Solving the Fire Alarm Problem:

Design and Commissioning of Fire Detection and Alarm Systems

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Safety Design in Buildings

Jeddah Conference

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Course Description

In the design and commissioning of fire alarm and detection system installations in the built environment, consideration of fundamental concepts is required to avoid nuisance alarms, yet maintain accurate notification in the event of an emergency. This presentation details critical aspects of design and installation of fire alarm systems to avoid nuisance alarms and other pitfalls in selected occupancies such as assembly, residential and high-rise facilities.

Presenter

Shamim Rashid-Sumar

Director of Business Development – Middle East, Aon Fire Protection

Shamim has over 13 years of experience in building and fire code consulting, fire dynamics, timed egress modeling, and performance based design. Since graduating with a B.S. in Fire Protection Engineering from the University of Maryland, she has performed fire protection evaluations, prepared fire and life safety strategies and design specifications, fire alarm system design, and other engineering analyses and studies.

As a registered professional engineer, she has worked on a multitude of projects including government facilities, hospitals and medical centers, airport terminals, museums, high-rise buildings, hotels, shopping malls, and many more.

Shamim was instrumental in establishing and currently serves as President of the UAE International Chapter of the Society of Fire Protection Engineers (SFPE). She is also an NFPA 101 International Instructor and a member of the UAE Code Committee.

Learning Objectives

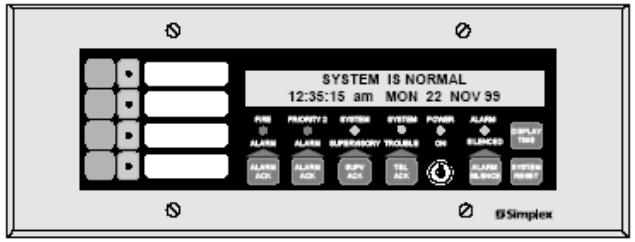
1. *Review fire safety concepts associated with fire alarm systems*
2. *Review key components of fire alarm systems*
3. *Investigate design strategies to avoid nuisance alarms*
4. *Understand the impact of proper installation, inspection and testing on avoiding nuisance alarms*

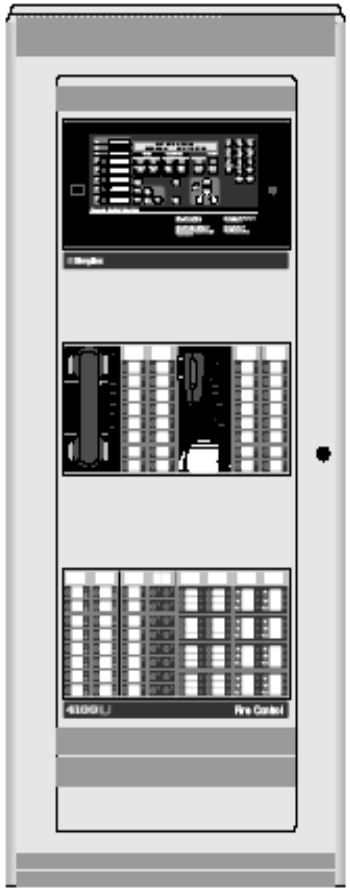
The purpose of this presentation is to convey technical knowledge to the conference participants.

The presentation also contains slides with text that summarises the content of the presentation and the main learning objectives.

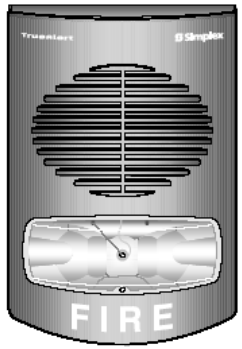
These may be used to update CPD records for relevant organisations including the Chartered Institute of Buildings (CIOB).

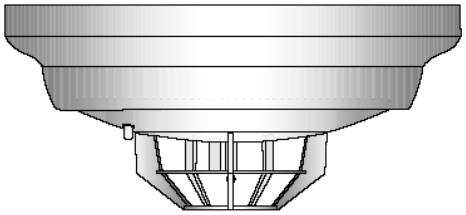
Overview

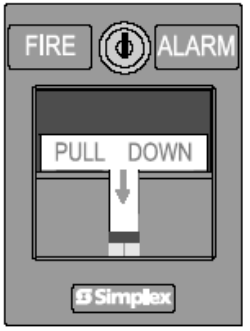




- Review of Fire Safety Concepts
- Fire Alarm System & How it Works
  - Definition of a Fire Alarm System
  - Lifespan
  - How does it work
  - Components of Fire Alarm System
- Primary Design Drivers
  - Codes
  - Standards
- False or Nuisance Alarms
  - Design
  - Installation
  - Testing, Inspection and Maintenance
- Summary







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Fire Safety Concepts Tree – NFPA 550

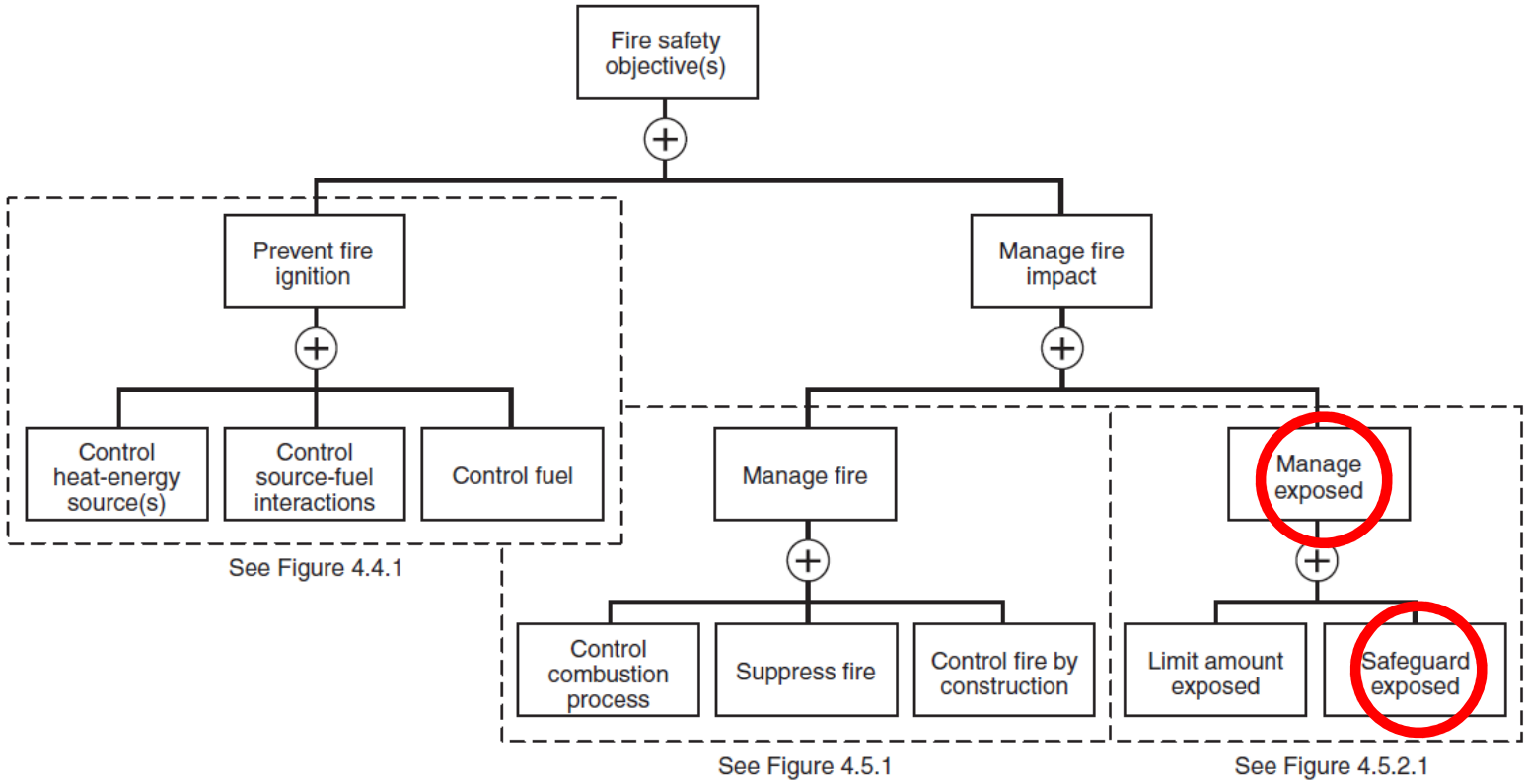

FIGURE 4.3 Top Gates of the Fire Safety Concepts Tree with Selected Lower-Tiered Gates.

Fire Safety Concepts Tree – NFPA 550

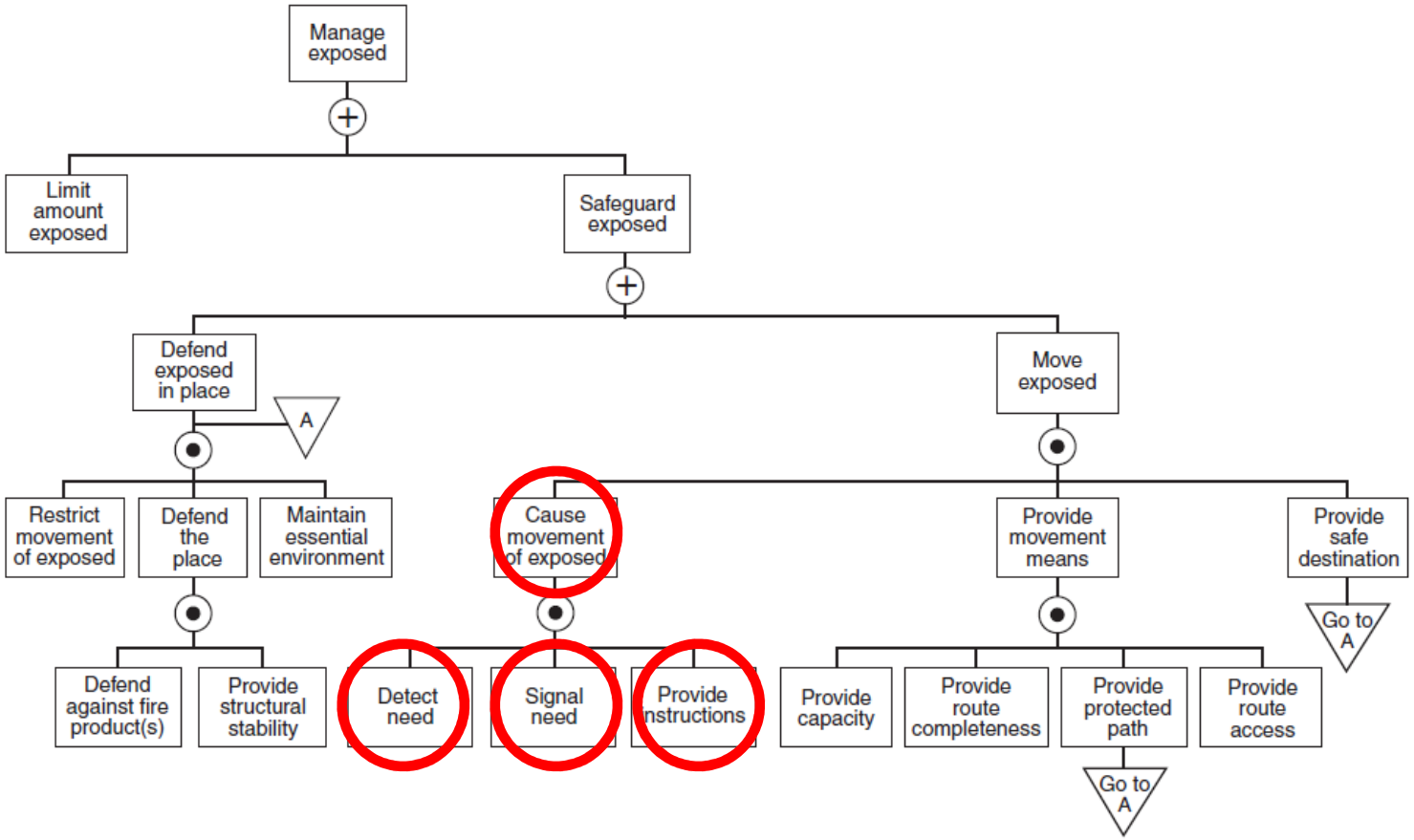

FIGURE 4.5.2.1 "Manage Exposed" Branch of Fire Safety Concepts Tree.

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What is a Fire Alarm System?

- Definition
  - A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signaling-initiating devices and to initiate the appropriate response to those signals. NFPA 72-2013 Edition

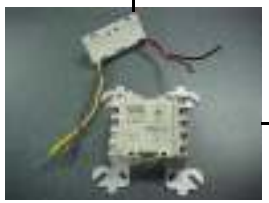
- Fire Alarm System Life Span
  - Commercial fire systems are generally upgraded about every 15 years, with replacement every 25 years due obsolete equipment and a facility's growth or change.

  - Today the modern fire alarm system acts as the central hub for monitoring many building and life safety systems required by the code.
    - Why? Because the system wiring is supervised.

How Does It Work?

- Input devices signal panels & auxiliary devices initiating output devices or actions
- Fire alarm Control Panel (FACP)
- Input devices
- Output devices
- Wiring considerations
- Fire alarm control panel

Input or initiation Devices



Auxiliary Devices

Output devices

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Fire Alarm System Components – Inputs and Outputs

- INPUT DEVICES DETECT AND PROVIDE CHANGE OF STATE INFORMATION BACK TO THE PANEL
  - Smoke
  - Smoke Duct
  - Heat
  - Various Gas & Flame
  - AND
  - Manual Activation - Pull Station
  - Monitor Modules

- MONITORING FUNCTIONS
  - Waterflow Switches
  - Valve Tamper Switches
  - Kitchen Hood Systems
  - Special Suppression Panels
  - (Clean Agent, Vesda,
  - Pre-action systems)








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Fire Alarm System Components – Inputs and Outputs

- OUTPUT DEVICES COMMUNCIATE
  - Horn, Horn/strobes, speakers, chimes, speaker/strobes, bells, chimes,
  - exterior loud speakers

- OR COMMAND
  - Close, Unlock
- Turn off, Turn on

- Elevator recall
- Door release
- Fan control
- Smoke control

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Fire Alarm Drivers – Codes & Standards

- The Code provides the requirement of when something is necessary and the Standard outlines the specific details relating to where and how.

- The IBC Sections 101.2 and 101.4.6 states that the IBC addresses fire prevention in regard to *construction and design* and the fire code addresses fire prevention in regard to the *operation of a completed and occupied building*.

NFPA Official Definitions

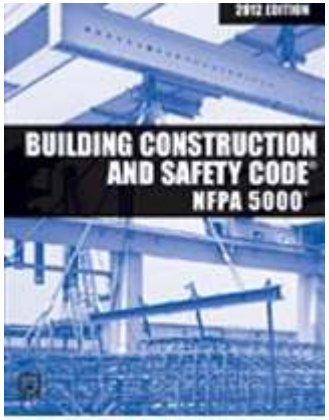
- 3.2.3* Code. An extensive compilation of provisions covering broad subject matter that is suitable for adoption into law independently of other codes and standards.
  International Building Code (IBC), International Fire Code (IFC), NFPA 1, NFPA 101, NEC (or commonly known as NFPA 70) and Local Amendments

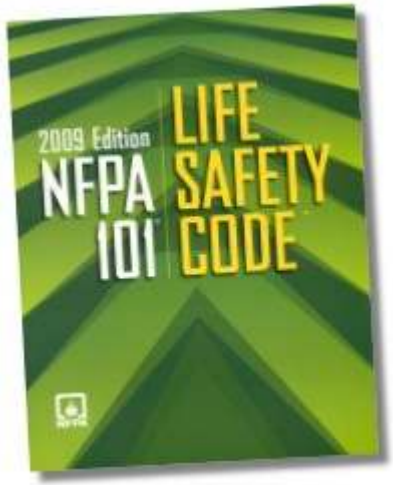
- 3.2.10 Standard. A document which contains only mandatory provisions to indicate requirements and which is in a form generally suitable for mandatory reference. Non-mandatory provisions are located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.
  NFPA 72, NFPA 13, NFPA 90A & B,

Primary Design Drivers - Codes

- The Adopted Building Code or Building Code of Record
  - (IBC, NFPA 101, NFPA 5000, GCC Code)
- The Adopted Fire Code or Fire Code of Record

  (IFC, NFPA 1)
- Local Amendments





Primary Design Drivers - Standards

The Adopted Standards or Standards of Record

- NFPA 72 - National Fire Alarm Code or National Fire Alarm & Signaling Code
  - NFPA 90A - Installation of Air Conditioning and Ventilating Systems
  - UL Standard 268 - Smoke Detectors for Fire Protective Signaling Systems
  - UL Standard 268A - Smoke Detectors for Duct Application
  - UL Standard 1971 - Signaling Applications for the Hearing-Impaired, Americans with Disabilities Act (ADA),
  - American National Standards Institute (ANSI) A117.1,
  - American Society of Mechanical Engineers (ASME) A17.1,
  - NFPA 92 - Smoke Control Systems

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False or Nuisance Alarms which Impair System Operations

The 3 main reasons for false or nuisance alarms:

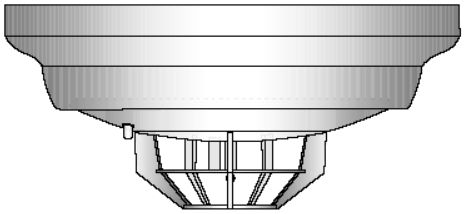
1. Improper Design
2. Poor Installation
3. Poor Testing, Inspection, and Maintenance

False or Nuisance Alarms which Impair System Operations

1. **Improper Design**.
   - The fire alarm system needs to take into consideration placement of devices particularly smoke detection in relationship to :
     - Ceiling elevations
     - Locations of diffusers and ceiling fans, 3ft (1m)
     - Rooms with high CFM airflows, and air velocity greater than 300 ft/min (1.5 m/sec)
     - Doors leading to the exterior
     - Spacing considerations as defined by NFPA 72
     - Temperature above 100°F (38°C)
     - Relative humidity above 93 percent
     - Auxiliary interfaces such as
       - Dampers, door closure equipment,
       - Suppression systems
       - Smoke control systems
     - Guestroom Smoke Alarms
     - Stratification
     - Consideration of Environment – condition space, high dust space, etc…

Detection – Other Considerations

- *Smoke Detection vs. Heat Detection.* Smoke detection likely not appropriate for kitchens, mechanical rooms, or dusty/ humid/ outdoor environments.
- *Supervisory Signals.* Not all initiating devices cause alarm , e.g. duct smoke detectors, fire pump running, smoke detector missing, etc.



Fire Alarm Interfaces – Cause and Effect Matrix (NFPA 72)

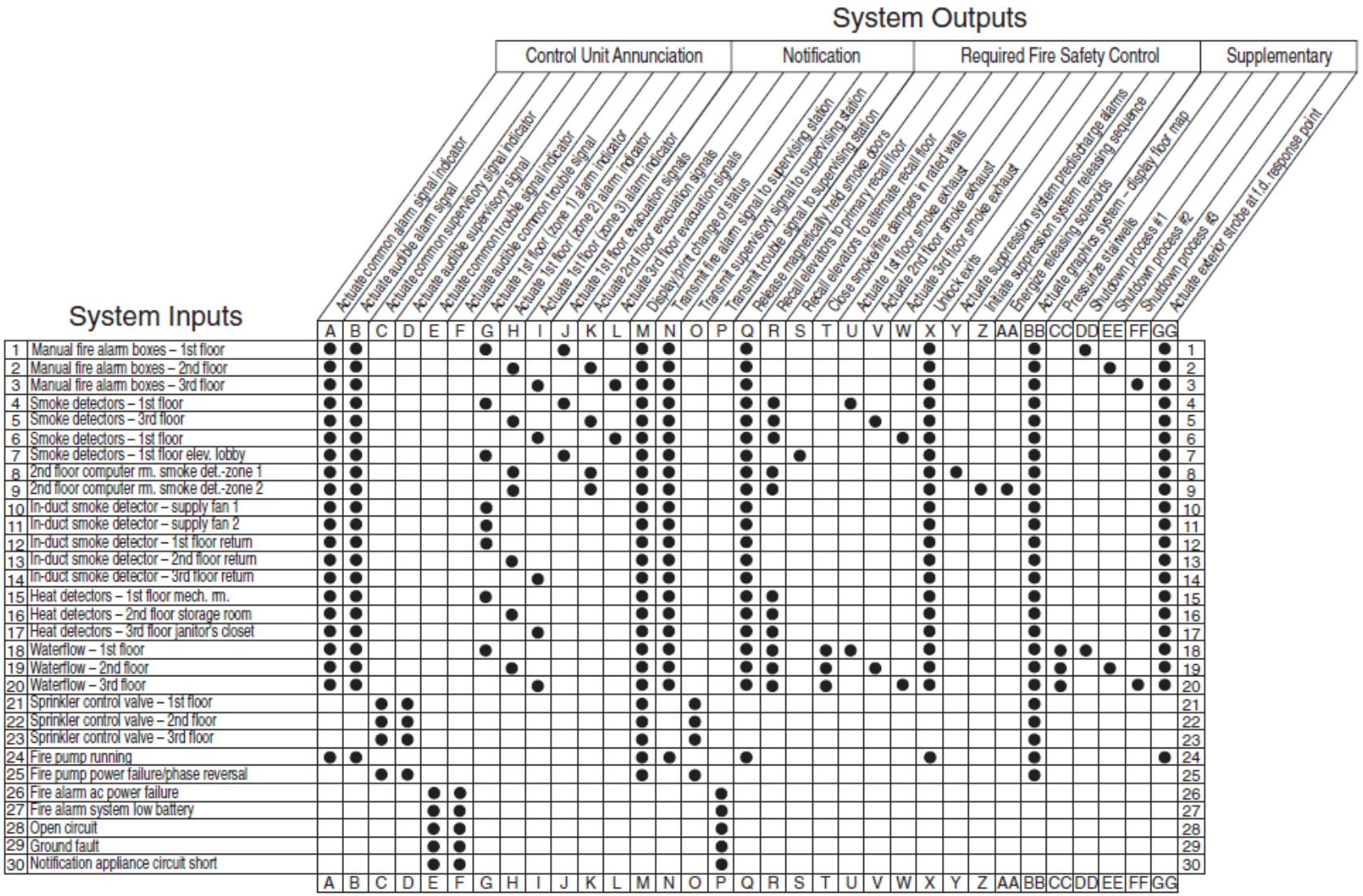


FIGURE A.14.6.2.4 Typical Input/Output Matrix.

Design Strategies for Avoiding False Alarms (NFPA 72)

Positive Alarm Sequence

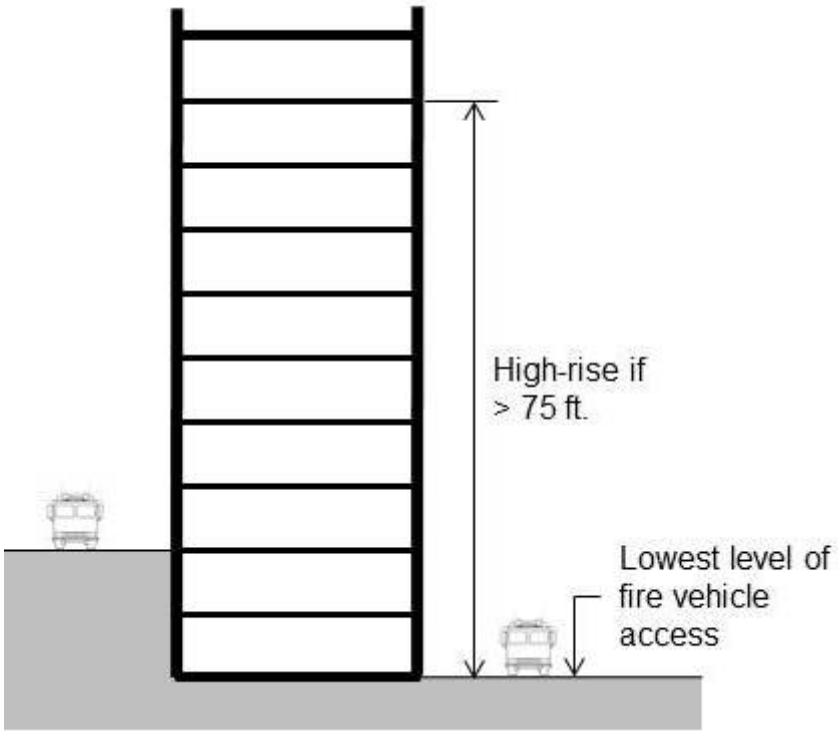
- Smoke detector activation followed by 15 second acknowledgement period.
- After acknowledgement, staff have 180 seconds to investigate and confirm fire conditions.
- After 180 seconds, fire alarm panel sounds alarm signal.
- If a second detector or an automatic sprinkler activates at any point in the interim, the fire alarm panel sounds alarm signal.

Alarm Verification

- Smoke detector activation followed by period of 1 minute where the panel checks to see if the smoke condition is still present. If at 1 minute smoke is still present at the detector, the fire alarm panel sounds an alarm signal.
- If a second detector or an automatic sprinkler activates at any point in the interim, the fire alarm panel sounds alarm signal.

Selective Evacuation

- *Alarm to the floor or zone of fire origin, floor above and floor below. Alert to adjacent zones.*



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False or Nuisance Alarms which Impair System Operations – Cont'd

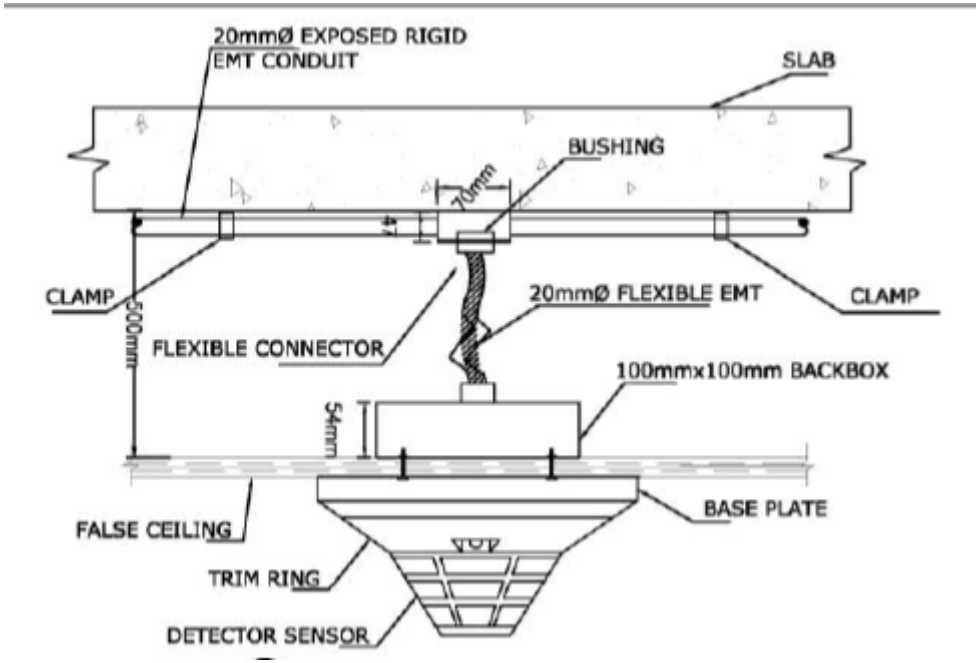
2. **Poor Installations**

- Failure to install backboxes
  - Fire alarm wiring issues:
    - Failure to secure wiring properly above false ceilings
    - Failure to ground properly
    - Failure to clear all grounds from the system prior to testing
    - Failure to secure wiring around terminal blocks
    - Equipment placement
    - Failure to place control equipment within 3 ft (1m) of control wiring

  - Device installation issues:
    - Failure to install intermediate dry contacts (fire alarm contacts 500 mAmps)
    - Failure to keep the devices clean until construction and cleanup is completed.
    - Failure to preform a Sensitivity/Dirty detector Report after commissioning
    - Failure to properly program and label devices

Speaker without backbox

Smoke detector without backbox



False or Nuisance Alarms which Impair System Operations – Cont'd

3. **Poor Test, Inspection, and Maintenance**
   - Testing with the wrong tools
     - Smoke detectors and heat detectors need to be tested with canned smoke and proper heat tools.
     - Testing systems with ground faults
     - Failure to perform functional testing
     - Failure to check a sensitivity or dirty detector report upon completion of testing
     - Failure to inspect annually
     - Bypassing equipment during testing
     - Failure to confirm proper point ID and location during testing
     - Failure to repair deficiencies

Testing & Inspection

- Upon installation completion of the fire alarm system all input devices, output devices including auxiliary functions must be functionally tested.

- This includes all door releases, air handling shut down, elevator recall, suppression system signals, smoke control systems, dampers, etc…

- Often this requires a coordinated testing process involving multiple contractors (fire alarm contractor, mechanical contractor, controls contractor, elevator contractor, test & balance contractor). Many times this test takes several days. This means that all systems must be functioning to complete the Fire Alarm Record of Completion test accurately.

Summary

- There are many considerations which need to be made during the fire alarm design process.
- There are design strategies available to ease the incidence of nuisance alarms.
- Proper installation of fire alarm system components in accordance with applicable codes and manufacturer's installation requirements , and attention to final testing and inspection will reduce nuisance alarms.

Thank you

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