Contractors for the Provision of Hydrogen End User Skills and Standards for Heat Supporting Research and Evidence Lot 3 – Ventilation

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Approved by
[This information has been redacted] Chief Financial Officer

Commercial in confidence

Trust
Quality
Progress

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1 Project appreciation

Hydrogen is being increasingly considered as a heating gas in homes as a means of aiding the UK in meeting its carbon dioxide emissions targets. However, the differences in physical properties between hydrogen and natural gas leave several questions around how current practice would alter, including ventilation requirements in voids between floors, and ventilation for open flued or flueless appliances. It is therefore apparent that work is required to adequately inform the standards committee on how to proceed with ventilation requirements for hydrogen piping and appliances inside the home.

This work will undertake a set of scenario specific ventilation and flueing projects to address specific gaps in the evidence base. The work is not seeking to examine whole property ventilation. It is intended to provide evidence to understand the requirements of specific sub-categories of installation work such as ventilation of inter floor piping/voids and flueing requirements of specific appliances such as hydrogen gas fires. The work splits into two workstreams:

- Ventilation associated with pipework located within voids, shafts and ducts.
- Ventilation and flueing requirements of open flued and flueless appliances such as hydrogen gas fires, water heaters, hobs and cookers.

This document details the proposal from Kiwa Ltd in response to the invitation to tender for Lot 3 of the Hydrogen Skills and Standards for Heat Supporting Research and Evidence. Below we describe our proposed route to complete the literature review and experimental work required to inform the ventilation requirements for hydrogen in the home.

Kiwa Gastec has worked on ventilation issues for many years and would like to discuss a number of additional issues (not identified in the Invitation to Tender) with BEIS during the project kick-off meeting. Some of these should be able to be included within the current budget. We suggest they could add real value to the output currently being considered.

1. Peak hydrogen and natural gas concentrations within the floor unit when first achieving 500 to 1000ppm in a room at head height. This is the concentration at which most people smell gas and are therefore likely to detect and address the leak. The relative concentrations can then be related to the relative risk of a deflagration.
2. Recent field work to consider properties' suitability for hydrogen has raised interesting questions about preferential venting into redundant chimneys as both a risk but also an opportunity for inconspicuous ventilation. It also raises questions about the need to repair holes in the ceilings of cupboards that might have had Regular boiler systems in the past (ie separate DHW and CH header tanks).
3. The best mechanisms for venting meter installations when the meter cannot be installed externally, perhaps because it restricts an access.
4. Discussions could also usefully be held with fan extract manufacturers.

2 Methodology and proposed approach

This section outlines our proposed approach and methodology to meet the project objectives. The methodology closely follows the requirements set out in the BEIS ITT.

2.1 Pipework in Voids

BS 6891:2015+A1:2019[1] – Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm (R1¼) on premises applies to natural gas installations only.

The Gas Safety (Installation and Use) Regulations require “adequate ventilation to be present when pipework is located within voids, shafts and ducts”.

The Advantica Research Report 6699[2] sets out detailed equipment descriptions and procedures for experimental test work using a simulated floor with leaks induced in the void between ceiling and floorboards. Annex C of BS 6891 summarises the results and conclusions of the work. More comprehensive results are included in the report itself.

The work detailed in the report will be repeated to address similar concerns in respect of “minor” leakage from installation pipework carrying hydrogen.

2.1.1 Literature Review

This will be a desk-based study finding and reviewing the relevant legislation, standards and industrial guidance documents pertaining to “minor” leakage from installation pipework and ventilation in voids. A thorough review of the Advantica Research Project, “Gas in intermediate floors” will be carried out. We will also review Hy4Heat outputs and any other relevant industry information. In particular, we expect to consult the Building Research Establishment on areas such as the impact of ventilation on energy efficiency and SAP. BEIS procedures and methodology for literature review will be adopted.

The literature review will be used to inform the design of a testing methodology to address the evidence gap.

2.1.2 Testwork

2.1.2.1 Test equipment

An experimental test floor section will be designed and built. This will closely follow the design in the Advantica report. To construct this equipment, Kiwa will adapt an existing test setup which has been used to test odorant addition to hydrogen, see

1 BS 6891:2015+A1:2019 Specification for installation of low pressure gas pipework of up to 35 mm (R1¼) on premises

2 Advantica Research Report 6699 Gas Pipes in Intermediate Floors (May 2007)

Figure 1 below. The work was carried out as part of SGN's H100 Fife programme. Hydrogen and natural gas were separately leaked into the room at a range of flowrates. The air sampling arrangement was used to take samples from 10 different points within the room. The concentration of gas in air was then determined using a gas chromatograph. Graphs of gas in air against time were produced, similar to the graphs presented in the Advantica report.

Figure 1 Room used to test odorant performance in hydrogen

The air sampling system was operated continuously throughout the test programme, and a proprietary sequencer was used to pass the samples to the chromatograph. The air sampling sequencing equipment. and the gas chromatograph and data logging system are shown in Figure 2. Gas injection equipment is shown in Figure 3.

Figure 2 Gas sampling, gas chromatograph and data logging equipment

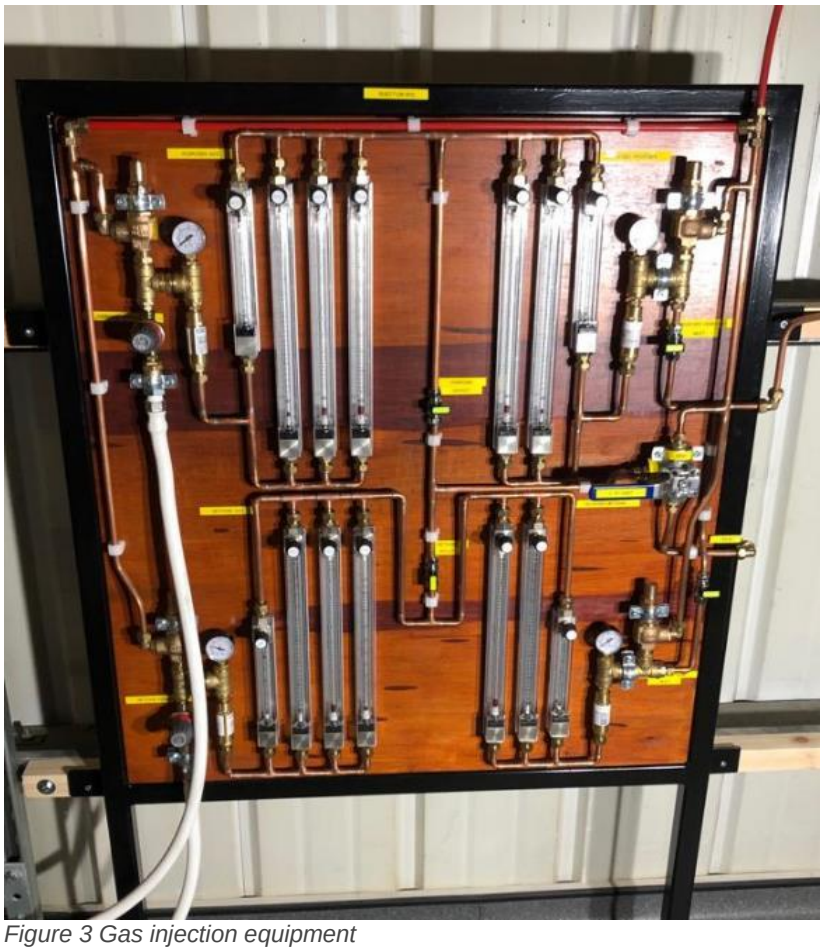


Figure 3 Gas injection equipment

The floor section will be constructed as a replica of the Advantica setup. Fortunately, the Advantica report contains sufficient description, diagrams and drawings to enable an exact replica to be built in Kiwa's laboratories.

2.1.2.2 Test programme development

A test protocol and test programme will be developed. The test protocol will closely follow the methodology developed by Advantica. The testwork will be divided into two parts:

- The first set of tests will use natural gas and will repeat parts of the Advantica test programme. This will enable direct comparison of the results from the Advantica and Kiwa test rigs. It may be necessary to adjust the air tightness of the floor section to obtain comparable and repeatable results.
- The second set of tests will use hydrogen and will replicate the natural gas testwork. This will enable a direct comparison between the behaviour of hydrogen and natural gas when leaked into voids.

Data will be logged using a PC and the resulting data files will be made available with the final report. The data will be analysed using standard data analysis and graphing procedures.

In line with Kiwa's normal experimental procedures, particular care will be taken to analyse the measurement uncertainties and determine repeatability.

2.1.3 Reporting

Two reports will be issued to BEIS as a result of the work discussed above:

- a literature review report, which will contain the findings of the review and will be issued part way through the 12 month timescale of the project; and
- a full report, which in addition to a summation of the key findings of the literature review will also outline the experimental methodology and results of the experimental work. The full report will give a complete description of the tests performed, and elucidate any differences observed in the behaviour of natural gas and hydrogen. It will also highlight any changes required in the ventilation of voids due to the introduction of hydrogen. This information can then be used to inform standards development, which will, in turn, allow the production of training and assessment programmes for gas fitters working with hydrogen.

Both reports will be written to the sufficient level of technical detail, but presented in an easy-to-understand manner.

2.2 Ventilation and Flueing

The research will cover ventilation and flueing requirements of open-flued and flueless appliances such as hydrogen gas fires, water heaters, hobs and cookers found in domestic and non-domestic settings. Such ventilation is required to ensure adequate air supply for efficient combustion without depleting air quality for the occupants of the

room. Conversion to hydrogen eliminates all risk from the production of either carbon monoxide or carbon dioxide, but it may change the potential production levels of other toxic or undesirable products such as oxides of nitrogen (NO_x).

Additionally, combustion of hydrogen results in the production of water vapour. This is easily calculable, and it will be straightforward to assess the impact on flue materials and what the appropriate ventilation and/or flueing requirements are which will protect against problems such as condensation and mould growth within properties. There is a need to determine whether any specific measures will be necessary to prevent problems arising from hydrogen combustion and to prepare the appropriate and associated standards, specifications and installation procedures.

2.2.1 Literature Search and Assessment of Existing Evidence

The principal standards covering combustion ventilation and flues for residential and small commercial appliances are BS 5440-13, BS 55464 and these relate to 1st and 2nd family gases. In addition, IGEM/UP/10, IGEM/UP/11 and IGEM/UP/16 also relate to flued appliances but mainly in relation to natural gas utilisation in non-domestic installations.

Some work has been carried out in the Hy4Heat[5] programme both by the technical teams and also by hydrogen appliance manufacturers. As technical lead on the Hy4Heat programme Kiwa is fully aware of this work. Kiwa maintain strong links to appliance manufacturers, developers, and the trade body, the Heating and Hotwater Industry Commission (HHIC). We have also worked on all the major domestic hydrogen programmes including H21[6], HyDeploy[7] and H100[8].

We will identify and review relevant standards and existing evidence covering combustion ventilation and flues for residential and small commercial to determine significant gaps and further testing work required. BEIS procedures and methodology for literature review will be adopted.

2.2.2 Physical Testing

The detailed methodology of the physical testing programme will be defined and carried out in Kiwa's appliance testing laboratory.by the appointed testing house to support the preparation of the standards under Hydrogen Skills and Standards for Heat.

3 BS 5440-1:2009 Flueing and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases).
4 BS 5546:2010 Specification for installation and maintenance of gas-fired water-heating appliances of rated input not exceeding 70 kW net
5 Hy4Heat Programme. **https://www.hy4heat.info/**
6 H21 Gas Industry Projects. **https://h21.green/**
7 HyDeploy Programme. **https://hydeploy.co.uk/**
8 H100 Fife Project. **https://www.sgn.co.uk/H100Fife**

The exact programme of work will be developed and defined in the early stages of the research, and will be dependent on the results of the literature review. However, it is likely to involve testing of hydrogen fired appliances, and measurement and calculation of flue gas emissions, in particular NO_x and water vapour.

2.2.3 Reporting

Two reports will be issued to BEIS as a result of the work discussed above:

- a literature review report, which will contain the findings of the review and will be issued part way through the 12 month timescale of the project; and
- a full report, which in addition to a summation of the key findings of the literature review will also outline the experimental methodology and results of the test work. The full report will give a complete description of the tests performed, and calculations and measurements made. It will also highlight any changes required in the ventilation of rooms or flueing of appliances. This information can then be used to inform standards development, which will, in turn, allow the production of training and assessment programmes for gas fitters working with hydrogen.

Both reports will be written to the sufficient level of technical detail, but presented in an easy-to-understand manner.

2.3 Answering the research questions

The tasks identified by the project team that are required to answer the key research questions are outlined in Table 1 below. The team would welcome any further questions identified by BEIS.

Table 1: Research questions and their link to the methodology

Area	Questions
Ventilation and leaks in voids	How does the dispersion of hydrogen from leaks in voids differ to the dispersion of natural gas?
	What are the risks resulting from hydrogen leaks in voids compared with natural gas leaks?
	Are current standards for ventilation in voids adequate if the internal pipework is repurposed to carry hydrogen?
	What would installers need to do differently when repurposing internal pipework to hydrogen?
Appliance testing and ventilation	What is the impact of hydrogen use on water vapour in flue gas compared with natural gas?
	Does the change in gas result in additional ventilation requirements for rooms where flued or flueless appliance are installed?
	What is the impact of hydrogen use on oxides of nitrogen in flue gas compared with natural gas?
	Does flue material need to be changed for hydrogen use?

Area	Questions
	What is the impact of room air tightness on ventilation requirements to prevent mould growth?
Recommendations	Do installation standards need to be changed to take account of hydrogen use?
	What additional training would be required for installers replacing natural gas pipework and appliances in domestic and commercial properties?

3 Kiwa skills and expertise

Kiwa Ltd is a UK based private company wholly owned by the Kiwa Group (which has its headquarters in the Netherlands). Kiwa Gastec is a trading division of Kiwa Ltd. It undertakes energy consultancy activities including feasibility studies, research and development, verification of greenhouse gas emissions, operative certification and product testing services for a wide range of commercial customers.

With roots in the testing of heating systems (from the former Coal Research Establishment) Kiwa Gastec has developed a long and wide-ranging experience with renewable gas, liquid, and solid fuels. Kiwa also has experience with heating technologies through numerous practical projects evaluating real life performance of heat pump, gas boiler and biomass systems. Over the past 10 years, Kiwa has had a deep involvement with the work to progress hydrogen as a major energy vector across all energy sectors in the UK, particularly as a solution to decarbonising the UK's heat demands.

Kiwa has played a significant role in many of the major projects undertaken in the UK to develop the knowledge and understanding of hydrogen energy systems. A few example projects are outlined below:

- ***Kiwa SMR:*** Kiwa is currently developing its own hydrogen production site to be able to feed large quantities of hydrogen into its testing laboratories. This includes both the production site and a new hydrogen laboratory space, including facilitating the connection of domestic-scale appliances.
- ***BEIS Hy4Heat:*** Kiwa is the technical lead on this government programme developing the standards, appliances, components and safety case to de-risk the provision of distributed hydrogen for heat.
- ***SGN H100 R&D phase:*** Kiwa has carried out extensive experimental testing in support of the H100 programme. This has included the dispersion of hydrogen and natural gas in rooms, meter boxes, and appliances along with the consequences of ignition of leaks. Studies have measured the overpressures from ignitions, along with the resulting force and impulse. We have also carried out experimental work on the dispersion of odorised hydrogen and methane within a room.
- ***SGN H100 Design phase:*** Kiwa completed the feasibility and FEED designs of the hydrogen system utilising renewable electricity from offshore wind to produce hydrogen distributed through pipelines to 300 homes for use in domestic heating.

- ***Cadent HG2V – Hydrogen Grid to Vehicle:*** Kiwa was part of a consortium addressing the challenges associated with impurities picked up through hydrogen pipeline distribution. Kiwa developed work addressing purification challenges around impurities such as odorants.
- ***BEIS Hydrogen Appliances Project:*** An investigation of the state of the art of hydrogen heating equipment including domestic, commercial, and industrial scales of technologies.

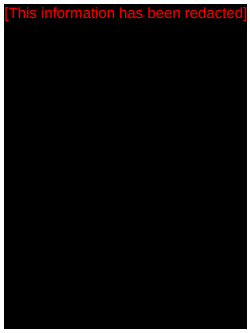
Kiwa is accredited for testing and certification of gas appliances, including equipment fuelled by gas that is 'mainly hydrogen'. Appliance testing with hydrogen is already being undertaken and currently the Kiwa SMR plant (fuelled mainly by biogas) is under construction adjacent to the test laboratory to provide a reliable source of hydrogen for prolonged testing of appliances.

Kiwa has worked with the UK government on many occasions, informing policy development for energy, in particular, domestic renewable heating technologies and hydrogen for heat.

3.1 Team member specific skills and expertise

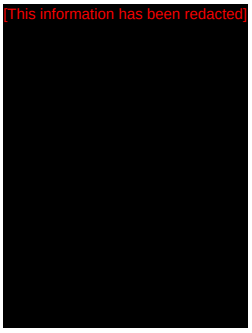
Each team member has the high level of relevant research, analytical expertise and practical experience required to deliver their assigned tasks. CVs are included in an Annex to this proposal, brief descriptions of the team members are shown below.

[This information has been redacted] **Project Director**



[This information has been redacted] is Head of Special Projects at Kiwa. He is an environmental chemical engineer with a broad experience in energy and environmental research and consultancy. He was recently Project Manager for a number of hydrogen projects for Gas Distribution Network Operators, notably feasibility and safety studies for SGN's H100 programme.

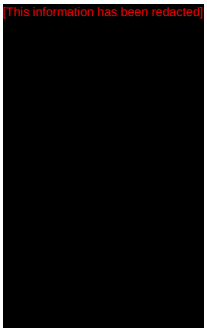
[This information has been redacted] **Project Manager**



[This information has been redacted] is an experienced energy consultant with an interest in integration of renewable energy technologies into the existing energy infrastructure and the potential role of hydrogen for decarbonisation. Her role at Kiwa includes leading and contributing to a range of projects for UK Government, network operators, independent organisations and local authorities. [This information has been redacted] has project management and organisational skills having led and coordinated national field trials and experimental studies. She has technical knowledge and practical experience of innovative research into hydrogen as well as a large variety of domestic and commercial technologies at varying scale and complexity. [This information has been redacted] led one of Kiwa's first experimental programmes to assess the comparative risk between natural gas and hydrogen. She was the PM for the

work on odorisation which used the equipment proposed here. Most recently she has led the development of Kiwa's on-site SMR.

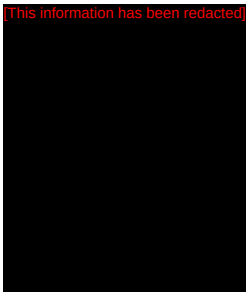
[This information has been redacted] **Experimental Expert**



[This information has been redacted] is a Senior Energy Consultant working on projects involving carbon reduction and NetZero strategies. His role at Kiwa involves managing consultancy projects as well as being responsible for experimental work on new developments in domestic energy use.

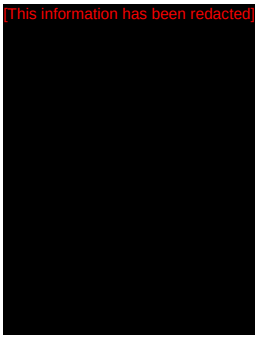
[This information has been redacted] has led or contributed to large projects for government, local authorities and network operators on decarbonisation strategies involving hydrogen, with a particular focus on gas analysis and experimental analysis. This includes work on the Hy4Heat and H100 programmes.

[This information has been redacted] **Appliance Testing Expert**



[This information has been redacted] is responsible for the certification of gas, oil and solid fuel appliances to the Gas Appliance Regulation, Boiler Efficiency Directive and Construction Products Regulations, with over thirty years of experience testing a range of gas, oil, and solid fuel appliances to European and British Standards.

[This information has been redacted] **QA**



[This information has been redacted] has a broad knowledge of conventional and renewable energy technologies and is a technical specialist in the area. [This information has been redacted] has extensive experience of QA reviewing of the outputs from a wide range of research projects including those from the BEIS biomass field trial and various outputs from the Hy4Heat programme. He managed the QA work by Kiwa on the BEIS heat pump field trial.

3.2 Skills matrix

The skills matrix of the team members proposed is shown in Table 2 below.

Table 2: Skills matrix for proposed project team. Values for the relevant assignments are shown in bold.

Skill	[This information has been redacted]				
Literature Searching	2	3	2	1	3
Experimental design	3	3	3	1	3
Experimental work	3	3	3	2	2
Appliance test work	2	1	1	3	2
Data Analysis	2	3	3	2	2
Reporting	3	3	2	2	2
Project Management	3	3	1	1	1
Quality Assurance	2	2	2	1	3

Key:

Grade	Skill Level
1	Familiar
2	Proficient
3	Expert

4 Addressing challenges

Individual projects have different associated challenges. Several are identified in the ITT and here we respond to these and others identified during the preparation of this bid.

Table 3: Risk Register

Risk - description - the event	Risk - the causes	Risk - the impact, effect, consequences	Proximity	Manage Risk?	Controls in place	Adequacy	Probability; Impact; PxI			Actions to reduce risk to target
Important literature overlooked or missed from review	Reviewer was not aware of the existence of evidence Literature not publicly available	Proposed methodology does not reflect current thinking	Medium	Treat	• List of important contacts will be devised during project inception meeting • Multiple people will input into review • Budget to purchase literature as needed	OK	1	3	**L**	
Unable to replicate previous Advantica results for voids	Equipment design differences	Comparison between hydrogen and natural gas behaviour invalidated	Medium	Treat	• Detailed design drawings and photos available • Can adjust air tightness to ensure replicable results	OK	1	4	L	
Inadequate results from appliance testing	Empirical test results are inconclusive or do not verify the theoretical calculations as required	Proposed methods for new installation standards are not empirically verified	Medium	Treat	• ISO 17025 accredited test laboratory • Results reviewed by test colleagues and QAM	OK	1	4	L	

Risk - description - the event	Risk - the causes	Risk - the impact, effect, consequences	Proximity	Manage Risk?	Controls in place	Adequacy	Probability; Impact; PxI			Actions to reduce risk to target
BEIS not satisfied with work	Work of inadequate quality, misunderstanding of requirements	Project delay, budget exceeded	Medium	Treat	• Obtain early feedback from reviewers • Discuss and seek clarification from BEIS, resolve issues, communicate to project team	OK	1	2	L	
Quality of reporting inadequate	Errors made in reporting, inadequate understanding of BEIS report format	Inadequate reporting quality, BEIS dissatisfied	Medium	Treat	• Effective QA process in place • Contractor has years of experience delivering reports to BEIS standard • Acceptance of the reporting standards as specified in the ITT	OK	1	3	L	All outputs will be reviewed by another senior member of Kiwa staff before they enter the QA stage.
Non-availability of experts with the right skills at the appropriate time	Contractor cannot provide staff with appropriate set of skills Expected absence or unexpected illness Loss of key staff	Project delay, missed deadlines, inability to deliver objectives	Medium	Treat	• Ample overlap of skills within the project team • Each member of the project team has skilled colleagues to call upon, and can do so easily	OK	1	3	L	

Risk - description - the event	Risk - the causes	Risk - the impact, effect, consequences	Proximity	Manage Risk?	Controls in place	Adequacy	Probability; Impact; PxI			Actions to reduce risk to target
Test facilities/ equipment not available at required time	Equipment malfunction Unavailability of technical staff Conflicts with other commitments	Project delay	Medium	Treat	• Bespoke test equipment for the voids work • Multiple test settings available for appliance tests • Kiwa has strong project management capabilities	OK	1	3	**L**	
Progress stalled/overspent due to miscommunication	Project partners		Medium	Treat	• Regular meetings to be arranged between partners to ensure all are informed	OK			L	

5 Management and delivery

5.1 Project management

We recognise the three KPIs that will be used to monitor the work:

- Timeliness of delivery: Work delivered to timescale agreed
- Quality of delivery: Work delivered to the standard agreed
- Risk register: Up-to-date risk register maintained

The project team consists of experienced energy consultants and researchers from Kiwa.

The key roles are described below.

Project Director (PD) – [This information has been redacted]

To provide continuity across the whole duration of the project there will be an overall PD. The PD will provide oversight of the activities of the activities of the project team. The PD will be responsible for final sign off of outputs.

Project Manager (PM) – [This information has been redacted]

Day to day project management will be carried out by the Kiwa Project Manager. BEIS will be updated at regular intervals throughout the duration of the project. [This information has been r] will also be heavily involved in completing the tasks of the project.

The PM will be the primary point of contact with BEIS. She will provide the regular progress reporting tasks and meetings are delivered as defined in the ITT. The PM will also be responsible for the construction of the test equipment and completion of the whole research project to time and budget.

Experimental Expert – [This information has been redacted]

The experimental expert will be responsible for the completion of the experimental programme on ventilation in voids. This will include experimental programme design and implementation, data analysis, and reporting.

Gas Appliance Testing Expert – [This information has been redacted]

The appliance testing expert will be responsible for the work on ventilation and appliances. This will include test programme design and implementation, data analysis, and reporting.

QA Manager (QAM) – [This information has been redacted]

The QAM will be responsible for the ongoing data quality throughout the project. In particular, interactions with stakeholders and other participants, data analysis and reporting will be monitored.

5.2 Project team allocation

The organisation and management structure are summarised in Figure 4 below.

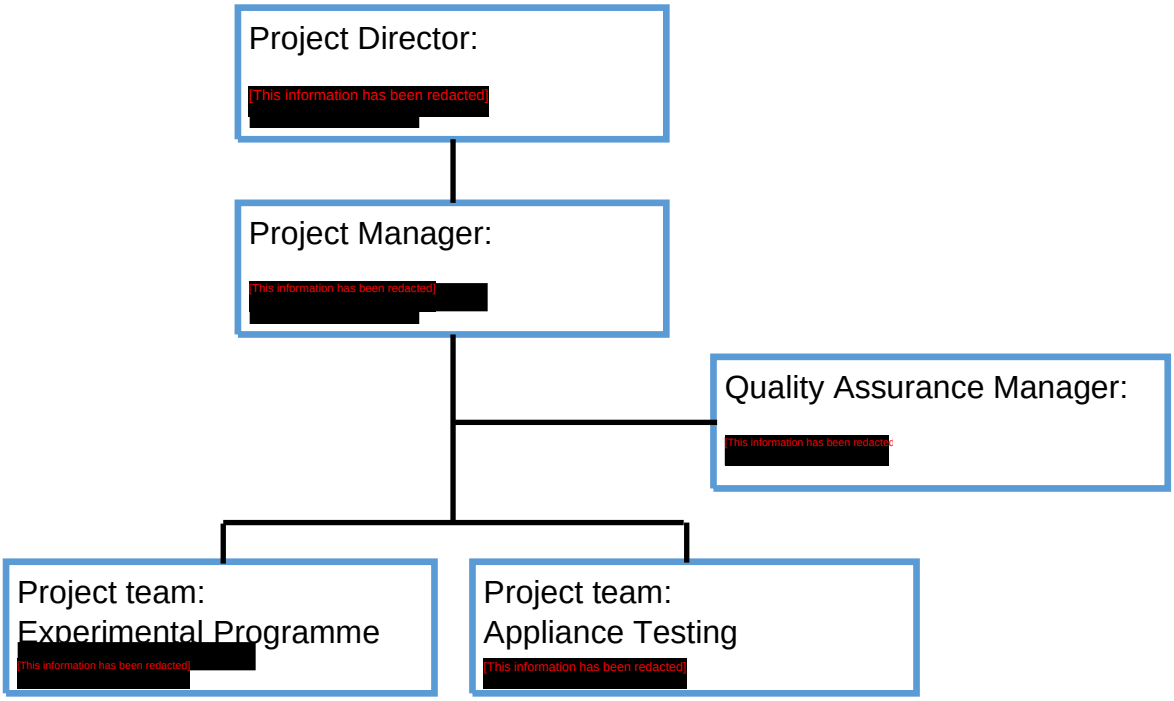


Figure 4 Project Team Structure

5.3 Kiwa ethics

This project includes literature review and engagement with relevant industry and trade organisations to provide scientific / technical context for any experimental activities. Engagement will relate only to their business activities. Outcome of any engagement will only be reported in anonymised form.

Consultees will be selected on the basis of their areas of business activity in relation to the area of research covered by the project. The context of the engagement (i.e. to inform research commissioned by government with regards to the defined scientific and technical area), will be described. It will be made clear that:

- involvement is voluntary
- information will be treated in confidence
- information will not be published without permission from the consultee.

No research is envisaged directly with members of the general public or with any persons whose business is not linked to the scientific/technical area covered by the research. Should the need for any interaction of this sort arise it will only be undertaken once the methodologies have been fully defined and agreed with BEIS. Such methods will adhere to the relevant Government Social Research Principles.

5.4 Delivery plan

The tasks and sub-tasks from the methodology (Section **Error! Reference source not found.**) are shown below in the Gantt chart in Figure 5 and are illustrated with planned timescales.

Task	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Planning												
Pipework in Voids												
Literature Review												
Test work												
Reporting												
Ventilation and Flueing												
Literature Review												
Test work												
Reporting												
Project Management												

Figure 5 Timescales

5.5 Change control

If BEIS wishes to change the scope, the PM would request the scope of the change is defined and offer a series of priced options for fulfilling the scope. If Kiwa identify a potential change, which could have an impact on budget or programme, the PM will propose the change with several options for implementing it to BEIS. Subject to approval by BEIS, the proposed change in scope will be added to or subtracted from the previously agreed scope.

5.6 Quality assurance

Kiwa's quality management system is designed to meet the requirements for accreditation to ISO 17025 for testing and to ISO 17065 for product certification. For a test laboratory compliance with ISO 17025 is a means of ensuring that both the technical competence requirements and management system requirements are met. These are necessary to ensure consistent delivery of valid test results and calibrations.

The management system requirements in ISO/IEC 17025:2005 (Section 4) are couched in terms appropriate to laboratory operations and meet the principles of ISO 9001:2008 Quality Management Systems — Requirements and are aligned with its pertinent requirements.

To ensure the successful delivery of this project, clear structures will be put in place to define the responsibilities of the project team, to encourage team working and to ensure that the customer's needs are fully understood. Every project task item will be planned in detail, defined, timed and costed and the progress will be continually reviewed against the plan. Corrective actions will be implemented immediately if progress deviates from the plan. This will be backed up by a review process to ensure that the project is working towards the desired outcome.

By collaborating as delivery team partners, [This information has been redacted] will act as day-to-day quality assurance, acting to check the work of the others as it is produced, and ensure that the final product meets our high quality standards.

As an additional quality assurance check, [This information has been redacted] will act as quality assurance manager (QAM). [This information] will provide independent assurance as someone within Kiwa who will not be directly involved in the project's delivery.

6 Social Value

In this section we identify how Kiwa addresses the social value matters identified in the ITT.

Measures to tackle workforce inequality. Demonstration of supporting in-work progression to help people, including those from disadvantaged or minority groups, to move into higher paid work by developing new skills relevant to the contract.

Kiwa operates an equal opportunities policy, which is underpinned by a technical competency framework that identifies career paths and the technical competencies required to reach each grade within each career. These technical competencies are benchmarked against national and international standards for engineering, science and management. This framework acts as the corporate point of reference for recruitment, training, performance assessment and the setting of pay bands. As such, its use ensures that Kiwa is objective and competency-led in its employment decisions.

Kiwa's work is knowledge-based and often unique, so individuals are recruited as much for their ability to apply scientific principles and engineering best practice, as they are for their knowledge on day one. Staff are promoted from within the organisation wherever possible, since the technically rigorous approach to the work, applied across a broad range of technologies and projects, is not easy to replicate elsewhere. Therefore Kiwa tends to recruit from younger demographics with increasingly diverse backgrounds and to grow talent from within.

Measures to increase supply chain resilience and capacity. Demonstration of collaboration throughout the supply chain, and a fair and responsible approach to working with supply chain partners in delivery of the contract.

Kiwa is a specialist technical organisation, so most of its work is delivered in partnership with other technical specialists and organisations. Often Kiwa will have a mutually supportive relationship with a partner organisation (e.g. Building Research Establishment) that allows it to take the lead on some projects and provide specialist advice on others led by the partner (e.g. supporting BRE on the development of SAP). It is therefore in Kiwa's best interests to treat its partners fairly and responsibly, since this helps to build closer, longer-term relationships, which in turn increase efficiency and productivity.

7 Costs and pricing arrangements

Costs are shown in Table 4 and Table 5 below.

Table 4 Costs broken down by work package and tasks

Item	Price
Project Management	[This information has been redacted]
Pipework in Voids	
Literature Review	
Testwork	
Reporting	
Ventilation and Flueing	
Literature Review	
Testwork	
Reporting	
Consumables	
Equipment	
Contingency	
Total	**£210,900**

Table 5 Costs in BEIS format

Deliverable / Milestone	Charge type	Activity undertaken	Day rate/ charge (exc VAT)	Number of days	Total
BEIS acceptance of the project delivery plan	Director Level 1		[This information has been redacted]		
	Head of Department Level 2	Planning and PM			
	Principal Consultant Level 3	Planning and PM			
	Senior Consultant / Engineer Level 4	Planning and PM			
	Non-Staff:				
	Non-Staff:				
BEIS acceptance of literature review	Director Level 1				
	Head of Department Level 2	Literature Review			
	Principal Consultant Level 3	Literature Review			
	Senior Consultant / Engineer Level 4	Literature Review			
	Equipment				
	Consumables				

Deliverable / Milestone	Charge type	Activity undertaken	Day rate/ charge (exc VAT)	Number of days	Total
Interim presentation and report of progress (to be held and submitted once at least 50% of the work can be presented)	Director Level 1		[This information has been redacted]		
	Head of Department Level 2	Experimental work and data analysis and reporting			
	Principal Consultant Level 3	Experimental work and data analysis and reporting			
	Senior Consultant / Engineer Level 4	Experimental work and data analysis and reporting			
	Equipment				
	Consumables				
BEIS acceptance of the draft report	Director Level 1				
	Head of Department Level 2	Experimental work and data analysis and reporting			
	Principal Consultant Level 3	Experimental work and data analysis and reporting			
	Senior Consultant / Engineer Level 4	Experimental work and data analysis and reporting			
	Equipment				
	Consumables				

Deliverable / Milestone	Charge type	Activity undertaken	Day rate/ charge (exc VAT)	Number of days	Total
Receipt of final report	Director Level 1		[This information has been redacted]		
	Head of Department Level 2	Reporting			
	Principal Consultant Level 3	Reporting			
	Senior Consultant / Engineer Level 4	Reporting			
	Equipment				
	Consumables				
BEIS acceptance of the final report	Director Level 1				
	Head of Department Level 2	Reporting			
	Principal Consultant Level 3	Reporting			
	Senior Consultant / Engineer Level 4	Reporting			
	Equipment				
	Consumables				
		[Add			
Full Price Offered				**TOTAL (exc VAT)**	**£ 210,900**
				VAT	**£ 42,180**
				TOTAL (inc VAT)	**£ 253,080**

8 Declarations

Declarations are included in the attached files:

Kiwa - Lot 3 - Declaration 1 Statement of Non-Collusion.pdf

Kiwa - Lot 3 - Declaration 2 Form of Tender

Kiwa - Lot 3 - Declaration 3 Conflict of Interest.pdf

Kiwa - Lot 3 - Declaration 4 Standard Selection Questionnaire.pdf

Kiwa - Lot 3 - Declaration 5 - GDPR Declaration.xlsx

Kiwa - Lot 3 - Declaration 6 Research Code of Practice.pdf

9 CVs of team members

Full CVs of the delivery team are included in the attached file (Kiwa - Lot 3 - Staff CVs.pdf).