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Fire Protection

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Fundamentals of SH&E



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Agenda



Introduction

- Science of Fire
- Fire Controls
- Fire Protection
 - **Detection / Suppression**
- Testing - Maintenance
- Warehousing / Storage
- Questions

What is Fire ?



Classic Definition

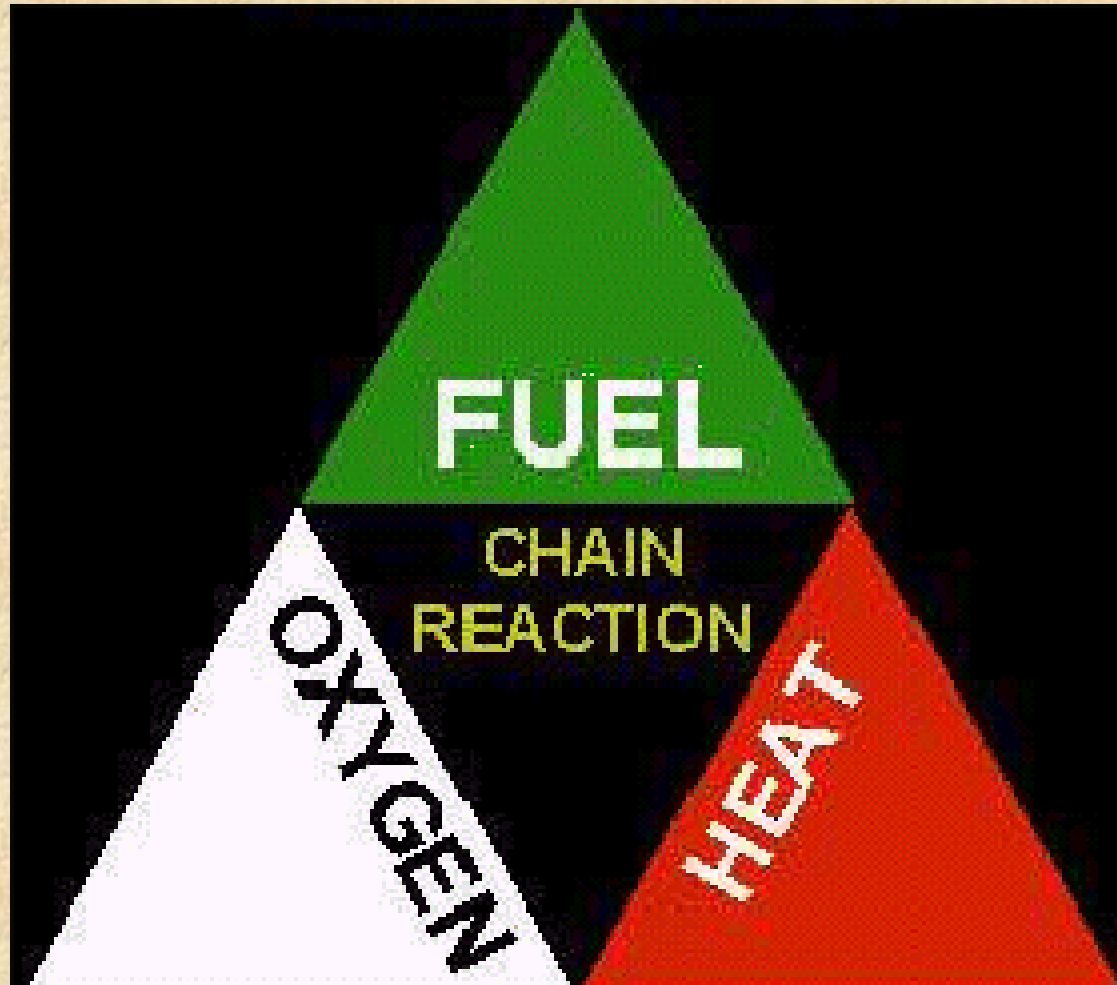
Fire is rapid oxidation with the evolution of heat and light



The Fire Triangle



Triangle? Not a Tetrahedron?



What's Burning?



Pyrolysis

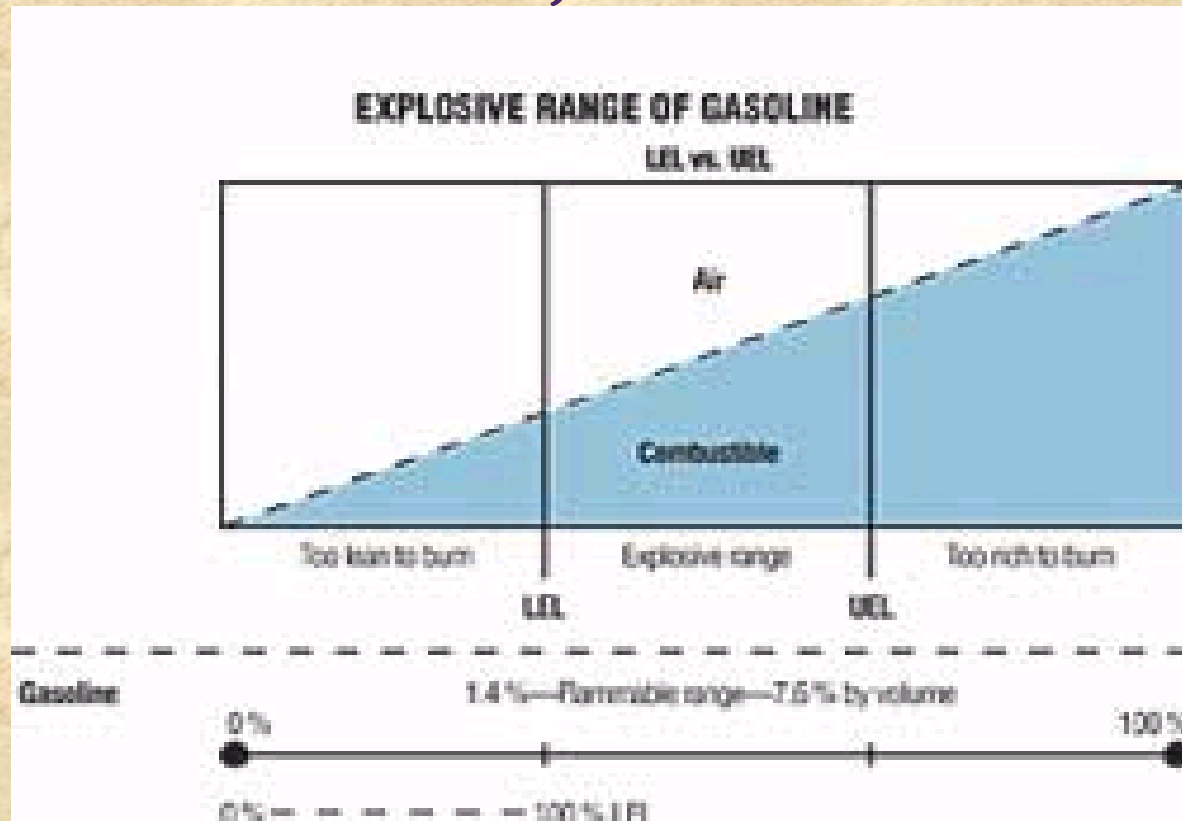
- Some of the heat is lost (convective)
- Some of the heat goes back into the system (conductive)
- Heat produces vapors
- Vapors ignite and propagate



Vapors

Flammable Range LFL – UFL, LEL – UEL

- Lean
- Rich



So Far

- **Defined Fire**
- **Know what is burning**
- **Concept of Flammability Range**

Control

Remove one or more legs of the triangle

- Omit the Fuel
- Inert the Atmosphere
- Cool the Reaction
- Interfere with the combustion process

Applied Controls -- Fuel



- Segregate fuel from processes
- Minimize the amount of fuel
- Use less combustible materials
- Housekeeping - Dusts

Applied Controls -- Oxygen



- Can the process operate rich?
- Can the process operate lean?
- Inert the operation – N₂, CO₂

Applied Controls -- Heat

- Exothermic processes
- Frictional heat
- Chemical heat
- Sparks - Electrical



Applied Controls -- Heat

- Sparks - Welding, Hot Work
- Grinding
- Open Flames
- Lightning
- Smoking



Applied Controls -- Chain Reaction



- **Less Hazardous Materials**
 - **Water Soluble vs. Oil Based**
 - **Paints, Cutting Oils, Lubricants, Inks Etc.**
- **Fire Resistive Materials**
 - **Phenols, PVC's vs. Polyethylene, Styrene**
 - **Inerting Fillers for Plastic**
 - **Intumescent**

Applied Controls -- Management

Written Procedures

- Air Sampling
- Hot Work
- Self Inspections
- Outside Contractors

FOR ALL CUTTING/WELDING OPERATIONS

SPECIAL INSTRUCTIONS

Cutting/Welding Permit
Applies Only to Area Specified Below

SEE INSTRUCTIONS ON REVERSE SIDE

SECTION A

LOCATION	JOB OR WJA NUMBER
----------	-------------------

INSTRUCTIONS

1. Supervisor completes section to be used from (1) to (3) and (4) & (5).
2. Supervisor retains the top copy of the form and issues the permit card to (1) & (2) in the work area.
3. Worker completes Section C, then Section B in the work area, and returns Section C to the supervisor.
4. Section B remains at the work area until it is picked up one hour after work is completed, and is then returned to the Supervisor.

IS THERE A SAFER WAY?

So Far



- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls

System Controls -- Devices

- Fire Detection
- Fire Suppression



System Controls -- Devices

Fire Detection

- **Smoke**
 - Ionization, Photoelectric
- **Heat**
 - Restorable, Rate of Rise
- **Beam**
 - Obscuration
- **Flame**
- **IR**



System Controls -- Devices

Four Stages of a Fire

- Incipient
 - Days to microseconds
- Smoldering
 - Hours to microseconds
- Flaming
- High Heat



Time –Temperature Curve

**INCIPIENT
STAGE**

**SMOLDERING
STAGE**

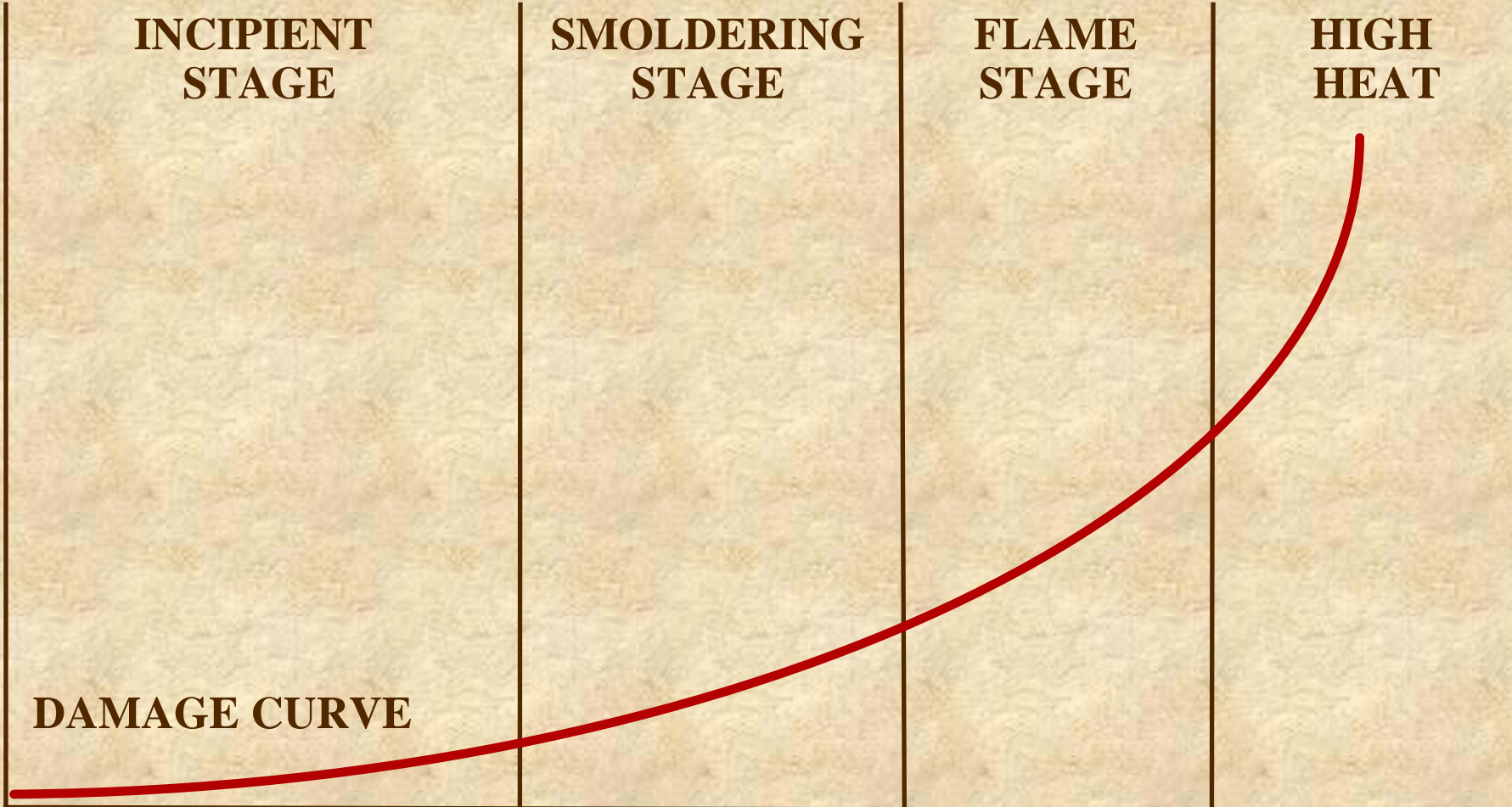
**FLAME
STAGE**

**HIGH
HEAT**

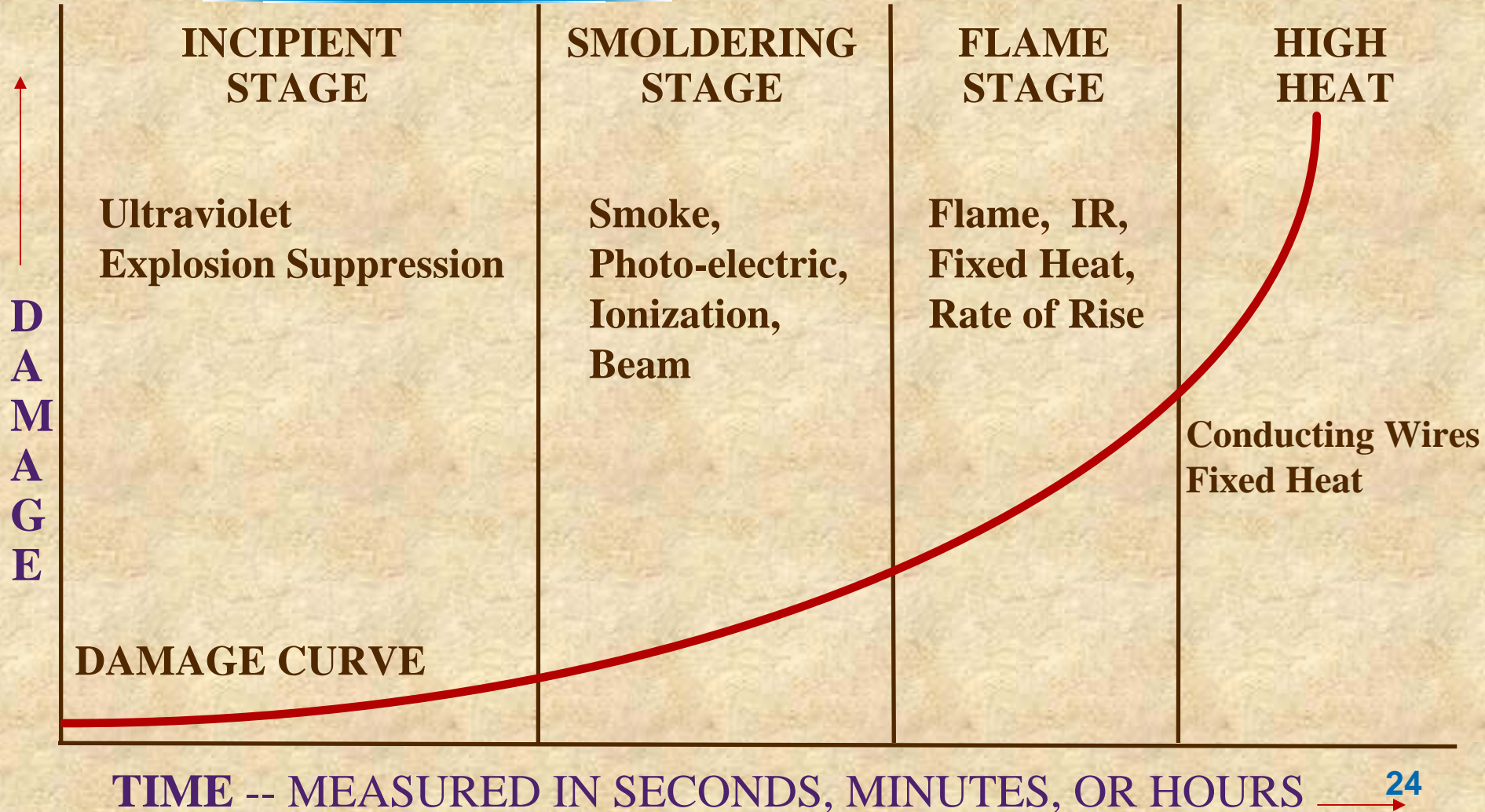
**T
E
M
P**

DAMAGE CURVE

TIME MEASURED IN SECONDS, MINUTES, OR HOURS



Time –Temperature Curve



So Far

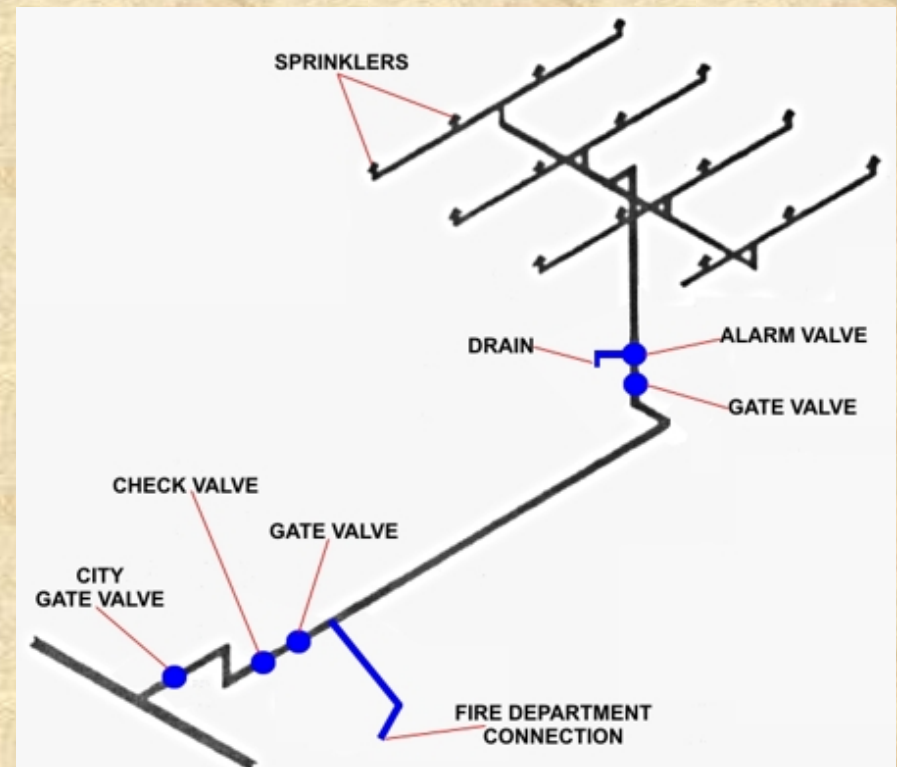


- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection

System Controls - Fixed Suppression

Sprinkler Systems

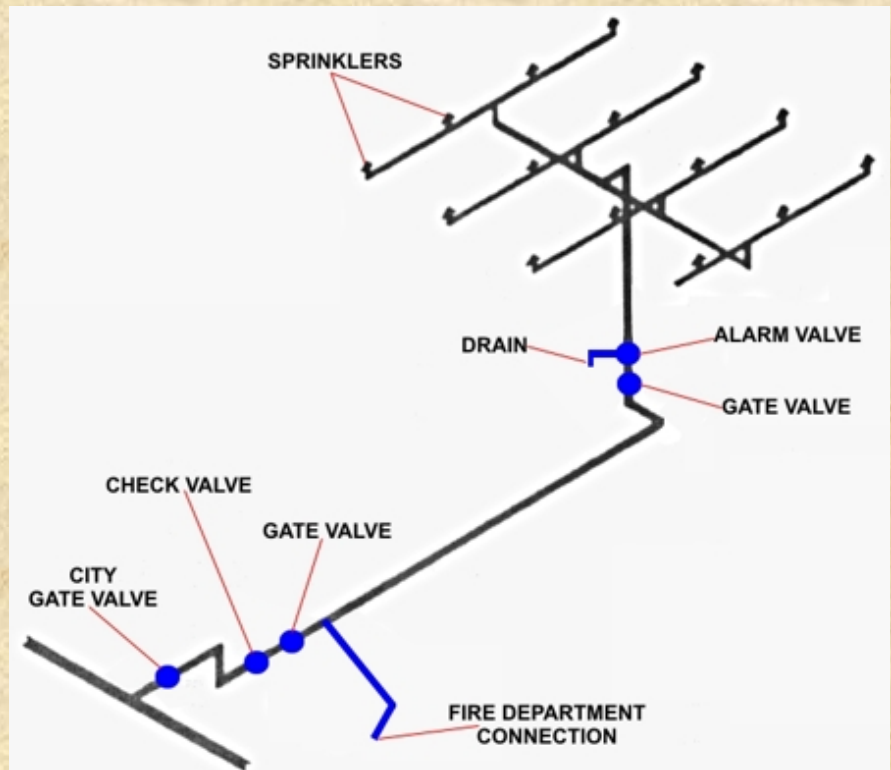
- Wet
- Dry
- Anti-freeze
- Deluge
- Pre-action
- Combined Dry / Pre-action
- Cycling On-Off
- Ref: NFPA 13



System Controls - Fixed Suppression

Sprinkler Systems

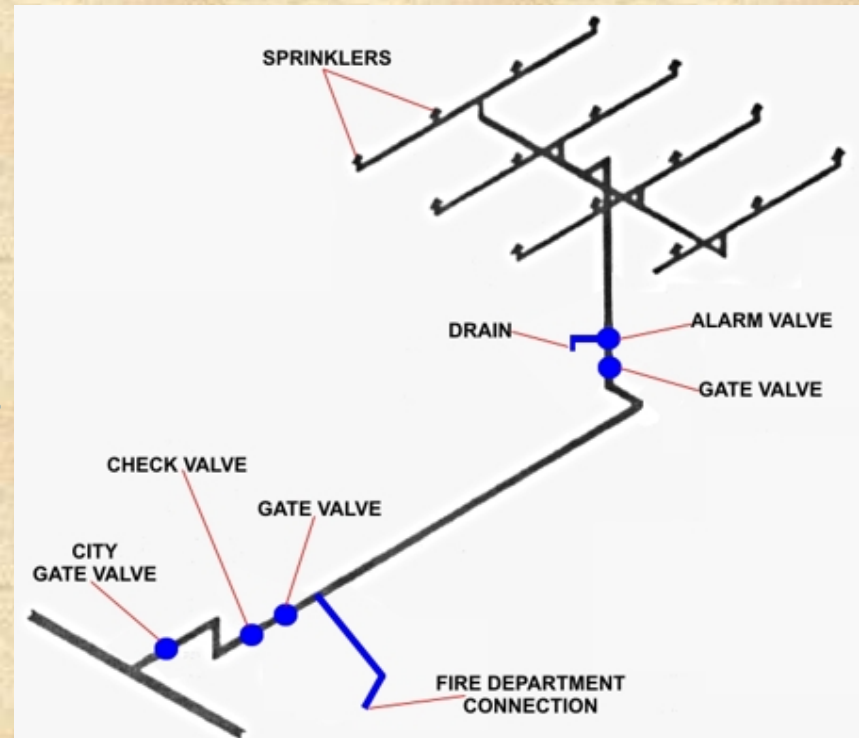
- **Wet**
 - Most Common
 - Water in the pipes
 - Very efficient
 - Requires Heat



System Controls - Fixed Suppression

Sprinkler Systems

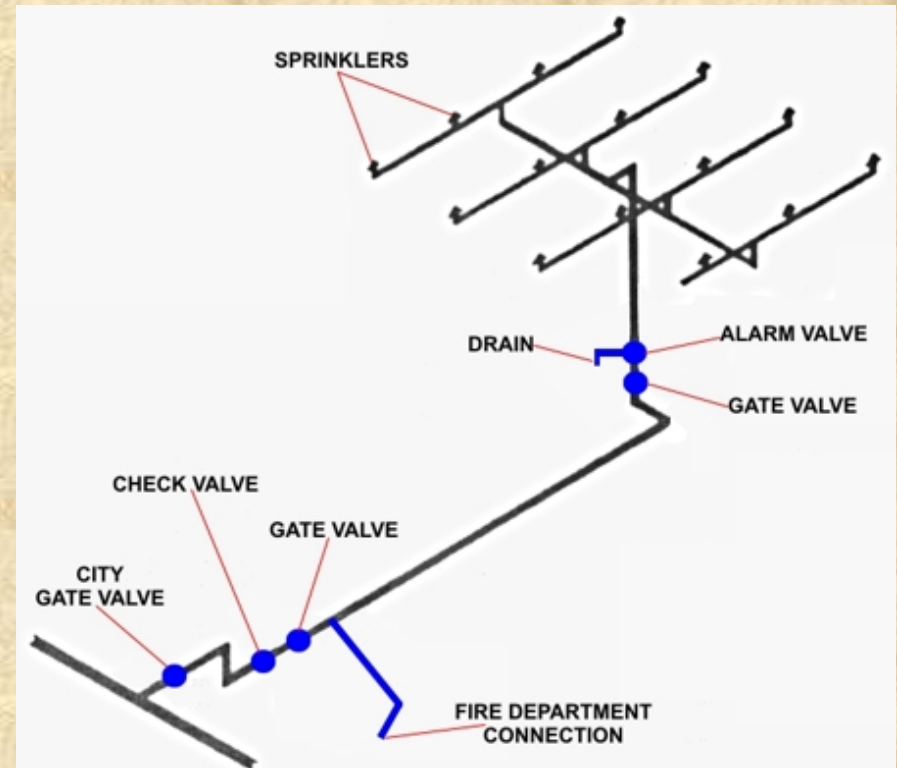
- **Dry**
 - Compressed air in pipes
 - Needs more devices
 - Used in areas subject to freezing
 - Limited in size



System Controls - Fixed Suppression

Sprinkler Systems

- Anti-Freeze
 - Filled with a glycol solution
 - Limited in size
 - Some applications to storage occupancies

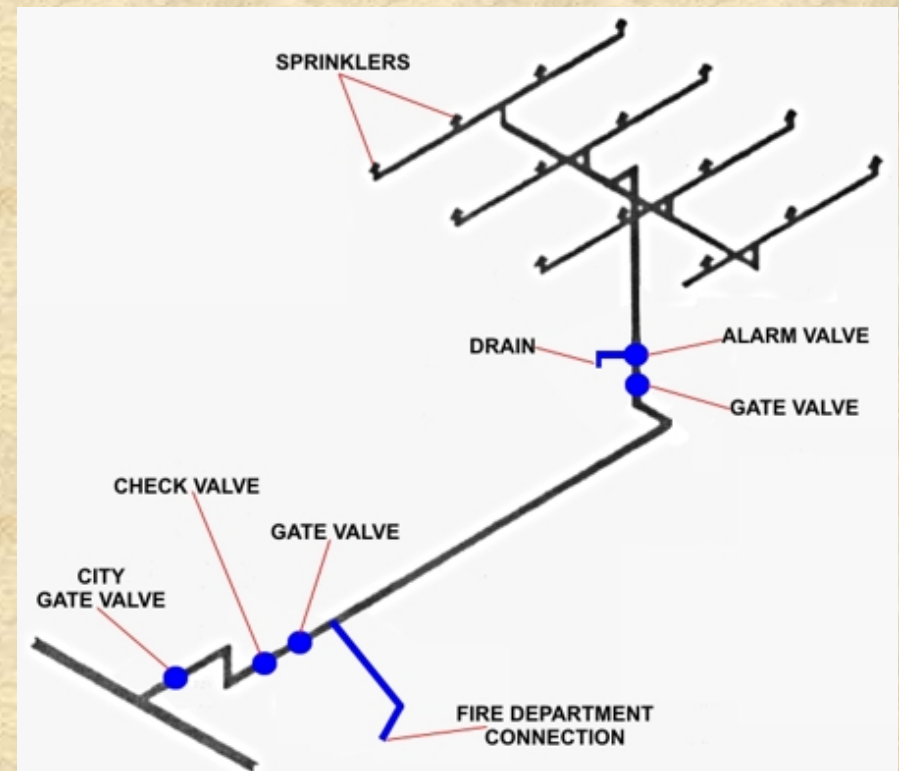


System Controls - Fixed Suppression

Sprinkler Systems

• Deluge

- Nothing in pipes
- Sprinklers are open
- Used in High Hazard areas / processes
- Requires an actuation system

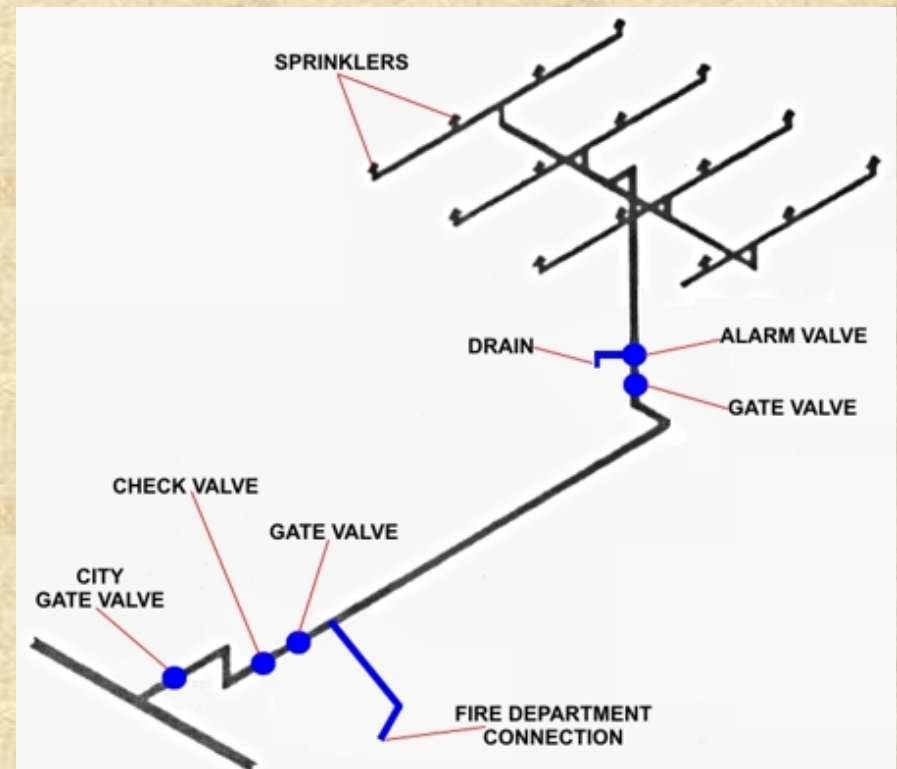


System Controls - Fixed Suppression

Sprinkler Systems

•Pre-Action

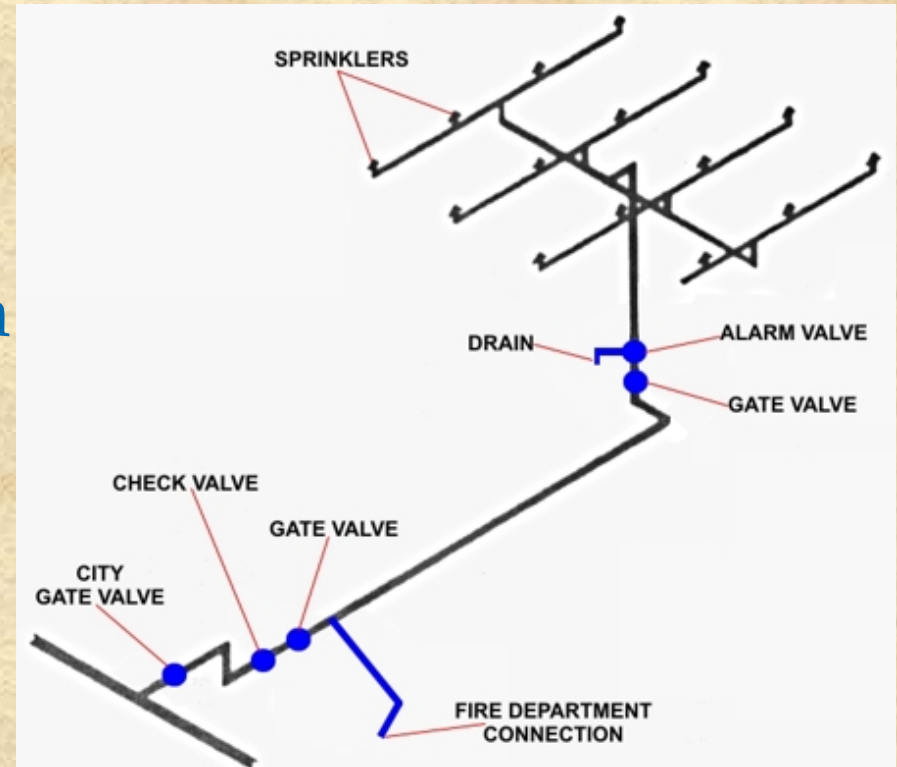
- Pipes filled with a compressed air
- Requires an actuation system
- Minimizes water damage



System Controls - Fixed Suppression

Sprinkler Systems

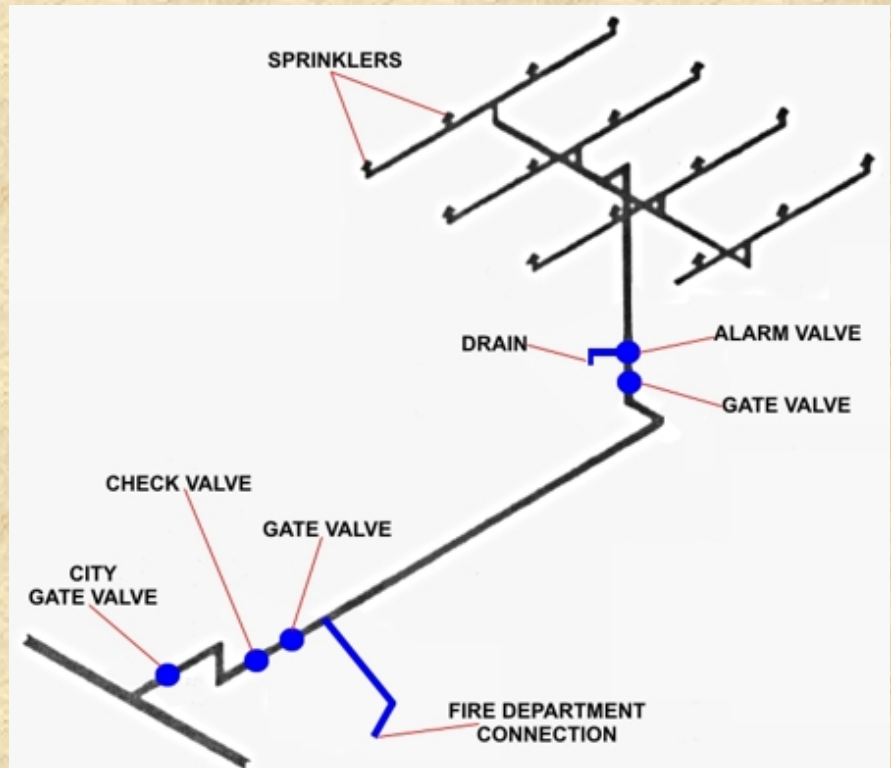
- Combined Systems
 - Two Valves
 - Used where water damage is a concern
 - Used in freezers
 - Used in Computer rooms
 - Requires an actuation system



System Controls - Fixed Suppression

Sprinkler Systems

- Cycling On - Off
 - Filled with water
 - Used where water damage needs to be minimized
- Museums, Art Galleries, Cultural Institutions



System Controls - Fixed Suppression



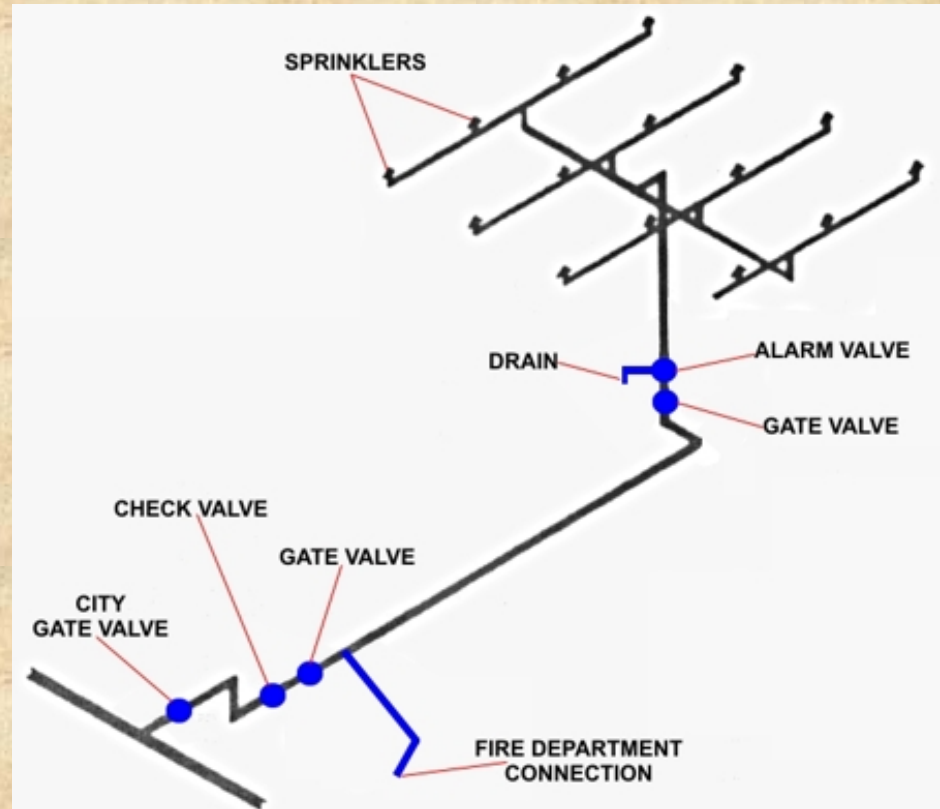
Terminology

- **Pipe Schedule System**
 - **Pre – 1972**
 - **Pipes Sized per a schedule**
 - **Pipes Sized based on Occupancy**
 - **Light, Ordinary Hazard, Extra Hazard**
- **Hydraulically Calculated Systems**
 - **Pipes sized on friction loss**
 - **Loops and Grids MUST be Calculated**
 - **Risers Clearly Placarded with Design Info**

System Controls - Fixed Suppression

Terminology

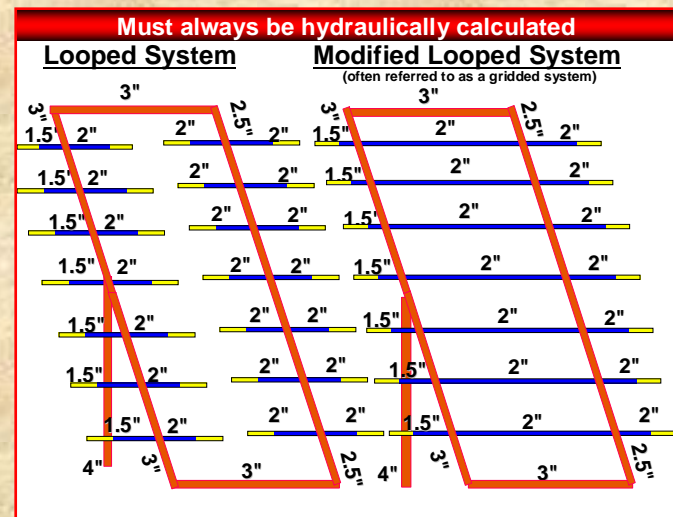
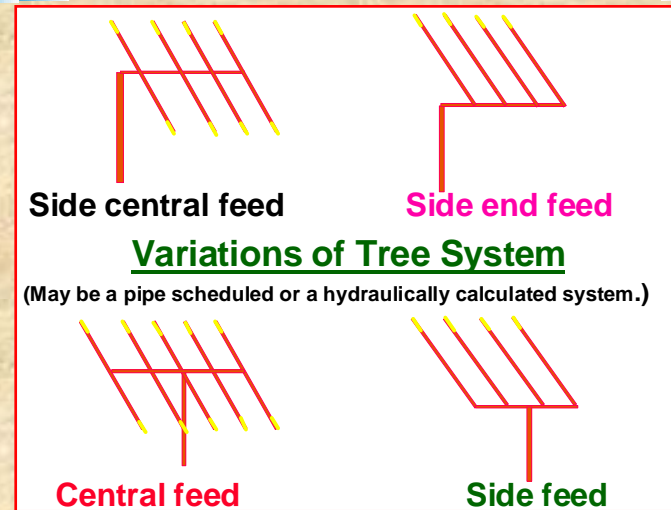
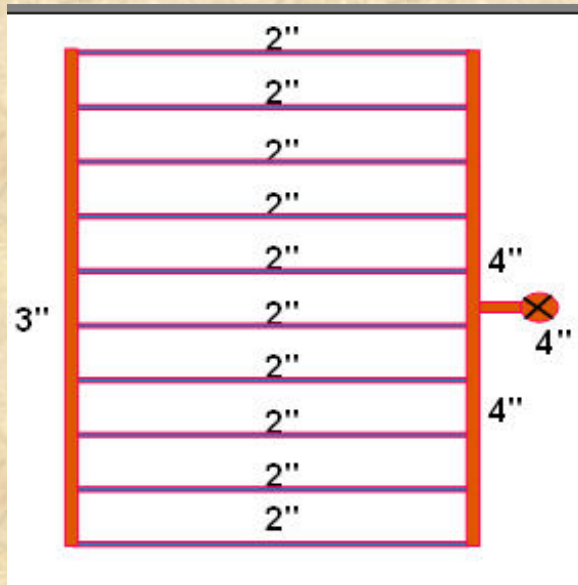
- Branch lines
- Crossmains
- Feedmains
- Risers
- Sprinklers



System Controls - Fixed Suppression

Sprinkler Systems

- Tree Systems
- Looped Systems
- Gridded Systems



So Far



- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection
- Sprinkler Systems

System Controls - Fixed Suppression

Sprinklers

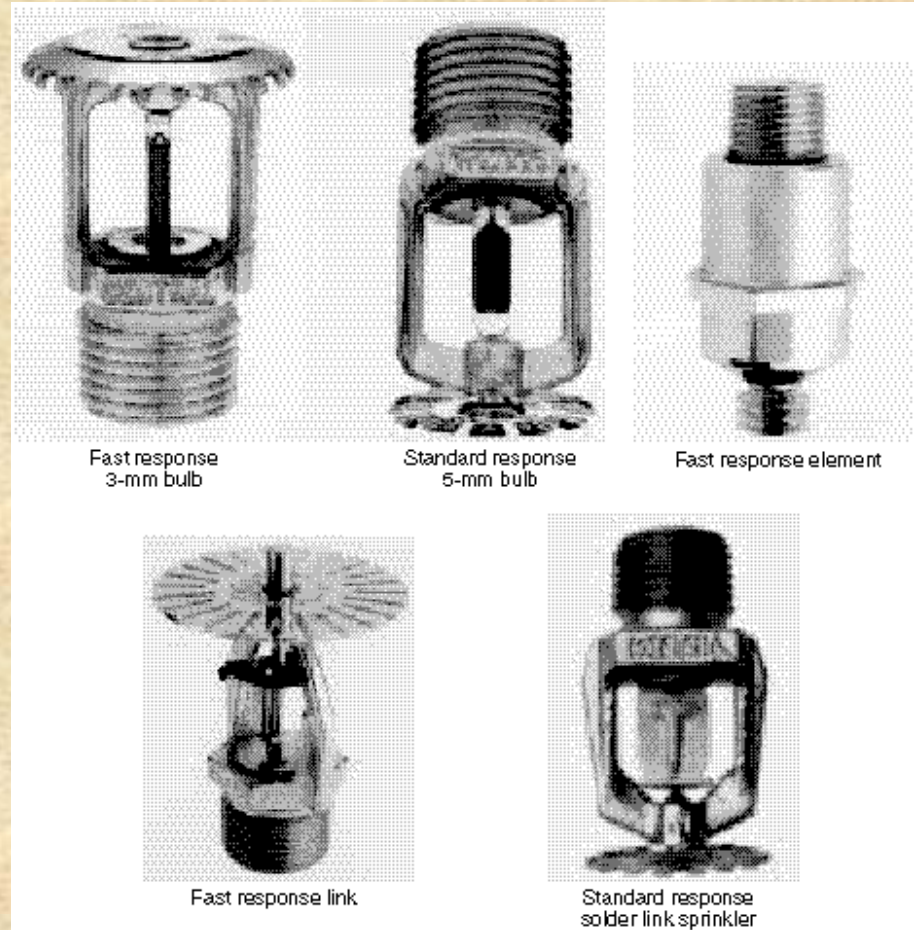
- Upright
- Pendant
- Special Application



System Controls - Fixed Suppression

Sprinklers

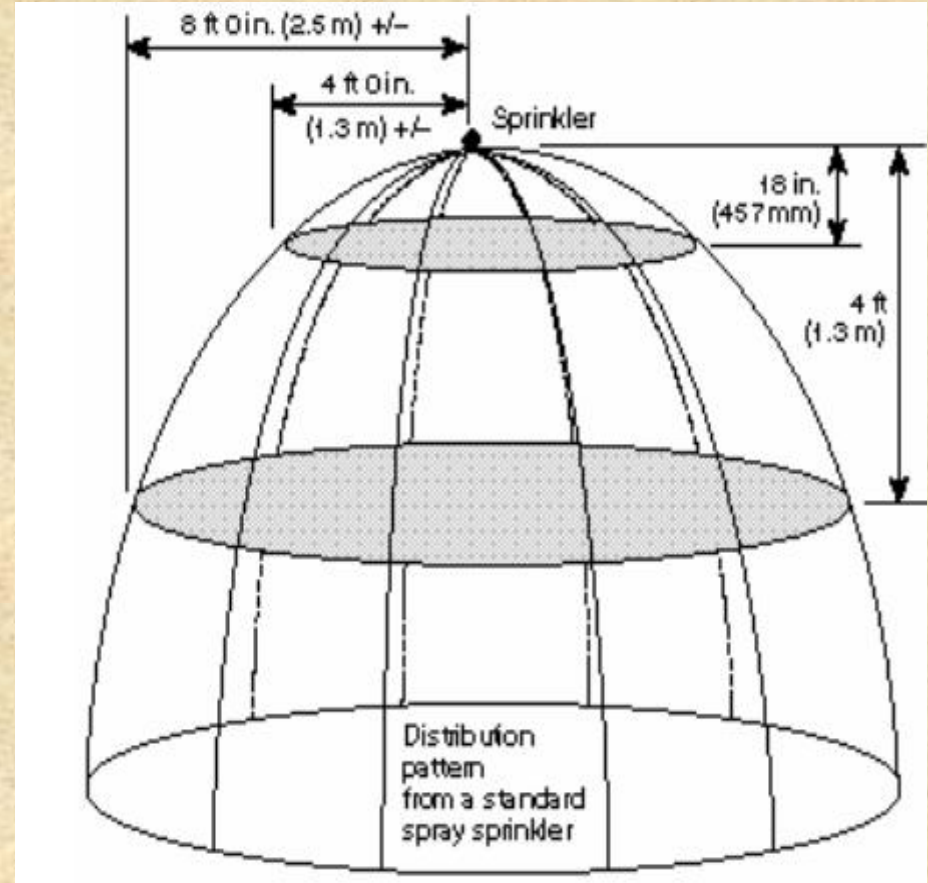
- Upright
- Pendant
- Quick Response
- Fast Response
- Nozzles
- Storage
- Special Application



System Controls - Fixed Suppression

Sprinklers

- Good for 50 years
 - Must be tested
- Orientation
 - Replace like kind
- Obstructions
 - Adequate Clearance



So Far



- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection
- Sprinkler Systems

System Controls - Fixed Suppression

Other Systems

- CO2
- Halon (They are still in use)
 - 1301 1211
- Clean Agents
 - FM 200, Inergen
Sapphire
- Dry Chemical
- Liquid Salts
- Explosion Suppression



System Controls - Fixed Suppression

Other Systems

- Used Where water damage is an issue
- Can be used in inhabited areas
- Preferred for Specific Hazards
- Special Maintenance Needs



So Far



- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection
- Sprinkler Systems
- Special Extinguishing Systems

System Controls - First Attack

- **Hand Held Extinguishers**
 - Water
 - Dry Chemical
 - CO2
 - Metal Powders
 - Liquid Salts
- **Class Of Fire**
 - “A” Paper, Cloth, Wood
 - “B” Oils, Grease
 - “C” Electrical
 - “D” Metal
 - “K” Kitchens



System Controls - First Attack

- **Hand Held Extinguishers**
 - **Placement**
 - **Correct Extinguisher for Class of Fire**
 - **Employee Training**
 - **Maintenance**
 - **Ref: NFPA 10**



Maintenance



- **Maintenance for Suppression Systems**
 - **Prescribed by NFPA 25**
- **Maintenance for Detection Systems**
 - **Prescribed by NFPA 72**
- **Maintenance for Extinguishers**
 - **Prescribed by NFPA 10**
- **Document the Work / Tests**

So Far



- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection
- Sprinkler Systems
- Special Extinguishing Systems
- Hand Held Extinguishers

WHEW !!

Storage and Warehousing



NFPA Commodity Classifications

- **Class I**
Noncombustible product on pallet or in carton
- **Class II**
Noncombustible product in wood or multi-layered carton
- **Class III**
Combustible product, with or without cartons, pallets and not > 5% Class A plastic

Storage and Warehousing



NFPA Commodity Classifications

- **Class IV**

Product with 25% (vol.) 15% (wt.) Grp. A Plastic

- **Plastics**

Group "A" POLY – anything, Styrene

Group "B" Nylon, Rubber

Group "C" Phenols, CPVC

- **Idle Pallets**

Storage and Warehousing



Remember -- *The Brick*

Storage and Warehousing

Protection Based On:

- What is being Stored?
 - Commodity Class (Worst Class)
- How is it being Stored?
 - Stock pile. Racks, Shelves, Multi-row Racks
- How High is it being Stored?
 - Measured from floor to top of storage
- How High is the ceiling?



Changes in Storage and Warehousing

- Metal vs. Plastic
- Stock Pile vs. Rack
- Rack vs. Multi-Row Racks
- 12', 20', 22', 25' Storage?

In general change is *Not* good



Whew !! – Were Finished



- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection
- Sprinkler Systems
- Special Extinguishing Systems
- Hand Held Extinguishers
- Storage

Questions

