Gaseous and Chemical Suppression Systems

- Determine when gaseous and chemical suppression agents are appropriate
- Describe how gaseous and chemical systems suppress fires
- Select appropriate safety precautions and maintenance for gaseous and chemical suppression systems

Carbon Dioxide Background

- Used in fire extinguishing systems for more than 100 years
- First systems were installed between 1910 and 1915 in Europe
- Safely extinguished more fires than any other gas fire-extinguishing system
- 1928 – work began on the NFPA Standard for carbon dioxide extinguishing systems
- Systems almost phased out in the ‘70s and 80’s
  - Resurgence
- NFPA 12 Standard on Carbon Dioxide Extinguishing Systems

Carbon Dioxide

- 0.038% concentration normally in air
- Colorless, odorless, electrically nonconductive inert gas
- Atomic weight 1.5 times that of air
  - Where does it go when released from a system?
  - Atomic weight of CO_2
    - 12+32=44
  - Atomic weight of air
    - $0.21O_2 + 0.79N_2$
    - 0.21*32+0.79*28=28.84

Suppression Agent

- Clean/gaseous agent
  - No residue
  - Creates its own pressure for delivery
- Extinguishing Methods:
  - Smothering (oxygen reduction/displacement)
  - Minimum concentration for extinguishment can be calculated
  - Minimum design concentration is 120% of the calculated concentration but never less than 34% in any case
- Relatively small cooling effect despite its temperature of approximately -110ºF at discharge
  - Water is better at cooling but results in water damage

Suppression Agent

- Chemically inert
  - No reaction with most substances
  - Exceptions are a few active metals and metal hydrides and materials
- Gaseous – can penetrate and spread to all parts of a fire area
- Static electricity during discharge
  - Discharge nozzles must be grounded

Typical Applications

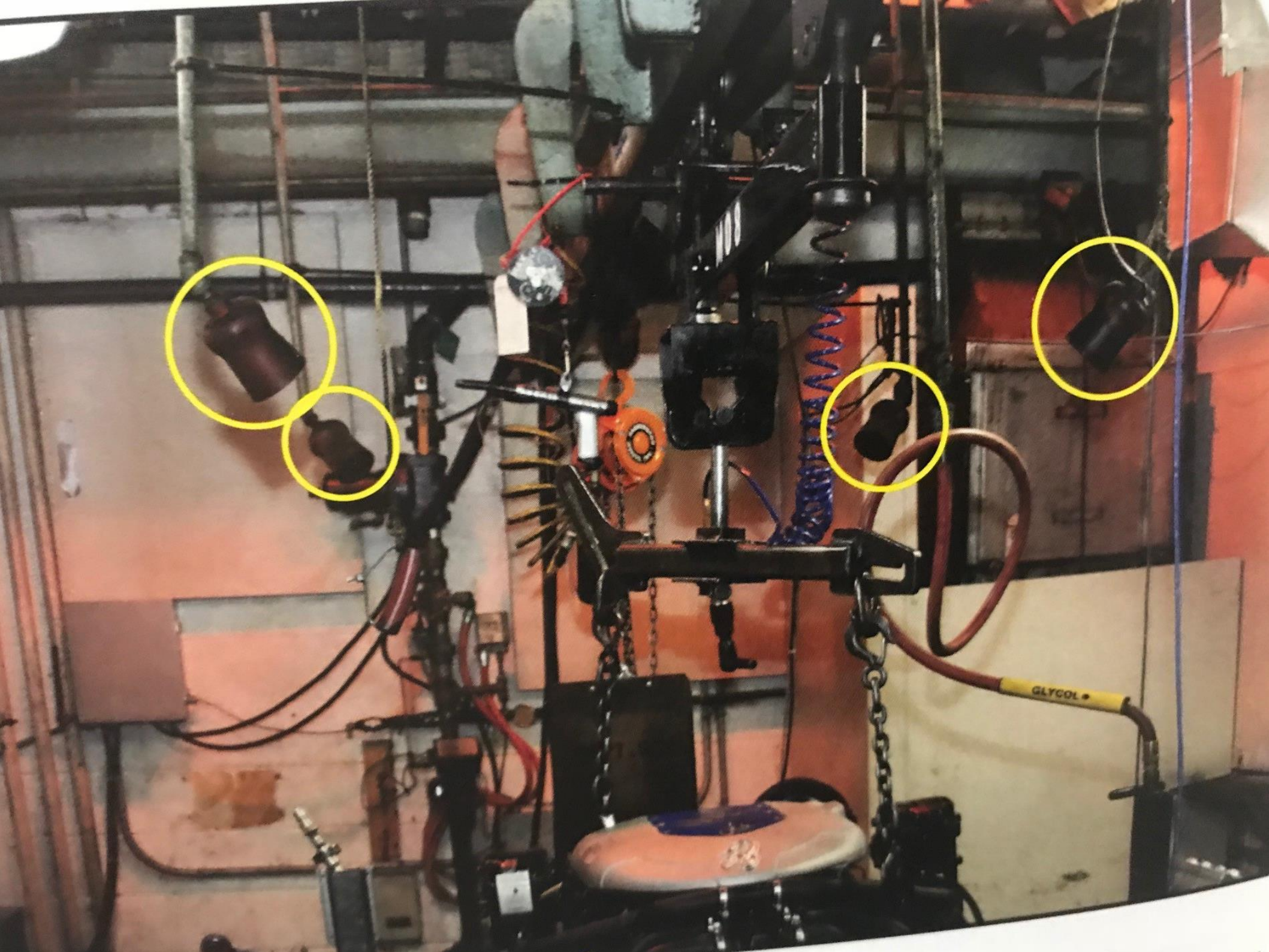
- Class A
  - Record storage rooms
  - Dust collectors
  - Grain elevators
  - Food milling machines
- Class B
  - Open top lube oil pits
  - Industrial fryers
  - Dip tanks
  - Marine engines
  - Solvent storage
  - Printing presses
  - Paint spray booths
  - Chemical storage labs
  - Flammable liquid storage
  - Test cells for aircraft
- Class C
  - Data processing
  - Turbine generators
  - Switchgear rooms
  - Battery storage
  - Electric cabinets
  - Electric transformers

Methods of Application

- Total Flooding
  - Well sealed space
    - Integrity of the enclosure
    - Close all openings to minimize leakage
  - Surface fires
    - Slows progression of a deep-seated (suppression) fire but does not “extinguish” it
  - Compensate for the openings by an extended discharge
  - Opening in the ceiling relieves pressure
    - Why no opening at the bottom of the space?

Methods of Application

- Local Application
  - Pre-engineered
  - Directly on hazard
  - Surface fire
- Hand Hose Lines
  - Trained personnel
- Standpipe Systems and Mobile Supply


GLYCOL

Limitations

- Not effective on
  - Chemicals containing their own oxygen supply
  - Reactive metals
- Life safety concerns
  - 6-7% harmful effects become noticeable
  - > 9% most people lose consciousness quickly
  - With 17% to 30% breathing stops immediately
  - Dry ice produced during the discharge
    - Frost bite if contacted

Safety Considerations

- NFPA 12 prohibits the use of total flooding carbon dioxide systems in normally occupied spaces with certain specific exceptions
  - Arrangements to assure evacuation before discharge
  - If evacuation not assured, system requires a “lockout”
- NFPA 12 requires system “lockouts” to be provided for all systems except those where the dimensional characteristics of the space will prevent personnel from entering the space
  - Lockout: a manually operated valve in the discharge pipe between the nozzles and the (carbon dioxide) supply which can be locked in the closed position to prevent flow of carbon dioxide to the protected area
  - The Lockout is not activated by the emergency manual release
  - Fire watch must be established to activate in event of fire

Safety Considerations

- Pneumatic pre-discharge time delays
- Pre-discharge alarm
  - Distinctive
  - Audible and Visual
- Easy access to exits
  - SCBA may be provided
  - Trained personnel only

Safety Considerations

- Warning signs
  - Located outside each entryway to the enclosure
- Training
- Manual controls
  - Located to avoid confusion
  - Labeled with safe operating procedures
- Odorizers
  - To provide an olfactory indication of the presence of carbon dioxide

Components

- Carbon Dioxide Storage
- Piping System
  - Two-phase flow
- Discharge Nozzles
- System Controls
- Automatic Actuation
- Normal Manual Operation
- Emergency Manual Operation
  - Used only if automatic and normal manual fail
- Control Panels
- Alarms

CO_2 Storage

- High-pressure storage
  - Liquid at 850 psi (70 °F)
  - Maximum 120 lb per cylinder
- Low-Pressure Storage
  - Can be multiple hazards from central storage unit
  - Pressure ≥ 325 psi
- Reserve supply = demand supply
- Stored between 32 °F and 120 °F

Inspection and Maintenance

- Acceptance Testing
  - NFPA 12 required a full discharge test for new systems
    - Total flooding – performance evaluated based on concentration
    - Local system – performance evaluated by observation
- Inspections
  - Verify operations status monthly
  - Verify carbon dioxide supply weekly
  - Full system inspection annually
    - Typically done by a third party

Dry Chemical Background

- Developed because water is not effective on class B fires
- Started appearing in the 1950s
- NFPA 17, Standard for Dry Chemical Extinguishing Systems

Dry Chemical Agent

- Powder mixture
  - Nontoxic, nonconductive, and non-carcinogenic
  - Not dry powder system
- Main chemicals
  - Sodium bicarbonate
  - Potassium and urea-potassium bicarbonate
  - Monoammonium phosphate
- Extinguish fire by:
  - Breaking chemical chain reaction
  - Smothering
  - Radiation shielding

Dry Chemical Disadvantages

- Does not provide an inert atmosphere for long
- Caking
  - Agent needs to be replaced periodically
- Residue
  - May not be allowed to wash away
- Cleanup time

Dry Chemical Applications

- Most commonly used to protect:
  - Flammable and Combustible liquid and gases
  - Dip tanks
  - Paint spray booths
  - Exhaust dust systems
  - Commercial cooking equipment
  - Transformers
  - Heavy diesel equipment such as earthmovers
- Not recommended for area that contains sensitive electronic equipment
  - Corrosion after application
- Not suitable for fires involving flammable metals or deep-seated burning activity

Dry Chemical Systems

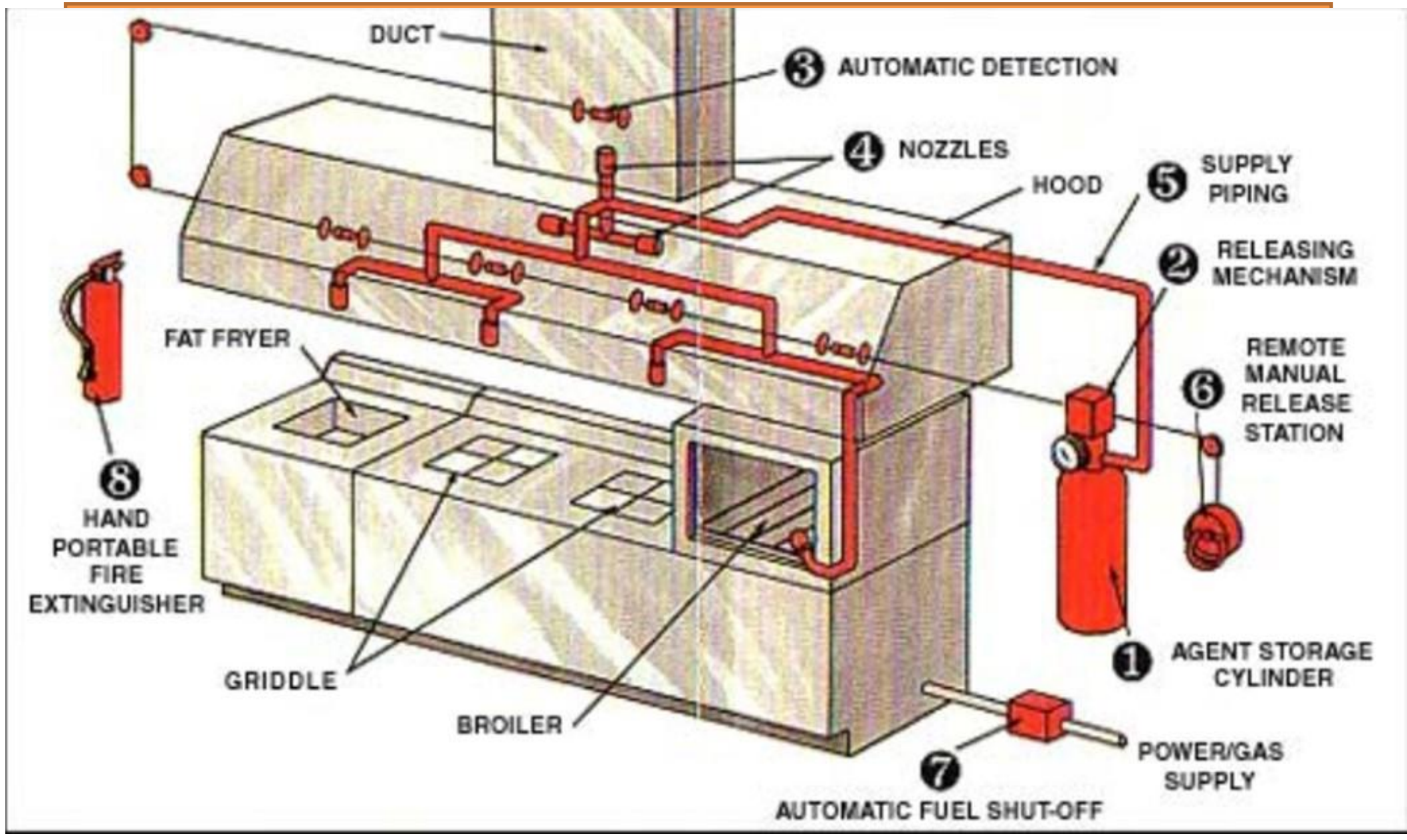
- Total Flooding
- Engineered
- Pre-engineered
  - “Packaged system” is more common

Dry Chemical Total Flooding Systems

- Fill entire volume
- Enclosure sealed
  - 1% to 5% of surface area open=0.5 lb/ft^2 of opening
  - 5% to 15% of surface area open=1 lb/ft^2 of opening
- Typically 1 nozzle per 500 ft^3

Dry Chemical Local Application Systems

- Isolated from other hazards
- Must consider dispersal of agent
- Minimize splashing


DUCT
3 AUTOMATIC DETECTION
4 NOZZLES
HOOD
5 SUPPLY PIPING
2 RELEASING MECHANISM
FAT FRYER
6 REMOTE MANUAL RELEASE STATION
8 HAND PORTABLE FIRE EXTINGUISHER
GRIDDLE
BROILER
1 AGENT STORAGE CYLINDER
7 AUTOMATIC FUEL SHUT-OFF
POWER/GAS SUPPLY

Dry Chemical System Components

- Storage tank
  - Nearest safe location to hazard
  - Max amount 3000 lb
- Expellant gas cylinders
  - Typically nitrogen
  - Gas and agent are stored together or separate until needed
- Piping
  - Use tees to make turns
  - Compatible with agent
- Nozzles
  - Depends on application
- Activation system

Dry Chemical System Operation

- Automatic detection
  - Detector activates agent flow
  - Alarm sounds
  - Equipment shuts down
- Manual detection
  - Manual pull station/push button
- Nitrogen tank opens (if stored separately)
  - Mixes with agent
  - Pressure in tank increases
  - Rupture disk
- Fluidized mixture through piping to nozzle

Inspections and Maintenance

- Inspections
  - Has hazard expanded outside system coverage?
  - Proper operating condition monthly
    - Buildup on fusible links. Must be replaced annually from date of installation
  - Check dry chemical every 6 years
    - Bag test – chemical collected in bags and weighed
  - Perform full discharge test is system inspection requires further testing
- Maintenance
- Conducted in accordance with the manufacturer's requirements
  - Usually conducted by a third party