Other Detection Considerations

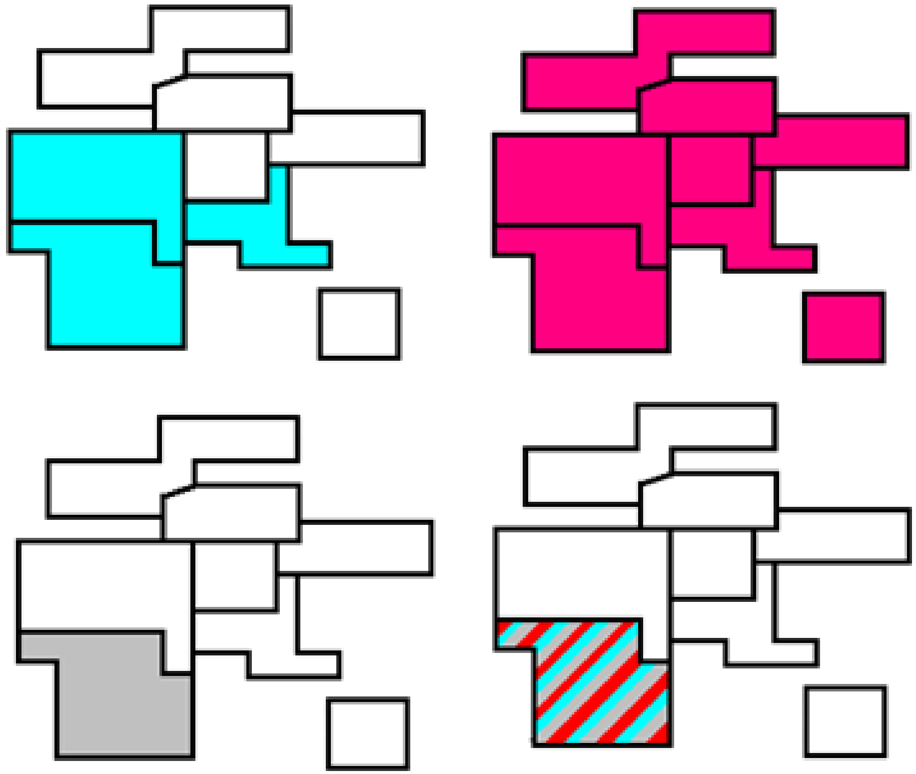
- Select appropriate zoning strategies for detectors
- Identify different types of sensors
- Explain limitations with using other types of detectors

Zoning

- Manual stations typically by floor or wing
- Building Code may limit size of alarm zone
  - Often ~20,000 ft^2
  - Maximum dimension of 300 ft
- Water flow alarms zoned to ≤ 52,000 ft^2
- Smoke detectors may be zoned by special function, smoke zone, corridor, etc.
  - Special zones: computer/electrical room, kitchen hood system, etc.
- Zones should correspond and not contradict

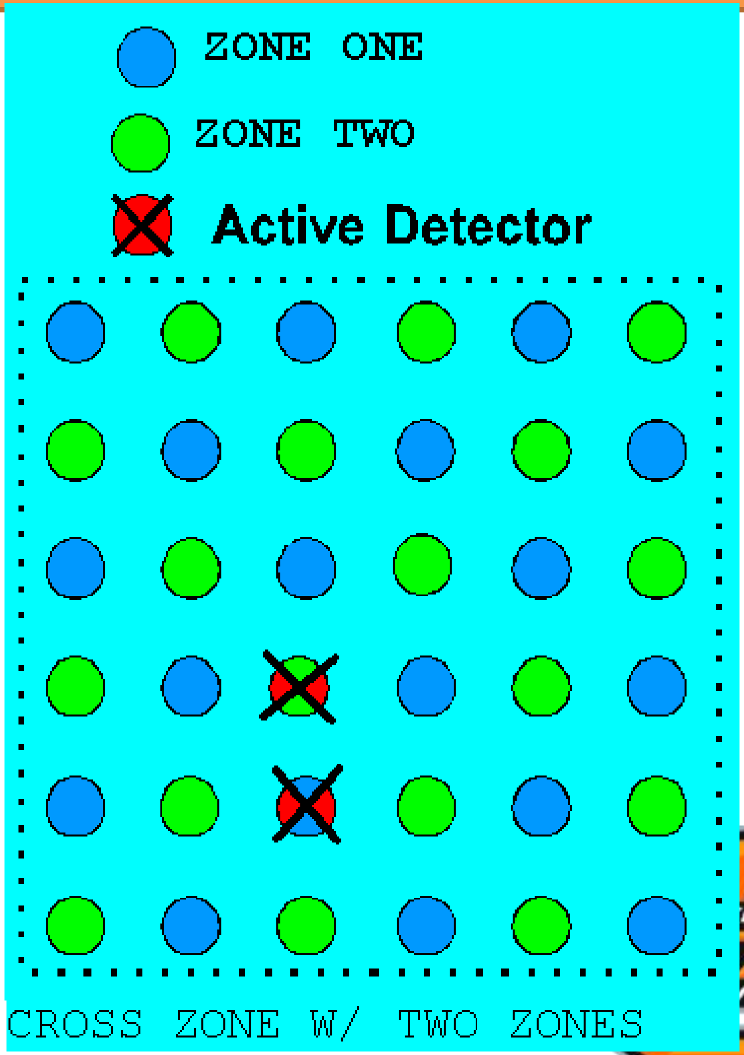
Zone/System Alarm Allowable Areas and Requirements of Facility Operations

- Sprinkler zone
- Smoke control zone
- Pull station zone



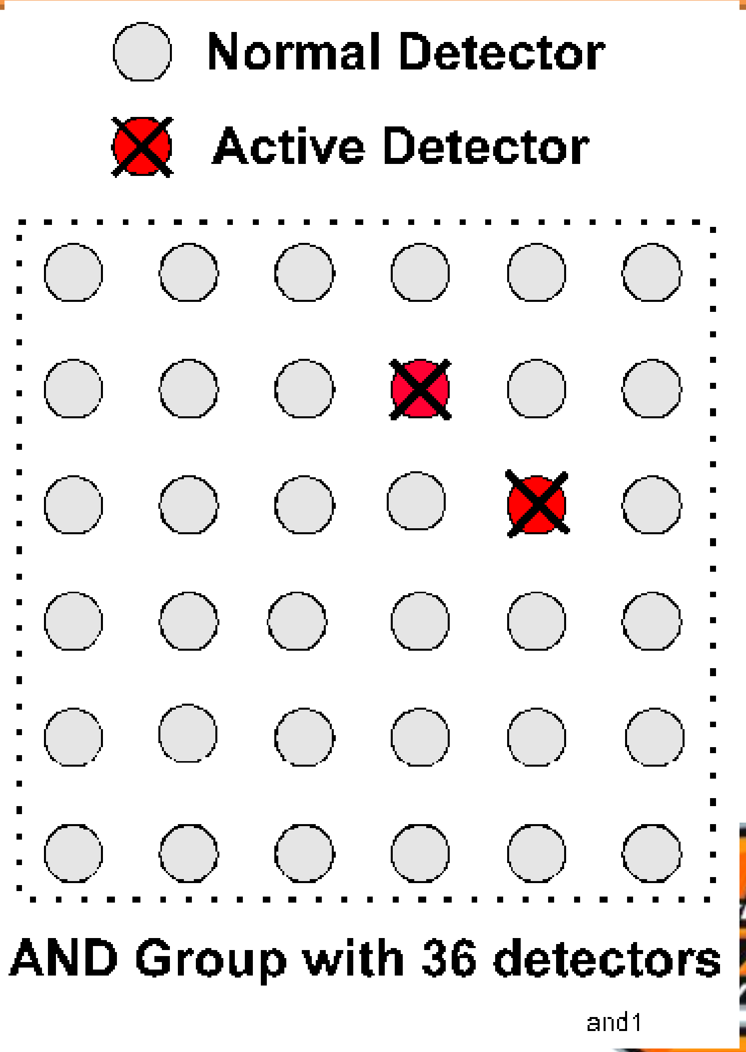
Cross Zone Groups

- Example
  - 2 groups each with 18 devices
  - Any activation at least one device in each group results in alarm condition



And Zone Groups

- Large number of groups each with large number of devices permitted
- Any activation number greater than one and less than total



Gasses and Vapors

- Gas
  - At normal STP (standard temperature and pressure) will occupy the entire containment area
- Vapor
  - Matter in the gas phase that at normal STP exists as a liquid
  - The result of evaporation of a liquid and normally associated with a liquid source

Gasses and Vapors

- Combustible
  - Flashpoint
    - Lowest temperature of a liquid which will produce enough gaseous fuel in excess of the LFL (lower flammable limit) of the material to support a flame
      - LEL = Lower Explosive Limit
        - Term is slowly being phased out
- Toxic
  - Measure in ppm (parts per million)
    - 10,000 ppm = 1%
  - Most flammable gasses are toxic, but not all toxic gasses are flammable

Gas Detection

- Some typical gasses
  - CO
  - CO_2
  - SO_2
  - H_2S
  - Methane
  - Propane
  - Butane
  - Fluorine
  - Chlorine
- Detection System
  - Sensor, transmitter and display
  - Produces small current proportional to the gas concentration
    - Typically as a % of the LFL

Hazardous Locations

- The National Electrical Code (NEC) defines hazardous locations as those areas
  - "where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers…"

NOTE: Hazardous Locations are also described as “Classified Locations”

Hazardous Locations

- Class 1
  - Flammable gases or vapors
  - Division 1
    - Where gases or vapors exist under normal conditions
    - May exist frequently because of repair or maintenance
    - Might exist due to faulty equipment or processes
  - Division 2
    - Gases or liquids in closed containers or systems and would escape only with accidental rupture or equipment breakdown
    - Ignitable gases or vapors are prevented by positive mechanical ventilation and would become hazardous through failure or abnormal operations of the ventilating equipment

Hazardous Locations

- Class 2
  - Combustible dusts
  - Division 1
    - Combustible dust in air under normal conditions in quantities sufficient to produce explosive or ignitable mixtures; or
    - Mechanical failure or abnormal operation of equipment releases dust and might provide a source of ignition; or
    - Combustible dust of a electrically conductive nature (i.e. magnesium and aluminum dust)
  - Division 2
    - Combustible dust not normally in high enough quantities to produce explosive or ignitable mixtures
    - Dust accumulations will normally be insufficient to interfere with the normal operation of electric equipment or other apparatus
    - Accumulation on, in, or near electrical equipment may cause heat build-up and be ignitable by equipment failure

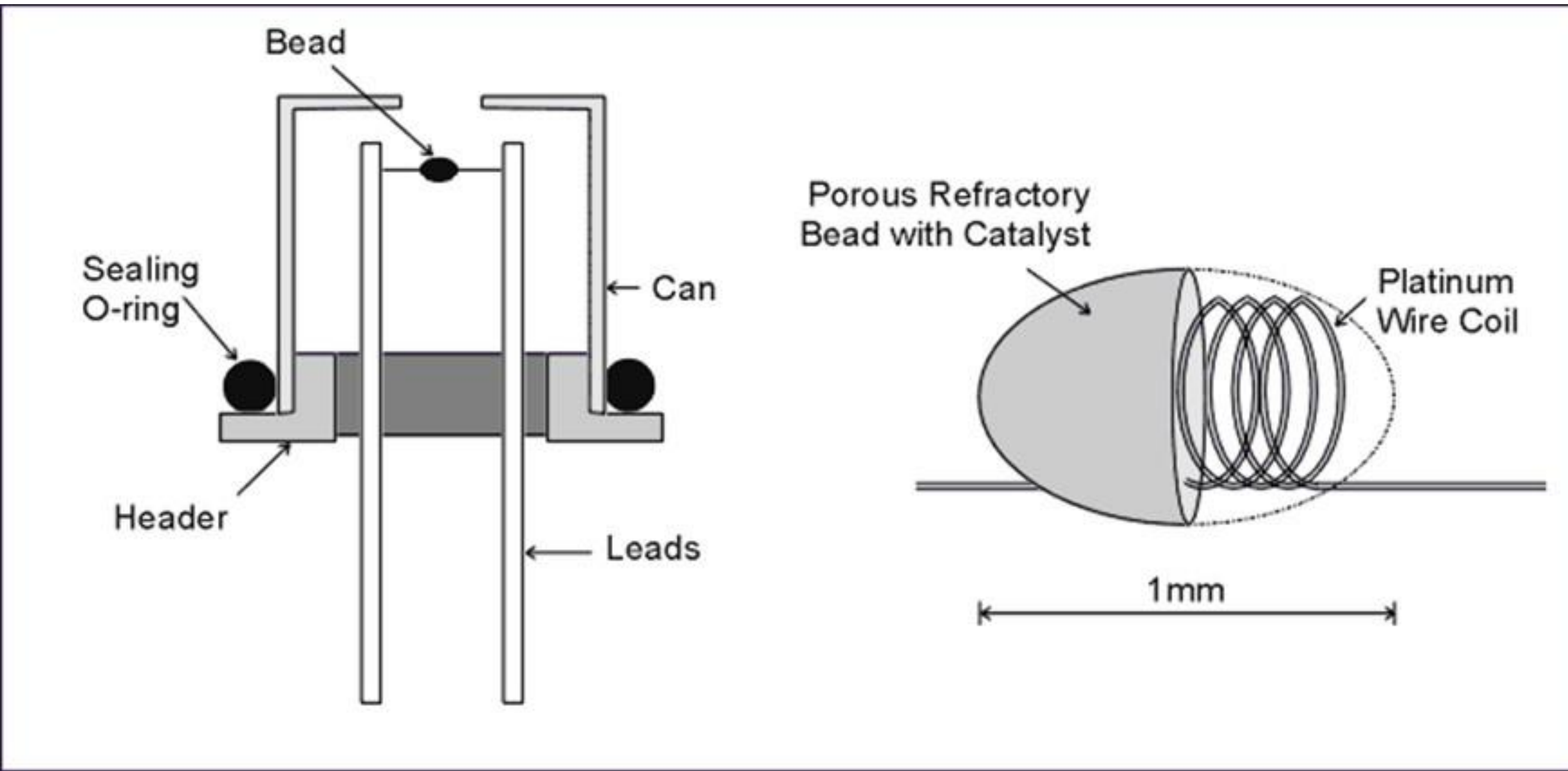
Hazardous Locations

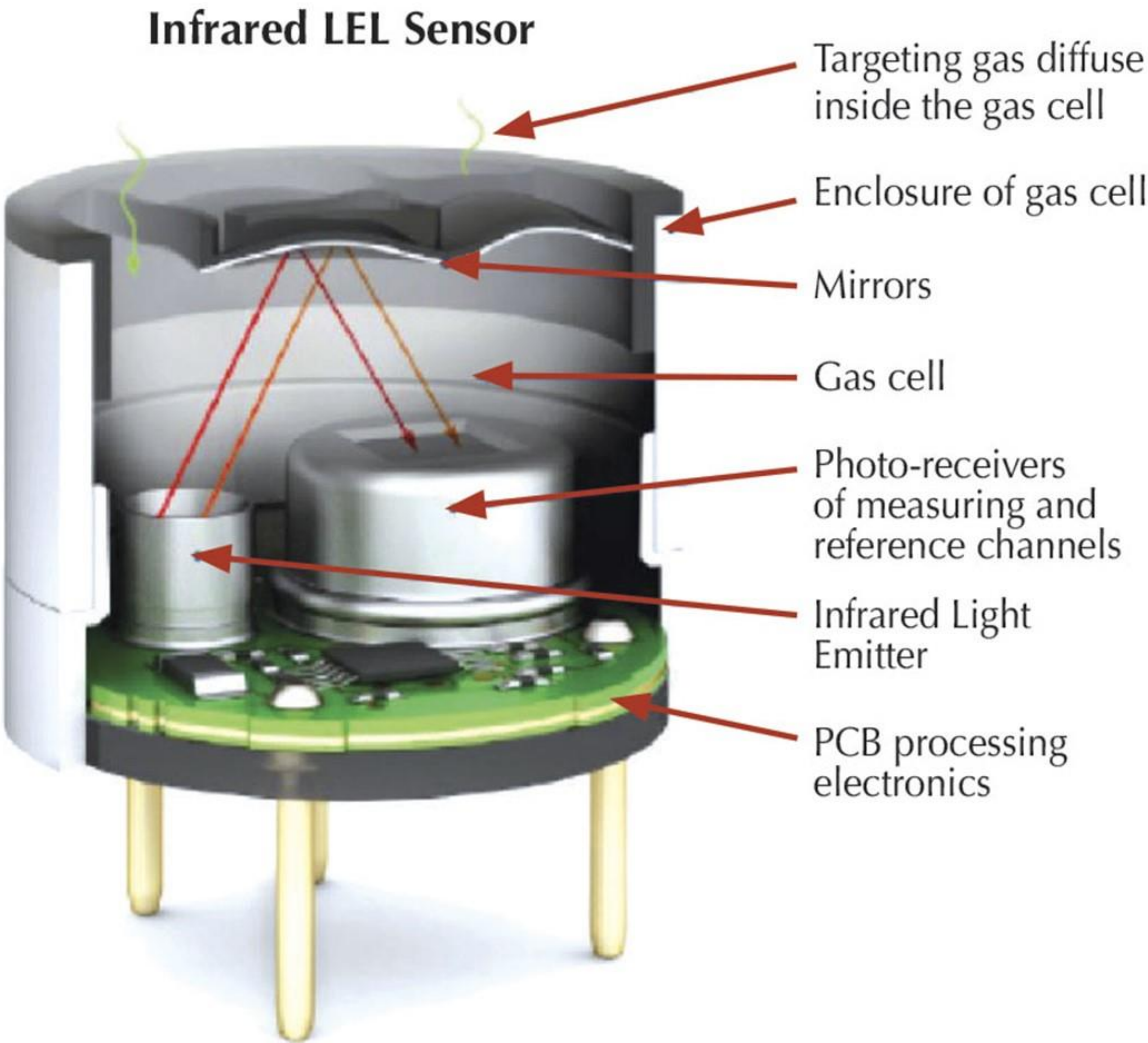
- Class 3
  - Ignitable fibers
  - Division 1
    - Location in which easily ignitable fibers or materials are handled, manufactured, or used
  - Division 2
    - Location in which easily ignitable fibers are stored or handled, other than in the process of manufacture

Summary of Class I, II, III Hazardous Locations			
Classes	**Groups**	**Divisions**	
		1	**2**
Class I Gases, Vapors & Liquids	A: Acetylene B: Hydrogen, etc. C: Ester, etc. D: Hydrocarbons. fuels	Normally explosive and hazardous	Not normally present in an explosive concentration but may accidentally exist.
Class II Dusts	E: Metal dusts (conductive and explosive) F: Carbon dusts (some are conductive, all are explosive) G: Flour, starch, grain, combustible plastic or chemical dust (explosive)	Ignitable quantities of dust are or may be in suspension, or conductive dust may be present	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.
Class III Fibers & Flyings	Textiles, woodworking etc. (easily ignitable but not usually explosive)	Handled or used in manufacturing	Stored or handled in storage (exclusive of manufacturing)

Sensors

- Catalytic bead sensors are used primarily to detect combustible gases and have been in use for more than 50 years
  - Initially, in coal mines, replaced canaries
- Principle of Operation
  - Combustible gas mixtures will not burn until they reach an ignition temperature
  - In the presence of certain chemical media, the gas will start to burn or ignite at lower temperatures
    - catalytic combustion
  - A gas molecule oxidizes on the catalyzed surface of the sensor at a much lower temperature than its normal ignition temperature.
  - All electrically conductive materials change their conductivity as temperature changes
    - coefficient of temperature resistance


Bead
Sealing
O-ring
Can
Header
Leads
Porous Refractory
Bead with Catalyst
Platinum
Wire Coil
1mm


Infrared LEL Sensor
Targeting gas diffuse inside the gas cell
Enclosure of gas cell
Mirrors
Gas cell
Photo-receivers of measuring and reference channels
Infrared Light Emitter
PCB processing electronics

Sensors

- The concentration of gas readings are in direct proportion to the electrical signal
- The electrical circuit used to measure the output of catalytic sensors is called a Wheatstone bridge
- A balanced bridge has no output signal
- When the gas burns on the active sensor surface, the heat of combustion causes the temperature to rise, which in turn changes the resistance of the sensor
- The bridge becomes electrically unbalanced resulting in a signal
- NFPA HB 14-102

Sensors

- Contain a small flame arrestor to prevent propagation of flame outside the sensor
- Must have sufficient oxygen present to function
  - Special arrestors may be necessary in oxygen-enriched atmospheres (O_2 > 21%)
- Suffer from "poisoning"
  - Material only partially burns and leaves residue on sensor surface
  - Regular field calibration is necessary

Sensors

- Metal Oxide Semiconductors (MOS)
  - Voltage across sensor changes when the applicable gas contacts the sensor. Voltage change equals presence of gas resulting in signal
    - Cannot be made specific for one single gas
- Electrochemical
  - Detection of toxic gasses
  - Applicable gas creates an electrochemical reaction producing voltage change and subsequent signal
    - CO, SO_2, H_2S, etc.
    - Do not require presence of oxygen to function

CO Detectors

Sensors

- Flame Cell
  - Flame fueled by flammable gas in unit
  - Hydrocarbon gasses enter unit, are burnt adding to the heat
  - Temperature rise is proportional to the gas concentration and signal is sent
  - Not affected by poisoning like catalytic bead
  - Require less calibration
  - More expensive

Sensors

- Nondispersive IR
  - Two projected beams at different wavelengths
    - One that the applicable gas will absorb, the other that it will not (reference beam)
  - Presence of gas absorbs projected IR beam
  - Difference between affected beam and reference beam results in signal
  - Can be spot type of projected beam

Integration with Fire Alarm Systems

- Fixed detectors only
- Inconsistencies exist between NFPA 72 and applicable standards for gas detection
  - Power source compatibility issues
  - Interconnection methods cause a variety of issues

Fixed or Portable

Fixed

Portable