Institution of Gas Engineers & Managers

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Communication 1843

HYDROGEN INTERIM STANDARD

Draft after Comment

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Institution of
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SECTION 1: INTRODUCTION

1.1 This Interim Technical Standard has been prepared to support the training and assessment program for Gas Safe Registered engineers who are to be engaged in the 100% hydrogen (see clause 2.5) trials.

1.2 The Standard sets down the specific additional requirements and procedures to enable engineers to carry out work on hydrogen installations during the initial community-based trials.

1.3 The aim of the document is to identify the differences in practices and procedures that will be required for hydrogen domestic installations.

1.4 Because of this new direction in the gas industry and the associated emerging technology associated with hydrogen fuel gas, gaps exist in knowledge and experience which will limit the guidance given here. Where these arise, they have been identified in order to stimulate further investigation in these areas, thereby enabling existing gaps to be closed.

1.5 Some procedures and equipment required by this Standard may only be applicable during trials. Further research and development, in conjunction with experience gained from trials, may result in different approaches being adopted.

1.6 Many of the methods and equipment required for these activities are still being developed and finalized, and updates to this document will be required as information becomes available.

1.7 This document will be superseded by definitive Standards and procedures once they are fully developed.

1.8 This Standard makes use of the terms "must", "shall" and "should", when prescribing particular procedures:

- the term "must" identifies a requirement by law in Great Britain (GB) at the time of publication
- the term "shall" prescribes a procedure which, it is intended, will be complied with in full and without deviation
- the term "should" prescribes a procedure which, it is intended, will be complied with unless, after prior consideration, deviation is considered to be acceptable.

Such terms may have different meanings when used in legislation, or Health and Safety Executive (HSE) Approved Code of Practice (ACoPs) or guidance, and reference needs to be made to such statutory Legislation or official guidance for information on legal obligations.

1.9 The document identifies (via highlighted notes) where work is outstanding, for example:

(Note: exact details of size and flow limits to be agreed.)

1.10 The document identifies (at the end of each section) where gaps in knowledge exist, for example:

CURRENT GAPS
1. Validated design data for pipework sizing.

SECTION 2: SCOPE

2.1 To cover gas utilization activities associated with the design, installation, commissioning, and maintenance of low-pressure hydrogen gas installations in domestic premises, forming part of a coordinated trial.

2.2 This document covers new pipework systems for hydrogen but introduces the potential future requirement of repurposing existing natural gas installations for use with hydrogen.

2.3 The range of appliances available for the initial trials will be limited. Therefore this Interim Standard focuses primarily on the installation of those appliances that will be used for both training and assessment of competence.

2.4 Some trials may also include selected appliances serving small commercial premises. The principles of this Interim Standard could be applied to those installations, where the pipework size and capacity are within scope.

2.5 The hydrogen gas supplied to trial installations is assumed to be nominally 100% hydrogen, though it may contain small quantities of other components and the odorant. Blends of hydrogen and natural gas are not within the scope of this document.

2.6 The Standard applies to hydrogen installation pipework and meters having the following:

- MOP at the outlet of the ECV not exceeding 75 mbar and,
- Nominal OP at the outlet of the primary meter not exceeding 21 mbar and,
- a nominal bore of not greater than 35 mm and,
- a maximum badged capacity through the primary meter of not exceeding 20 m^3h^{-1} and,
- a maximum installation volume of 0.035 m^3
- individual appliance heat input not exceeding 70 kW

Commentary: The increase in meter capacity is due to the characteristics of hydrogen.

(Note: exact details of size, pressures, and flow limits to be agreed.)

SECTION 3: LEGAL & ALLIED

3.1 The initial 100% hydrogen (see clause 2.5) installations shall form part of a coordinated and managed community-based trial, for evaluation and demonstration.

3.2 Where trials involve occupied premises, the Gas Safety (Installation and Use) Regulations (GSIUR) must apply. Trials shall be supported by a HSE approved Site Specific Safety Case.

Note: 'The Annex to Site Specific Safety Case for Hydrogen', developed by the Hy4Heat program [ARP-WP7-HSE-RFR-0001], provides requirements for the types of properties that can be included in trials.

3.3 Trials in commercial premises must be covered by the Health and Safety at Work Act (HSWA).

3.4 The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) must be applied on premises other than domestic.

SECTION 4: COMPETENCE

4.1 All engineers involved in the 100% hydrogen community-based trials must be Gas Safe Registered in appropriate domestic natural gas categories. As such they are expected to know, understand, and comply with all relevant Legislation, Standards and Procedures relevant to domestic natural gas installations such as, for example BS6891 and IGEM/UP/1B. This Interim Standard deals only with the additional or supplementary specific requirements relating to installations for hydrogen, which existing Standards such as BS6891 and IGEM/UP/1B do not currently include.

4.2 For the trials, persons carrying out gas work covered by this interim standard must have the required competence requirements relevant for the task.

4.3 For the trials, each engineer must have the necessary 'hydrogen competent' work category on the Gas Safe Register, prior to carrying out any work on hydrogen installations.

Commentary: An industry recognized training and assessment program will be available for Gas Safe registered installers who are to be engaged in the hydrogen trials.

SECTION 5: SURVEY OF A PROPOSED INSTALLATION

As the installations covered by this Interim Standard will all be part of coordinated and managed community-based trials, prior survey and inspection of premises will have been undertaken to establish specific design and installation requirements.

5.1 Premises considered for inclusion in trials should be surveyed and inspected, to establish installation requirements, prior to installation commencing.

Note: 'The Annex to Site Specific Safety Case for Hydrogen', developed by the Hy4Heat program, provides requirements for the types of properties that can be included in trials.

5.2 Where surveys and inspections have been undertaken prior to installation, their recommendations shall comply with the requirements of this Standard. Where premises are found not to comply with this Standard the installation shall not be undertaken.

Note: The location of the meter installation may have already been determined as part of the gas supply survey and installation.

SECTION 6: METER INSTALLATION

6.1 General

The hydrogen trial meter installation is expected to be similar in form and layout to a typical natural gas ultrasonic/electronic meter installation. The installation will only be housed in a standard surface-mounted meter box as found on natural gas installations.

It is expected that the meter box will be fitted when the service is laid to the property.

It is expected that the meter installation components will be fitted separately to the installation pipework, with the outlet sealed allowing individual tightness testing following installation. Connection to the installation pipework will occur separately.

It may be necessary to wait until the downstream installation pipework is connected and gas user's equipment is operable before any required final adjustments to the meter installation can be completed.

6.1.1 If any part of the meter installation does not comply with the requirements in this section, installation of the meter shall not take place.

6.2 Location

6.2.1 The meter installation shall only be fitted in an industry standard surface-mounted meter box complying with BS 8499:2017.

6.2.2 The meter box shall be installed so that it prevents hydrogen entering the fabric of the building behind the box.

6.2.3 The meter box shall be located in a well-ventilated external position and shall be positioned away from any openings in the building structure.

Note: This is to reduce the possibility of any leaking gas entering the building structure.

6.2.4 If an installed meter box if found not to comply with clauses 6.2.1, 6.2.2 and 6.2.3, the meter installation shall not be installed.

6.3 Components

6.3.1 All meter installation components shall be approved as being suitable for use with hydrogen.

6.3.2 All necessary meter installation components should be supplied as a complete set for assembly. If the hydrogen meter installation differs from a typical NG installation, a diagram and any necessary instructions shall be provided.

6.3.3 An approved EFV (excess flow valve) shall be included in the meter installation.

Note: It is expected that the EFV will be integral to the hydrogen meter.

6.4 Installation

6.4.1 The closed ECV (emergency control valve) shall be checked for signs of let-by by applying an approved LDF (leak detection fluid) to the closed valve ball, before assembly of the meter installation.

Note 1: Any leakage of hydrogen through valve let-by into a meter installation which has not been purged and contains air, could result in an explosive mixture being contained within the installation.

Note 2: The new ECV will have been checked and tested at the time of installation of the service.

(Note: LDF specification to be agreed)

6.4.2 If the ECV if found to be letting-by, the ECV shall be capped and the meter installation shall not be fitted. The defective valve shall be reported, and arrangements made for it to be replaced.

6.4.3 If the ECV does not show signs of letting-by, the hydrogen meter and meter installation components shall be installed.

6.4.4 All meter installation components shall be assembled in the correct order using the associated sealants and washers.

6.4.5 The hydrogen meter shall be installed in accordance with the manufacturer's instructions.

6.4.6 The meter outlet shall not be connected to the installation pipework and shall be sealed with an appropriate fitting and labeled to indicate that purging and commissioning has not been undertaken.

(Note: Sealing method and label to be agreed)

6.5 Installation pipework connection

6.5.1 When the installation pipework is connected to the meter outlet fitting it shall exit the meter box before running externally to the point of entering the building structure above ground level. The installation pipework shall not enter the building structure from within the meter box.

6.6 Testing & Purging

6.6.1 Following assembly, the meter installation shall be tightness tested with AIR in accordance with Section 9 and Appendix B.

6.6.2 The ECV shall be left in the closed position until purging takes place.

6.6.3 Following connection to the outlet pipework, the complete installation (including the meter) shall be tightness tested in accordance with Section 9 and shall be purged in accordance with Section 10.

6.7 Commissioning

It may be necessary to wait until the installation pipework is connected and gas user's equipment is operable before any required final adjustments to the meter installation can be completed.

6.7.1 The meter installer shall ensure that any required checks and adjustments are made. For example:

- The regulator gives an operating pressure at the outlet of the meter of between 19 mbar and 23 mbar at corresponding flow rates between X m^3h^{-1} and Y m^3h^{-1}

  (Note: Regulator flow rates to be determined)

- The regulator locks up at a pressure not exceeding 30 mbar, with no flow through the installation.
- The regulator is sealed to prevent its setting from being interfered with.
- The EFV is set and labelled.

  (Note: EFV settings and labelling requirements to be determined)

6.7.2 The meter shall be commissioned in accordance with the manufacturer's instructions.

6.8 Notices

6.8.1 The necessary identification, warning and emergency notices and labels shall be fitted to the meter installation and meter box.

(Note: Specific notices and labels for hydrogen will be developed.)

CURRENT GAPS

1. Material and component specifications for hydrogen meter installations.
2. Commissioning requirements for the hydrogen meter and regulator.

SECTION 7: INSTALLATION PIPEWORK

7.1 General

Installation pipework is from the outlet of the primary meter to the appliance isolation valve. This section does not apply to materials or components comprising the meter installation.

7.1.1 If any part of the installation does not comply with the requirements in this section, installation of the pipework shall not take place.

7.2 Design

7.2.1 The installation pipework components shall be of sufficient size for the design flow rate.

7.2.2 The installation pipework should be sized to ensure that design pressure loss from the outlet of the primary meter to the connected appliance inlet point does not exceed 1 mbar at the design flow rate.

Commentary: The characteristics of hydrogen may require larger flow rates, which may result in differently sized installations to those for natural gas.

7.2.3 Appendix A should be used to size the pipework for a given flow rate.

Note: The information given in Appendix A is for use with a new copper pipework system.

(Note: Appendix A has been specifically developed for hydrogen as an example of a pipe sizing table. This will be shown in greater detail, together with information on the allowance for fittings and worked examples, when further research and experimental validation is completed.)

7.3 Materials

The properties of hydrogen will restrict the selection and use of materials to those which have been shown to be suitable for use with hydrogen.

Commentary: Hydrogen can permeate though certain materials. It can also cause certain materials to suffer embrittlement during their service lifetime.

Note: At this stage, only the materials and fittings which are known to be safe to use are included.

(Note: Exact specifications can only be included as they become known.)

7.3.1 Only materials complying with this section shall be used.

7.3.2 Only materials approved as being suitable for use with hydrogen shall be used.

7.3.3 Copper tube shall be used conforming to BS EN 1057 or BS EN 13349 (for copper tube with a factory finished protective covering).

7.3.4 Only copper capillary and mechanical compression fittings shall be used.

(Note: Specifications to be confirmed)

7.3.5 Only soft solders approved for use with hydrogen shall be used.

(Note: Specification of BS EN ISO 9453:2020 yet to be confirmed)

7.3.6 Soldering flux shall be suitable for use with hydrogen.

(Note: Specification to be confirmed)

7.3.7 Jointing Materials and Compounds shall be suitable for use with hydrogen.

(Note: Specifications to be confirmed)

7.3.8 Sleeving sealant materials shall be suitable for use with hydrogen.

(Note: Specification to be confirmed)

7.3.9 Flexible hoses, assemblies and connections shall be suitable for use with hydrogen.

Note: For the trials, the only component in this category will be a cooker flex and any associated self-sealing socket.

(Note: Specifications to be confirmed)

7.4 Jointing

7.4.1 Jointing shall be by means of copper capillary and mechanical compression fittings.

7.5 Valves

7.5.1 Valves shall be approved for use with hydrogen. The valve mechanical components, seals and lubricants shall be suitable for use with hydrogen.

(Note: Specification to be confirmed)

7.5.2 Valves should be of a full-bore design to minimize flow restriction and pressure loss.

7.6 Pressure Test Points

7.6.1 Pressure test points shall be suitable for use with hydrogen.

(Note: Specification to be confirmed)

7.7 Connection to the Meter Installation

7.7.1 Installation pipework shall be connected to the meter outlet fitting and shall exit the meter box externally before running to the point of entering the building structure above ground level. The outlet pipework shall not enter the building structure from within the meter box.

7.7.2 Pipework entering the building structure shall be in accordance with clause 7.13.

7.8 Purge Points

7.8.1 Purge points shall be provided as close as possible to each appliance connection point. The purge point should comprise a tee with the offtake having a full-bore valve plugged at the outlet. The purge point should be the same size at the inlet pipework.

Note 1: Full bore fittings are required to prevent restricting purge flow rates.

Note 2: A purge point may also be used as an inert gas injection point when decommissioning (gassing-down) an installation.

7.9 Inert Gas Injection Point

7.9.1 An inert gas injection point shall be provided at the outlet of the meter installation and ideally within the meter enclosure. The inert gas injection point should comprise a tee with the offtake having a full-bore valve plugged at the outlet. The inert gas injection point should be the same size at the meter outlet pipework.

Note 1: Full bore fittings are required to prevent restricting purge flow rates.

Note 2: The inert gas injection point may also be used as a purge point when decommissioning (gassing-down) an installation.

(Note: Consideration is being given to the practicalities of locating the inert gas injection point in the meter installation after the ECV.)

7.10 Location

7.10.1 For the trial installations, pipework shall be internally surface mounted or run externally in order to avoid any internal enclosed spaces or poorly ventilated areas.

Note: This will also enable trial installations to be easily removed at the end of the trial.

Commentary: Further research and evidence is required before hydrogen pipework can be located within the building structure, beneath floors and in inter-floor spaces.

7.10.2 The number of joints in pipework shall be kept to a minimum.

7.10.3 Internal pipework shall not be installed in voids and shall be surface-mounted.

Note: Pipework can be installed in ventilated loft spaces providing the pipework is run in an open area, laid above any insulation or floor covering, and can be readily inspected.

7.11 Protection

7.11.1 External pipework shall not be installed where it could be subjected to mechanical damage. Where possible factory coated pipe should be used with joints wrapped with suitable tape.

7.11.2 External buried pipework should be laid in a channel loose filled with a suitable backfill material.

7.11.3 Pipework to be buried must be tested for tightness before being buried or wrapped.

7.12 Support

7.12.1 Pipework should be adequately supported throughout its length as it would be for natural gas, in accordance with BS 6891.

7.13 Sleeving

7.13.1 All pipework passing through walls or structures shall be free of joints and shall pass through a suitable sleeve, sealed to the structure, and the annular space sealed with a suitable sealant (see clause 7.3.8) on the internal face, to prevent any leaking gas from entering the building structure or passing between each side of the wall.

(Note: Sleeving specification to be confirmed)

7.14 Labelling

7.14.1 Installation pipework should be identified throughout its length in order to avoid confusion with other pipework services.

Note: This is a recommendation for the trial installations.

(Note: The means of identification to be agreed.)

CURRENT GAPS

1. Validated design data for pipework sizing.
2. Material and component specifications for hydrogen use.
3. Research into running hydrogen pipework within the building structure, beneath floors and in inter-floor spaces.

SECTION 8: GAS APPLIANCES

8.1 General

8.1.1 If any appliance does not comply with the requirements in this section, installation shall not take place.

8.1.2 Only appliances approved for use in the trials shall be installed.

Commentary: The Organization controlling the trial identifies which hydrogen appliances are acceptable for installation. Appliance types may also form part of the Safety Case for any trial.

Note: 'The Annex to Site Specific Safety Case for Hydrogen', developed by the Hy4Heat program, provides requirements for the types of properties that can be included in trials, which includes building ventilation.

8.1.3 Appliances must be installed and commissioned in accordance with the manufacturer's instructions.

8.1.4 In the absence of dedicated flueing and ventilation standards for hydrogen appliances, manufacturers shall include all the necessary information on appliance location, flueing (including terminal position) and any additional ventilation requirements. If these have not been included the appliance must not be installed.

Note: Although the air required for combustion of hydrogen (for a given thermal input) is similar to that required for natural gas, additional ventilation may be required for flueless appliances to dilute and disperse the increased levels of water vapor produced.

Commentary: Additional information is required to address any issues which could arise from the increased levels of water vapor produced by a hydrogen appliance: from flueless appliances within the room, and from open-flued and room-sealed appliances in flues and from terminals, throughout the operating cycle (from start up to shut down).

CURRENT GAPS

1. **Research on the effects of increased levels of water vapor in open flues of hydrogen appliances and in rooms containing un-flued hydrogen appliances.**
2. **Research into increased pluming from hydrogen appliance terminals.**
3. **Formal process to require appliance manufacturers to adequately cover installation requirements in areas where there are no formal standards in place. For example, flueing and ventilation requirements.**

SECTION 9: TIGHTNESS TESTING

9.1 General

Tightness testing is undertaken to determine that an installation has no perceptible leak rate i.e., below a level which could ever be considered to form a hazard, assuming adequate ventilation has been provided.

Commentary: It is accepted that leakage rate of hydrogen from typical installation joints and fittings will be similar to that of natural gas.

Commentary: Any leakage of hydrogen by valve let-by into an installation filled with air could result in an explosive mixture being contained within the installation which would necessitate purging.

9.2 Equipment

9.2.1 Any pressure gauge used for tightness testing shall have been approved for use with hydrogen. The connection tube material shall be approved for use with hydrogen.

(Note: Specifications to be confirmed)

9.3 Installations for Trials

9.3.1 A new meter installation shall have been installed in accordance with section 6. This shall include checking the ECV for signs of let-by using LDF, and following assembly, tightness testing the meter installation (to a sealed outlet) using air in accordance with the procedures given in Appendix B.

9.3.2 New installation pipework shall be tested using air in accordance with the procedures given in Appendix B, prior to purging in accordance with section 10.

9.3.3 If further testing is required, throughout the trial, it shall be tested using gas in accordance with the procedures given in Appendix B.

9.3.4 Where an existing installation has been purged of hydrogen to undertake work, the completed installation shall be tested using air in accordance with the procedures given in Appendix B, prior to purging in accordance with section 10.

CURRENT GAPS

1. **Checks on expected maximum installation volumes. Increased pipe sizes could take the total installation volume above the scope of IGEM/UP/1B (i.e., 0.035 m^3). This would create a need to undertake validation of the tightness test for an extended scope.**
2. **Develop an existing test (with a possible permissible drop allowance) for longer term 'existing' hydrogen installations.**

SECTION 10: PURGING

10.1 General

A potentially flammable fuel gas – air mixture must not be allowed to occur within the installation pipework. The potential for this to occur is greatest during commissioning (gassing-up) or decommissioning (gassing-down) an installation.
It is essential that purging occurs, particularly if the installation is being decommissioned for gas work or redundancy.

Commentary: The wider flammability limits, greater flame speed and lower ignition energy of hydrogen when compared with natural gas requires additional precautions and safer practices to be adopted. Current evidence shows that hydrogen requires indirect purging techniques to be applied, where an inert gas is used as an interface between air and hydrogen.

Commentary: Indirect purging requires an inert gas to be put into the pipework to create a barrier between the air and hydrogen. The method of indirect purging to be used here is commonly called slug purging.

Note: Evidence may emerge that could support the use of less involved direct purging techniques for domestic installations. However, even these techniques would differ from those currently used for NG operations.

10.1.1 Purging is a potentially hazardous operation and must be undertaken in a safe manner, ensuring any release of gas is controlled.

10.1.2 A successful tightness test (in accordance with Section 9) must have been carried out immediately before any purge is undertaken.

10.1.3 The tightness test shall have included a check for let-by of the ECV.

Note: Any leakage of hydrogen through valve let-by into an installation filled with air could result in an explosive mixture being contained within the installation.

10.2 Survey

10.2.1 The installation shall be inspected before starting any purge procedure.

10.2.2 The installation shall have an inert gas injection point and sufficient purge points to permit all the pipework to be purged.

10.2.3 There shall be access to an outside area (via a door or window) within X m of the purge point, where the purge hose can run to and where purge gas can be vented without causing danger, alarm, or a nuisance.

(Note: Maximum distance (X) to be determined)

10.2.4 If clauses 10.2.2 and 10.2.3 are not confirmed, the purge procedure shall not take place.

10.2.5 The size and length of the pipework installation shall be recorded to permit the installation volume and purge volume to be calculated.

10.2.6 The main leg of the installation pipework to be used for the purge shall be established.

10.2.7 If the individual branches off the main leg exceed X m of Y mm pipework, they shall be treated as significant branches and shall require separate purging.

(Note: Significant branch lengths (X) and diameters (Y) to be determined)

10.3 Purge Volume

10.3.1 The purge volume shall be calculated.

Note: The method given in IGEM/UP/1B can be used - but with a hydrogen meter volume of X m^3

(Note: Meter volume (X) yet to be determined)

10.4 Equipment

(Note: Much of the purge equipment is still in development and definitive specification is yet to be confirmed)

10.4.1 Any purge hose shall be suitable for use with hydrogen and have an internal diameter of X mm.

(Note: Hose diameter (X) yet to be determined)

10.4.2 A suitable stand arrangement shall be used to support the flame trap at the external purge gas venting point.

(Note: A suitable support will be developed)

10.4.3 The purge hose shall have full bore valves fitted at each end of the hose, to allow full unrestricted flow, to permit isolation and safe removal from the premises, and for indirect purging of the hose to take place in accordance with clause 10.7.

10.4.4 The purge hose and fittings shall be inspected for integrity before use and shall be checked for gas tightness before use.

10.4.5 A flame trap which has been approved for use with hydrogen within the required pressure and flow range, shall be fitted to the end of the purge hose.

(Note: Flame traps having a larger diameter than the purge hose may be required to reduce the restriction to purge flow rates.)

10.4.6 Any gas detector and connection tube used during purging shall have been approved for use with hydrogen within the expected pressure and flow range.

(Note: Specifications to be confirmed)

10.4.7 Any purge equipment (including hoses) shall be purged of hydrogen following a purging operation.

Note: When indirect purging from hydrogen to air, purging of equipment is not required.

10.4.8 A suitable fire extinguisher shall be readily available.

10.4.9 Suitable warning notices shall be used during purging. For example, 'No smoking', 'Purging in progress', 'Do not operate' etc.

10.5 Inert Gas

A portable supply of inert gas will be available, with a means of connection to the inert gas injection point and an assembly to allow the gas to be injected.

(Note: An inert gas supply, assembly and connection equipment will be developed.)

10.5.1 Inert gas is an asphyxiant and shall be used with caution. It shall not be used in confined spaces.

10.5.2 Any inert gas containers and associated inert gas injection equipment shall be approved for use.

10.5.3 Any empty inert gas containers shall be appropriately disposed of after use.

10.6 Indirect Purging Procedures

(Note: As much of the purge equipment is still in development, the following procedures may change to reflect the final equipment selected.)

10.6.1 Before starting a purging operation the following safety precautions shall be considered:

- Avoid any accumulation of purged gas within confined spaces.
- Prevent inadvertent operation of any electrical switch or other appliance.
- Extinguish all potential sources of ignition.
- Ensure that there is no smoking or naked lights.
- Ensure good ventilation by opening doors, windows, passive stack ventilation systems, etc.
- The flame trap is located away from any ignition sources, and from openings to prevent purge gas entering the building.
- Advise the responsible person for the premises or other persons in the area of the above of the intent to purge and that there may be a smell of gas.
- Ensure the purge is complete by passing the calculated purge volume.

10.6.2 The following procedure shall be applied to commission an installation:

- Ensure the ECV is fully closed and labelled 'Do not operate'
- Note the required purge volume (from clause 10.3)
- Locate and access the external purge gas venting point (as selected in clause 10.2.3)
- Ensure the inert gas injection point at the meter is fully closed
- Ensure all appliance isolation valves and purge point valves are fully closed
- Locate and unseal the purge point valve outlet on the main leg of the installation and connect the required length of purge hose to the purge point
- With the flame trap connected to the end of the hose, run the hose to the external purge termination point and open the hose outlet valve
- Open the purge point valve and the purge hose inlet valve
- Unseal the injection point valve outlet

- Connect the inert gas container assembly to the injection point
- Open the injection point valve
- Slowly open the inert gas container assembly valve and allow inert gas to enter the pipework
- After X seconds, close the injection point valve, carefully remove the inert gas assembly

(Note: Inert injection time (X) to be established)

- Seal the injection point valve outlet
- Open the ECV and observe the meter until the correct purge volume PV has passed – avoid exceeding the PV to minimize the gas release
- Close the purge point valve
- Close both purge hose valves
- Disconnect the purge hose
- Seal the purge point valve outlet
- Repeat the above for all significant branches (see clause 10.2.7)

(Note: Further work is required to determine the exact procedure to be applied to significant branches)

- Ensure all purge points and injection points are fully closed and sealed
- Check any disturbed joints for leaks
- Carefully transport the purge hose to a safe area to be purged in accordance with section 10.7.

10.6.3 The following procedure shall be applied to decommission an installation.

- Ensure the ECV is fully closed and labelled 'Do not operate'
- Locate and access the external purge termination point (as selected in clause 10.2.3)
- Ensure the inert gas injection point at the meter is fully closed
- Ensure all appliance isolation valves and purge point valves are fully closed
- Locate and unseal the purge point valve outlet on the main leg of the installation and connect the required length of purge hose to the purge point
- With the flame trap connected to the end of the hose, run the hose to the external purge termination point and open the hose outlet valve
- Open the purge point valve and the purge hose inlet valve
- Unseal the injection point valve outlet
- Connect the inert gas container assembly to the injection point
- Open the injection point valve
- Slowly open the inert gas container assembly valve and allow inert gas to enter the pipework
- After X seconds, close the injection point valve, carefully remove the inert gas assembly

(Note: Inert gas injection time (X) to be established)

- Seal the injection point valve outlet
- Close the purge point valve
- Close both purge hose valves
- Disconnect the purge hose
- Seal the purge point valve outlet
- Repeat the above for all significant branches (see clause 10.2.7)

(Note: Further work is required to determine the exact procedure to be applied to significant branches)

- Ensure all purge points and injection points are fully closed and sealed
- Check any disturbed joints for leaks

10.7 Purging Hoses

10.7.1 The following procedure shall be applied.

- Move the purge hose (with flame trap connected) to an open area away from any ignition sources
- Uncoil the hose and place the flame trap in a well-ventilated area and open the hose exit valve
- Connect the inert gas container assembly to the hose inlet, via the adaptor fitting, and open the hose inlet valve
- Slowly open the inert gas container assembly valve
- After X seconds, close the injection point valve, remove the inert gas canister assembly

(Note: Inert gas injection time (X) to be established)

- Close the purge hose inlet and outlet valves
- Coil and store the hose & flame trap

CURRENT GAPS

1. **Research to establish the purging parameters required for hydrogen.**
2. **Research to review if direct purging approach could be developed for domestic installations.**
3. **Work to test and validate the purging procedures.**
4. **Work to develop and test appropriate equipment for undertaking indirect purging operations.**
5. **Research to investigate the risk from potential ignition sources to hydrogen releases e.g., static etc.**

SECTION 11: INSPECTION AND MAINTENANCE

It is expected that the initial trial hydrogen installations will be continually evaluated and inspected to gather information and data. Maintenance may also be carried out at more frequent intervals.

11.1 Inspection

11.1.1 Any inspection that requires gas work must be undertaken by competent persons (see section 4).

11.2 Maintenance

11.2.1 Maintenance must be undertaken by competent persons (see section 4), to ensure continued safety of the installations.

11.2.2 Appliances must be maintained by competent persons (see section 4), in accordance with manufacturer’s instructions.

SECTION 12: DECOMMISSIONING

It is expected that at the end of a trial, the hydrogen installations will be removed from premises.

12.1.1 Pipework must be purged of hydrogen in accordance with section 10, before disconnection and/or removal.

12.1.2 Any sections of pipework which are not removed must be sealed at each end with an appropriate fitting.

SECTION 13: REPURPOSING

(This document covers new pipework systems for hydrogen. However, the potential future requirement of repurposing existing natural gas installations for use with hydrogen is introduced here.)

A future roll-out of hydrogen will be influenced by the suitability of existing Natural Gas installation to be repurposed for hydrogen use.

13.1 Installation Pipework

13.1.1 Repurposing shall only be considered if the existing Natural Gas installation pipework meets the acceptance criteria, and as such, each installation would have to be inspected prior to any work commencing.

The acceptance criteria shall cover, but may not be limited to:

- Gas Tightness - as an installation shall be free from leakage.
- Pipework Size – as an installation shall be of sufficient size to accommodate the potential increased flowrates required for hydrogen and a possible change in appliance type (e.g., from a conventional boiler to a combi boiler).
- Material Suitability and Integrity – as an installation shall contain only materials which are deemed suitable for hydrogen, and those materials must be of sufficient integrity for the intended service life.
- Location Suitability – as any appliance installation shall be in locations that are suitable for hydrogen.

13.2 Meter Installation

13.2.1 Repurposing shall only be considered if the existing natural gas meter position meets the acceptance criteria, and as such each meter position would have to be inspected.

The acceptance criteria shall cover, but may not be limited to:

- Location Suitability – meters shall be in locations which are suitable for hydrogen (for example, not in enclosed areas).

13.3 Appliance Position

13.3.1 Repurposing a natural gas appliance position shall only be considered if the existing natural gas appliance position meets the requirements for a similar hydrogen appliance. For example, the flueing method or flue position may differ.

Commentary: The increased levels of moisture and associated condensate production in the products of combustion from hydrogen could lead to problems within existing open-flued systems and to an increase in pluming from terminal positions.

CURRENT GAPS

1. Research is required to evaluate repurposing.
2. Existing natural gas systems should be surveyed to establish the potential for future repurposing.

APPENDIX A: PIPEWORK SIZING GUIDE

(Note: This appendix has been specifically developed for hydrogen to provide an example of a typical pipe sizing table. This will be shown in greater detail, together with information on the allowance for fittings and worked examples, when further research and experimental validation is completed.)

A1.1 General

To provide a guide to assist in estimating pipework sizing, the method from BS 6891:2015+A1:2019 has been adopted with values then developed for hydrogen service. These are tabulated in Table A1. This is a method that is under development and is applicable for domestic copper pipework installations.

This approach uses the equation given in BS 6891:2015+A1:2019 as shown below:

$$Q = 57.1\times10^{-5}[pd^5(sLf)^{-1}]^{0.5}$$

where:

- Q is the gas flow rate (m^3/h);
- p is the pressure loss (mbar);
- d is the internal pipe diameter (mm);
- s is the density of gas relative to air;
- L is the length of pipe (m); and
- f is the friction factor.

Commentary: The gas properties of hydrogen are different to those for natural gas, especially the viscosity, density, and calorific value.
As the volumetric calorific value of hydrogen is lower than that for natural gas, the volumetric flow rates to achieve the same heat input are higher.

A1.2 Pipe Sizing Table

Table A1 Approximate hydrogen pressure loss data (mbar/m) – copper tube

	Heat Input			Nominal Pipe Size (mm)			
Flow rate	Gross	Net	OD (mm)	15	22	28	35
m^3h^{-1}	kW	kW	ID (mm)	13	19	25	32
1.0	3.36	2.83		0.0183	0.0033	0.0010	0.0003
2.0	6.72	5.67		0.0533	0.0095	0.0027	0.0009
3.0	10.08	8.50		0.1016	0.0178	0.0051	0.0017
4.0	13.44	11.33		0.1617	0.0281	0.0080	0.0026
5.0	16.81	14.17		0.2328	0.0402	0.0114	0.0037
6.0	20.17	17.00		0.3143	0.0540	0.0152	0.0049
7.0	23.53	19.83		0.4057	0.0695	0.0195	0.0062
8.0	26.89	22.67		0.5066	0.0865	0.0242	0.0077
9.0	30.25	25.50		0.6167	0.1051	0.0294	0.0094
10.0	33.61	28.33		0.7359	0.1251	0.0349	0.0111
11.0	36.97	31.17		0.8637	0.1466	0.0408	0.0130
12.0	40.33	34.00			0.1695	0.0472	0.0150
13.0	43.69	36.83			0.1937	0.0538	0.0171
14.0	47.06	39.67			0.2193	0.0609	0.0193
15.0	50.42	42.50			0.2462	0.0683	0.0216
16.0	53.78	45.33			0.2744	0.0760	0.0241
17.0	57.14	48.17			0.3039	0.0842	0.0266
18.0	60.50	51.00			0.3347	0.0926	0.0292
19.0	63.86	53.83			0.3667	0.1014	0.0320
20.0	67.22	56.67			0.4000	0.1105	0.0349

For a given flow rate or heat input the pressure drop per metre length of pipe is given for different pipe sizes.

APPENDIX B: TIGHTNESS TESTING PROCEDURES

These procedures cover the tightness testing of the meter installations, installation pipework and the complete systems (i.e., installation pipework connected to the meter installation).

B1 TIGHTNESS TESTING PROCEDURE

B1.1 New Meter Installations (not connected to installation pipework) – Test with AIR

Note: This assumes that NO gas has been introduced into the system.

Carry out the following:

(a) Ensure the ECV is fully closed.

(b) Ensure the ECV has been checked for let-by using LDF before assembly.
If the ECV if found to be letting-by, the ECV shall be capped and the meter installation shall not be fitted. The defective valve shall be reported, and arrangements made for it to be replaced.

(c) Visually inspect the meter installation and ensure all components are connected in the correct order, all joints are correctly made, and the outlet of the meter installation is sealed with an appropriate fitting.

(d) Connect the pressure gauge to the test point on the meter via a branch of a test T-piece which is valved on the other branch for air to be pumped into the installation.

(e) Using AIR, slowly raise the pressure in the installation, using a hand pump, to between 20 and 21 mbar.

Note 1: Avoid higher pressures to prevent regulator lock-up.

Note 2: If whilst raising the pressure to the test pressure it was to exceed 21 mbar but not exceed 23 mbar re-adjust the pressure to between 20 and 21 mbar. If the pressure were to exceed 23 mbar it is necessary to drop the pressure back to between 7 and 10 mbar before raising the pressure to between 20 and 21 mbar. This helps to ensure that the regulator is not locked-up during the tightness test.

(f) Allow 1 minute for the pressure and temperature within the installation to stabilise, if necessary, at the end of the stabilisation period re-adjust the pressure to between 20 and 21 mbar.

The test procedure shall not proceed until a stable reading is obtained.

Note: There may still be a slight increase or decrease in the pressure reading on the gauge during this period as the installation stabilises. Further time may need to be allowed until a stable reading is obtained.

(g) Check for any perceptible movement (fall) of the gauge reading over the next 2-minute period.

(h) If there is no perceptible movement (fall) of the gauge reading the installation shall be deemed to have passed the test. Otherwise, the installation shall be deemed to have failed the test.

(i) If the installation fails the test, trace and repair the escapes(s) and re-test the meter installation.

(j) Upon completion of the test, remove the pressure gauge and re-seal the test point/test T-piece connection.

(k) Record the test results.

B1.2 New Installation Pipework (not connected to the meter installation) - Test with AIR

Note: This assumes that NO gas has been introduced into the system.

Carry out the following:

(a) Visually inspect the installation and ensure all sections to be tested are connected, all joints are correctly made and any exposed gas ways (for example, open ends) on the installation are sealed with an appropriate fitting. Check any appliance(s) and ensure the AIV is open and all burner control taps are turned off.

(b) Connect the pressure gauge to the installation via a branch of a test T-piece which is valved on the other branch for air to be pumped into the installation.

(c) Slowly raise the pressure in the installation with AIR, using a hand pump, to between 20 and 21 mbar.

(d) Allow 1 minute for the pressure and temperature within the installation to stabilise, if necessary, at the end of the stabilisation period re-adjust the pressure to between 20 and 21 mbar and turn off the pressure source.

The test procedure shall not proceed until a stable reading is obtained.

Note: There may still be a slight increase or decrease in the pressure reading on the gauge during this period as the installation stabilizes. Further time may need to be allowed until a stable reading is obtained.

(e) Check for any perceptible movement (fall) of the gauge reading over the next 2-minute period.

(f) If there is no perceptible movement (fall) of the gauge reading the installation shall be deemed to have passed the test. Otherwise, the installation shall be deemed to have failed the test.

(g) If the installation fails the test, trace and repair the escapes(s) and re-test the installation.

(h) Upon completion of the test, remove the pressure gauge and re-seal the test point/test T-piece connection.

(i) Record the test results.

Once the installation has been connected to the meter installation, the complete installation shall be tightness tested following the procedure B1.3 before the installation may be purged.

B1.3 New Complete Installation (installation pipework connected to the meter installation) - Test with AIR

Note: This assumes that NO gas has been introduced into the system.

Carry out the following:

(a) Ensure the ECV is fully closed.

(a) Visually inspect the installation and ensure all sections to be tested are connected, all joints are correctly made and any exposed gas ways (for example, open ends) on the installation are sealed with an appropriate fitting. Check any appliance(s) and ensure the AIV is open and all burner control taps are turned off.

(c) Connect the pressure gauge to the installation via a branch of a test T-piece which is valved on the other branch for air to be pumped into the installation.

(d) Using AIR, slowly raise the pressure in the installation, using a hand pump, to between 20 and 21 mbar.

Note 1: Avoid higher pressures to prevent regulator lock-up.

Note 2: If whilst raising the pressure to the test pressure it was to exceed 21 mbar but not exceed 23 mbar re-adjust the pressure to between 20 and 21 mbar. If the pressure were to exceed 23 mbar it is necessary to drop the pressure back to between 7 and 10 mbar before raising the pressure to between 20 and 21 mbar. This helps to ensure that the regulator is not locked-up during the tightness test.

(e) Allow 1 minute for the pressure and temperature within the installation to stabilize, if necessary, at the end of the stabilization period re-adjust the pressure to between 20 and 21 mbar.

The test procedure shall not proceed until a stable reading is obtained.

Note: There may still be a slight increase or decrease in the pressure reading on the gauge during this period as the installation stabilizes. Further time may need to be allowed until a stable reading is obtained.

(f) Check for any perceptible movement (fall) of the gauge reading over the next 2-minute period.

(g) If there is no perceptible movement (fall) of the gauge reading the installation shall be deemed to have passed the test. Otherwise, the installation shall be deemed to have failed the test.

(h) If the installation fails the test, trace and repair the escapes(s) and re-test the installation.

(i) Upon completion of the test, remove the pressure gauge and re-seal the test point/test T-piece connection.

(j) Record the test results.

B1.4 Existing Complete Installation (installation pipework connected to the meter installation) - Test with GAS

This is where a test is required to check for leakage, or for periodic testing of a complete installation.

Note: Where an installation has lost pressure or has been worked on or extended, it has to be tested with AIR using the procedure B1.3.

Carry out the following:

The following procedure assumes that the installation is connected to a live hydrogen supply isolated at the ECV.

(a) Ensure the ECV is fully closed.

(b) Visually inspect the installation and ensure all sections to be tested are connected, all joints are correctly made and any exposed gas ways (for example, open ends) on the installation are sealed with an appropriate fitting. Check any appliance(s) and ensure the AIV is open and all burner control taps are turned off.

(c) Connect the pressure gauge to a suitable pressure test point on the installation.

(d) Carry out a let-by test of the closed ECV as follows:
adjust the gauge pressure to between 7 and 10 mbar

Note: If the pressure requires reducing to achieve the required test pressure at this stage or any stage in the tightness testing process then, if there is any potential for any hydrogen to be released ensure it vented to an external area.

(e) Check for any perceptible movement (rise) of the gauge reading over the next 1-minute period.

(f) If there is no perceptible movement (rise) of the gauge reading the valve shall be deemed to have passed the test. Otherwise, the valve shall be deemed to have failed the test.

If the ECV if found to be letting-by, report the defective valve so that arrangements made for it to be replaced, before repeating this let-by test and proceeding with the tightness test.

Note: The installation may require purging to air before repairs can be undertaken, which will then require a re-test with air (using procedure B1.3) before purging back to hydrogen.

(g) Using the ECV, slowly raise the pressure in the installation to between 20 and 21 mbar.

Note 1: Avoid higher pressures to prevent regulator lock-up.

Note 2: If whilst raising the pressure to the test pressure it was to exceed 21 mbar but not exceed 23 mbar re-adjust the pressure to between 20 and 21 mbar. If the pressure were to exceed 23 mbar it is necessary to drop the pressure back to between 7 and 10 mbar before raising the pressure to between 20 and 21 mbar. This helps to ensure that the regulator is not locked-up during the tightness test.

(h) Allow 1 minute for the pressure and temperature within the installation to stabilize, if necessary, at the end of the stabilization period re-adjust the pressure to between 20 and 21 mbar. If the supply control valve has been turned on to re-adjust the pressure, then turn off the ECV.

The test procedure shall not proceed until a stable reading is obtained.

Note: There may still be a slight increase or decrease in the pressure reading on the gauge during this period as the installation stabilizes. Further time may need to be allowed until a stable reading is obtained.

(i) Check for any perceptible movement (fall) of the gauge reading over the next 2-minute period.

(j) If there is no perceptible movement (fall) of the gauge reading the installation shall be deemed to have passed the test. Otherwise, the installation shall be deemed to have failed the test.

(h) If the installation fails the test, trace and repair the escapes(s) and re-test the installation.

Note: The installation may require purging to air before repairs can be undertaken, which will then require a re-test with air (using procedure B1.3) before purging back to hydrogen.

(i) Upon completion of the test, remove the pressure gauge and re-seal the test point/test T-piece connection.

(j) Record the test results.