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

Wet Chemical Systems

- NFPA 17A, Standard for Wet Chemical Extinguishing Systems

  https://www.youtube.com/watch?v=fYlQDAyR-ME
- Fine spray
- Commercial cooking
  - Deep-fat fryers, griddles, range tops, broilers, ducts, plenums
- Also works on ordinary combustibles
- Engineered or pre-engineered systems

Wet Chemical Agents

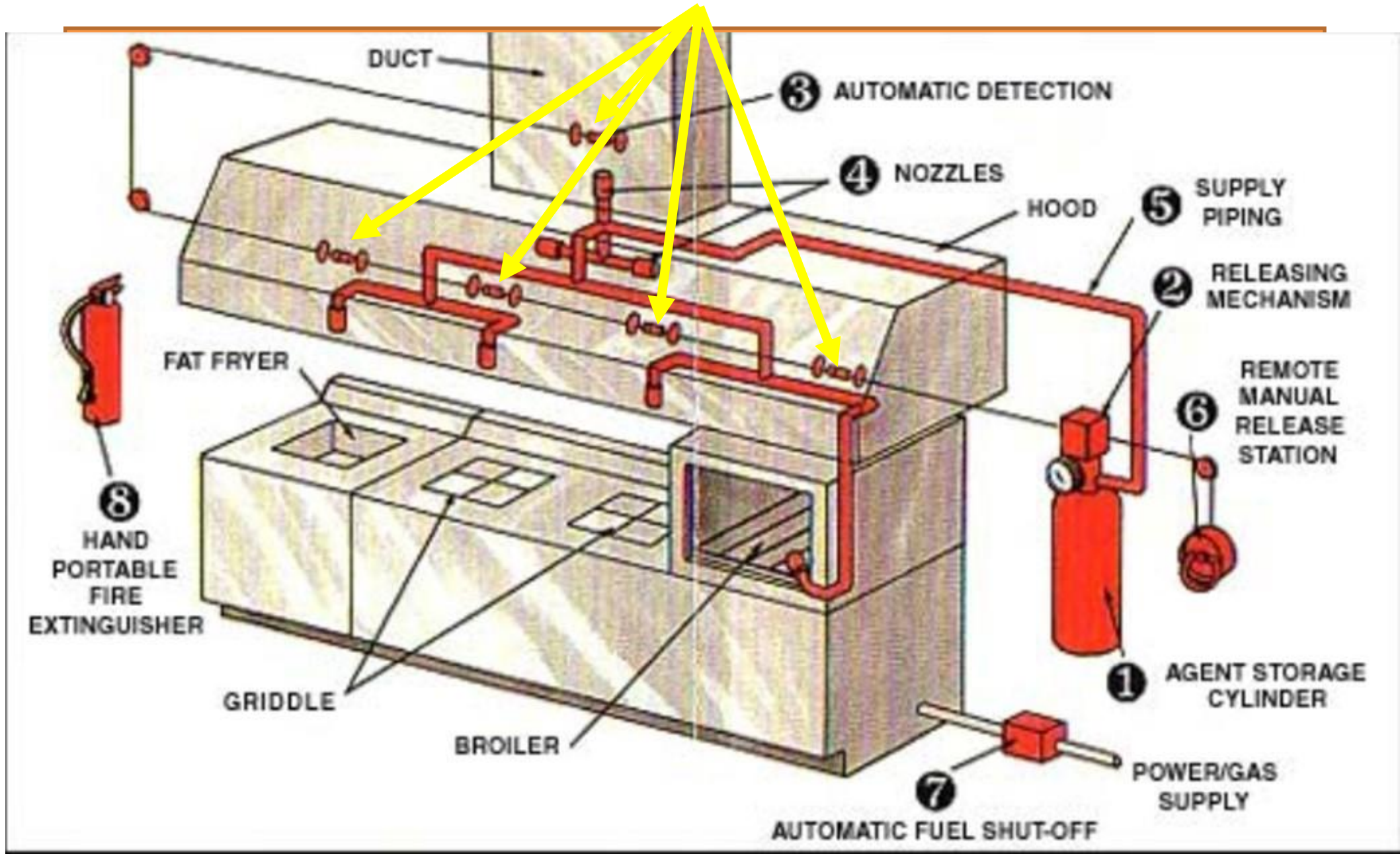
- Stable, nontoxic, and noncarcinogenic
- Salts in water
  - Potassium carbonate or potassium acetate
- Incompatible with:
  - Reactive metals
  - Electrically energized equipment
  - Any other material that is reactive with the water
- Saponification

  Chemical reacts with cooking oils to form foam that coats oil surface
  - Smothering
  - Cooling

Wet Chemical Components

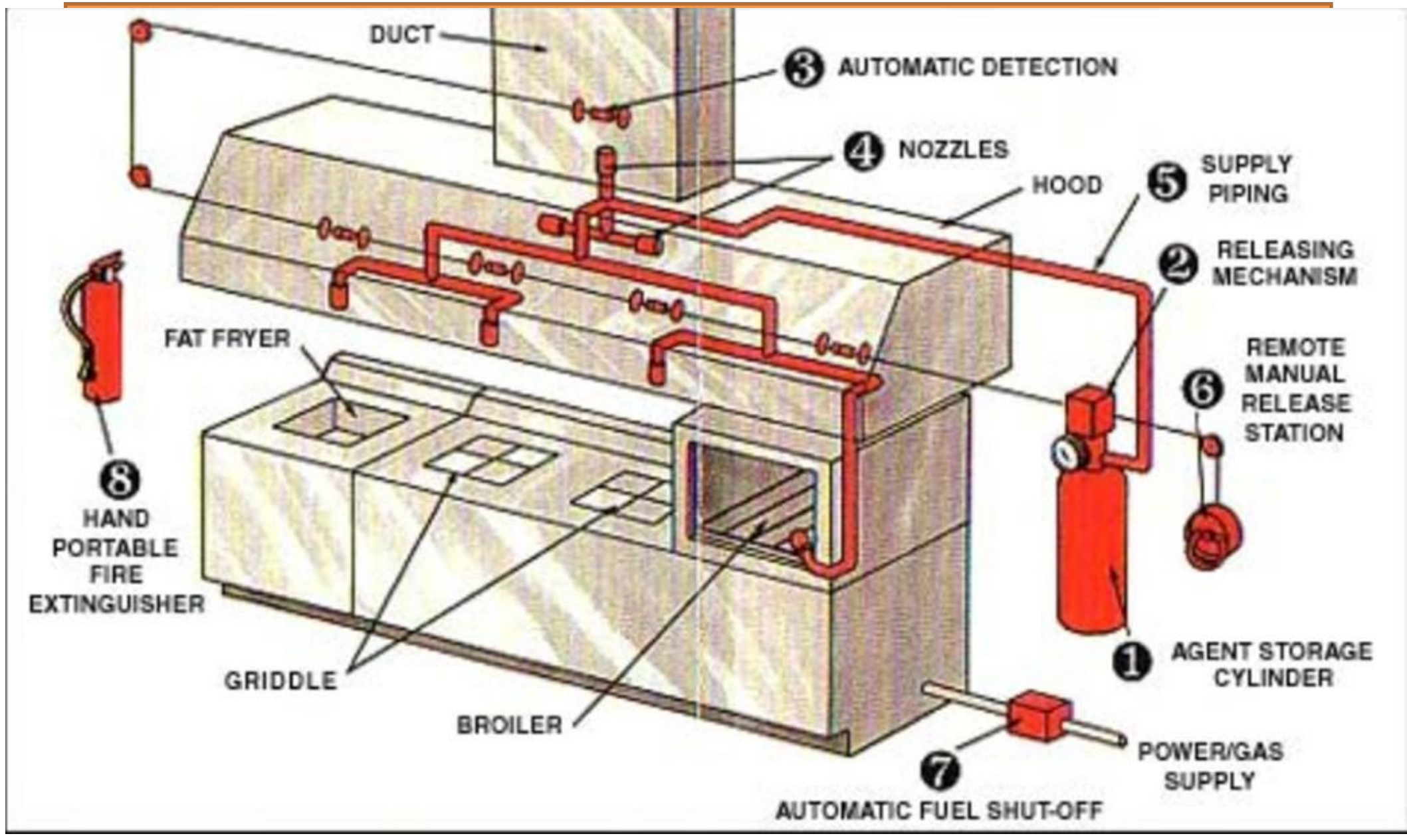
- Storage tank for expellant gas and agent
- Piping to carry the gas and agent
- Nozzles to disperse the agent
- Actuating mechanism

What are these?



Fusible links

https://www.youtube.com/watch?v=ubrjSMzevBk



Inspection and Testing

- Monthly

  Change in hazard

  - Mechanical damage
  - Aim of nozzles
  - Manual actuators for obstructions
  - Tamper indicators and seals
  - Pressure on stored-pressure containers
  - Blow-off caps in place

Inspection and Testing

- Semiannual
  - Examine all components thoroughly
    - Verify that the piping is not obstructed
    - Examine system for evidence of corrosion, structural damage, or repairs
  - Check liquid levels of non-pressurized containers

Clean Agents

- Primary distinction between clean agent and carbon dioxide is toxicity
  - CO_2 is used far in excess of fatal limits
  - Clean agents in occupied areas are used below toxic thresholds
- Advantages
  - NFPA Handbook p 17-95

Halogenated Hydrocarbon

- Early halons
  - Carbon tetrachloride
  - Bormochloro-methane
  - Both toxic to humans
- 1940s
  - Halon 1301 developed by the U.S. Army
  - Inside aircraft engines and tanks. Not toxic to humans
- Very effective
  - Interrupts chemical chain reaction
- Noncorrosive
- Halon 1301- NFPA 12A, personnel expected
- Halon 1211- NFPA 12B, local application, extinguishers

Naming Halogenated Agents

- #C, #F, #Cl, #Br
- Bromo=Bromine
- Chloro=Chlorine
- Fluoro=Fluorine
- Methane=Carbon
- Di=2
- Tri=3
- Tetra=4

- Halon 1211:
  - CF_2ClBr
  - Bromochlorodifluoromethane
- Halon 2402:
  - $C_2F_4Br_2$
  - Dibromotetrafluoroethane
- Halon 1011:
  - Bromochloromethane
- Halon 1202:
  - Dibromodiflоromethane
- Halon 1301:
  - Bromotrifluoromethane

Halon 1301

- Safety Features
  - Continuous alarm before/during discharge
    - Time delay
  - More exits
    - Regular training
    - SCBA
- Storage and delivery
  - Compressed liquid
  - 360 psi or 600 psi by N_2
  - Between -20ºF to 130ºF
  - Two-phase flow
    - Gas at discharge
  - Total flooding

Halon 1301 Design Concentration

- Inerting – Prevent explosion
- Extinguishment – Stops flame
- Account for leakage-extended discharge
- 10 s to discharge
- 10 min containment (minimum)

Fuel	Inerting Concentration (% Vol)	Extinguishment Concentration (% Vol)
Acetone	7.6	5.0
Benzene	5.0	5.0
Ethanol	11.1	5.0
Ethylene	13.2	8.2
Hydrogen	31.4	-
Methane	7.7	5.0
Heptane	6.9	5.0
Propane	6.7	5.2

Downfall of Halon

- Ozone depleting
  - Halons are said to be the worst of all ozone depleting substances
- 1987 Montreal Protocol
  - International agreement
    - Over 140 countries
  - Control production and trading of ozone depleting substances
- Production ceased on 1/1/1994
  - Recycled material now serves as halon source for existing systems

Halon Alternatives

- Two types
  - Halocarbon compounds
  - Inert gasses or mixtures
- NFPA 2001 *Standard on Clean Agent Fire Extinguishing Systems*

Halocarbon Compounds

- Primary components one or more of fluorine, chlorine, bromine, or iodine
  - Examples
    - Hydrofluorocarbons (HFCs)
    - Hydrochlorofluorocarbons (HCFCs)
    - Perfluorocarbons (PFCs or FCs)
    - Fluoroiodocarbons (FICs)
- Halon 1301
  - 80% interruption chain reaction bromine
  - 20% cooling
- Halocarbon Alternatives
  - 20% interruption chain reaction
  - 80% cooling by extracting heat from the flame as the fire decomposes the media
  - Examples
    - FM-200
    - FE-227
    - CEA-410
    - FE-13

Inert Gases

- Primary components one or more of helium, neon, argon or nitrogen
- CO_2 as secondary component
- Reduces oxygen from 21% to below 15%
  - 12 % - 5 min evacuation
  - 10% - 3 min evacuation
  - 8% - 30 s evacuation (normally unoccupied)
- Examples
  - Inergen
  - Argotech
  - Argonite
  - Nitrogen

Advantages and Disadvantages

- NFPA Handbook 17-109

Novec

- Liquid storage, gaseous when applied
- Safe for electronics
- Safe for occupied areas
  - 4.5 % concentration
  - 10 % NOAEL
- Data centers and telecommunication
- Marine
- Aerospace
- Transportation
- Museums and libraries

System Components

- Suppression
  - Cylinders
  - Piping
  - Discharge nozzle
- Fire alarm panel
- Consider
  - Fire department emergency purge
  - Pressure venting
  - Location of cylinders
  - Operating pressures
  - Safety
- Cylinders near hazard
- Nozzles to evenly distribute gas

Systems

- Automatic detection
- 24 hr standby power
- Audible and visual pre-discharge alarms
  - Time delay
- Abort switches in areas
- Warning signs at entrance and throughout
- Shut down ventilation systems
  - Or extended discharge
- Provide venting
- Discharge time
  - Halocarbon systems 95% design within 10 seconds maximum
    - NFPA HB p 17-114
  - Inert gasses 95% design within 60 seconds maximum

Inspections and Maintenance

- Complete test required annually
  - Discharge test is not required
- Semiannually agent quantity and/or pressure test
  - Refill or replace agent that varies by 5% of weight or pressure
  - Containers shall not be refilled if > 5 years since last hydrostatic test
- Annual review of enclosure integrity