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
Public Demonstration

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

Winlaton, Gateshead
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:
  1. **Design**: Test programme designed to be representative across the UK domestic appliance population
  2. **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)
Gas Characteristics

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

- **Mechanical failure**
- **Leak occurs**
- **Gas accumulates**
- **Flammable atmosphere**
- **Ignition**
- **Fire/explosion**

- 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 4\textsuperscript{th} 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