Wet and Dry Chemical Suppression System

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Objectives

- Describe the characteristics of fixed wet and dry chemical extinguishing systems.
- Discuss the hazards fixed wet and dry chemical extinguishing systems most likely protect.
- Describe how fixed wet and dry chemical agents control and extinguish fire.

Objectives

- Describe a pre-engineered system.
- List the major components that make up fixed wet and dry chemical extinguishing systems.
- Describe the types of fixed wet and dry chemical extinguishing systems.

Objectives

- Discuss the various acceptance and periodic inspection, testing, and maintenance requirements for fixed wet and dry chemical extinguishing systems.

Objectives

- Estimate the quantity of dry chemical needed for a total flooding system
- Describe the differences between dry chemical and wet chemical systems
- Discuss wet chemical protection of cooking equipment
- List the operating sequence and extinguishment mechanism of wet chemical extinguishing systems

Introduction

- **Fixed wet and dry chemical extinguishing systems are an alternative to water.**
  - **Many similarities between systems**
    - **Components**
    - **Design and operational characteristics**
    - **Pre-engineering possible**
    - **Gas used to expel agent**
    - **Can be manual or automatic**
    - **Finite availability of extinguishing agent**

Introduction

- **Fixed wet and dry chemical extinguishing systems are an alternative to water (cont'd).**
  - **Design professionals must consider:**
    - **Environment**
    - **Equipment**
    - **Type of system**
    - **Amount of agent needed to control fire**

Introduction

- **Fixed wet chemical extinguishing systems**
  - **Protect commercial kitchen appliances and associated ductwork, exhaust hoods, filters, and plenum chambers**

Introduction

- **Fixed wet chemical extinguishing systems (cont'd)**
  - **Water-based solutions mixed with potassium acetate, carbonate, or citrate and other additives**
    - **Soapy foam blanket smothers/cools fuel.**
    - **Manufacturers develop agents specific to their appliances then seek approval.**
  - **Agents are usually harmless to humans but can corrode/stain equipment.**
  - **Agents are effective against Class K fires.**

Introduction

- **Fixed dry chemical extinguishing systems**
  - **Protect equipment and processes against flammable and combustible liquid fires**
    - **No longer used with commercial cooking appliances**

Introduction

- **Fixed dry chemical extinguishing systems (cont'd)**
  - **Agents are small solid particles that use pressurized gas as medium.**
    - **Delivered by fire extinguisher or hose**
    - **Knock down flames and smother fire area**
    - **When system activates, mixture flows out of containers through nozzles.**
  - **Agents are effective on surface fires where other agents would run off.**

Introduction

- **Fixed dry chemical extinguishing systems (cont'd)**
  - **Three categories of agents:**
    - **Sodium carbonate based (Class B and C fires)**
    - **Potassium based (Class B and C fires)**
    - **Multipurpose (Class A, B, and C fires)**
  - **Agents are generally nontoxic but:**
    - **May create cloud that limits visibility and causes respiratory problems**
    - **May leave corrosive residue**

Introduction

- Smothers
- Rapid Discharge Limits Radiation
- Interfere With The Chain Reaction
  - Sodium And Potassium Attach Themselves To The H And OH^- Radicals
  - Scavenging of free radicals

Introduction

- **Fixed wet and dry chemical system operation**
  - **Activation can be automatic or manual.**
  - **Once control panel receives activation signal, electronic or mechanical release initiates a sequence:**
    - **Discharging of agent**
    - **Control of associated utilities such as electricity**
    - **Alarm (may tie in to building's system)**

Dry Chemical Systems

- **Sodium Bicarbonate**
  - **Used For Class B, C Fires**
  - **Effective On Solid Surface Fires**
  - **Forms A Soap Like Surface On Grease/cooking Oil Fires**
  - **Treated With Silicon To Enhance Compatibility With Protein Based Foams**

Dry Chemical Systems

- **Potassium Based**
  - **More Effective Than Sodium Against Class B And C, Except Cooking Grease**
  - **Purple K-potas. Bicarb**
  - **Super K-potas. Chloride**
  - **Monnex-urea Based Potas. Bicarb**

Dry Chemical Systems

- **Multi- Purpose Agents**
  - **Monomonium Phosphate-class A, B,c**
    - **Forms A Molten Residue To Smother**
  - **Not Effective For Fat Fryers Or Electrical Equipment Due To Residue (Temps Greater Than 250^{o}F or R.H. >50%)**

Introduction

- **Fixed wet and dry chemical system operation (cont'd)**
  - **Sequence varies with system design.**
    - **Container holds agent and expelling gas: released by opening a valve and discharged through nozzle.**
    - **Gas in separate container: Valve opens and lets gas flow into container with agent.**
    - **Gas cartridge: Seal puncture allows gas to flow into container with agent.**

Standards for Wet and Dry Chemical Systems

- **Basis of all systems is amount of agent needed to protect hazard.**
  - **Pre-engineering**
  - **Full engineering**
  - **Once amount determined, design is completed.**
    - **Size and number of containers**
    - **Piping**
    - **Nozzles**
    - **Other components**

Standards for Wet and Dry Chemical Systems

- **No specific design parameters**
  - **Each manufacturer's agent and components are different.**
  - **Standards cover:**
    - **General design considerations**
    - **Info about hazard agents**
    - **Requirements for system activation/supervision**
    - **Requirements for testing, inspection, maintenance**

Standards for Wet and Dry Chemical Systems

- NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
- NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
- NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*
- *International Mechanical Code*

Standards for Wet and Dry Chemical Systems

- **UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment***
- **UL 1254, *Standard for Pre-Engineered Dry Chemical Extinguishing System Units***

System Component Requirements

- **Agent storage containers and gas cartridges**
  - **Storage containers are made of metal.**
  - **Containers must handle high pressure and be sized to accommodate needed amount of agent.**
    - **1.5 to 6 gallons**

System Component Requirements

- **Agent storage containers and gas cartridges (cont'd)**
  - **Manufacturers may separate wet chemical agent and expelling gas.**
    - **Gas can be stored in a cartridge.**
    - **Agent may be shipped separately.**
  - **Agents must be kept at correct temperature and humidity and protected from damage.**

System Component Requirements

- **Agent storage containers and gas cartridges (cont'd)**
  - **Dry chemical containers can be bigger than wet chemical containers.**
  - **Smaller pre-engineered installations to protect kitchens have smaller containers.**
  - **All containers must meet DOT storage and shipping guidelines.**

System Component Requirements

- **Piping and fittings**
  - **Distribute wet or dry agent to nozzles**
  - **Usually made with metal approved for specific agent and system**
  - **Installed fittings include elbows, tees, couplings.**
  - **Arrangement and size of pipe depend on hazard and agent.**
    - **Standardized in wet chemical pre-engineered systems**
    - **Dry chemical systems may require full engineering.**

System Component Requirements

- **Nozzles**
  - **Means of distributing agent on hazard**
  - **Different types for wet and dry systems**
  - **Selection and arrangement based on application, hazard, and amount of agent needed**
  - **Specific requirements:**
    - **Noncombustible**
    - **Brass, stainless steel, or corrosion-resistant materials**
    - **Blow-off caps and strainers**

System Component Requirements

- **Activation devices**
  - **Automatic and manual systems are independent of each other.**
  - **Automatic activation occurs through sensing device located in hazard area (e.g., fusible link).**
  - **Manual activation devices are placed near protected area or path of egress.**
  - **Activation systems must operate associated safety equipment and shut down hazard utilities.**

System Component Requirements

- System alarms and indicators
  - When wet or dry system activates, it must initiate alarm signal (alarm, supervisory, trouble).
    - If building has fire alarm system, extinguishing system ties in.
    - If not, audible or visual indicator is mandated.
  - Supervisory alarms for electrical or pneumatically controlled system are required.

Types of Fixed Wet and Dry Extinguishing Systems

- **Local application systems**
  - **Protect a specific area, piece of equipment, process, or operation**
    - **Can use wet or dry agents**
    - **Discharge directly onto hazard**
  - **Must protect entire hazard and hazard must be isolated**
    - **Examples: A cooking appliance, a vehicle fuel island**

Types of Fixed Wet and Dry Extinguishing Systems

- **Total flooding systems**
  - **Protect enclosed hazards and areas within a structure**
    - **Example: A paint spray booth or liquid storage area**
    - **Dry chemical agent smothers, cools, and disrupts chain reaction.**
  - **Amount of agent needed varies based on total volume and manufacturing specs.**
  - **Suppression agents may require sealing.**

System Operation

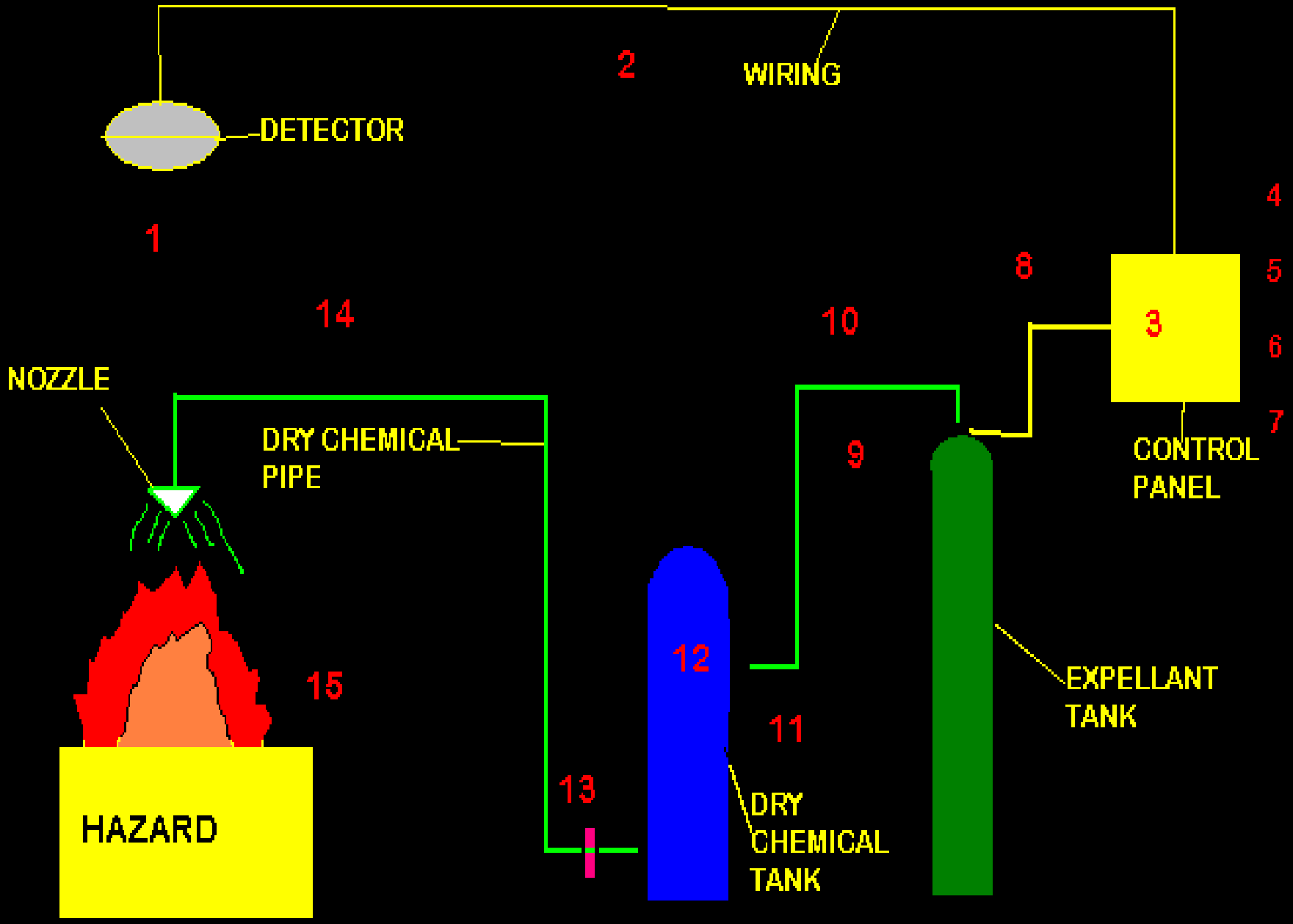
1. Detector Senses Fire Condition
2. Signals Control Panel
3. If Interpreted As Fire…
4. Alarm Sounds
5. Equipment Shut Down, Supply And Return Air Shut-Off

System Operation

6. **Activation Could Be Automatic Or Manual**
7. **Could Be Remote Push Button**
8. **Signal Sent To Actuator On Expellant Tank**
9. **Valve Opens**
10. **Expellant Piped Into Dry Agent Tank**

System Operation

11. **Expellant Enters Tank And Mixes (Fluidization)**
12. **Pressure Build As Volume In Tank Increases**
13. **Pressure Bursts Rupture Disk**
14. **Fluid Mixture Flows Through Piping Under Pressure**
15. **Nozzle Applies Dry Chemical**


2
WIRING
DETECTOR
1
4
5
6
7
8
3
CONTROL
PANEL
14
10
NOZZLE
DRY CHEMICAL
PIPE
9
15
12
11
EXPELLANT
TANK
13
DRY
CHEMICAL
TANK
HAZARD

Types of Fixed Wet and Dry Extinguishing Systems

- **Other wet and dry chemical application methods**
  - **Many different methods**
  - **Hand hose lines can stand alone, supplement extinguishers, or supplement dry chemical systems.**
    - **May be installed if dry chemical system is inadequate**
    - **Must have its own dry chemical supply**
    - **Hose lines must be accessible and able to reach hazard.**

Inspection, Testing, and Maintenance

- **Visual inspections**
  - **Confirm that equipment is located and installed correctly**
  - **The inspection:**
    - **Verifies correct nozzle type and location**
    - **Verifies piping material, size, and length**
    - **Verifies correct agent type and amount**
    - **Determines if auxiliary equipment is in correct location, is correct type, and is free of damage and operable**

Inspection, Testing, and Maintenance

- **Discharge test**
  - **Ensures correct amount of agent discharged from nozzles and equipment functions**
  - **Balloons, containers, and bags are attached to nozzles to capture agent when it is discharged.**
  - **Also confirms piping is not clogged**

Inspection, Testing, and Maintenance

- **Acceptance test**
  - **Confirms proper operation by manual or automatic release**
  - **Safety processes that occur:**
    - **Fuel and electrical shut-off**
    - **Supply air shut-down**
    - **Alarm activation**
    - **Exhaust fan shut-down and damper closing**
  - **Record event by placing tag on equipment.**

Inspection, Testing, and Maintenance

- **Inspection**
  - **Occurs at least monthly, possibly more frequently**
    - **No obstruction to manual release or equipment**
    - **No coating or deposits on nozzles or equipment**
    - **Protective blow-off caps/covers in place, no damage**
    - **Nozzles in correct location**
    - **Auxiliary systems in place and ready**
    - **No visible corrosion**
    - **Pressure gauge normal**

Inspection, Testing, and Maintenance

- **Inspection (cont'd)**
  - **Same checks are done as during monthly inspections, plus:**
    - **Checking dry chemical systems that use gas cartridges for pressure and weight**
    - **Ensuring that dry chemical agents flow freely and are not lumped or caked**
  - **Dry chemical agents in stored-pressure containers must be checked every 6 years.**

Inspection, Testing, and Maintenance

- **Testing**
  - **Ensures system is operating as designed and identifies problems**
  - **Inspection results determine necessary testing level.**
  - **When inspection reveals a problem, address immediately.**
    - **Corrosion, leaks, damage, equipment repair may require more extensive testing/maintenance.**

Inspection, Testing, and Maintenance

- **Testing (cont'd)**
  - **Manual and automatic system activation determines if fuel and electricity shut down.**
    - **Expelled gas determines performance level.**
  - **Insurance/government authorities may require full discharge.**
    - **Weigh captured product.**
  - **Clean and dry internal piping to avoid blockage/corrosion.**

Inspection, Testing, and Maintenance

- **Maintenance**
  - **Follows manufacturer's guidelines**
  - **In addition to monthly/semi-annual testing:**
    - **Replacement of fusible alloy-type fixed temperature-sensing elements; not fusible replaced as necessary**
    - **System piping and nozzles internally examined**
    - **Response to corrosion, leakage, or damage**
    - **Full discharge every 6 years**
    - **Hydrostatic testing of containers every 12 years**

Inspection, Testing, and Maintenance

- For visual inspection, component test, or required maintenance, equipment must be tagged.
  - Records should also be kept.

Dry Chemical Systems

NFPA 17 On Caking

Originally

- **Caked-Dry Chemical Is Caked If It Does Not Crumble When Dropped From A Height Of 4 Inches.**

Now

- **Caking-evidence Of Lumps Present In The Chemical**

Dry Chemical Systems

- Dry Chemical Agent Analysis
- Dry chemical: a powder consisting of small particles suspended in a gaseous medium; can distribute to a hazard
- Sodium Bicarbonate-based Dry Chemicals
- Potassium-based Dry Chemicals
- Multipurpose Dry Chemicals

Dry Chemical Systems (con't.)

- Advantages of Dry Chemical Agents
- Disadvantages of Dry Chemical
- Personnel Hazards with Dry Chemical
- Testing of Dry Chemical Systems
- Dry Chemical Extinguishing Mechanism

Dry Chemical System Components

- Dry Chemical Containers
- Dry chemical skid: a pre-assembled assembly that includes pre-piped dry chemical storage and pressurization facilities
- Expellant Gas Cylinders for Dry Chemical Systems
- Dry Chemical System Piping and Nozzles
- Detection Systems for Dry Chemical Systems

Applications for Dry Chemical Systems

- Dry Chemical Systems for LNG Hazards
- Vaporized LNG:
  - Fires in an enclosed volume
  - Total flooding carbon dioxide is recommended as the best solution
  - Pressure and pool fires
  - Dry chemical is the best solution

Applications for Dry Chemical Systems

- **Liquid LNG:**
  - **Spill fires**
  - **Dry chemical or a combination of dry chemical, followed by the application of high expansion foam, is recommended as the best solution**
  - **Pressurized and pool fires**
  - **Dry chemical or a combination of dry chemical, followed by the application of high expansion foam, is recommended as the best solution**

Total Flooding Dry Chemical Systems

- Unclosable Openings in Total Flooding Dry Chemical Applications
- Total Flooding Quantity Calculation
- Nozzle Spacing and Location for Total Flooding Systems

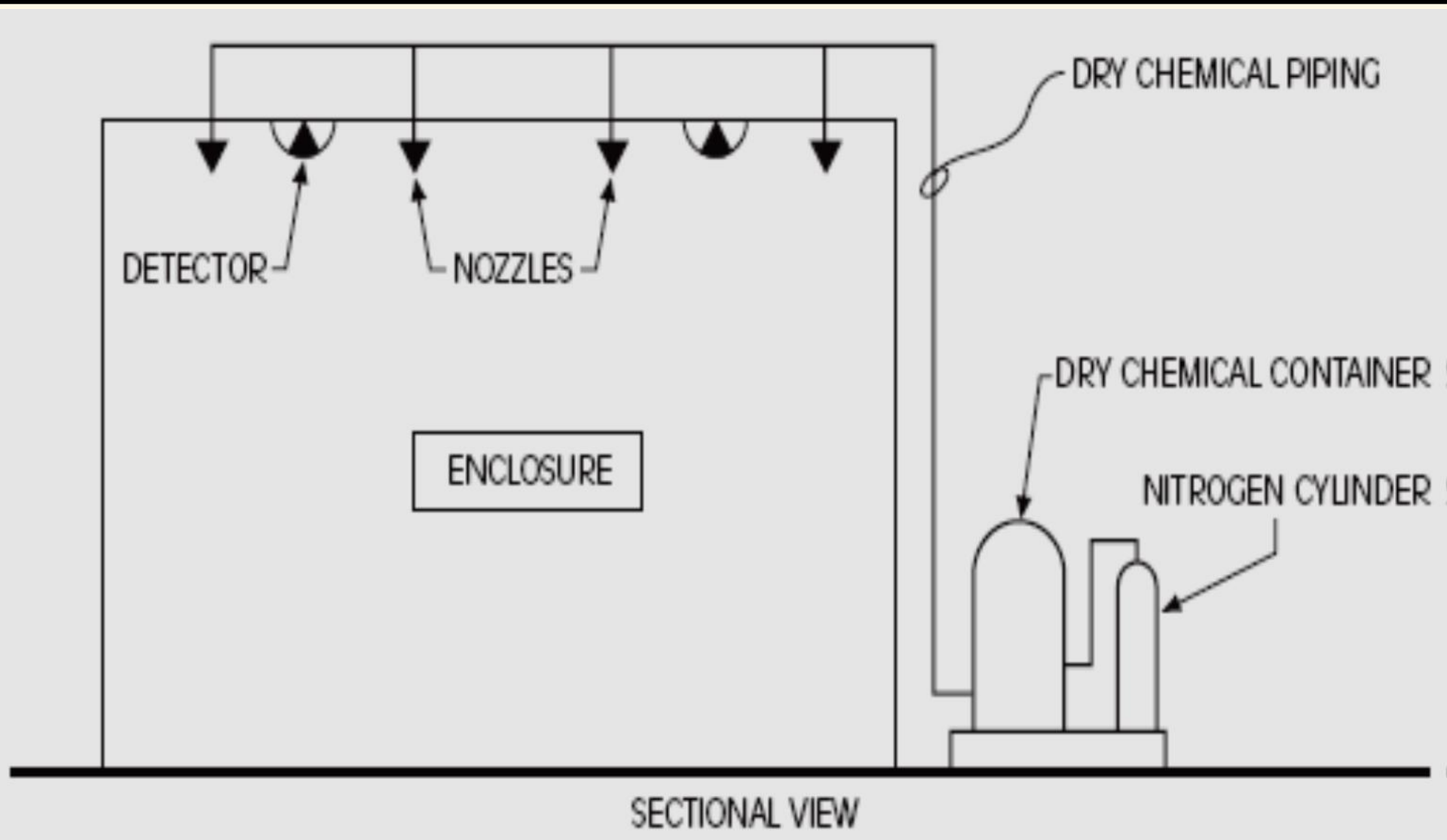
Total Flood V. Local Application

- **NFPA 17 states that if the area is predominantly enclosed, with the sum of the uncloseable openings not exceeding 15% of the surface area of all the walls, then a total flooding system may be employed, subject to the provisions below.**

Total Flood V. Local Application

- If the area of uncloseable opening is less than 1%, then no additional dry chemical suppressant is required.
- Between 1 and 5%, extra dry chemical suppressant is required, and if the area of uncloseable openings exceeds 5%, then a screening system, or approved local application system is required.

Total Flooding Dry Chemical Systems



Determining Dry Chemical Total Flooding Quantity

Using NFPA 17 criteria, determine whether a total flooding system or a local application system is appropriate to protect an enclosure 10 ft. wide, 20 ft. long, and 8 ft. high, with 90 sq ft. of unclosable openings. If total flooding is appropriate, use Ansul criteria to determine the minimum amount of dry chemical required.

Solution

The volume of the hazard is:

$$V = (L) \times (W) \times (H)$$
$$= (20') \times (10') \times (8')$$
$$= 1600 \text{ ft.}^3$$

The interior surface area of the enclosure is:

ceiling:	$(20') \times (10')$	$= 200 \text{ ft.}^2$
floor:	$(20') \times (10')$	$= 200 \text{ ft.}^2$
wall:	$(20') \times (8')$	$= 160 \text{ ft.}^2$
wall:	$(20') \times (8')$	$= 160 \text{ ft.}^2$
wall:	$(10') \times (8')$	$= 80 \text{ ft.}^2$
wall:	$(10') \times (8')$	$= 80 \text{ ft.}^2$

Therefore, total interior surface area is 880 ft.^{2}.

Determining Dry Chemical Total Flooding Quantity

The total area of unclosable openings is 90 ft.^{2}, as stated in the problem. To determine the percentage of unclosable openings relative to the total interior surface area:

$$\frac{90 \text{ ft.}^2}{880 \text{ ft.}^2} = 0.102 \text{ or } 10.2\%$$

Because the percentage of unclosable openings as related to the total interior surface area is less than 15%, a total flooding system is appropriate for this application.

Using Ansul criteria, the minimum basic quantity (Q_b) of dry chemical required is:

$$\begin{aligned} Q_b &= (V) \times (0.0385 \text{ lb/ft.}^3) \\ &= (1600 \text{ ft.}^3) \times (0.0385 \text{ lb/ft.}^3) \\ &= 61.6 \text{ lb dry chemical} \end{aligned}$$

The total of unclosable openings falls between 5% and 15% of the total interior surface area, so 1 pound of dry chemical per square foot of unclosable opening must be added to the basic quantity calculated previously. The problem stated that the area of unclosable openings is 90 ft.^{2}. The additional quantity required for the openings (Q_o) is:

$$Q_o = (1 \text{ lb/ft.}^2) \times (90 \text{ ft.}^2) = 90 \text{ lb}$$

Determining Dry Chemical Total Flooding Quantity

The total minimum dry chemical required (Q_t) for this total flooding application is equal to the basic quantity (Q_b) plus the quantity required to compensate for the openings (Q_o):

$$Q_t = Q_b + Q_o$$
$$= (61.6 \text{ lb}) + (90 \text{ lb})$$
$$= 151.6 \text{ lb}$$

This quantity is required to be distributed to the hazard within 30 seconds. It should be noted that a pre-engineered dry chemical suppression likely would be specified for this hazard, using these calculations as the basis for specification. Note that the amount of dry chemical flowing through openings exceeds the basic flooding quantity. This may be a concern for designers, but the calculations demonstrate that the preceding procedure is permissible.

Determining the Number and Spacing of Nozzles for a Total Flooding Dry Chemical System

Determine the minimum number of nozzles for the enclosure described in Example 10.1, and sketch the nozzle layout.

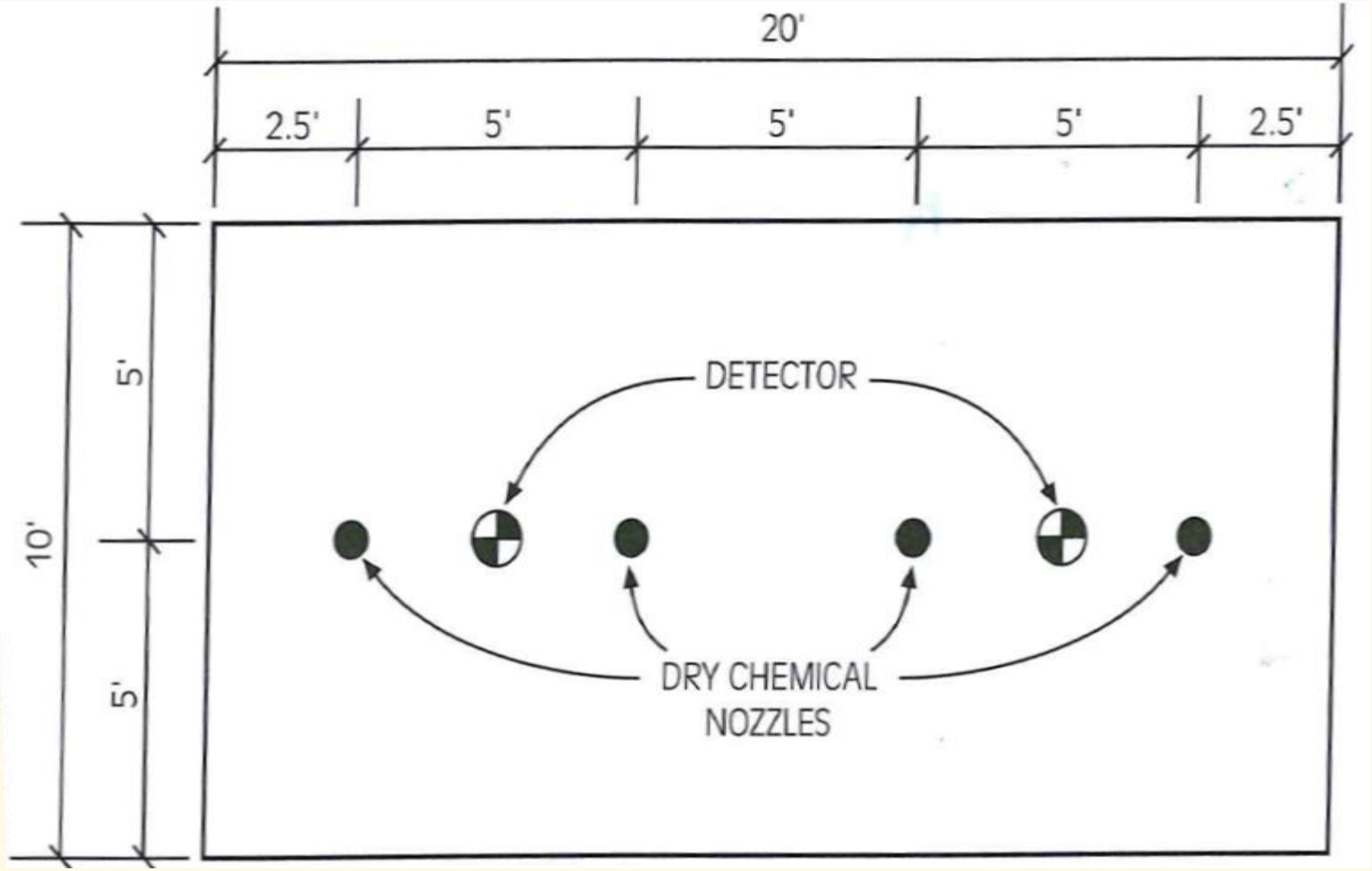
Solution

Room volume is 1600 ft.^{3}, so the number of nozzles is:

$$N = (V)/(500 \text{ ft.}^3)$$
$$= (1600 \text{ ft.}^3)/(500 \text{ ft.}^3)$$
$$= 4 \text{ nozzles}$$

Figure 10-10 is a sketch of the system.

Determining the Number and Spacing of Nozzles for a Total Flooding Dry Chemical System



Local Application Dry Chemical Systems

- NFPA 17 requires that a hazard protected by a local application system
  - Be isolated from other hazards
  - Be protected individually without affecting or being affected by other hazards
- NFPA 17 does not provide design criteria for local application dry chemical extinguishing systems
- Based upon manufacturers data

Hand Hose Line Dry Chemical Systems

- Manually actuated hand hose line systems are permitted only as a supplement for automatic fixed extinguishing systems
- The agent supply capable of supporting discharge of dry chemical from a hand hose line must consider a supply capable of supporting a minimum duration of 30 seconds for each hand hose line operated from a fixed source

Pre-Engineered Dry-Chemical Systems

- **Pre-engineered systems: packaged units in which supply quantity, nozzle selection, pipe size, and detector selection are predetermined for a range of volumes, areas, or applications, and listed as a unit**
- **May be designed for local application, total flooding, or hand hose line systems**

Questions?