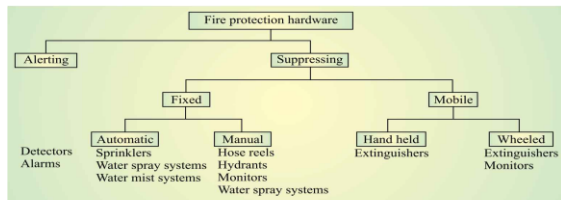
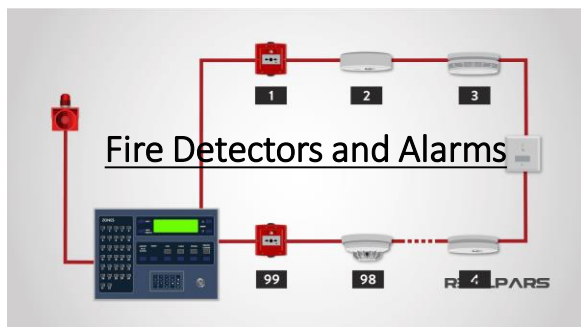


Fire Protection





Fire Detection and Alarm Systems

What are you expecting from it?

- to identify a developing fire emergency in a timely manner, and
- to alert the building's occupants and fire emergency organizations.

This is the role of fire detection and alarm systems.

Fire Detection and Alarm Systems

What are you expecting from it?

Depending on the anticipated fire scenario, building and use type, number and type of occupants and criticality of contents and mission, these systems can provide several main functions:

- provide a means to identify a developing fire through either manual or automatic methods.
- alert building occupants to a fire condition and the need to evacuate.

Fire Detection and Alarm Systems

Another common function is the transmission of an alarm notification signal to the fire department or other emergency response organization.

- Fire detection and alarm systems
- Fire-aid fire fighting equipment
- Water-based fixed fire protection systems
- Fixed systems based on media like carbon dioxide and vaporizing liquids.
- Mobile fire fighting appliances
- Communication systems.

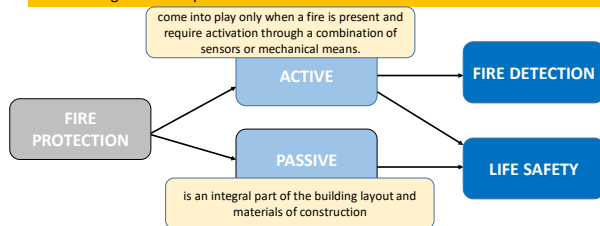
Fire alarm systems are installed to....

- To provide for the safety of occupants in buildings, and to make provision for their evacuation or refuge during a fire or other emergency,
- To provide fire department with early notification of a fire in a building and to direct them to the area of risk,
- To reduce loss of property; the property may have considerable intrinsic value and the insurers either require a fire detection system or may incentives its use,
- To reduce building damage; the building may be unoccupied for periods where equipment is still powered and the owner wishes to ensure that if anything goes wrong the fire department is called to the scene in a timely manner. Sometimes fire detection and alarm systems are used to compensate for structural fire protection shortcomings or to give special cover for items of high value,

- To reduce the amount of business lost, and
- Minimize risk to the public who attend unfamiliar properties. It is often a mandatory requirement by the Building Codes

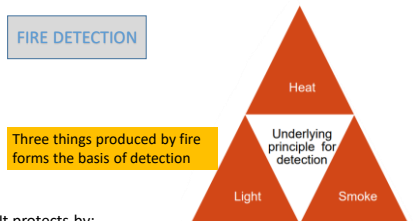
Fire Detection and Alarm System is electronic equipment which detects fire and raises alarm as warning of fire.

A fire alarm system is number of devices working together to detect and warn people through visual and audio appliances when smoke, fire, carbon monoxide or other emergencies are present.



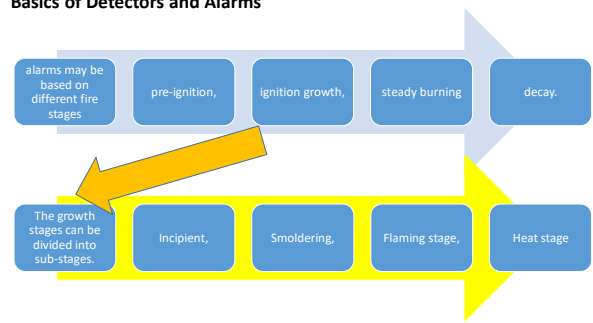
Basics of Detectors and Alarms

- When **people are present** v/s **people are not present** or not alert...
- Detectors make you alert by sensing one or more effects or products of fire, it may be thermal or non-thermal.



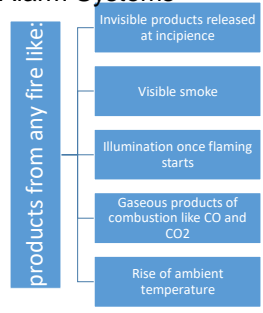
- It protects by:
- Detecting a fire at an early stage
 - To alert occupants, so that they escape the building safely.
 - Notifying the relevant personnel
 - To initiate automatic fire control and suppression system.
 - Identifying and guiding fire fighters

Basics of Detectors and Alarms



Fire Detection and Alarm Systems

a detector is primarily intended to detect the changes beyond some threshold value in its immediate environment due to either the effect or products of fire.



Fire Detection and Alarm Systems

Heat	Fixed temperature (expansion, melting/fusion, resistance thermistor)
	Rate of rise of temperature
	Combination
	Rate compensation
Smoke	Ionisation
	Photoelectric
	Aspirating
Gases	Carbon monoxide
Light	Visible light – light obscuration
	Visible light – light scattering
	IR radiation
	UV radiation

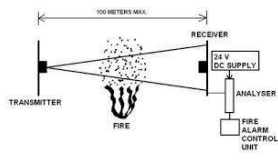
Classification of Sensors



Detectors Types Based on Effects



Spot Fire Detector



Line Fire Detector

- Remember it is the duty of a **Civil Engineer** and **Architect** to design such type of safe and protected buildings when they are at the stage of designing of any new site.

Fire Detection and Alarm Systems

- The area may be covered by the **spot detectors** will depend on...
 - the type of detectors,
 - compartment configuration,
 - ambient conditions etc.
- In large spaces, **Line detectors** are preferred.

Fire Detection and Alarm Systems

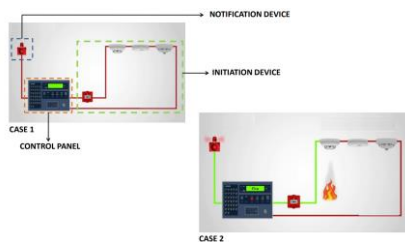
Choice of selecting a detector depends on

- The speed of response required
- Need to minimize false alarms
- The nature of the fire hazard
- Cost, suitability for environment, maintenance requirement, etc.

Fire Alarm System Components

System Components

- Control Panel
- Initiation Device
- Alarm Notification device



Control Panel

1. Control panel serves as the “brain” of the system.
2. Manages and monitors the proper operation of the system
3. It can indicate the source of an alarm so that responding fire personnel will know what activated the alarm and where the initial activation occurred.
4. Also manages the primary power supply and provides a backup power supply for the system.
5. It may perform additional functions, such as notifying the fire department when the alarm system is activated, and may interface with other systems and facilities.
6. Control panels vary greatly, depending on the age of the system and the manufacturer.

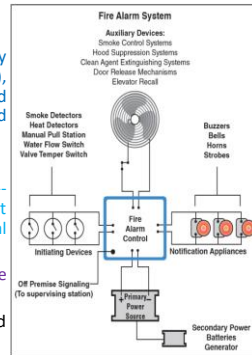


Control Panel

7. Fire alarm control panels are used to silence the alarm and reset the system.
8. Many buildings have an additional display panel, called a remote annunciator, in a separate location.
9. The fire alarm control panel should also monitor the condition of the entire alarm system to detect any faults.
10. A fire alarm system is usually powered by a 110-volt line, even though the system's appliances may use a lower voltage.
11. In some systems, a battery in the fire alarm control panel will automatically activate when the external power is interrupted.
12. The control panel in a large building may be programmed to perform several additional functions

Fire alarm control unit (FACU)

- The fire alarm control unit (FACU), formerly called the fire alarm control panel (FACP), contains the electronics that supervise and monitor the integrity of the wiring and components of the fire alarm system.
- The FACU --- the brain for the alarm system.
- It receives signals from alarm-initiating devices-- processes the signals, & produces output signals that activate audible and visual appliances.
- The FACU also transmits signals to an off-site monitoring station .
- Power and fire alarm circuits are connected directly into this panel



FACU can also perform other functions, such as:

- Providing two-way firefighter communication
- Controlling elevators, HVAC, fire doors, dampers, locks, or other fire protection features
- The FACU can also provide public address messages and mass notifications alerts through prerecorded evacuation messages or independent voice communications.

PRIMARY POWER SUPPLY

- The primary electrical power supply usually comes from the building's main power connection to the local utility provider.
- The FACU must supervise the primary power supply and signal an alarm if the power supply is interrupted



SECONDARY POWER SUPPLY

- All fire alarm systems must have a secondary power supply.
- This requirement is designed so that the system will be operational even if the main power supply fails.
- Secondary power sources can consist of batteries with chargers, engine-driven generators with a storage battery, or multiple engine-driven generators, of which one must be set for automatic starting.
- The system shall be capable of powering the required load for a duration of not less than 24 hours,

2. INITIATING DEVICES

- A fire detection system consists of manual and automatic alarm-initiating devices that are activated by the presence of fire, smoke, flame, or heat.
- **MANUAL ALARM-INITIATING DEVICES**
 - Manual pull stations
- **AUTOMATIC ALARM-INITIATING DEVICES**
 - Smoke detectors
 - Flame detectors
 - Heat detectors



A ceiling-mounted re alarm speaker and strobe light combination unit.



Different types of smoke detectors.



Smoke and carbon mono-oxide combination detector

NOTIFICATION APPLIANCES

- Audible notification signaling appliances are the most common types of alarm-signaling systems used for signaling a fire alarm in a structure.
- Once an alarm-initiating device is activated, it sends a signal to the FACU, which then processes the signal and initiates actions.
- The primary action initiated is usually local notification, which can take the form of:
 - Bells
 - Buzzers
 - Horns
 - Speakers
 - Strobe lights
 - Other warning appliances



Notification appliances fall under the following categories :

- Audible — Approved sounding devices, such as horns, bells, or speakers, that indicate a fire or emergency condition.
- Visual — Approved lighting devices, such as strobes or flashing lights, that indicate a fire or emergency condition.
- Textual — Visual text or symbols indicating a fire or emergency condition.
- Tactile — Indication of a fire or emergency condition through sense of touch or vibration.

ADDITIONAL ALARM SYSTEM FUNCTIONS

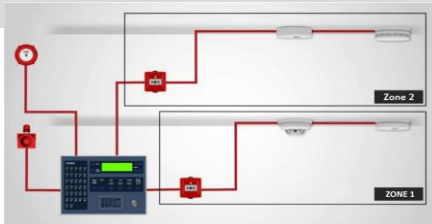
Building codes have special requirements for some types of occupancies in case of fire.

In these cases, the fire detection and alarm system can be designed to initiate the following actions:

- Turn off the heating, ventilating, and air-conditioning (HVAC) system
- Close smoke dampers and/or fire doors .
- Pressurize stairwells and/or operate smoke control systems for evacuation purposes
- Unlock doors along the path of egress
- Provide elevator recall to the designated floor and prevent normal operations .
- Operate heat and smoke vents
- Activate special fire suppression systems, such as preaction and deluge sprinkler systems or a variety of special-agent fire extinguishing systems

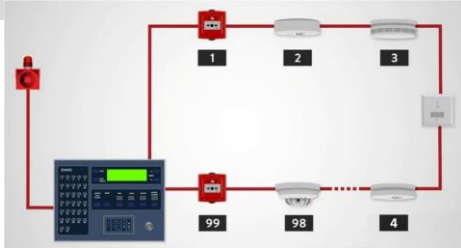
CONVENTIONAL ALARM SYSTEMS

A conventional alarm system is the simplest type of protected premises alarm system. When an alarm-initiating device, such as a smoke detector, sends a signal to the FACU, all of the alarm-signaling devices operate simultaneously.



ADDRESSABLE ALARM SYSTEMS

Addressable alarm systems display the location of each initiating device on the FACU and an annunciator panel if provided. This connection enables emergency responders to pinpoint the specific device that has been activated.



ZONED CONVENTIONAL ALARM SYSTEMS

- Fire-alarm system annunciation enables emergency responders to identify the general location, or zone, of alarm device activation.
- In this type of system, an annunciator panel, FACU, or a printout visibly indicates the building, floor, fire zone, or other area that coincides with the location of an operating alarm-initiating device



EMERGENCY COMMUNICATIONS SYSTEMS

- An emergency communications system is a supplementary system that may be provided in facilities in conjunction with detection and alarm signaling systems.
- The purpose of emergency communications systems is to provide a reliable communication system for occupants and firefighters.

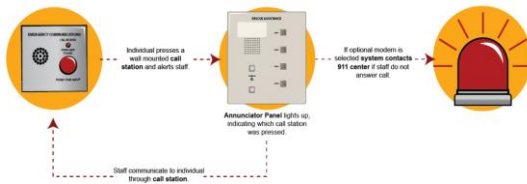
1. Voice Notification Systems

- A one-way voice notification system warns building occupants that action is needed and tells them what action to take.
- This type is most commonly used in high-rise buildings, places of assembly, and educational occupancies



2. Two-Way Communication Systems

- This system is most helpful to fire suppression personnel who are operating in a building, particularly in high-rise structures that interfere with portable radio transmissions.

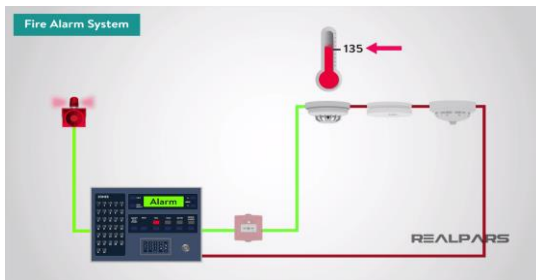


3. Mass Notification System (MNS)

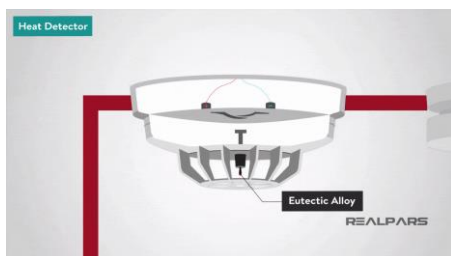
- MN System that notifies occupants of a dangerous situation and provides information and instructions.
- The purpose of a mass notification system (MNS) is to provide emergency communications to a large number of people on a wide-scale basis.
- This communication can be directed to the occupants of a building or even an entire community.

Heat Detector

Heat detector can either work on a fixed temperature basis, where it will trigger an alarm if the temperature exceeds a pre-set value or they can work on the rate of change in temperature.



Commonly Heat detectors work in a similar way to an electrical fuse, the detectors contain a eutectic alloy which is heat sensitive when a certain temperature is reached the alloy turns from a solid to a liquid which in turn triggers the alarm.



Heat Detector

Fires have two types of thermal effects:

- Rise of temperature in the immediate surroundings
- Faster rise of ambient temperature than that due to normal atmospheric changes.
- Both of these effects are utilized as principles of actuation of heat detectors.

Fixed-Temperature Heat Detector

- The detecting element in these detectors must be fully heated to its set temperature for the alarm to be actuated, which makes suited for slow-growing fires.
- For fast-growing fires, the detector element may not be fully heated but just getting even small heated, it will get activated.

Fixed-Temperature Heat Detector



Fixed-Temperature Heat Detector

- Fusible elements
- Expanding metal or a gas
- Quartzoid bulb type sprinklers
- Bimetallic elements
- Line detectors

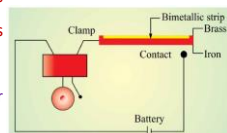
Fusible Elements

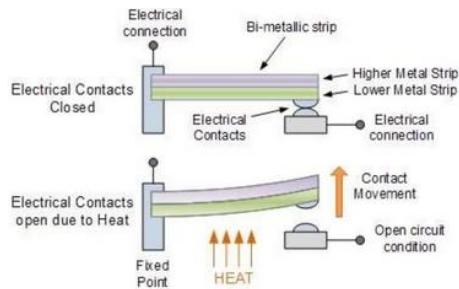
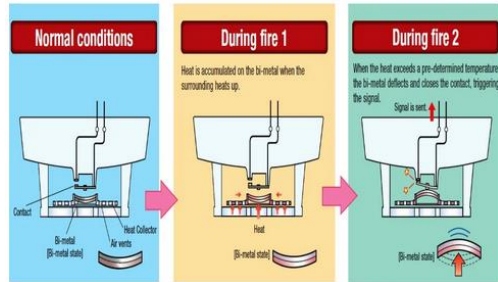
- Some alloys and eutectic metals such as Bi, Pb, Sn or Cd melt at relatively low temperatures (55-180 °C).
- The fusible element can be a solder to hold a spring under tension.
- When the element fuses due to fire, the spring is released to complete a circuit and initiate an alarm.
- These are not reusable detectors.



Bimetallic Elements

- When a bimetallic strip made of two metals with different thermal expansion coefficients such as Fe and Cu is heated, one expands more than the other.
- Ni-Fe alloy (Invar) which are generally used for low expansion components.
- While Mn-Cu-Ni, Ni-Cr-Fe or stainless steel alloys are used for high expansion components.





Break-line Cable

- A length of flexible PVC insulated cable is cut at intervals and the bared conductors are rejoined with a low-melting fusible alloy.
- Under the normal conditions, there is a steady flow of current through the conductor but during a fire, the fusible joint melts and this break in circuit acutates an alarm.
- This is a simple form of a line detector.

Expansion of Gases

- Gases have high expansion coefficient which can be used in pneumatic heat detectors.
- Air is filled into chamber with a flexible diaphragm.
- Rise in air temperature expands the air in the chamber and exerts pressures on the diaphragm.
- Sustained expansion pushes up the diaphragm until it completes an electrical circuit and raises the alarm.

Expansion of Liquids

- The best example of heat detector based on thermal expansion of liquids is the Quartzoid bulb sprinkler.
- Both liquid and the air bubble contained within the liquid expand when there is a rise in temperature of surrounding air.
- In the case of a fire, the temperature rises and the glass bulb shatters and water is sprayed over the designed area.

Rate-of-Rise (ROR) of Temperature Heat Detector

- This is designed for the fast growing fires as there will be rapid temperature rise.
- The internal components constantly compare the temperature of the surroundings to a baseline temperature programmed into the detector.
- It will compensate for any normal variations in ambient temperature.
- Once the temperature reaches at a predetermined criteria of temperature, alarm is actuated.
- ROR responds in the range of 7-8 °C/min or higher range and is best suited for the inaccessible areas.

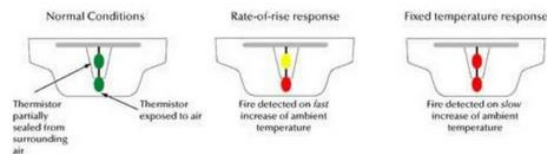
Combination Heat Detector

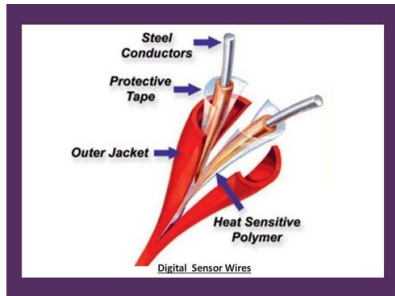
- This can give the advantage of both fixed temperature and ROR detectors i.e. for slow as well as rapid fire.
- In case of slow fire, it will compensate any temperature rise in chamber but if there is a rapid rise in temperature, the air in the chamber expands faster and it will push the diaphragm against the electrical contact to complete the circuit and raise the alarm.
- This combination heat detectors are good for the areas with unstable, high average temperatures such as an area where the several ovens are opened and closed routinely.

Line Detector



- There is a pair twisted wires of different metals or alloys to give them right strength, conductivity and corrosion resistance.
- Each wire is insulated with material that loses its insulating property at higher temperatures.
- The wire pairs have outer jacket to protect against damaging environmental conditions.
- When the fixed temperature is reached at any point along the line detector, the wires will come into the contact of each other to create a short circuit and actuate an alarm.





Smoke Detector

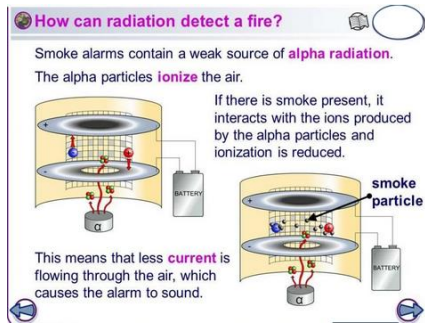
SMOKE DETECTION SYSTEMS

- IDENTIFY PARTICLES OF COMBUSTION

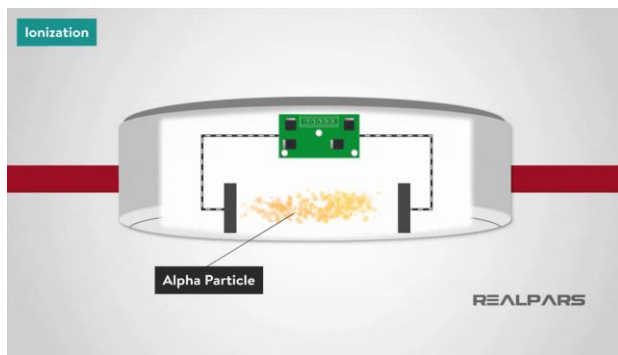
There are three basic types of smoke detectors including:

- ☐ Ionization
- ☐ Light Scattering
- ☐ Light Obscuring

- MOST COMMON TYPES ARE **PHOTOELECTRIC** AND **IONIZATION**



- Ionization Smoke detector generally contains two chambers.
- The first is used as a reference to compensate for changes in ambient temperature, humidity or pressure.
- The second chamber contains a radioactive source, usually alpha particle, which ionizes the air passing through the chamber where a current flows between two electrodes.
- When smoke enters the chamber the current flow decreases.
- This drop in current flow is used to initiate an alarm.



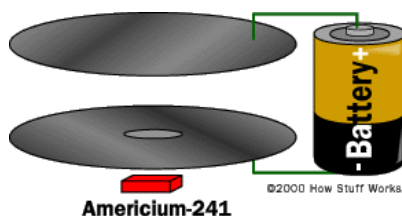
IONIZATION DETECTORS

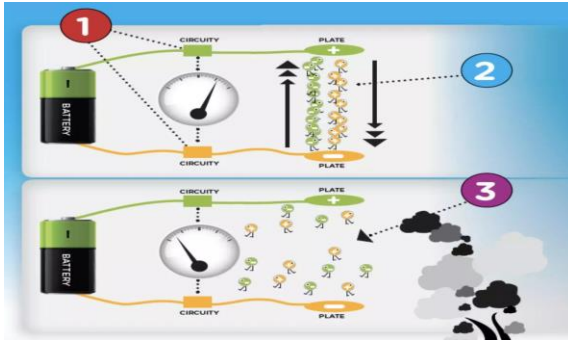
- USE A PIECE OF RADIOACTIVE MATERIAL (ALPHA RADIATION)
- The alpha particles generated by the americium ionize the oxygen and nitrogen atoms of the air in the chamber.
- When you knock an electron off of an atom, you end up with a free electron (with a negative charge) and an atom missing one electron (with a positive charge).

Ionization Detectors

- The electronic sensor in the smoke detector sense the small amount of electrical current that these electrons and ions moving toward the plates represent.
- When smoke enters the ionization chamber, it disrupts this current -- the smoke particles attach to the ions and neutralize them.
- The detector senses the drop in current between the plates and sets off the horn.

IONIZATION DETECTORS





IONIZATION DETECTORS



PHOTOELECTRIC DETECTORS

- Particles of combustion distort a light beam
- Distorted light beam activates signal
- work on the principles of the amount of light reaching a photoelectric cell.
- two types of photoelectric detectors: **Light Obscuration Type** and **Light Scattering type**.

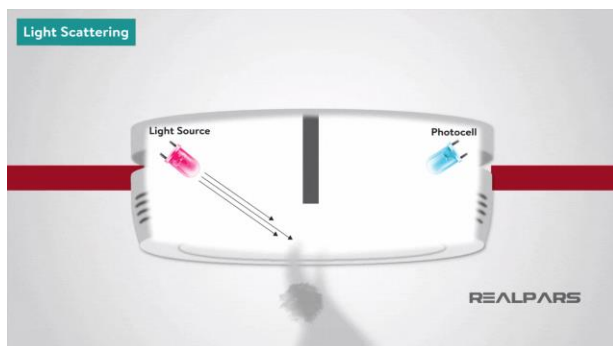
PHOTOELECTRIC DETECTORS

- These are installed under non-fire conditions when the detector chamber is free from any smoke particles, light emitted from the source does not reach the sensor.



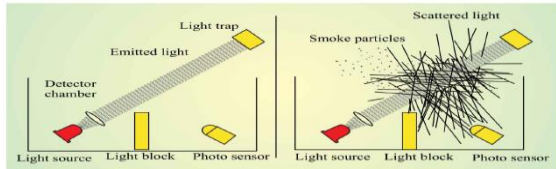
Light Scattering Smoke Detector

- The light scattering smoke detector operates on the [Tyndall effect](#); a photocell and light source are separated from each other by a darkened chamber such that the light source does not fall on the photocell.
- The passage of smoke into the chamber causes the light from the source to be scattered and fall on the photocell.
- The photocell output is being used to initiate an alarm.



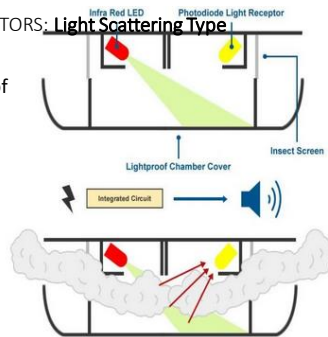
PHOTOELECTRIC DETECTORS: **Light Scattering Type**

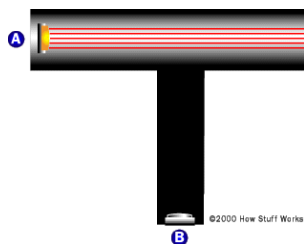
- When smoke enters the chamber, some of light is scattered toward the sensor and reaching to the cell will either create current or allow more current to flow through it and alarm will give sound.



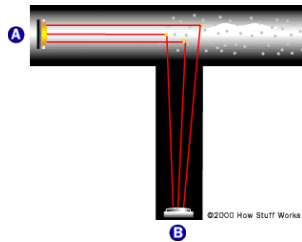
PHOTOELECTRIC DETECTORS: **Light Scattering Type**

- This is spot type of detector.

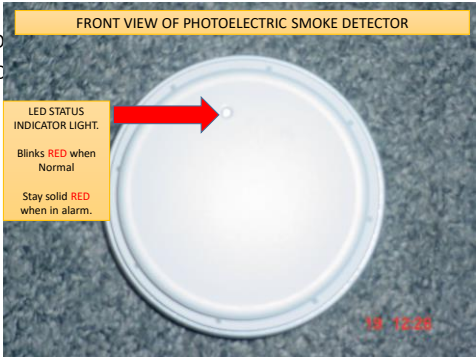


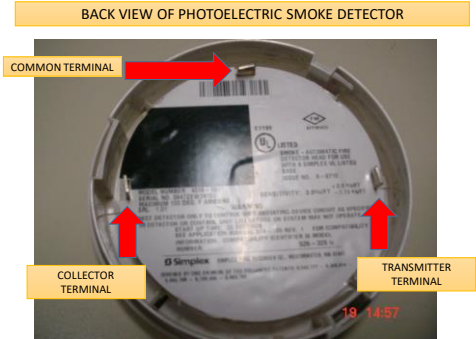
PHOTOELECTRIC DETECTORS: **Light Scattering Type**

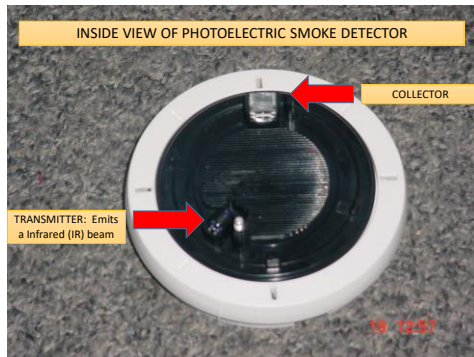
PHOTOELECTRIC DETECTORS: Light Scattering Type

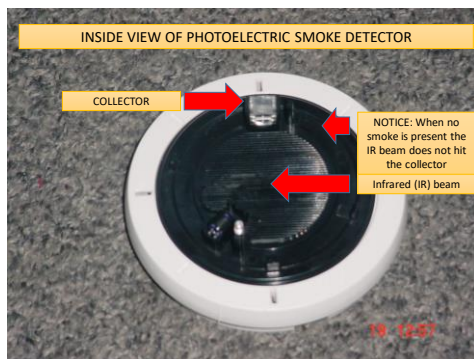


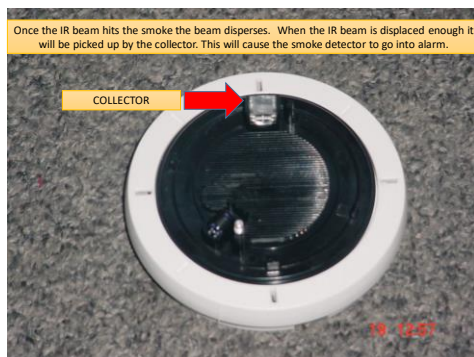
How
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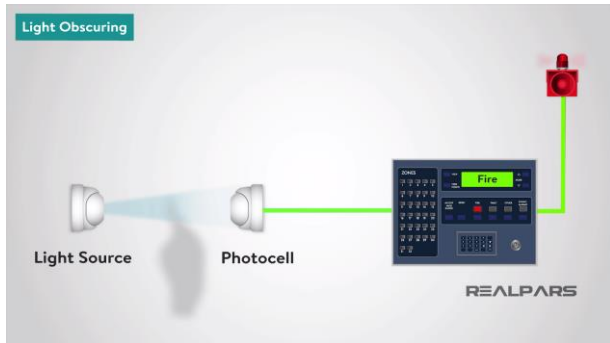


Light Obscuring Smoke Detector

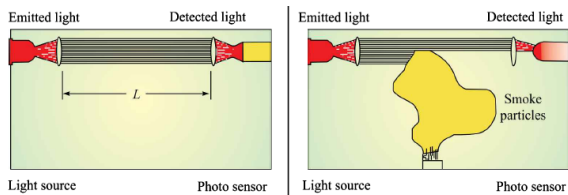
Photoelectric Type

- These detectors work on the principles of the amount of light reaching a photoelectric cell.
- There are two types of these detectors: First is **Light Obscuration Type** and **Light Scattering type**.

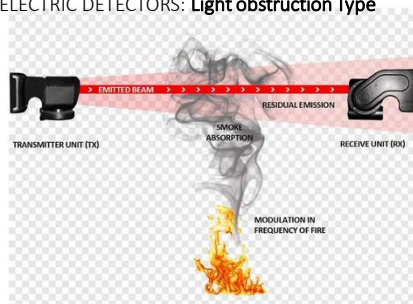
- In the Light obscuring smoke detector, smoke interferes with a light beam between a light source and photocell.
- The photocell measures the amount of light it receives.
- The variation in photocell output, is being used to initiate an alarm.
- This type of fire detection equipment can be used to protect large areas with the light source and photocell positioned some distance apart.



PHOTOELECTRIC DETECTORS: Light obstruction Type



PHOTOELECTRIC DETECTORS: Light obstruction Type



Aspirating Detectors

- Comprise of detector with a small air pump attached to piping manifold with perforations used to draw air samples from surroundings and send to sensing element
- Sampled air passed through filter before sensing element
- Very sensitive elements used due to dilution of smoke in air

Duct detector

- Used to monitor quality of air passing through HVAC duct
- Can sample large volume air with single detector
- Special type detectors developed:
 - duct prob units for use in ventilation system
 - Video smoke detection based on sophisticated computer analysis.

Thank You
