the battery backup time is allowed to be reduced to four hours (National Fire Protection Association (NFPA) 72, *National Fire Alarm and Signaling Code*® Section 10.6.7.3.1) from 24 hours (sections 10.6.7.2.1 and 10.6.7.2.1.3).

2. Mass notification systems for government installations typically require 48 hours of battery backup plus one hour of alarm time, regardless of the connection to emergency power, creating the need for larger batteries and battery cabinets. Mass notification systems for large buildings also require that a risk analysis be performed per NFPA 101[®], *Life Safety Code*[®], Section 9.14.
3. In-building fire EVAC systems.
 - a. Must be capable of operating the system under quiescent load for a minimum of 24 hours.
 - b. Must be capable of operating the system during a fire or other emergency condition for a period of 15 minutes at maximum connected load (NFPA 72, Section 10.6.7.2.1.2).
4. Supervising station facilities and equipment.
 - a. Must be capable of supporting operations for a minimum of 24 hours (NFPA 72, Section 10.6.7.2.1.2).
 - b. Equipment that transmits an alarm to a supervising station is also required to have a secondary power supply.

**METHODS OF PROVIDING
SECONDARY POWER**

- Storage batteries.
- Secondary circuits that provide power to the control unit.
- Branch circuit of multiple engine-driven generators.





Photo courtesy of Stock. Image courtesy of Power Sonic.
Slide 6-6

- B. Methods of providing secondary power.
1. Storage batteries.
 2. Secondary circuits that provide power to the control unit and are not integral to the unit.
 3. A branch circuit of an automatic-starting, engine-driven generator.

- 4. A branch circuit of multiple engine-driven generators.

SECONDARY POWER REQUIREMENTS (cont'd)

- In-building mass notification system.
- Carbon monoxide detection.




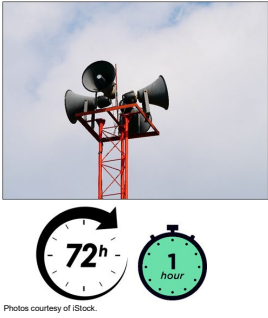
Photo courtesy of Honeywell. Photo courtesy of iStock. Slide 6-7

- 5. In-building mass notification systems.
 - a. Must be capable of operating the system under quiescent load for a minimum of 24 hours.
 - b. Must be capable of operating the system during emergency conditions for a period of 15 minutes at maximum connected load (NFPA 72, Section 10.6.7.2.1.7).
- 6. Carbon monoxide detection.
 - a. Secondary power supply shall have sufficient capacity to operate the carbon monoxide detection system under quiescent load (i.e., system operating in a non-alarm condition) for a minimum of 24 hours.
 - At the end of that period, shall be capable of operating the carbon monoxide detection system and all carbon monoxide notification appliances for 12 hours (NFPA 72, Section 10.6.7.2.3).
 - b. Where carbon monoxide detection is monitored by a supervising station, the secondary power supply shall have sufficient capacity to operate the carbon monoxide detection system under quiescent load (i.e., system operating in a non-alarm condition) for a minimum of 24 hours.

- At the end of that period, shall be capable of operating the carbon monoxide detection system and all notification appliances for five minutes (NFPA 72, Section 10.6.7.2.4).

SECONDARY POWER REQUIREMENTS (cont'd)

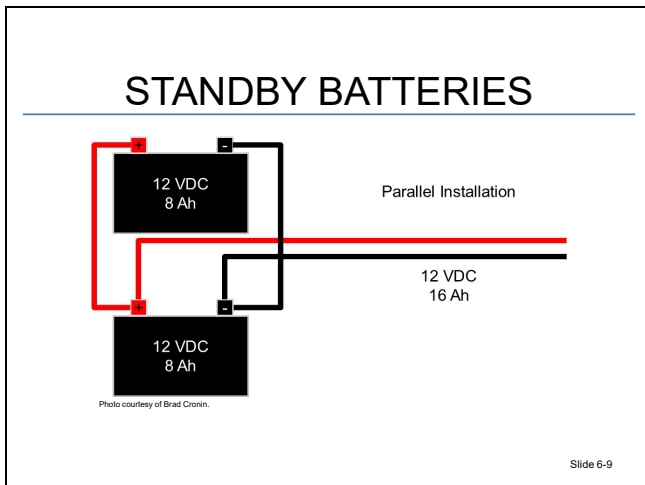
- High-power loudspeaker arrays (HPLA).
- Textual visual notification appliances.



Photos courtesy of iStock.

Slide 6-8

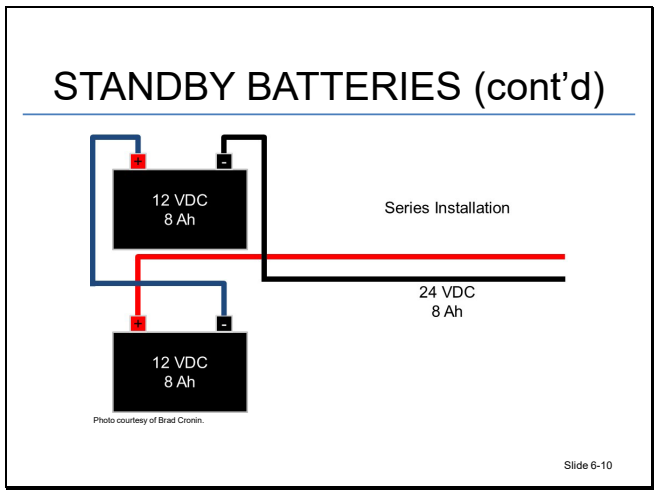
7. High-power loudspeaker arrays (HPLAs) used for wide-area mass notification systems must have sufficient capacity to operate the unit for a minimum of three days in standby and 60 minutes of operation at full load (NFPA 72, Section 24.6.5.2).
8. Textual visual notification appliances. Primary textual visual notification appliances must have sufficient secondary power to operate for a minimum of two hours of continuous display times during an emergency event after loss of primary power (NFPA 72, Section 24.6.10.1).



- C. Standby batteries.

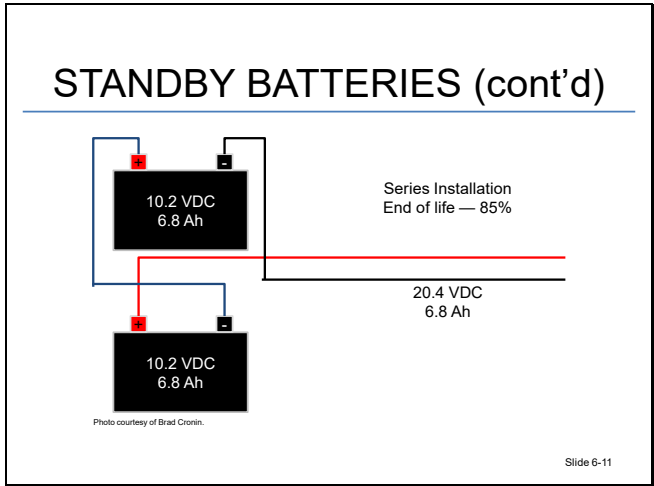
1. When batteries are used as the secondary source of power for a fire alarm system, they must be sized correctly to serve the system for the time frames that were previously mentioned. The sizing would include sufficient capacity in amp hours (Ah) and voltage. When multiple batteries are used to meet that capacity of the system, we have to determine how they are connected to one another.
2. When batteries are installed in parallel, we add the amps and not the volts.

If we were to think of this in terms of firefighting, consider two fire engines with pumps that deliver 1,250 gallons per minute (gpm) at 150 pounds per square inch (psi), each pumping their capacity to a fire. At the fire, we would have 2,500 gpm at 150 psi. This analogy equates pressure (psi) to voltage (volts) and flow (gpm) to current (amps).

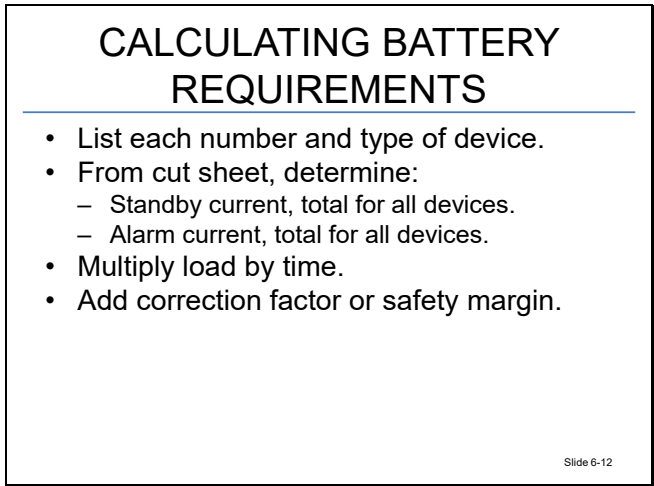


3. Batteries can also be wired in a series if an increase in voltage is needed.
4. In this example of a series installation, the 12 volts (V) of each battery are added together for a resulting 24 volts of direct current (VDC) serving the system. Since the installation is in series and we are getting the benefit of the added voltage, we don't get to add the current together. Therefore, the 24V system shown above would only have a capacity of 8 Ah.

Again, if we were to think of this in terms of firefighting, this would equate to the same two 1,250-gpm, 150-psi fire engines pumping in relay. The discharge of one pump would feed the intake of the next, so at the fire, we would have 1,250 gpm — but now at 300 psi.



5. All fire alarm system components need to function at a voltage range of 85% to 110% of rated voltage. This means that a 12V battery needs to be replaced when it falls below 85% or 10.2 VDC. At the end of life, if both batteries are at 85%, the 24V system would only be receiving 20.4V.



- D. Calculating battery requirements.
1. List each number and type of device.
 2. From cut sheet, determine:
 - a. Standby current, total for all devices (if there is one).
 - b. Alarm current, total for all devices.
 3. Multiply load by time.

4. Add correction factor or safety margin.

CALCULATING BATTERY REQUIREMENTS EXAMPLE

- Central Station.
- Number of devices.
 - Fire alarm control unit (FACU): 1.
 - Smoke detectors: 12.
 - Water flow switches: 3.
 - Horn/strobes: 12.


Slide 6-13

E. Calculating battery requirements example.

1. Central Station.
2. Number of devices:
 - a. Fire alarm control unit (FACU): 1.
 - b. Smoke detectors: 12.
 - c. Water flow switches: 3.
 - d. Horn/strobes: 12.

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

- FACU.
 - Plans show a Potter PFC-6006 conventional FACU.
 - Current draw.
 - Standby: 105 mA.
 - Alarm: 160 mA.



PFC-6006
Conventional Fire Panel

Photo courtesy of Potter.

Technical Specifications	
Size (H x W x D)	18.12" x 14.12" x 4.54"
Finish	Red/White (R) powder coated steel with tempered aluminum locked door
AC Mains	115 range or 230 VAC, 60 Hz
Battery	160 mA Standby 160 mA Alarm
Temperature	32° to 129°F, humidity 95%, non-condensing
Standby	13.8Ah
Alarm	14.0Ah @ 72

Slide 6-14

3. FACU.

BATTERY AND VOLTAGE DROP CALCULATIONS

- a. Plans show a Potter PFC-6006 conventional FACU.
- b. Current draw.
 - Standby: 105 milliamps (mA).
 - Alarm: 160 mA.

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

Device	QTY	Standby current	Total standby load	Alarm current	Total alarm load
FACU	1				
Smoke detectors	12				
Water flow	3				
Horn/strobes	12				
		Totals			

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CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

Device	QTY	Standby current	Total standby load	Alarm current	Total alarm load
FACU	1	0.105	0.105	0.16	0.16
Smoke detectors	12				
Water flow	3				
Horn/strobes	12				
		Totals			

Loads need to be in amps (A).

$$1 \text{ mA} = 0.001 \text{ A}$$

$$1 \text{ } \mu\text{A} = 0.000001 \text{ A}$$

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CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

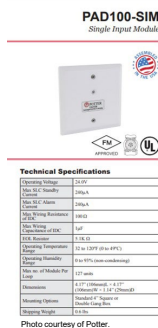
- Water flow devices.
 - Plans show Potter VSR vane-type water flow devices.
 - Current draw.
 - Standby: N/A.
 - Alarm: N/A.
 - Just dry contacts.



5. Water flow devices.
 - a. Plans show Potter VSR vane-type water flow devices.
 - b. Current draw.
 - Standby: N/A.
 - Alarm: N/A.
 - c. Just dry contacts.

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

- Input module.
 - Plans show Potter PAD100-SIM.
 - Current draw.
 - Standby: 240 µA.
 - Alarm: 240 µA.



6. Input module.
 - a. Plans show Potter PAD100-SIM.
 - b. Current draw.

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

Device	QTY	Standby current	Total standby load	Alarm current	Total alarm load
FACU	1	0.105	0.105	0.16	0.16
Smoke detectors	12	0.000059	0.000708	0.15	1.8
Water flow	3	0.00024	0.00072	0.00024	0.00072
Horn/strobes	12	N/A	N/A	0.141	1.69
		Totals			

Loads need to be in A.

1 mA = 0.001 A

1 μA = 0.000001 A

Slide 6-23

- Alarm:

-- Strobe: 75 candela (cd) = 116 mA.

-- Horn: 25 mA.

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

Device	QTY	Standby current	Total standby load	Alarm current	Total alarm load
FACU	1	0.105	0.105	0.16	0.16
Smoke detectors	12	0.000059	0.000708	0.15	1.8
Water flow	3	0.00024	0.00072	0.00024	0.00072
Horn/strobes	12	N/A	N/A	0.141	1.69
		Totals	0.106428		3.65

Loads need to be in A.

1 mA = 0.001 A

1 μA = 0.000001 A

Slide 6-24

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

- Calculating total load.
 - Amp hours (Ah) = current x time (hour).
 - Standby calculation (24 hours).
 - Standby Ah = $0.1064 \times 24 = 2.55$.
 - Alarm calculation (five minutes).
 - $3.65 \times 0.083 = 0.30$.

Slide 6-25

F. Calculating total load.

1. Amp hours (Ah) = current x time (hour).
2. Standby calculation (24 hours).
 $Standby\ Ah = 0.1064 \times 24 = 2.55$.
3. Alarm calculation (five minutes).
 $3.65 \times 0.083 = 0.30$.

CALCULATING BATTERY REQUIREMENTS EXAMPLE (cont'd)

- Battery sizing.
 - Standby + alarm = total.
 - $2.55\ Ah + 0.30\ Ah = 2.85\ Ah$.
 - Correction factor:
 - $2.85\ Ah \times 1.25 = 3.56\ Ah$.
 - Required battery: 3.56 Ah.

Slide 6-26

G. Battery sizing.

1. Standby + alarm = total.
 $2.55\ Ah + 0.30\ Ah = 2.85\ Ah$.

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ACTIVITY 6.1

Battery Backup Calculations

Purpose

Verify and determine the required secondary power using the provided scenarios and calculations.

Directions

1. In your small group, the instructor will assign you a scenario and provide you with calculations to verify and determine the required secondary power.

- a. Scenario 1: high-rise building backup power with an emergency generator.

The FACU has a quiescent load of 2.8 A and a total alarm load of 4.5 A. How many amp hours of battery backup are required?

- b. Scenario 2: low-rise building backup power without an emergency generator.

The FACU has a quiescent load of 1.8 A and a total alarm load of 4 A. How many amp hours of battery backup are required?

- c. Scenario 3: in-building mass notification system backup power.

The FACU has a quiescent load of 2.7 A and a total alarm load of 3.2 A. How many amp hours of battery backup are required?

BATTERY AND VOLTAGE DROP CALCULATIONS

2. Using the Central City High School plans on page F010, verify the battery calculations for the panel assigned.

a. Group 1: Panel 640 (NFS2-640).

b. Group 2: NACP1 (PSE-10).

c. Group 3: NACP2 (PSE-10).

3. Be prepared to share your responses with the larger group.

III. VOLTAGE DROP CALCULATIONS

INTRODUCTION

- Voltage: pressure exerted by a flow of electricity on wiring and circuits.
- Electrical wiring: provides resistance to the flow of voltage.
- Resistance of voltage flow results in a voltage drop.

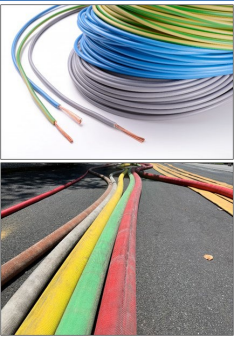


Photo courtesy of iStock. Slide 6-30

- A. Introduction.
1. Voltage is the “pressure” that a flow of electricity exerts on wiring and circuits.
 2. Electrical wiring offers resistance to the flow of voltage in the wire.
 3. The resistance results in a voltage drop in the wiring. This voltage drop has the potential to impede the operation of a fire alarm appliance on the circuit if the voltage drops to a level below the minimum voltage rating of the appliance.

CURRENT CAPACITY OF WIRING

- The voltage drop of a circuit is directly related to the wire size and the current carrying capacity of the wire used.
- Larger conductors have less resistance, and smaller conductors have higher resistance.

Slide 6-31

- B. Current capacity of wiring.
1. The voltage drop of a circuit is directly related to the wire size and the current carrying capacity of the wire used.

CURRENT CAPACITY OF WIRING (cont'd)

- Maximum distance of a circuit, given the current and wire size and using the most conservative end-of-line method.

Slide 6-34

- b. The equation for the maximum distance of a circuit, given the current and wire size and using the most conservative end-of-line method, is as follows:

$$D = \left(\frac{V_{max}}{I} \div R \right) \times 1,000$$

CURRENT CAPACITY OF WIRING (cont'd)

$$D = \left(\frac{V_{max}}{I} \div R \right) \times 1,000$$

or $D = \frac{R1}{R2} \times 1,000$

- **D** = distance.
- **V_{max}** = maximum allowable voltage drop.
- **I** = total current on circuit.
- **R** = maximum resistance/1,000 feet.
- **R1** = maximum resistance in ohms.
- **R2** = wire resistance/1,000 feet.

Slide 6-35

The equation can be simplified as:

$$D = \frac{R1}{R2} \times 1,000$$

- **D** = distance.
- **V_{max}** = maximum allowable voltage drop.
- **I** = total current on circuit.

- R = resistance per 1,000 feet.
- $R1$ = maximum resistance in ohms.
- $R2$ = wire resistance per 1,000 feet.

CURRENT CAPACITY OF WIRING (cont'd)

- Using 14 American Wire Gauge (AWG) conductors based on a minimum voltage of 20.4V at the last device, calculate the voltage drop of a notification appliance circuit loaded at 1 A.

Slide 6-36

- c. Example: Using 1,000 feet of American Wire Gauge (AWG) 14 AWG coated conductors based on a minimum source terminal voltage of 20.4, calculate the voltage drop of a notification appliance circuit (NAC) loaded at 1 A.

Based on the above equation, the maximum distance will be:

- Maximum voltage drop = 20.4 VDC - 16 VDC = 4.4 VDC.
- From NFPA 70[®], *National Electrical Code*[®], Table 8, conductor properties, AWG 14 coated conductors have a resistance of 3.19 ohms per 1,000 feet.

$$D = \left(\frac{V_{max}}{I} \div R \right) \times 1,000$$

- Where:
 - D = distance (length of circuit).
 - V_{max} = maximum allowable voltage drop.
 - R = conductor unit resistance (in ohms) per 1,000 feet.
 - I = load in A.

BATTERY AND VOLTAGE DROP CALCULATIONS

- From NFPA 70, Table 8, we find that for coated AWG 14, R = 3.19 ohms/1,000 feet.

-- $I = 1 \text{ A.}$

- When the battery is at the end of its capacity, the NAC terminal voltage is about 20.4V. When we subtract the 16V minimum operating voltage from 20.4V, we have a maximum voltage drop of 4.4V.

- Plugging values into the equation above:

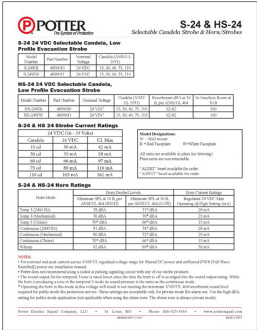
$$D = \left(\frac{4.4}{1} \div 3.19\right) \times 1,000$$

$D = 1,379 \text{ feet (maximum length).}$

- As the circuit load is increased, the circuit resistance will increase. This will necessitate a shorter circuit.
- The calculation in this equation allows for a maximum voltage drop of 3.8V, assuming worst-case conditions (i.e., total load of the circuit at the end of the circuit); therefore, $19.8 - 3.8 = 16V$.
- Audiovisuals are rated to operate at 16-33 VDC; therefore, the circuit will still operate at the end of useful battery life.

SOURCES AND LOADS

Power supplies for most commercial fire alarm systems use filtered, regulated 24 volts of direct current (VDC).



POTTER S-24 & HS-24
Substation Guide
Substation Guide

S-24 & HS-24 Substation Guide, Low Profile Excitation Station

Excitation Station	Excitation Voltage	Excitation Current	Excitation Power	Excitation Resistance
S-24	24 VDC	0.5 A	1.2 W	48 Ω
HS-24	24 VDC	0.5 A	1.2 W	48 Ω

S-24 & HS-24 Substation Guide, Low Profile Excitation Station

Excitation Station	Excitation Voltage	Excitation Current	Excitation Power	Excitation Resistance
S-24	24 VDC	0.5 A	1.2 W	48 Ω
HS-24	24 VDC	0.5 A	1.2 W	48 Ω

S-24 & HS-24 Substation Current Ratings

Excitation Station	Excitation Voltage	Excitation Current	Excitation Power	Excitation Resistance
S-24	24 VDC	0.5 A	1.2 W	48 Ω
HS-24	24 VDC	0.5 A	1.2 W	48 Ω

S-24 & HS-24 Wire Ratings

Wire Size	Wire Length	Wire Resistance	Wire Voltage Drop	Wire Power Loss
14 AWG	1000 ft	3.19 Ω	0.12 V	0.06 W
12 AWG	1000 ft	1.98 Ω	0.07 V	0.04 W
10 AWG	1000 ft	1.22 Ω	0.04 V	0.02 W
8 AWG	1000 ft	0.76 Ω	0.03 V	0.01 W

Photo courtesy of Potter. Slide 6-37

C. Sources and loads.

1. Power supplies for most commercial fire alarm systems use filtered, regulated 24 VDC, as opposed to unfiltered, full-wave rectified (FWR) power.
2. Due to the efficiency of a regulated power supply, the current draw of connected devices is less than that for FWR power supplies, as clearly shown on the data sheets for notification appliances.

DEVICE-SPECIFIC REQUIREMENT

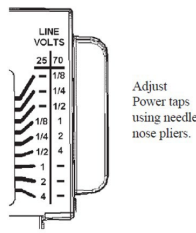
- Loudspeaker voltage drop calculations are similar, with each tap setting of the loudspeaker converted to current.

Slide 6-38

DEVICE-SPECIFIC REQUIREMENT (cont'd)

Power Tap Selection

Speaker dBA @ 10 ft.		
Input Watts	25 Volts	70.7 Volts
1/8	74.6 dBA	73.7 dBA
1/4	77.7 dBA	76.7 dBA
1/2	80.5 dBA	79.6 dBA
1	83.1 dBA	82.5 dBA
2	85.6 dBA	85.4 dBA
4	87.9 dBA	87.9 dBA



Photos courtesy of Potter.

Slide 6-39

- D. Device-specific requirement.
1. Loudspeaker voltage drop calculations are similar, with each tap setting of the loudspeaker converted to current.

The same Ohm's law and maximum distance equations apply.
 2. Resources for calculation.

- a. Devices, their cut sheets, and setting in wattage that was selected to match the decibels as part of the audibility design.
- b. Manufacturers' tools (e.g., spreadsheets) that are available to help verify calculations.
 - Example calculation tool: Eaton Circuit Calculator (<https://www.eaton.com/content/dam/eaton/products/safety-security-emergency-communications/lsmns/wheelock/info/lsmns-wheelock-speaker-tool.zip>).

METHODS OF CALCULATION

- Three types:
 - Point-to-point.
 - End-of-line.
 - Load-centering.

Slide 6-40

- E. Methods of calculation.
 - 1. Three types:

METHODS OF CALCULATION (cont'd)

- Point-to-point.

Device	0.2	0.2	0.2	0.2	0.2
Current	amps	amps	amps	amps	amps

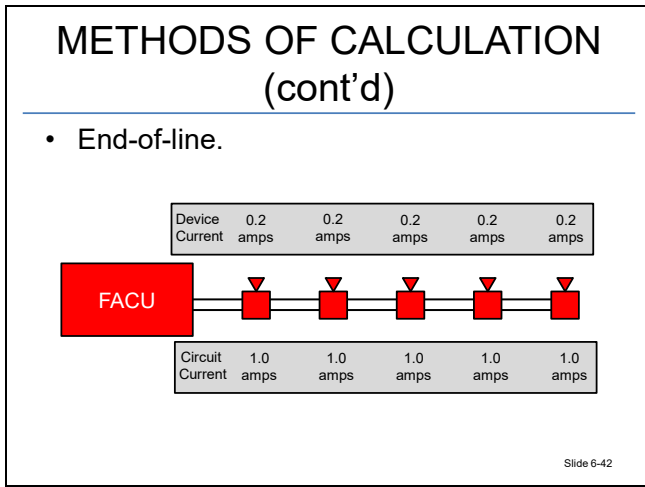
FACU

Circuit	1.0	0.8	0.6	0.4	0.2
Current	amps	amps	amps	amps	amps

Slide 6-41

- a. Point-to-point method.

- If each of the horn/strobe devices has a 200 mA draw or 0.2 A, that load is added to the circuit wiring calculation where it occurs. Therefore, as we add devices, we add their current to the system.
- This is a much more precise method of calculating voltage drop than the end-of-line method, but the distances between each device need to be known. Since voltage drop calculation is step by step, the voltage at each device is more accurate.



b. End-of-line method.

- Instead of adding the current draw for each device where it occurs, the total load of all devices is added at the most remote point of the circuit, and that total load is calculated through the length of the entire circuit.
- This is a more conservative method of calculation since the whole current is added at the end of the line rather than specifically where it occurs in the system, and the voltage drop is calculated on that total load for the entire length of the circuit. The realistic voltage at each device will not be known. However, if the voltage at the last device is above the minimum required (16 VDC in a 24 VDC system), then all other devices closer to the power source will function as intended.

c. Load-centering method.

- The load-centering method is similar to the end-of-line method, with the entire load of the circuit being added in one place. However, unlike the end-of-line method, the entire load is added at the end of the circuit for the most conservative approach.
- For the load-centering method, the load is added at the midpoint of the circuit, so the first half has no load to calculate. The last half has the whole load and simulates an average of an even dispersion of devices on the circuit.

METHODS OF CALCULATION (cont'd)

- All calculations can be done using Excel or a similar program.

		Point to Point Method			End of Line Method			Load Centering Method		
		CIRCUIT IS WITHIN LIMITS			CIRCUIT IS WITHIN LIMITS			CIRCUIT IS WITHIN LIMITS		
		Totals		Voltage	Totals		Voltage	Totals		Voltage
		Current	Distance	Drop	Current	Distance	Drop	Current	Distance	Drop
Project Name										
Date										
Circuit Number										
Area Covered										
Normal System Voltage	20.4	0.656	1075	2.15	0.656	1075	4.330	0.656	1075	2.165
Minimum Device Voltage	16				End of Line Voltage	18.25	End of Line Voltage	18.07	End of Line Voltage	18.24
Total Circuit Current	0.656	Wire	Ohm's		Percent Drop	10.52%	Percent Drop	21.23%	Percent Drop	10.61%
Distance from source to 1st device	14	Gauge	Per 1000		use only the wire gauge for the first device to source					
Wire Gauge for balance of circuit	14		3.07		Standard Wire Resistance in Ohms per 1000 feet					
Enter current in amps					18-14 Awg = Solid Conductors	16-4 Awg = Solid Conductors	12-10 Awg = Stranded Conductors			
150 = 150 ma										
Device Number	Device Current	from device	At Device	Drop from source	Percent Drop	Notes:				
Device 1	0.041	25	20.38	0.101	0.49%	Wire resistance is doubled in the calculations for two wires (Positive and Negative)				
Device 2	0.041	50	20.11	0.290	1.42%	The voltage calculated to the last device in any method must not be lower than the manufactures listed minimum operating voltage (IE. rated operating voltage 20-32 VDC).				
Device 3	0.041	50	19.93	0.466	2.28%	Device Manufacturer		Device Manufacturer		
Device 4	0.041	25	19.89	0.548	2.80%	Current @/Strand		Current @/Strand		
Device 5	0.041	100	19.55	0.850	4.16%	Strobe Only		Strobe Only		
Device 6	0.041	100	19.27	1.127	5.52%	Model #	Candela	Model #	Candela	Current @/Strand Voltage

Photo courtesy of Andrew Roe.

Slide 6-43

2. All the calculations are done using Excel spreadsheets or some similar program, so this information is provided so that you may understand how to check at least one of the calculations to ensure that the program is functioning properly.

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ACTIVITY 6.2

Verify Voltage Drop Calculations

Purpose

Analyze the voltage drop to determine if devices will function correctly using the sample circuit provided.

Directions

1. In your small group, the instructor will assign each group a scenario and a related sample circuit.
2. Using the sample circuit, analyze the voltage drop to determine if devices will function correctly.

Audiovisual circuit voltage drop calculation: The wire gauge is 14 (resistance - 5.2) and draws .022 A. What is the maximum number of 15 cd strobe devices allowed on a 1.5 A NAC that is 300 feet in length?

3. Using the Central City High School plans on page F012, verify the voltage drop for the circuit assigned.
 - a. Group 1: NACP1 N3.

- b. Group 2: NACP1 N4.


c. Group 3: NACP1 N5.

d. Group 4: NACP2 N1.

e. Group 5: NACP2 N2.

4. Be prepared to share your responses with the larger group.

IV. SUMMARY



SUMMARY

- Battery calculations.
- Battery calculations walk-through.
- Voltage drop calculations.

Slide 6-45

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APPENDIX

NOTIFICATION APPLIANCE CIRCUIT CALCULATOR

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NOTIFICATION APPLIANCE CIRCUIT CALCULATOR

This calculator provides voltage drop calculations in three formats (Point to Point, End of Line, and Load Centering).
 Make sure that you know what method is accepted by, and the results do not exceed the limits set by the respective jurisdiction

Project Name		#NAME?		#NAME?		#NAME?	
Date		#NAME?		#NAME?		#NAME?	
Circuit Number		#NAME?		#NAME?		#NAME?	
Area Covered		#NAME?		#NAME?		#NAME?	
Nominal System Voltage		20.4		#NAME?		#NAME?	
Minimum Device Voltage		16		#NAME?		#NAME?	
Total Circuit Current		#NAME?		#NAME?		#NAME?	
Distance from source to 1st device		Gauge		Ohm's		Per 1000	
Wire Gauge for balance of circuit		14		3.07		3.07	
Enter current in amps.		14		3.07		3.07	

Standard Wire Resistance in Ohms per 1000 feet.
 18=7.77 16=4.89 14=3.07 12=1.98 10=1.24
 18-14 Avg = Solid Conductors 12-10 Avg = Stranded Conductors

Device Number	Device Current	Distance from previous device	Voltage Drop from source		Percent Drop
			At Device	Drop	
Device 1	0.041	25	#NAME?	#NAME?	#NAME?
Device 2	0.041	50	#NAME?	#NAME?	#NAME?
Device 3	0.041	50	#NAME?	#NAME?	#NAME?
Device 4	0.041	25	#NAME?	#NAME?	#NAME?
Device 5	0.041	100	#NAME?	#NAME?	#NAME?
Device 6	0.041	100	#NAME?	#NAME?	#NAME?
Device 7	0.041	50	#NAME?	#NAME?	#NAME?
Device 8	0.041	100	#NAME?	#NAME?	#NAME?
Device 9	0.041	50	#NAME?	#NAME?	#NAME?
Device 10	0.041	100	#NAME?	#NAME?	#NAME?
Device 11	0.041	50	#NAME?	#NAME?	#NAME?
Device 12	0.041	100	#NAME?	#NAME?	#NAME?
Device 13	0.041	50	#NAME?	#NAME?	#NAME?
Device 14	0.041	100	#NAME?	#NAME?	#NAME?
Device 15	0.041	100	#NAME?	#NAME?	#NAME?
Device 16	0.041	50	#NAME?	#NAME?	#NAME?
#NAME?	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
END	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
END	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
END	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Totals	#NAME?	1075	End of Line Voltage	#NAME?	#NAME?

Notes:
 Wire resistance is doubled in the calculations for two wires (Positive and Negative)
 The voltage calculated to the last device in any method must not be lower than the manufacturer's listed minimum operating voltage (IE: rated operating voltage 20-32 VDC).

Device Manufacturer		Current @ Rated Voltage	
Strobe Only	Model #	Candela	

Device Manufacturer		Current @ Rated Voltage	
Horn Strobes	Model #	Candela	

Device Manufacturer		Current @ Rated Voltage	
Strobe Only	Model #	Candela	

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UNIT 7: DEFICIENCY LETTER

TERMINAL OBJECTIVE

The students will be able to:


- 7.1 *Verify that fire alarm system plans comply with nationally recognized standards, given fire alarm shop drawings.*


ENABLING OBJECTIVE

The students will be able to:

- 7.1 *Apply knowledge gained from previous units to prepare a response to the submitter of the plan set, identifying deficiencies in the submittal.*
-

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 **FEMA**

 U.S. Fire Administration

**UNIT 7:
DEFICIENCY LETTER**

Slide 7-1

TERMINAL OBJECTIVE

Verify that fire alarm system plans comply with nationally recognized standards, given fire alarm shop drawings.

Slide 7-2

ENABLING OBJECTIVE

Apply knowledge gained from previous units to prepare a response to the submitter of the plan set, identifying deficiencies in the submittal.

Slide 7-3

I. DEFICIENCY LETTER

WHAT TO INCLUDE

- What to identify.
 - Sender, receiver and project information.
 - Insufficient information.
 - Imprecise presentation that requires clarification.
 - Noncompliance with codes/standards.

Slide 7-4

A. What to include.

1. What to identify.

- a. Sender, receiver and project information.
- b. Insufficient information or details needed in the submittal.
- c. Imprecise presentation that may lead to confusion or misunderstanding.
- d. Noncompliance with codes or standards.

WHAT TO INCLUDE (cont'd)

- How to identify.
 - Include location.
 - State what is missing, deficient or needs clarification/correction.
 - State the correct condition.
 - Reference relevant codes/standards.
 - Indicate action or response expected.

Slide 7-5

2. How to identify.

- a. Include the location of the condition identified (sheet/drawing number, grid coordinates, room number, etc.).

- b. Clearly state what is missing, deficient, or needs clarification or correction.
- c. State the correct condition required.
- d. Reference the relevant code or standard, including the edition and applicable section.
- e. Indicate the action or response expected, such as “Resubmit revised plans with changes highlighted,” or “Provide further details on...”

WHAT NOT TO INCLUDE

- Vague information.
- Opinions or recommendations not based on codes/standards.
- Suggestions of technical solutions or design changes.

Slide 7-6

- B. What not to include.
 - 1. Vague information.
 - 2. Opinions or recommendations that are not based on legally adopted codes and standards applicable to the project.
 - 3. Suggestions or provision of technical solutions or design changes.

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ACTIVITY 7.1

Writing the Deficiency Letter

Purpose

Prepare a written deficiency letter to the designer stating issues of concern and appropriate code sections.

Directions

1. Individually, review the submittal for the Central City High School project and prepare a deficiency letter to the designer.
2. Use the following considerations to understand what is in the submittal and whether the notification device layout is code compliant:

- a. Is the scope of work clear?

- b. Should incomplete submittals be returned asking for the missing information?

- c. What are the pathway class and survivability designations for installing these notification devices?

DEFICIENCY LETTER

d. Verify the audible notification device layout.

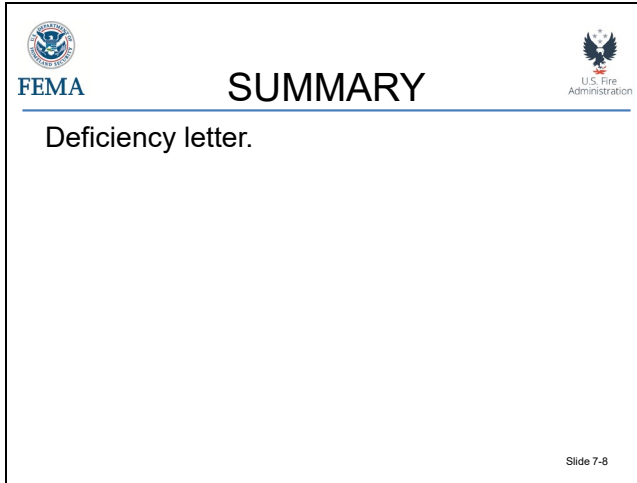
e. Verify the smoke detection device layout.

f. Verify the visual notification device layout.

g. Confirm voltage drop calculations for audiovisual devices.

3. Be prepared to share your responses with the larger group.

II. SUMMARY



III. FINAL EXAM AND COURSE WRAP-UP

- A. Final exam.
 - 1. The final exam is a comprehensive assessment based on the information presented during the class.
 - 2. You will have one hour to complete the exam.
- B. Course wrap-up.

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APPENDIX A

SAMPLE DEFICIENCY LETTER TEMPLATE

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SAMPLE DEFICIENCY LETTER TEMPLATE

[Date]

To: [Name of the designer or point of contact (POC), if available]
[Name of the organization, if available]
[Address of the POC or organization, if available]

From: [Name of the reviewer]
[Name of the organization]
[Address of the reviewer organization or reviewer]

Re: [Name of the project or building]

Dear [Name of the designer or POC, or "To whom it may concern"],

All projects are reviewed under the requirements outlined in the [relevant region or authority having jurisdiction] building code. The following observations require corrections per the described sections of the building code.

1. [Sheet/drawing number, location of the building] — [Description of the deficiency],
[Relevant section of a code or standard and its edition]
2. [Sheet/drawing number, location of the building] — [Description of the deficiency],
[Relevant section of a code or standard and its edition]
3. [Sheet/drawing number, location of the building] — [Description of the deficiency],
[Relevant section of a code or standard and its edition]

Please resubmit the revised plans by [date]. A written response letter must accompany plan revisions.

Please contact the plans examiner for any clarification of the comments.

Regards,
[Name of the reviewer]

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APPENDIX B

SAMPLE DEFICIENCY LETTER

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SAMPLE DEFICIENCY LETTER

[Name of the reviewer]
National Fire Academy
Plans Review of Fire Alarm Systems
16825 S Seton Ave.
Emmitsburg, MD 21727

[Date]

Partners in Design Architects
600 52nd St., Ste. 220
Kenosha, WI 53140

Alfred Benesch & Company
4633 Washington Rd.
Kenosha, WI 53144

Subject: Canterbury Home of Kenosha Building Permit

Dear Applicant,

Your plans for the building permit referenced above are in the process of being reviewed. Unfortunately, the review cannot be completed until we receive all the information relevant to the project as proposed. This letter reflects only those items that are necessary to continue the Building and Fire Code reviews and does not contain the findings of the review or note the corrections that may be necessary once the review is completed, nor does it address any needs of any other city division or department.

Please review the following comments, and then follow the resubmittal directions. The code references in the following comments refer to the 2015 editions of the International Building Code (IBC), International Fire Code (IFC) and International Mechanical Code (IMC), unless otherwise noted.

1. The code referenced in the project title block is not adopted in this jurisdiction. Please change any code references to the codes in effect at this time (IBC 101.2).
2. The building plans are required to be designed by an architect or engineer licensed by the state, and the professional designer is required to stamp and sign the plans (IBC 107.1).
3. The civil drawings are required to be prepared by a surveyor or civil engineer licensed in the state. Please provide civil drawings that have been designed, stamped and signed by a surveyor or civil engineer licensed by the state (IBC 107.1).
4. Sheet C1 shows a different configuration of the parking lot from sheets C2 and C3. Please clarify (IBC 107.2.5).

DEFICIENCY LETTER

5. Sheet A5 indicates the wall details are for Computer Technologies, Inc. Please provide the wall details for the Canterbury Home or change the project information as appropriate.
6. Apparatus access is required to be provided within 150 feet of any portion of the building. Please provide details on the site plan to indicate if the location of the apparatus access is from the street or from the parking lot (IFC 503.1.1).
7. Please provide water supply data prepared by the water department. A fire flow test is to be performed and the data verified by the water department. Water supply shall be adequate to supply fire flow and fire sprinkler system (IFC 507.1).
8. The trash enclosure is shown in different sizes and in different locations and configurations on the site plans. Please show the final size, configuration and location of the trash enclosure on each side of the sheets showing a site plan (IBC 107.2.5).
9. Please change the information block on the Title Sheet to show Type VA construction as provided in the code analysis letter (IBC 602.1).
10. Please provide a fire-resistance rating of at least one hour for the exterior wall protection due to fire separation distance on the West wall. The wall shall have sufficient details to be determined in accordance with the test procedures set forth in ASTM E119, Underwriters Laboratories (UL) 263, or in accordance with Section 703.3 (IBC 703.2).
11. Please provide construction details in adequate detail to show that the building will comply with Type VA construction, including one-hour fire-resistance-rated assemblies for the exterior bearing walls, interior bearing walls, primary structural frame and secondary members (IBC Table 601).
12. The corridor is required to be constructed with fire-resistance-rated construction of at least one hour per the classification of the occupancy as a Group I-1. Please provide details of fire-resistance-rated construction that is determined in accordance with the code provisions of IBC Section 703 (IBC 1020.1).
13. Please provide the specifications for the vinyl wall covering to be used in the main living area according to the Room Finish Schedule on Sheet A3 (IBC 803.1).
14. The legend on Sheet E1 indicates that the shaded side of the symbol for an exit sign is the side that will indicate "Exit." Some of the exit symbols on Sheet E2 are indicating an incorrect orientation of the exit sign. Please revise the drawings so that the exit signs will be installed in the proper orientation (IBC 1013.1).
15. Please include the layout of the cooking appliances in the kitchen, including the type and fuel supply (IMC 106.3.1).

DEFICIENCY LETTER

16. Group I occupancies are required to be provided with an automatic fire sprinkler system installed in accordance with IBC Section 903.3.1.1. The sleeping rooms are required to be provided with quick-response sprinkler heads. Please provide the details for the fire sprinkler system for review (IBC 420.5, 903.2.6, 903.3.2).
17. Portable fire extinguishers shall be provided within 30 feet of commercial-type cooking equipment. Cooking equipment involving solid fuels or vegetable or animal oils and fats shall be protected by a Class K-rated portable extinguisher in accordance with Section 904.12.5.1 or 904.12.5.2, as applicable. Please provide details of the type of cooking that will occur and the type of fire extinguisher that will be installed (IFC 904.12.5).

Please make the required corrections and/or clarifications and submit two sets of the revised sheets. Please be sure to reference the building permit number to identify the file to which all resubmitted documents belong.

If you have any questions or comments regarding this review, please contact me by email at [email address] or by telephone at [phone number].

Sincerely,
[Name of the reviewer]

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ACRONYMS

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ACRONYMS

AC	alternating current
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
ADS	acoustically distinguishable space
AFF	above finished floor
AHJ	authority having jurisdiction
AHU	air handling unit
AIM	addressable input module
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASSD	air sampling smoke detector
AWG	American Wire Gauge
CIS	common intelligibility scale
CMS	Centers for Medicare & Medicaid Services
DACT	digital alarm communicator transmitter
DC	direct current
ECS	Emergency Communications System
ELSS	engineered life safety system
ESS	energy storage systems
EVAC	emergency voice alarm communication
FACP	fire alarm control panel
FACU	fire alarm control unit

FEMA	Federal Emergency Management Agency
FPL	Fire Power Limited
FPLP	Fire Power Limited Plenum
FPLR	Fire Power Limited Riser
FWR	full-wave rectified
HHS	U.S. Department of Health and Human Services
HPLA	high-power loudspeaker array
HVAC	heating, ventilating and air conditioning
HVLD	high-volume, large-diameter
HVLS	high-volume, low-speed
IBC	International Building Code
ICC	International Code Council
IDC	initiating device circuit
IFC	International Fire Code
IMC	International Mechanical Code
I/O	input/output
LED	light-emitting diode
MC	metal clad
NAC	notification appliance circuit
NEC	National Electrical Code
NETC	National Emergency Training Center
NFA	National Fire Academy
NFPA	National Fire Protection Association

NM	non-metallic
NRTL	nationally recognized testing laboratory
OS&Y	outside stem and yoke
POC	point of contact
PRFAS	“Plans Review of Fire Alarm Systems”
RTI	response time index
RTS	remote alarm indicator and test switch
RTU	remote terminal unit
SAW	Student Activity Worksheet
SFPE	Society of Fire Protection Engineers
SLC	signaling line circuit
SM	Student Manual
THHN	thermoplastic high heat-resistant, nylon coated
UL	Underwriters Laboratories
ULC	UL Solutions of Canada
UPS	uninterruptable power supply
VAC	volts of alternating current
VDC	volts of direct current

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