Proposal for
Provision of Hydrogen end User Skills and Standards for Heat Supporting Research Evidence. Lot 5

Department for Business, Energy & Industrials Strategy

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1 THE DNV PROPOSED SOLUTION: LOT 5: METER INSTALLATION VENTILATION AND EFV SETPOINTS AND INSTALLATION

Aim 1: Investigate and gather evidence for the fitness for purpose of current meter installations in terms of ventilation requirements.

Aim 2: Develop guidance for specification of Excess Flow Valves (EFVs) in relation to certainty of operation, setpoint level versus demand.

The task is divided into two distinct parts:

- Ventilation associated with meters – both domestic and industrial.
- Use of Excess Flow Valves – practicalities and effect on risk

A practical experimental approach is suggested, supported by upfront literature review to focus the experimental programmes at the most evident gaps in knowledge.

1.1 Evidence Gathering

The structure and scope of the overall study associated with Lot 5 – task 1 will be based on an initial literature survey and evidence gathering activity. Key documentary evidence including BS 6400-1:2016 Specification for installation, exchange, relocation, maintenance and removal of gas meters with a maximum capacity not exceeding 6 m3/h – Part 1: Low pressure (2nd family gases) and IGEM/GM/6 Edition 2 - Non-domestic meter installations, with specific reference to the housing of meter installations and ventilation requirements, the H21 research into accumulation and explosion in distribution kiosks and street furniture and the Hy4Heat reports with information on leakage, dispersion and accumulation.

The structure and scope of the overall study associated with Lot 5 – task 2 will be based on an initial literature survey and evidence gathering activity. Key documentary evidence including ASTM F2138 – 12 (2017) Standard Specification for Excess Flow Valves for Natural Gas Service. The research conducted as part of the Hy4Heat and H21 programmes of work where leakage directly into buildings at varying flow rates was conducted. Studying the available information will allow for maximum EFV setpoints to be recommended for different installation load requirements. For higher power load installations, the application of an EFV becomes less of a strong mitigation (e.g. if an installation requires 100 kW and most risk is apportioned to releases up to 100 kW, there is less benefit from using an EFV).

1.2 Experimental Programme

This section of the proposal conveys the anticipated experimental arrangements, methodology and basis of safety which DNV propose to use to deliver the experiments identified in the Evidence Gathering stage of this Lot.

1.2.1 Ventilation associated with meters

Leakage into meter cupboards in domestic buildings, kiosks and street furniture has already been investigated to some level within H21 Phase1b, at Spadeadam. Some example installations which were subjected to experimentation for gas accumulation and explosion are shown in Figure 1.

1. Brick wall-mounted meter box

2. Telecommunication box

3. Small governor kiosk (Mk1)

3. Small governor kiosk (Mk2)

Figure 1: Example Meter Installations and Kiosks tested in H21 Phase1b

It is expected that the literature review in this Lot will identify installations of interest in domestic and industrial installations which have not be investigated. The experimental work is expected to focus on determining if the existing installations, designed for natural gas service, are fit-for-purpose if the fuel is changed to hydrogen. The fit-for-purpose status of an installation will need to be assessed by determination of the following:

1. Credible leakage scenarios within the installation
2. Effectiveness of ventilation in the installation

3. Effectiveness of any pressure relief devices / designs to relieve pressure generated in ignitions of credible releases of hydrogen.

For the purposes of this proposal, it is expected that a maximum of 4 different installation types will be identified for further investigation. These 4, as-yet-to-be-defined, installation types will be installed near to the HyStreet facility on Spadeadam where they can be subjected to mass metered gas injection, real-time sampling of gas concentrations, monitoring of atmospheric conditions and ignited when flammable volumes are generated. Each installation will be subjected to a maximum of 4 different accumulation experiments before a condition for explosion testing is selected. The installation under test will then be subjected to a minimum of 1 explosion test using one of the previously determined accumulation conditions.

The explosion event in the installation will be monitored for dynamic overpressure using high frequency response sensors (max. 4) and high speed cameras to capture video images of the events.

Should the installation survive the first explosion attempt, subsequent explosion experiments will be conducted to find the point at which the installation becomes severely damaged or does not relieve the explosion pressure in the manner in which it was designed.

In summary, this proposal allows for a total of 16 accumulation experiments and a minimum of 4 ignited explosion experiments on the 4 selected installation types.

1.2.2 Use of EFVs

It is expected that the outcome of the literature review will be that EFVs will be specified alongside meters for specific installations, i.e. a U6 equivalent meter will be installed with a U6 equivalent EFV in the service and also within the meter itself. For the purposes of pricing this proposal, it is assumed that a maximum of 4 different meter installations will be considered between U6 and U60 in equivalent hydrogen capacity. For each meter installation selected, a maximum of 2 EFVs will be procured (or provided by industry), making for a total of 8 distinct EFVs being tested for setpoint accuracy and repeatability. Where EFV's within hydrogen specific meters are available, these will be prioritised.

The above EFV set-point experiments will be conducted on a modified version of an existing arrangement developed for the pressure drop testing of distribution services pipes (depicted in Figure 2). The flow rates for which the existing facility was developed were only for domestic energy requirements (i.e. up to ~20 SMCH). To accommodate the higher flows which may be specified here for commercial installations, a larger capacity flow control unit will be procured and fitted into the facility. In short, the facility works by controlling a set flow of hydrogen into a test piece and then simulating a demand back-pressure by throttling of the outlet of the test piece until the desired inlet pressure is attained. EFV setpoint accuracy will be investigated for the sizes and capacities defined in the literature review by gentle increase of the flow set point on this test bed until the EFV closes. This process will be repeated a minimum of 10 times per EFV under test and the closing flowrate and differential pressure across the EFV will be recorded.

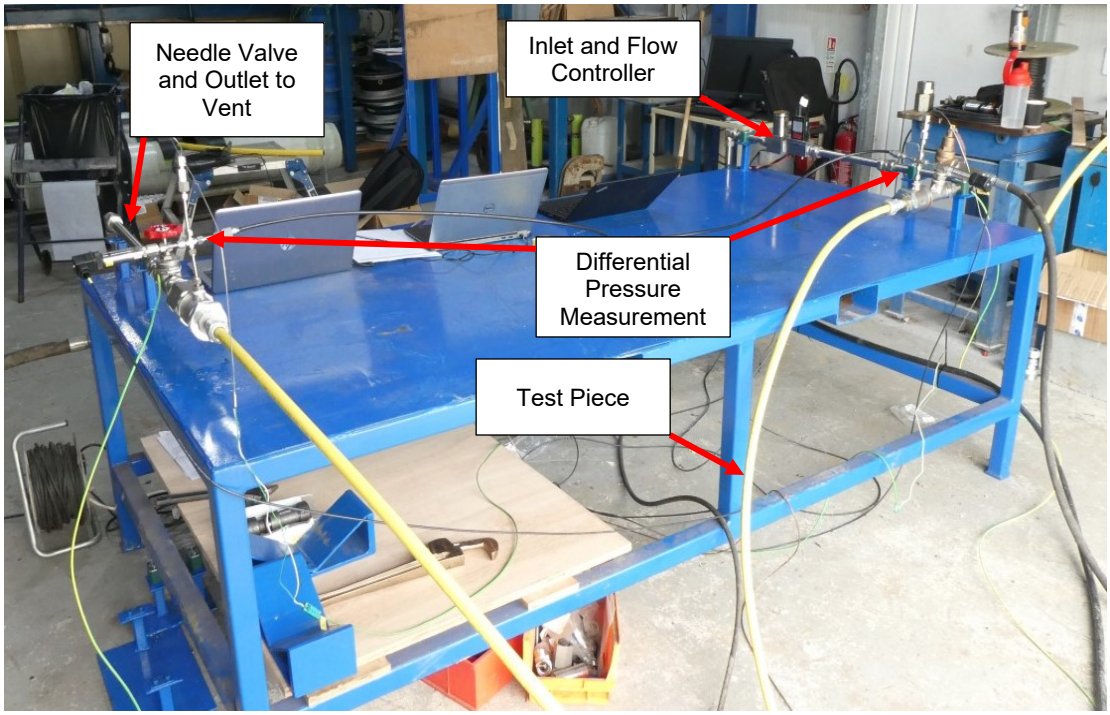

Figure 2: Existing Pressure Drop Test Rig

1.3 Analysis of Results

1.3.1 Ventilation associated with meter installations

Assessment of the fit-for-purpose of the meter installation subjected to testing will be discussed in an interpretation report. Where installations were deemed fit-for-purpose against credible hydrogen leakage, interpretation of the limitations of such a judgement will be made, e.g. the report will give an estimate of the conditions at which the installation is no longer fit-for-purpose.

1.3.2 Use of EFVs

Comprehensive data and interpretation reporting of the experiments will be conducted. The mean and standard deviation of closing values of each of the EFVs under test will be calculated and interpretation of what these values might mean in terms of risk to properties or nuisance operation if incorrectly selected will be made. Feedback of results from DNV into standards committees (e.g. IGEM, BSI) will be conducted by the relevant representatives working with each organisation.

1.4 Deliverables

The deliverables listed in the ITT will be supplied at the appropriate points in the project, these are:

1. Presentation at Project Inception Meeting
   a. Proposed Approach, testing plan and schedule
2. Final Project Plan
   a. After comment from BEIS
3. Progress Updates

a. Minutes from regular update meetings between the DNV staff and BEIS Project Manager

4. Interim Meeting Presentation

a. Experimental progress and findings from the first 50% completion of the project

b. Delivered at BEIS team meeting in the UK (or online)

5. Interim Project Report

a. Formal report detailing the progress, data and findings at the 50% completion stage.

6. Final Presentation

a. Presentation of the draft findings at the completion of experiments and analysis

7. Written Report

a. Report on Literature Survey

b. Detailed written record of experiments detailing the experimental arrangement, methodology, results and any analysis / conclusions from the project.

8. Electronic Data Set

a. All data recorded throughout the project. This will include the raw, quality checked data set as well as any processed data and details of the processing methods used.

2 SCHEDULE

A nominal schedule is shown from date of project plan approval is shown in Figure 3 for delivery of Lot5. A full schedule will be submitted with the project plan for agreement between BEIS and DNV at project kick off.

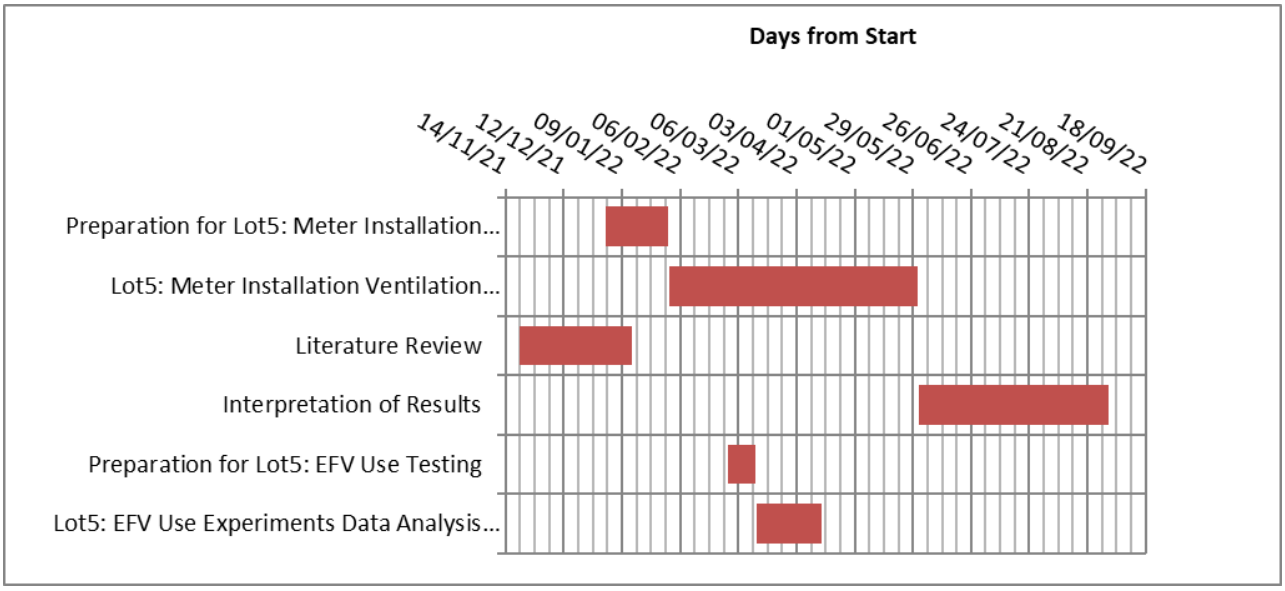

Figure 3: Nominal Schedule

3 COMPENSATION

3.1 General

All rates and prices provided in this proposal are quoted in GBP and exclusive of VAT or any other taxes.

3.2 Lump sums

The following activities shall be compensated on a lump sum basis:

Table 1: Pricing in GBP

Task	[This information has been redacted]
Literature Review	
Preparation for Lot5: Meter Installation Ventilation Testing	
Lot5: Meter Installation Ventilation Experiments Data Analysis and Reporting	
Preparation for Lot5: EFV Use Testing	
Lot5: EFV Use Experiments Data Analysis and Reporting	
Interpretation of Results	