

American Society of Safety Engineers
Professional Development Conference June 24-27, 2013



**Fundamentals of SH&E:
Fire Protection 101C**

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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

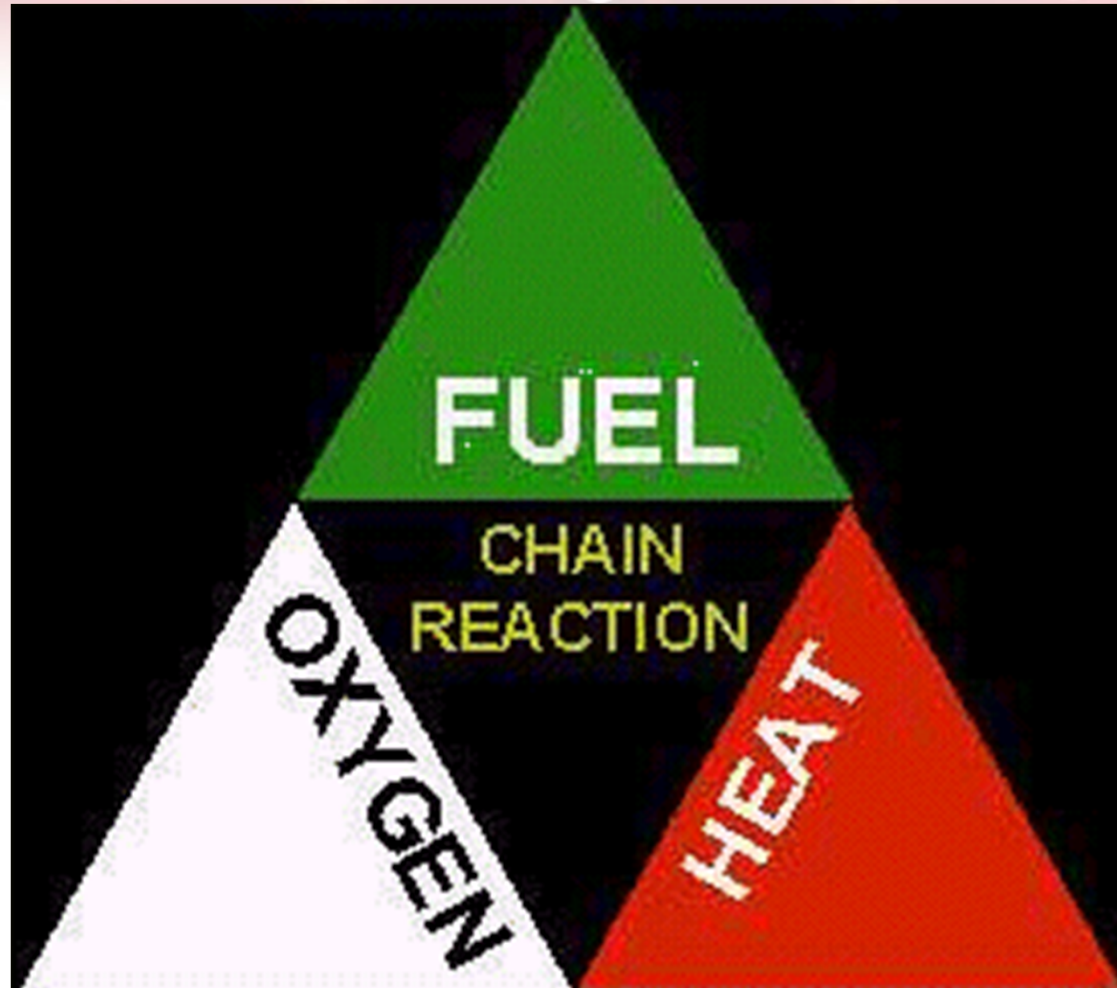


The Fire Triangle





Triangle? Not a Tetrahedron?



What's Burning?





Pyrolysis

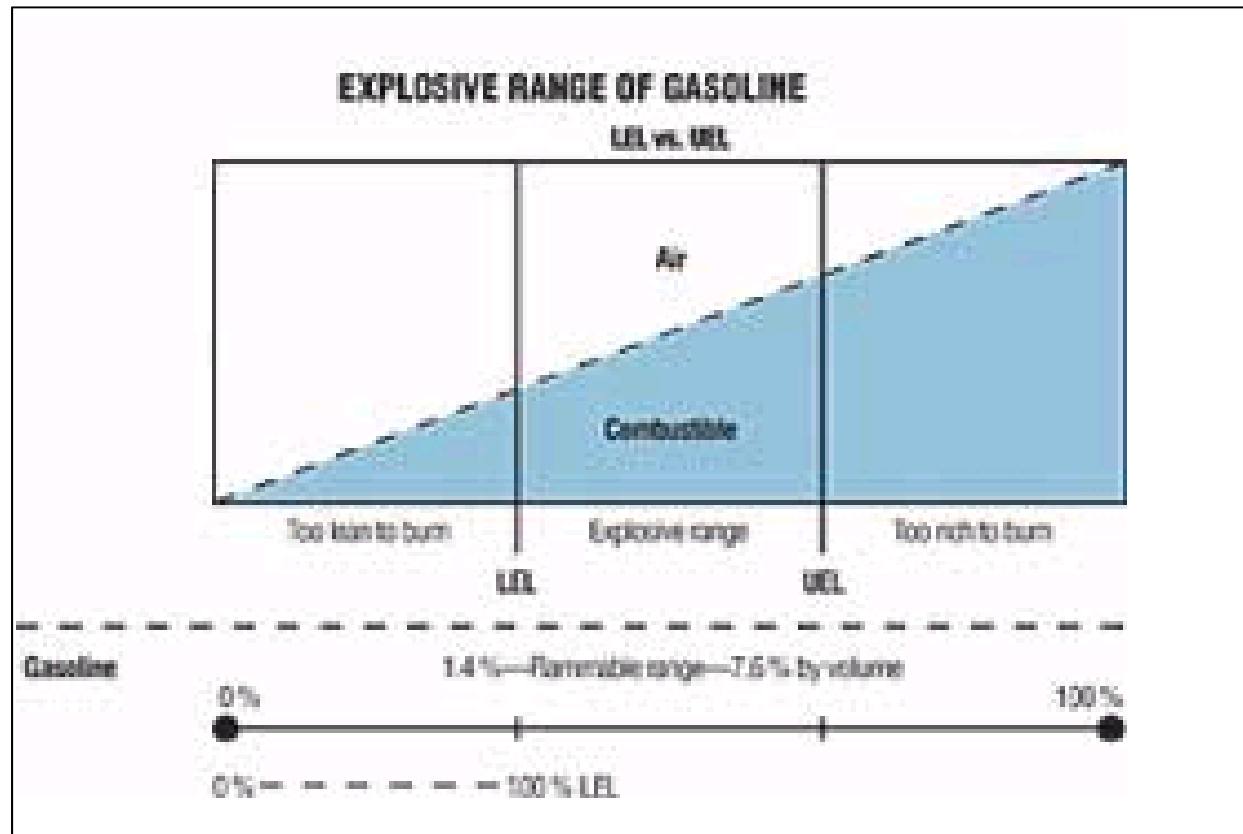
- Some of the heat is lost (convective)
- Some of the heat goes back into the system (conductive)
- Heat produces vapors
- Vapors ignite and propagate



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 AREA NUMBER _____

INSTRUCTIONS

1. Supervisor completes section to be and then fills in Sections A & C.
2. Supervisor retains the top copy of the form and issues the permit card (Sections B & C) to the worker.
3. Worker completes Section D, 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

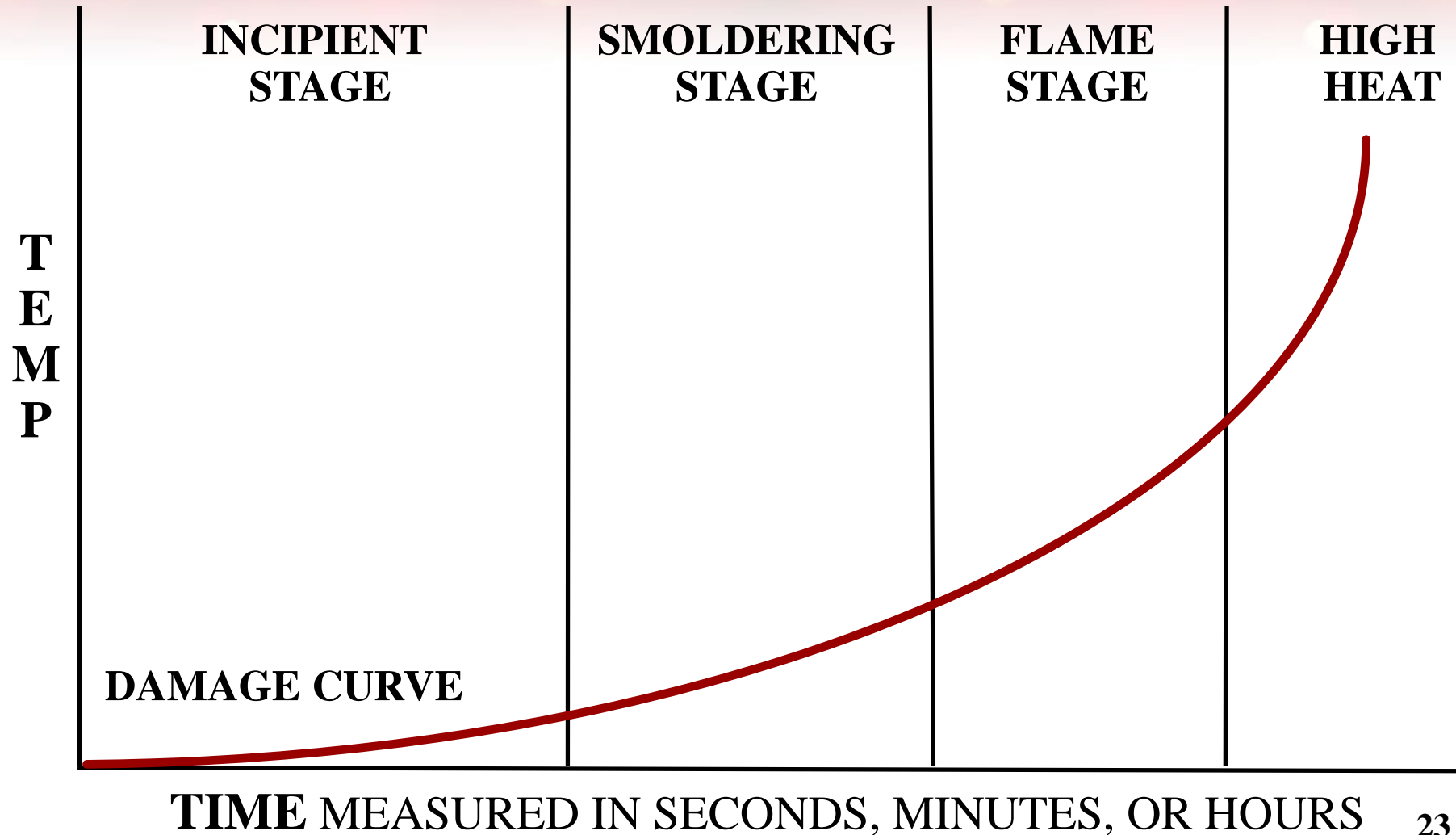
Four Stages of a Fire

- **Incipient**
 - Microseconds to days
- **Smoldering**
 - Microseconds to hours
- **Flaming**
- **High Heat**



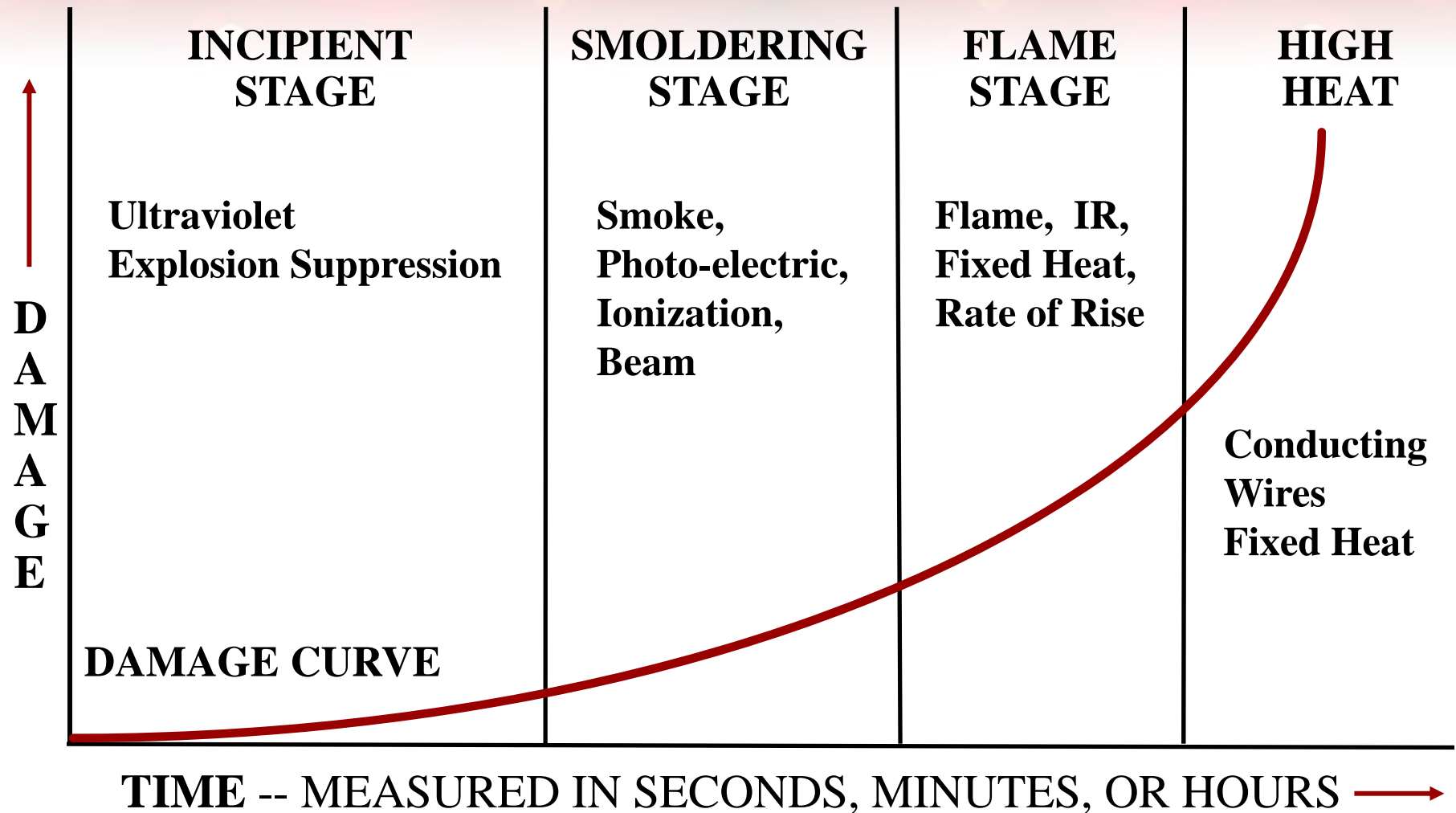


Time – Temperature Curve





Time – Temperature Curve





So Far

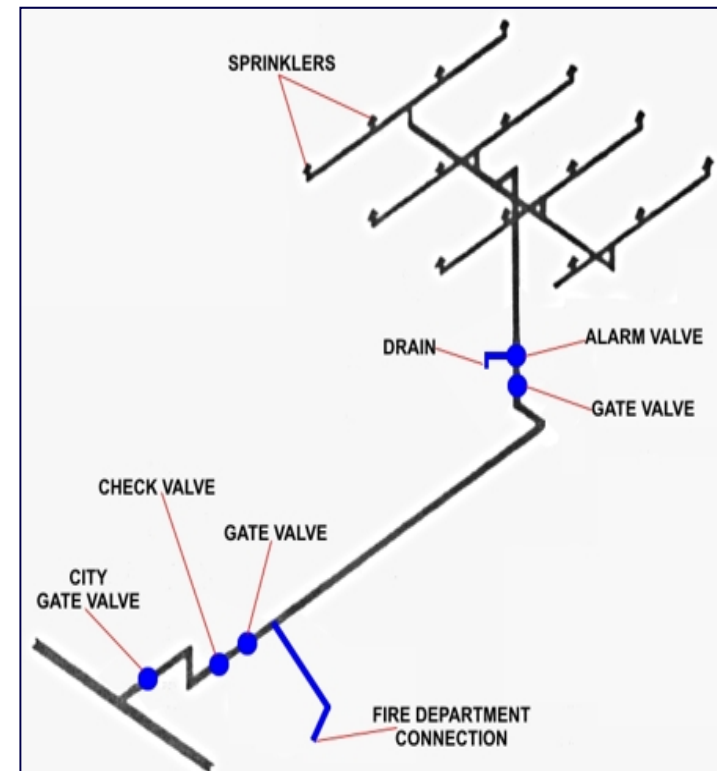
- Principles of Extinguishment
- Know what is burning
- Concept of Flammability Range
- Applied Controls
- Stages of a Fire
- Fire Detection



System Controls – Fixed Suppression

Sprinkler Systems

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

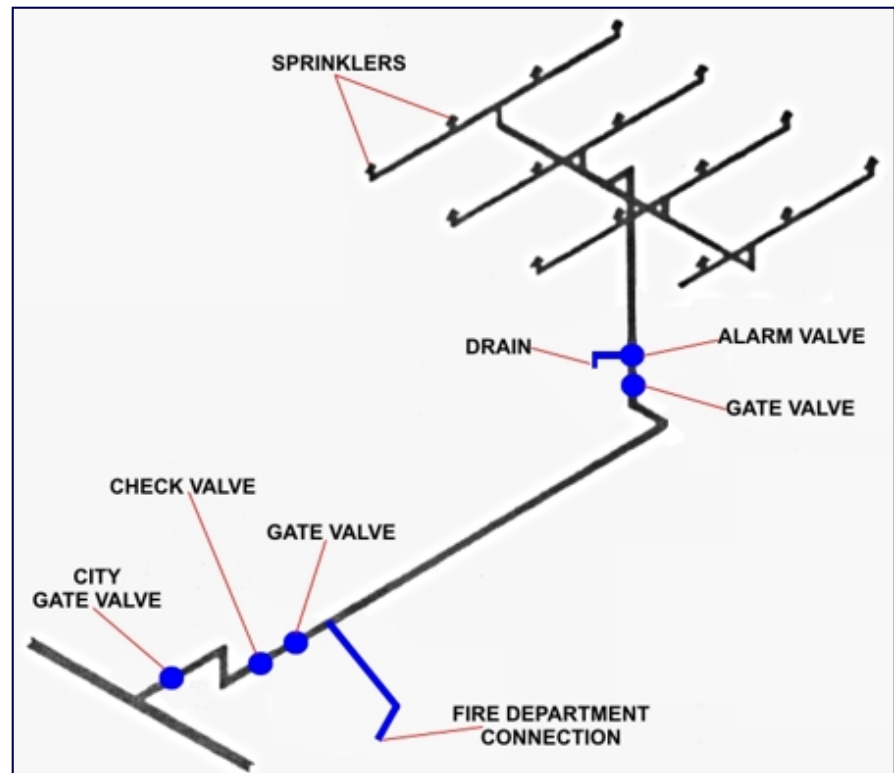




System Controls – Fixed Suppression

Sprinkler Systems

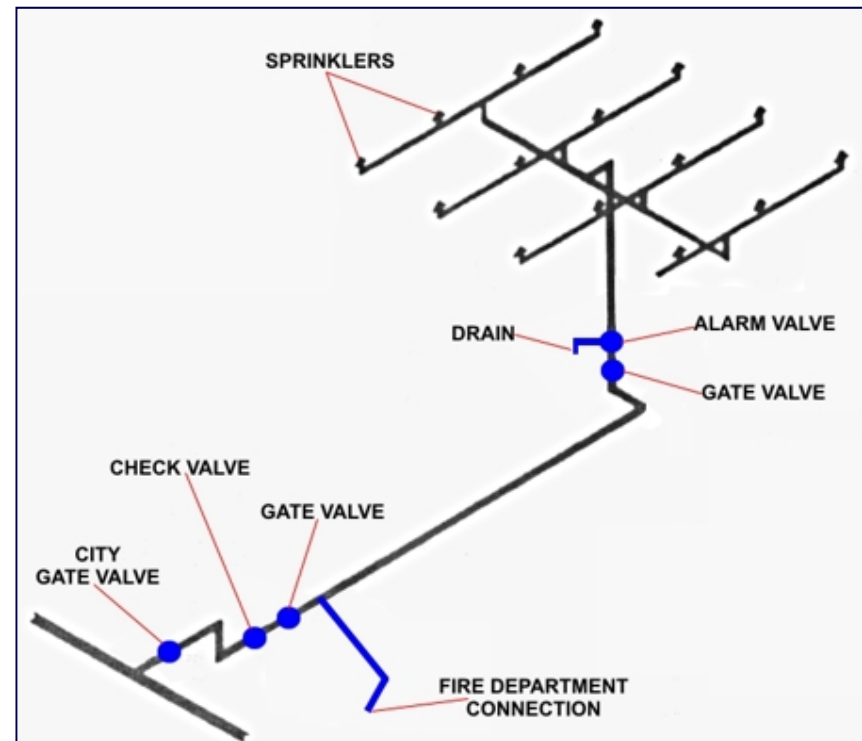
- **Wet**
 - Most Common
 - Water in the pipes
 - Very efficient
 - Requires Heat



System Controls – Fixed Suppression

Sprinkler Systems

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

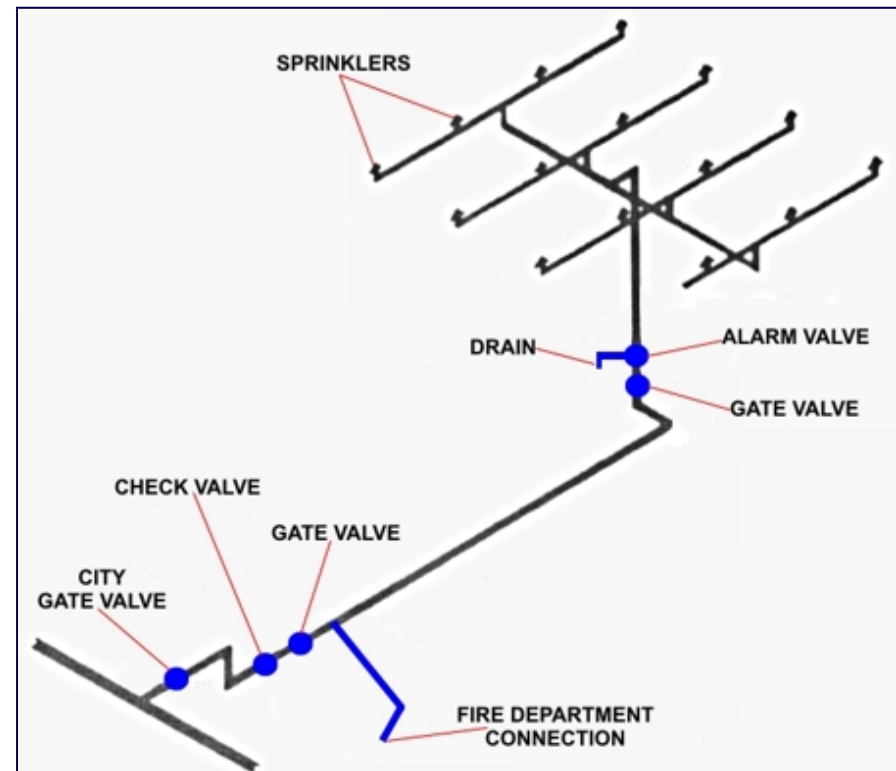




System Controls – Fixed Suppression

Sprinkler Systems

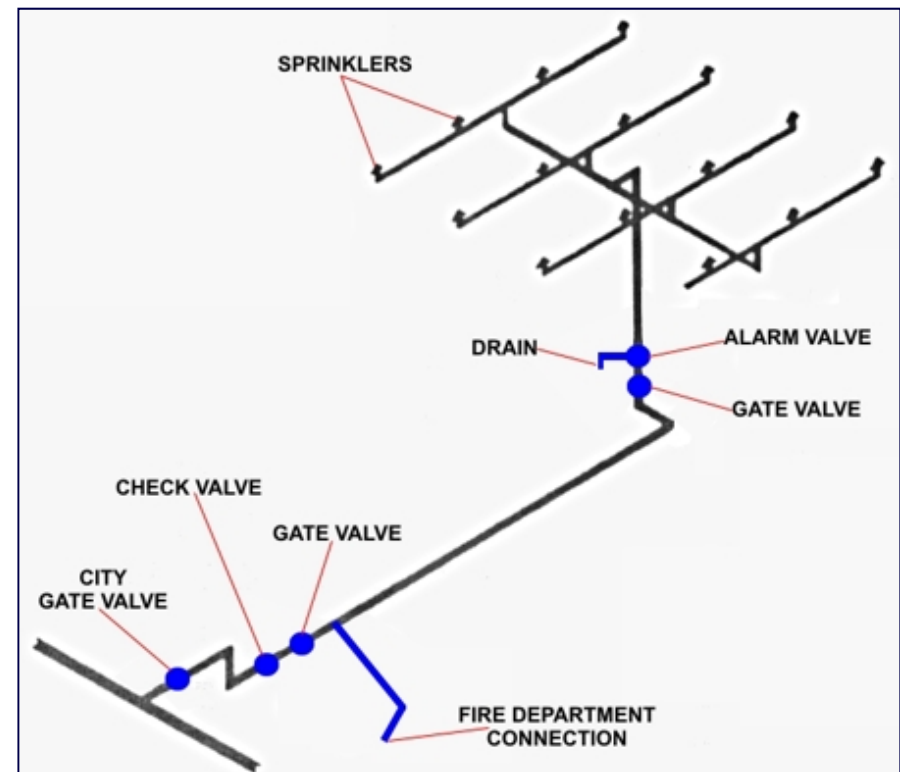
- Anti-Freeze
 - Filled with a glycol solution
 - Limited in size
 - Some applications to storage occupancies



System Controls – Fixed Suppression

Sprinkler Systems

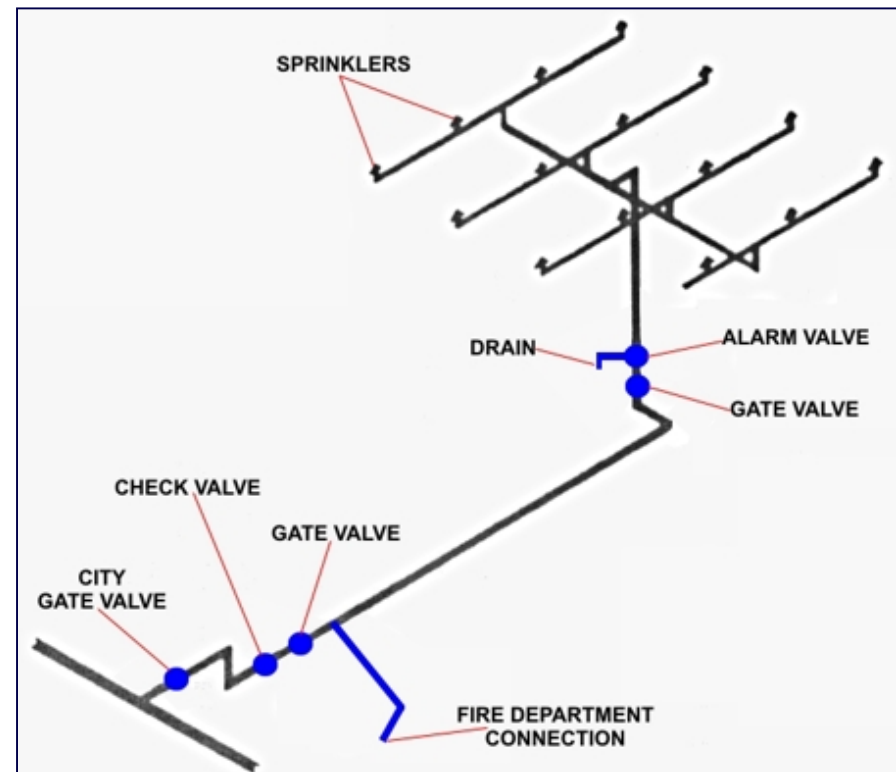
- Deluge
 - Nothing in pipes
 - Sprinklers are open
 - Used in High Hazard areas / processes
- Requires an actuation system



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

Terminology

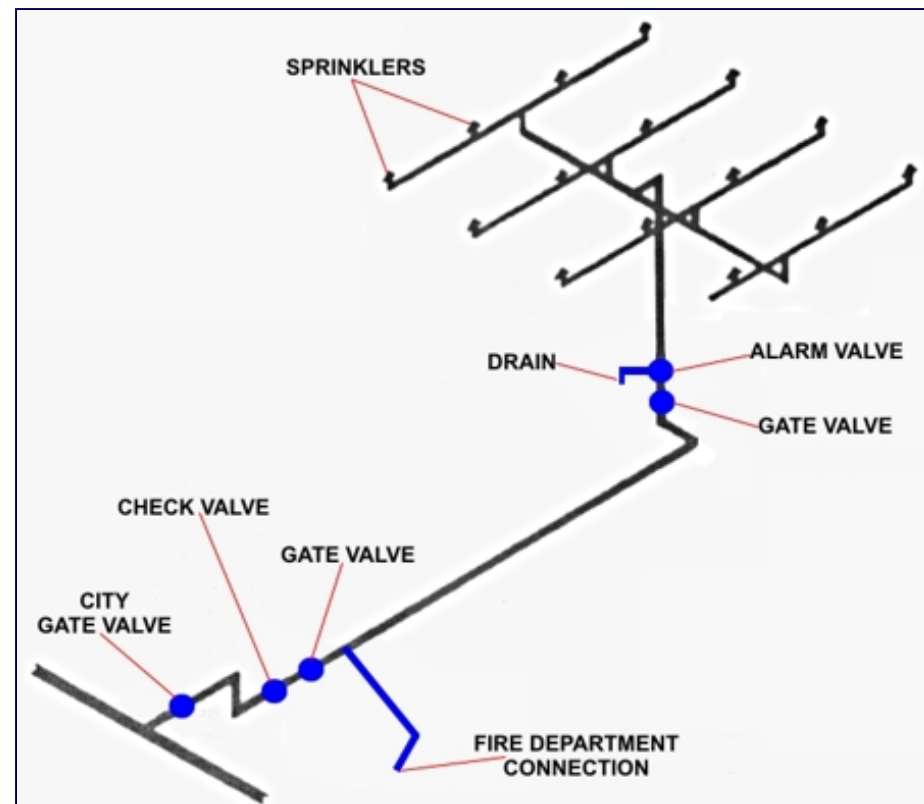
- **Pipe Schedule System**
 - Pre – 1972
 - Pipes Sized per a schedule
 - Pipes Sized based on Occupancy
 - Light, Ordinary Hazard, Extra Hazard
- **Hydraulically Calculated Systems**
 - Pipes sized on friction loss
 - Loops and Grids **MUST** be Calculated
 - Risers Clearly Placarded with Design Info

System Controls – Fixed Suppression



Terminology

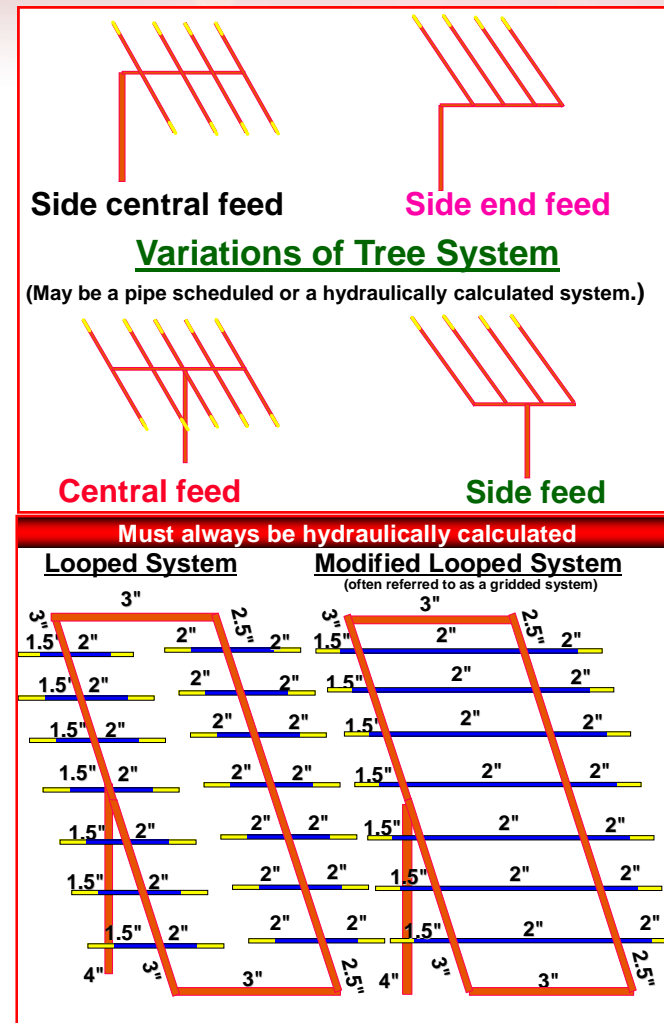
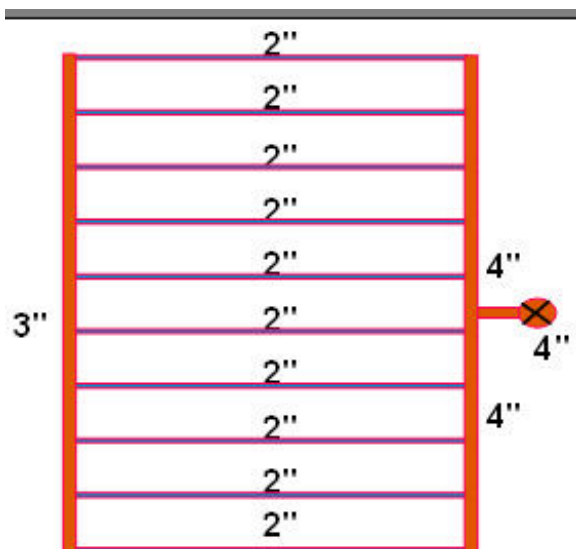
- Branch lines
- Crossmains
- Feedmains
- Risers
- Sprinklers



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

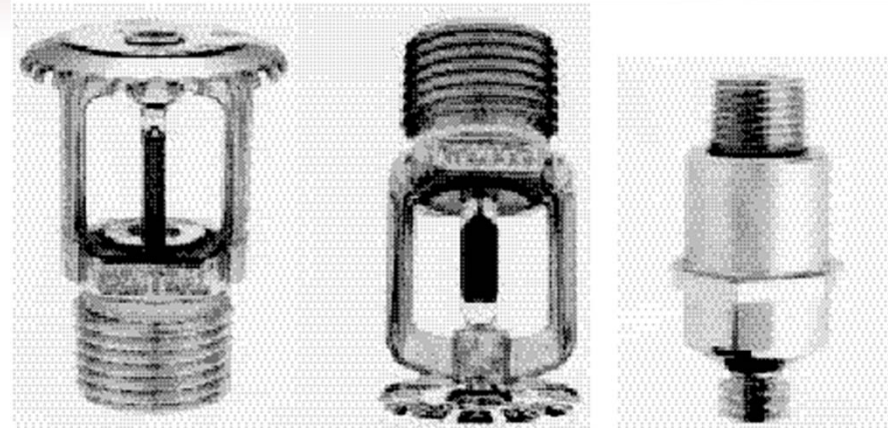


System Controls – Fixed Suppression



Sprinklers

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



Fast response
3-mm bulb

Standard response
5-mm bulb

Fast response element



Fast response link

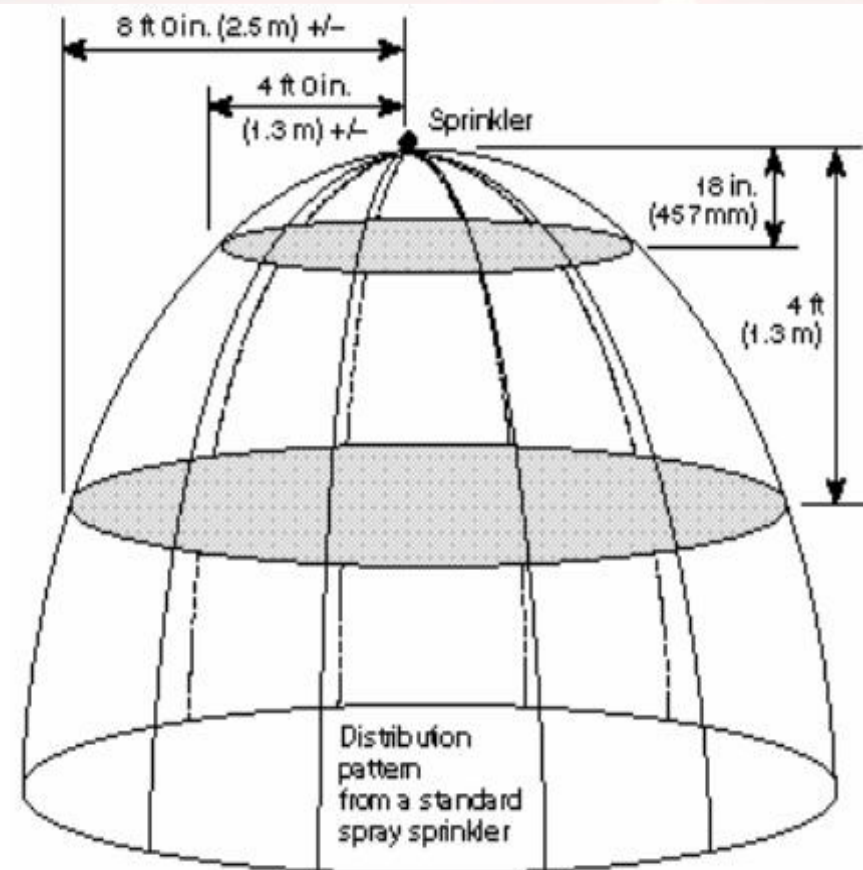


Standard response
solder link sprinkler

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 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
 - Size
 - Correct Extinguisher for Class of Fire
 - Employee Training
 - Maintenance
 - Obsolete Extinguishers





Maintenance

- **Maintenance for Suppression Systems**
 - Prescribed by NFPA 25
- **Maintenance for Detection Systems**
 - Prescribed by NFPA 72
- **Fire 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.) Group A Plastic

- **Plastics**

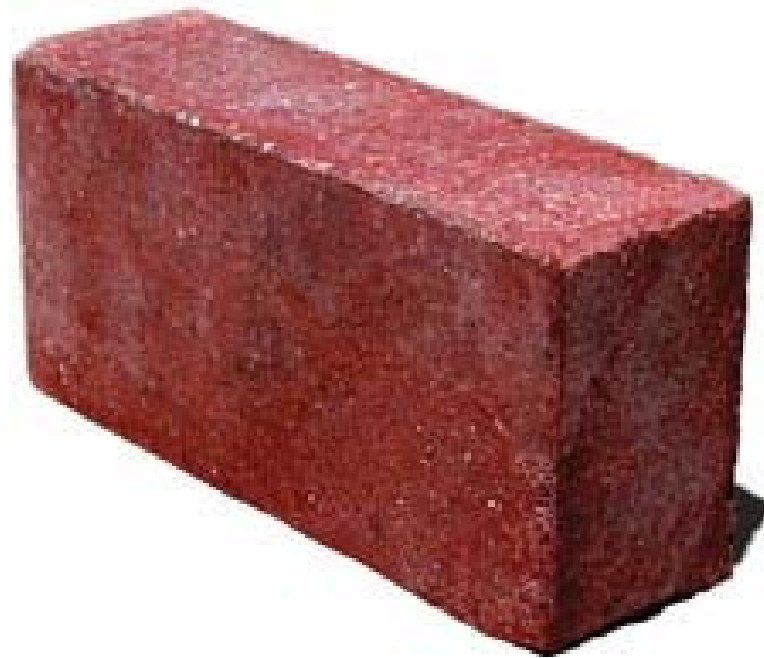
Group "A" POLY – anything, Styrene

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

