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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

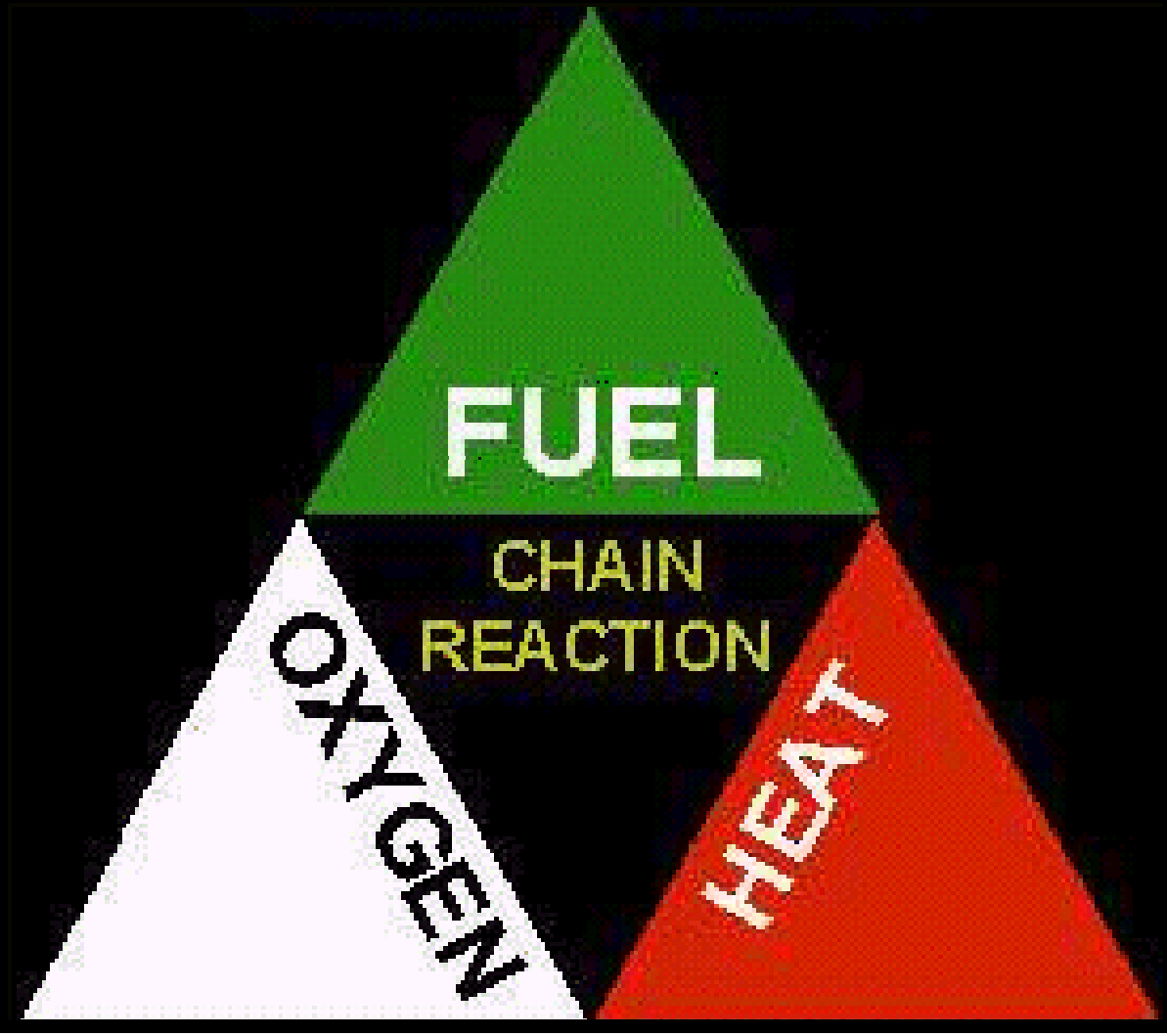
What is Fire ?

Classic Definition

- Fire is rapid oxidation with the evolution of heat and light

The Fire Triangle

Triangle? Not a Tetrahedron?



What's Burning?

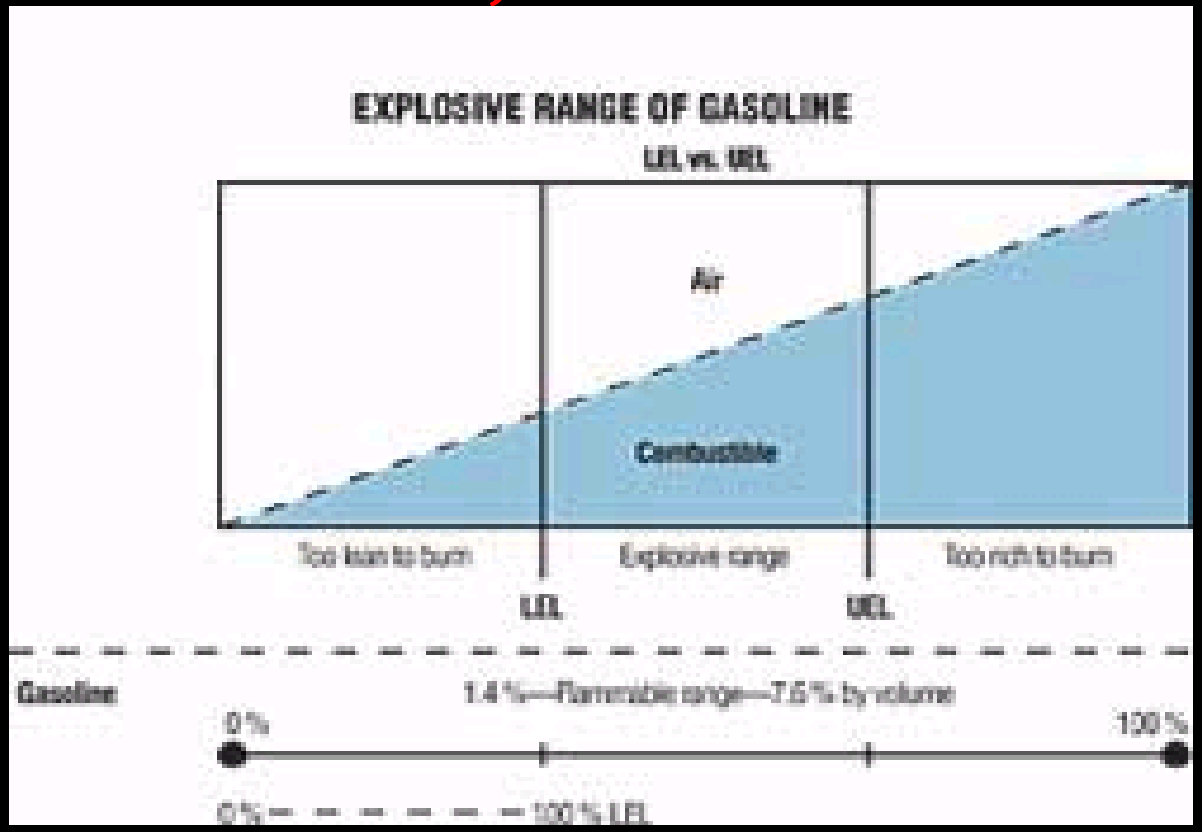
Pyrolysis

- 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

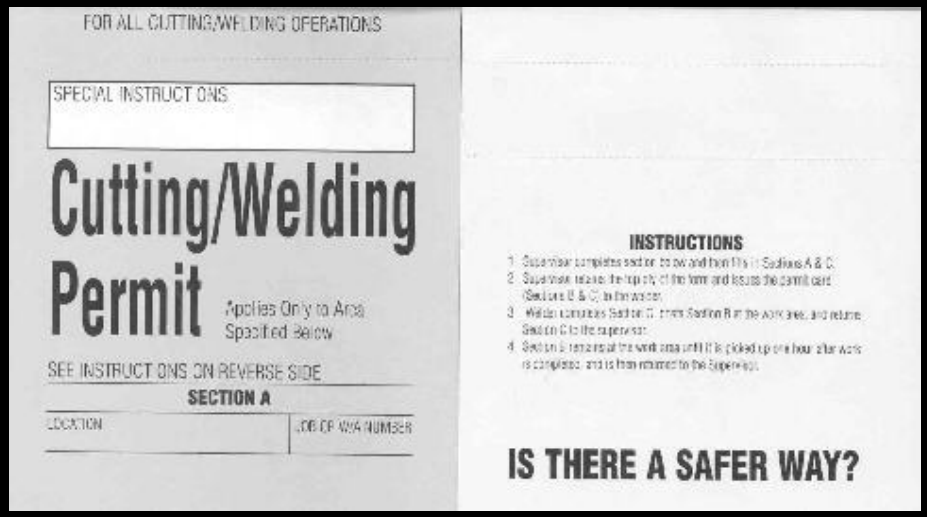
Applied Controls -- Chain Reaction

- 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
  - Intumescents

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 W/A NUMBER

INSTRUCTIONS

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

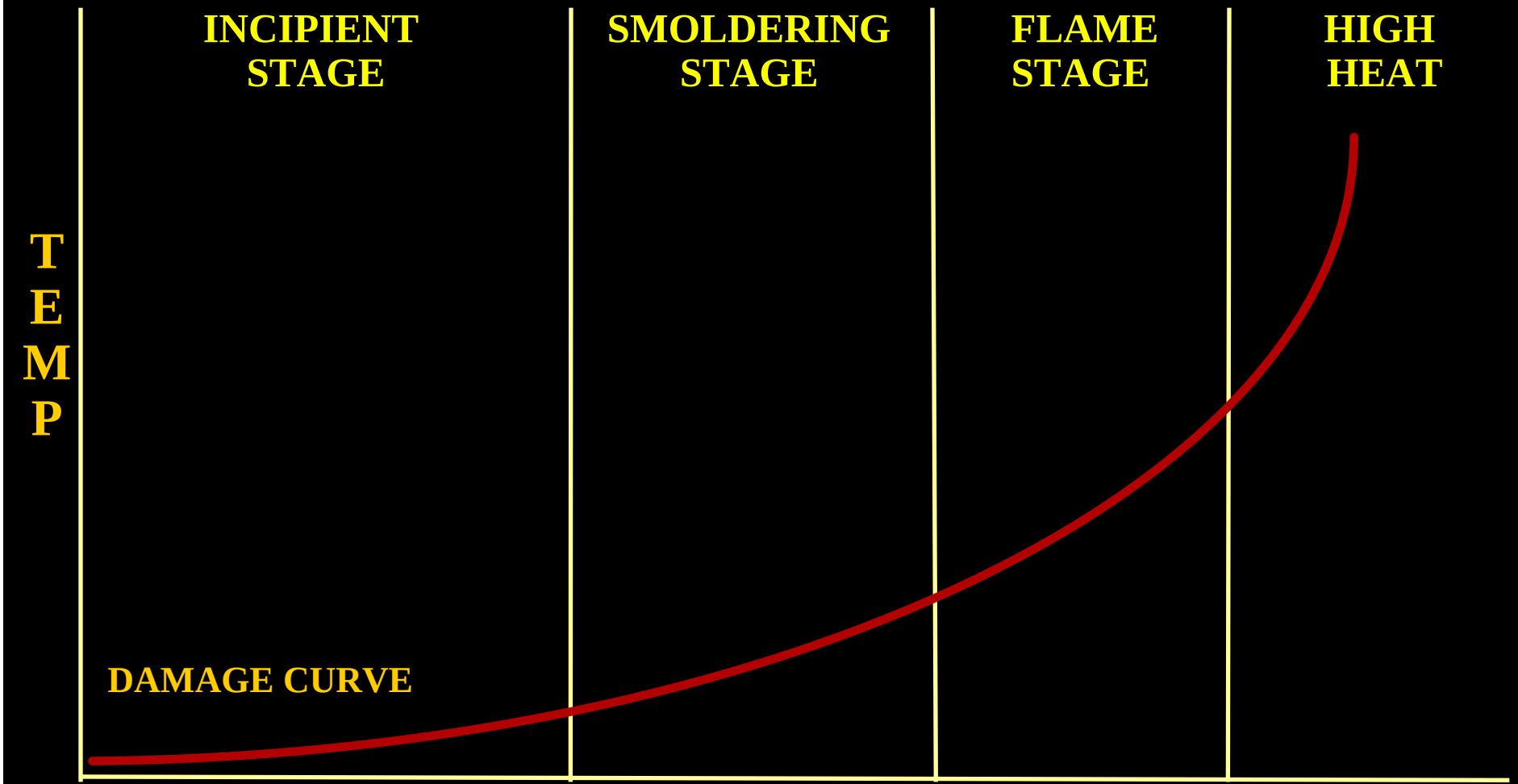
- Smoke
  - Ionization, Photoelectric
- Heat
  - Restorable, Rate of Rise
- Beam
  - Obscuration
- Flame
- IR

System Controls -- Devices

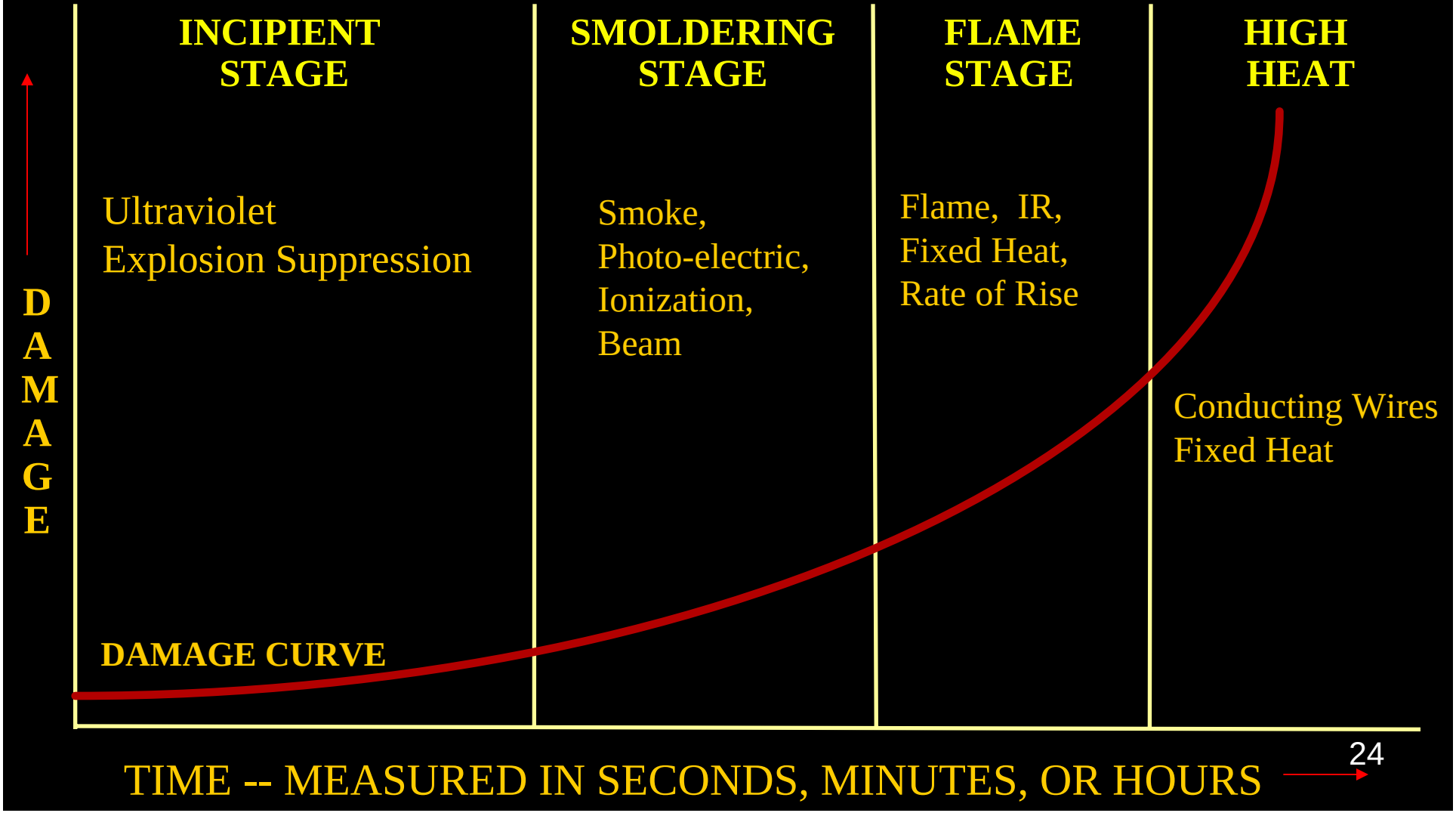
Four Stages of a Fire

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

Time –Temperature Curve



Time –Temperature Curve



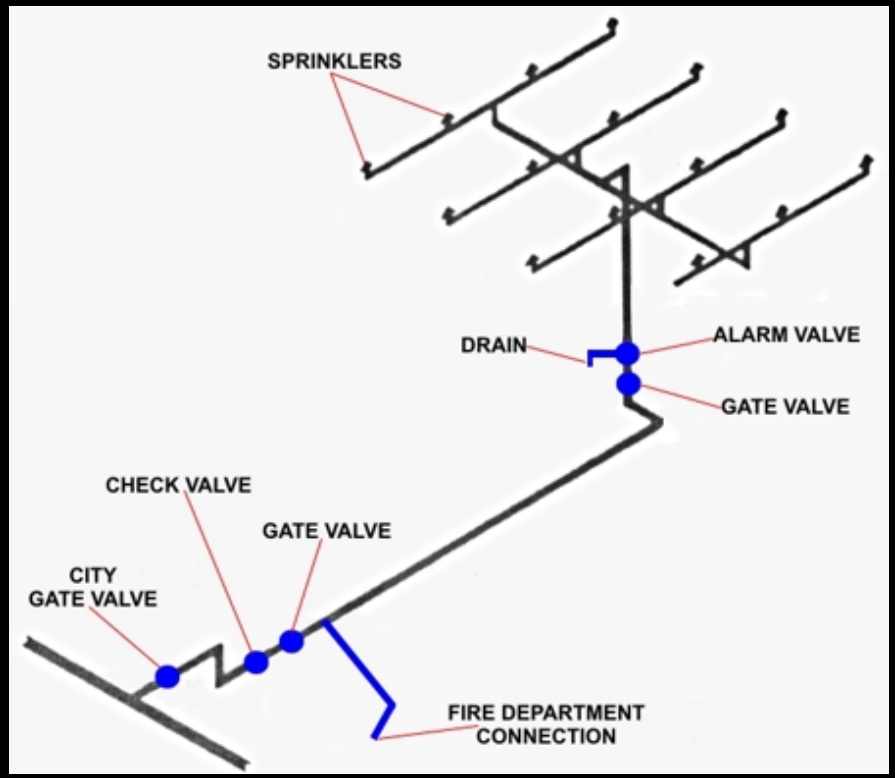
So Far

- 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

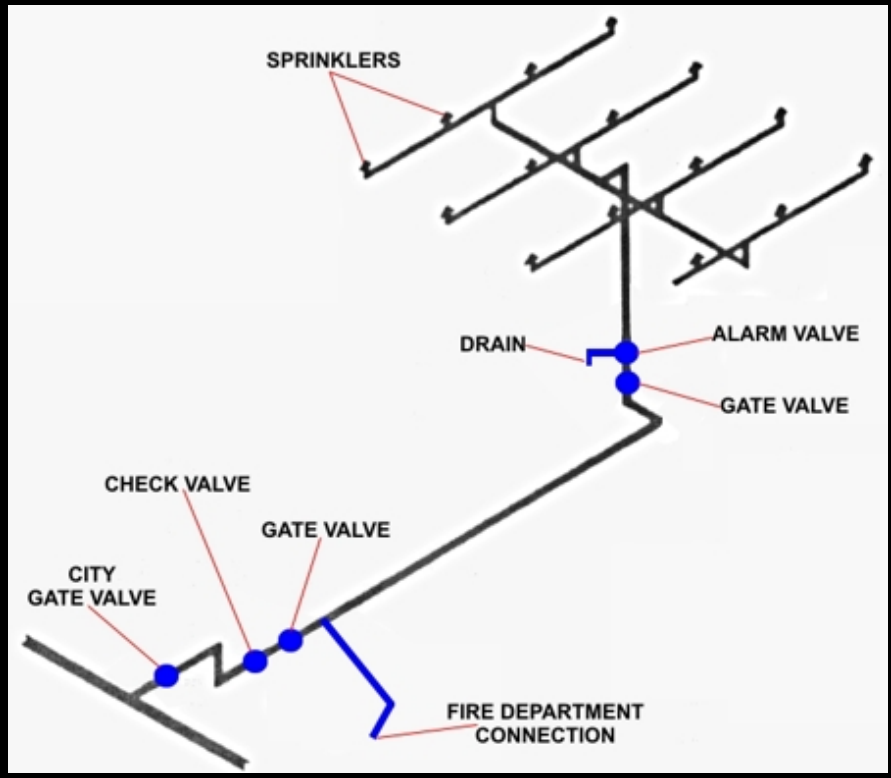
- Wet
- Dry
- Anti-freeze
- Deluge
- Pre-action
- Combined Dry / Pre-action
- Cycling On-Off
- Ref: NFPA 13



System Controls - Fixed Suppression

Sprinkler Systems

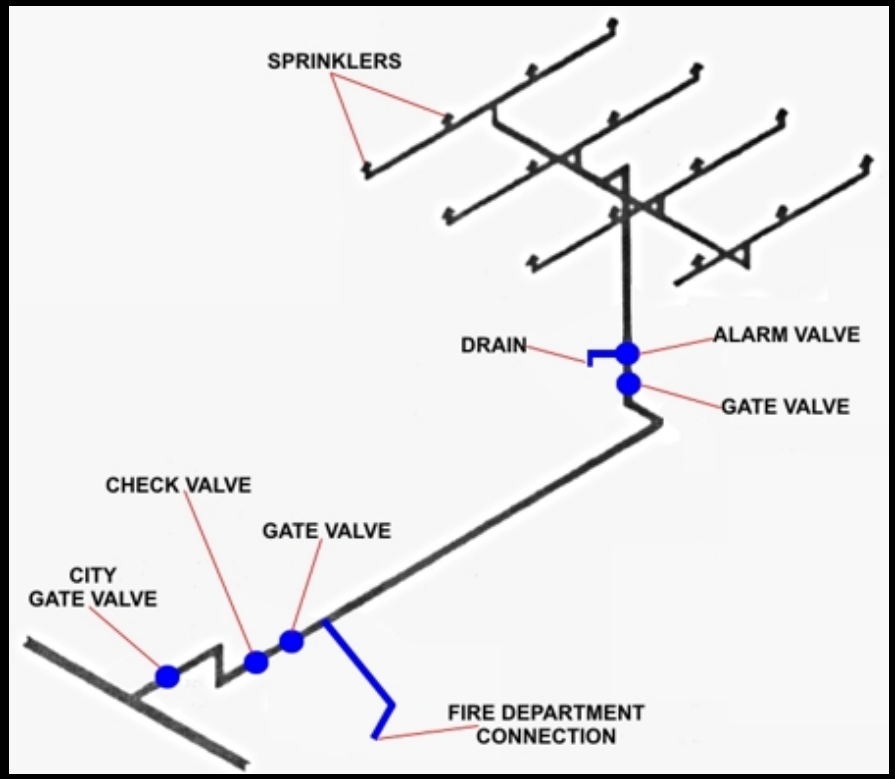
- **Wet**
  - **Most Common**
  - **Water in the pipes**
  - **Very efficient**
  - **Requires Heat**



System Controls - Fixed Suppression

Sprinkler Systems

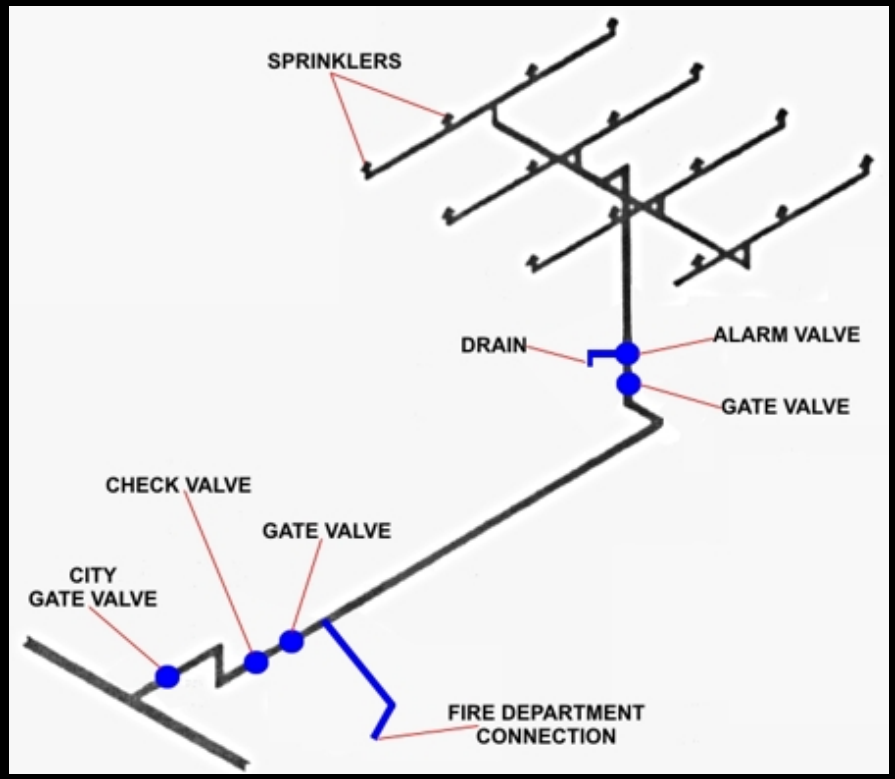
- Dry
  - Compressed air in pipes
  - Needs more devices
  - Used in areas subject to freezing
  - Limited in size



System Controls - Fixed Suppression

Sprinkler Systems

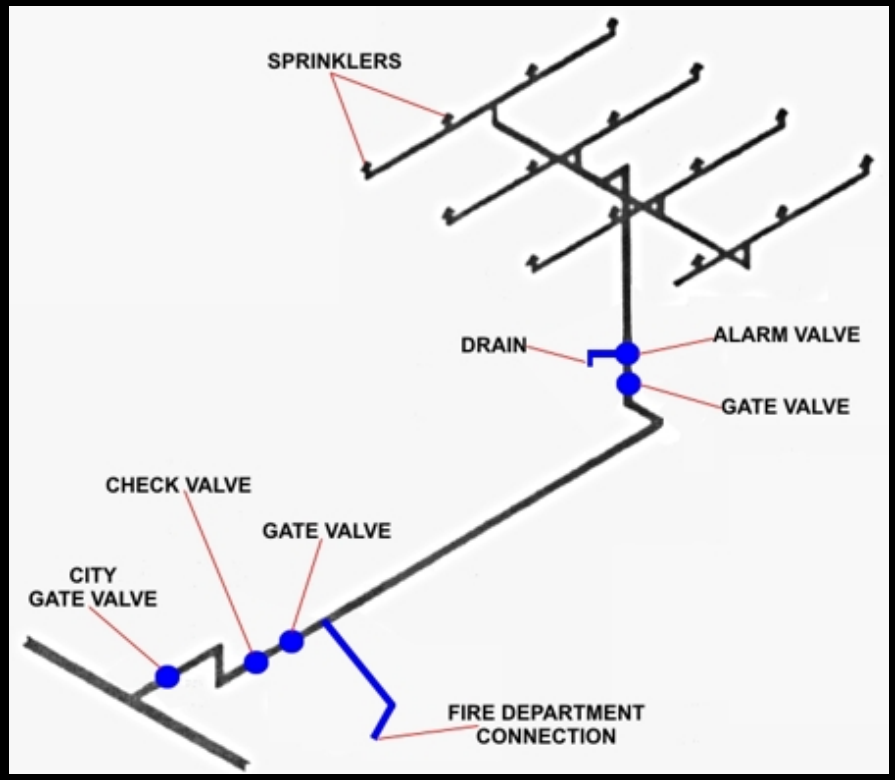
- Anti-Freeze
  - Filled with a glycol solution
  - Limited in size
  - Some applications to storage occupancies



System Controls - Fixed Suppression

Sprinkler Systems

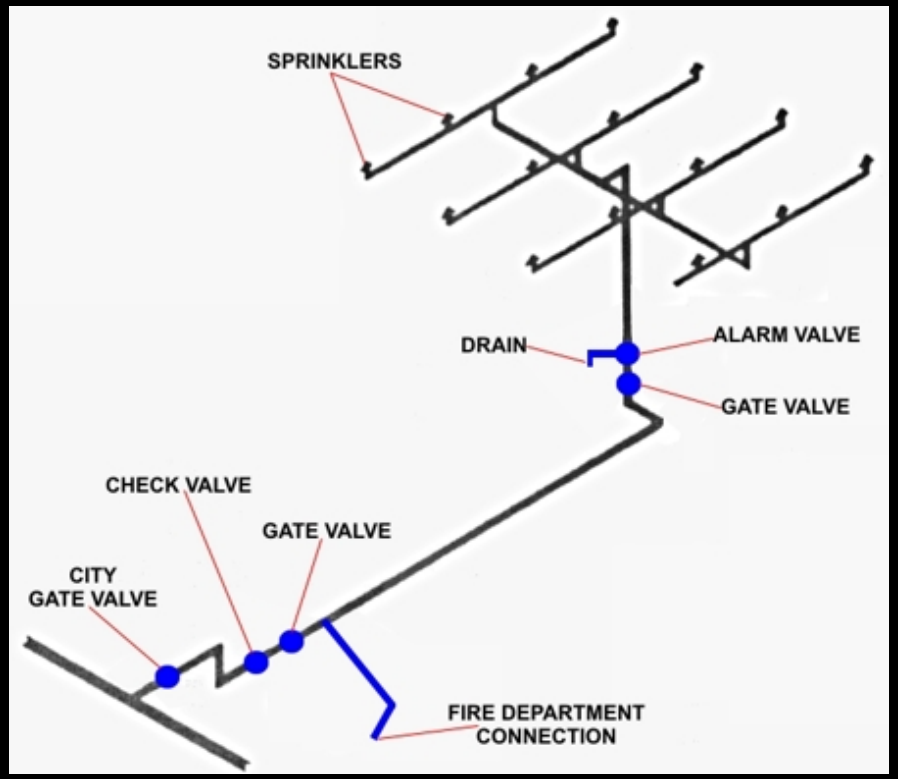
- **Deluge**
  - Nothing in pipes
  - Sprinklers are open
  - Used in High Hazard areas / processes
  - Requires an actuation system



System Controls - Fixed Suppression

Sprinkler Systems

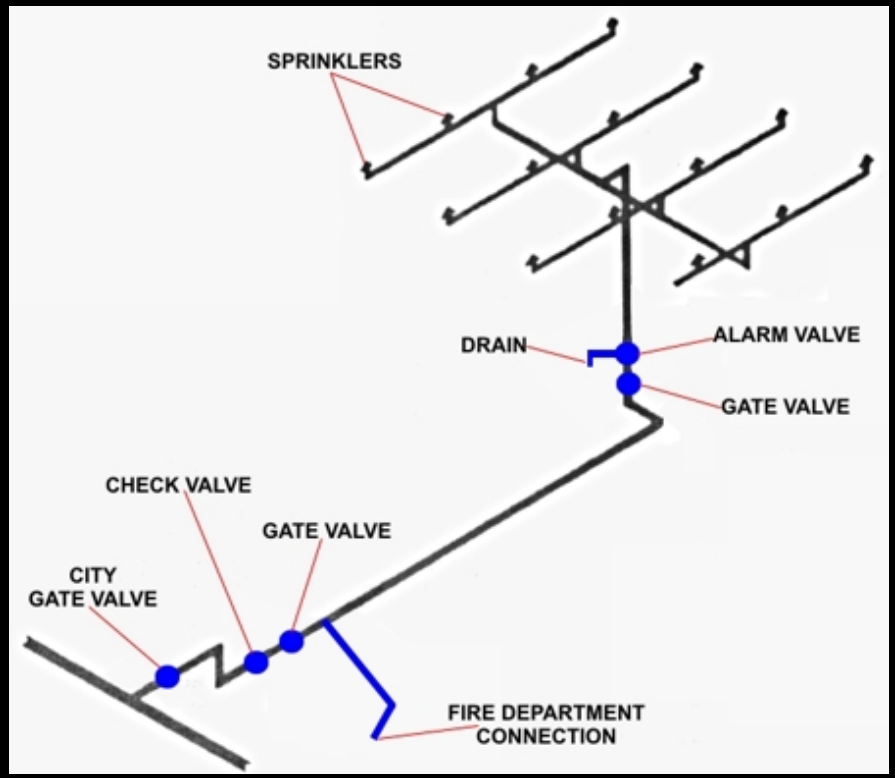
- **Pre-Action**
  - **Pipes filled with a compressed air**
  - **Requires an actuation system**
  - **Minimizes water damage**



System Controls - Fixed Suppression

Sprinkler Systems

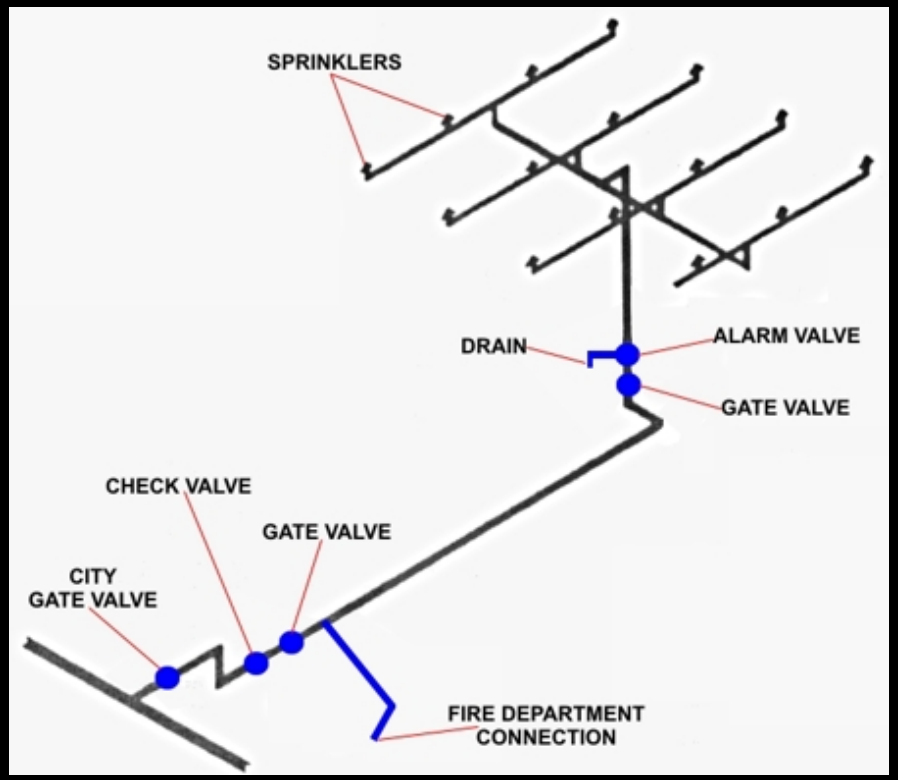
- Combined Systems
  - Two Valves
  - Used where water damage is a concern
  - Used in freezers
  - Used in Computer rooms
  - Requires an actuation system



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

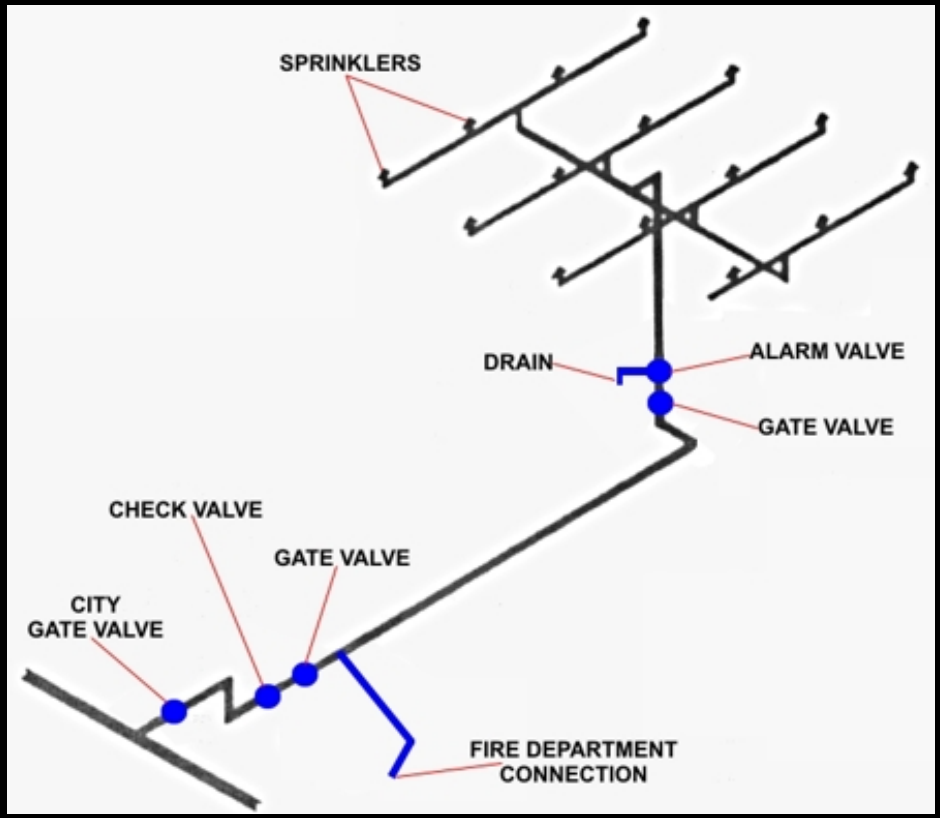
Terminology

- 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

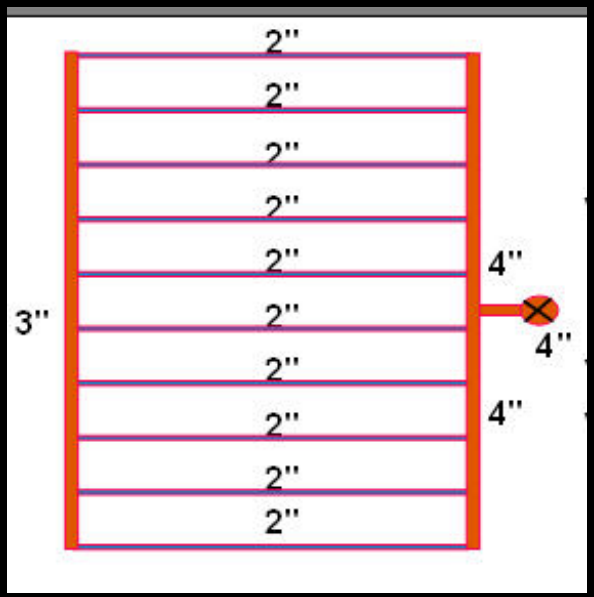
- Branch lines
- Crossmains
- Feedmains
- Risers
- Sprinklers

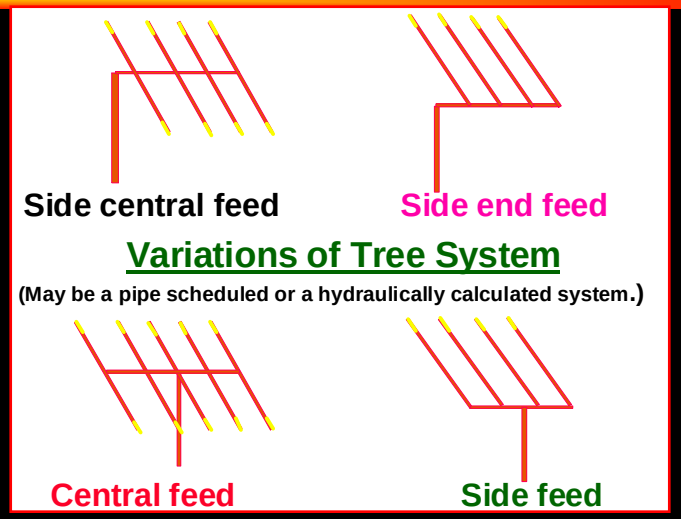


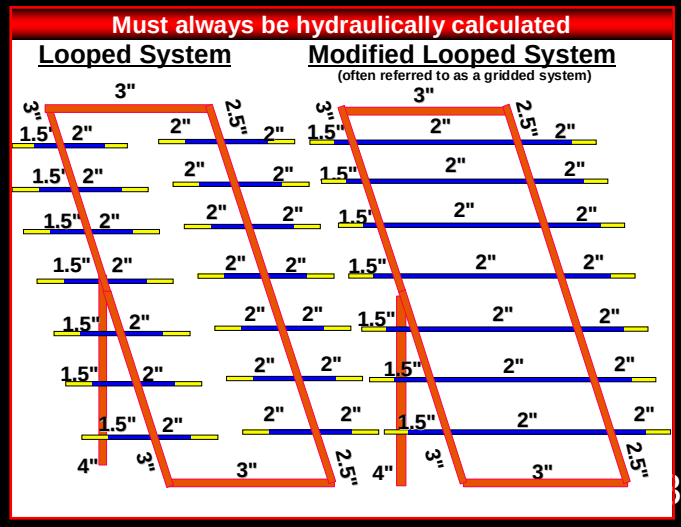
System Controls - Fixed Suppression

Sprinkler Systems

- Tree Systems
- Looped Systems
- Gridded Systems







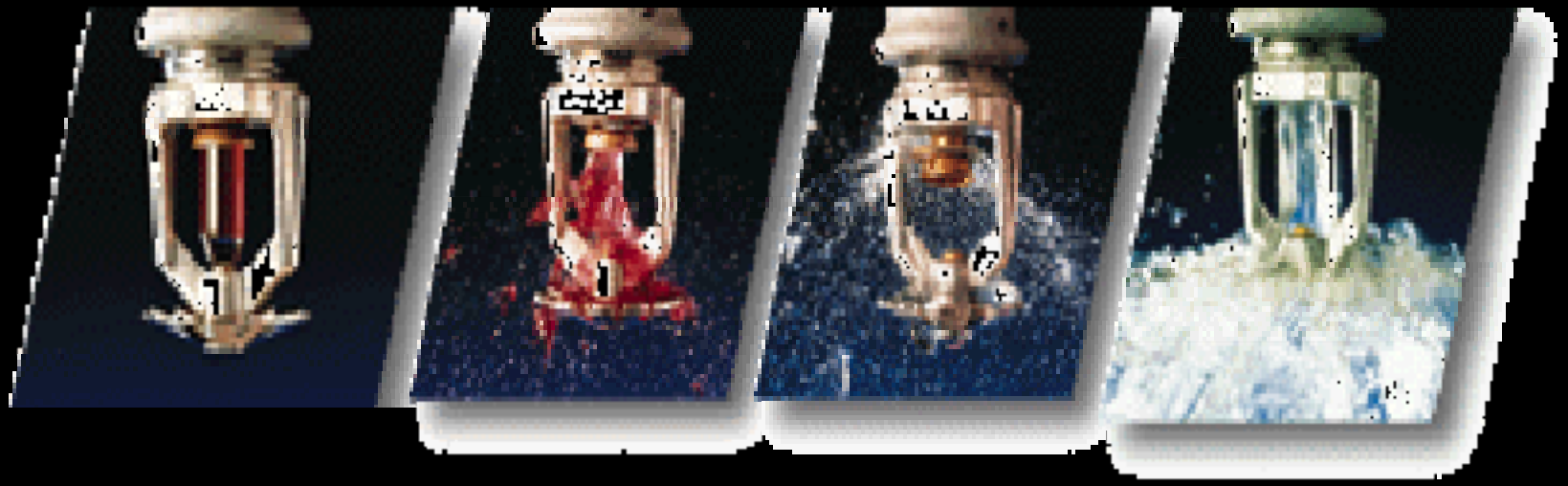
So Far

- 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

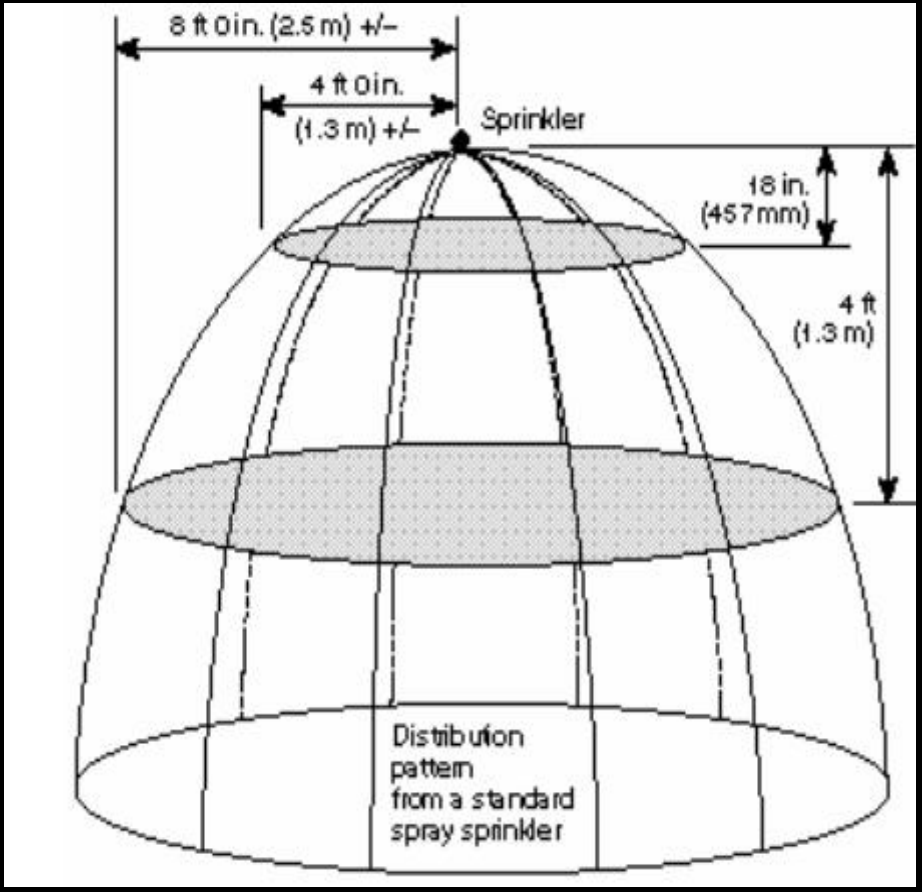
Sprinklers

- 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

- CO_2
- 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
  - CO_2
  - 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

Storage and Warehousing

NFPA Commodity Classifications

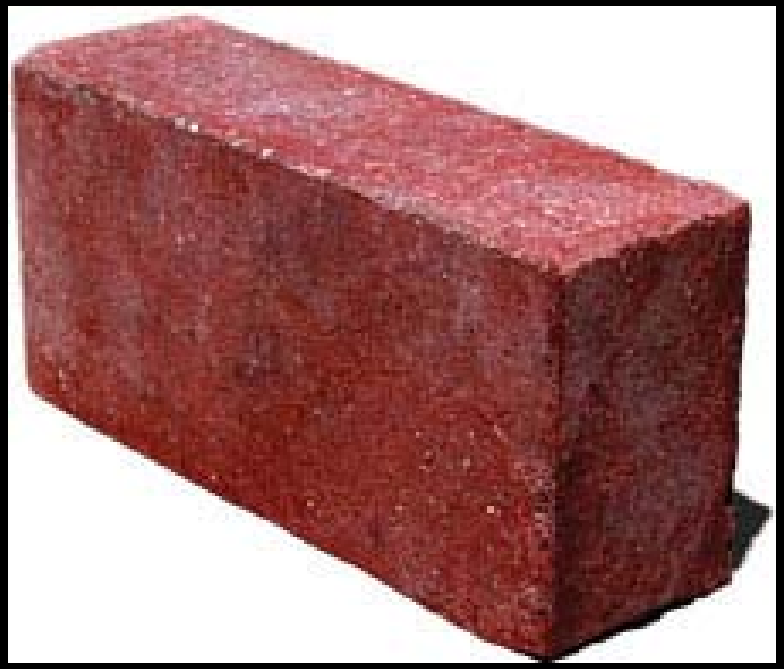
- **Class I**
  Noncombustible product on pallet or in carton
- **Class II**
  Noncombustible product in wood or multi-layered carton
- **Class III**
  Combustible product, with or without cartons, pallets and not > 5% Class A plastic

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