Kidde Aerospace

A Review of Aircraft Fire Detection Technology

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Fire Sensing - Methods

- SMOKE PARTICLES AND P.O.C. → SMOKE DETECTORS
- FLAME ENERGY
  - CONVECTED → THERMAL SENSORS
  - CONDUCTED → THERMAL SENSORS
  - RADIATED
    - UV → OPTICAL SENSORS
    - VIS → OPTICAL SENSORS
    - IR → OPTICAL SENSORS

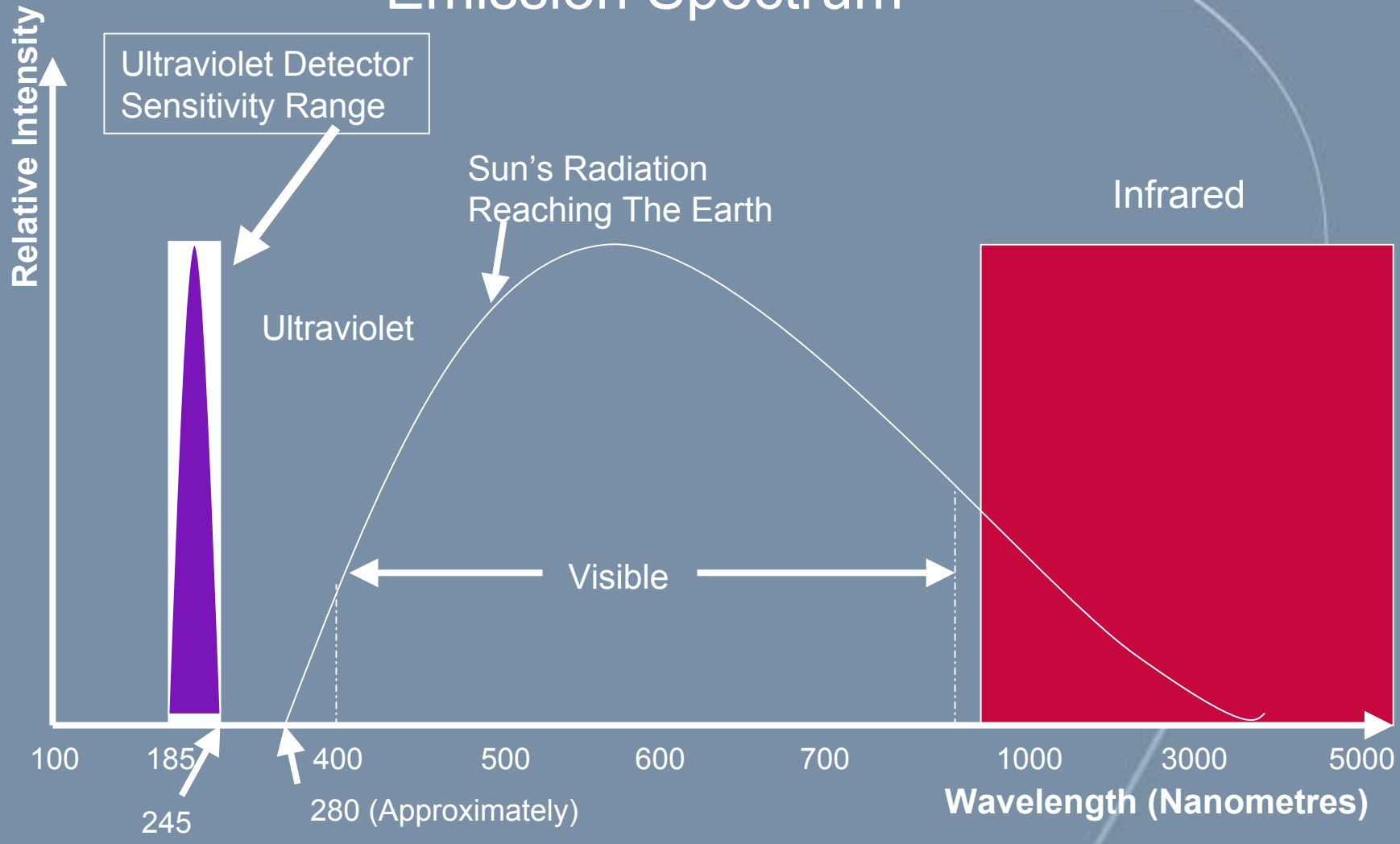
Optical Fire Detection

- Ultraviolet
- Infrared
- Visible

Ultra Violet (UV) Detector - Theory of Operation

- Senses UV radiation in 190 - 240nm waveband - emitted from fire
- High energy photons cause UV tubes to conduct by emission of electrons from cathode
- High voltage field between cathode & anode causes the tube to conduct
- APPLICATIONS: Engine, APU and wheel well compartments

Emission Spectrum



Single Channel Infrared Detector - Theory of Operation

- Detects peak hydrocarbon emissions at 4.3 µm (co_2 molecular oscillations)
- Flame flicker logic, alarms when fire is sensed
- APPLICATIONS: Engine, APU and wheel well compartments

Typical Hydrocarbon Fire Emission

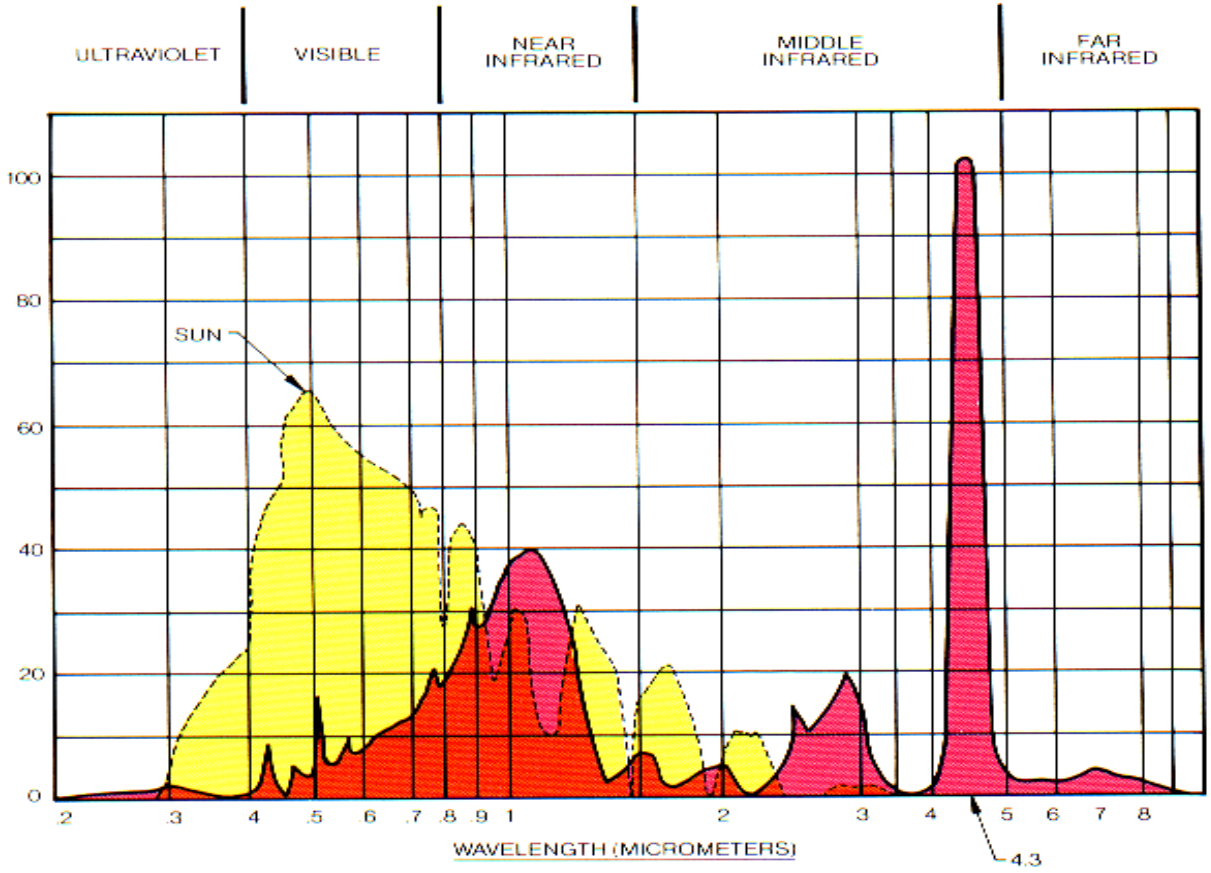


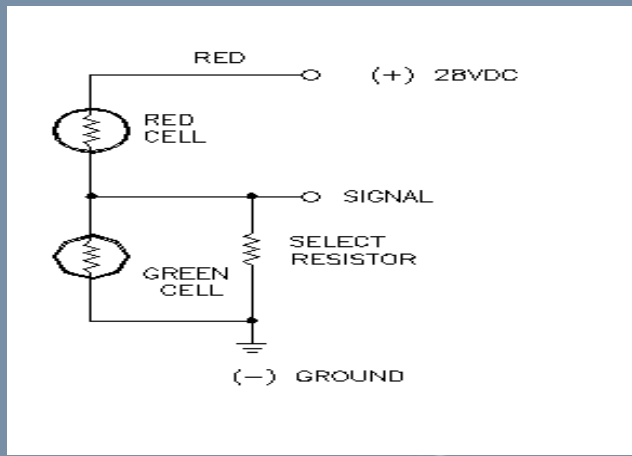
FIGURE 1

Dual Band InfraRed (IR) Detector - Theory of Operation

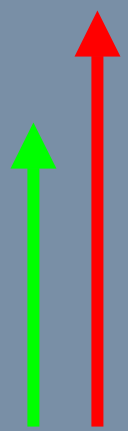
- Dual wavelength detection technique using 4.4µm (thermopile) & 0.9µm (photodiode)
- Dual bank logic enhances false alarm immunity
- APPLICATIONS: Fire and Explosion Detection Dry Bay Compartments

Visible Flame Detection

- Cadmium sulfide photo resistors
- Sees red content in flame emission
- Simple / low cost
- APPLICATIONS: Engine, APU and wheel well compartments



CdS Optical Flame Detector



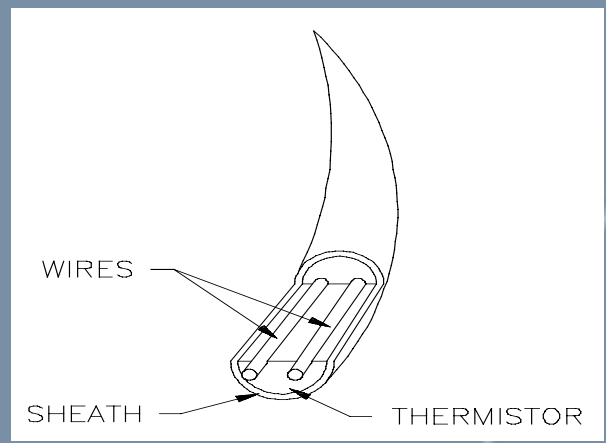
- CdS photocells sensitive over range from 0.4 - 0.8 microns.
- False alarm immunity and flame discrimination gained from dual wavelength bands.
- Ratio of Red (0.75 μm) to Green (0.55 μm) light intensities.
- Mostly Red = “Flame”
- Mostly Green = “Other”

Thermal Fire Detection

- Thermistor
- Discrete
  - Continuous - Eutectic
  - Spot - Thermal Switches
- Pneumatic

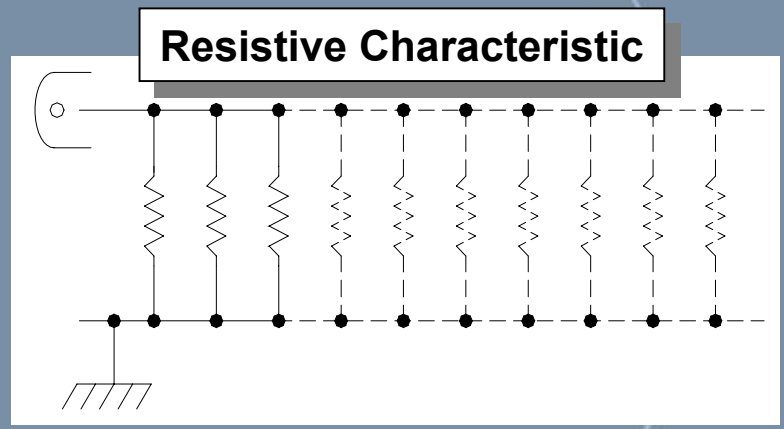
Thermistor - Continuous Detector

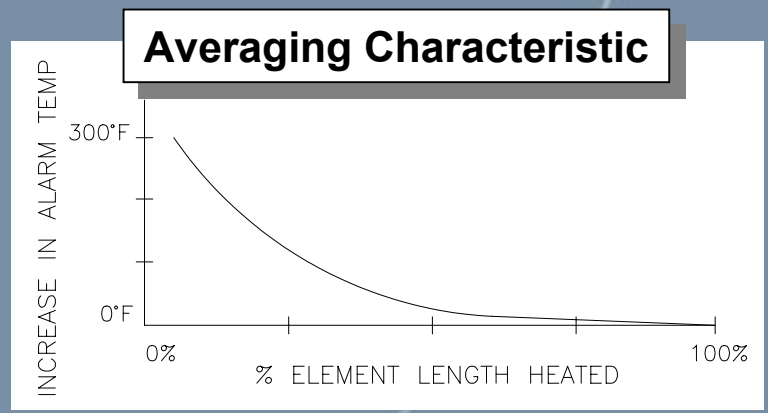
- Solid state
- Electronic monitoring required
- Precision Analog thermal measurement
- APPLICATIONS: Engine, APU, wheel well compartments



Operating Characteristics

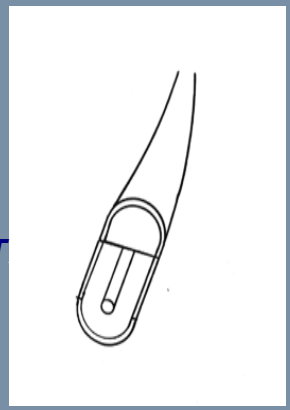
- Thermal Detection Mechanism
  - Convection Heat Transfer
  - Decreasing Resistance
- Averaging Characteristic
  - Operate temp decreases as length heated increases
  - Tolerant of local hot-spots
- TSO C11e Approved
  - 5 sec response to “TSO flame”
  - 1100^{0}C 150 mm (6 in) dia. Flame

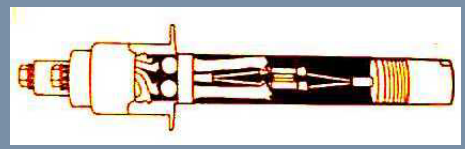




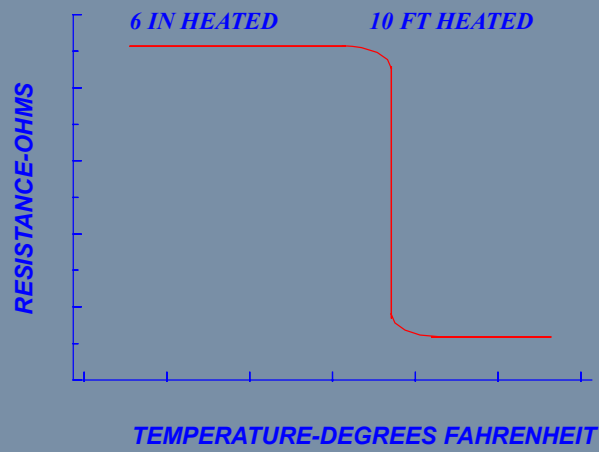
Discrete “Overheat” Detection

EUTECTIC SALT



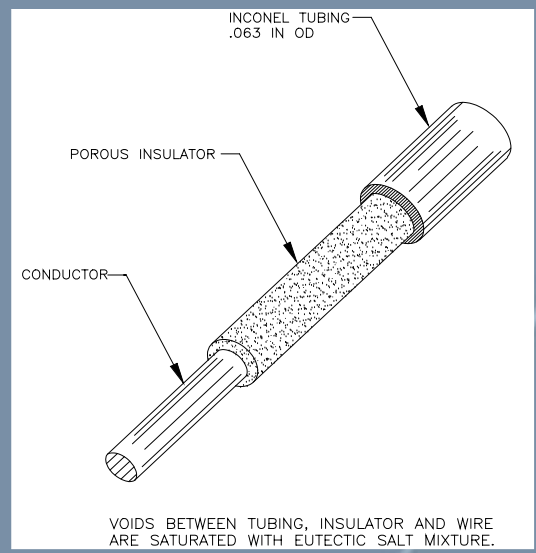


Discrete Sensing Element **“Point” Detector/Switch**



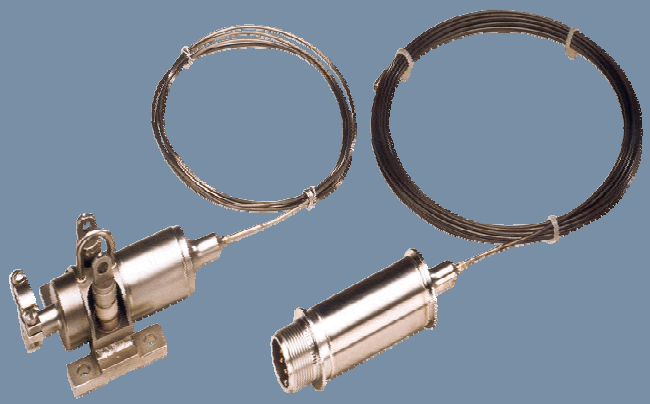
Discrete Continuous Sensing Element

- Solid state eutectic salt
- Step change in impedance when salt melts
- Temperature alarm set-points
  - 180°, 255°, 310°, 400°, 460°, 575°, 765°, 900°, 1050°F
- APPLICATIONS: Engine, APU wheel well and bleed air duct leak detection

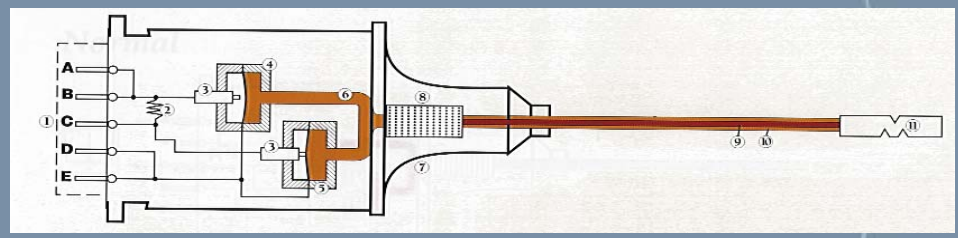


Pneumatic Thermal Detector

- Convection heat transfer
- Pneumatic pressure increases and closes pressure switch contacts.



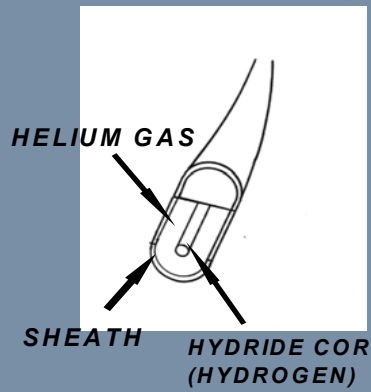
APD Section View

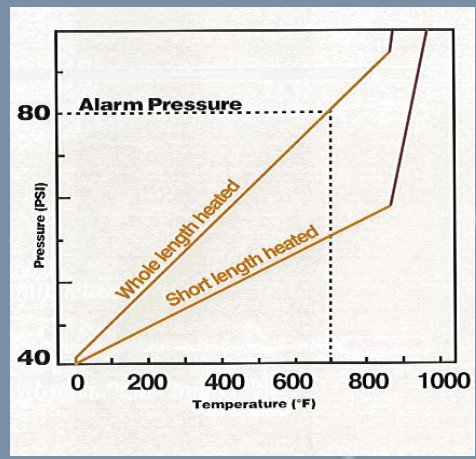


1. Connector pins
2. Resistor (optional)
3. Electrical contact pin
4. Alarm switch (normally open)
5. Low pressure switch (normally closed)
6. Helium gas
7. Transponder housing
8. Manifold/capillary tubes
9. Hydride (hydrogen)core
10. Sensor tube
11. Protective end cap

Pneumatic Thermal Detector

- Averaging and discrete alarm output temperatures
- Stand alone detector
- APPLICATIONS: Engine, APU and wheel well compartments



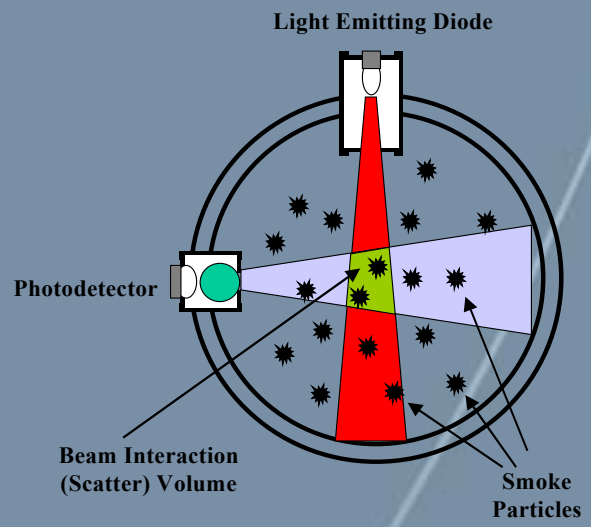


Smoke Detection

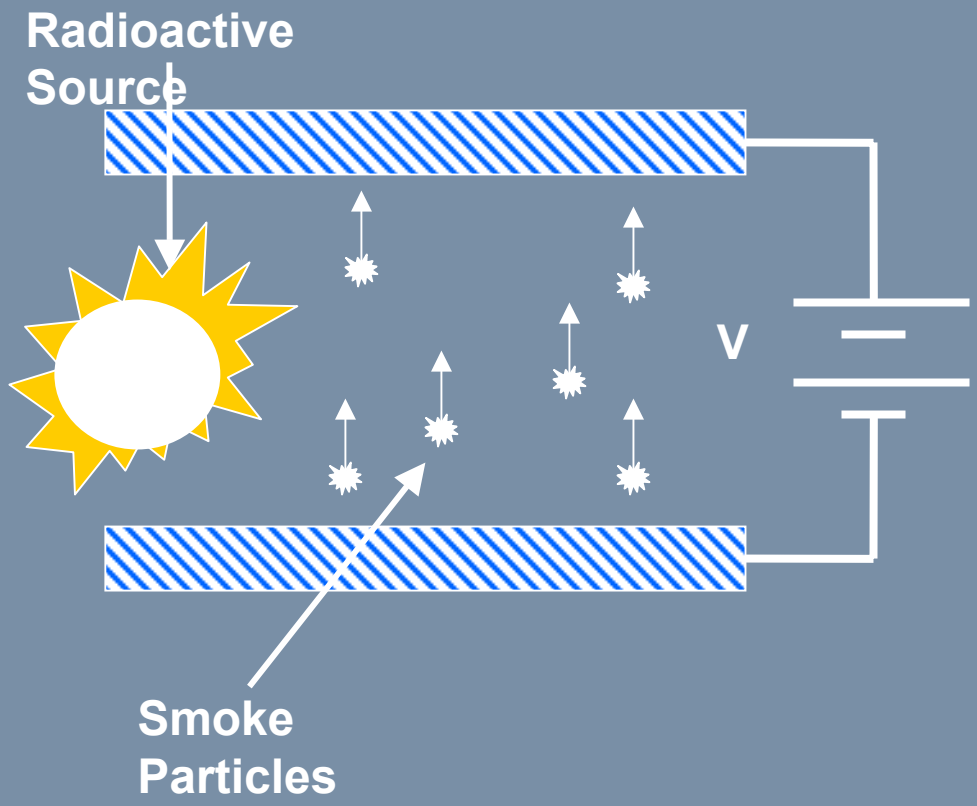
- Photo Electric Type
- Ionization Type

Photoelectric Smoke Detector

- Collimated light source provides excitation beam
- Smoke particles scatter light
- Photodetector detects scattered light from smoke particulates
- APPLICATIONS: Cargo Bays, EE Bays Lavatories, other remote zones



Ionization Smoke Detector



- Am^{241} emits α particles which ionize smoke.
- Ionized smoke particles attracted to charged plates.
- Resulting current flow detected as alarm signature.

Future Trends

- Flame and smoke imaging using visible and IR CCD's
- Fiber optic thermal sensors
- Fiber optic flame emission viewing
- Multi fire signature smart logic
  - UV / IR
  - Smoke / Thermal / P.O.C.
- TDR event location
- Particle size discriminating smoke detection
- Engine and fire detection self health monitoring using thermal detection

Closing Thoughts

- All detection systems have strengths and weaknesses.
- Up-front investment in robust installation design and later on system preventative maintenance are essential.
- Multi-parameter smart logic has the greatest potential to eliminate nuisance alarms.
- Designers must be extremely vigilant to insure that above all the detection system always detects a real fire.