Hy4Heat Competence Framework

ACoP Assessment Module

(To support 100% Hydrogen Community Trials)

09 March 2021

1 INTRODUCTION

1.1 This Hydrogen ACoP Assessment Module is applicable only to:

Existing Gas Safe Registered (GSR) engineers (i) who will be carrying out installation, commissioning, handover and maintenance work, including potential manufacturer modifications as necessary, on appliances fuelled by **100%** hydrogen gas, and (ii) who have satisfied the entry criteria and have successfully completed a Hydrogen Pathway Training Course, recognised under the IGEM/IG/1 Standard of Training in Gas Work.

1.2 The initial use of this Independent Assessment is intended for engineers involved in initial Community Trials. Once endorsed and ratified through the existing standard setting process, the Specification will in future support any subsequent wider roll out of hydrogen fuelled installations.

1.3 The Assessment Module was developed by EU Skills as part of a Hy4Heat project commissioned by the Department for Business, Energy and Industrial Strategy (BEIS) and then offered for comment to industry stakeholders. Following this consultation, the Assessment was endorsed by the Standards Consultation Forum (SCF) and ratified by the Strategic Management Board (SMB) as an ACoP approach, pending any wider roll out of hydrogen. If and when this becomes a policy decision, an additional hydrogen ACS Module is expected to replace this Assessment Module.

1.4 Throughout this Assessment Module, references are made as necessary to the Hydrogen Interim Standard [IGEM/H/2]. This Standard has been developed specifically to support the training and assessment of Gas Safe Registered engineers involved in the initial community-based trials of 100% hydrogen. **With more research and testing of hydrogen appliances and their application still underway, ongoing revision of the Interim Standard may be expected in the short and medium term. It is essential that any organisation offering this assessment ensures that it aligns with the current version of the Standard, in place at the time of the assessment.**

1.5 This ACoP Assessment has been created to be independent of any training and may be delivered by an approved ACS Assessment Centre, formally linked to an accredited Certification Body. Although this ACoP is outside the scope of UKAS accreditation in terms of ACS governance, the Certification Body will administer, and certificate successful learners as would be the case for any additional ACS module.

1.6 Engineers successfully completing the hydrogen assessment module will be certificated as competent in matters of gas safety relating to hydrogen and have a new category to that effect added to their Gas Safe registration. A five-yearly renewal of competence in hydrogen will be required as with existing categories of work and a process to facilitate this will be developed as required.

1.7 This Assessment is designed to enable existing engineers to extend their competence to include hydrogen fuelled appliances **only** in the categories they currently hold for natural gas or LPG. This Assessment **does not** facilitate or enable an engineer's changeover or conversion from domestic to non-domestic or any other category.

Holders of exclusively limited scope categories (e.g. meter exchange only) are not eligible for this hydrogen assessment module.

1.8 This, post industry consultation, ACoP Assessment Module was produced in March 2021. The document has been referenced, as appropriate, to the Interim Technical Standard that was also produced in March 2021.

1.9 It is important to note that further research and testing work is continuing on some aspects relevant to this assessment. It is likely that current gaps identified in the Interim Technical Standard, will be closed prior to the initial community trials of hydrogen. Therefore, it is likely that the initial Standard will be subject to revision. Any such revision will necessitate a review of both the Hydrogen Transition Training Specification and this ACoP Assessment Module.

1.10 Pending any update or revision of this Assessment Module, supplementary information that may be helpful to an Assessment Centre or Certification Body preparing to deliver the hydrogen assessment, may be found in Appendix One of this document.

2.0 SCOPE

2.1 All Gas Safe Registered engineers who have completed a recognised Hydrogen Transition Training Course, must achieve certification through this ACoP Assessment

2.2 This competence assessment enables an engineer to carry out work **only** within the same valid appliance categories currently held for natural gas or LPG.

2.4 Hydrogen transition training is expected to be tutor led and primarily centre based. Given that there are no existing hydrogen networks installed, obtaining off site workplace practical experience is not possible. A centre based training course must instead, take steps to provide a live simulation, demonstrating a hydrogen gas supply connected to suitable appliances and equipment. This will allow learners to demonstrate their knowledge and understanding of hydrogen installation practice on the range of appliances listed in 3.1 below.

3.0 THEORY & PRACTICAL ASSESSMENT PROVISION

3.1 An Assessment Centre offering this Hydrogen ACoP Assessment must have the following facilities, equipment, and appliances available for the assessment of learners.

3.1.1 A live hydrogen gas supply operating at normal domestic operating pressure (20mbarg).

3.1.2 At least one hydrogen gas meter installation connected to a live hydrogen gas supply.

3.1.3 A minimum of two installed domestic gas CH Boilers from different manufacturers.

3.1.4 At least one installed free-standing cooker, or hob unit/

3.1.5 At least one installed gas fire and/or gas heater

3.2 A suitable room for theory assessment that enables learners to attempt multiple choice question papers, away from noise and distractions. The room must be temperate with good lighting and with desks spaced out to provide adequate separation between learners. There should also be a desk for an invigilator to use during the assessment.

4.0 HYDROGEN ACoP ASSESSMENT METHODOLOGY

4.1 Learners may be assessed using appropriate methods including (i) by multiple choice questions to determine an appropriate level of knowledge and understanding, (ii) by direct observation of practical performance tasks set out in an assessment specification and (iii) practical assessment workbook scenarios.

4.2 The marking scheme for any testing method used needs to be open and transparent to the learner and the trainer.

4.3 A hydrogen assessment pass mark is set at 100% for matters of gas safety in accordance with recognised industry practice.

4.4 Final details of the Hydrogen assessment documentation will be finalised with the Certification Body and centre(s) involved in the initial roll out of the Hydrogen Transition Training and Assessment pathway, prior to the launch of the programme.

4.5 Irrespective of Job Role (e.g., Gas Fitter, Domestic Installer or FCO) there is a single hydrogen transition competence assessment for all. This is to ensure that, in the early stages of UK hydrogen implementation, all GSR registered engineers involved in hydrogen trials must have the same knowledge and understanding of the gas and the practical capability to operate safely with this new fuel Note: as previously stated, while successful completion of this assessment will facilitate a "hydrogen competent" endorsement on Gas Safe Register, it does not change the categories of work that an engineer is able to work on. It is a fuel changeover module and **does not facilitate a GSR category change** (i.e. an FCO is not able to install appliances as a result of this assessment, and vice-versa a domestic installer is not able to carry out the role of an FCO).

5.0 KNOWLEDGE AND UNDERSTANDING

5.1 To be assessed using appropriate oral and written questions or Performance Assessment Workbook Scenarios, the specific core matters of gas safety (MoGS) that must be completed by all learners are listed below. It is important to ensure that learners are assessed on their knowledge and understanding of the fundamental differences between the properties, characteristics and behaviour between the familiar hydrocarbon gases and hydrogen. These differences necessitate changes to some work practices and the reasons for these changes must be well understood by engineers.

5.2 During the Assessment, oral answers to questions and demonstrations of performance must align, where relevant and appropriate, to the requirements of the Hydrogen Interim Standard [IGEM/H/2]. Please refer to note 1.4 for more information.

5.3 Where relevant, references to IGEM/H/2 are shown as (H2: Section/Clause) after each criterion.

5.4 **Knowledge and Understanding Criteria**

K1 Application of the Gas Safety Installation and Use Regulations in relation to hydrogen (H2:3.2,4.1)

K2 Specific requirements relating to hydrogen installations and appliances. (H2:7.1-7.14, 8.1)

K3 An understanding of the differences between hydrogen and natural gas especially with regards to any pre-existing misconceptions. To include:

(i) Combustion of hydrogen and the absence of CO.

(ii) Calorific Value (CV) of hydrogen.

(iii) Effect of the higher required flow rates for hydrogen

(iv) Effect of difference in gas density.

(v) Effect of little difference in Wobbe Index between natural gas and hydrogen.

(vi) Effect (or non-effect) of increased permeability of some materials.

(vii) Laminar leaks from cracks.

(viii) Turbulent leaks from holes.

(ix) Effect of difference in density on accumulations of hydrogen.

(x) Observed concentrations in rooms vs. predicted values.

(xi) Underlying reasons for different response of hydrogen and natural gas to tightness tests and failed tightness tests.

(xii) Effect of flame speed on overpressures.

(xiii) Potential increased noise from hydrogen ignitions.

(xiv) Differences in stochiometric mixtures of natural gas (~10%) and hydrogen (~29%).

(xv) Importance of confirming ventilation of all properties using hydrogen.

(xvi) Hydrogen does not spontaneously ignite upon leaking from LP systems, but its ignition energy is low.

(xvii) Importance of purging the whole installation from air to 100% hydrogen.

K4 Safety precautions when other hazardous materials are encountered whilst working on hydrogen installations. (H2:3.2,4.1).

K5 Engineer responsibilities regarding health, safety, and the environment. (H2:3.2,4.1)

K6 New or Interim Standards, Engineering Instructions and/or Codes of Practice relating specifically to hydrogen installations and applications (H2:3.2,4.1).

K7 Risk assessment methodology as applied to the suitability of existing installation pipework and fittings (H2: 5.1,5.2,7.1.1).

K8 Record keeping and filing of risk assessment, as necessary (H2: 5.1,5.2,7.1.1).

K9 Suitable, approved and prohibited materials for use with hydrogen installations and appliances (H2: 7.3.1 – 7.3.9).

K10 Combustion equations relating to hydrogen.

K11 Oxygen requirements for complete combustion.

K12 Actions to take when undertaking combustion performance analysis. (H2: 4.1, 8.1).

K13 Why hydrogen is not subject to incomplete combustion.

K14 State significant behavioural differences of hydrogen compared with hydrocarbon gases.

K15 Ignition temperature and flammable range.

K16 How to use a gas analyser to measure oxygen content.

K17 Define Flame picture, flame lift and light back.

K18 Hydrogen Burner types

K19 Hydrogen Gas controls

K20 Fault diagnosis methods on hydrogen installations

K21 How Hydrogen safety devices contribute to create a safe hydrogen system with reference to:

- Excess Flow Valves (H2: 6.3)
- Use of odorant
- Fixed hydrogen alarms
- UV/ temperature-based flame detection (H2: 4.1, 8.1.2, 8.1.3)
- FFDs and pre-ignition purge cycles in appliances (H2: 4.1, 8.1.2, 8.1.3)

K22 Hydrogen Condensate requirements (H2: 4.1, 8.1.2, 8.1.3).

K23 CO Alarm false positive alarms on hydrogen gas escapes.

K24 Factors affecting ventilation. (H2: 5.1).

K25 Design and types of ventilation provision. (H2: 5.1).

K26 Calculating ventilation requirements for hydrogen installations. (H2: 5.1).

K27 Ventilation labels and notices. (H2: 4.1, 8.1.2, 8.1.3).

K28 Air supply requirements for cooling and combustion (H2: 4.1, 8.1.2, 8.1.3).

K29 Mechanical ventilation and extraction requirements (H2: 4.1, 8.1.2, 8.1.3).

K30 Free area and position of ventilation (H2: 4.1, 8.1.2, 8.1.3).

K31 Route and configuration (H2: 4.1, 8.1.2, 8.1.3).

K32 Define operating pressures for hydrogen installations (H2: 2.6, 8.1).

K33 Types of pressure gauge and perceptible movement. (H2: 9.2.1).

K34 Application of permissible pressure loss. (H2: 9.1, 9.3).

K35 Dealing with let by (H2: 6.4).

K36 Actions to take when a smell of gas persists after a satisfactory test or after the ECV has been turned off. (H2: 4.1).

K37 Calculating installation and purge volumes (H2: 10.3).

K38 Potential need for inert purging of existing installations (H2: 10.1, 10.6, 13.1).

K39 Testing pipework of diameter > 35 mm or total IV > 0.035 m^3. (H2: 9.2, 9.3, Appendix B).

K40 Tightness testing before working on an installation. (H2: 9.3).

K41 Factors to consider when installing gas installation pipework for use with hydrogen (H2: 7.1, 7.2, 7.3).

K42 Copper and mild steel pipe and fittings standards, suitability, and use. (H2: 7.3.3, 7.3.4).

K43 Approved Jointing and cleaning agents for jointing copper and threaded pipework fittings. (H2: 7.3.5, 7.3.6, 7.3.7).

K44 Restrictions and specific requirements for fittings used in hydrogen installations. (H2: 7.3).

K45 Pipe sizing for hydrogen installations. (H2: Appendix A, Table A1.2).

K46 The correct types of meter approved for use with hydrogen. (H2: 6.1, 6.2, 6.3, 6.4).

K47 The need for, and purpose of an Excess Flow Valve on a hydrogen installation. (H2: 6.3.3).

K48 Meter box and enclosures approved for use with hydrogen meters (H2: 6.1, 6.2).

K49 Location criteria for hydrogen meter installations (H2: 6.2).

K50 Meter installation, exchange, and removal of hydrogen meters (H2: 10.1 – 10.7, Section 12).

K51 IGEM/G/11 - Gas Industry Unsafe Situation Procedure (GIUSR) (H2: 4.1).

K52 Situations reportable under RIDDOR. (H2: 4.1),

K53 Situations reportable to Gas Safe Register and/or HSE which are not RIDDOR reportable (H2: 4.1).

K54 Correct use of notices and labels. (H2: 6.8, 7.14).

K55 Requirements for range rated appliances. (H2: 4.1, 8.1.3).

K56 Requirements for variable-rated appliances (H2: 4.1, 8.1.3).

K57 Causes and effects of pressure loss. (H2: 4.1, 9.1).

K58 Use of electronic pressure gauge. (H2: 9.2).

K59 The principles of operation of hydrogen gas safety devices and controls.

K60 The sequence of operation of hydrogen gas safety devices and controls.

K61 Causes of leakage of combustion products from room sealed positive combustion chamber pressure appliances.

K62 Condensate management and discharge to waste (H2: 4.1, 8.1.3).

K63 Condensate production from hydrogen appliances (H2: 4.1, 8.1.3).

K64 How and where condensate may be discharged (H2: 4.1, 8.1.3).

K65 Actions to take when inspection hatches are not available for flues in voids. (H2: 4.1).

K66 Background to hydrogen transition.

K67 Development, research and testing to confirm safety of hydrogen as an alternative to natural gas

K68 Benefits to consumers of hydrogen as a fuel.

K69 Specific purging and commissioning requirements of hydrogen appliances and systems (H2: 4.1, 8.1.3).

K70 Operational checks and procedures required prior to handover (H2: 4.1, 8.1.3).

K71 Sources of additional information or support for hydrogen installations.

K72 Essential information on hydrogen usage to communicate with the end user.

K73 Specific maintenance and servicing requirements of hydrogen appliances (H2: 4.1, 8.1.3, 11.2).

K74 Operational maintenance procedures (H2: 4.1, 8.1.3, 11.2).

K75 Appliance performance checks to be carried out following maintenance work (H2: 4.1, 8.1.3, 11.2).

K76 Combustion products checks and analysis (H2: 4.1, 8.1.3, 11.2).

K77 Interpretation of data resulting from combustion product analysis (H2: 4.1, 8.1.3).

K78 Actions to take when an un-commissioned appliance is identified. (H2: 4.1, 8.1.3).

K79 Actions to take if pipework and appliance(s) are not tested (commissioned) when the gas supply is re-established. (H2: 4.1, 8.1.3, 9.1 – 9.3, 10.1 – 10.7, 11.2).

K80 Priorities and actions when dealing with hydrogen gas escapes and incidents. (H2: 4.1, 9.1 – 9.3).

K81 Hydrogen Installation Emergency Procedures (H2: 3.2, 4.1, 8.1.3, 11.2).

K82 Evacuation criteria and procedures (H2: 3.2, 4.1, 8.1.3, 11.2).

K83 Essential communication with customer(s) (H2: 3.2, 4.1).

K84 Sources of support and additional resources if required (H2: 3.2, 4.1).

K85 Effective liaison with Network Distribution personnel assisting in detection and repair (H2: 3.2, 4.1).

K86 Communication with third parties such as emergency services (H2: 3.2, 4.1).

6.0 PERFORMANCE ASSESSMENT by OBSERVATION

6.1 The tasks that must be assessed through observation are listed below. Several related tasks are combined to provide the engineer with the opportunity to demonstrate competence on all the steps needed for a particular work activity (for example: testing, purging, and commissioning an appliance).

6.2 Tasks must be performed on at least one operational CH Boiler installation, plus at least one other operational appliance type.

6.3 To determine that the learner knows the correct procedure and is competent to carry out the tasks on a range of appliances consistently, supplementary questioning may be used to enable the learner to explain a procedure, or the rationale for a particular approach.

6.4 Performance Criteria

P1 Identify correct flame picture for specific appliances (H2: 4.1, 8.1.3).

P2 Identify false positives and early warning devices of a hydrogen gas escape (H2: 3.2, 4.1).

P3 Identify and operate an approved gas analyser for use with hydrogen and undertake combustion performance analysis on a hydrogen appliance. (H2: 3.2, 4.1, 10.4.6).

P4 Identify and operate approved gas detection equipment (H2: 3.2, 4.1, 10.4.6).

P5 Explain procedures for the control of moisture from hydrogen appliances (H2: 3.2, 4.1, 8.1.3).

P6 Identify correct and incorrect ventilation provision. (H2: 3.2, 4.1, 5.1, 8.1.3).

P7 State the relevance of, and potential need for compartment ventilation (H2: 3.2, 4.1, 5.1, 8.1.3).

P8 Test for tightness and purge low pressure hydrogen gas installations. (H2: 4.1, 8.1.3, 9.1 – 9.3, 10.1 – 10.7).

P9 Trace and make safe a downstream hydrogen gas escape (H2: 4.1, 9.1 – 9.3).

P10 Initiate appropriate actions dependent upon tightness test outcome (H2: 4.1).

P11 Check that the meter fitted is for use with hydrogen (H2: 6.1, 6.3, 6.4).

P12 Correct setting of domestic SMART meter excess flow valve (see Appendix One).

P13 Testing of domestic SMART meter excess flow valve (see Appendix One).

P14 Installation of mechanical excess flow valve downstream of ECV and confirmation of operating regime. (see Appendix One).

P15 Check that the hydrogen meter is correctly located, installed, and labelled (H2: 6.1, 6.3, 6.4, 6.8).

P16 Measure and record the meter outlet pressure. (H2: 4.1).

P17 Measure and record appliance inlet pressures. (H2: 4.1).

P18 Calculate the heat input of an appliance. (H2: 4.1, 8.1.3).

P19 Determine if the installation working pressure is correct or incorrect. (H2: 4.1, 8.1.3).

P20 State the actions to take if the working pressure is incorrect. (H2: 4.1, 8.1.3).

P21 Test and adjust the operation of Excess Flow Valves as necessary (H2: 6.7).

P22 Explain the operation of Smart Meter excess flow valve (H2: 6.7).

P23 Identify and classify different categories of unsafe situations (H2: 4.1).

P24 Demonstrate the procedure to follow for each classification of unsafe situation (H2: 4.1).

P25 Visually inspect each appliance for unsafe situations (H2: 4.1, 8.1.3).

P26 Complete, explain and issue appropriate warning/advisory labels and notices.

P27 Identify and explain the operation of hydrogen gas specific safety devices and controls.

P28 Check gas safety devices and controls for correct operation and carry out any corrective action where necessary (H2: 4.1, 8.1.3).

P29 Visually inspect chimney systems to confirm correct and incorrect installation. (H2: 4.1, 5.1, 8.1.3).

P30 Perform a spillage test on a hydrogen appliance connected to an open flue system. (H2: 4.1, 8.1.3).

P31 Carry out a Flue Flow Test for a hydrogen gas fire installation (H2: 4.1, 8.1.3).

P32 Perform a combustion case seal test on a room sealed fan assisted positive pressure appliance (H2: 4.1, 8.1.3).

P33 Establish a stable flame on each appliance (H2: 4.1, 8.1.3).

P34 Check operation of any Flame Failure Device (FFD) (H2: 4.1, 8.1.3).

P35 Demonstrate the ability to commission a hydrogen appliance in accordance with Manufacturer's Instructions to full working operation (H2: 4.1, 8.1.3).

P36 Confirm satisfactory operation of user controls. (H2: 4.1, 8.1.3)

P37 Handover the appliance to the end user, explaining new features and appliance operation in accordance with manufacturer's instructions (H2: 4.1, 8.1.3).

P38 Demonstrate the ability to adjust appliance components as necessary to manufacturer's instructions (H2: 4.1, 8.1.3).

APPENDIX ONE – SUPPLEMENTARY NOTES FOR ASSESSMENT CENTRES AND CERTIFICATION BODIES

Introduction

Research, testing and development of appliances and associated equipment that will be used in the initial public trials of hydrogen, is ongoing. Outcomes of this work are likely to impact on the content of this Assessment Module and amendments, to align with these outcomes are possible. These supplementary notes are intended to provide guidance on some specific aspects to those involved in delivering and certificating this assessment.

Assessing Knowledge and Understanding

Section 5.3 of the Module provides the K/U criteria, with K3 listing a range of aspects. It is essential that all engineers are assessed on their knowledge and understanding of the different properties and characteristics of hydrogen…and what effect these differences make. Assessment questions may be grouped appropriately if preferred, for example:

- Properties of hydrogen as compared with natural gas (cv, density, Wobbe number, etc.)
- Effect of hydrogen properties on (ignition; combustion products; required flow rates; leakage through materials, creaks, holes; etc.).

Note on Ventilation (K24-30)

This is an active area of work. It is currently agreed that properties using hydrogen will have to demonstrate compliance with Building Regulations ADF (England and Wales) or regional equivalent. The details of this are still being developed.

Note on Inert purging (P8)

This is another area subject to ongoing work. It is possible that inert purging will not be recommended for domestic installations (<35mm pipe and <0.035m3) and, once a definitive decision has been made, this assessment may need to be amended accordingly

Note on Excess Flow Valves (P12,13,14,21,22)

Excess Flow Valves (EFV) that shut off the gas in the event of a major internal leak, will be installed as part of the hydrogen installation. Currently it is not known if the EFV will need to be set and/or adjusted by the installation engineer. If this is required then an assessment of both knowledge and capability to perform this task will need to be included, to cover the following aspects:

- The purpose and functionality of excess flow valves
- The installation of mechanical excess flow valves (20m3/h)
- The testing of mechanical excess flow valves
- The calculation of the set point of SMART meter excess flow valves using manufacturers literature
- The adjusting and/or exchange of hydrogen meters to achieve the required SMART meter excess flow valve trip point.
- The testing of SMART meter trip point (if required).

Note on Audible Alarms

There may be a need for the installation of audible alarms for some hydrogen installations. If this does become a general requirement then the assessment will need to be amended to incorporate this.

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