

ID 117: Evidence Base Utilised to Justify a Hydrogen Blend Gas Network Safety Case

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Gas Safety (Management) Regulations

- GS(M)R governs gas quality in the UK gas grid
- **Current specification limits hydrogen to 0.1 mol%**
- The HSE can grant an exemption if a demonstration can be made of **no increase in risk** to those affected

SCHEDULE 3		Regulation 8
CONTENT AND OTHER CHARACTERISTICS OF GAS		
PART I		
REQUIREMENTS UNDER NORMAL CONDITIONS		
1. The content and characteristics of the gas shall be in accordance with the values specified in the following table.		
Content or characteristic	Value	
hydrogen sulphide content	$\leq 5 \text{ mg/m}^3$;	
total sulphur content (including H_2S)	$\leq 50 \text{ mg/m}^3$;	
hydrogen content	$\leq 0.1\%$ (molar);	
oxygen content	$\leq 0.2\%$ (molar);	
impurities	shall not contain solid or liquid material which may interfere with the integrity or operation of pipes or any gas appliance (within the meaning of regulation 2(1) of the 1994 Regulations) which a consumer could reasonably be expected to operate;	
hydrocarbon dewpoint and water dewpoint	shall be at such levels that they do not interfere with the integrity or operation of pipes or any gas appliance (within the meaning of regulation 2(1) of the 1994 Regulations) which a consumer could reasonably be expected to operate;	
WN	(i) $\leq 51.41 \text{ MJ/m}^3$, and (ii) $\geq 47.20 \text{ MJ/m}^3$;	
ICF	≤ 0.48	
SI	≤ 0.60	

Public Demonstration

- Live demonstration proposed of hydrogen blending on a public gas network
- 668 homes
- Church, school and corner shop



Risk Assessment Methodology

- Quantitative Risk Assessment (QRA) based on two fault trees:
 - CO fault tree
 - Fire and explosion fault tree
- Risk measured by individual frequency of fatality
- Model validated at GB scale, then regional risks for natural gas and hydrogen blends calculated and compared

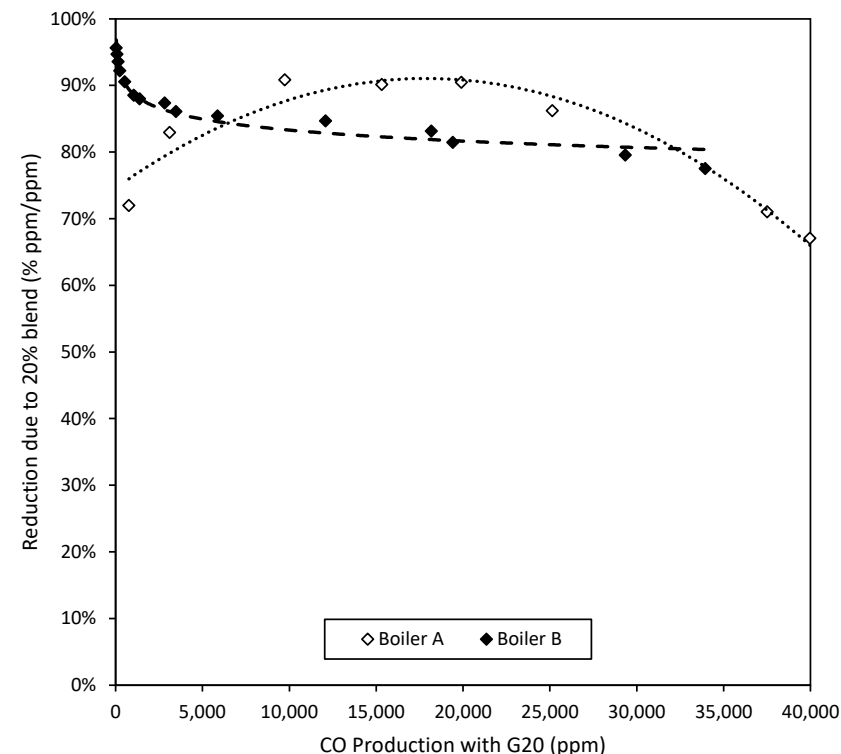


Appliance Performance

- Appliance performance was studied in relation to two variables:
 - Design:** Test programme designed to be representative across the UK domestic appliance population
 - Condition:** Test programme designed to give representative results for all possible appliance conditions

Across all baseline conditions (well operating to dangerous) a hydrogen blend reduced CO hazard

No safety or performance issues identified for all natural gas appliances (1976 – present)



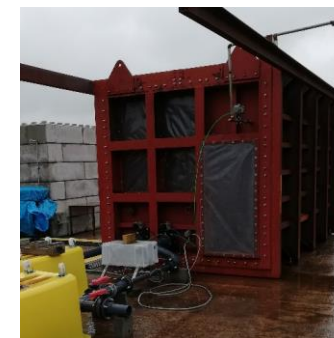
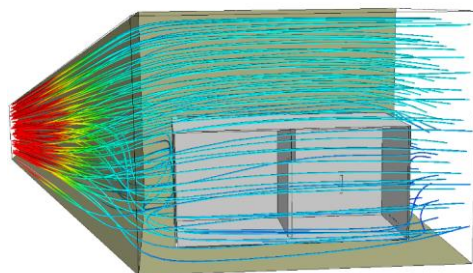
100% CH₄



28% H₂ / 72% CH₄

Gas Characteristics

Full hazard chain studied to understand the impact of a hydrogen blend at each stage:



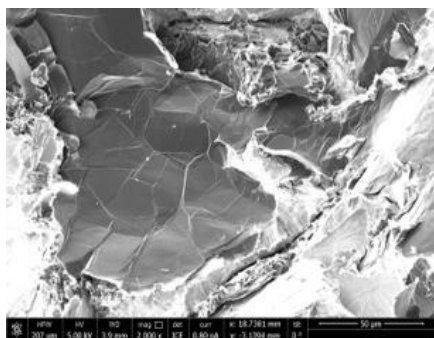
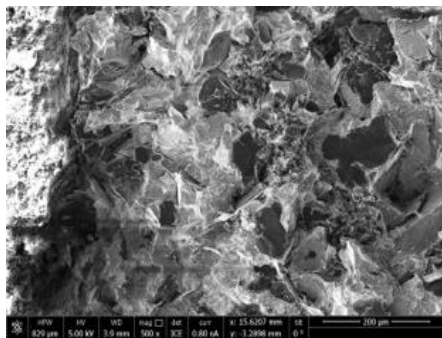
- Leakage analysis (modelling and experimentation) undertaken to assess real world behaviour
- **No change in gas cloud concentration or size due to a 20% hydrogen blend**

- Explosions modelled and measured using bespoke experimental container
- **No change in pressure impulse, however increase in overpressure in line with modelling expectation**

Materials

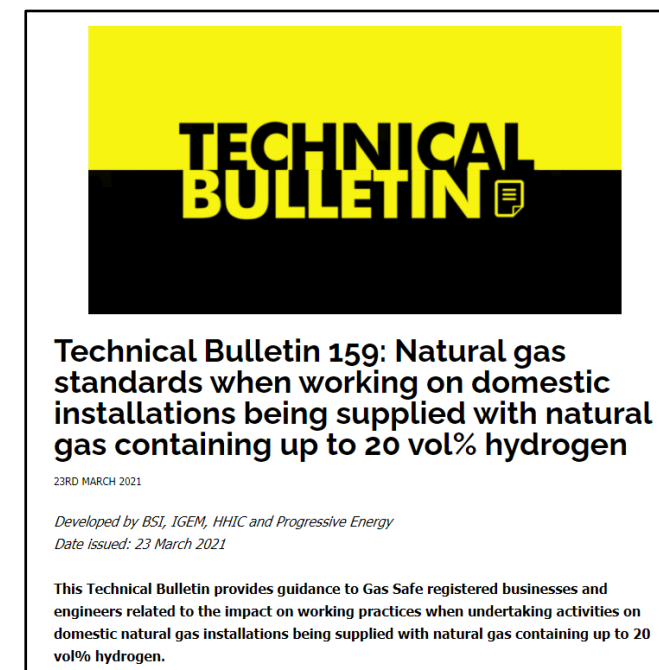
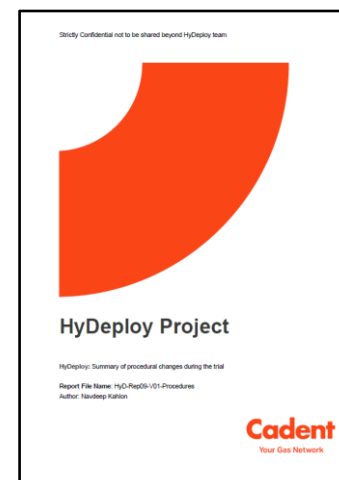


- **All common materials** tested (steels, irons, aluminum, brass, plastics, etc)
- Testing comprised of soaking material samples at **8 bar 100% hydrogen over a number of weeks** to saturate materials with hydrogen
- **Mechanical integrity testing** then performed and fracture surfaces inspected for evidence of hydrogen effects
- **No mechanical integrity issues identified across all materials**, indicating general suitability for a 20% hydrogen blend



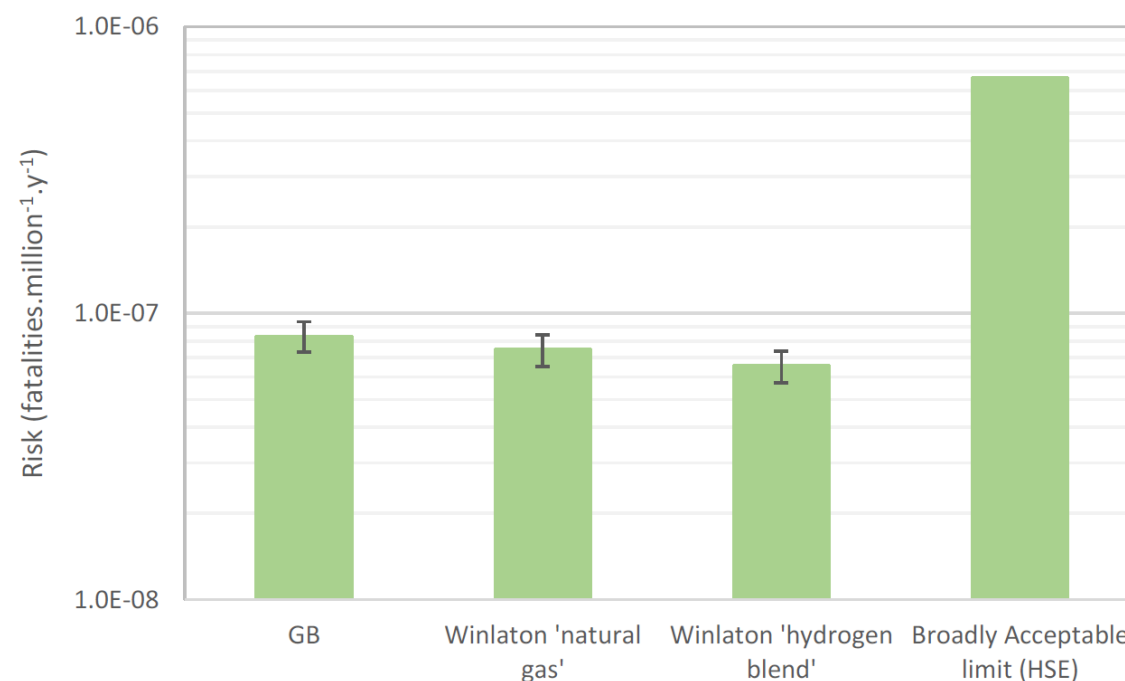
Procedures

- **Network procedures:** All impacted procedures reviewed, with supplementary protocols established, leading to a training package for network operators
- **Gas Safe procedures:** All domestic procedures reviewed and signed off by IGEM and BSI as not requiring any changes – no additional training required for Gas Safe engineers

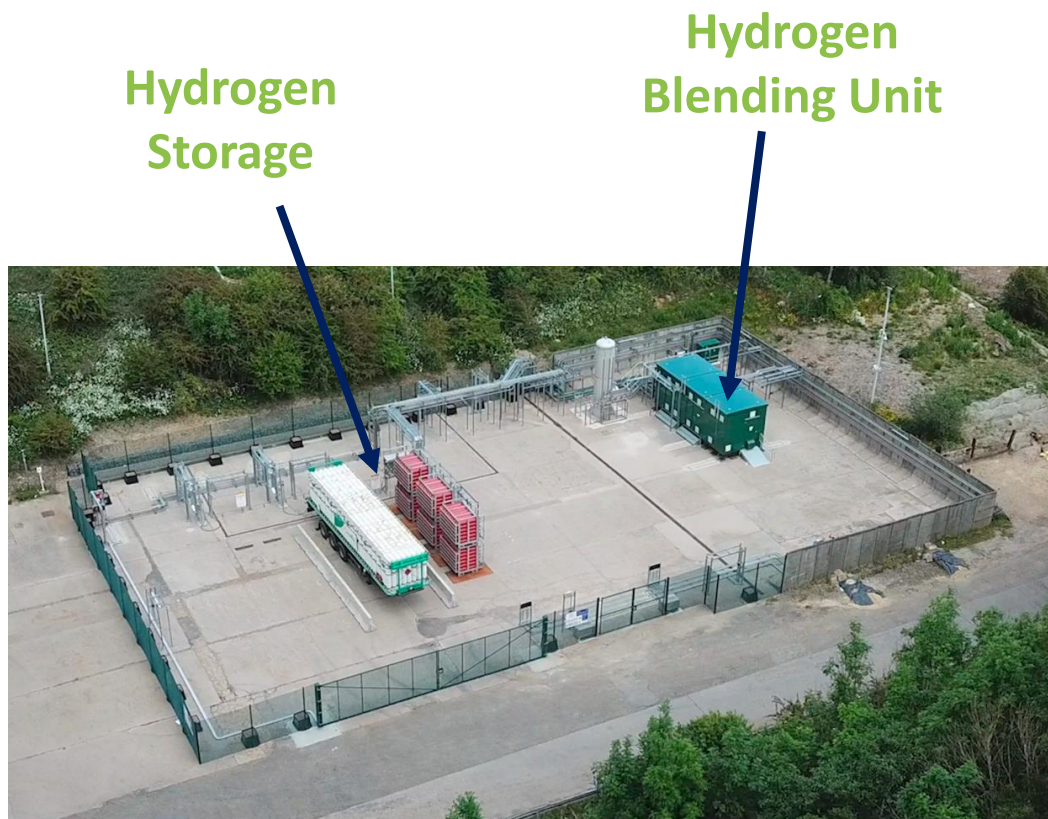


Risk Assessment Results

- **Absolute risk:** Natural gas and hydrogen blend risks found to be an order of magnitude below the HSE Broadly Acceptable limit
- **Relative risk:** Blending hydrogen at 20 mol% found to reduce individual risk by 15% compared to natural gas



Live Demonstration



- Live operations started 4th August 2021
- First use of hydrogen blends in a public UK gas network since 1976
- **No operational, network integrity or appliance performance issues identified to date**

Project Consortium

CadentNorthern
Gas NetworksPROGRESSIVE
ENERGYHSEKeele
UNIVERSITYITM POWER
Energy Storage | Clean Fuel

Funding

ofgemRIIO NIC
NETWORK INNOVATION
COMPETITION

Contributors

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