AkzoNobel
Tomorrow's Answers Today

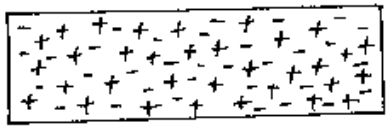
Martin van Mierlo
May 2011 - Barcelona

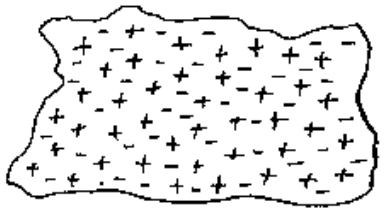
Static electricity and aerosol production, a bad combination?

AkzoNobel
Tomorrow's Answers Today

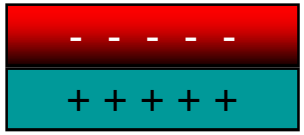
Static electricity – result of movement

Start with two neutral materials

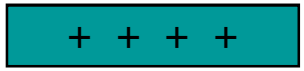




Contact, layer formation



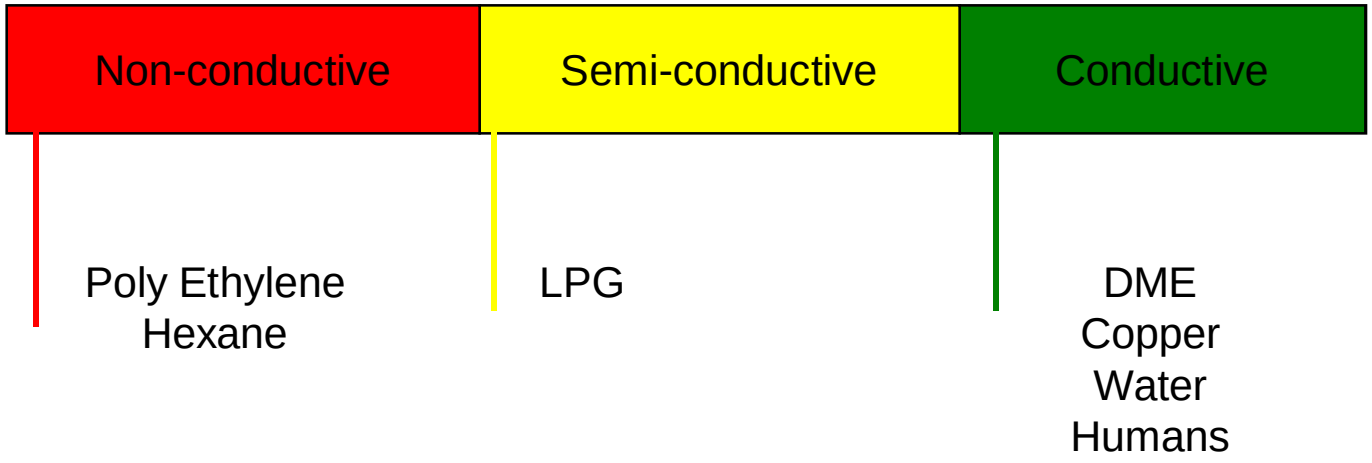
Charged materials



- one material + (electrons left the material)
- other material – (additional electrons)

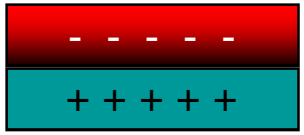
AkzoNobel
Tomorrow's Answers Today

Liquid Conductivity



AkzoNobel
Tomorrow's Answers Today

Flowchart Static Electricity - General



Contact - materials

Time

Spark

Energy

AkzoNobel
Tomorrow's Answers Today

Static electricity – accumulation

Moved charge wants to flow back

Good conductors (and path to earth),
easy flow of charge

- examples: metals, humans, water etc.

Bad conductors, high resistivity, charge build up

- examples: most plastics, hexane, toluene etc.

AkzoNobel
Tomorrow's Answers Today

Static electricity – discharge

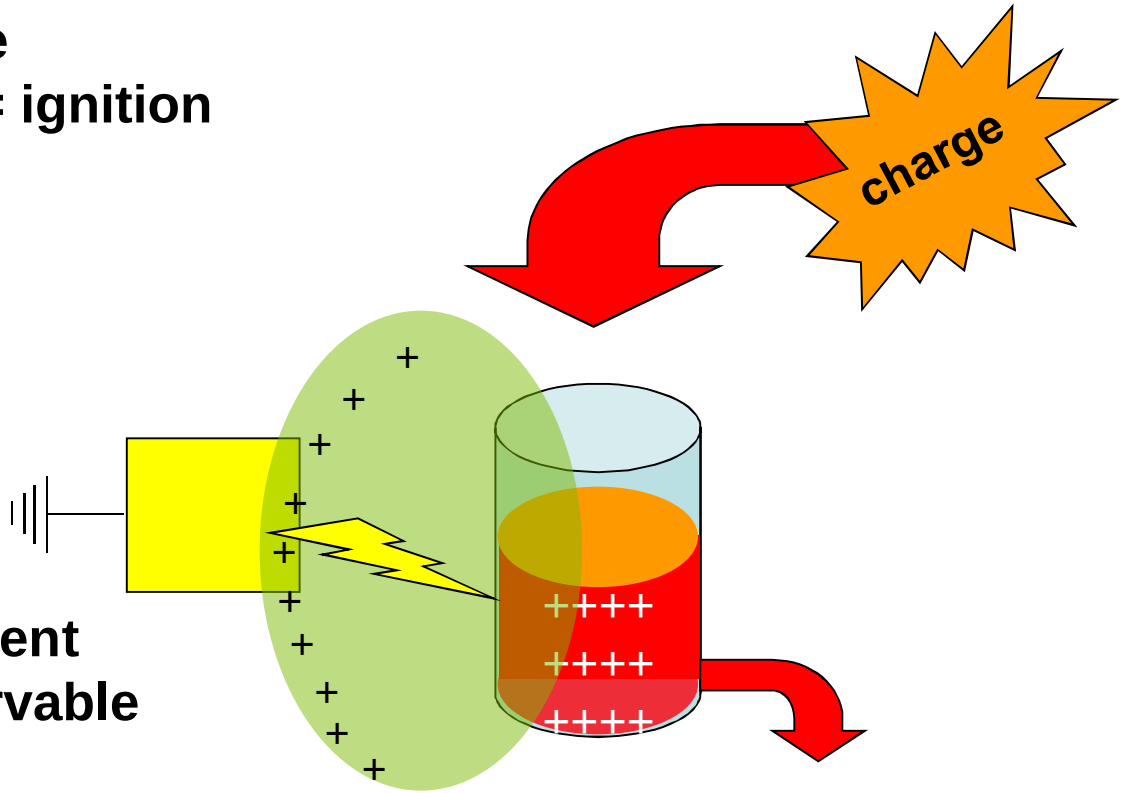
Charge flows back, energy released (eg. spark)

- can result in ignition of flammable atmosphere!
- also by humans
- even without seeing or feeling the spark!

AkzoNobel
Tomorrow's Answers Today

Electrostatic discharge - spark

- between conductors
- high potential difference
- plasma channel = heat = ignition



- up to 10.000 mJ
- 0,25 mJ is already sufficient
- up to 10 mJ hardly observable
- mostly limited to 250 mJ

AkzoNobel
Tomorrow's Answers Today

Static electricity a hazard ?

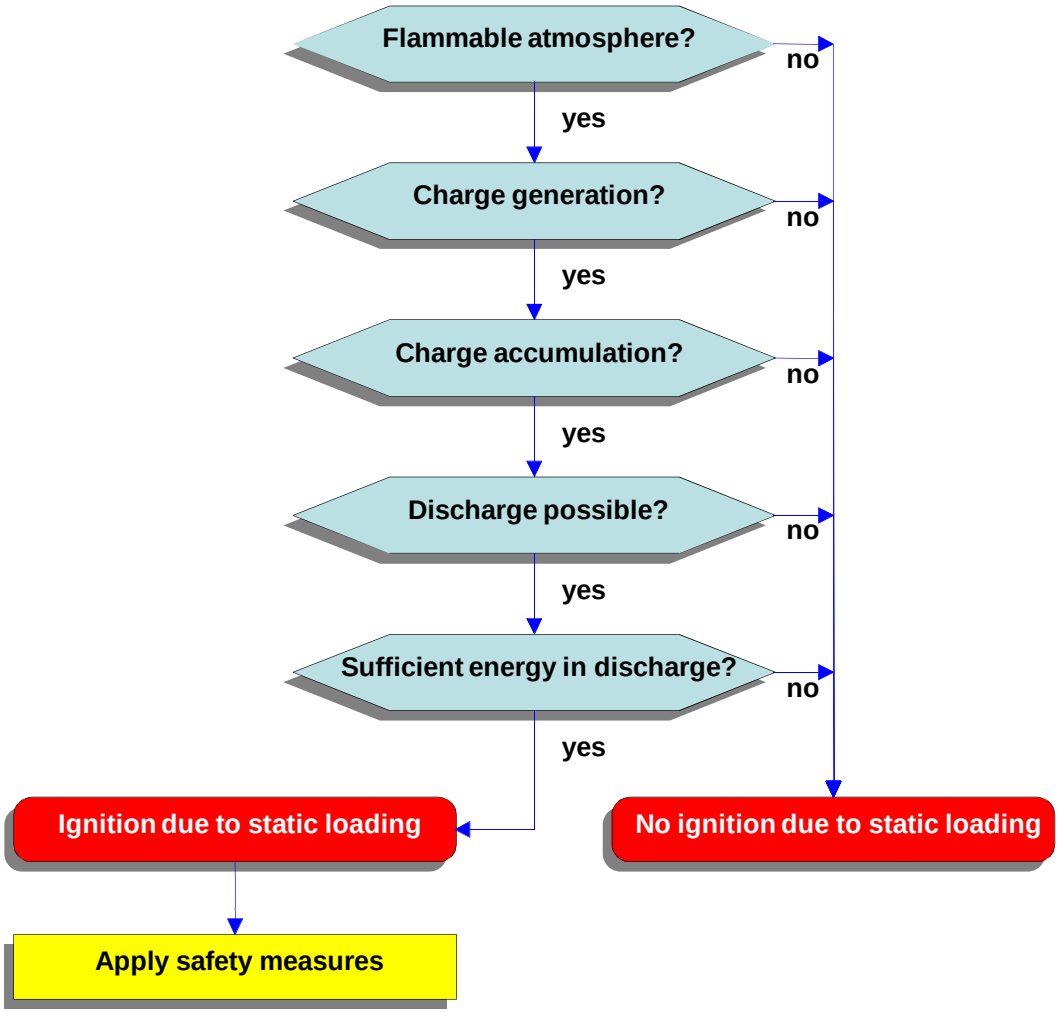
Every day an serious accident occurs in Europe due to static electricity

In England one static electricity related incident occurs per week

Often irrational feeling of being safe due to “history”!

AkzoNobel
Tomorrow's Answers Today

Flowchart Static Electricity - General



AkzoNobel
Tomorrow's Answers Today

Steps in risk control

Prevent formation of explosive atmospheres

- 1. no flammable substances
- 2. no flammable atmosphere
- 3. limit amount of flammable atmosphere
- 4. no explosive circumstances - zoning

Avoid ignition sources in explosive atmospheres

- 5. investigate possible sources and reduce probability of ignition

Protection

- 6. mitigate all possible explosion effects

AkzoNobel
Tomorrow's Answers Today

5. Reduce probability of ignition

Apply protective measures in all zones

- limit maximum surface temperature below ignition temperature of the potentially explosive atmosphere
- organizational & technical measures to prevent open fire & mechanical sparks from welding, smoking etc.
- use electrical equipment in accordance with the flammable material present and the zone
- take protective measures against hazardous electrostatic discharges

AkzoNobel
Tomorrow's Answers Today

General measures against static electricity

- Earth and bond all conductors (< $10^6\Omega$)
- Use conductive liquids and solids
- Control and reduce conditions that promote charging
  - flow velocities, humidity
- Make floors more conductive (< $10^8\Omega$)
- Be aware: Operators are sometimes part of the "problem"
  - people should wear conductive shoes (10^4 - $10^8\Omega$)
  - in sensitive cases wear anti static gloves and overall

AkzoNobel
Tomorrow's Answers Today

Phase specific measures

- Gases
  - do not allow two phase flow release in the open air
- Liquids
  - with conductivity < 1000 pS/m
    - avoid: free fall > 1 m & two phase flow & violent agitation
  - in general, do not allow mist formation
  - prevent liquid separation
- Insulated conductors: active ionizers in air blowers, relax surface charge

AkzoNobel
Tomorrow's Answers Today

Grounding

Conductive connection between isolated conductors and earth

Adequate mechanical strength

Resistance < 10 Ω

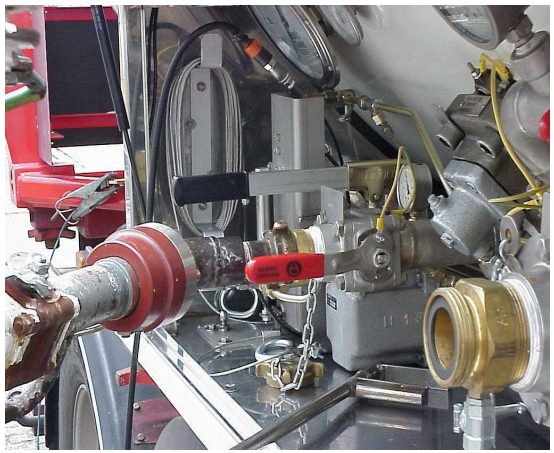
Mobile grounding recommended via crocodile clips with hard pointed teeth & resistivity check

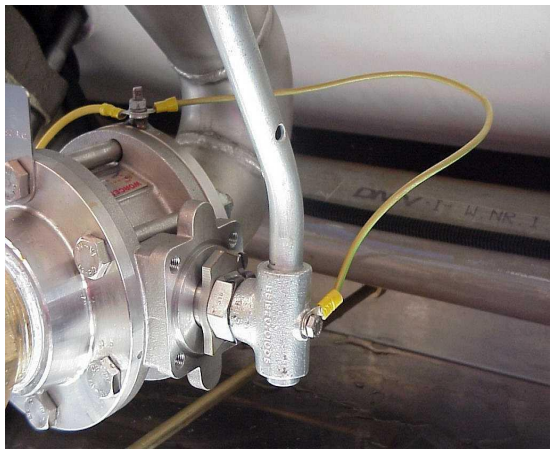
Mobile grounding is preferred above conductive floor coatings and conductive wheels

AkzoNobel
Tomorrow's Answers Today

Bonding

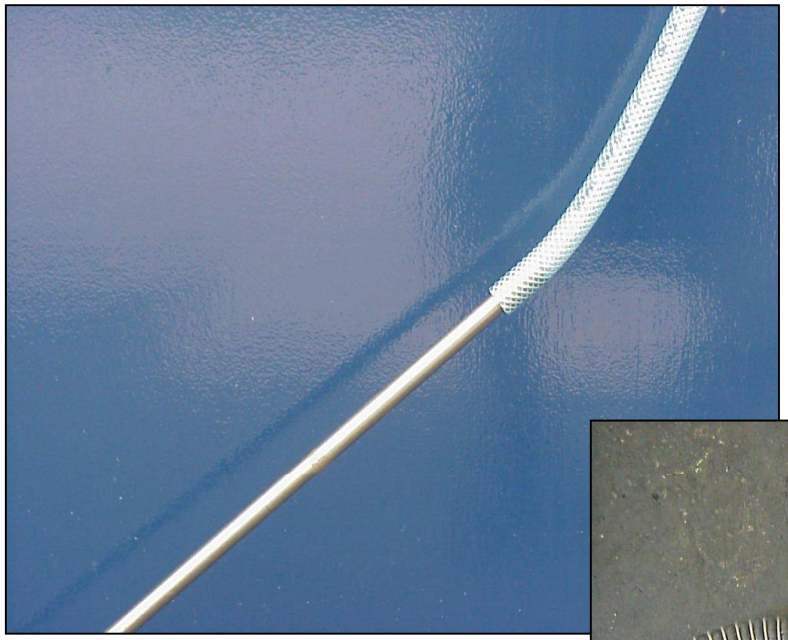
- Conductive interconnection of conductive parts of plant equipment
- Check electrical continuity across joints & flanges, if necessary bond across
- Bond the spindle of ball valves in case of insulating seat gaskets (PTFE in particular)
- Use larger bore piping after obstructions in piping to relax charge
- Flexibles should be lined or wired to enhance conductivity





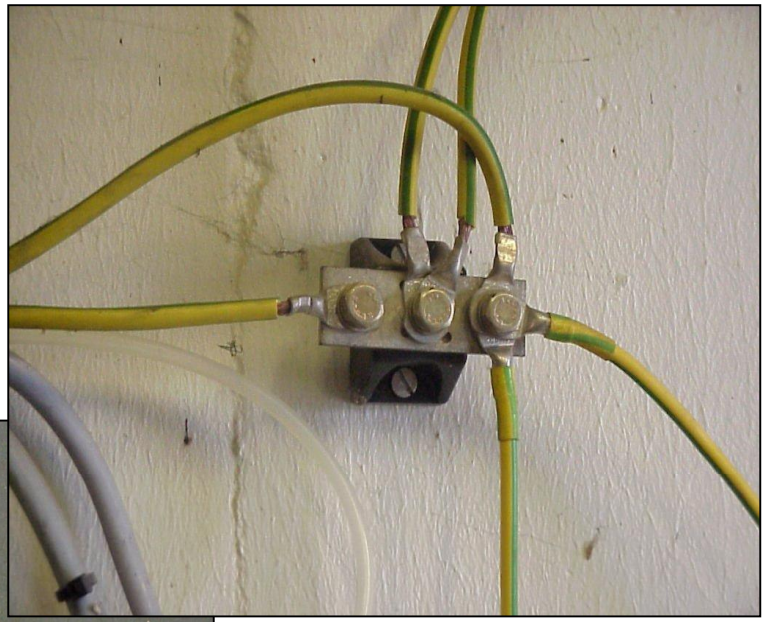
AkzoNobel
Tomorrow's Answers Today

General measures - Bonding, example



Non proper bonding

Proper bonding

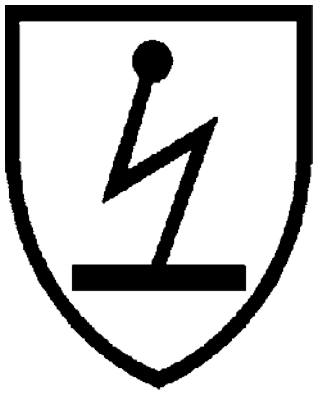


Bonding point

AkzoNobel
Tomorrow's Answers Today

Requirements shoes & clothing

- Overall, anti-static (EN1149-1)
- Antistatic (dissipative) footwear,
  $5x10^4\ \Omega$ < resistance < $10^8\ \Omega$
  - Not lower! Danger with mains voltage (5 mA at 230 V)
- Safety gloves with < $10^8\ \Omega$,
  to prevent isolation of conductors
- Do not remove clothing with flammable atmosphere in vicinity!

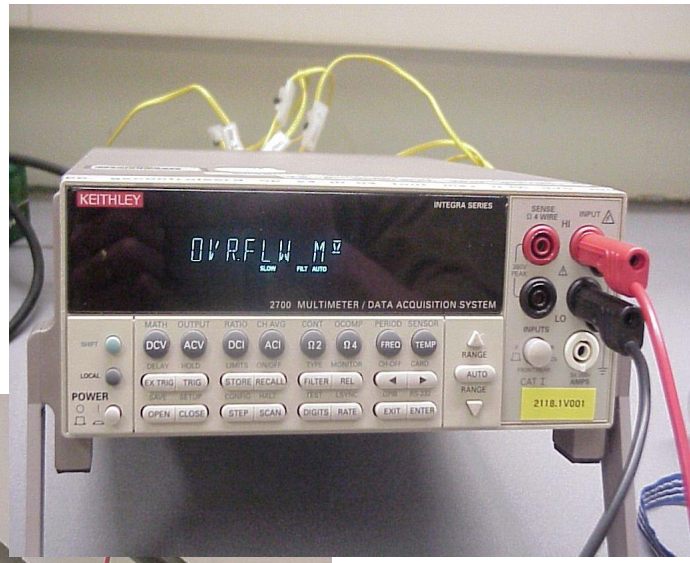


AkzoNobel
Tomorrow's Answers Today

Footwear resistance measurement

Also use of Electrometer, due to high resistance levels

Human body only contributes to minor extent to resistance level



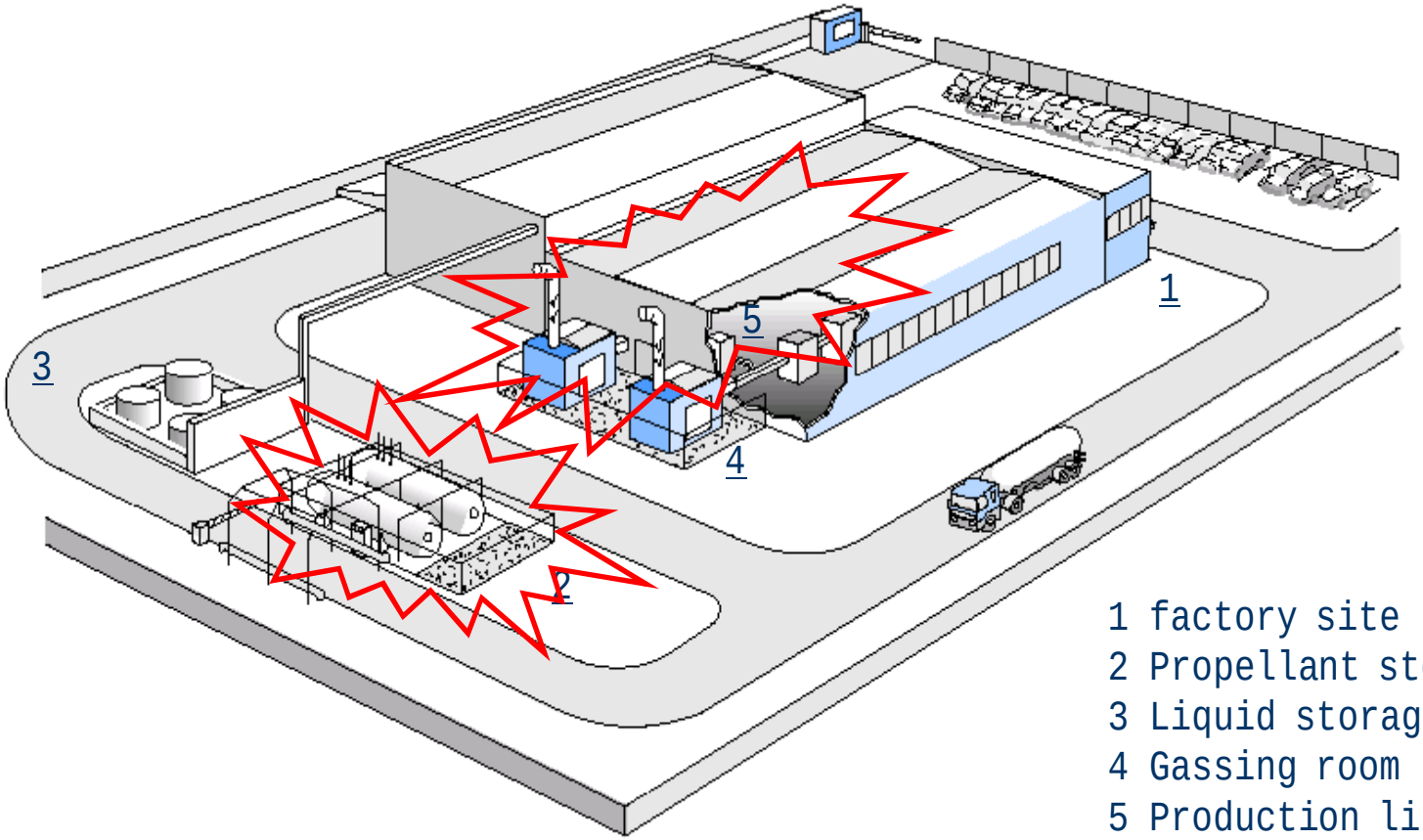
AkzoNobel
Tomorrow's Answers Today

General measures - People (shoes)

- Use of wrist or ankle straps
  - connect people to the ground (use of conductive fibers)
  - $1.10^6\ \Omega$ resistor included to prevent accumulation

AkzoNobel
Tomorrow's Answers Today

Prevention & Protection at your site



1 factory site
2 Propellant storage
3 Liquid storage
4 Gassing room
5 Production line

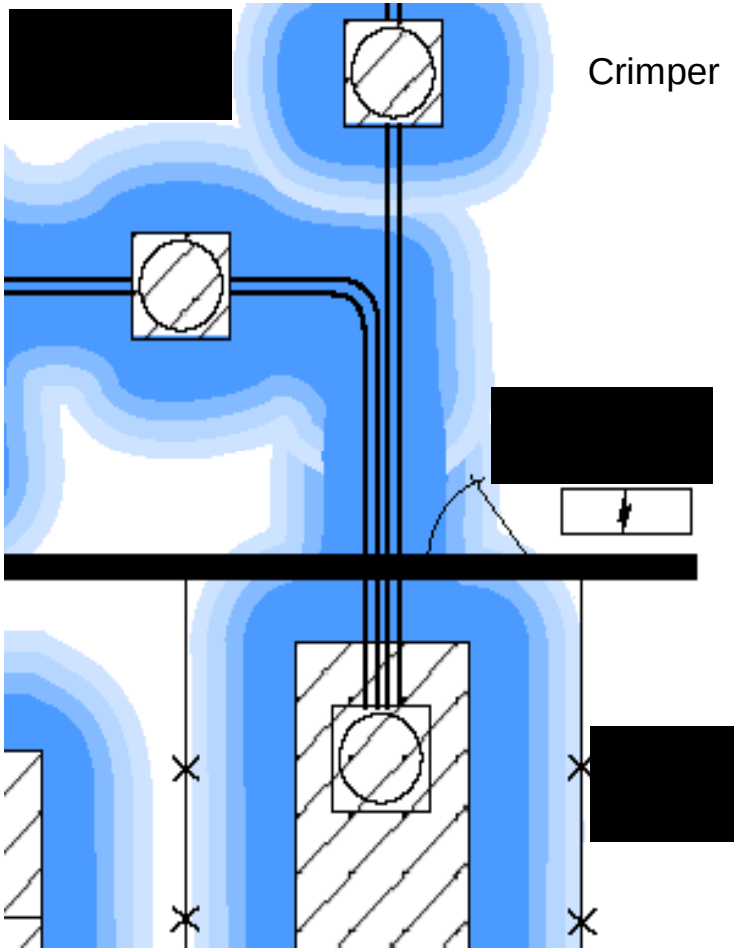
AkzoNobel
Tomorrow's Answers Today

Electrical equipment in zoned areas

Electrical installation must comply with area classification (zone), a CE mark must be present

Equipment classification in the zone to comply with safety data of the various hazardous materials

- auto-ignition temperature vs Tclass
- Ignition properties vs gas class



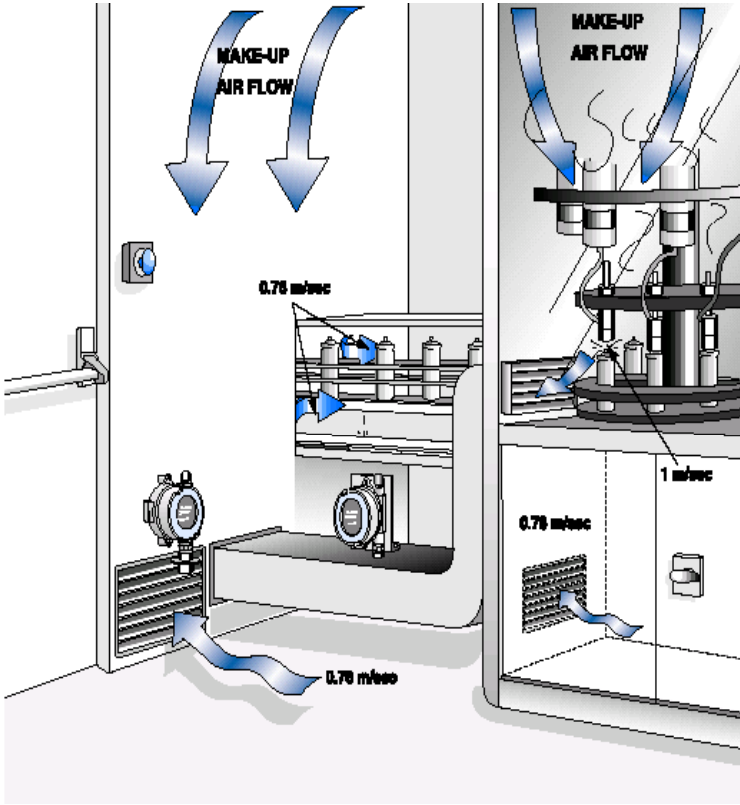
AkzoNobel
Tomorrow's Answers Today

Gas-filling room, practical implications

Gas detection

- at ventilation suction point
- one extra point of possible propellant leakage (near product filler)
- actions required
  - alarm on 20% LEL (stop filling if measured in secondary enclosure)
  - shut-down functions at 40% LEL

No permanent operator in gassing room



AkzoNobel
Tomorrow's Answers Today

Gas-filling room, practical implications

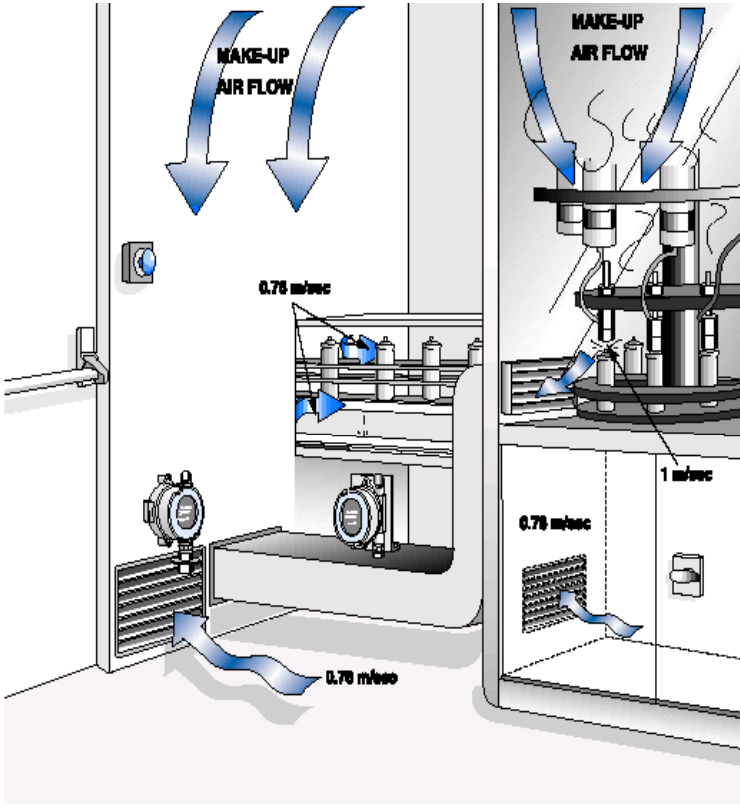
Ventilation exhaust & safety valves to exit into safe area

Antistatic conveyers, bonding/earthing

Only Explosion Proof machinery

Operators need to be trained for equipment & materials

Fire resistant & antistatic clothes, shoes



AkzoNobel
Tomorrow's Answers Today

Aerosol storage, zoning?

- Aerosol is UN package
  - However according to Dutch NPR7910, secondary source….?
- On behalf of NAV consultation with authorities
- Impact when storage facilities should be zoned not only at aerosol producers:
  - Distribution centre, traders, retail
- In Holland and UK:
  - Aerosol storage considered as “non dangerous area”
  - However, guidelines in place to ensure “safe use of storage”

AkzoNobel
Tomorrow's Answers Today

Conclusions

- Aerosol filling will be vulnerable to static electricity
  - Flammable materials
  - High speed (propellants)
  - Different phases (liquid, gas, powder)
  - Insulation materials (lacquers, valves, belt etc)

- However, aerosols can be produced safely
  - Proper measures to avoid build-up of static electricity
  - Earthing, bonding, conductive materials
  - Avoid dangerous combinations like:
    - PET coated valves with anti-perspirants

AkzoNobel
Tomorrow's Answers Today

Questions left