

Fire Sprinkler Fundamentals

Presented by:
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Why Sprinkler?

Life Safety

- Early fire intervention enhances building occupant safety by applying water directly onto a fire while the fire is in the growth stage
- If controlled/extinguished early in its growth stage, the products of combustion, particularly smoke and toxic gases are limited

Life Safety

- Sprinkler systems alone are not totally effective, because water may not reach the seat of the fire or may not be effective for the materials/chemicals involved
 - Intent of system is to contain fire, not extinguish fire (suppress)
- International Building Code (IBC) specifies where systems are required & what sprinkler systems may be installed

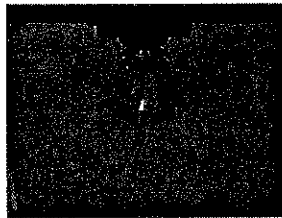
Advantages of Sprinkler Systems

- Always Ready
- 24 hours a day, 7 days a week
 - Protection is automatic and does not rely on human intervention



Advantages of Sprinkler Systems

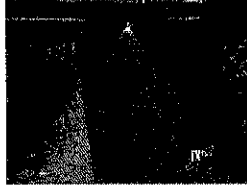
- Prompt Action
- Attacking fire before even the best trained and equipped fire departments are even dispatched



Advantages of Sprinkler Systems

Prompt Action

- Operate over the seat of the fire
- Reduce the hazards to firefighters trying to manually fight an uncontrolled fire



Advantages of Sprinkler Systems

Prompt Action

- System activation can automatically notify fire department



Advantages of Sprinkler Systems



Advantages of Sprinkler Systems

Common misconception:

- When one sprinkler head activates, all of the sprinkler heads in the area or within the building activate
- Where does this belief come from?

Advantages of Sprinkler Systems



Advantages of Sprinkler Systems

Common misconception:

- In reality, only the sprinkler head(s) directly over the fire area will activate
- How many sprinkler heads operate in a typical fire?
 - Fires investigated by Factory Mutual Engineering
 - 75% of fires controlled by 1-5 heads
 - 95% of fires controlled by <25 heads



U.S. Experience With Sprinkler, NFPA, July 2017

Advantages of Sprinkler Systems

Prewetting Combustibles

- Water is not only applied directly to a fire, but water spray prewets combustibles in the immediate area
- Reduces temperature of environment and combustibles, reducing ability of combustibles to ignite

Advantages of Sprinkler Systems

Less water required

- Water discharges directly onto the fire and prewets surrounding combustibles
- Less water is used than would be discharged from a hose stream
- Fire is much smaller when sprinkler activates vs. delay until FD arrives
- Damage caused by pressure of hose streams

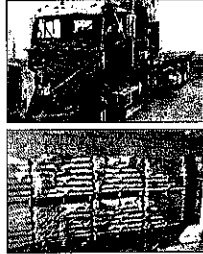
Advantages of Sprinkler Systems

- Fire occurs on a week night
- 1 sprinkler head controls
- Fire does not spread to adjacent combustibles
- No structural damage



Advantages of Sprinkler Systems

- Truck inside building
- Fire on Saturday
- Fire controlled by 3 sprinkler heads
- Pallets of roof shingles 6' from cab.
 - Prewetting prevents ignition
- No structural damage
- Open for business Monday morning



Basic Sprinkler Systems

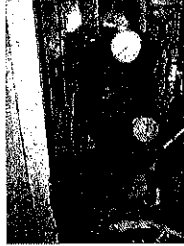
- NFPA-13, *Standard for the Installation of Sprinkler Systems*, identifies four primary types of automatic sprinkler systems and how they are to be installed:
 - **Wet-Pipe Sprinkler Systems** (includes most residential sprinkler systems)
 - **Dry-Pipe Sprinkler Systems**
 - **Deluge Sprinkler Systems**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

Wet-Pipe Sprinkler System

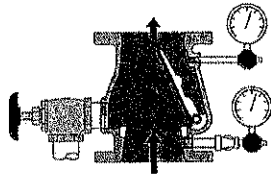
- Most common and efficient type
- Simplest system
- Generally requires little maintenance
- Contains water under pressure at all times
- Connected to public/private water supply, so fused sprinkler head immediately discharges water spray and activates alarm

Wet-Pipe Sprinkler Systems

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

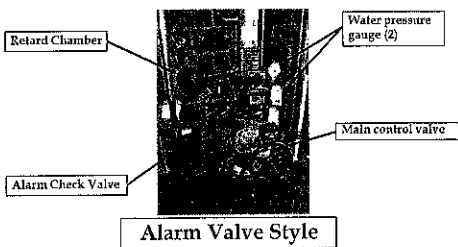


Wet-Pipe Sprinkler Systems

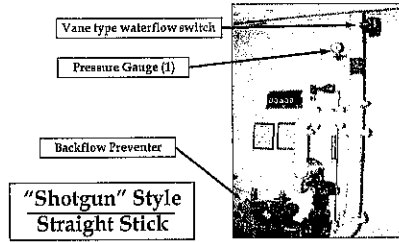


• Alarm Valve Style

Wet-Pipe Sprinkler Systems

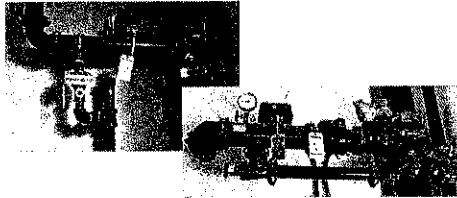


Wet-Pipe Sprinkler Systems

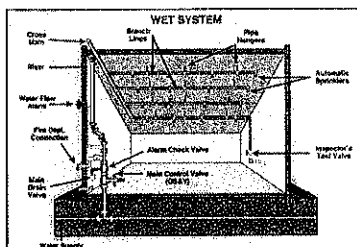


Wet-Pipe Sprinkler Systems

- Sectional valve arrangement

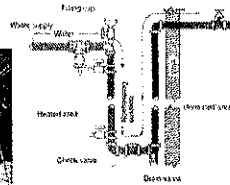


Wet-Pipe Sprinkler Systems



Wet Pipe Sprinkler Systems

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



Operational Sequence

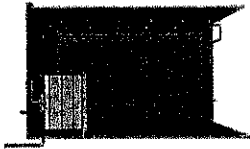
- Fire must generate sufficient heat to fuse the heat sensitive element in a sprinkler head to flow water
- Water contained in the piping immediately flows from the open sprinkler head

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).

Dry-Pipe Sprinkler Systems

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



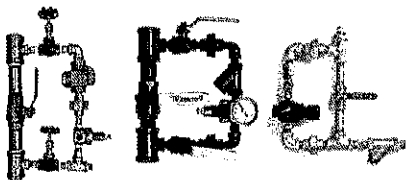
Dry-Pipe Sprinkler Systems

- Piping above dry valve filled with air or nitrogen, holding dry valve in set position
- Requires an air or N₂ supply
 - Typically a dedicated air compressor
- Air supply capable of restoring required pressure with 30 minutes



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)



Dry-Pipe Sprinkler Systems

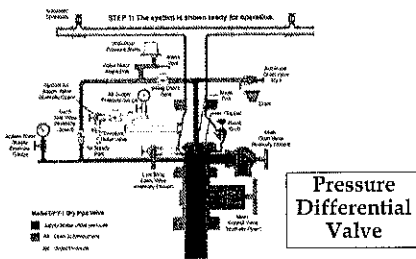
- Designed so small amount of air pressure above dry valve holds back much greater water pressure on water supply side of valve
- Fused sprinkler head releases air pressure



Dry-Pipe Sprinkler Systems

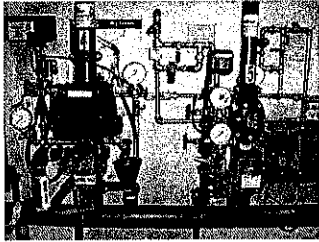
- When a sprinkler head activates, a delay occurs while compressed air/nitrogen discharges from piping, lowering the pressure until the dry valve trips. Water then fills the piping and reaches the sprinkler head and then flows onto the fire.
- NFPA requires maximum 60 second water flow

Dry-Pipe Valves



Two Types Dry-Pipe Valves

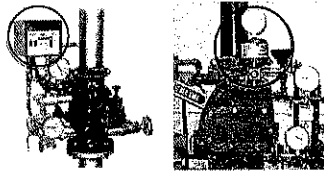
Traditional pressure differential valve



Low pressure, pilot operated

Dry-Pipe Sprinkler Systems

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



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

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)

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.

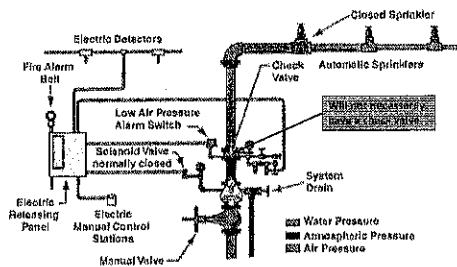
Preaction Sprinkler Systems

- 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

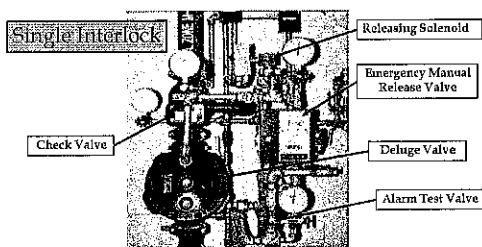
Preaction Sprinkler Systems

- 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

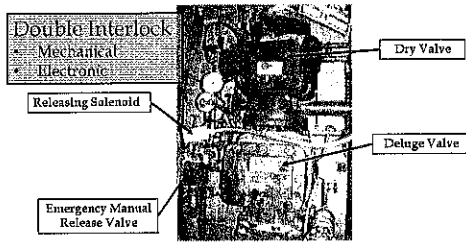
Preaction Sprinkler Systems



Preaction Sprinkler Systems



Preaction Sprinkler Systems



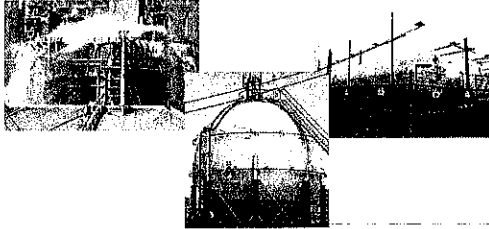
Release Control Panel (RCP)

- 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

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
 - Wall curtain

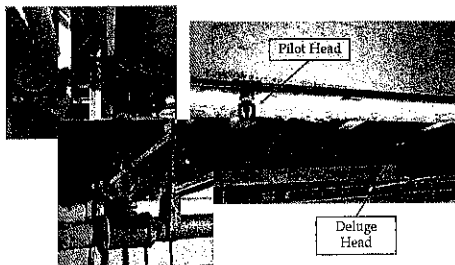
Deluge Sprinkler Systems



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)

Operational Sequence



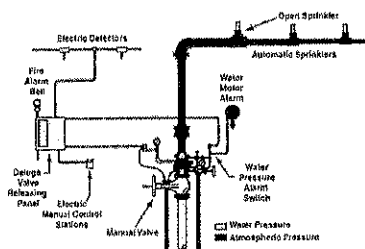
Operational Sequence

- 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

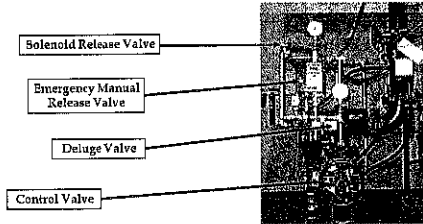
Deluge Sprinkler Systems

- Limitation/Concern: A false activation of system will cause rapid flooding and potential damage to all of the property the system was designed to protect

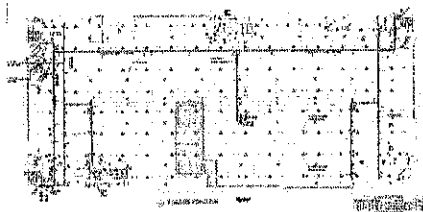
Deluge Sprinkler Systems



Deluge Sprinkler Systems

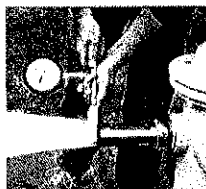


System Components



Water

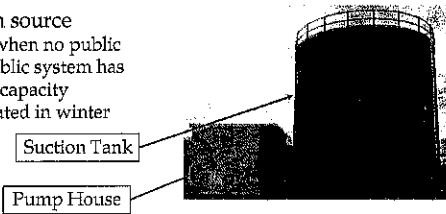
- Most essential component.
- Must be adequate capacity and pressure
 - Both sprinkler system and hose streams
- Public water system most common source
- Available volume and pressure must be measured to ensure it meets the system demand



Water

Static suction source

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



Water

Static suction source

- Not typical due to volume of water required

Pressure tank?



Water

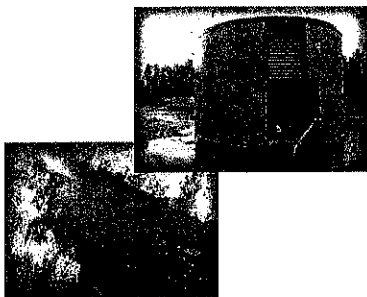
Gravity tank

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



Water

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



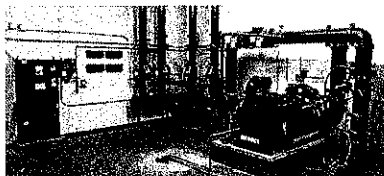
Water Backflow Preventer

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

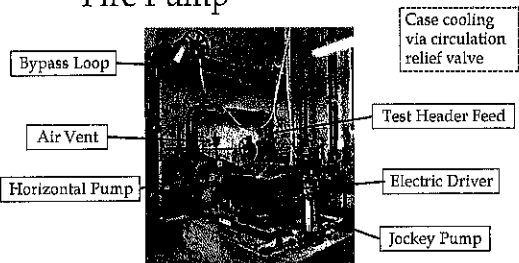


Fire Pump

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

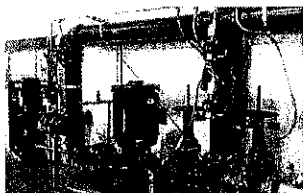


Electric Horizontal Split Case Fire Pump



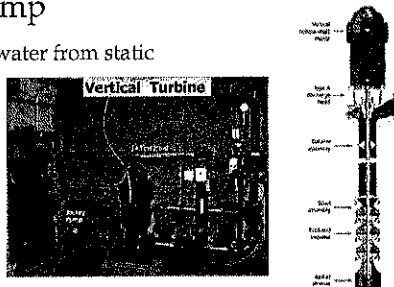
Inline Electric Fire Pump

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



Vertical Turbine Electric Fire Pump

- Vertically lifts water from static source



Diesel Fire Pumps



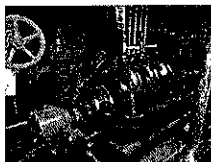
Horizontal Split Case



Vertical Turbine

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

Fire Pumps



600 FSI, Three Stage, Horizontal Split Case



Electric and Diesel

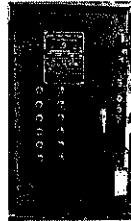
Fire Pump Controllers

- 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

Fire Pump Controllers



600 PSI, Three Stage,
Horizontal Split Case



Electric Pump

Fire Pump Controllers

▪ Diesel Pump Controllers

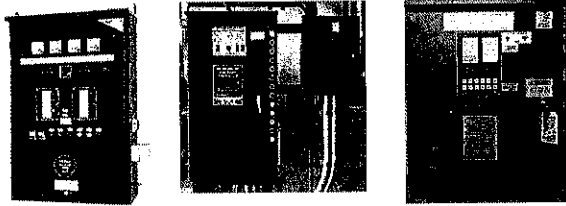
- Closes circuit between batteries and engine starter
- Indicating light for automatic position
- Other lights or alphanumeric display and common audible alarm:
 - Low engine oil pressure
 - High engine coolant temperature
 - Failure to start automatically
 - Engine overspeed shutdown
 - Battery failure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

Fire Pump Controllers

▪ Diesel Pump Controllers

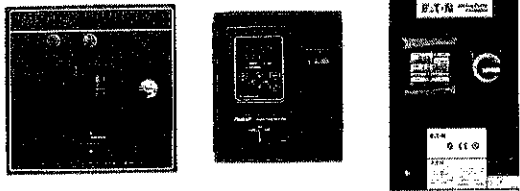
- Controller will be monitored (fire alarm system)
 - Engine start
 - Controller turned off
 - Controller turned to manual operation
 - Trouble condition on engine or controller
- Typically programmed to automatically start the engine every week
 - Minimum 30 minute run time per start
 - Immediate shutdown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

Fire Pump Controllers



Diesel Pump Controllers

Fire Pump Controllers



Jockey Pump Controllers

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

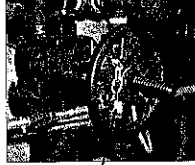
Control Valves

- Outside Stem & Yoke (OS&Y)

- Gate Valve



Tamper Switch



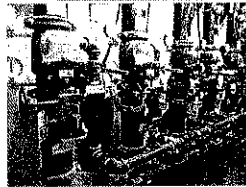
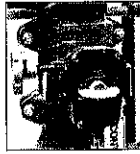
Lock and Chain



Control Valves

- Butterfly Valve (BFV)

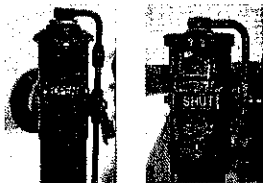
- Disc rotates on shaft inside valve
- Integral tamper switches



Indicating Control Valves

- Post Indicator Valve (PIV)

- Gate valve, below ground



Indicating Control Valves

Post Indicator Valve Assembly (PIVA)

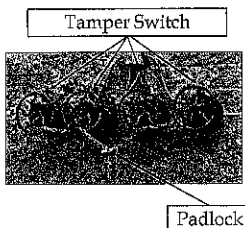
- Disc rotates on shaft below ground
- Very old facilities



Indicating Control Valves

Wall Post Indicator valve (WPIV)

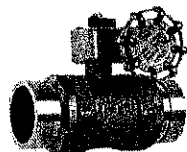
- Gate valve



Indicating Control Valves

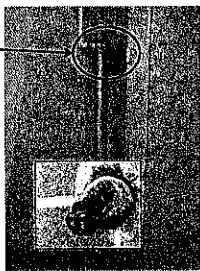
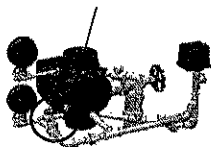
Butterball Valve

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



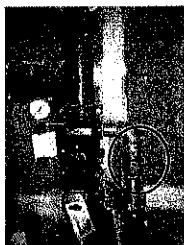
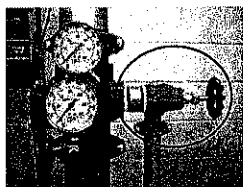
Operating Valves

- Inspector's test valve
- Alarm test valve



Operating Valves

- Main drain valve



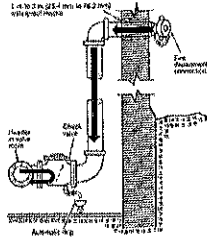
Operating Valves

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



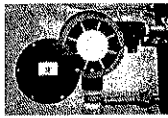
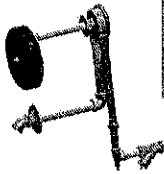
Fire Department Connection (FDC)

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



Alarm Devices

- Water Motor Gong (WVG)
- Only notification?



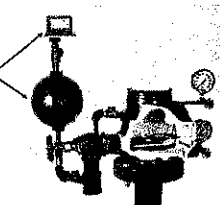
Alarm Devices

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



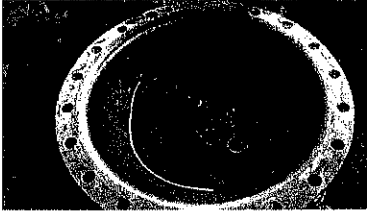
Vane Type

Pressure switch & retard chamber



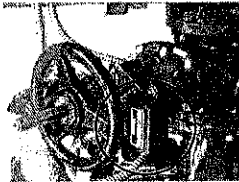
Alarm Devices

- Retard Chamber



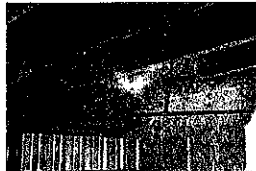
Alarm Devices

- Supervisory Tamper Switch

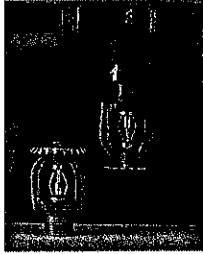


Sprinklers

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



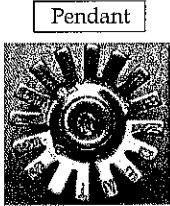
Sprinklers



Pendant

Upright

Sprinklers



Pendant

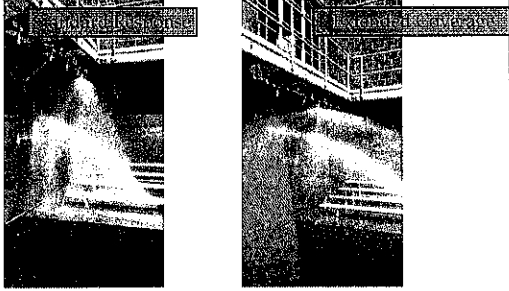


Upright

Sprinklers

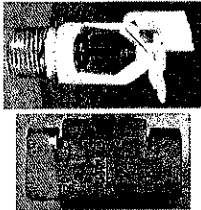


Sprinklers



Sidewall Sprinklers

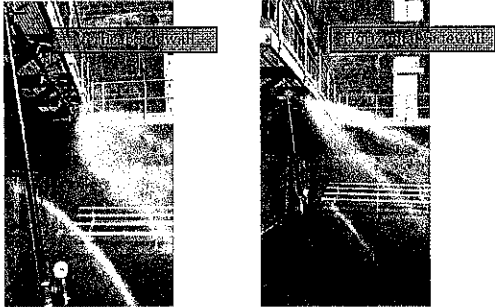
Horizontal Sidewall



Vertical Sidewall

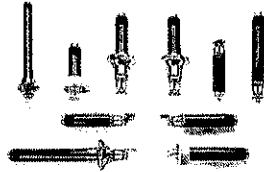


Sidewall Sprinkler Heads



Dry Barrel Sprinklers

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

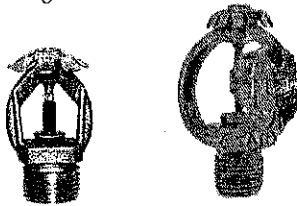


Concealed Sprinklers



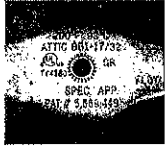
Conventional Sprinklers

- Combustible ceilings
- Prior to 1960's



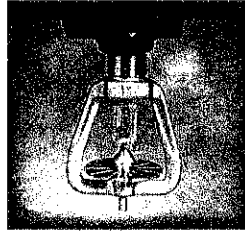
Attic Sprinklers

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

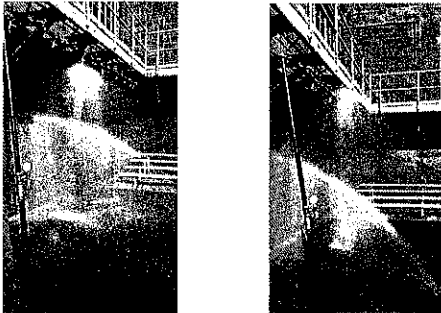


Early Suppression Fast Response Sprinklers

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



Early Suppression Fast Response (ESFR)



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.

Sprinkler Types

- Fusible Link-Pendant



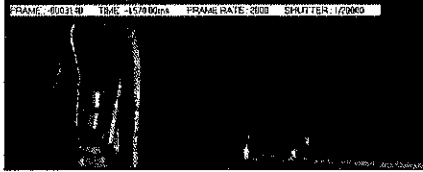
Sprinkler Types

- Fusible Link-Upright



Sprinkler Types

- Eutectic Pellet Strut-Upright



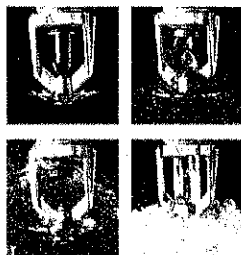
Sprinkler Types

- Concealed Sprinkler

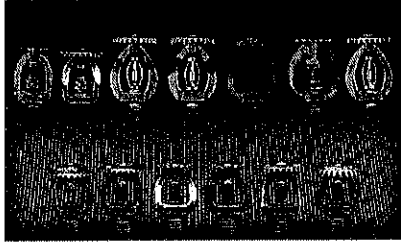


Sprinkler Types

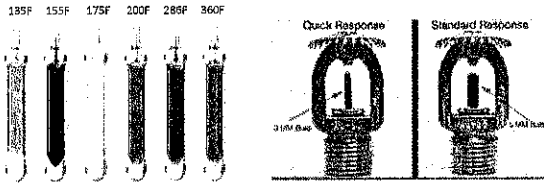
- Bulb Type



Temperature Ratings



Temperature Ratings



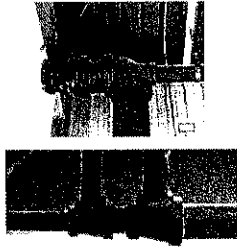
Temperature Ratings

▪ NFPA 13

Maximum Ceiling Temperature		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Colors
*F	*C	*F	*C			
100	38	133-170	57-77	Ordinary	Uncolored or black	Orange or red
150	60	175-225	75-107	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	204-236	Very extra high	Green	Black
475	246	500-575	260-302	Ultra high	Orange	Black
625	329	650	343	Ultra high	Orange	Black

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



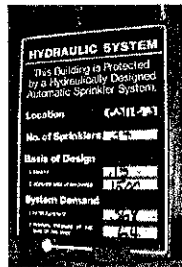
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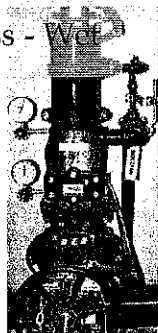
Piping Arrangements

- 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.

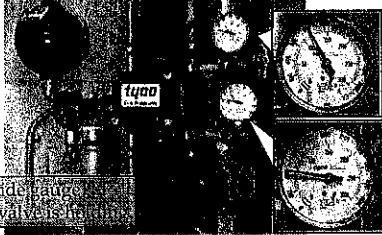


Operational Readiness - Wet

- 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



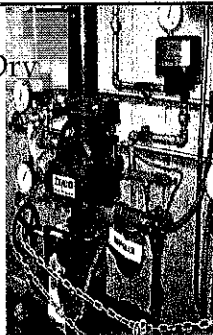
Operational Readiness - Wet Sprinkler System



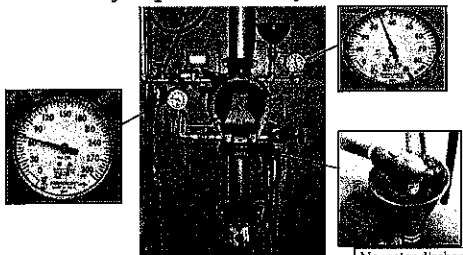
Higher system side gauges indicates alarm valves

Operational Readiness - Dry

- The main water supply control valve must be OPEN
- The main drain valve must be SHUT
- The air pressure gauges should reflect the system air pressure supplied by the air compressor
- 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



Operational Readiness - Dry Sprinkler System



No water discharge

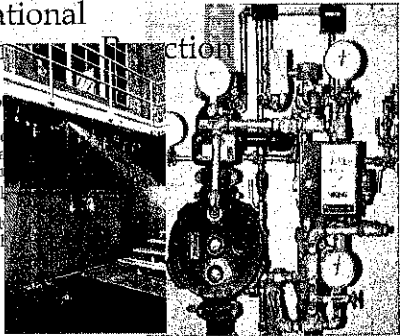
Operational Readiness - Deluge

- 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
- Main drain valve(s) must be SHUT
- Emergency release control valve must be closed
- Alarm test valve is SHUT



Operational Readiness - Inspection

- Main water supply control valve must be OPEN
- The water system pressure gauges should reflect the water pressure as supplied by the municipal water system
- Supervisory air gauge displays correct pressure
- Main drain valve(s) must be SHUT
- Emergency release control valve must be closed
- Alarm test valve is SHUT



Thank You

Future Questions

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