

Solving the Fire Alarm Problem:

Design and Commissioning of Fire Detection and Alarm Systems

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Safety Design in Buildings



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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

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Senior Vice President – Aon Fire Protection Engineering

Mr. Bychowski is a Fire Protection Engineer with over 30 years of fire protection experience and has worked in the Middle East for the past 10 years.

Mr. Bychowski has served both the NFPA 72 and NFPA 13 technical committees and is a founding board member of the International Chapter of the UAE Society of Fire Protection Engineers (SFPE). He has prepared fire strategies, and designed and commissioned fire suppression and alarm systems for all types of facilities throughout the Middle East.

Learning Objectives

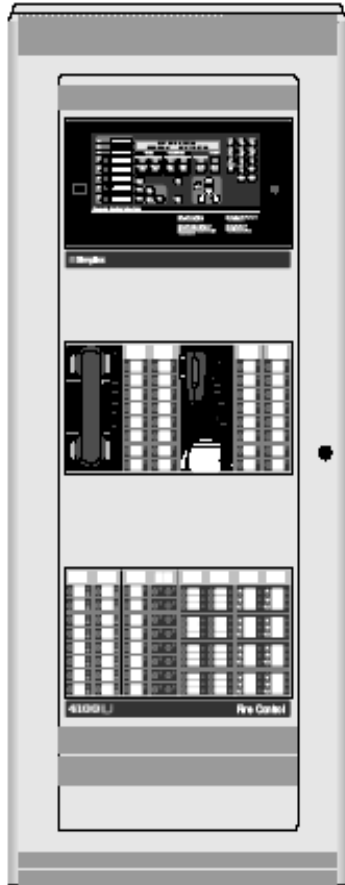
1. *Review fire safety concepts associated with fire alarm systems*
2. *Review key components of fire alarm systems*
3. *Investigate basic design strategies*
4. *Understand the impact of proper installation, inspection and testing to avoid nuisance alarms*

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

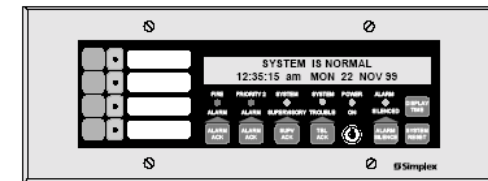
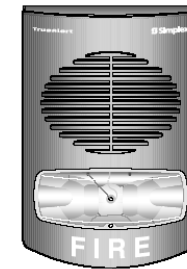
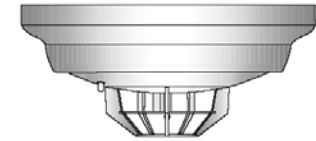
The presentation also contains slides with text that summarises the content of the presentation and the main learning objectives.

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

Overview



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



Fire Safety Concepts Tree – NFPA 550

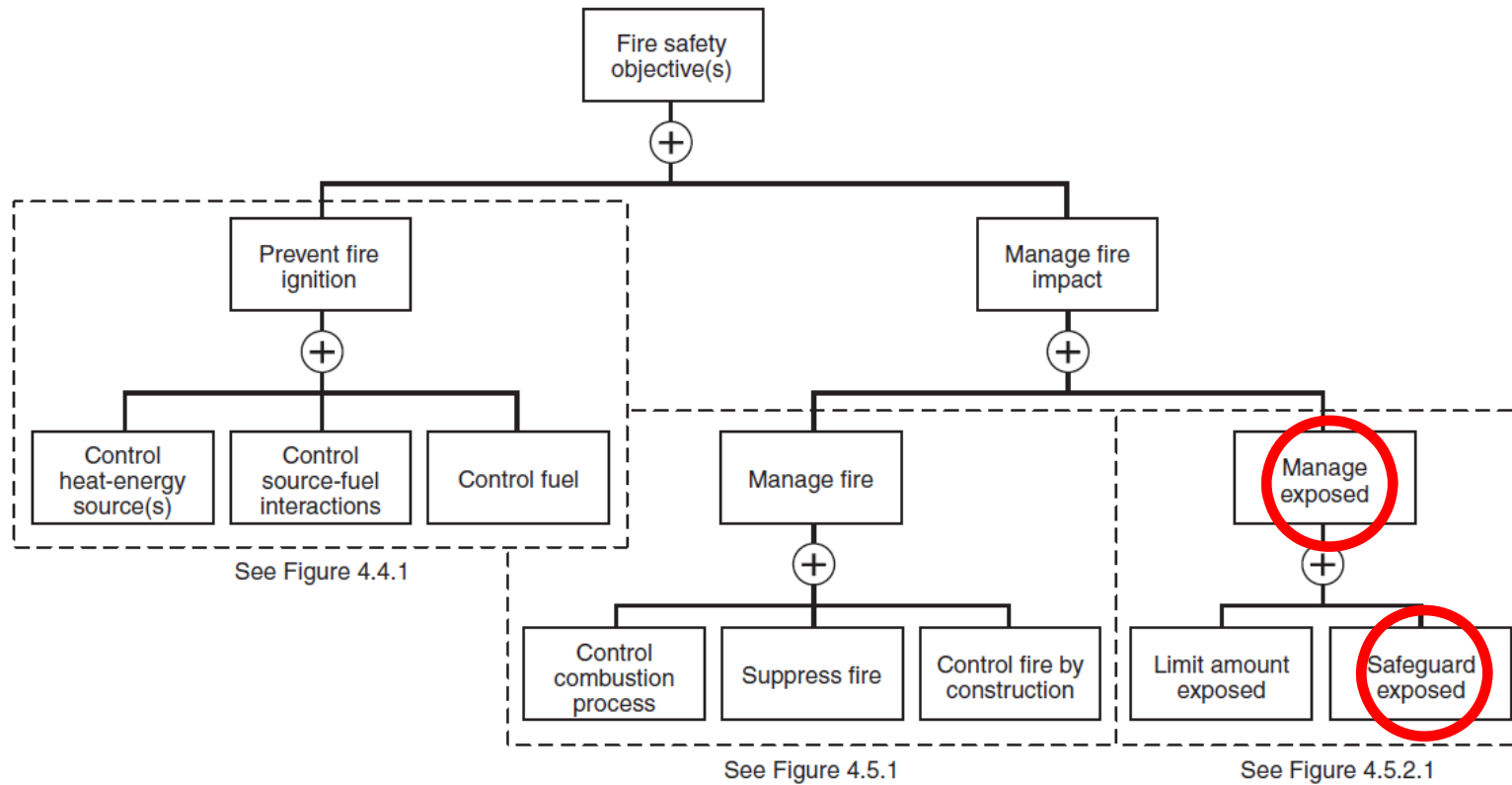


FIGURE 4.3 Top Gates of the Fire Safety Concepts Tree with Selected Lower-Tiered Gates.

Fire Safety Concepts Tree – NFPA 550

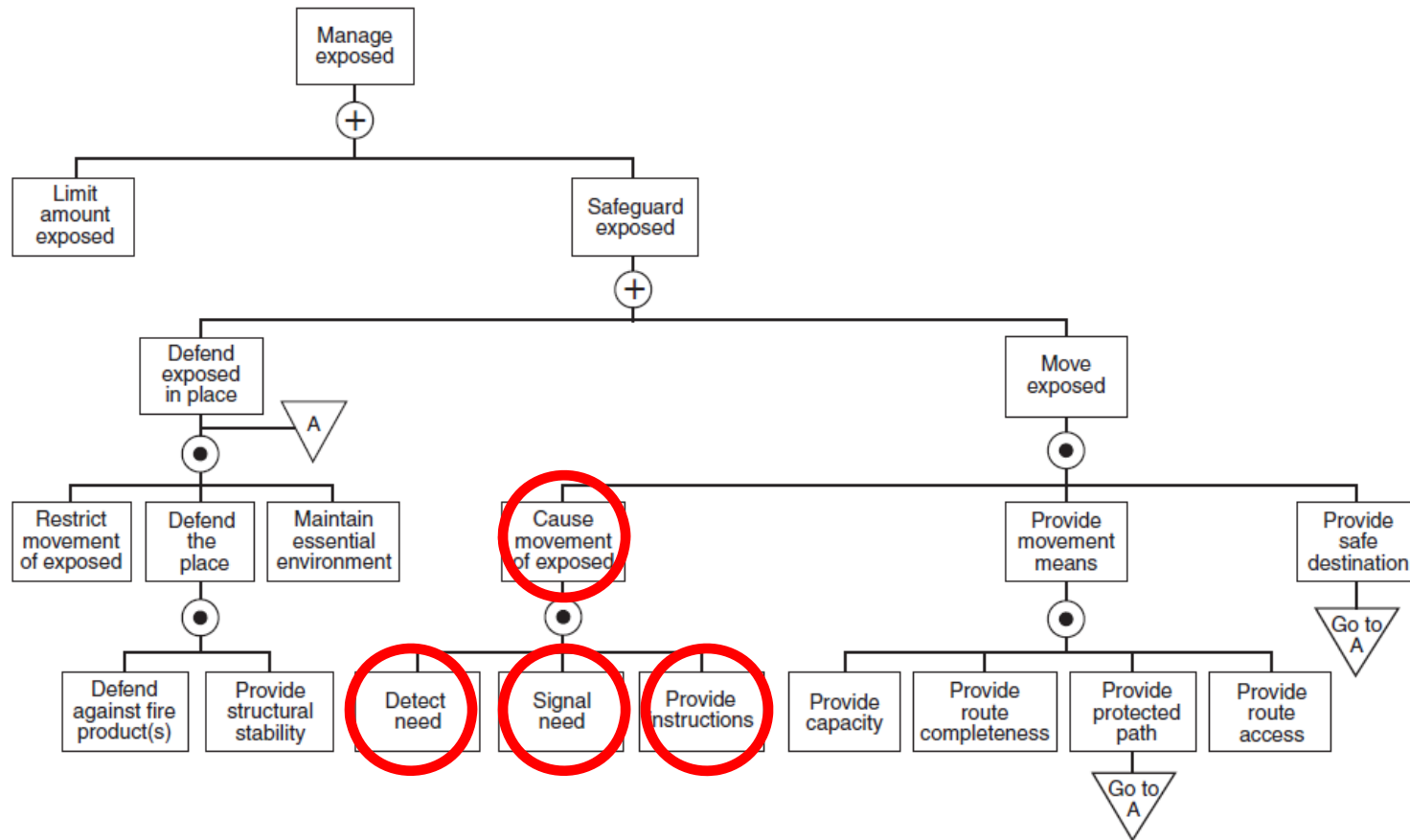


FIGURE 4.5.2.1 “Manage Exposed” Branch of Fire Safety Concepts Tree.

Fire Alarm Drivers – Codes & Standards

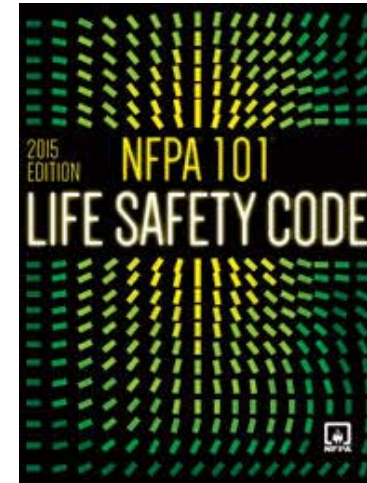
- Building Codes - determine “what” is required for each building type
- Standards - outline specific details on “where” and “how” to install various components or systems
- Fire Codes - determine fire prevention for operating buildings.

NFPA Definitions

- Code - An extensive compilation of provisions covering broad subject matter that is *suitable for adoption into law* independent of other codes and standards.
- Standard - A document which contains only *mandatory provisions* to indicate requirements and which is in a form generally suitable for mandatory reference.

Primary Design Drivers - Codes

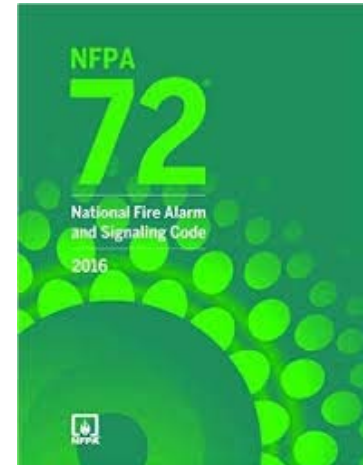
- Adopted Building Code or Building Code of Record
 - IBC, NFPA 5000, GCC Code
 - NFPA 101
- Adopted Fire Code
 - (IFC, NFPA 1)
- Local Civil Defense Requirements



Primary Design Drivers - Standards

Adopted Standards or Referenced Standards

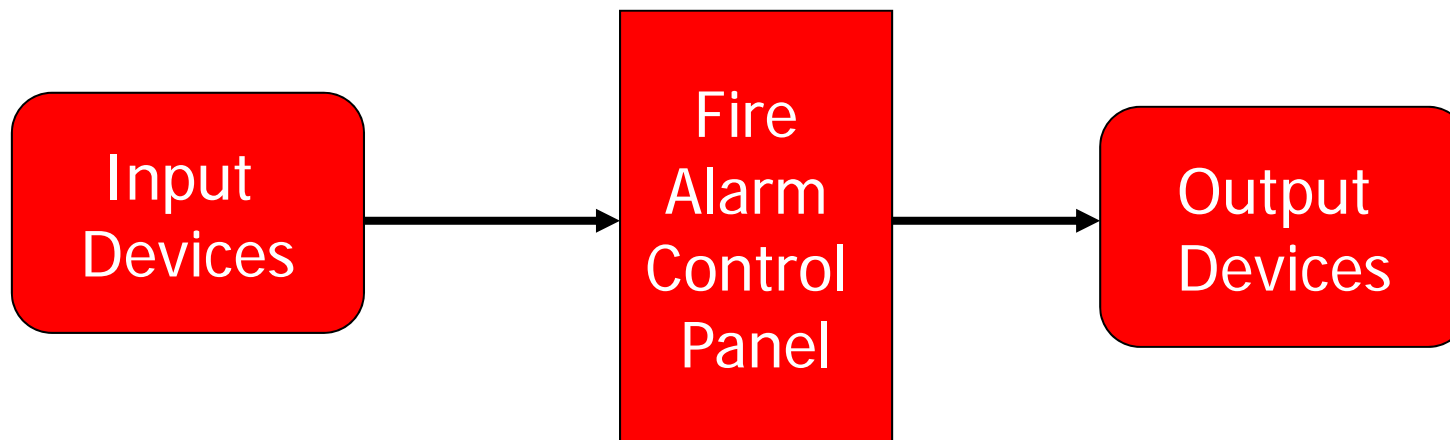
- NFPA 72 - National Fire Alarm and Signaling Code
- NFPA 90A - Installation of Air Conditioning and Ventilating Systems
- NFPA 92 - Smoke Control Systems
- NFPA 13 – Standard for the Installation of Automatic Sprinkler Systems
- UL Standard 268 - Smoke Detectors for Fire Alarm Systems
- UL Standard 268A - Smoke Detectors for Duct Application



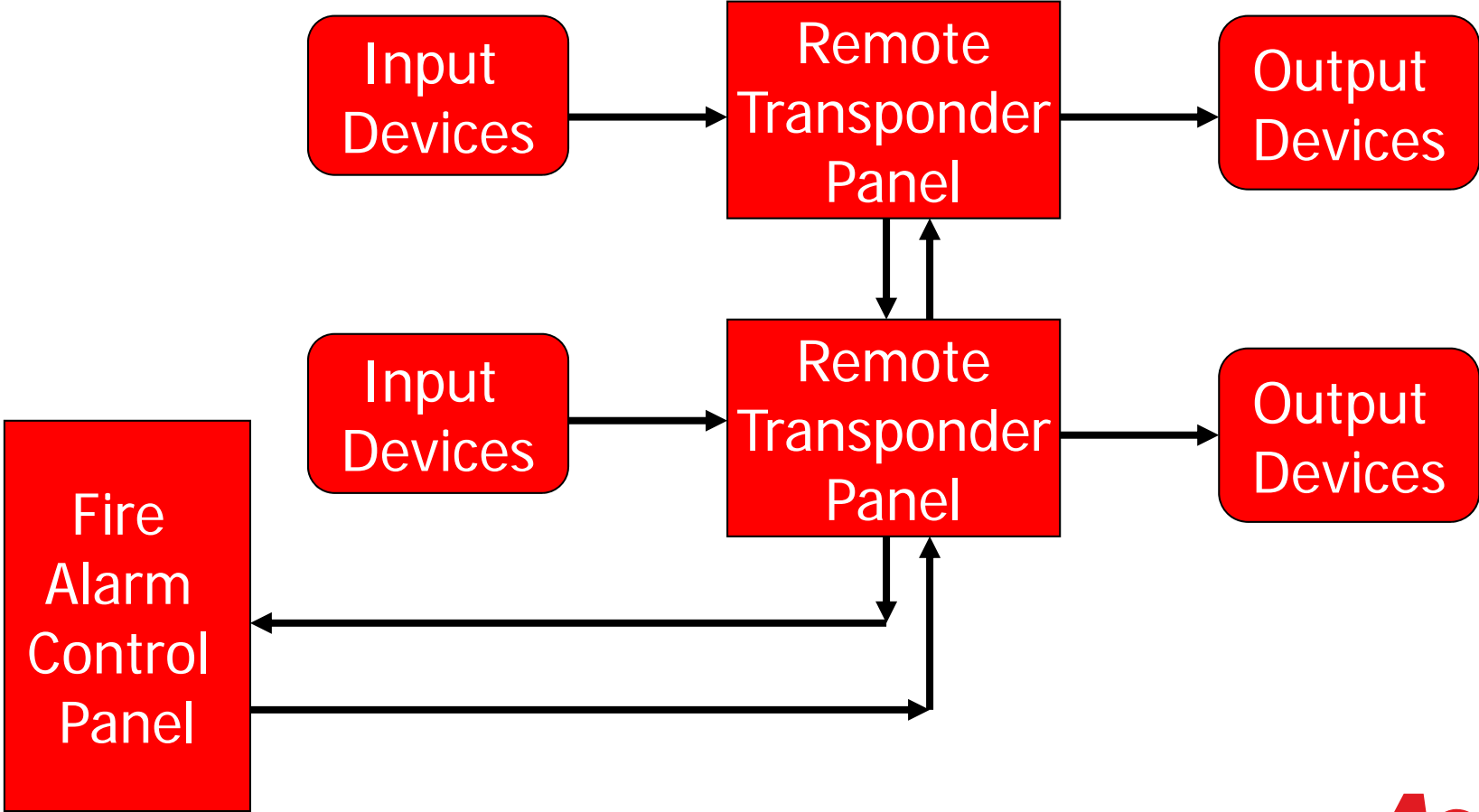
What is a Fire Alarm System?

Definition - NFPA 72-2016 Edition

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.



Networked Fire Alarm System



Fire Alarm System Components – Inputs and Outputs

- Input Devices

- Smoke Detectors
- Heat Detectors
- Gas & Flame Detectors
- Manual Pull Stations
- Water Flow Switches
- Valve Tamper Switches
- Suppression System Releasing Panels (Kitchen Hood Suppression or Clean Agent Suppression)
- Monitor Modules

- Input devices detect smoke or fire, or monitor status of other fire safety equipment



Fire Alarm System Components – Inputs and Outputs

- Output Devices

- Horns
- Speakers
- Bells
- Chimes
- Control Modules
 - Elevator Recall
 - Door Release
 - Fan Control
 - Damper Control
 - Solenoid Activation



Cause and Effect Matrix

Fire Alarm System Input/Output Matrix		<i>Activate audible alarm devices</i>						<i>Activate visual alarm devices</i>						<i>Notify fire department</i>						<i>Recall elevators</i>						<i>Release doors</i>						<i>Shut down fans</i>					
		Output																																			
Input																																					
Smoke Detector Operation																																					
Manual Pull Station Operation																																					
Water Flow Switch Operation																																					
Kitchen Suppression System Operation																																					
Sprinkler Valve Operation																																					
Duct Smoke Detector Operation																																					
Heat Detector Operation																																					

Cause and Effect Matrix (NFPA 72)

System Inputs		System Outputs																																			
		Control Unit Annunciation							Notification							Required Fire Safety Control							Supplementary														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	BB	CC	DD	EE	FF	GG			
1	Manual fire alarm boxes – 1st floor	●	●					●										●																	●		
2	Manual fire alarm boxes – 2nd floor	●	●						●									●																	●		
3	Manual fire alarm boxes – 3rd floor	●	●							●								●																	●		
4	Smoke detectors – 1st floor	●	●					●			●							●	●				●												●		
5	Smoke detectors – 3rd floor	●	●						●			●						●	●				●												●		
6	Smoke detectors – 1st floor	●	●						●			●						●	●				●												●		
7	Smoke detectors – 1st floor elev. lobby	●	●					●			●							●		●															●		
8	2nd floor computer rm. smoke det.-zone 1	●	●						●			●						●	●						●										●		
9	2nd floor computer rm. smoke det.-zone 2	●	●						●			●						●	●						●			●								●	
10	In-duct smoke detector – supply fan 1	●	●						●									●																	●		
11	In-duct smoke detector – supply fan 2	●	●						●									●																		●	
12	In-duct smoke detector – 1st floor return	●	●						●									●																		●	
13	In-duct smoke detector – 2nd floor return	●	●						●									●																		●	
14	In-duct smoke detector – 3rd floor return	●	●						●		●							●																		●	
15	Heat detectors – 1st floor mech. rm.	●	●						●									●	●																	●	
16	Heat detectors – 2nd floor storage room	●	●						●									●	●																	●	
17	Heat detectors – 3rd floor janitor's closet	●	●						●		●							●																		●	
18	Waterflow – 1st floor	●	●						●									●				●														●	
19	Waterflow – 2nd floor	●	●						●									●				●														●	
20	Waterflow – 3rd floor	●	●						●		●							●				●														●	
21	Sprinkler control valve – 1st floor			●	●													●																		●	
22	Sprinkler control valve – 2nd floor			●	●													●																			●
23	Sprinkler control valve – 3rd floor			●	●													●																			●
24	Fire pump running	●	●															●																		●	
25	Fire pump power failure/phase reversal			●	●													●																		●	
26	Fire alarm ac power failure					●	●											●																			●
27	Fire alarm system low battery					●	●											●																			●
28	Open circuit					●	●											●																			●
29	Ground fault					●	●											●																			●
30	Notification appliance circuit short					●	●											●																			●

FIGURE A.14.6.2.4 Typical Input/Output Matrix.

False or Nuisance Alarms



3 main reasons for false or nuisance alarms:

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

Causes of False or Nuisance Alarms

Improper Design

- Placement of smoke detection devices in relationship to:
 - High ceilings / stratification
 - Locations with respect to diffusers and ceiling fans, 1.0 m
 - Rooms with high airflows, and air velocity greater than 1.5 m/sec
 - Doors leading to the exterior
 - Temperature above 38°C
 - Relative humidity above 93 percent.



Causes of False or Nuisance Alarms

Improper Design

- Programming of supervisory and monitoring devices
 - Sprinkler valve supervisory switches – supervisory signal or alarm?
 - Kitchen hood extinguishing system operation – supervisory signal or alarm?
 - Fire pump supervision – supervisory signal or alarm?
 - Clean agent suppression system – supervisory signal or alarm?
 - Duct smoke detectors – supervisory alarm or alarm?

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

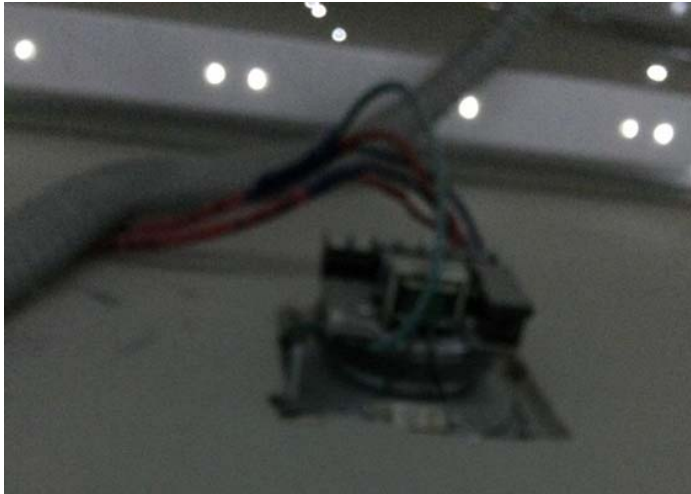
Poor Installations

- Fire alarm wiring issues:
 - Failure to install electrical back boxes for devices
 - 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
 - Failure to place control equipment within 1m of control wiring

- Device installation issues:
 - 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.



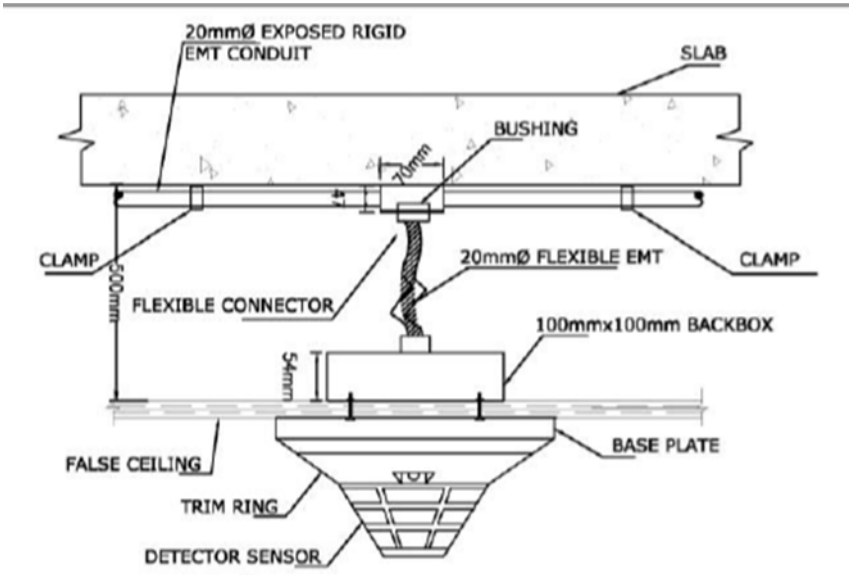
What's wrong here?



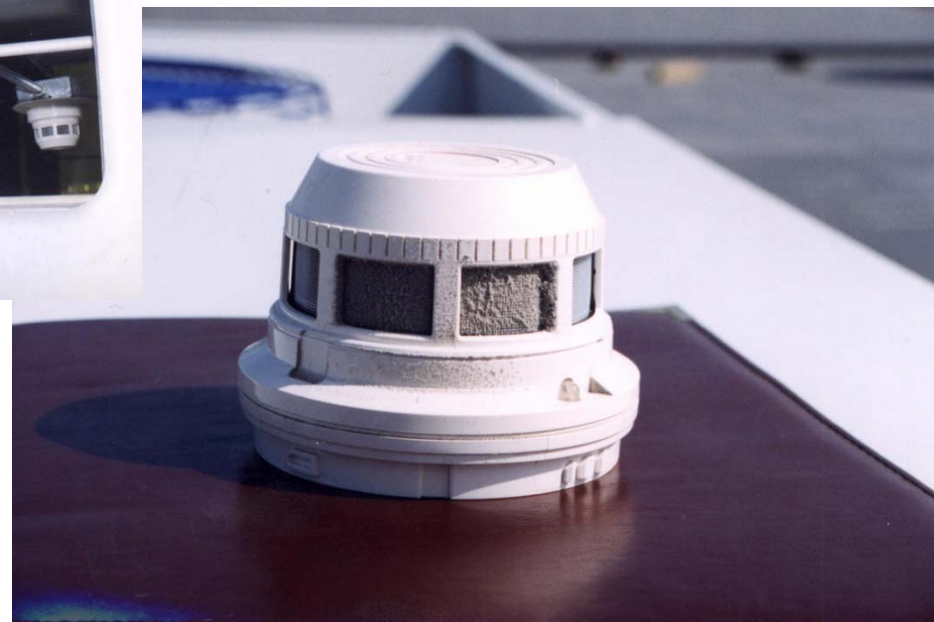
Speaker without back box



Smoke detector without back box



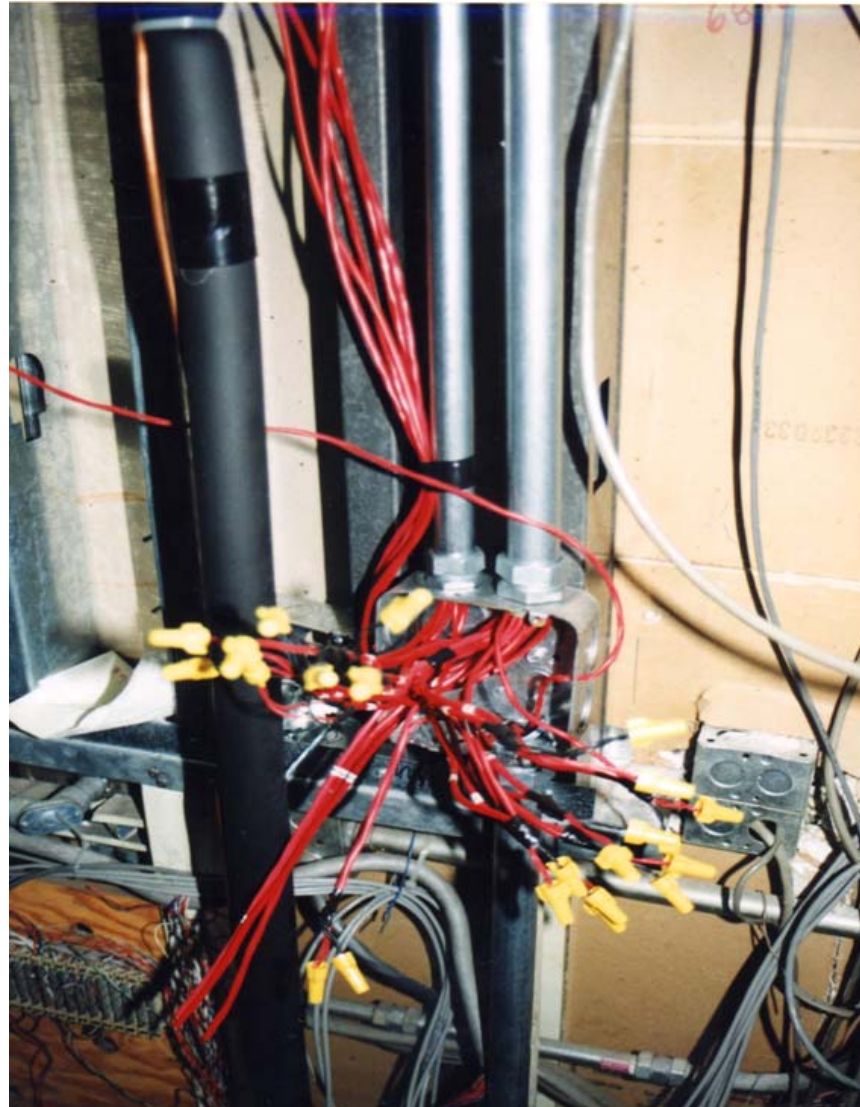
What's wrong here?



What's wrong here?



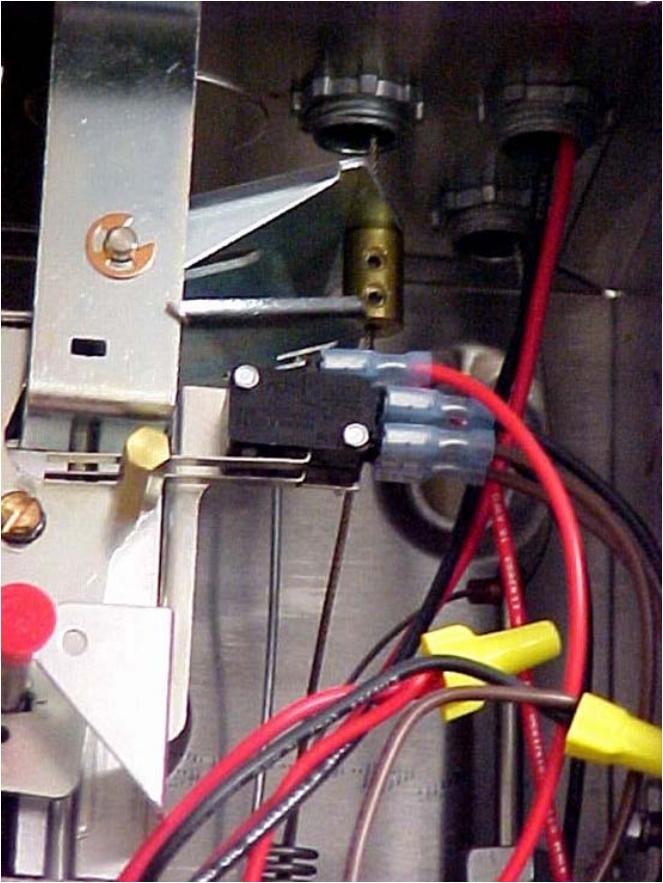
What's wrong here?



What's wrong here?



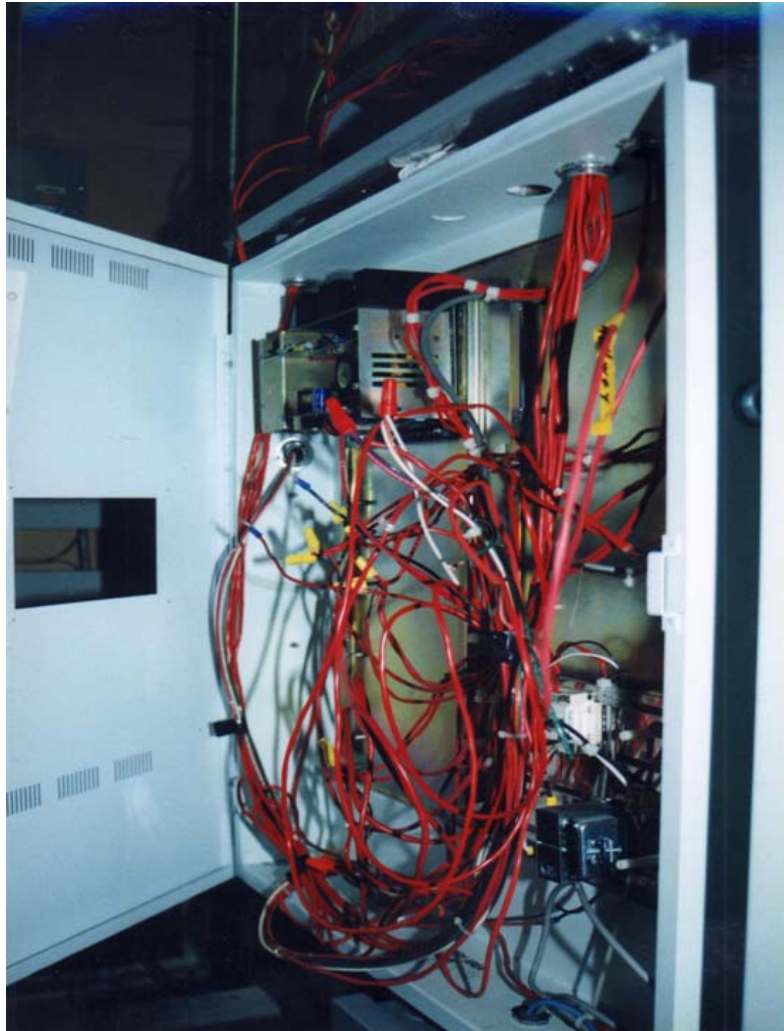
What's wrong here?



What's wrong here?



What's wrong here?



False or Nuisance Alarms which Impair System Operations

Poor Testing, Inspection and Maintenance

- Failure to perform 100% functional testing at commissioning
 - Testing systems with ground faults
 - Failure to check sensitivity or dirty detector report upon completion of testing

- Testing with the wrong tools or methods
 - Smoke detectors and heat detectors need to be tested with listed canned smoke and proper heating tools.
 - Bypassing equipment during testing
 - Failure to confirm proper point ID and location during testing

- Failure to repair deficiencies following inspection/test.

- Failure to inspect weekly and monthly, and test annually per NFPA 72.



Summary

- Building or Life Safety Codes – What is required
- NFPA 72 – How to design, install and test
- Include a Cause and Effect Matrix for all FA system designs
- Coordinate location of smoke detectors with regard to high ceilings, high airflows and environmental conditions
- Never test a fire alarm system if system faults are present
- Always perform a 100% functional test of all input/output functions
- Require contractors to provide NFPA 72 inspection, test and maintenance forms as part of as-built documentation.

Thank You

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