Fire Sprinkler and Alarm Systems 101

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Why are you here?

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Basic Sprinkler Systems

- NFPA-13, *Standard for the Installation of Sprinkler Systems*, identifies four primary types of automatic sprinkler systems and how they are to be installed:
  - **Wet-Pipe Sprinkler Systems** (includes most residential sprinkler systems)
  - **Dry-Pipe Sprinkler Systems**
  - **Deluge Sprinkler Systems**
  - **Preaction Sprinkler Systems**

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Wet-Pipe Sprinkler System

- Most common and efficient type
- Simplest system
- Generally requires little maintenance
- Contains water under pressure at all times
- Connected to public/private water supply, so fused sprinkler head immediately discharges water spray and activates alarm

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Wet-Pipe Sprinkler Systems

- Used in locations where temperatures below 40°F not expected

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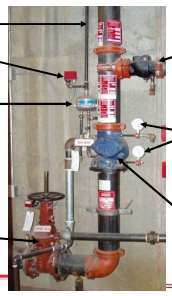
Wet-Pipe Sprinkler Systems



Alarm Valve Style

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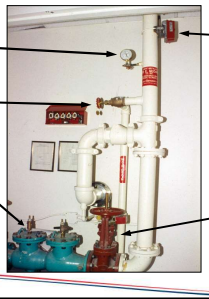
Wet-Pipe Sprinkler Systems



"Shotgun" Style
Straight Stick

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Wet-Pipe Sprinkler Systems

- Sectional valve arrangement

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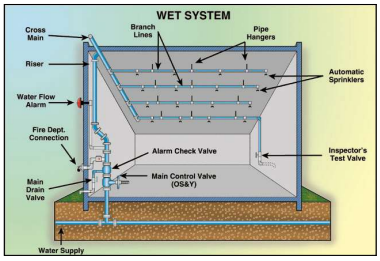
Wet-Pipe Sprinkler Systems



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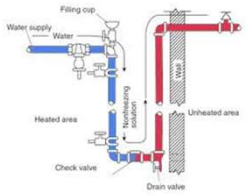
Wet-Pipe Sprinkler Systems

- Antifreeze protection
  - Propylene glycol (non-galvanized metal pipe)
  - Glycerin (CPVC pipe)



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Operational Sequence

- Fire must generate sufficient heat to fuse the heat sensitive element in a sprinkler head to flow water
- Water contained in the piping immediately flows from the open sprinkler head

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Operational Sequence

- As water begins to flow through the system, the alarm check valve on the riser opens (lifts) and activates the water motor gong and/or an alarm pressure switch or on the "shotgun" system the waterflow switch detects water movement.
  - Alarm shall be received by alarm system within 90 seconds.
  - The alarm is transmitted to an alarm supervising station or fire department via the Fire Alarm Control Panel (FACP).

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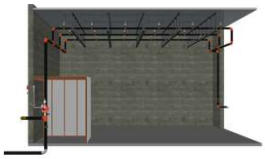
Dry-Pipe Sprinkler Systems

- Installed in areas where piping may be exposed to temperatures below 40°F
- Dry valve and water supply must be in heated enclosure



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Dry-Pipe Sprinkler Systems

- Piping above dry valve filled with air or nitrogen, holding dry valve in set position
- Requires an air or N_2 supply
  - Typically a dedicated air compressor
- Air supply capable of restoring required pressure with 30 minutes



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Dry-Pipe Sprinkler Systems

- Compressor supplying multiple dry systems or a facility compressor being utilized, each dry system will have an air maintenance device (AMD)



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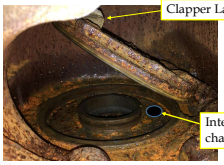
Dry-Pipe Sprinkler Systems

- Designed so lower amount of air pressure above dry valve holds back greater water pressure on water supply side of valve (Differential)
- Fused sprinkler head releases air pressure



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Dry-Pipe Sprinkler Systems

- When a sprinkler head activates, a delay occurs while compressed air/nitrogen discharges from piping, lowering the pressure until the dry valve trips. Water then fills the piping and reaches the sprinkler head and then flows onto the fire.
- NFPA requires maximum 60 second trip time

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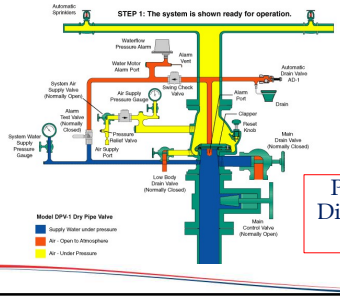
Dry-Pipe Valves



Pressure Differential Valve

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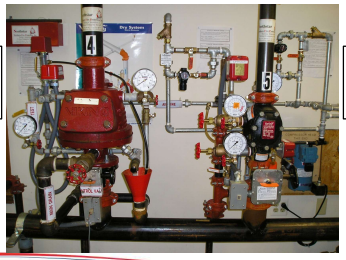
Two Types Dry-Pipe Valves

Traditional pressure differential valve



Low pressure, pilot operated

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Dry-Pipe Sprinkler Systems

- Larger systems may have several-minute delay while air is expelled from system
- 750 gallon maximum capacity
  - Accelerator
  - Exhauster

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Dry-Pipe Sprinkler Systems

- Has air pressure gauge above the sprinkler valve and a water pressure gauge below the sprinkler valve
  - Low pressure, pilot style will have third gauge
- Uses alarm pressure switch to signal waterflow alarm
  - No vane style switches
- Hi/low pressure switch for air supply supervision
- System piping pitched to drain
  - Auxiliary drains

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Operational Sequence

- Fire must generate sufficient heat to fuse the heat sensitive element in a sprinkler head
- Pressurized air/nitrogen contained in the piping vents through the open (fused) sprinkler head
- Once air pressure in the piping is reduced sufficiently, the dry valve opens
- Water fills sprinkler piping and discharges from the fused sprinkler head(s)

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Preaction Sprinkler Systems

- Installed in facilities (art museums, collections, rare book areas, document storage, telecommunications, computer center, high voltage electric/transformer vaults, etc.), where a sprinkler system is required, but its equipment/contents are considered valuable/critical and that any accidental water discharge is unacceptable.

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Preaction Sprinkler Systems

- Piping system contains supervisory air pressure
- Water does not enter the piping until a fire detection system responds and activates the release solenoid
- Water is not released until sufficient heat fuses a closed sprinkler head

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Preaction Sprinkler Systems

- In the event a sprinkler head or sprinkler pipe is broken, water will not flow into the sprinkler piping unless the fire detection system is actuated
  - Would cause a supervisory signal on control panel
- Will be equipped with manual emergency release valve
- Single Interlock: Detector activation fills piping
- Double Interlock: Detector activation AND sprinkler head must fuse to fill piping

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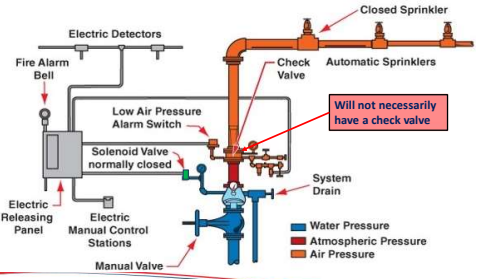
Preaction Sprinkler Systems



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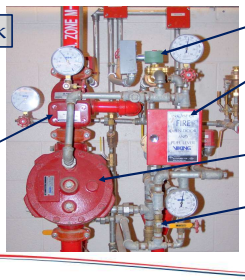
Preaction Sprinkler Systems

Single Interlock



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Preaction Sprinkler Systems

Double Interlock
- Mechanical
- Electronic

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Release Control Panel (RCP)

- The RCP is an essential part of any preaction and most deluge systems.
  - Stand-alone control panel or part of building FACP.
  - Solenoid-audio/visual circuits
- Detection may consist of:
  - Smoke, heat or flame detectors
  - Cross zone
  - Air sampling system
  - Manual pull station

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Deluge Sprinkler Systems

- Designed to quickly supply a large volume of water throughout a high-hazard occupancy such as aircraft hangers, fuel transfer stations, ammunition storage facilities, flammable liquid storage, etc., where the contents are very hazardous and there is a potential for very rapid fire development and extension
- Fire separations
  - Water curtain

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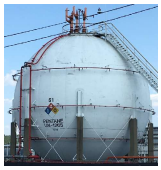
Deluge Sprinkler Systems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Deluge Sprinkler Systems

- ALL sprinkler heads are open; they have no heat-responsive elements which, therefore, cannot function as heat detection devices.
- Sometimes these systems are designed to discharge foam solution
- Deluge systems employ a fire detection system to detect products of combustion and activate the deluge valve
  - Heat detectors
  - Flame detectors
  - Pilot air line (closed sprinkler heads)

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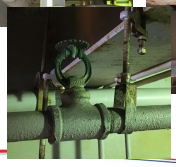
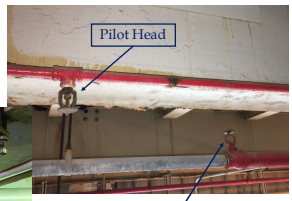
Operational Sequence

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Operational Sequence

- Water flows through all OPEN sprinkler heads/nozzles simultaneously to apply an overwhelming quantity of water or foam on the burning and exposed materiel
- Preaction type system with open heads instead of closed heads
- Preprimed systems

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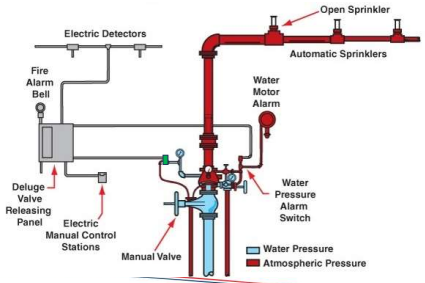
Deluge Sprinkler Systems



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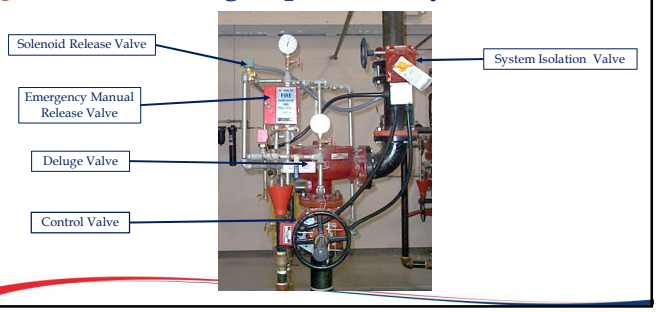
Deluge Sprinkler Systems



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System Components

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Water

- Most essential component.
- Must be adequate capacity and pressure
  - Both sprinkler system and hose streams
- Public water system most common source
- Available volume and pressure must be measured to ensure it meets the system demand

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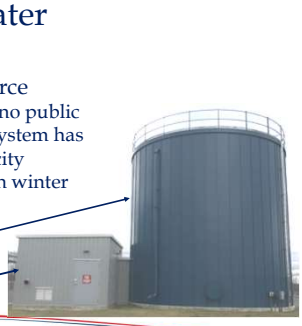
Water

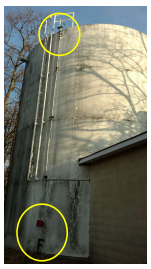
Static suction source

- Necessary when no public water or public system has inadequate capacity
- Must be heated in winter

Suction Tank

Pump House





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Water

Static suction source
- Not typical due to volume of water required

Pressure tank?

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Water

Gravity tank
- Not as common today
- Must be heated during winter
- Height provides pressure without need for booster pump

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Water

- Static suction source
  - Surface water
  - Fire pond
  - River/stream
  - Large water body

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Water Backflow Preventer

- Required by the United States, Safe Drinking Water Act-1974
- Protects potable water supplies from contamination or pollution due to backflow

DCA

DCDA

RPZ

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Fire Pump

- If water pressure is inadequate but water volume is acceptable, a stationary fire pump will be required
  - Jockey pump

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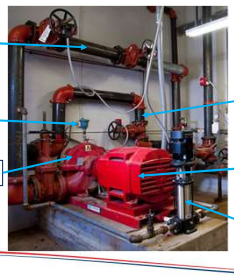
Electric Horizontal Split Case Fire Pump



Bypass Loop

Air Vent

Horizontal Pump

Case cooling via circulation relief valve

Test Header Feed

Electric Driver

Jockey Pump

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Inline Electric Fire Pump

- Basically a horizontal pump, standing on end
- Used where space is limited
- Maintenance issues

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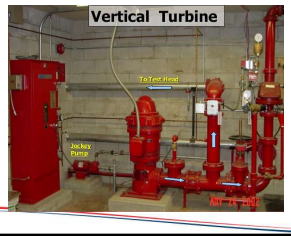
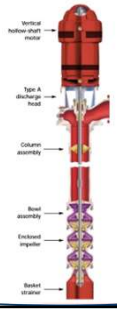
Vertical Turbine Electric Fire Pump

- Vertically lifts water from static source





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Diesel Fire Pumps

Horizontal Split Case

Vertical Turbine

- Typically have open pressure relief valve on pump discharge due to over-speed possibility
- Engine cooled via heat exchanger

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Fire Pump Controllers

- Electric Pump Controllers
  - May not have a disconnect means from the electric utility!
  - Closes high voltage circuit from utility to drive motor
  - Contains:
    - Electric components must be at least 12″ above floor
    - Circuit breaker provides overcurrent protection
    - Isolation switch between power supply and breaker
    - Pilot light
    - Manual start/stop buttons
    - Emergency start lever
    - Run timer-10 minutes
    - Pressure switch-pressure drop closes switch

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Fire Pump Controllers



Electric Pump

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Fire Pump Controllers

- Diesel Pump Controllers
  - Closes circuit between batteries and engine starter
  - Indicating light for automatic position
  - Other lights or alphanumeric display and common audible alarm:
    - Low engine oil pressure
    - High engine coolant temperature
    - Failure to start automatically
    - Engine overspeed shutdown
    - Battery failure
    - Battery charger failure (no audible)

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Fire Pump Controllers

- Diesel Pump Controllers
  - Controller will be monitored (fire alarm system)
    - Engine start
    - Controller turned off
    - Controller turned to manual operation
    - Trouble condition on engine or controller
  - Typically programmed to automatically start the engine every week
  - Minimum 30 minute run time per start
  - Immediate shutdown is overspeed is detected

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Fire Pump Controllers



Diesel Pump Controllers

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Fire Pump Controllers


Jockey Pump Controllers

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Control Valves

- Part of every sprinkler system
- Used to turn off water supply to system to perform maintenance or interrupt operations
- Located between water supply and riser
  - Below wet, dry or deluge valve
  - Outside building, near riser it controls
- Secured in open position by lock and chain or electronically supervised
- Must be an "indicating" valve
  - Tell at a glance whether open or closed

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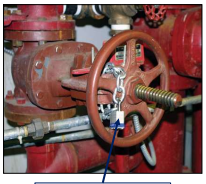
Control Valves

- Outside Stem & Yoke (OS&Y)
  - Gate Valve


Tamper Switch


Lock and Chain

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Control Valves

- Butterfly Valve (BFV)
  - Disc rotates on shaft inside valve
  - Integral tamper switches

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Indicating Control Valves

Post Indicator Valve (PIV)
- Gate valve, below ground

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Indicating Control Valves

Post Indicator Valve Assembly (PIVA)
- Disc rotates on shaft below ground
- Very old facilities

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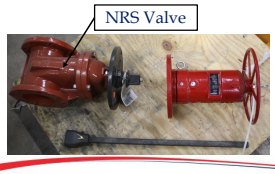
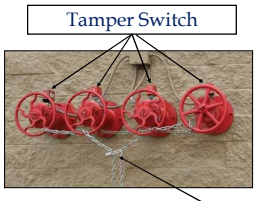
Indicating Control Valves

Wall Post Indicator valve (WPIV)
- Gate valve





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Indicating Control Valves

Butterball Valve
- Slow operating ball valve
- Isolate small sections of systems
  - Elevator shaft

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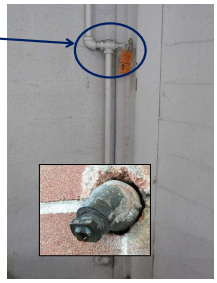
Operating Valves

- Inspector's test valve
- Alarm test valve



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Operating Valves

- Main drain valve

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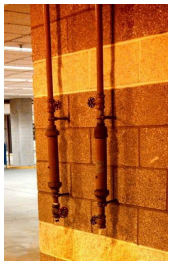
Operating Valves

- Drum drip
- Auxiliary drain
- Normal position
  - Upper valve open
  - Lower valve closed
  - NEVER both open at same time
- Optional visual or audible indicator

2″ pipe barrel



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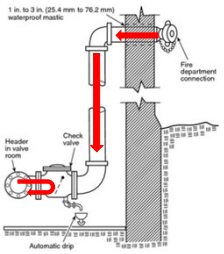
Fire Department Connection (FDC)

- 4″ pipe
- Above alarm valve-single wet
- Below dry valve-single dry
- Manifold for multiple risers



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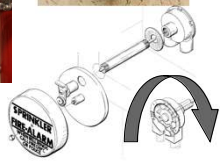
Alarm Devices

- Water Motor Gong (WMG)
- Only notification?



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Alarm Devices

- Pressure switch or vane paddle
- May be equipped with retarding device (time delay)

Vane Type

Pressure switch & retard chamber

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Alarm Devices

- Retard Chamber

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Alarm Devices

- Supervisory Tamper Switch

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Sprinklers

- Sprinklers can extend from exposed pipes or protrude through ceiling or walls from hidden pipes
- Sprinkler coverage; complete or partial

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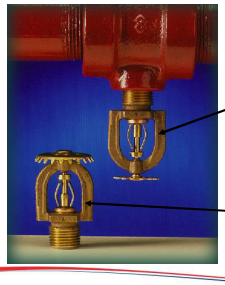
Sprinklers



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Sprinklers

Pendant

Upright

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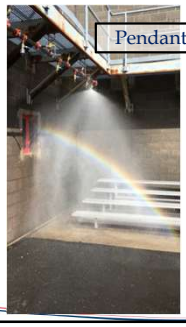
Sprinklers

Upright



Pendant

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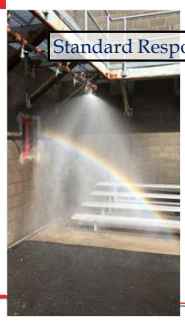
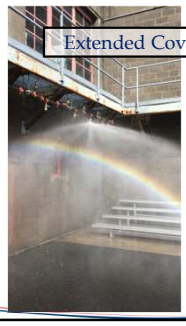
Sprinklers



Standard Response



Extended Coverage

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Sidewall Sprinklers

Horizontal Sidewall

Corridor Sidewall

Vertical Sidewall

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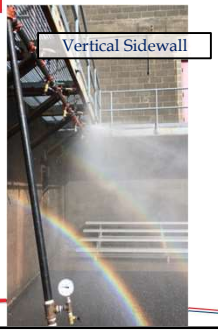
Sidewall Sprinkler Heads



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Dry Barrel Sprinklers

- Pendant position on dry pipe sprinkler systems
- Unheated spaces of wet pipe systems

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Concealed Sprinklers

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Conventional Sprinklers

- Combustible ceilings
- Prior to 1960's

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Attic-Interstitial Sprinklers

- Combustible attic/roof spaces
- Deflector angles designed for specific roof angles

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Early Suppression Fast Response Sprinklers

- ESFR
- 160 GPM
- Large Droplets
- Eliminate in rack requirement up to 40' ceiling

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Early Suppression Fast Response (ESFR)

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Activation Mechanism

- Closed sprinklers activate when the temperature at the head exceeds the rated temperature of the fusible element or glass bulb
  - *Response Time Index* (RTI) is a number that relates to the speed at which a head activates when exposed to temperatures above its rating.

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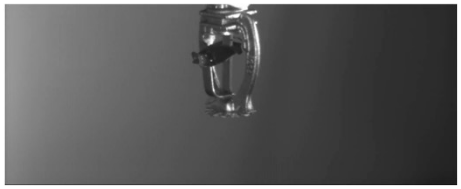
Sprinkler Types

- Fusible Link-Pendant



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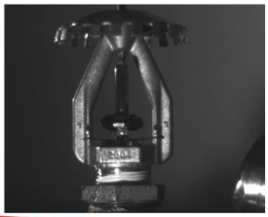
Sprinkler Types

- Fusible Link-Upright



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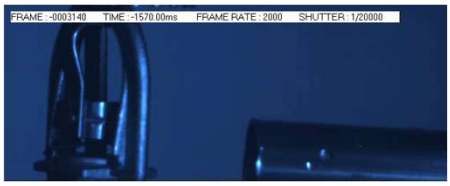
Sprinkler Types

- Eutectic Pellet Strut-Upright



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Sprinkler Types

- Concealed Sprinkler

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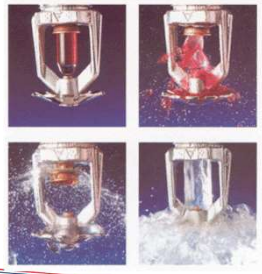
Sprinkler Types

- Bulb Type



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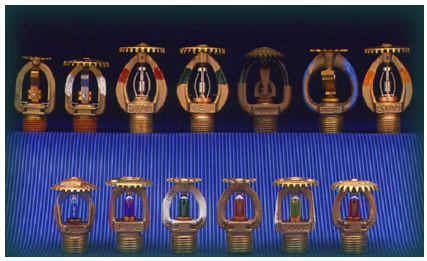
Temperature Ratings



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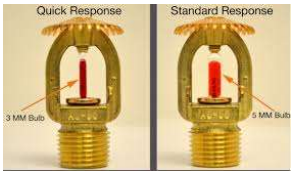
Temperature Ratings



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Temperature Ratings

- NFPA 13

Maximum Ceiling Temperature		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Colors
°F	°C	°F	°C			
100	38	135–170	57–77	Ordinary	Uncolored or black	Orange or red
150	66	175–225	79–107	Intermediate	White	Yellow or green
225	107	250–300	121–149	High	Blue	Blue
300	149	325–375	163–191	Extra high	Red	Purple
375	191	400–475	204–246	Very extra high	Green	Black
475	246	500–575	260–302	Ultra high	Orange	Black
625	329	650	343	Ultra high	Orange	Black

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Piping Arrangements

- Older systems are designed by the pipe schedule method, while modern systems are a hydraulically calculated design
- Pipe schedule based on the concept of using larger pipe as more sprinklers are supplied
  - Pipe starts as 1" at the first sprinkler head and increases with more sprinkler heads upstream

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Piping Arrangements

- Modern systems are hydraulically calculated using a computer program
  - Calculates friction loss in pipe, fittings and elevation changes
  - Piping remains the same size for longer distances.

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Operational Readiness - Wet Pipe Sprinkler

- The main, water supply control valve must be OPEN
- The lower water pressure gauge should reflect the same water pressure as supplied by the municipal water system
- The main drain valve must be SHUT
- If installed, the alarm line valve must be OPEN

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Operational Readiness – Wet Pipe Sprinkler

Higher system side gauge indicates alarm valve is holding

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Operational Readiness – Dry Pipe Sprinkler

- The main water supply control valve must be OPEN
- The main drain valve must be SHUT
- The air pressure gauge(s) should reflect the system air pressure supplied by the air compressor
- Air Maintenance Device (AMD) bypass valve closed
- The water pressure gauge should reflect the pressure as supplied by the municipal water system
- The alarm line valve must be OPEN
- Alarm test valve must be SHUT

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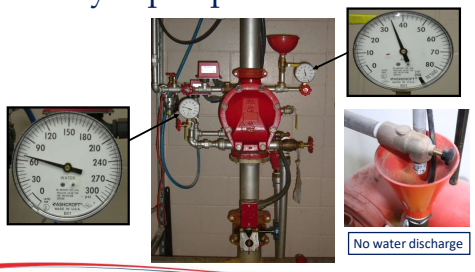
Operational Readiness – Dry Pipe Sprinkler



No water discharge

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Operational Readiness – Deluge System

- Main water supply control valve must be OPEN
- The water system pressure gauge should reflect the water pressure as supplied by the municipal water system
- Pilot pressure gauge same as street pressure
- Main drain valve(s)must be SHUT
- Emergency release control valve must be closed
- Alarm line valve must be open

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Operational Readiness– Preaction System

- Main water supply control valve must be OPEN
- The water system pressure gauge should reflect the water pressure as supplied by the municipal water system
- Pilot gauge same as street pressure
- Supervisory air gauge displays proper pressure
- Main drain valve(s)must be SHUT
- Emergency release control valve must be closed
- Alarm line valve must be open

March 2019

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None Operational Readiness

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Why Do Sprinklered Buildings Burn

- Design deficiencies
  - Available volume or pressure of water is inadequate to control fire
- Three factors
  - Adequate water supply
    - Where does water come from?
  - Sprinkler system properly designed
    - Proper system layout and densities?
  - System designed for the occupancy
    - What is being stored in building?
    - Has the occupancy changed?

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Why Do Sprinklered Buildings Burn

- Impairments before the fire
  - Leave the building defenseless
- Three factors
  - Renovations or construction
    - System is impaired for renovation or is not yet in service during construction
  - Inadequate maintenance
    - Poor maintenance fails to detect impairments to the system
  - Deliberate actions
    - Arsonist impairs system before setting fire

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Why Do Sprinklered Buildings Burn

- Impairments during the fire
  - Improper actions by someone can cause breakdown in protection during event
    - Employee assumes forklift stuck a sprinkler pipe or head
    - Fire department shuts system down to quickly

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Why Do Sprinklered Buildings Burn

Barkley Friends

- November 16, 2017
- Four civilian fatalities

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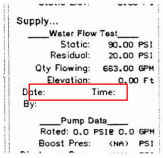
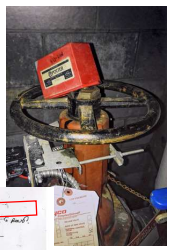
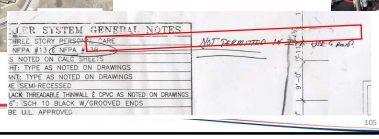
Why Do Sprinklered Buildings Burn

Barkley Friends







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Fire Alarm Systems

Fire Alarm Control Unit (FACU)

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Fire Alarm Systems

- **NFPA** 70, the ***National Electrical Code*** **(NEC)**
  - Regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States.
  - Article 760 covers the installation of wiring and equipment for fire alarm systems, including all circuits controlled and powered by fire alarm system.
    - Article 725 covers circuits powered and controlled by other building systems such as HVAC; security; lighting controls; and time recording.

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Fire Alarm Systems

- **NFPA** 72, the ***National Fire Alarm and Signaling Code***
  - Provides the requirements for the listing, selection, installation, performance, use, testing, and maintenance of fire alarm systems and components.
  - Requirements address the application, location, and limitations of fire alarm system components, such as manual fire alarm boxes, automatic fire detectors, and notification appliances.
  - Chapter 29 addresses household single- and multiple-station alarms and systems.
  - Carbon monoxide detection and warning equipment requirements were added throughout the Code in 2019.

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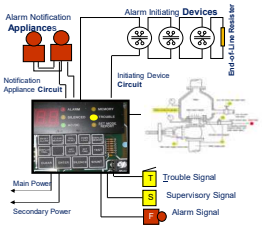
3 Types of FACU Signals



Alarm
Red LED
- Alarm is activated

Trouble
Yellow LED
- Problem with the system's integrity (e.g., component failure, power supply failure or a broken circuit wire)

Supervisory
Yellow LED
- A detection or suppression system's readiness is compromised

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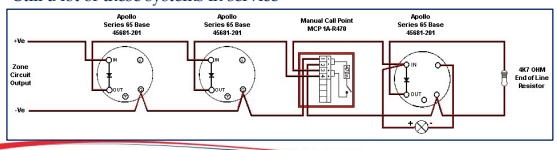
Conventional Alarm System

- Simplest system
- All devices act as a simple switch, close on activation
- FACU cannot identify the specific device that activated, only the circuit
- Detector removed or wire break, devices further downstream will not operate
- Most likely, no history storage
- Current codes no longer recognize this type
- Still a lot of these systems in service



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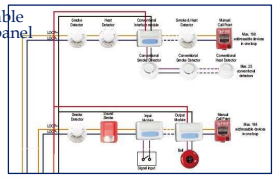
Addressable/Intelligent Alarm System

- Input devices contain microprocessor to communicate to control panel
- Activated device will be displayed on FACU, unique address
- FACU communicates with each device, checking its status; poling
  - Blinking LEDs
- Wiring can be spider-webbed
- Audible devices may be on same circuit
- Most audible/visual devices are not addressable
- Individual devices can be disabled from the panel
- History log



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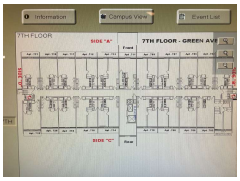
FACU/FAAP Signal Displays

- May have a Fire Alarm Annunciator Panel (FAAP) located at entrances or emergency control locations
- May visually display location of activated device in pictogram of building



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FACU/FAAP Button Variations

- Some FACUs and FAAPs have separate **ACK**nowledge buttons that correspond with separate fire alarm, trouble and supervisory signals/lights
- Some systems will use a common **ACK**nowledge button

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FACU & FAAP Display Variations

- Some fire alarm systems may require a numeric code to ACKnowledge or RESET the system
- Common on small combination fire-security systems
- Some common codes are:
  - 1-1-1-1-1-1
  - 1-2-3-4
  - Zip Code

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Fire Alarm System Power Supplies

- All fire alarm systems must have two power supplies: **primary & secondary**
  - Primary is generally, the building's electrical service
  - Secondary is generally batteries or generator
  - Must provide back-up power within 10 seconds whenever primary power supply is insufficient
- Systems may have **power extender panels** to supply power to its many detectors and alarm appliances

The location of the branch circuit disconnecting means shall be posted at the FACP

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Primary Power Supply

- On a dedicated 110 VAC electrical circuit
- The circuit must be labeled "Fire Alarm, Emergency Communications or Fire Alarm/ECS", have red marking, be locked in the ON position and have limited access by either:
  - Locked panel
  - Locked tab
  - Circuit Breaker Lock

Where a circuit breaker is the disconnecting means, a listed breaker locking device shall be installed. NFPA-72, 10.6.5.4

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Power Extender Panels

- Power extender panels are designed to extend, add to, the power capabilities of existing Notification Appliance Circuits (NACs)
- No system controls located in NAC panel
- The extender panels are installed almost anywhere in a building:
  - Janitor closets, electrical rooms, data rooms, etc.

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Secondary Power Supply

- Fire alarm system must operate in the normal, standby mode for at least 24 hours
- After 24 hours, operate all building alarm signaling appliances continuously for at least 5 minutes
  - Operate emergency voice/alarm communications for 15 minutes

Batteries shall be marked with the month and year of manufacture using the month/year format. NFPA-72, 10.6.10.1.1

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Initiating Devices

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Manual Pull Stations

- Single Action
- Dual Action
- Latch in activated position
- Red with white lettering
- 3½' to 4' above floor
- At least one per floor
- Maximum travel distance 200'

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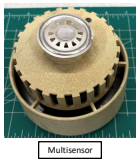
Automatic Fire Detectors

- Multisensor vs. Multicriteria Detectors
  - Both employ multiple sensors to respond to physical stimulus
    - Heat, smoke, carbon monoxide or other gases
  - Multisensor activates via the individual sensors
  - Multicriteria activates based on response of a combination of sensors and a mathematical evaluation
    - Less prone to false activations

Multicriteria



Multisensor

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Heat Detectors

- Oldest type of automatic detector (sprinkler head)
- Very reliable, lowest false alarm rate of automatic detectors
- Operate on one or more of three principles
  - Heat causes expansion of various materials
  - Heat causes melting of certain materials
  - Heated materials have thermoelectric properties that are detectible

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Heat Detectors

Fixed Temperature

- Relatively inexpensive compared to other detectors
- Least prone to false alarms
- Slowest to activate under fire conditions; thermal lag
- Typically are not resettable and must be replaced after activation

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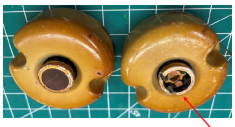
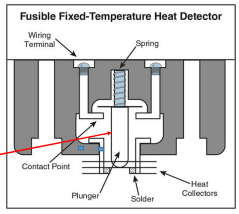
Heat Detectors
Eutectic Fixed Temperature



Plunger pops out



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Heat Detectors
Eutectic Fixed Temperature

Will be a hole if activated

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Heat Detectors

Bimetallic-Fixed Temperature

- Uses two types of metals that have different coefficients of thermal expansion
- Thin strips of each metal are bonded together
- When heated, one metal expands faster than the other, causing the strut to bend
- One or both ends of strut may be secured
- Larger the contact gap, higher the set temperature
- Typically reset themselves after cooling

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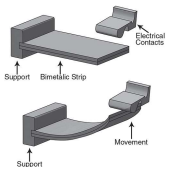
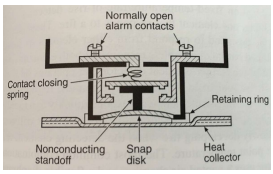
Heat Detectors
Bimetallic Fixed Temperature

Strut Type



Snap Disc Type



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Heat Detectors
Rate of Rise

Can activate at lower temperatures, compared to fixed temperature
- Activate when temperature rise exceeds 12°F to 15°F per minute
- Compensate for normal temperature changes
  - Avoid areas where rapid heat releases can be expected
- Automatically reset

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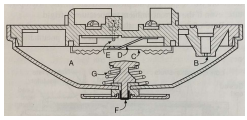
Heat Detectors
Rate of Rise

Spot Type-Rate of Rise
- Monitors a specific location
- Chamber air pressure increases faster than it can escape through vent (B)
- Diaphragm deflects (C), closing contact
- (F) fusible alloy melts at fixed temperature and spring forces plunger against diaphragm



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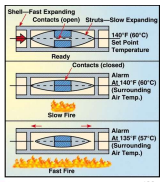
Heat Detectors
Rate Compensated

Rate Compensated
- Activated at a predetermined temperature, regardless of rate of temperature rise
  - No thermal lag
- Bimetallic struts inside
  - Activation during slow temperature rise
- Tubular case that expands lengthwise
  - Activation during fast temperature rise



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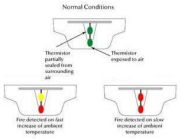
Heat Detectors
Thermistor

Electronic Spot Type
- Use two thermistors, which change electrical resistance as temperature rises
- One thermistor is sealed in unit and the other is exposed
- Rate of Rise: exposed thermistor heats up quicker than sealed thermistor
- Fixed temperature: both thermistors reach predetermined resistance together



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Smoke Detector Versus Smoke Alarm

- Smoke Detector
  - Low voltage powered from alarm system
  - Activates alarm condition on FACU
  - No audible alarm from detector itself
    - May be equipped with sounder base however
  - Detector placement and power supervised
- Smoke Alarm
  - Powered by 120 VAC or self contained battery
  - Detectors may be interconnected for common alarm
  - Detector itself contains audible alarm
  - No placement or power supervision

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Smoke Detectors

Ionization Smoke Detector

- Consists of two chambers, reference and sensing
- Radioactive Americium 241 emits alpha radiation, ionizing the air within the chambers
- This allows a minute current to flow between the charged plates
- Smoke particles entering the sensing chamber attach themselves to ions, reducing their mobility and decreasing the current flow
- Reference chamber is almost completely sealed, only humidity and atmospheric pressure affect it; prevents false alarms due to these changes

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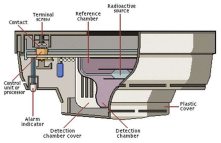
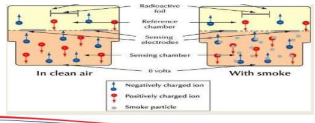
Smoke Detectors

Ionization Smoke Detector

- Responds quicker than photoelectric, to flaming, clean burning fire
  - Invisible particles, smaller than 1 micron
- Chemicals, gases can cause false alarms





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Smoke Detectors

Photoelectric Smoke Detector

- Suspended smoke particles affect the propagation of a light beam passing through the air
  - *Light Obscuration*, senses the reduction in light intensity
  - *Light Scattering*, senses the reflection of light off the smoke
- Respond quicker to dark, large particle smoke; smoldering fires, versus ionization
  - Visible particles larger than 1 micron

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Smoke Detectors

Photoelectric Smoke Detector

- Light Obscuration
  - IR light source and photo-sensitive receiver; *Projected Beam Detector*
    - Possibly a reflector
  - Dense smoke obscures part of the beam or less dense smoke obscures more of the beam, the light reaching the receiver is reduced, initiating an alarm
  - Typically, projected beam detectors shooting across large spaces
  - Complete blockage causes a trouble signal

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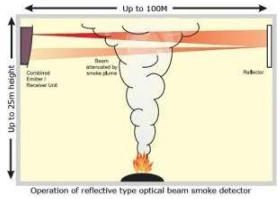
Smoke Detectors

Photoelectric-Light Obscuration



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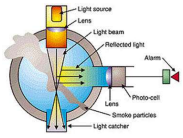
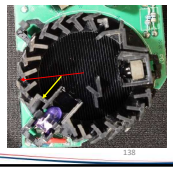
Smoke Detectors

Photoelectric Smoke Detector

- Light Scattering
  - Spot type detector containing a light source and photosensitive device arranged so light does not strike photo-cell
  - When smoke particles enter chamber, light is reflected/scattered onto the photo-cell
  - Flat black particulate can be issue





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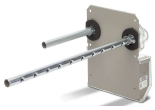
Smoke Detectors

Duct Smoke Detector

- Prevent spread of smoke and products of combustion throughout the building
- Are not a substitute for open area smoke detection
- Detection of smoke in ducts can be difficult since smoke can be diluted by return/outside air
- Samples complete width of duct and slows the flow of the sample across the detector
- Return air duct greater than 2,000 CFM, upstream of filters



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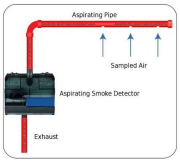
Smoke Detectors

Air Sampling Smoke Detector

- Piping network with spaced intake ports and aspirating fan
- Detector uses xenon strobe or pulsed laser to scatter light off smoke particle
- Very high sensitivity: 0.003 to 10 microns
- May be difficult to determine where particles entered network; location of problem



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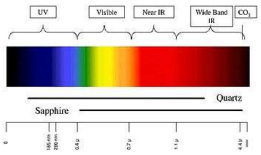
Flame Detectors

- Sense radiant energy (electromagnetic radiation) emitted as a byproduct of combustion
  - Ultraviolet
  - Visible
  - Infrared
- Detector's spectral response must match the spectral emissions of the potential fire to be detected



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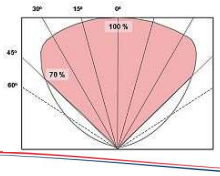
Flame Detectors

- Fastest response to fire, but may be activated by non-fire conditions; welding, sunlight, lightning
- Must be positioned for unobstructed view of protected area
  - If field of view blocked, detector will not respond



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Flame Detectors

Ultraviolet

- 0.1 µm to 0.35 µm wavelength
- Typically use a vacuum photodiode Geiger-Muller tube
- UV photons strike the active area of tube allowing a current flow. Control unit counts current flow rate, activating alarm.
- Sensitive to most fires; hydrocarbons, ammonia, hydrogen and metals
- Nuisance alarms caused by lightning, arc welding, X-rays

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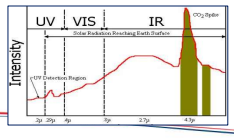
Flame Detectors

Infrared

- 0.76 µm to 220 µm wavelength
- Lens and filter arrangement screens out unwanted wavelengths and focuses remaining energy on a photo-resistive cell
- May be combined with a flame flicker sensor (5-30 Hz)
- Only work on carbon-containing fuels
- Nuisance alarms caused by oxy-acetylene welding, and solar radiation



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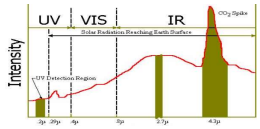
Flame Detectors

Ultraviolet/Infrared (UV/IR)

- Sense radiation from portions of both spectrums
- Requires both sensors to respond
- Removes much of the nuisance alarm issue



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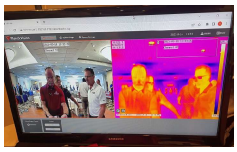
Dual Vision Thermal Detectors

- Thermal IR camera connected to computer processing system
- Detects heat increase over normal parameters
- Detects before heat increase prior to fire ignition



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Audio Visuals
Notification Appliances

- Continuous sounding
- Temporal 3 pattern
- Voice
- Strobe
  - Stay active upon system silence?

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Thank You
Future Questions
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