The Investigation of Domestic Gas Explosions

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SEVEN SISTERS: JUNE 2020

Part Number: 8803

Propane Low Pressure Regulator - 4 kg/hr

Propane single stage regulator 37 mbar, POL x 3/8" BSP F

Capacity: 4 kg/hr (187 500 Btu/hr)

To EN 16129.

Bulk Discounts Available

QTY	Price per pack	Saving
100+	£11.47 Incl. VAT	10%

QTY 1 **£12.76** Incl. VAT

Add to Basket

Part Number: 22987

Propane Low Pressure Regulator - 4 kg/hr

OPSO (Single Stage) POL x 1/2" BSP TF propane low pressure regulator.

700E cylinder regulator with user resettable OPSO.

Capacity: 4 kg/h (187,500 Btu/h)

QTY 1 **£54.01** Incl. VAT

Add to Basket

You May Like

Fulham Gas Hose Nozzle -

HEYSHAM: MAY 2021


AYR: OCTOBER 2021
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BIRMINGHAM: JUNE 2022

CROYDON: AUGUST 2022

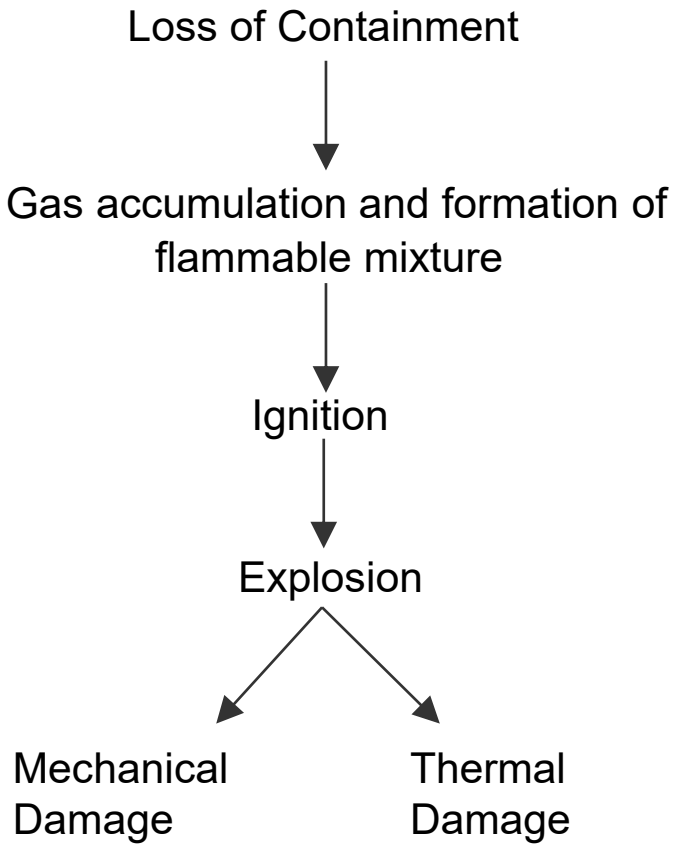

BERKSHIRE
WAY

The Investigation

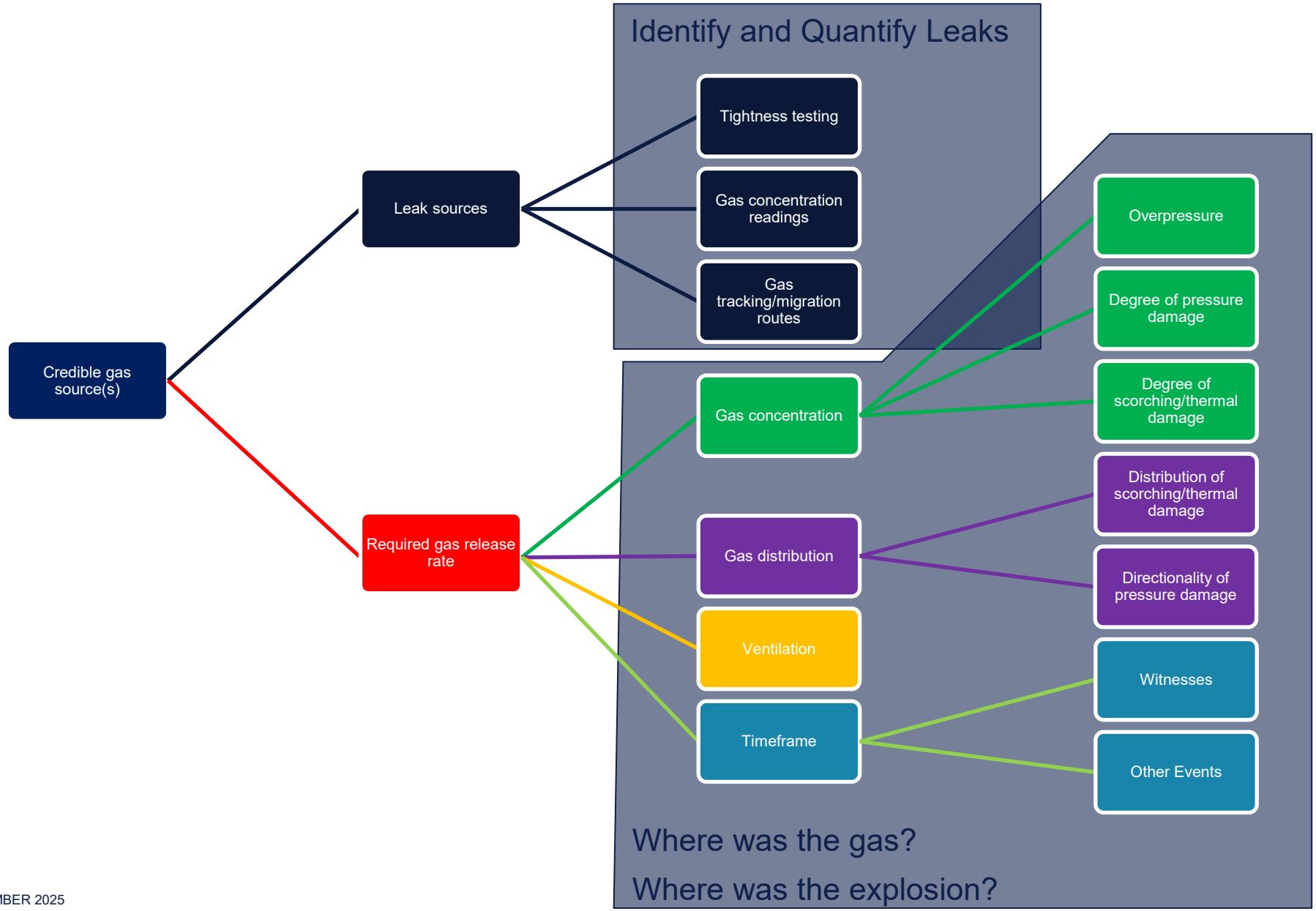
Investigation Objectives

- Main objectives
  - Type of explosion
  - Type of gas
  - Source of gas
  - Reason for the release and accumulation
- Ancillary information
  - Concentration and distribution of gas
  - Pressure generated/distribution of damage
  - Source of ignition

Stages of a Gas Explosion



Gas Explosion Investigation



Where was the explosion?
Where was the gas?

Evidence Collection

- Did physical damage occur:
  - Before the incident
  - During the incident
    - Structural damage – pressure
    - Damage from flying debris
    - Damage from structural collapse
    - Fire damage
    - Fire fighting/rescue
  - After the incident
    - Make safe activities
- May be addressed by:
  - Records of on-site activities
  - Subsequent laboratory examination

Types of Explosions

- Type of explosion
  - Gas/vapour
  - Solid state
  - Backdraft during fire
- Type of gas/vapour explosions
  - Distributed natural gas
  - LPG – propane & butane
  - Distributed LPG/air.
  - Aerosol canisters
  - Flammable liquids - petrol, paint thinners, paraffin
  - Biogenic methane and mines gas
  - Manufactured gases
  - Potentially hydrogen

Vented Explosion – Minor Damage

Vented Explosion - Structural Failure

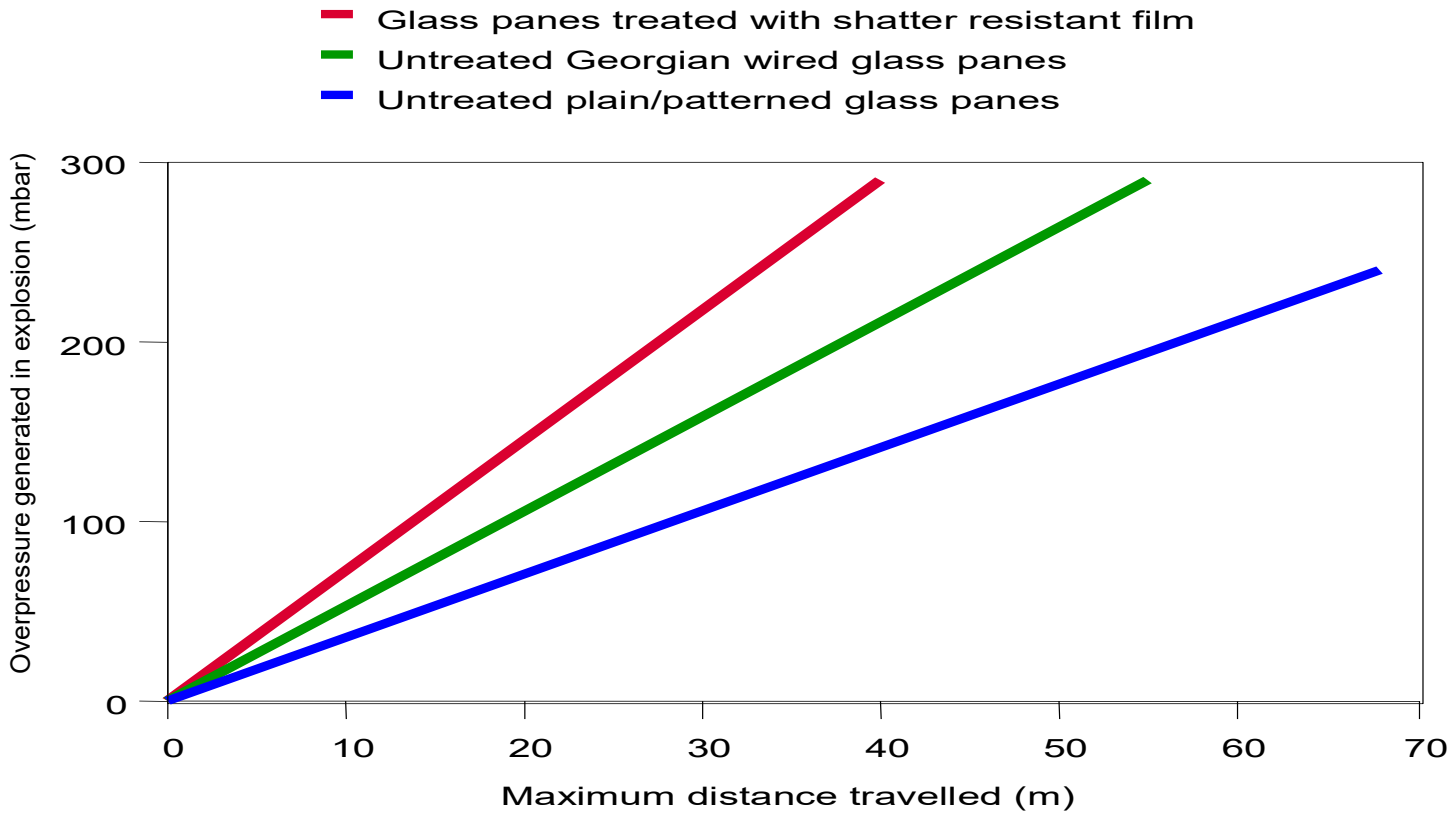
•Building components fail at pressures measure in 10’s or 100’s of mbar

Gas explosion – created by DNV for TV programme

Window Failure

- Weakest elements fail first – usually windows
- Estimation of pressure generated for single glazed windows from:
  - Size of window panes broken
  - Travel of broken glass
- Sealed unit double glazing
  - Window panels generally strong
  - Fixings of window frame to wall likely to fail before the glazing.

Window Breakage - distance of travel of glass

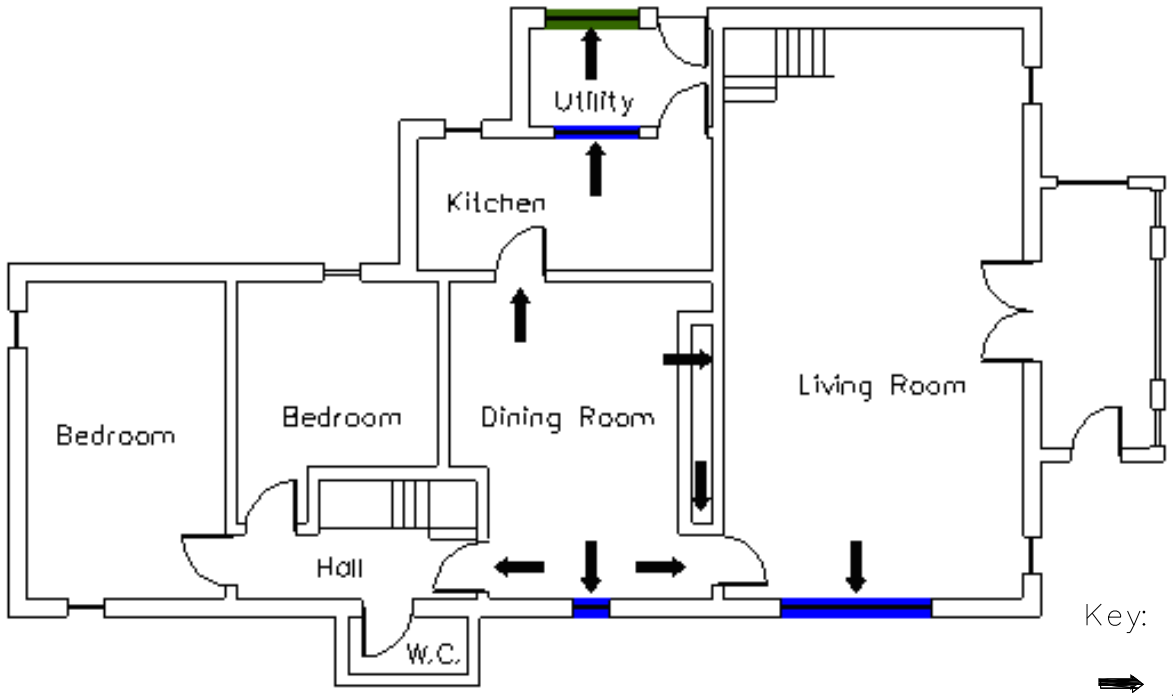


Failure of Structural Components

Building Element	Typical Failure Pressure (mbar)
Glass Windows	20-70
Room doors	20-30
Light Partition Walls (e.g. plasterboard on wooden studding)	20-50
50 mm thick block walls	40-50
Unrestrained Brick Walls	70-150

Pressure Vectors

Ground Floor



Key:

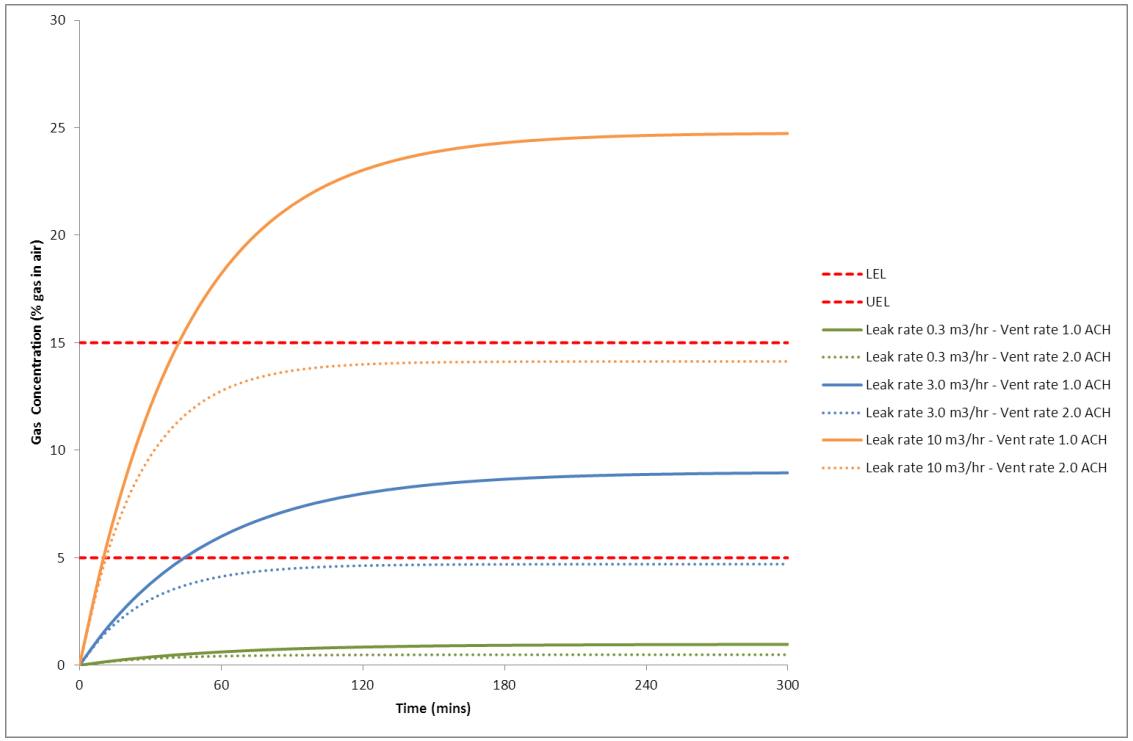
- Apparent pressure effects
- Window failure
- Impact damage on glazing

Accumulation

- Accumulation in enclosed spaces determined by volume of enclosed space, buoyancy of gas, gas ingress rate, air change rate and time since release
- Generally:
  - Buoyant gases accumulate above the release point, mixing into the layer according to:

$$C = \left(\frac{100 Q_g}{Q_a + Q_g} \right) \left\{ 1 - \exp\left[-\left(Q_a + Q_g \right) t / V \right] \right\}$$

  - At higher concentrations, buoyancy driven ventilation becomes dominant – more advanced modelling required



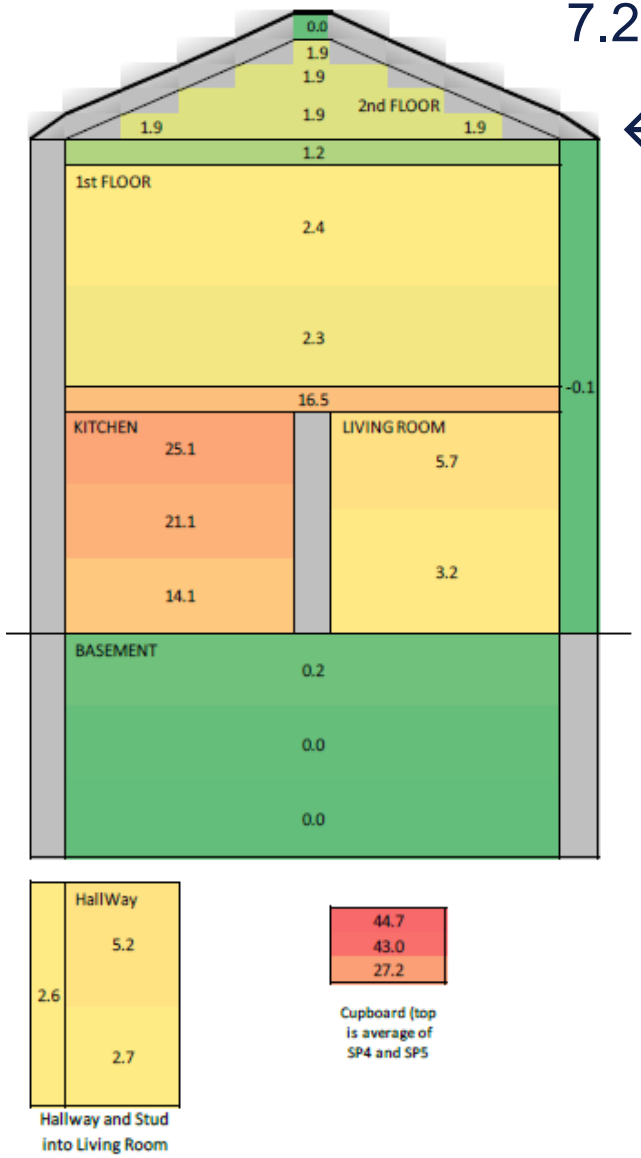
But…..real buildings, buoyancy and diffusion de-simplify it!

Accumulation in Practice

7.2 mm hole, 20 mbar

← Methane

8
m3/hr



Thermal Damage

Before Explosion

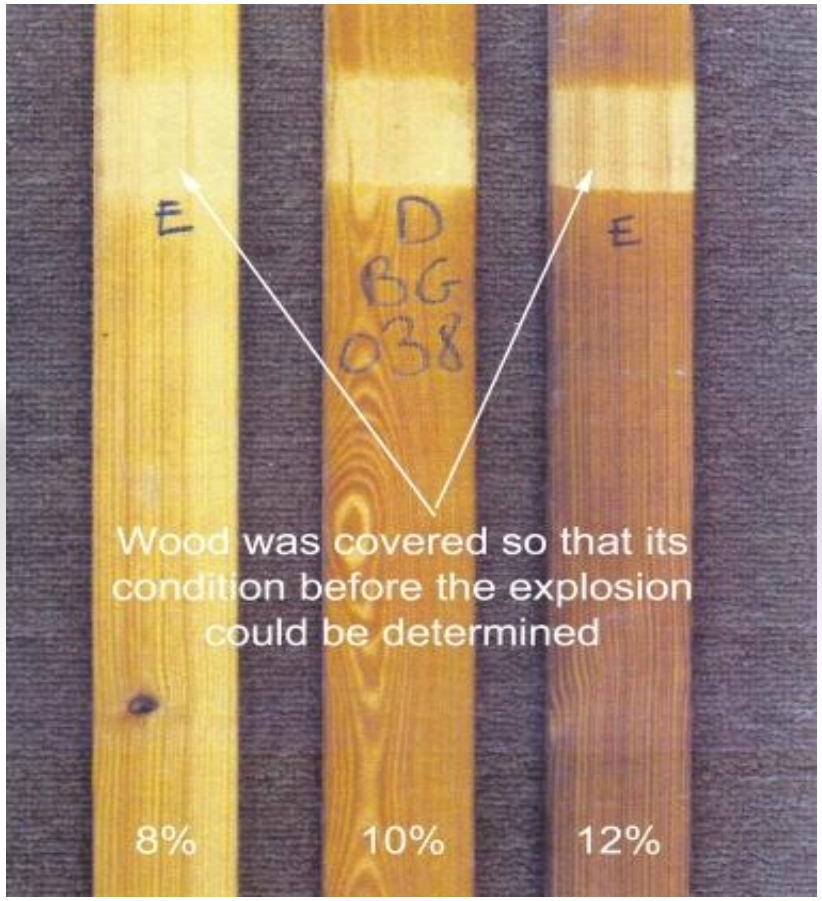
During Explosion

After Explosion

Scorching

- Flame/heat damage consistent with the passage of a transient flame front
  - Not smoke/soot
  - Not fire damage/burning
- Discolouration of gloss paint
- Melting of plastic
- Charring of surfaces of cotton / paper

Thermal damage & the Effect of Initial Mixture Composition



Natural gas concentration (% gas in air)

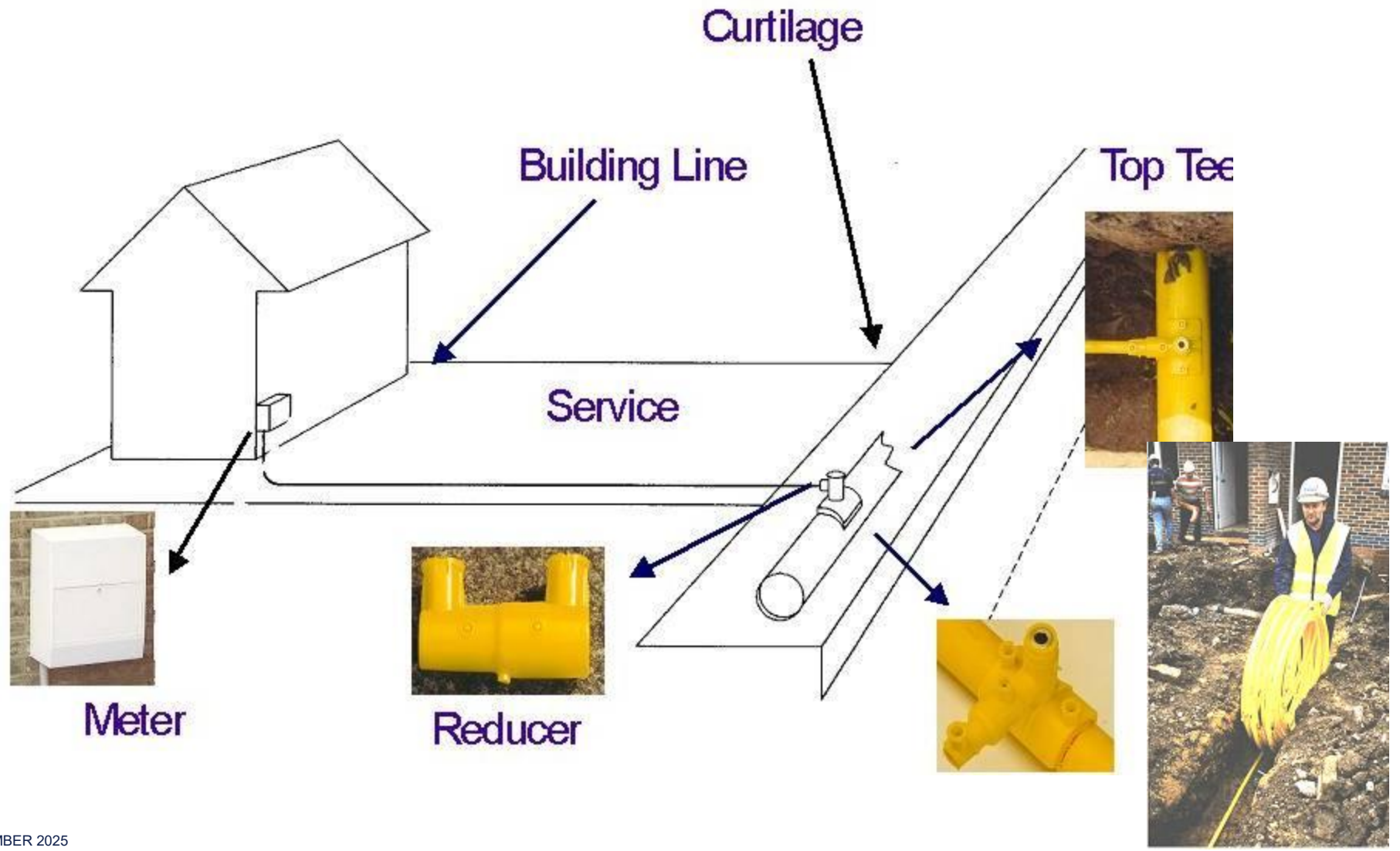
- The severity of thermal damage increases with gas concentration over the range (8% – 12%).
- However, a few additional tests were conducted at concentrations of 6% and 13%. No scorching was evident on most of the test samples at 6%, and the damage at 13% natural gas was slightly less than that observed at 12%.
- By observing the severity of the thermal damage, it was possible to estimate the natural gas concentration prior to ignition to the nearest 2%, over the concentration range 6% to 12%.

Identifying and Quantifying Leaks

UK Transmission & Distribution System

- Transmission Pipelines
  - Above 7barg
- Distribution mains
  - IP 2 to 7 barg
    - **Steel, PE**
  - MP 75mbarg to 2 barg
    - **PE, CI, DI, steel**
  - LP up to 75 mbarg
    - **PE, CI, DI, steel**
    - **Asbestos cement, copper, lead, wood, PVC**

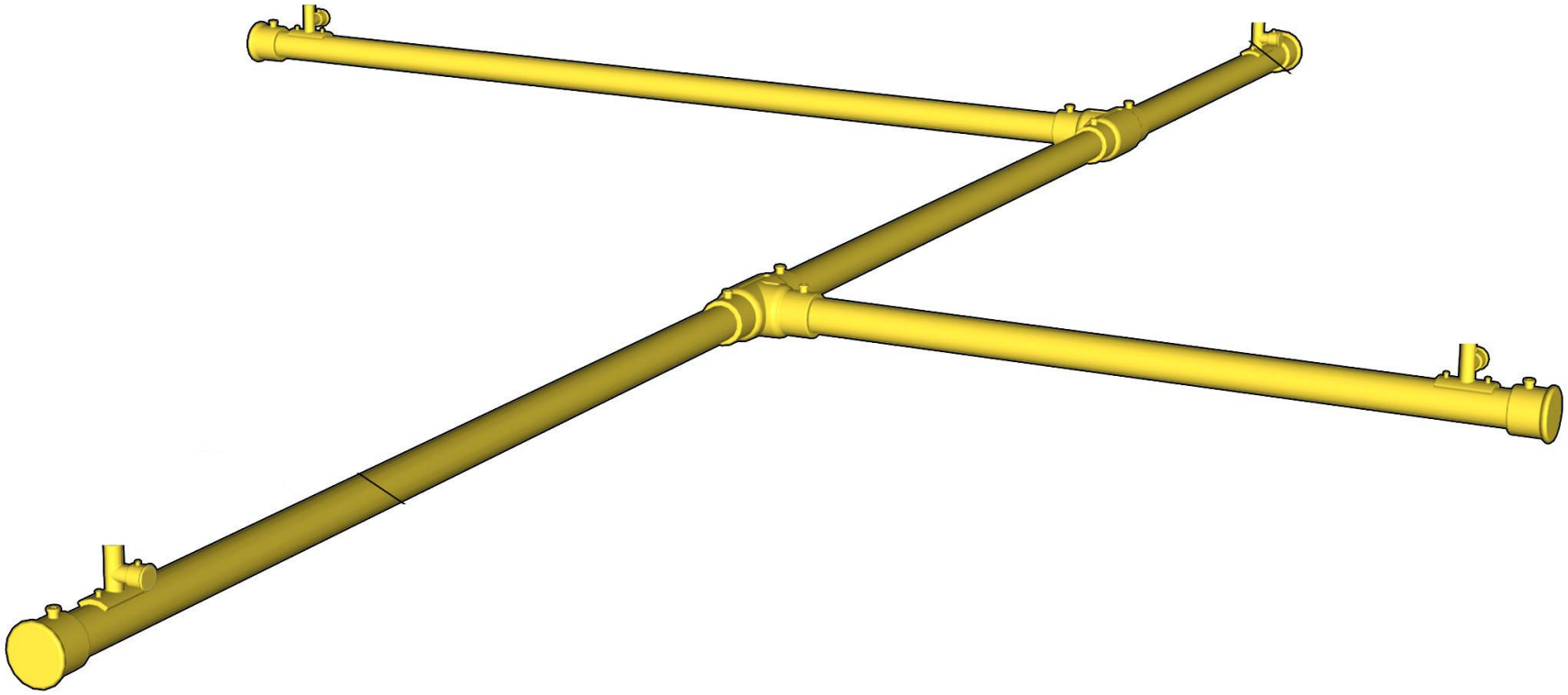
Gas Service



Tightness Testing

- Pressurise pipe work etc. to WORKING pressure
  - Isolate system
  - Monitor rate of pressure loss
- Working pressure
  - Downstream of meter = 20 to 22 mbarg
  - Mains generally 25 to 50 mbarg
- No Loss of Pressure = Gastight
- Check continuity
- Small loss of pressure = Small release
- Unable to pressurise = Significant escape

Check Continuity



Tightness Testing – Leak Detection Fluid

Barhole Testing

Measured release rates

Gas Releases into soil

- Rate of gas release into soil is function of
  - Size of hole
  - Pressure in pipe
  - Density of gas
  - Permeability of soil
- Experimental work indicated that flow into soil could be up to 50% flow into air.
  - Release into void
  - Sandy soil, porous soil
- Clay could be essentially 0%

Migration Routes

- General through ground migration
  - Soil permeability
  - Sealed surface
- Tracking routes
  - Under ground ducts/pipes
  - Sewers
  - Along line of services
- Buildings are not gastight underground
  - Myriad cracks in brickwork
  - Obvious holes
  - Around service entries

Odorant

- Distributed natural gas has stenching agent added
  - Blend of tertiary-butyl mercaptan (TBM) and di-methyl sulphide (DMS)
- LPG has stenching agent added
  - Ethyl mercaptan

- Stenching agent added at concentrations to ensure flammable gas in air can be detected at concentrations well below LEL

- Odorant can be removed by transport through the soil
  - Adsorption
  - Oxidation

- Odorant might not be detected by occupants
  - Individuals response to odorant
  - Nasal fatigue – particularly overnight whilst asleep
  - Masking

Notes on Causes of Leaks

- Outside of the property:
  - Corrosion
  - Workmanship
  - Interference
  - Loading (traffic, ground movement)
- Inside the property:
  - Workmanship
  - Interference
  - Deliberate acts
    - Attempts at suicide
    - By-pass attempts
    - Theft of pipework

Often requires laboratory examination to confirm cause of a leak

Sometimes supporting specialists (e.g. Civil Engineers) are required

Ignition

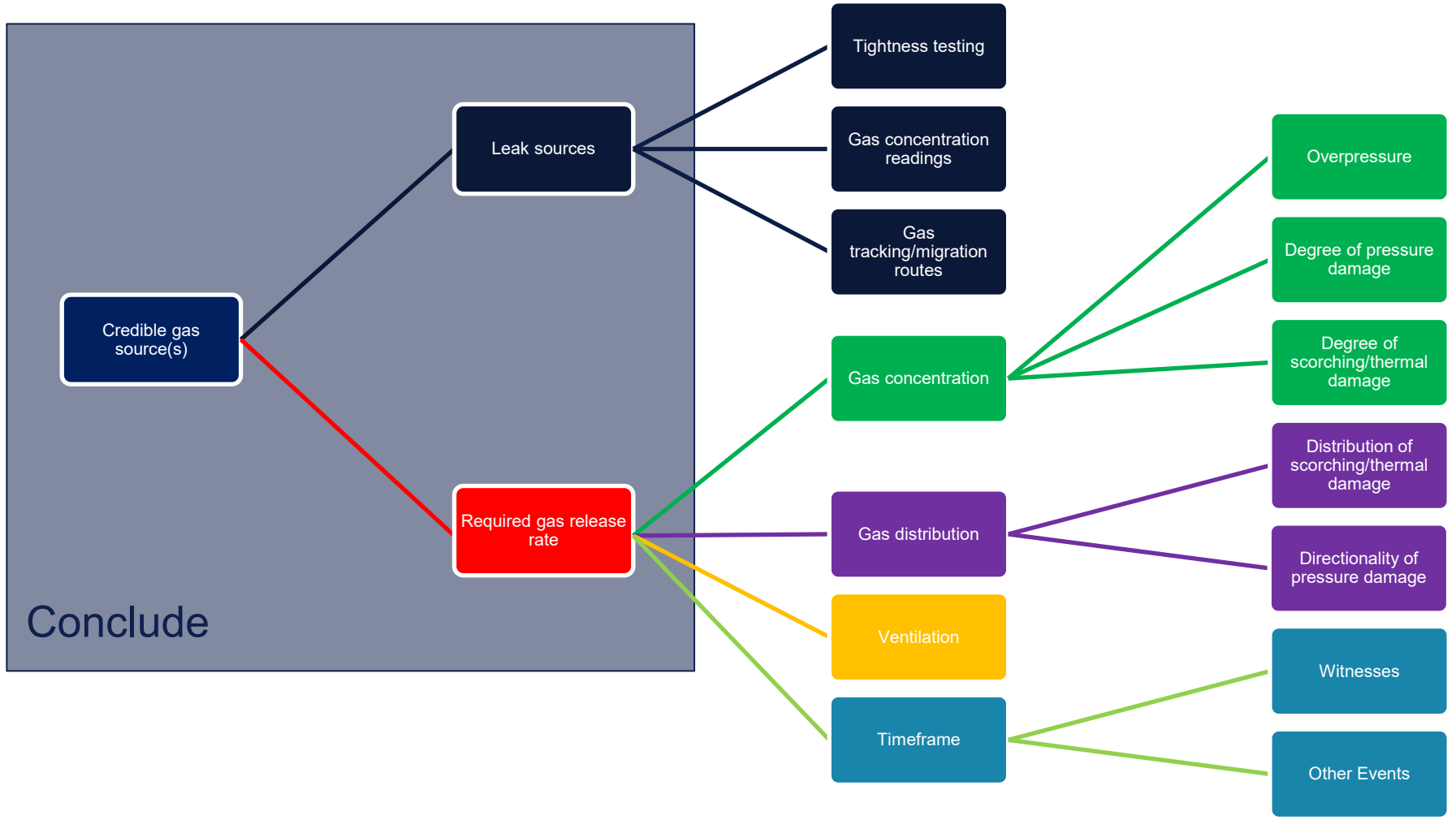
Ignition sources for gas explosion investigation

Likely	Other	Not Credible

• Electrical switches
  • Automatic/manual
  • On/ Off
• Naked flames
	• Static electricity
	• Hot surface ignition
	• Mechanical sparks
		• Telephones
		• Mobile phones
		• Cigarettes

Check Leak Sources against Evidence

Test Leak Sources against Explosion Evidence



Questions?

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