Illinois Fire Inspectors Association Presents

Fire Alarm 101
for the
First Responders

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Today's Agenda

1. Fire Principles & Behavior

2. System Needs Assessment

3. System Basics

4. Conventional vs. Addressable

5. Input Detection Initiating Devices

6. Output Notification Signaling

   Appliances

7. FA Panel Views-Operation

8. Alarm System Monitoring

9. Fire Sprinkler monitoring

History of Fire Alarms

1800's   First Heat Sensing Alarm System

1929   Smoke Detect on Ships

1947   Cerberus develops first Ion SD

1954   Cerberus first UL Listed Ion SD

1964   First Alert24v Ion SD

1964   Stratitrol first Photo 24v SD
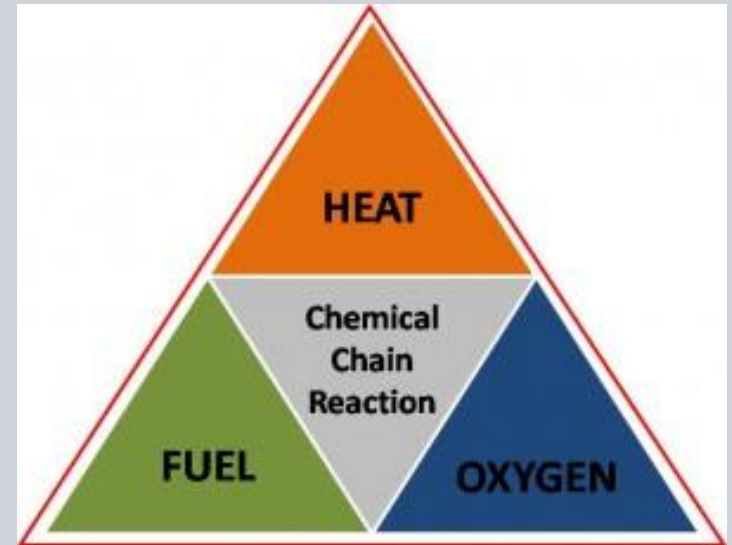
1973   BRK first Battery Operated SD

Loss of Life
- 1800's   45,000
- 1925   15,000
- 1970   8,800
- 2009   3,000

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Fire Principles – The Fire Triangle

In order to understand how to detect fire, you first need to know a little bit about fire. Four things must be present at the same time in order to produce fire:

- Fuel or combustible material

- The chemical, exothermic reaction that is fire

- Enough heat to raise the material to its ignition temperature

- Enough oxygen to sustain combustion (air: 21%, fire need min 16%)

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Fire Principles – Stages of Fire Development

1   **Denial** - No there is no fire.

2   **Anger** - Darn that stupid fire!!!

3   **Grief** - Oh man, there's a fire, I can't go on!

4   **Acceptance** - Ok, so there's a fire.

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Fire Principles – Stages of Fire Development

Fire Growth
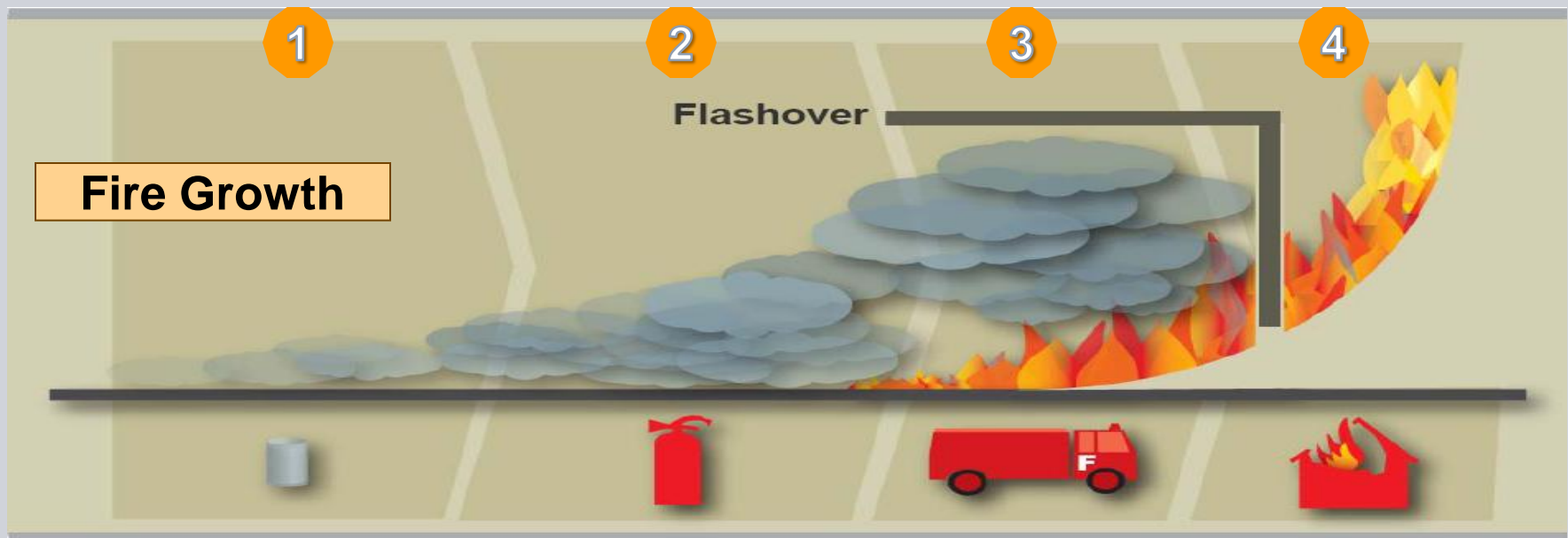
1. **Incipient stage:** Little visible smoke occurs
2. **Smoldering stage:** Smoke, but no flame and little heat.
3. **Flaming stage:** Visible flame, more heat, much less smoke.
4. **Heat Stage or Flashover:** Large amounts of heat, flame, smoke and toxic gases are produced. This is the explosive fire spread, taking place exactly at the point when the gases and aerosols produced during the previous phases ignite and carry the fire into all rooms already penetrated by the smoke gases.

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Fire Principles – How Fires are Classified

CLASS A - Ordinary combustibles or fibrous material, such as wood, paper, cloth, rubber and some plastics.

CLASS B - Flammable or combustible liquids such as gasoline, kerosene, paint, paint thinners and propane.

CLASS C - Energized electrical equipment, such as appliances, switches, panel boxes and power tools.

CLASS D - Certain combustible metals, such as magnesium, titanium, potassium and sodium. These metals burn at high temperatures and give off sufficient oxygen to support combustion. They may react violently with water or other chemicals, and must be handled with care.

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Why Install A Fire Alarm System?

- Required by building code, AHJ, insurance underwriter, or facility standards

- To provide for the safety of occupants in buildings, and to make provision for their evacuation or refuge during a fire or other emergency

- Early notification of a fire to fire department to reduce response time

- Compensate for structural fire protection shortcomings or to give special cover for items of high value

- Reduce loss of property

- Business continuance

- Minimize owner's risk and liability

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Risk Assessment

Consult With All Interested Parties

Before embarking on a detailed design, it is highly recommended as a minimum to consult the following agencies so as to ensure that the fire detection and alarm system meets the requirements of all concerned.

1. The authority responsible for enforcing health and safety legislation

2. Fire engineering specialists or consultants

3. The property insurer

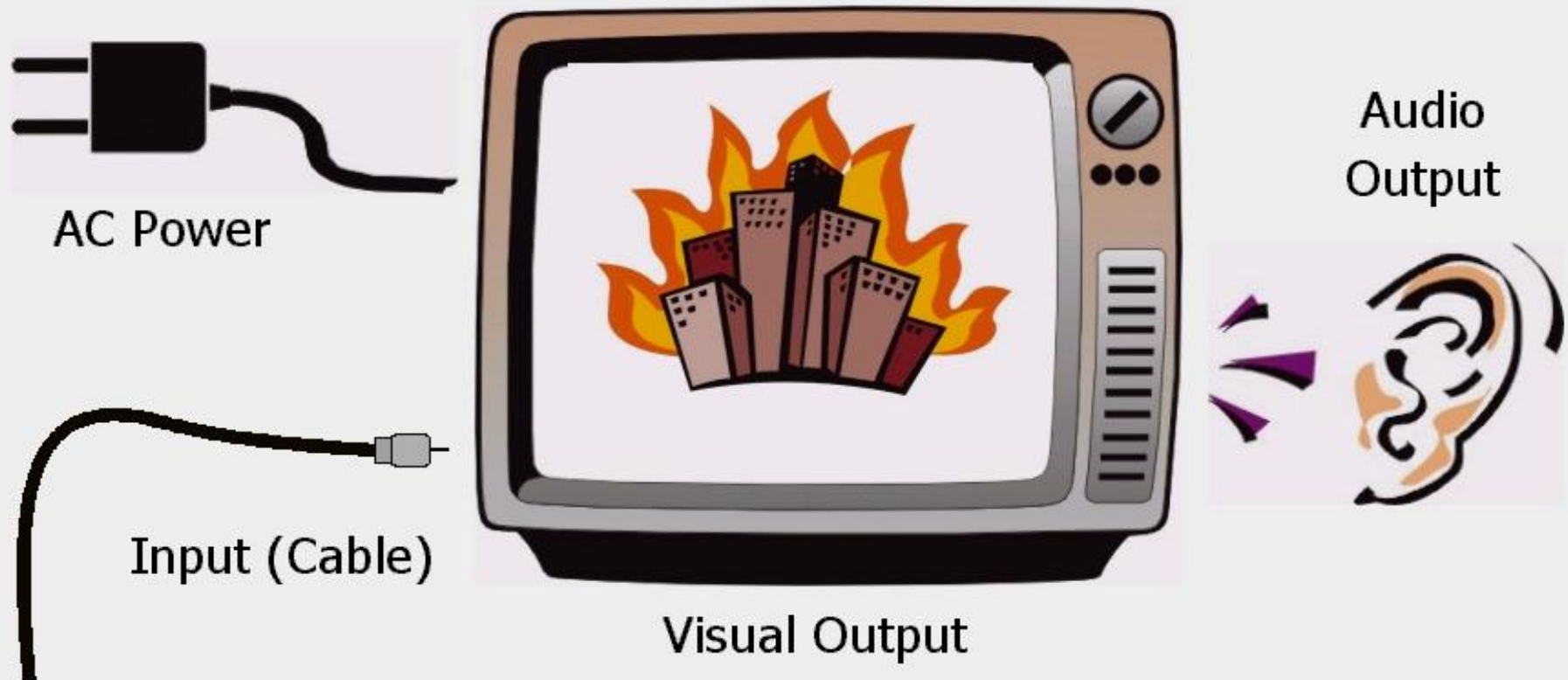4. The building user

5. The proposed installer

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Review of the Building

1) Review the physical properties of the building

- Building height?

- Area of each floor?

- Number of floors?

- Fire department access?

- Protected by fire sprinklered?

- Smoke compartments and/ or fire zones?

2) What fire alarm equipment is required in this occupancy?

3) Where are fire alarm devices required?

4) Determine if there is a special use or occupancy (refer to the adopted Model Building Code) and how the building will function during an emergency.
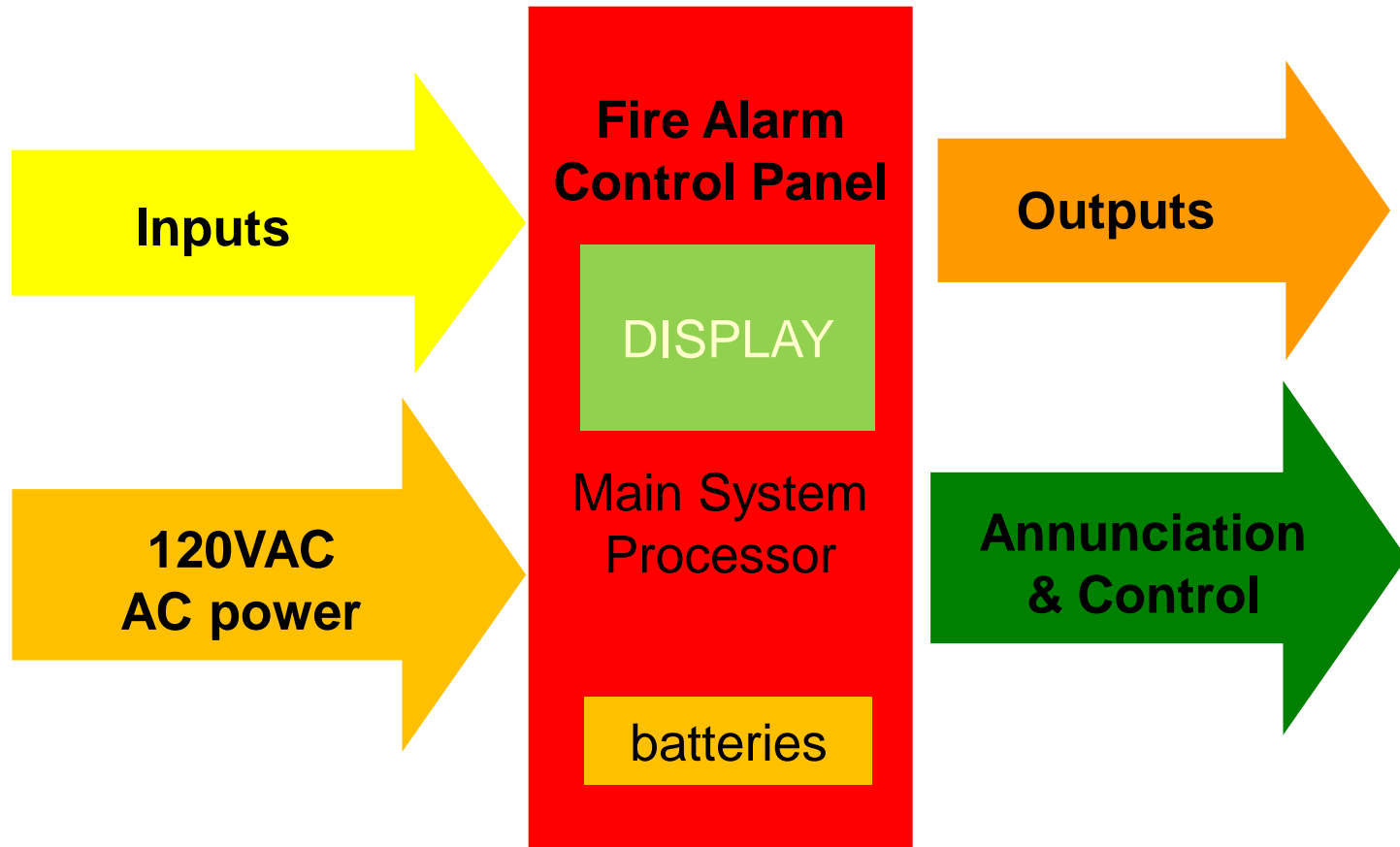
This is <u>NOT</u> a Fire Alarm System

Elements of a Fire Alarm System

AC Power

Input (Cable)

Visual Output

Audio Output

Fire Alarm Components

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Inputs

120VAC AC power

Fire Alarm Control Panel

DISPLAY

Main System Processor

batteries

Outputs

Annunciation & Control

Fire Alarm Components

AUTOMATIC INPUTS

NOTIFICATION OUTPUTS

**Fire Alarm
Control Panel**

MANUAL INPUTS

FIRE
PULL DOWN
SIEMENS

Annunciation/ Control

Main System
Processor

120VAC power

batteries

NFPA 72
CLASS B

Addressable vs. Conventional

Conventional	Addressable
More wire	Less wire
No history log	History log
Voltage Communication	Analog Communication
Reports by zone	Reports by device
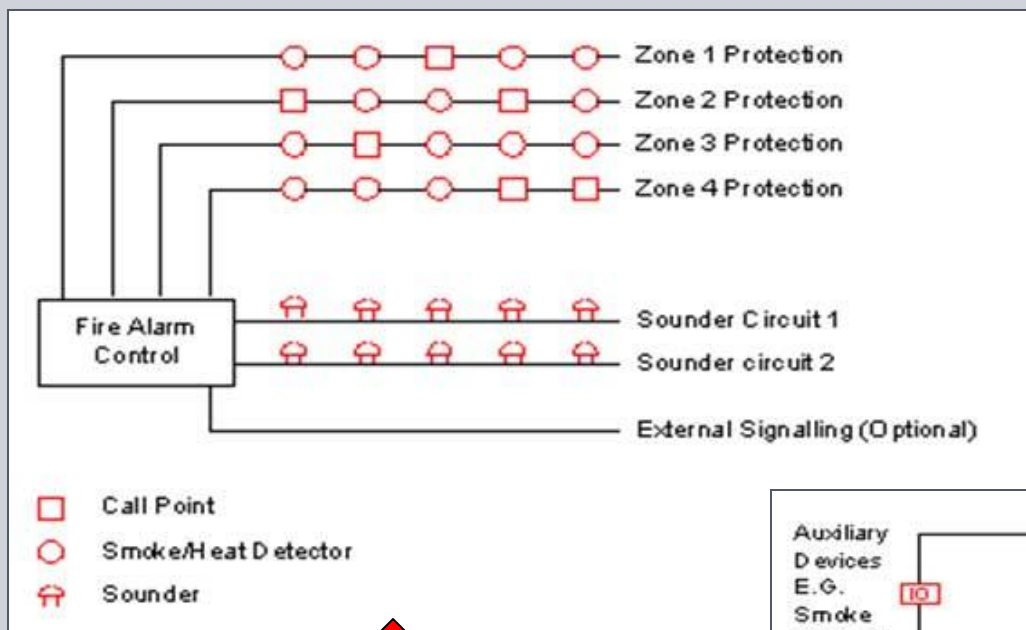
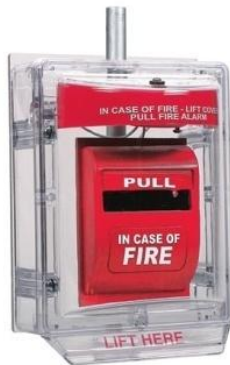# Addressable vs. Conventional

Addressable

Conventional
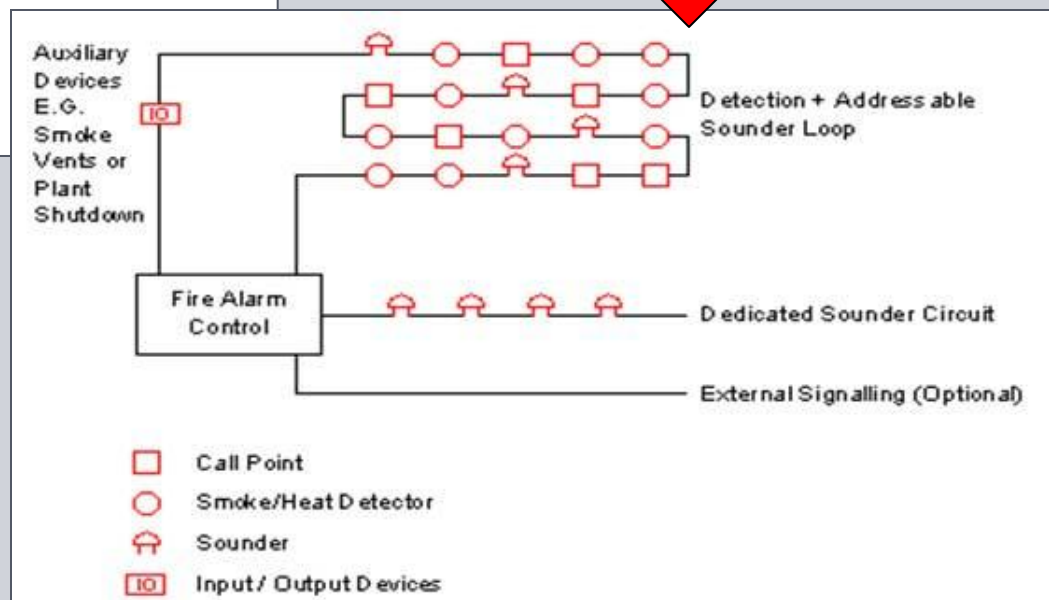
DEVICE TYPE	DESCRIPTION
	A manual pull station is a wall mounted device meant to be pulled by a building occupant to signal to the building fire alarm system that a fire emergency exists.
	In areas where false calls are a problem, pull stations may be covered with a clear plastic cover that sounds a loud tamper alarm when removed, creating focus on the fire alarm.

Automatic Inputs

| DEVICE TYPE	DESCRIPTION
	A smoke detector is an electronic device that optically detects the presence of smoke. The photoelectric type operates by projecting a small beam of light across an internal chamber. If the beam of light becomes obscured by smoke the detector will sound an alarm.
	A heat detector senses heat instead of smoke. Heat detectors come in two basic varieties, rate of rise and fixed temperature. Rate of rise detects when the ambient temperature rises much more quickly than normal, and then activates an alarm. Fixed temp detectors are calibrated to alarm at a specific temperature, such as 135 degrees.

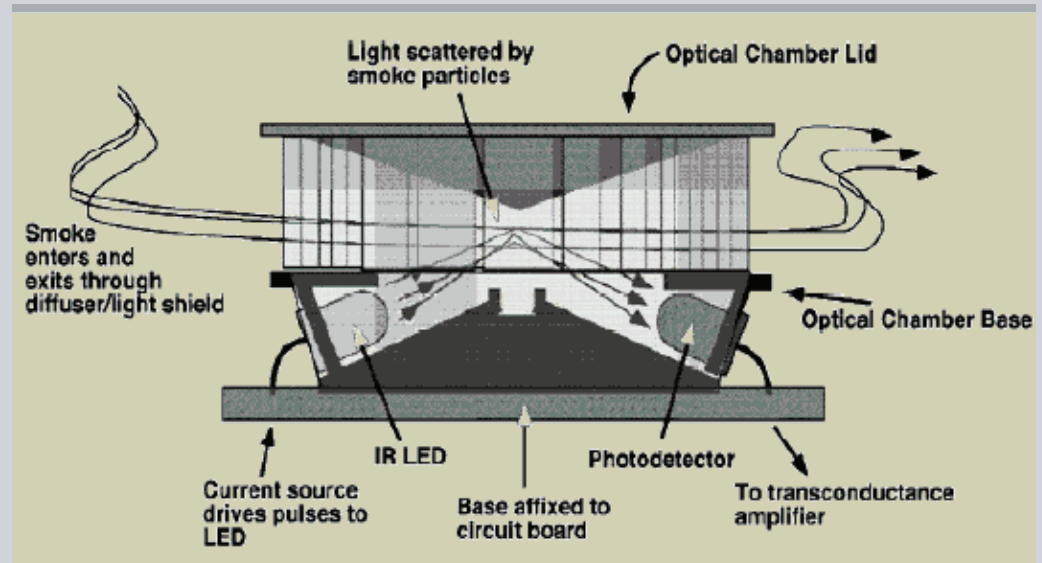# Spot Smoke Detection – Photoelectric

Principle of Detection – Light Scattering

- Infrared LED light source

- Mirror used to pass beam through chamber

- Smoke particles scatter the light beam

- Photo sensor detects loss of light to create an alarm

1 Light source
2 Lens
3 Photoelectric cell
4 Signal
5 Smoke particles
6 Labyrinth
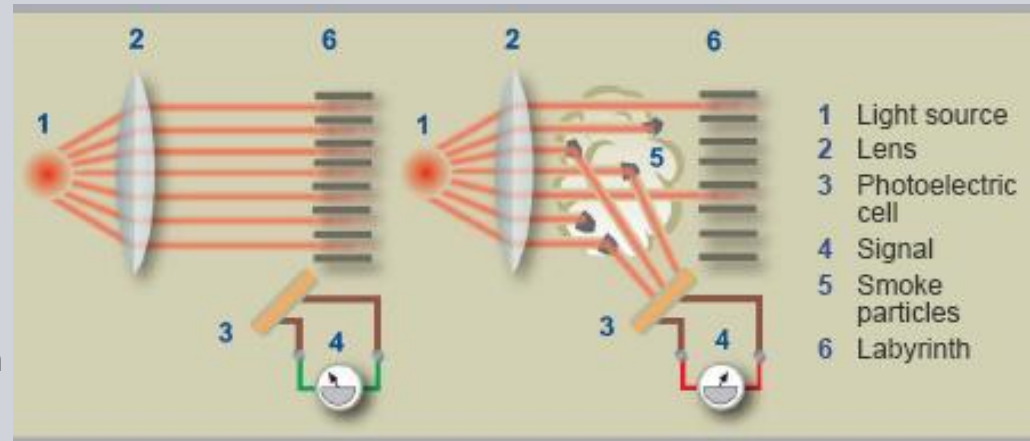
Application Notes

- Detects fire in the smoldering stage

- Detects particles >= 3 microns in size

- More resistant to deceptive phenomenon
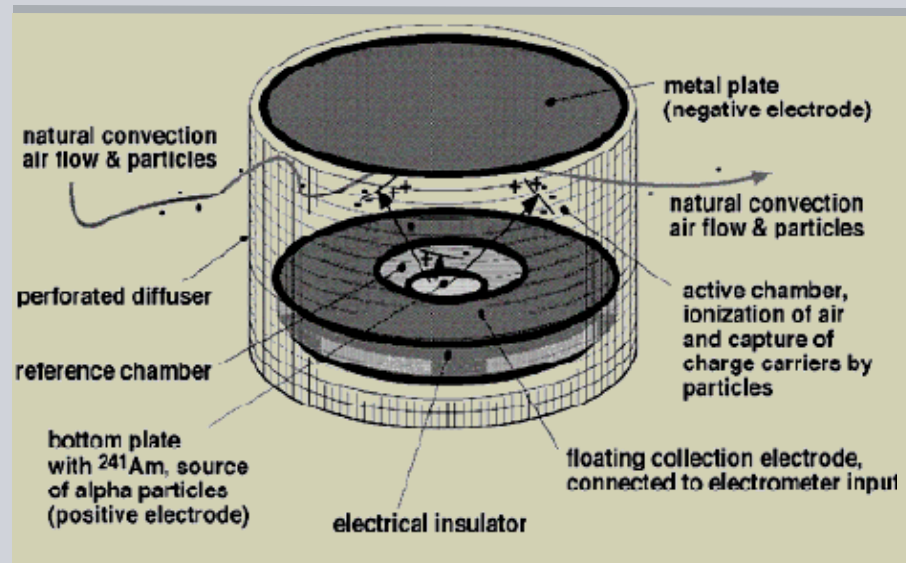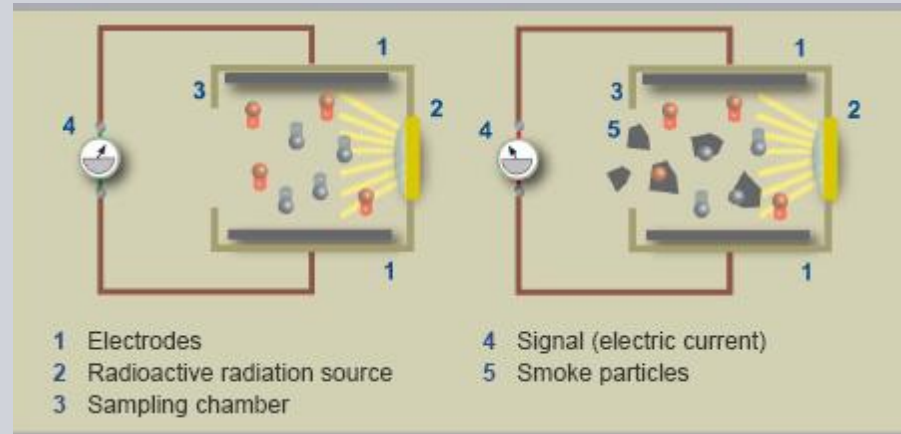

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Spot Smoke Detection – Ionization

Principle of Detection – Changes in Conductivity

- ^{241} Am – (Americium 241) source of alpha particles

- Half-life of ^{241} Am is 432.2 years

- Alpha particles are emitted to create current flow

- Emitter and collector electrodes measure changes

- Smoke particles absorb alpha particles and reduce current flow to create an alarm
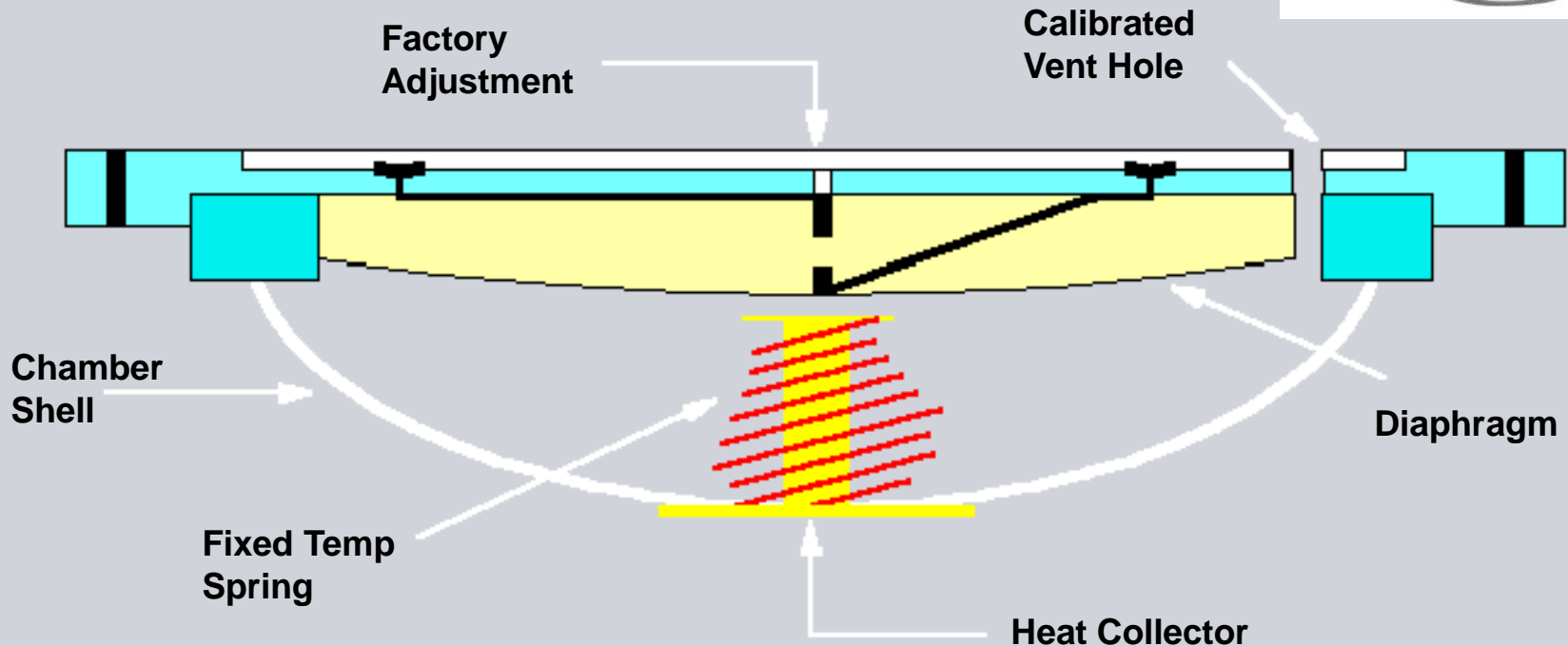
Application Notes

- Detects fire in the incipient stage

- Detects particles < 3 microns in size

- More unstable at higher airflows

- Requires proper safe disposal procedures

1	Electrodes	4 Signal (electric current)
2	Radioactive radiation source	5 Smoke particles
3	Sampling chamber	

- metal plate (negative electrode)
- natural convection air flow & particles
- natural convection air flow & particles
- perforated diffuser
- active chamber, ionization of air and capture of charge carriers by particles
- reference chamber
- bottom plate with ^{241}Am, source of alpha particles (positive electrode)
- floating collection electrode, connected to electrometer input
- electrical insulator

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Heat Detection – Fixed Temperature & Rate of Rise

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Factory Adjustment

Calibrated Vent Hole

Chamber Shell

Diaphragm

Fixed Temp Spring

Heat Collector

Temperature Rise of 15 degrees in 1 minute

Automatic Inputs

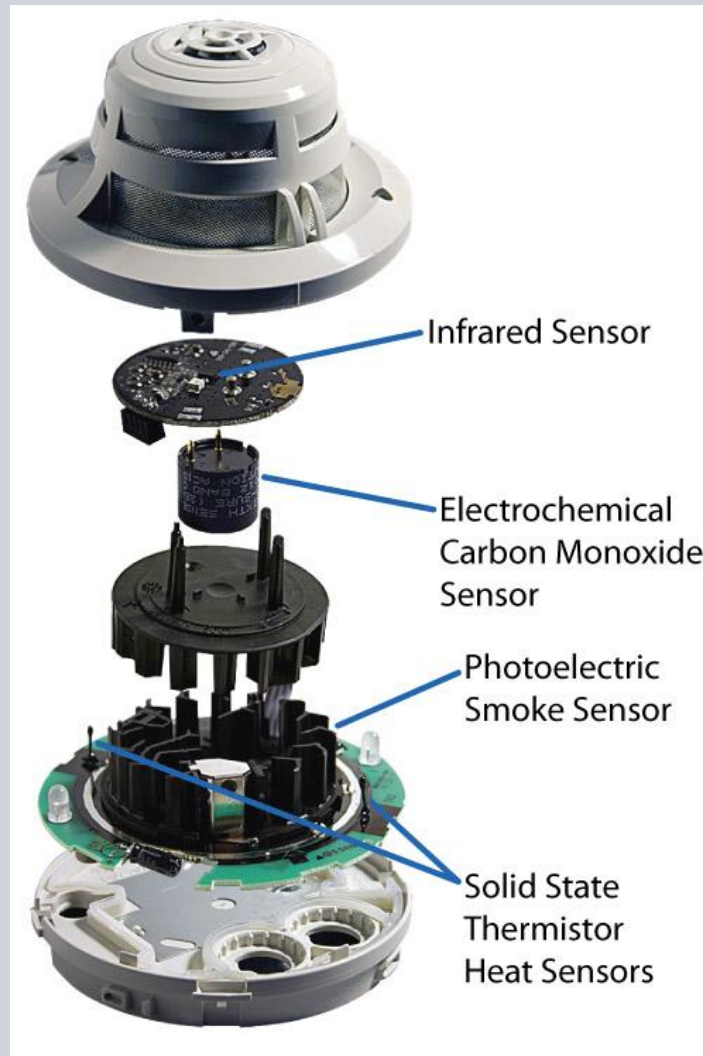| DEVICE TYPE	DESCRIPTION
	A multi-criteria detector is an electronic device that detects both smoke and heat. Specific algorithms that are loaded into the detector to detect fire faster and more reliably
	Carbon monoxide (CO) detectors sense the, colorless, odorless, poisonous gas produced by the incomplete combustion of various fuels, including coal, wood, charcoal, oil, kerosene, propane, and natural gas.

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Automatic Inputs

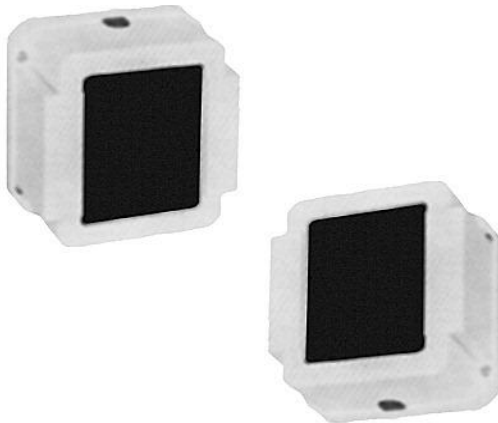| DEVICE TYPE	DESCRIPTION
	A multi-criteria detector CO detector is an electronic device that incorporates all the same features with the addition of carbon monoxide (CO) detection
	Detectors snap into fixed bases. Optional bases can provide a relay with a Form C output or a audible base with a local sounder.

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Multi Criteria

Infrared Sensor

Electrochemical Carbon Monoxide Sensor

Photoelectric Smoke Sensor

Solid State Thermistor Heat Sensors

Automatic Inputs

DEVICE TYPE	DESCRIPTION
	A duct smoke detector is a smoke detector that is built into a housing that can be mounted on the side of an HVAC air handling duct. It uses pipe-like probes to sample the air inside the duct for smoke.
	A beam smoke detector is a line-of-sight device that projects an electronic light beam across an open area to detect smoke. It measures the level of obscuration, the more smoke present, the more the beam will be obscured. Beam detectors are usually used effectively in large and/or high ceilinged spaces

Duct Smoke Detector – Typical Application

Detector Locations

- Downstream of the air filters and ahead of any branch connections in the air supply systems having a capacity greater than 2000 ft^3/min.

- At each story prior to the connection to a common return and prior to any recirculation or fresh air inlet connection in the air return systems having a capacity greater than 15,000 ft^3/min and serving more than one story. *NFPA 90A 6.4.2.1 2002 edition.*
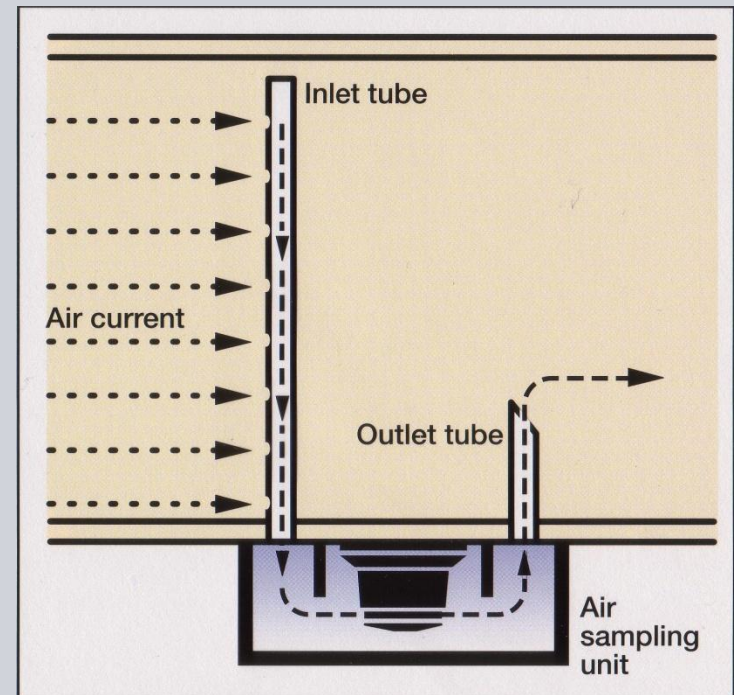

Detector Installation Example

But wait… now there is a choice!

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Beam Smoke Detection – Device Examples

PB 1191 Projected Beam Smoke Detector

- Easy Alignment and Installation
- Transmitter and Receiver in the Same Housing
- Two-Wire Installation
- Suitable for Ranges from 17 Feet to 280 Feet
- Spacing of 30 Feet between Parallel Installed units

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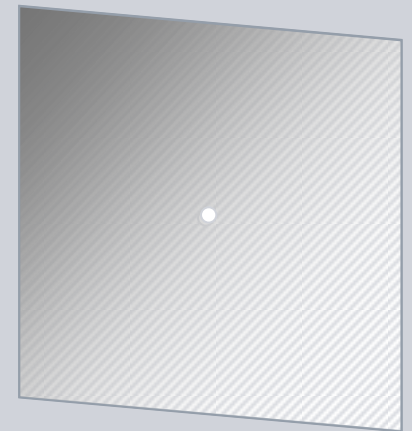
Automatic Inputs

DEVICE TYPE	DESCRIPTION
	Optical flame are line-of-sight detectors sense changes in radiant energy. They detects IR, UV & flicker rate of 0.5-15Hz . Triple IR flame detectors compare three specific wavelength bands within the IR spectral region and their ratio to each other to reliably detect flames.
	An aspirating smoke detector (ASD), consists of a central detection unit which draws air through a network of pipes to detect smoke. It is highly sensitive, and can detect smoke before it is even visible to the human eye.

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Flame Detector

Principle of Detection – Changes in Radiant Energy

- Detects IR, UV and Flicker Rate of 0.5-15Hz to verify flame

**Safe for Class I. Div 1**

Hazardous areas

Line of Sight

- Calibrated for a 1 sq. ft gasoline pan fire (60, 30, 15 ft selectable)

- Wired and supervised as a 4-wire initiating device (24vdc required)

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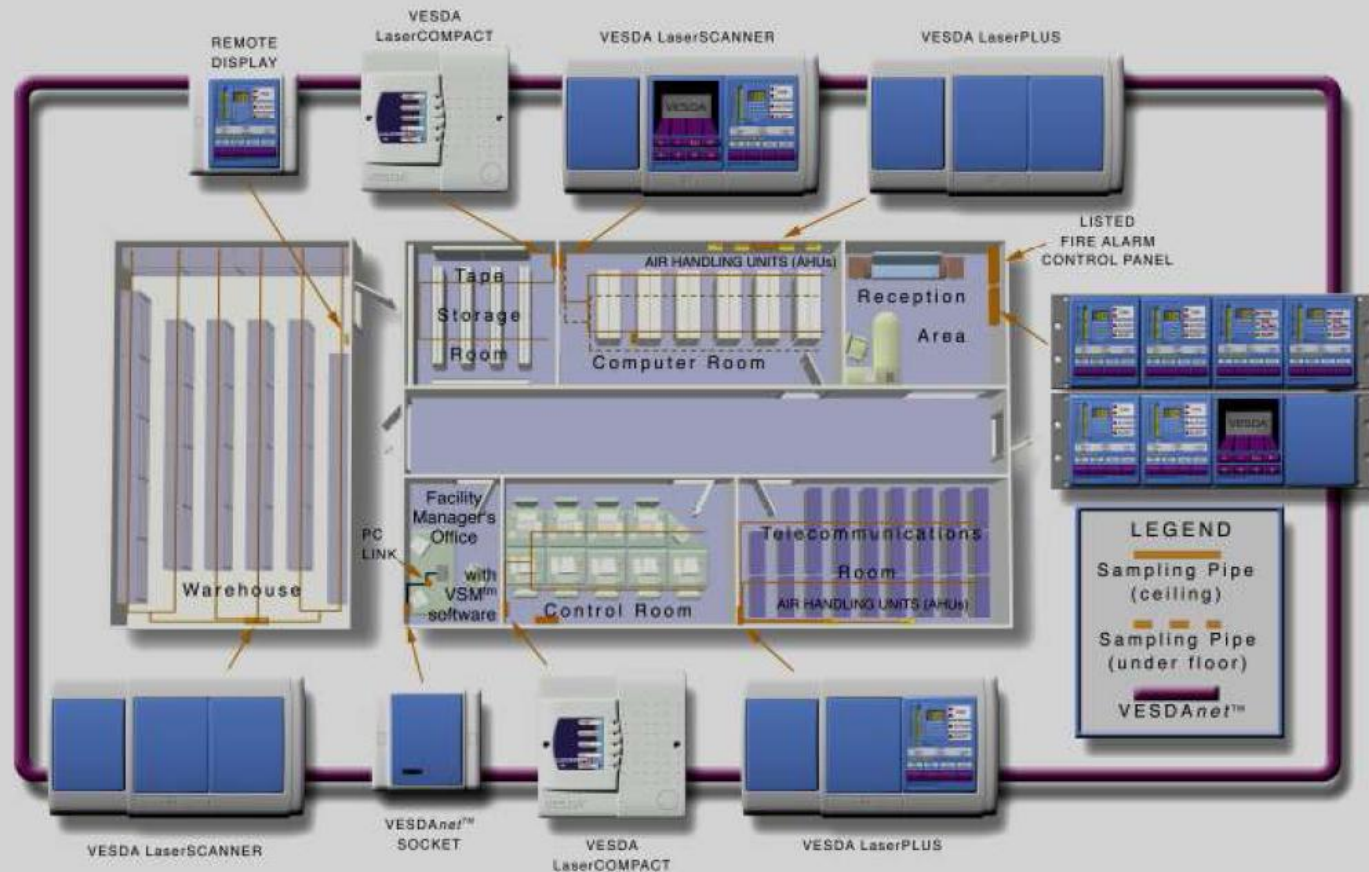# Aspirating Smoke Detection Principle

Aspirating smoke detectors are also known as air sampling smoke detection system or aspiration smoke detection (ASD). In the air sampling smoke detection system, air samples from the monitored area are guided to the detection chamber via a pipe network by means of a powerful suction system.

Pipe network   Suction points

Detection chamber

Suction mechanism
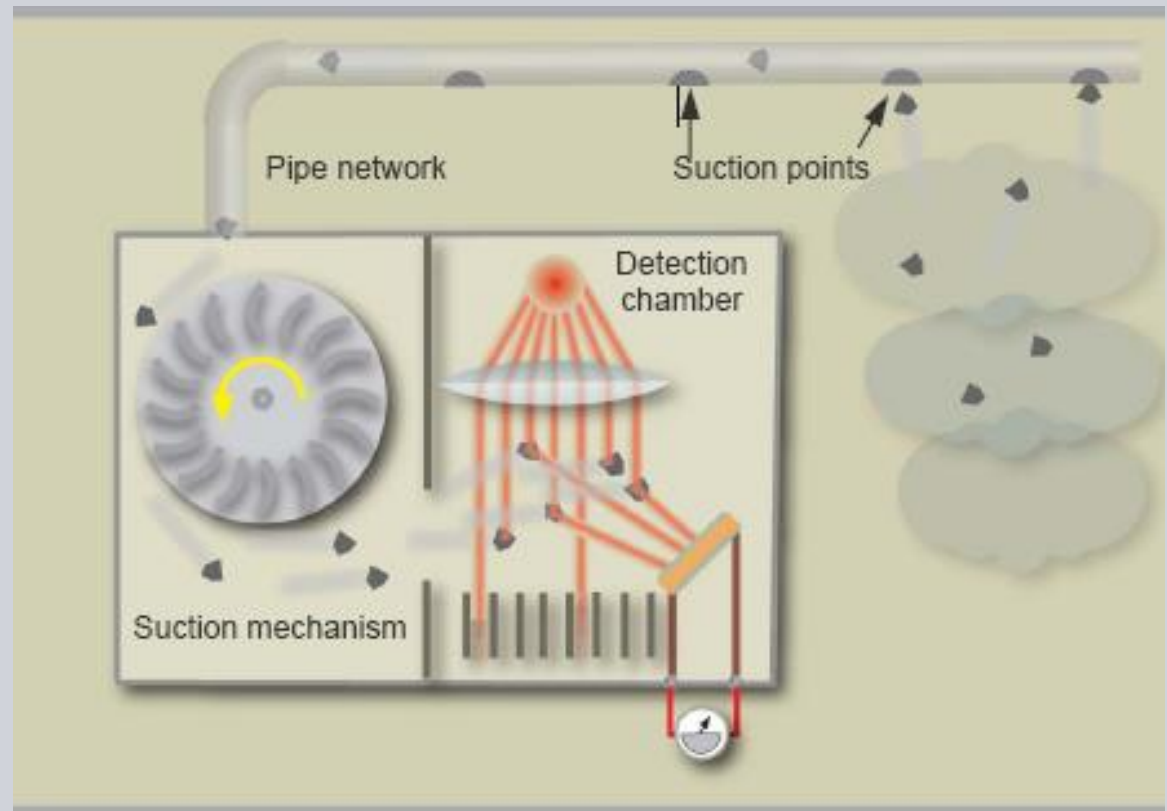
VESDA-NET

VESDA network allows for remote viewing and control of detectors.

High level interface to the fire alarm network reduces complexity and cost.

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VESDA Detection – Sample Layout

Air sampling piping network provides inlets which are spaced as smoke detectors.

There is no reduction needed for high air flow as with spot smoke detectors.

Air sampling point

VESDA Panel

CRAC Unit

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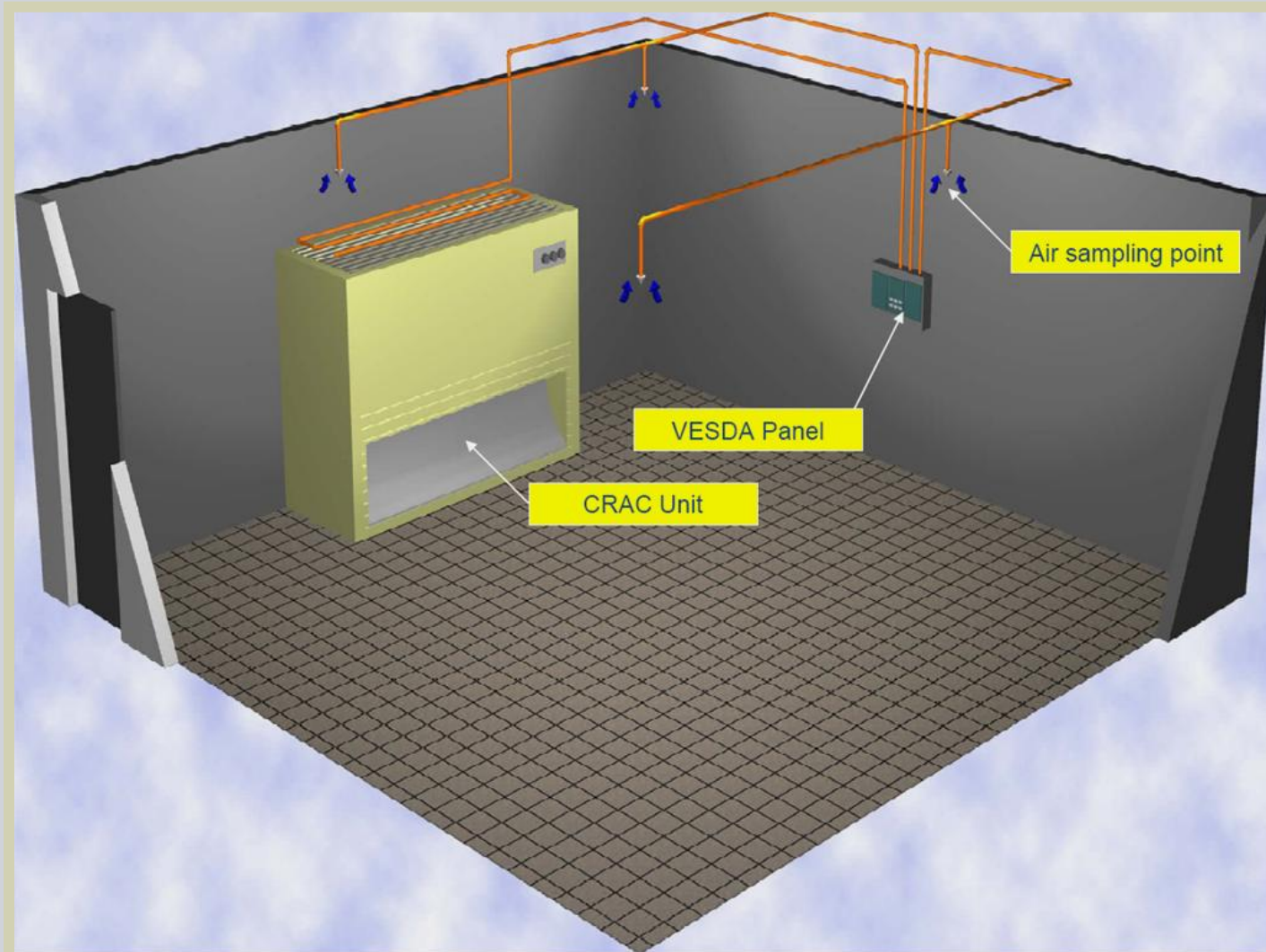
Video Smoke Detection

Principle

The system concept is to utilize advanced video analytics to identify smoke or flame utilizing either existing CCTV cameras or specialized devices.

This technology is recognized by NFPA 72 as an alternative provided the specific devices are listed for the purpose.

The NFPA technical committees that review this technology are currently working on a paper related to the best application for this detection.

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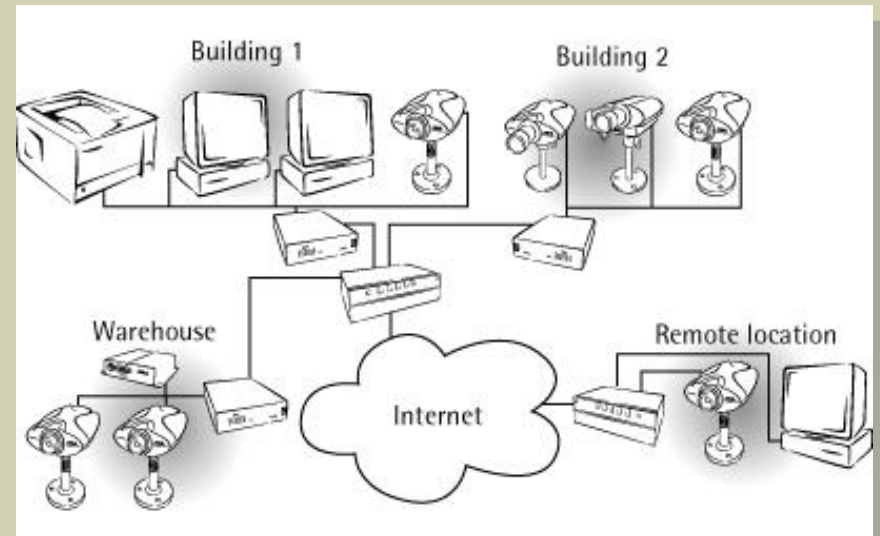
VID Video Imaging Smoke Detection

Video Detection

Video Imaging Smoke and Flame Detection using video cameras are now recognized by NFPA 72

There is not a lot of information in the 2007 edition but it is a sign that this new technology is approaching

You will see more from Siemens on this in the future. Please contact us with any questions you may have with this emerging technology

Detector Response – Summary

The selection of the **optimum fire detector is based on the expected fire phenomena**, generated by the incipient fire. For an office building, smoke detectors will preferably be selected, as in this case fires will produce clearly visible smoke both in the incipient phase and later. In a storage area where combustible liquids are stored, flame detectors and / or heat detectors would be the right choice.
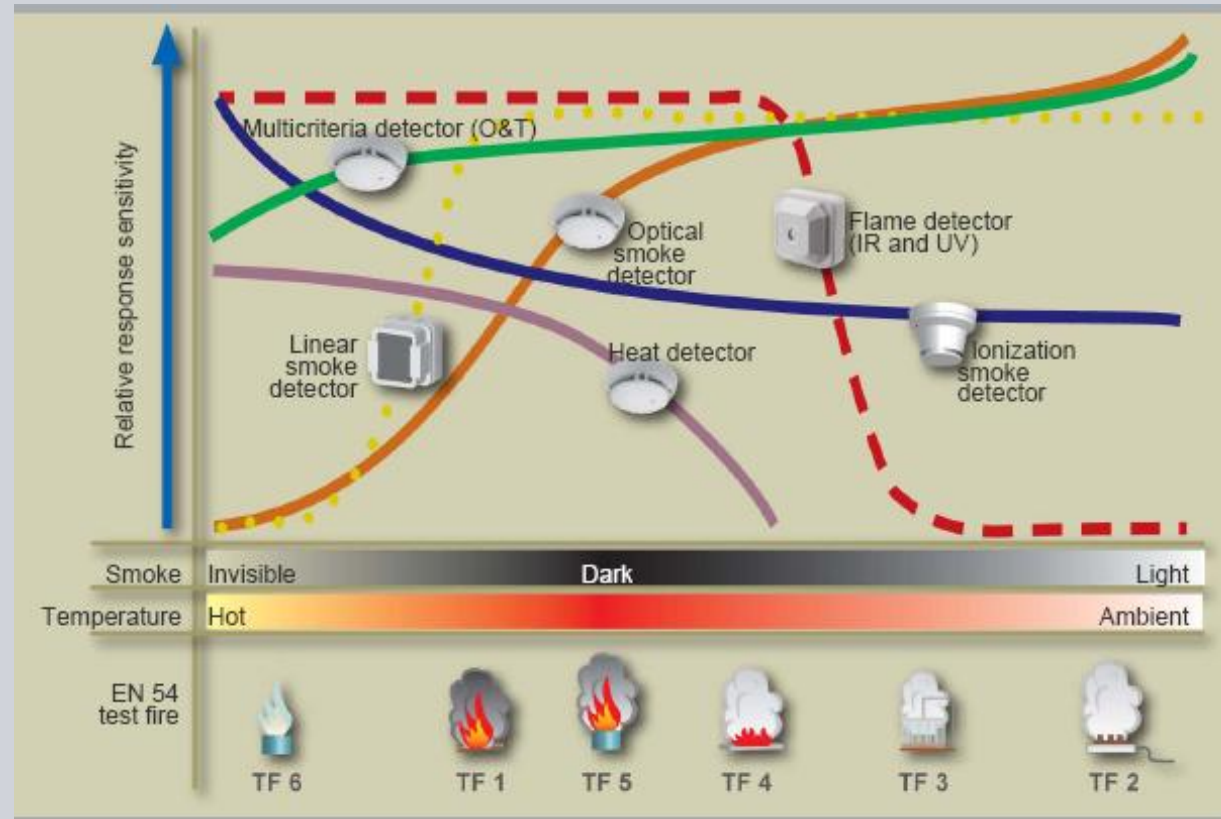

To be able to reliably detect all expected incipient fires, it may be necessary to combine different fire detector types.

Fire Alarm Input & Output Modules

Addressable modules can be customized for Almost any type of building system interface.

- General equipment override shutdowns
- Release holders for fire and smoke doors
- Override the building security system
- Cross zoning smoke detection (polling)
- Door locks release (Card Access)
- Extinguishing system Interface
- Elevator recall functions
- Air handling shutdown
- Damper control
- Smoke control

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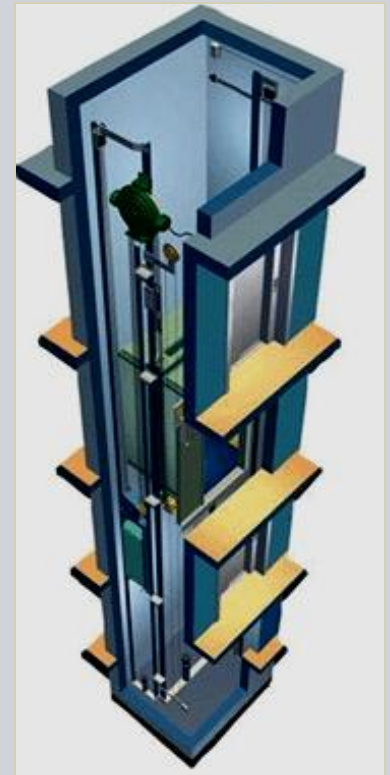
Construction Challenges for Detection

Considerations in product and technology selection:

- Accessibility for installation and future maintenance

- Extreme environments (temperature, humidity, dust, corrosive)

- Interference with building operations, such as an MRI room

- Security and limited access such as casinos, and detention centers

- Hazardous environments (Class 1 - Division 1, Explosion Proof)

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Notification Appliances

Upon receiving an alarm notification, the fire alarm control panel must now tell someone that an emergency is underway. Fire alarm systems utilize a variety of devices to alert building occupants and fire authorities within the protected area as well as outside that an event or fault has occurred. These appliances include:

1. Audible alarms (horns, voice speakers, bells, buzzers, chimes, etc.)
2. Visual alarms (strobes, flashing lights, etc.)
3. Text or video display that provides audible, tactile, or visible outputs

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Notification Appliance Power Boosters

With the introduction of the Americans With Disabilities Act ADA in 1991 it became a requirement to put visual signals thru any public accessible building. Most fire panels do not have the power capacity to support large quantities of strobes and the average 24vDC NAC can only run about 500ft with a 20% voltage drop (max permitted).

So the industry responded by producing signal booster panels that can be remotely located from the fire panel to give the extra power needed to operate the strobe lights, which have a high current, draw on start up. These panels are monitored and controlled by the FACP and require 120VAC and internal batteries.

PAD-3

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Fire Alarm Control Panels

Review of Controls on FA Panels

Fire Alarm Panel Controls

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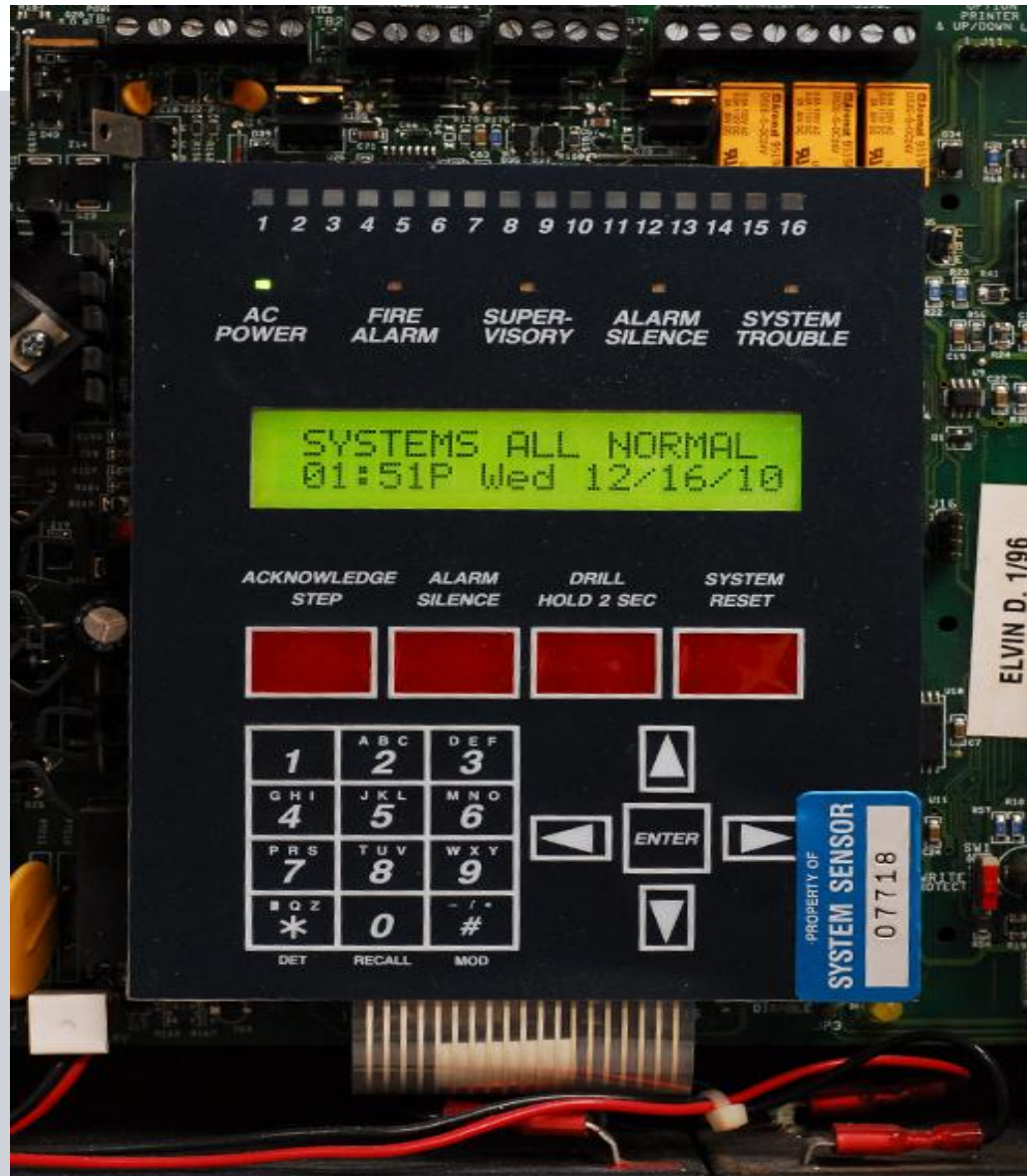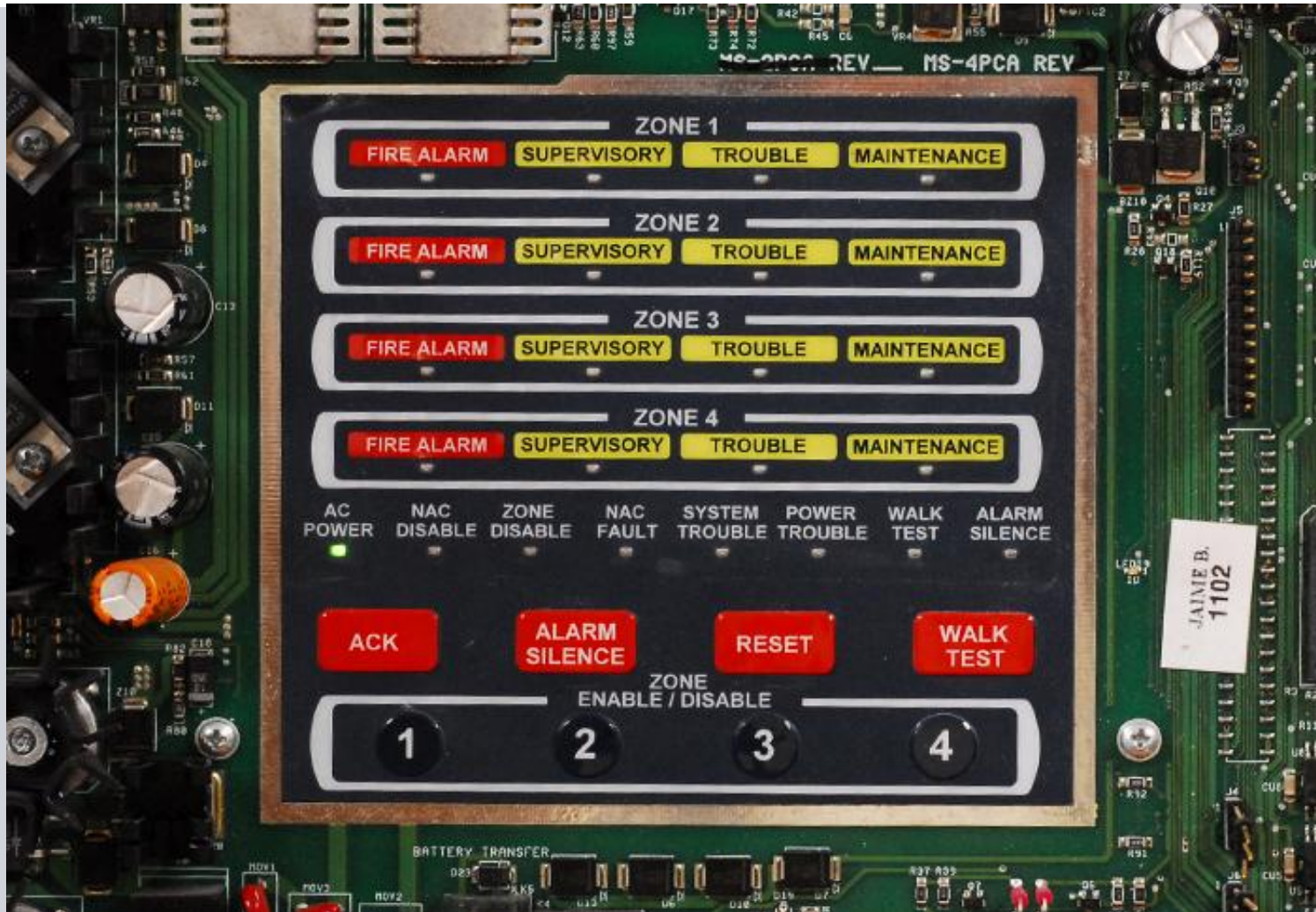
DACT Digital Alarm Communicator Transmission

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Integral Onboard DACT

▪UDACT Universal Digital Communicator Transmitter

▪411UD Slave/Stand Alone DACT

▪ Dedicated DACT "daughterboard"

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WIRELESS SERVICE FOR REMOTE SUPERVISING STATION CONNECTIONS

Wireless has been used in military and other government applications for more than 30 years.

Wireless began entering the Chicago's municipal market in the mid-90s.

Wireless networks replace the network of phone lines previously used to transmit the alarm signal.

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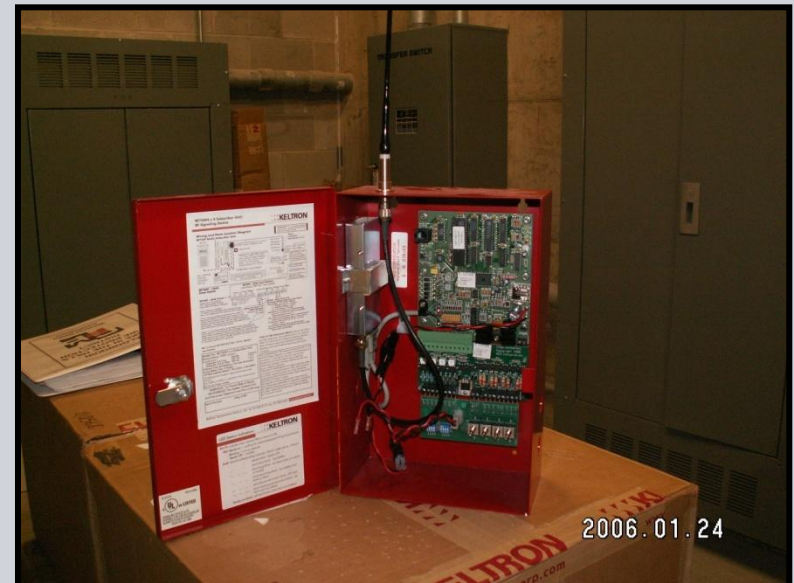
Wireless Connection to Fire Department

The wireless radio signal replaces the reverse polarity
or tones transmission that is currently carried
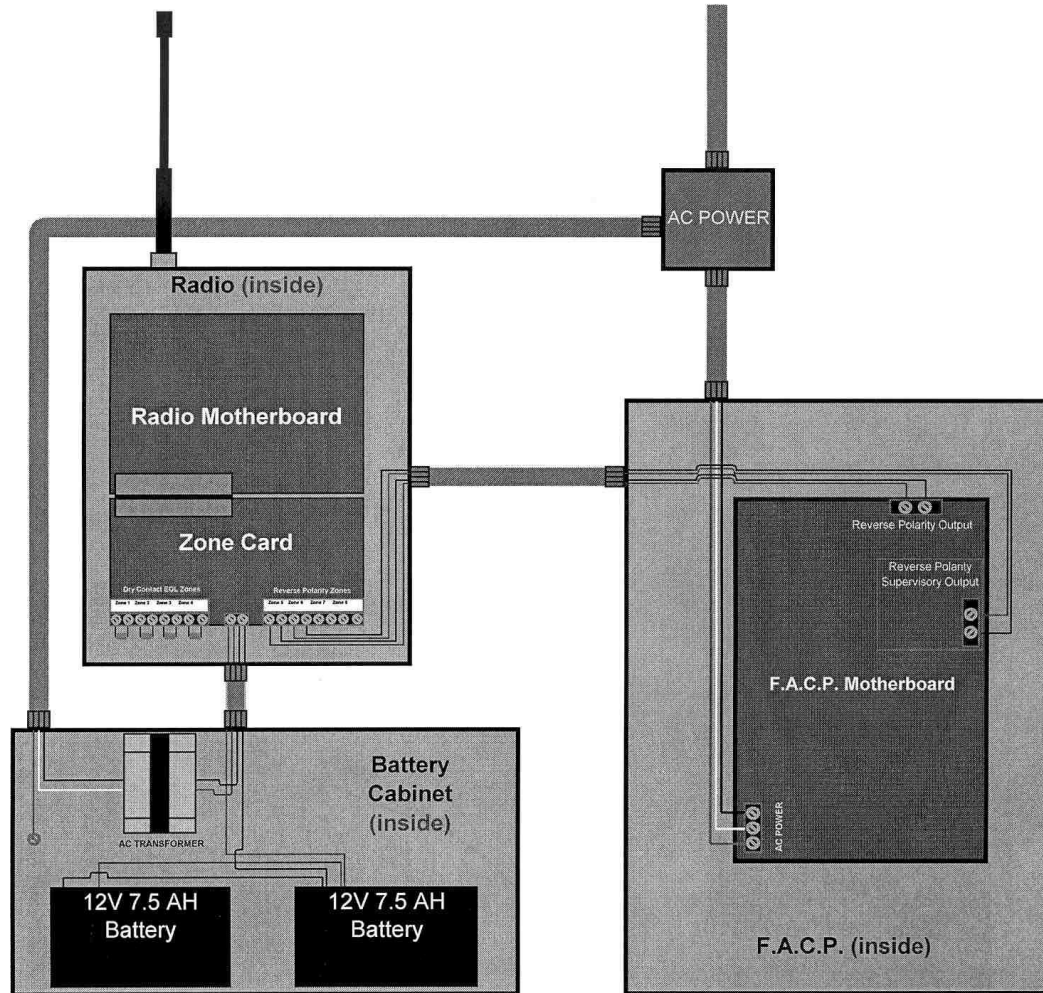on the fire alarm phone circuit.

The wireless network transmits:

- Full alarm conditions

- Supervisory conditions

- Trouble conditions

- Problems with the radio (loss of power, connection problems)

The radio network does not replace the fire alarm control panel. Connection is
made to the radio from the fire alarm control panel in a similar fashion as occurs
between the phone company's demark location and the fire alarm control panel.

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# Keltron Radio Standard Installation

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A. Operating power for the radio shall be from a dedicated fire alarm circuit. Power is permitted to be on the same circuit as the FACP, but may not be tapped from the inside of the FACP. NFAC NFPA 72 & NEC NFPA 70

B. The transformer is to be mounted in an enclosure and the power to the radio is required to be installed in conduit. The transformer may not be mounted within the FACP. NFAC NFPA 72 & NEC NFPA70

C. The radio shall be furnished with 60 hours of battery standby. NFAC NFPA 72

D. Fire alarm and supervisory inputs for Remote Station Signaling are required to be reverse polarity. Fire alarm and trouble signals shall be input 5 of the radio, Supervisory signals shall be on input 6. NFAC NFPA 72 and UL 864

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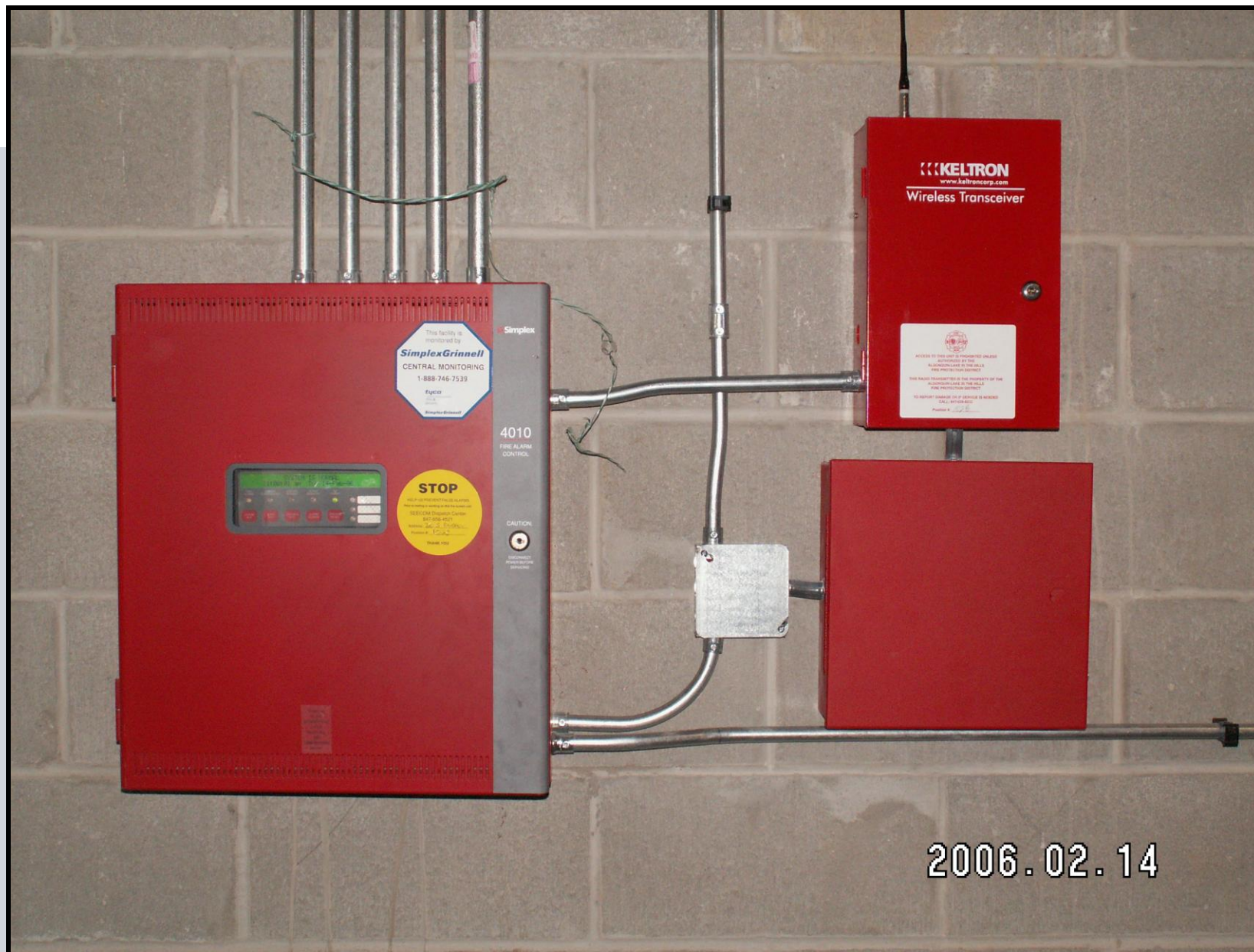
Fire Sprinkler Systems- FA Connections

Fire Sprinkler Waterflow Switch

Wet-Pipe Sprinkler Systems
use a vane-activated Water Flow Device (WFD) sized to the piping. The device reacts to a change in flow pressure of 10 psi, *which is the equivalent of one sprinkler head activating*. Retard devices inhibit false activation due to changes in water supply pressure.
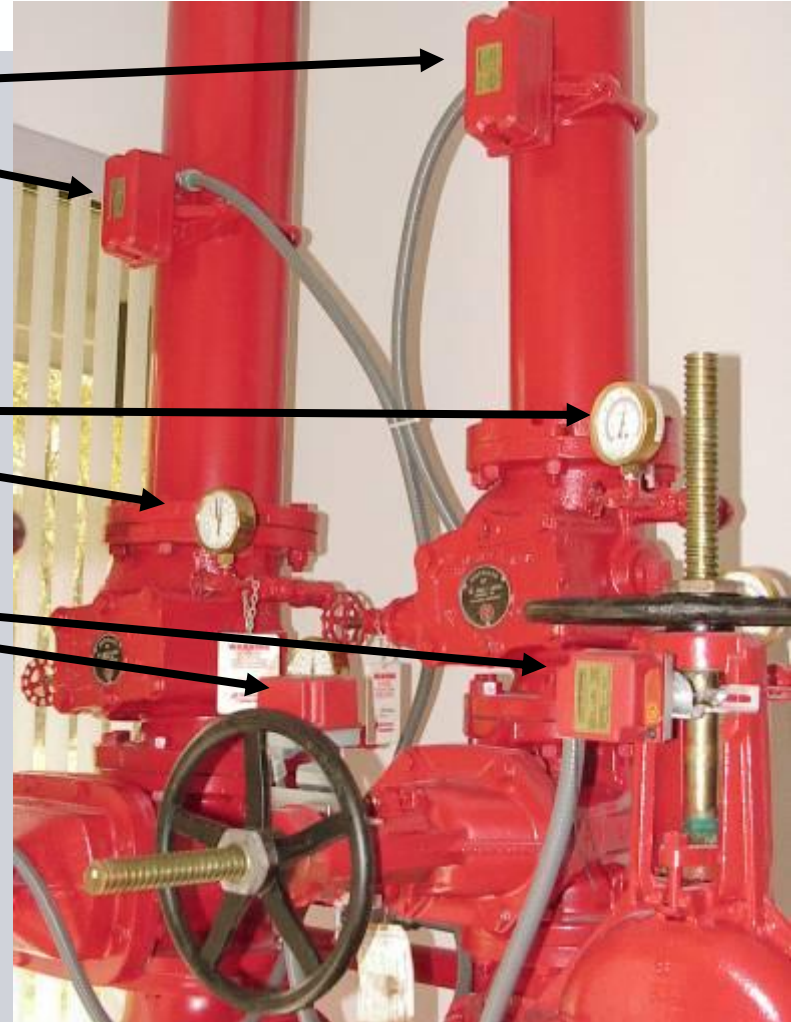
Fire Sprinkler Riser

- Waterflow Detectors

- Pressure Gauges

- Tamper Switches
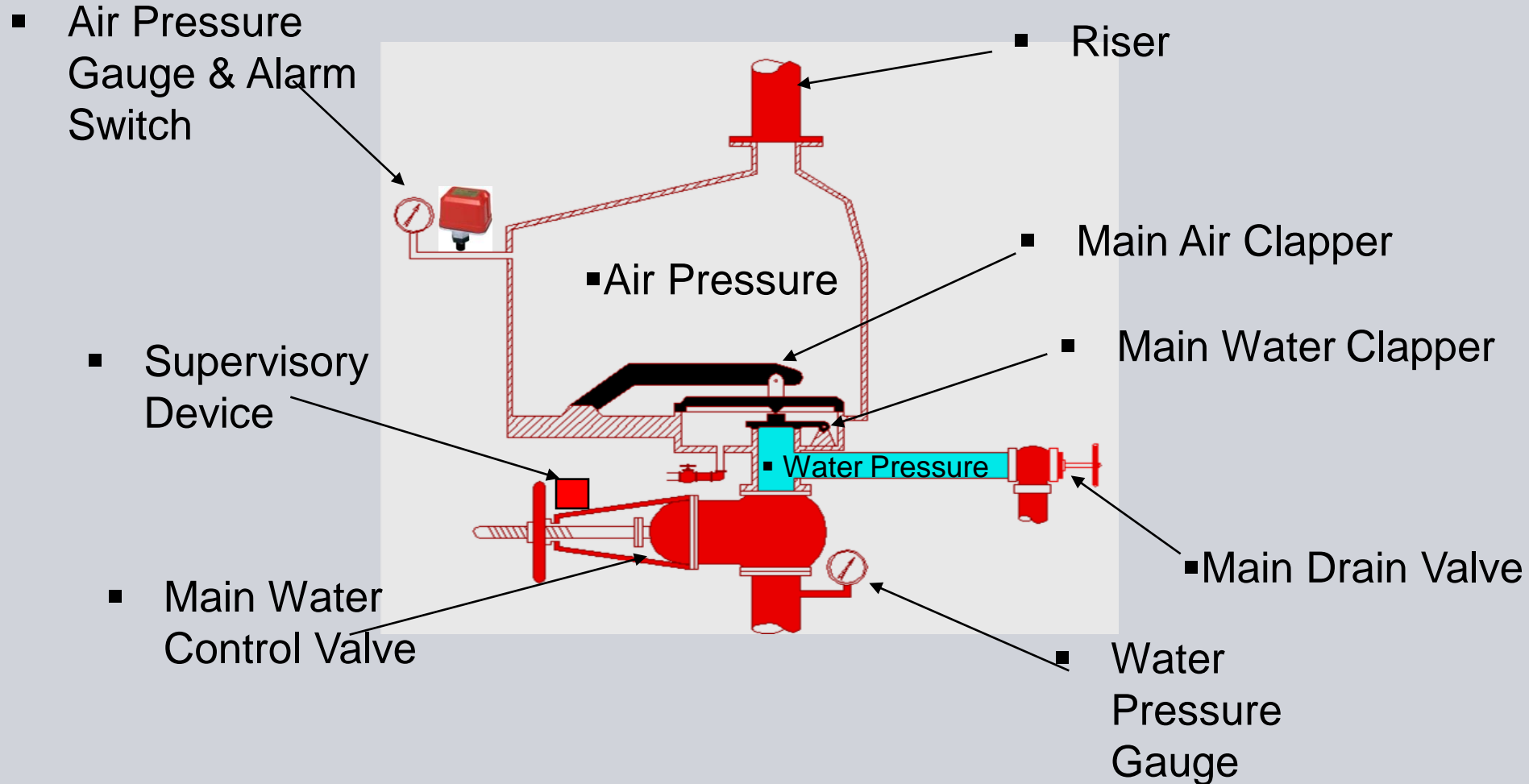

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Dry-Pipe Sprinkler: An automatic sprinkler system where all piping contains air under pressure. When a sprinkler head opens, the air is released and water flows into the system and through any open sprinkler heads into the fire. This type of system is used when freezing of water in the pipes is a concern.
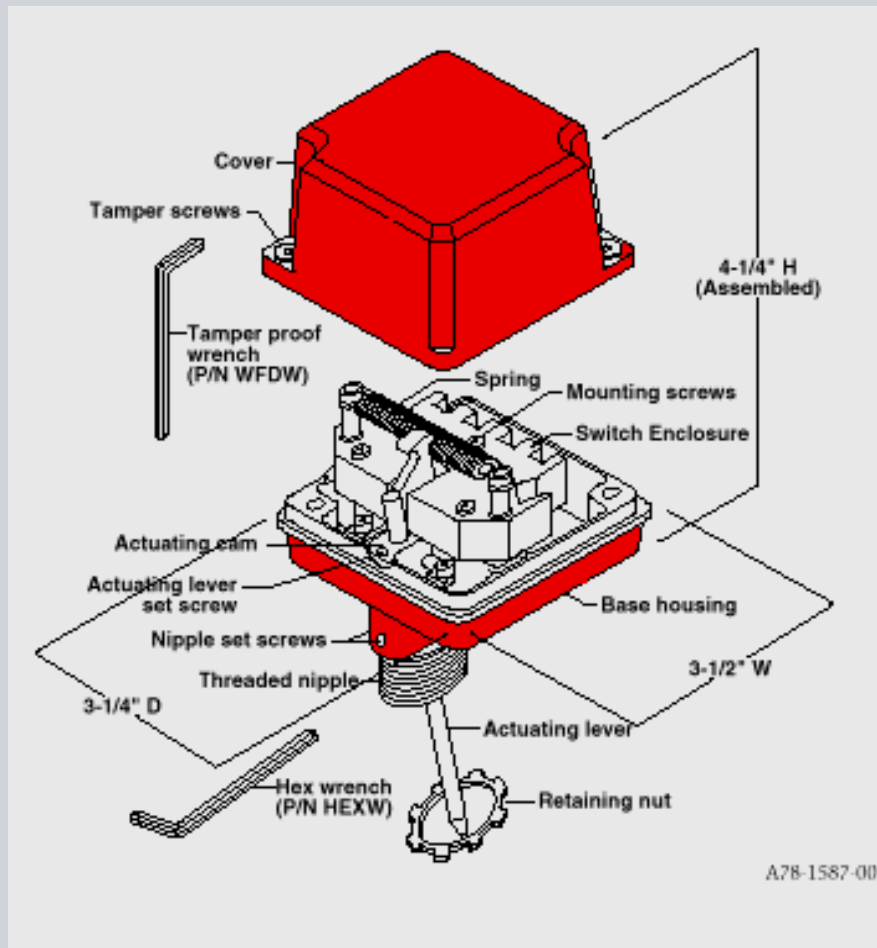
Dry-Pipe Sprinkler Systems use a pressure switch. The device reacts to a change in pressure due to water filling the system.

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Dry Pipe Valve

- Air Pressure Gauge & Alarm Switch

- Riser

- Air Pressure

- Main Air Clapper

- Supervisory Device

- Main Water Clapper

- Water Pressure

- Main Water Control Valve

- Main Drain Valve

- Water Pressure Gauge

PIV Post Indicator Valve

A fire alarm control panel could be used to monitor a number of critical sprinkler-related systems:

Air Pressure in a Dry System

Room Temperature Devices

Pressure Tanks

Fire Pumps (Pump running, Power failure)

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SIEMENS

References

- Jason Lupa, PE Siemens Industry

- Max McLeod,   Siemens Industry

- For Copies contact
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Thank You

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