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Advancing the Science of Safety

SOLVING THE FIRE ALARM PROBLEM: Design and Commissioning of Fire Alarm and Detection Systems

Shamim Rashid-Sumar
18 April 2016

Safety Design in Buildings



Doha Conference

Crowne Plaza Doha - The Business Park, Monday, April 18, 2016

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, P.E.

Director of Business Development – Middle East, Jensen Hughes

Ms. Rashid-Sumar has over 15 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 in the United States, 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 special use facilities.

Ms. Rashid-Sumar was Vice President of Middle East Operations for Rolf Jensen & Associates in Dubai prior to joining Aon Fire Protection Engineering in 2014 as Director of Business Development for the Middle East and Project Manager and has continued in this role following the acquisition of Aon Fire Protection Engineering by Jensen Hughes in April 2016.

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, a member of the UAE Code Committee, and a member of the SFPE International Committee on Membership and Chapters Relations.

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.

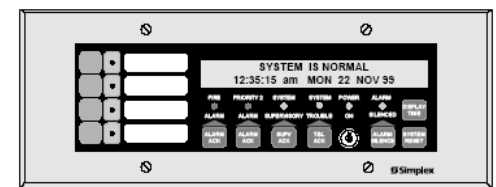
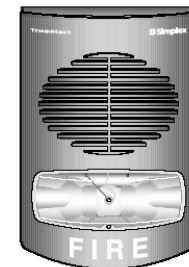
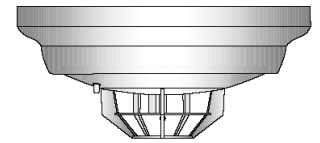
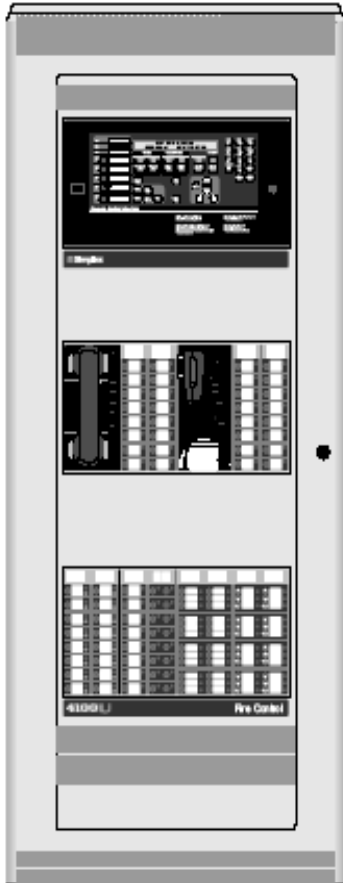
The presentation also contains slides with text that summarises the content of the presentation and the main learning objectives.

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

OVERVIEW

SOLVING THE FIRE ALARM PROBLEM: Design and Commissioning of Fire Detection and Alarm Systems

- Fire Safety Concepts
- Primary Fire Alarm 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

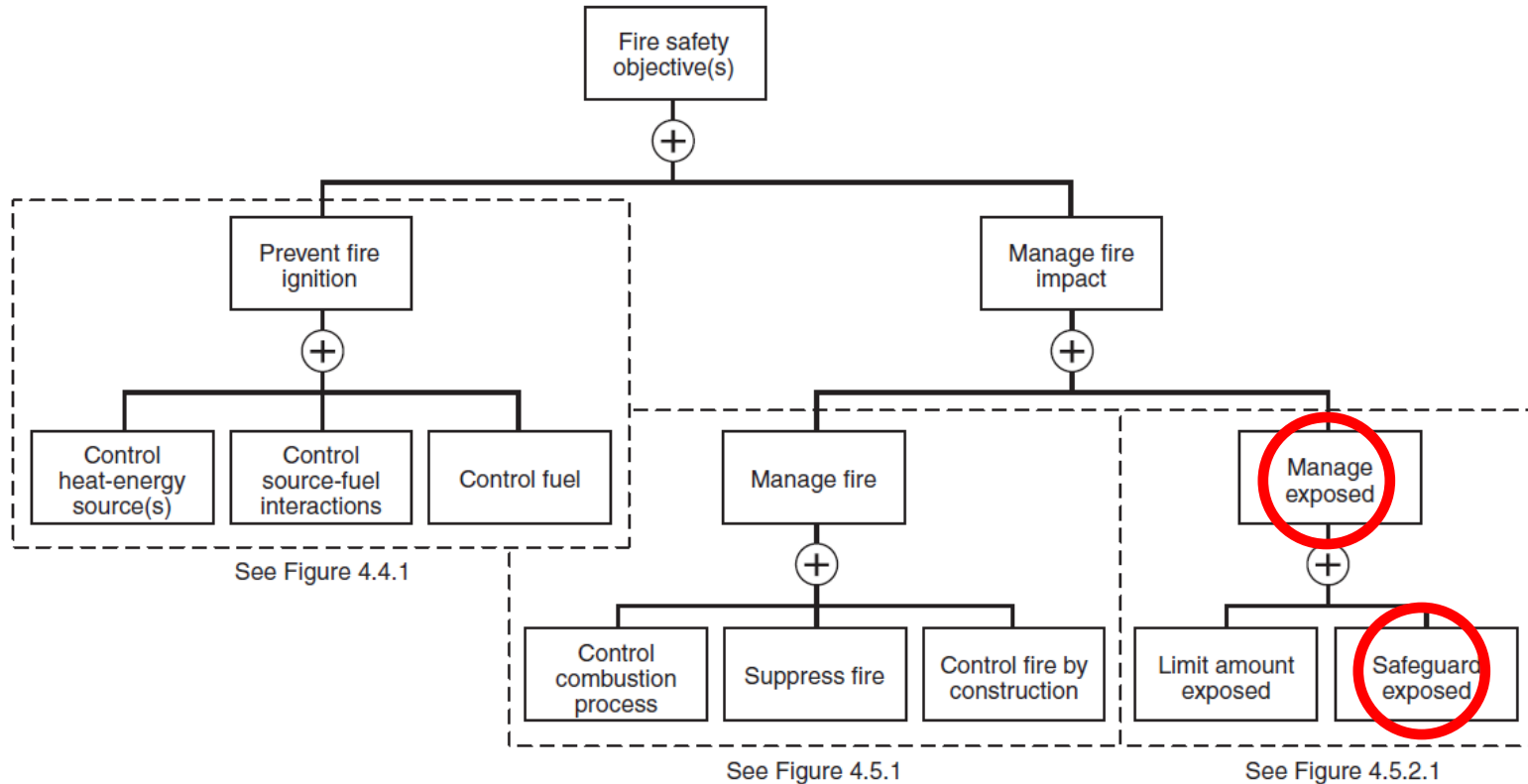


FIGURE 4.3 Top Gates of the Fire Safety Concepts Tree with Selected Lower-Tiered Gates.



FIRE SAFETY CONCEPTS TREE – NFPA 550

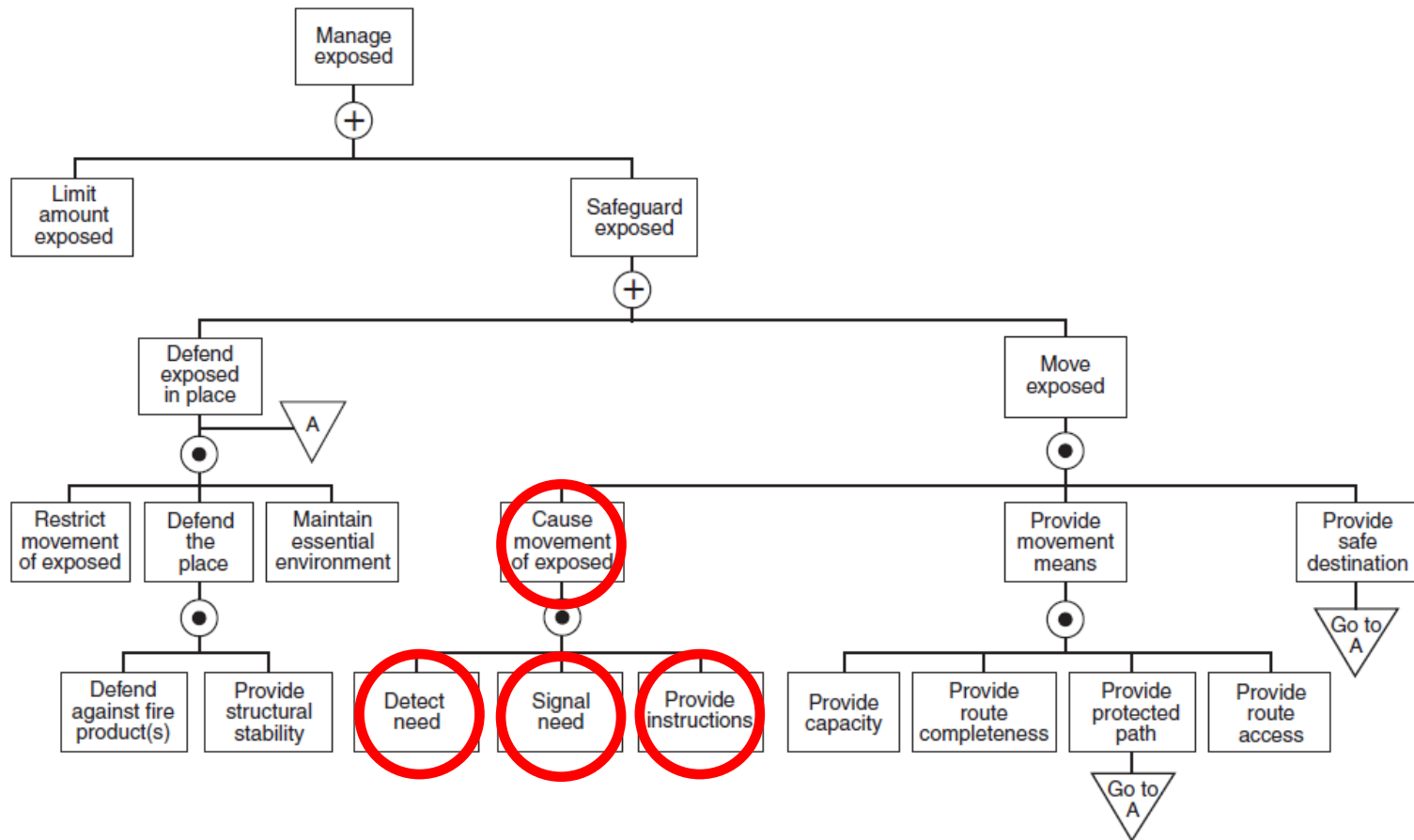


FIGURE 4.5.2.1 “Manage Exposed” Branch of Fire Safety Concepts Tree.



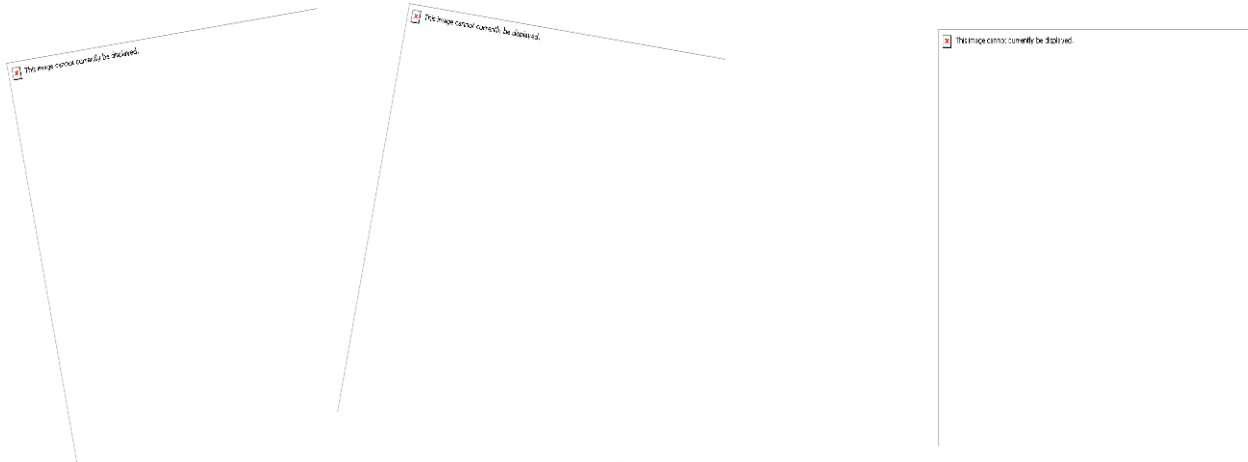
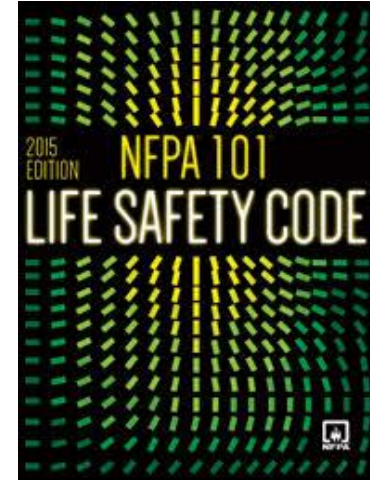
FIRE ALARM DRIVERS – CODES & STANDARDS

- 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.



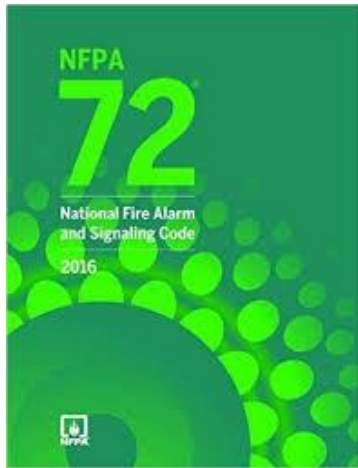
PRIMARY DESIGN DRIVERS - CODES

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



PRIMARY DESIGN DRIVERS - CODES

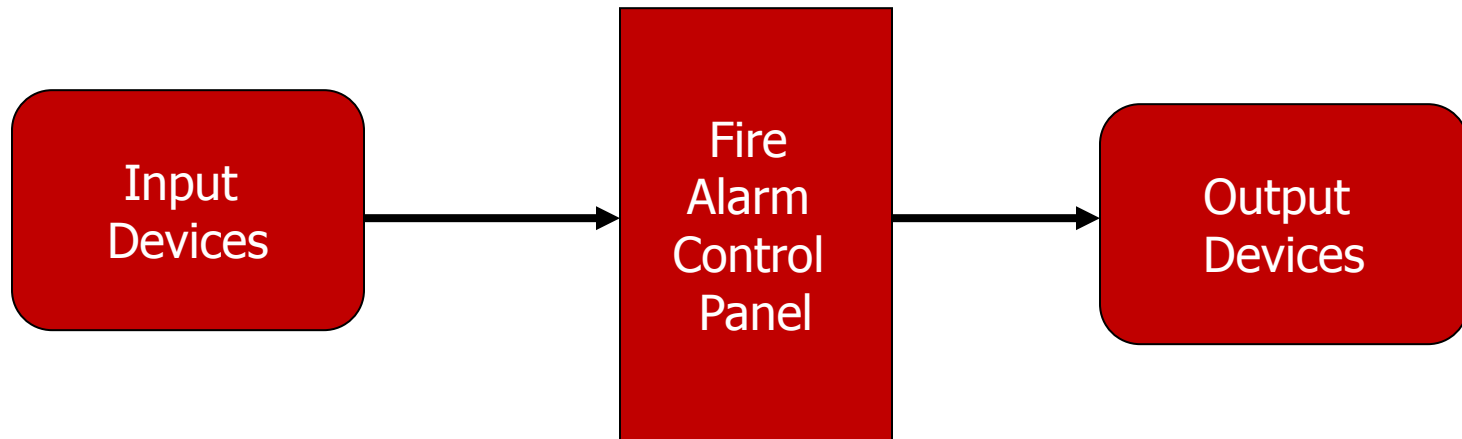
- Adopted Standards or Referenced Standards
 - NFPA 72 – National Fire Alarm and Signaling Code
 - NFPA 13 – Standard for the Installation of Automatic Sprinkler Systems



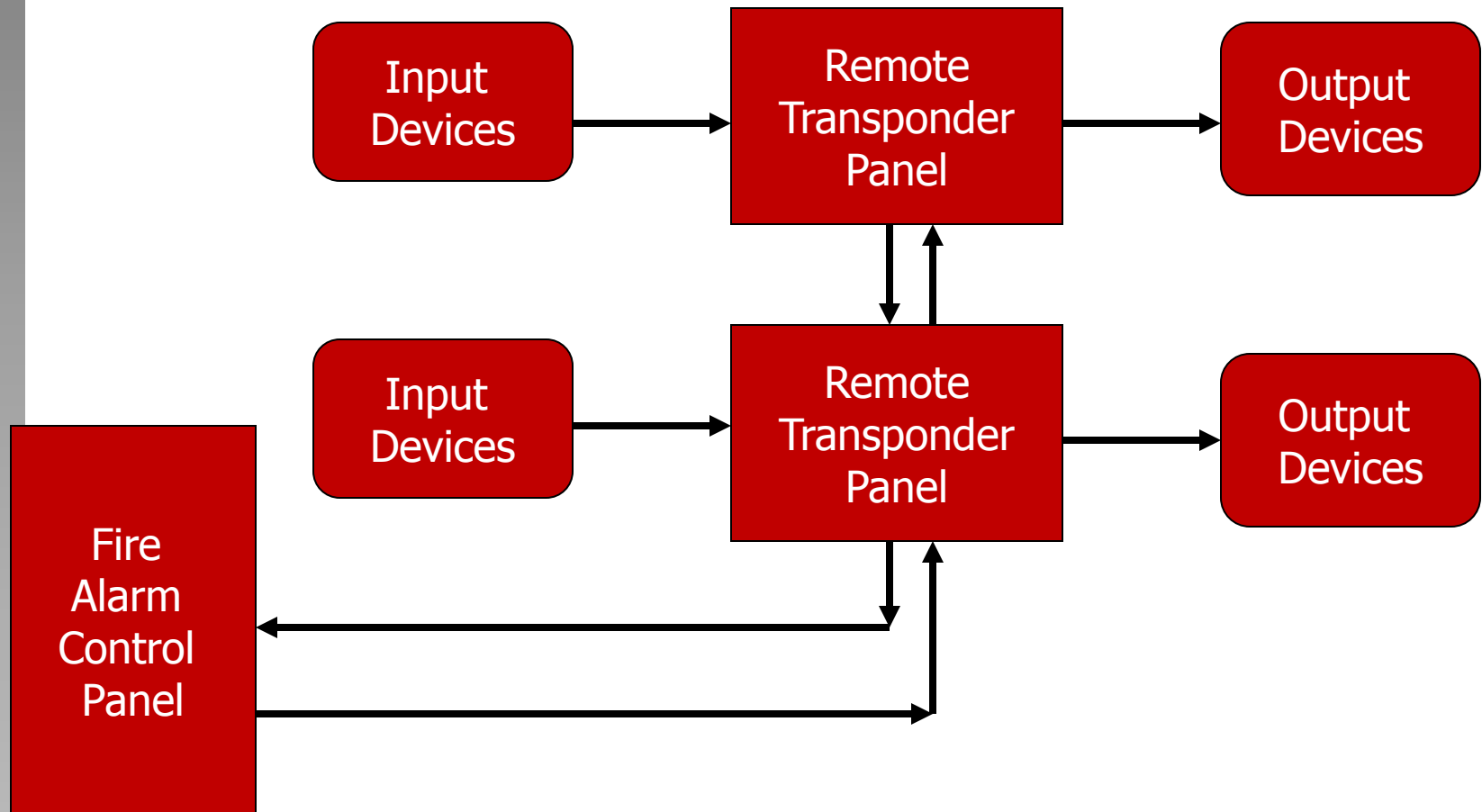
WHAT IS A FIRE ALARM SYSTEM?

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

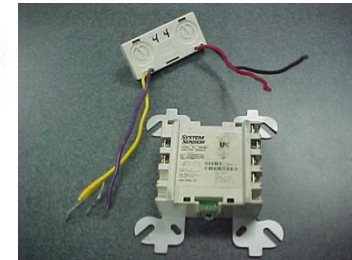
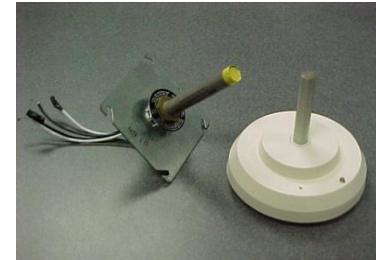


FIRE ALARM SYSTEM COMPONENTS – INPUTS AND OUTPUTS

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

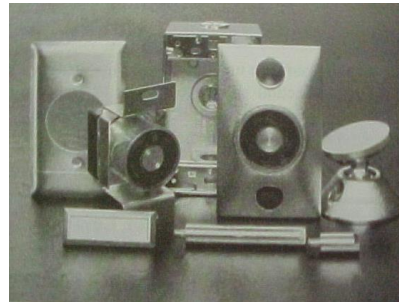
Input devices detect smoke or fire, or monitor status of other fire safety equipment



FIRE ALARM SYSTEM COMPONENTS – INPUTS AND OUTPUTS

Output Devices

- Horns
- Speakers
- Bells
- Chimes
- Control Modules
 - Elevator Recall
 - Door Release
 - Fan Control
 - Damper Control
 - Suppression System 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>	
Output		<i>Release doors</i>		<i>Shut down fans</i>			
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							

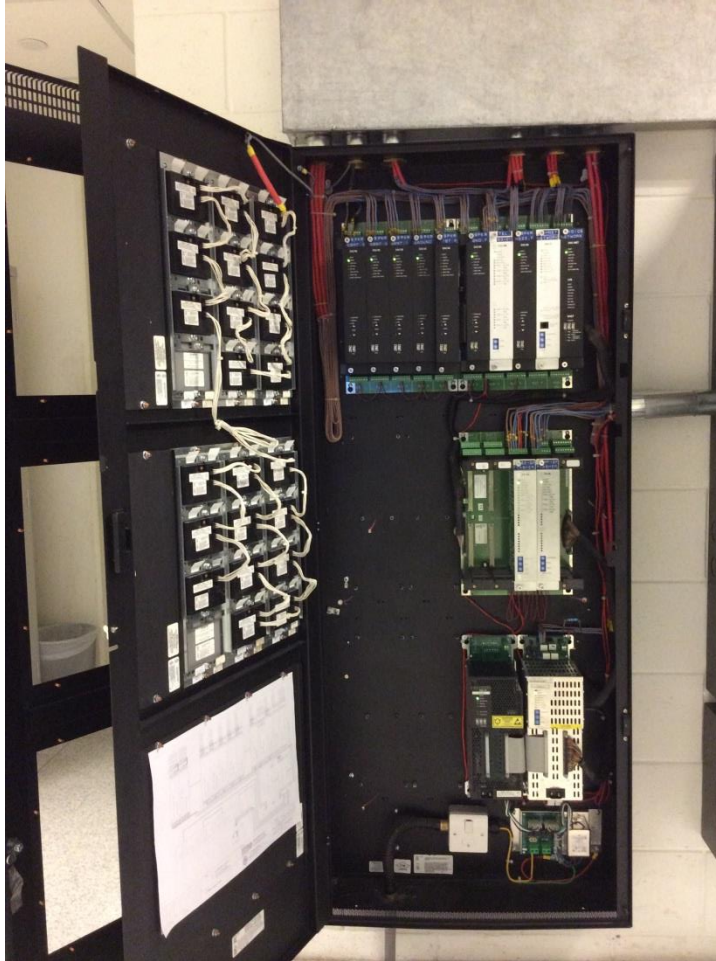


CAUSE AND EFFECT MATRIX (NFPA 72)

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	●	●					●			●			●				●																			●	1		
2	Manual fire alarm boxes - 2nd floor	●	●						●					●					●																			●	2	
3	Manual fire alarm boxes - 3rd floor	●	●							●					●					●																		●	3	
4	Smoke detectors - 1st floor	●	●					●			●				●				●				●															●	4	
5	Smoke detectors - 3rd floor	●	●						●					●					●																			●	5	
6	Smoke detectors - 1st floor	●	●						●					●					●																			●	6	
7	Smoke detectors - 1st floor elev. lobby	●	●					●			●				●				●																			●	7	
8	2nd floor computer rm. smoke det.-zone 1	●	●						●					●					●																			●	8	
9	2nd floor computer rm. smoke det.-zone 2	●	●						●					●					●																			●	9	
10	In-duct smoke detector - supply fan 1	●	●						●					●					●																			●	10	
11	In-duct smoke detector - supply fan 2	●	●						●					●					●																			●	11	
12	In-duct smoke detector - 1st floor return	●	●						●					●					●																			●	12	
13	In-duct smoke detector - 2nd floor return	●	●						●					●					●																			●	13	
14	In-duct smoke detector - 3rd floor return	●	●						●					●					●																			●	14	
15	Heat detectors - 1st floor mech. rm.	●	●						●					●					●																			●	15	
16	Heat detectors - 2nd floor storage room	●	●						●					●					●																			●	16	
17	Heat detectors - 3rd floor janitor's closet	●	●						●					●					●																			●	17	
18	Waterflow - 1st floor	●	●						●					●					●																			●	18	
19	Waterflow - 2nd floor	●	●						●					●					●																			●	19	
20	Waterflow - 3rd floor	●	●						●					●					●																			●	20	
21	Sprinkler control valve - 1st floor			●	●									●					●																			●	21	
22	Sprinkler control valve - 2nd floor			●	●									●					●																			●	22	
23	Sprinkler control valve - 3rd floor			●	●									●					●																			●	23	
24	Fire pump running	●	●											●					●																		●	24		
25	Fire pump power failure/phase reversal			●	●									●					●																			●	25	
26	Fire alarm ac power failure					●	●												●																				●	26
27	Fire alarm system low battery					●	●												●																			●	27	
28	Open circuit					●	●												●																			●	28	
29	Ground fault					●	●												●																			●	29	
30	Notification appliance circuit short					●	●												●																			●	30	

FIGURE A.14.6.2.4 Typical Input/Output Matrix.

COMPARISON



THREE (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 PROGRAMMING

- Supervisory Signal or Alarm?
 - Sprinkler valve supervisory switch
 - Kitchen hood extinguishing system
 - Fire pump supervision
 - Clean agent suppression system
 - Duct smoke detectors



FALSE OR NUISANCE ALARMS WHICH IMPAIR SYSTEM OPERATIONS – CONT'D

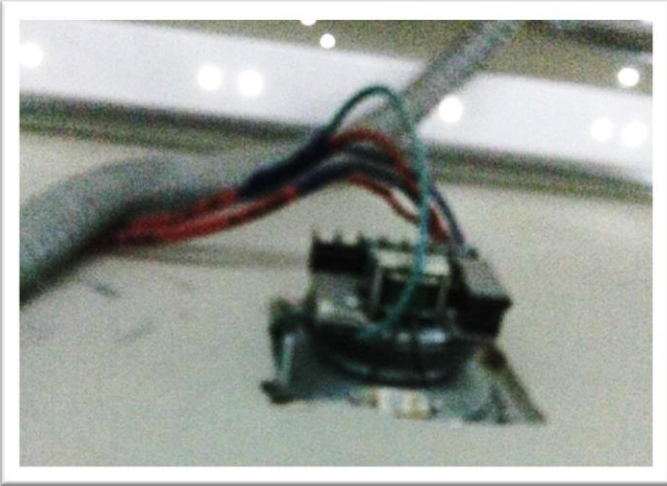
POOR INSTALLATIONS

- Fire alarm wiring issues:
 - No electrical back boxes for devices
 - Wiring not properly secured above false ceilings
 - Devices or circuits not properly grounded
 - Electrical grounds not cleared prior to testing
 - Wiring not secured on terminal blocks

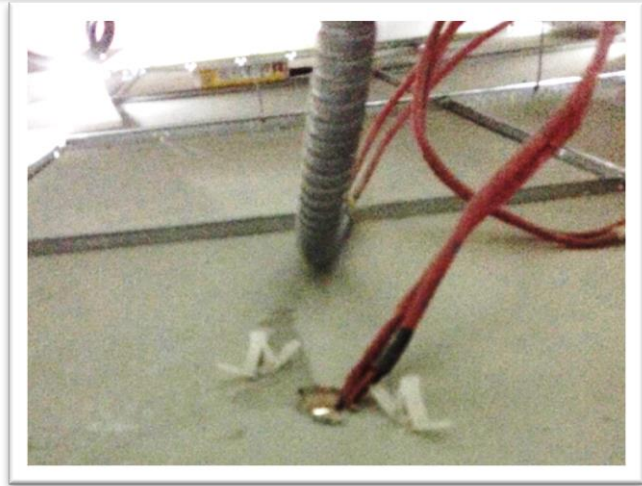
- Device installation issues:
 - Smoke detectors not kept clean during construction
 - Sensitivity/Dirty detector report not performed after commissioning
 - Devices not properly programmed and labeled.



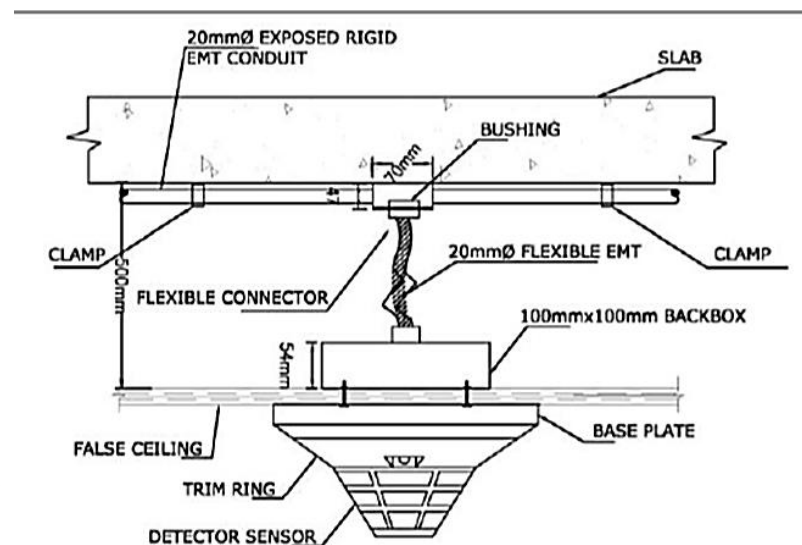
WHAT'S WRONG HERE?



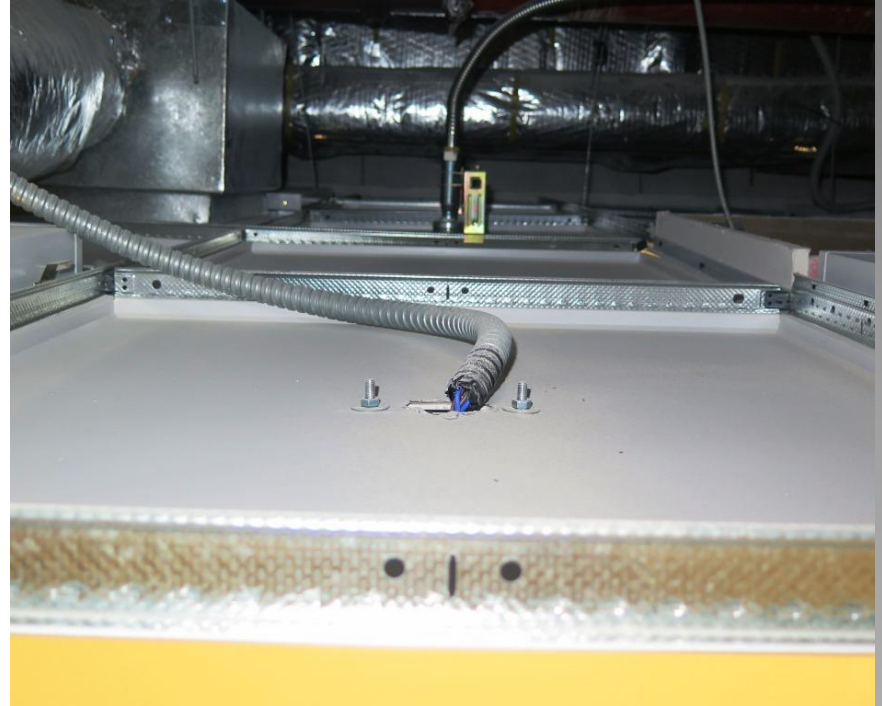
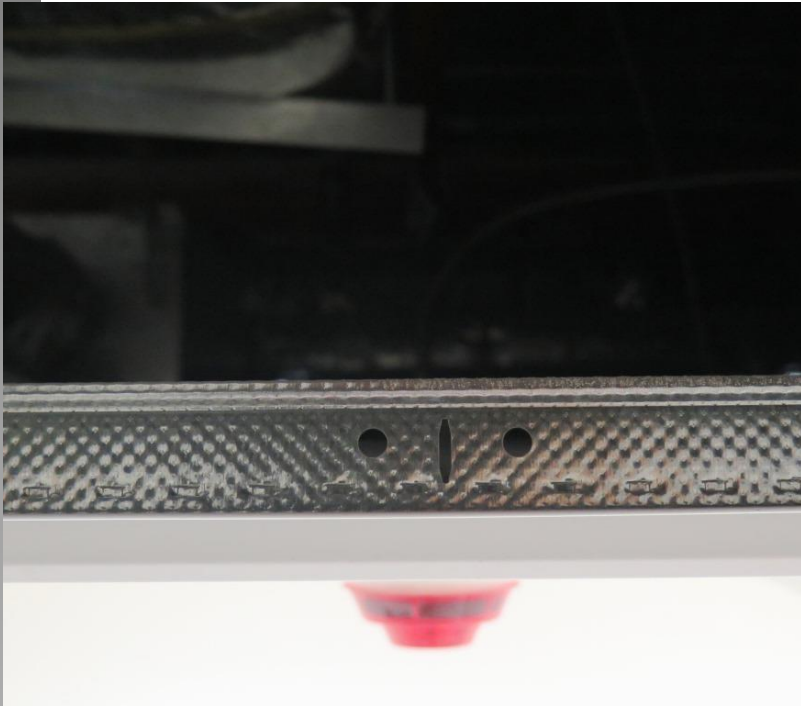
SPEAKER WITHOUT BACK BOX



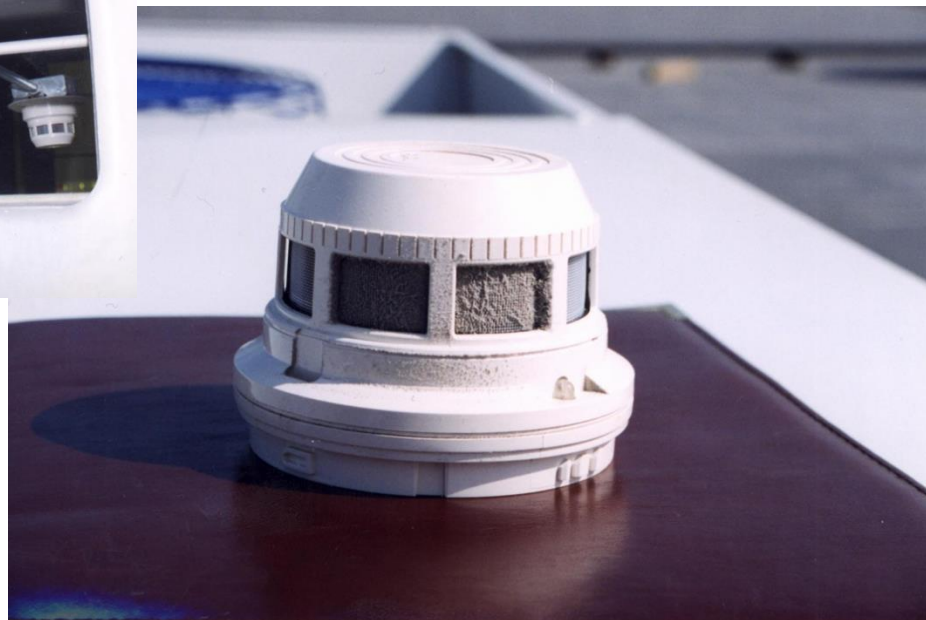
SMOKE DETECTOR WITHOUT BACK BOX



WHAT'S WRONG HERE?



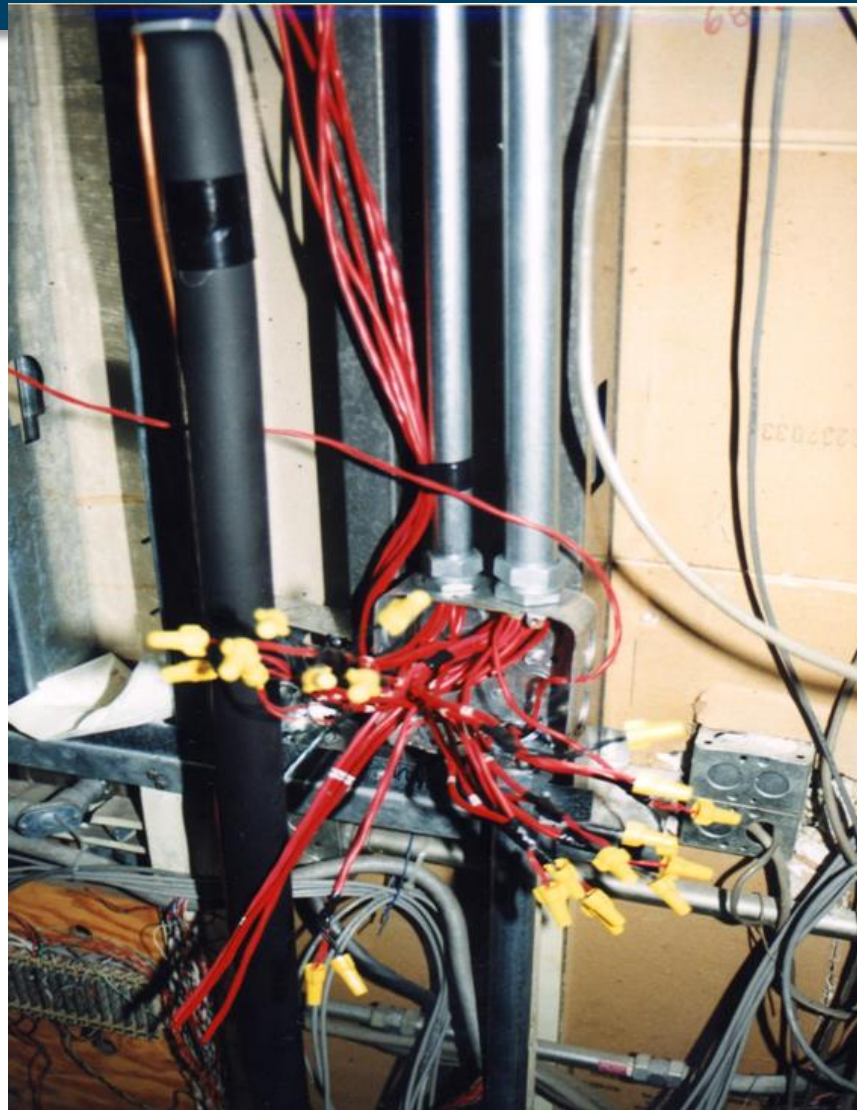
WHAT'S WRONG HERE?



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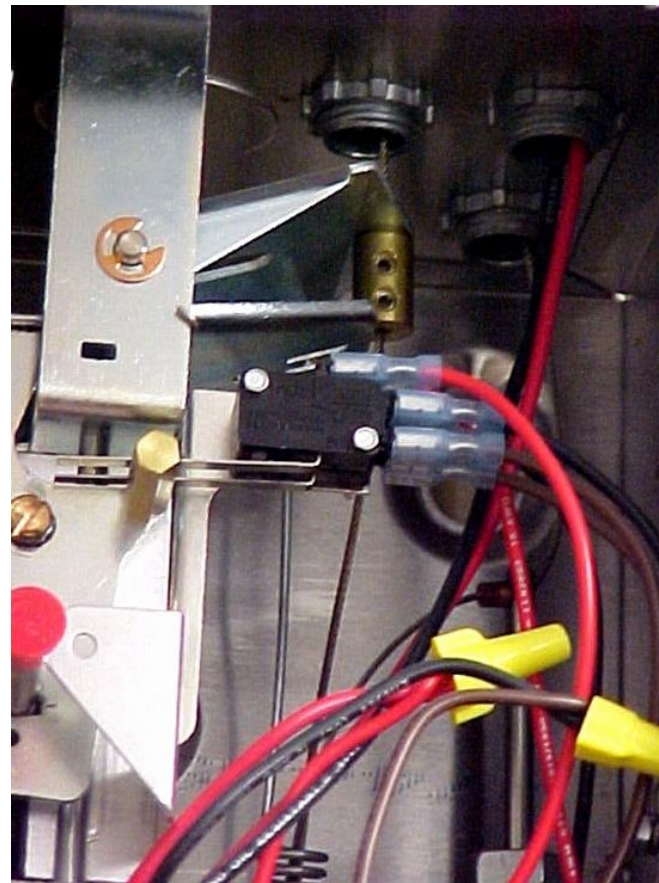
WHAT'S WRONG HERE?



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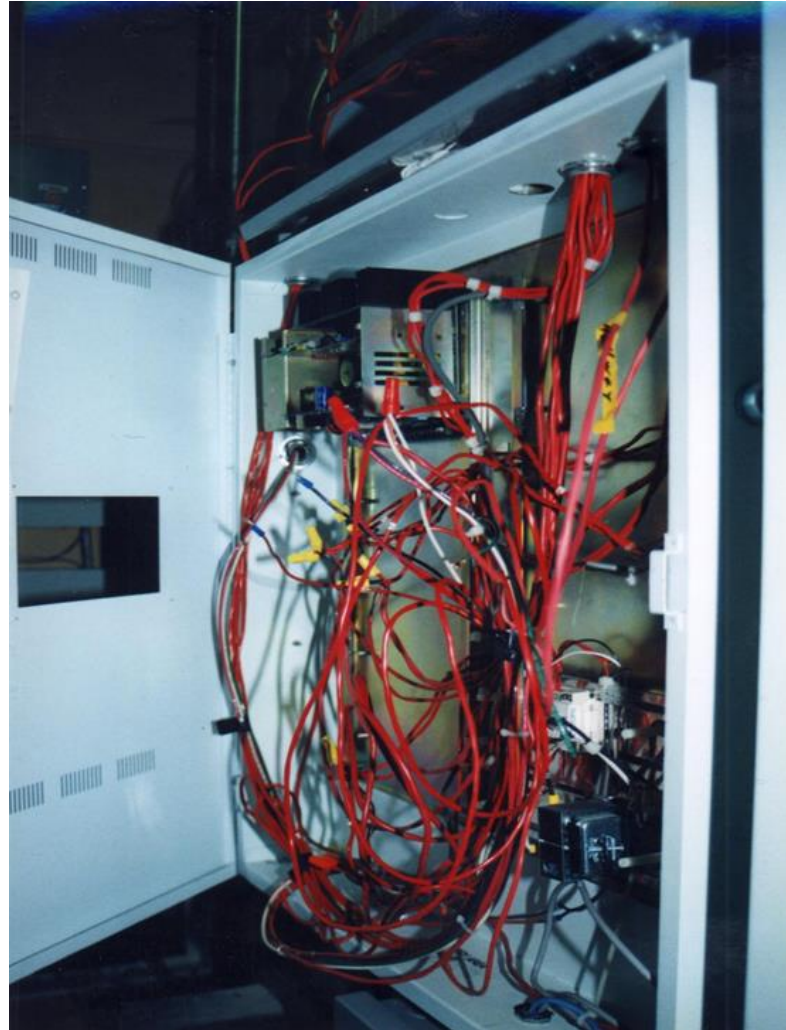
WHAT'S WRONG HERE?



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.



QUESTIONS?

Contact

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