

WORK PACKAGE 7

Annex:

To Site Specific Safety Case for Hydrogen Community Demonstration





**Annex to Site Specific Safety Case for Hydrogen
Community Demonstration – downstream of the ECV**

Site Specific Safety Case to be submitted by GDNO

5th May 2021, Final Version 1

PART I

Purpose

This annex has been prepared to support Site Specific Safety Cases (S3C) for hydrogen gas community demonstrations, based on work undertaken by the Hy4Heat programme.

It covers a collection of recommended risk reduction measures for application downstream of the Emergency Control Valve (ECV) and inside the consumers' home or premises associated with such community trials. The measures are proposed for use in initial community demonstrations in order to ensure that the risk should be no greater than those currently experienced by consumers, passing members of the public, and those working on domestic natural gas installations and networks.

The safety risk assessment evidence can be found in the following reports which are published on the hy4heat.info website

- Hy4Heat Safety Assessment Precis
- Hy4Heat Safety Assessment Conclusions Report incorporating Quantitative Risk Assessment
- Gas Escape Magnitude and Frequency Assessment
- Gas Dispersion Experimental Data Analysis & Modelling Assessment
- Consequence of Gas Ignition Data Analysis & Modelling Assessment
- Experimental Testing Reports

The duty holder's Site-Specific Safety Case for the neighbourhood demonstration shall detail any additional risk reduction measures or modifications to these recommendations (with supporting evidence) that may relate to the circumstances of that particular location.

Regulations

The Gas Safety (Management) Regulations (GSMR) shall be used as the overarching guide for hydrogen community trials and provide a suitable framework for dutyholders to develop their Site-Specific Safety Case. However, GSMR does not apply to 100% hydrogen gas networks and cannot be used by HSE to regulate the operators of the community trials. The trials are subject to the Health and Safety at Work Act 1974, the Pipelines Safety Regulations 1996 and the Management of Health and Safety at Work Regulations 1999. As such, the dutyholders are required, as part of their safety management system, to design, produce and follow appropriate site specific and operational risk assessments, so that people are protected against the specific hazards that they have identified. Additionally, the following regulations shall also be used as guides:

- Gas Appliances Regulations – Certification of gas appliances
- Gas Safety (Installation & Use) Regulations - HSE and Gas Safe

Content

The content of this Annex follows the particulars to be included in a safety case of a person conveying gas, as set out in the HSE document 'A Guide to the Gas Safety (Management) Regulations 1996, Schedule 1'. This Annex provides input on those particulars which are relevant to the domestic and 'light' commercial gas systems downstream of the emergency control valve (ECV). For reference purposes it is noted that current deaths from natural gas incidents are less than one per year and injuries are about 20 per year in the UK (GSMR downstream data).

PART II

Particulars to be incorporated into Site Specific Safety Case (S3C) for a hydrogen community trial

General

Description of operation

The Hy4Heat analysis to date has focussed on standard common U.K. building types. A community trial relying on the evidence gathered in this assessment should be confined to the gas properties/operating conditions, pipeline configuration and building layout/typology which the evidence supports, namely:

- Properties that are masonry-built terraced, semi-detached or detached homes of normal types (*whilst the QRA has been conducted for a 'two up, two down' terraced house, the principles can be assumed to be extendable to encompass the additional properties listed*)
- Properties that are compliant (*or made to be compliant*) with current Building Regulations (versions specified below) regarding ventilation and installation of appliances. Minimum levels of permanent ventilation required are detailed later in this document
- Commercial properties, where buildings are similar to domestic, providing the total gas usage (i.e. total usage of all appliances including those used as part of the business) does not exceed 100kW
- Properties that are up to two storeys; but may include for example a basement/cellar and/or a loft conversion
- Properties fed by service pipes with maximum operating pressures of 75mbarg

The Hy4Heat assessment did not include the following building types and so these should not be included in community trials until further risk assessment work has been undertaken:

- Industrial facilities
- Commercial properties with gas usage significantly greater than domestic environment, i.e. installed gas usage greater than 100kW (e.g. sports facility with a swimming pool)
- Houses in multiple occupation, for example blocks of flats or other buildings in multiple occupation
- Any large or prefabricated buildings
- Buildings that do not have continuous natural ventilation in excess of the level specified later in this document
- Buildings that use mechanical (or forced) systems for background ventilation

Regulations and Standards for components and installations

Conversion and installation of all system components shall be in accordance with:

- Gas Safety (Installation & Use) Regulations

- IGEM Hydrogen Reference Standard (IGEM/H/1) or equivalent hydrogen specific amendments to existing IGEM natural gas standards
- Installed hydrogen appliances must be new appliances (domestic or commercial), certified by a Notified Body in accordance with Gas Appliances (Enforcement), Miscellaneous Amendments Regulations with the use of PAS 4444
- Installed hydrogen smart gas meters must be new meters, certified by a Notified Body (for metrology and safety) and be SMETS2 compliant
- Excess flow valves shall be new and approved to a suitable published standard
- Building Regulations Approved Doc J Combustion appliances and fuel storage systems – *or equivalent regional documentation*
- Building Regulations Approved Doc F Ventilation (2021 draft) – *or equivalent regional documentation*

As and when the following is completed, conversion and installation practices should be brought into accordance with:

- BSI PAS Installation Standard – pipework and ventilation
- Other relevant IGEM standards
- Appropriate standard for mechanical hydrogen excess flow value
- Appropriate standard for hydrogen gas meter with reference to isolation in the event of excess flow

Safety Management

Safety assessment

The key findings from the safety assessment undertaken for Hy4Heat are as follows:

- Although there are differences between natural gas and hydrogen; through correct implementation of a holistic collection of risk reduction measures, the risk of using hydrogen can be made comparable to natural gas
- The consequences of the largest domestic hydrogen leak and subsequent explosion scenario are predicted to be more severe than those of the largest domestic natural gas explosion by the consequences model
- With the key risk reduction measures of fitting two Excess Flow Valves and ensuring adequate ventilation to properties supplied with hydrogen, as considered in the Quantitative Risk Assessment, the predicted likelihood of a largest domestic hydrogen explosion is lower than the predicted likelihood of a largest domestic natural gas explosion

- It is the combination of consequences and likelihood of explosions with the key risk reduction measures that has been evaluated in the Quantitative Risk Assessment and resulted in the conclusion that the risk of deaths and serious injuries can be made comparable

Health and Safety Arrangements

The following risk reduction measures should be put in place for a community trial:

- The following regulations and standards shall be complied with:
 - a. Gas Safety (Installation & Use) Regulations
 - b. IGEM Hydrogen Reference Standard (IGEM/H/1) or equivalent hydrogen specific amendments to existing IGEM natural gas standards
 - c. As and when it is completed, the BSI PAS Installation Standard – pipework and ventilation, and other relevant IGEM standards
 - d. All hydrogen appliances must be new (domestic or commercial), certified by a Notified Body in accordance with Gas Appliances (Enforcement), Miscellaneous Amendments Regulations with the use of PAS 4444 including Flame Failure Devices (FFDs) fitted on all appliances
 - e. Installed hydrogen smart gas meters must be new, certified by a Notified Body (for metrology and safety), and be SMETS2 compliant
- Excess Flow Valve (EFV) to limit the flow rate to 20m³/hr in the service pipe. This is either to be installed as a retrofit or as part of new installation. The installation of this mechanical excess flow valve should conform to the functionality of the standard ASTM F2138 - 12(2017) (Standard Specification for Excess Flow Valves for Natural Gas Service) or similar publicly acknowledged industry standard. It shall be located in either of the following locations:
 - a. In the service pipe itself, or
 - b. Immediately after the Emergency Control Valve (ECV)
- Hydrogen gas meter containing an integrated Excess Flow Valve (EFV) to limit the flow rate to <20m³/hr or set at a lower value that is related and proportionate to the maximum usage of appliances installed within the individual property. Minimum values for the setting of this should be agreed with appliance manufacturers
- Meter connections shall comply with the “Specification for gas meter unions and adaptors” upgraded from the Natural Gas specification (BS 746:2014) for use with hydrogen
- Hydrogen gas meter location: Hydrogen gas meters should be installed outside of the property* and comply with current best practice and BS6400-1:2016. **Where it is inappropriate to install the meter outside the property, then the GDNO shall conduct a full risk assessment for the individual property and ensure that any installation is within two metres of the service pipe entry*

- Ventilation:

- a. Whole property: Rooms with gas appliances or substantial pipework installed should have non-closable vents with equivalent area of 10,000 mm², located as close to the ceiling level as possible and no more than 500 mm below ceiling level.

Such vents can most readily be assessed in conjunction with the requirements for the ventilation of new properties 2021 draft of Building Regulations Approved Document F (England or Wales) (or regional equivalent), but with the additional requirement of proximity to the ceiling.

However, it should be noted that these regulations were not introduced with the intention of controlling the build-up of flammable gas.

Particular care should be taken regarding:

- Compliance with undercutting of internal doors in accordance with 2021 draft of Building Regulations Approved Document F (England or Wales) (or regional equivalent),
 - Vents that can be fully closed, either automatically or manually shall not be used. The use of stops to ensure provision of at least 10,000 mm² could be considered.
 - Mechanically ventilated buildings are excluded from the trial
- b. Hydrogen appliances in rooms: Compliance with appropriate product ventilation standards (domestic or commercial) is also required and/or manufacturers installation instructions
 - c. Hydrogen appliances in cupboards and other appliance compartments (e.g. boilers): All appliances in cupboards shall be vented in accordance with Building Regulation ADJ (England or Wales) or equivalent regional documentation; and exemptions shall not be permitted. Manufacturers' guidance should take precedence if larger vents are required. Building Regulation ADJ Para 1.18 should be followed regarding co-compliance with both ADJ and ADF. In this context, equivalent regional legislation is Scottish Building Regulations guidance document 'Building Standards Division – Domestic Ventilation' and 'Building standards technical handbook: domestic buildings'
 - d. Pipework in ducts: All ventilation of pipework in ducts shall be confirmed as complying with BS 6891 Specification for the installation and maintenance of low-pressure gas installation pipework of up to 35mm (R114) on premises

- Internal pipework (downstream of ECV):

- a. Shall be visually inspected where this can be done without disturbance to the fabric of the property and remedial work undertaken where it does not comply with current natural gas standards

- b. A tightness test shall be undertaken to current natural gas standards prior to conversion and subsequently prior to commissioning by a second person. The tightness test shall be assessed in accordance with IGEM/H/1 or other installation standards (e.g. BSI). Where this is not the case, then the pipework shall be replaced to meet current natural gas standards
 - c. Any cast iron components found during the inspection shall be removed or replaced
- For larger ‘light’ commercial properties up to 100kW, i.e. where demand is in excess of 20m³/hr (expected to be exclusively non-domestic), then a conventional interlock (AIV – automatic isolation valve) system shall be installed in accordance with IGEM UP/2 7.9.8 and associated Appendix 11. This shall cut off the supply to the building in the event of a leak being detected. An excess flow valve shall also be installed to limit peak flow to <30m³/h
 - Hydrogen detection alarms should be installed where residents are unable to smell the gas odorant or request such a device
 - Same odorant with the same effectiveness must be added to hydrogen as is currently used for natural gas (Odorant NB)
 - Each property (meter point) considered within the community trial shall be assessed for its suitability to accept hydrogen according to this guidance. The reasons should be recorded, including properties that have been assessed but deemed unsuitable for the initial community trial
 - Householder agreement shall be in place and shall agree to ensure appropriate safety management of appliances and other infrastructure, including maintaining the system and appropriate reporting of incidents throughout the trial period. This should also include any information about the use of hydrogen that is considered relevant

The precise means of implementing these measures shall be site specific.

Competence and training

Existing competent Gas Safe engineers must be upskilled for facilitation of the community trial, including installation, testing, commissioning, inspection and maintenance having undertaken an appropriate training course (and subsequent accredited assessment) for working with hydrogen gas.

Existing competent First Call Operatives with appropriate training in hydrogen gas should be used for responding to any reported incidents.

Monitoring of health and safety performance

During the community trial, data shall be collected to further inform and improve the hydrogen safety management system and procedures.

This should include data and information on:

- The practicalities of conversion especially the location of gas meters and the accurate assessment of building ventilation
- Ease of repair of existing hydrogen pipework carcass and the ability of fitters to render such systems gas tight
- The occurrence and reporting of hydrogen leaks
- Any arising incidents, or near misses, even if below the RIDDOR threshold

This information should then feedback into the safety assessment to enable further refinement, modification and amendments of the assessment to ensure the robustness of the QRA, Site Specific Safety Case and dutyholder safety management systems. This will ensure that the hydrogen gas system still meets the objective of risks being no greater than the existing natural gas system.

Other considerations for initial community trial

- Basements/Cellars – The installation of gas pipework and appliances in cellars should not be permitted as part of an initial community trial
- Appliances – All appliances (domestic and commercial) shall be specifically confirmed by their Original Equipment Manufacturer (OEM) that the appliance has been approved by a UKCA to participate in a hydrogen neighbourhood demonstration. Feedback shall be provided to the OEM on the performance of their equipment
- Gas service pipe upstream of ECV – all service pipes shall comply with the Pipelines Safety Regulations 1996 and current natural gas installation standards and shall be of appropriate and approved material. (In the context of this Hy4Heat assessment, upstream of the ECV, this means that the service pipe shall be a plastic pipe where it is underground. The dutyholder shall be responsible for assessing the site-specific case)
- A detailed method statement shall be prepared for each stage of the installation and commissioning of either a new hydrogen network or repurposing of an existing natural gas network



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