Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Jul 2024

Project Reference Number

NIA2_SGN0051

Project Registration

Project Title

Hazardous Areas Impact Mitigations (HAIM) Phase 2

Project Reference Number

NIA2_SGN0051

Project Licensee(s)

SGN

Project Start

July 2024

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Innes Maciver

Project Budget

£573,960.00

Summary

The IGEM/SR/25 hydrogen supplement reveals significant differences in the dispersion distances between Natural Gas and hydrogen, potentially extending hazardous areas beyond current site perimeters following a conversion to hydrogen. The Hazardous Area Impact Mitigation (HAIM) Phase 1 project (NIA2_SGN0041) revealed discrepancies between the calculated values in the hydrogen supplement and small scale empirical test results, necessitating a follow-on phase. Phase 2 will look to engage wider stakeholders, refine experiments to incorporate the impact of wind on releases, map additional vent types like angled vents, and conduct larger scale tests to validate Phase 1 findings across all pressure tiers. Additional work will also be carried out by DNV using industry standard packages to provide further comparison from modelling with the data tables from the IGEM/SR/25 hydrogen supplement.

Preceding Projects

NIA2_SGN0041 - Hazardous Areas Impact Mitigation Phase 1

Third Party Collaborators

DNV

Steer Energy

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

In the gas industry, venting of natural gas is controlled by the IGEM standard IGE/SR/23, with the classification of hazardous areas being detailed in IGEM/SR/25. When considering the differences in flammability limit and gas characteristics with respect to hydrogen

these operational practices need reviewing and amending to be fit for purpose.

One of the primary objectives of Phase 1 of Hazardous Areas Impact Mitigation (HAIM) was to evaluate any discrepancies there might be between the IGEM/SR/25 hydrogen supplement and real-world hydrogen scenarios. During the project a total of 22 gas releases were tested from two variations of vent diameters (13mm and 48mm) and 2 types of vents (ideal and non-ideal impeded). This provided a representative sample of results, however the range of flow rates available at this scale was limited as the tests were conducted in the workshop.

The results of these small-scale tests were colourmaps generated by the recorded data providing a representative shape and magnitude of the gas plume. The results have shown that in every case, the real-world results are significantly different to those stated in the tables in the IGEM/SR/25 hydrogen supplement. Both the horizontal and vertical dispersion distances are shown to be significantly different after the initial results from Phase 1.

Method(s)

This phase of the project will look to characterise the gas plume shape for a range of different vent scenarios, building on the work conducted in Phase 1. These real-world scenarios will be extrapolated from the representative NGN test cases from the NIA_346 project. The expanded testing will directly compare the real-world plume shapes against those provided in the IGEM/SR/25 hydrogen supplement. Several different testing configurations will be executed including:

- Increased flow rates: outdoor releases replicating conditions like those found in PRSs.
- Non-ideal vents: incorporating angled, downward-pointing vents, and introducing a horizontal vent option not included in IGEM/SR/25.
- Complex features: such as flanges and other elements that can influence plume dispersion.
- Wind effects: that may further influence horizontal dispersion.

Measurement Quality Statement
The methodology used in this project will be subject to Steer's own quality assurance regime. Quality assurance processes and the source of data, measurement processes and equipment, and data processing will be clearly documented and verifiable.

The measurements, designs and assessments will also be clearly documented in the relevant deliverables and final project report and will be made available for review. This will include the procedures and techniques used, and mechanisms to ensure traceability, reliability and comparability of results.

Note that we believe this project should be rated low in the common assessment framework detailed in the ENIP document after assessing:

- the total project value (less than £500, 000),
- the progression through the TRL levels (less than 2),
- the number of project delivery partners (less than 2) and
- clearly defined assumptions and principles are made regarding project data and delivery.

Data Quality Statement
We believe this project will be delivered under the NIA framework, in line with the agreed Energy Networks Innovation Process document, as well as SGN internal policies. We will follow good practice and relevant standards during this work.

Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and that sources of information are appropriately documented.

We have reflected on the data likely to be created, obtained, and used during this project:

- We are not expecting to have to deal with data sensitivities, such as personally identifiable information (GDPR) or intellectual property.
- We may be provided with potentially sensitive commercial data from product suppliers. If this is the case, we will agree to address the data management of this before receiving the data.
- We may be provided with potentially sensitive information from our client and other Networks. If this is the case, we will agree to address the data management of this before receiving the data.
- We will ensure that any data (raw and processed) created through testing is of sufficient completeness, accuracy and integrity.
- All deliverables and project outputs will be stored on our internal cloud platform (Tresorit) and Teams (where appropriate) ensuring

backup and version management.

- We use standard Microsoft office programmes (PowerPoint, Word, and Excel) throughout the work. In addition, we may use specialist software, which will be reported through standard Microsoft office programmes.

At the completion of the project, relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal, and dissemination material can be shared with the relevant stakeholders.

Scope

Phase 2a: Workshop Tests

WP1: Stakeholder Engagement
This work package provides a platform for discussing the results of the previous project and collaboratively mapping the best path forward. To gather meaningful insights, we anticipate engaging industry stakeholders like the gas network operators and those involved with the creation of the SR/25 hydrogen supplement, HSE science division, DNV and IGEM. It will deliver the target test programmes for WP2 and WP4 using a combination of facilitated discussions, potentially using roundtable or individual meeting formats, either face to face or online as appropriate.

Once the test programmes are confirmed, the work pack will feed into the dissemination proposed for WP8 in the form of monthly update meetings.

The work pack can also include the development of a roadmap to define any adaptation required for IGEM/SR/25 and the associated IGEM/SR/25 calculator. The working group can also be used to facilitate discussions regarding the validity of using additional resources, such as third-party modelling software to supplement the IGEM/SR/25 calculator in site assessments.

WP2: Define workshop test programme and adapt measurement equipment
The workshop test programme will measure, log, and map out the concentration profile of hydrogen and methane releases from a selection of non-ideal vents, flanges, meter installations, and installation pipework. The equipment used will be based on that used in the phase 1 project.

Gas concentration will be measured using one or more arrays of IIC ATEX-rated VQ546 (0-100% vol.) and VQ549 (0-100% LFL) gas detection sensors, mounted on adjustable masts positioned around the source of release. Vent flow will be precisely controlled and measured by Alicat mass flow controllers.

It is proposed that vent tests will be conducted indoors within the workshop environment. This controls the variability introduced by wind, and other outdoor environmental effects, thus enhancing the repeatability and reliability of experimental results. Further details of the proposed scope of testing and equipment adaptions are given in the next sections.

Phase 1 measured two instances of vent types provided in IGEM/SR/25. Additional vent types are to be considered and additional attributes of vent types or infrastructure are to be included in the scope of work. These could include, but are not limited to:

- flanges,
- drain holes,
- downwash,
- angled vents,
- downward pointing vents,
- and horizontal vents, (to determine the transition from momentum driven to buoyancy driven plumes).

The effect of wind needs to be considered as this will influence the direction of travel of the plume identified in Phase 1 of the work and hence the effective radius of the eventual gas cloud. Tests will therefore be carried out to explore some of the effects of wind during this investigation. The effects of trees, or other congestion can also be included in the programme of work as desired, with some of the releases being measured with and without obstacles above the plume.

This work will also include the opportunity to map out the limit of ignition for a selection of the relevant test cases. This will be achieved using a known ignition source, such as a pilot light to measure how close the source must be to the plume for reliable ignition.

The eventual scope of work will be proposed and agreed with the stakeholder group; however, the work scope will be managed flexibly so that earlier outcomes can influence the later programme of work.

WP3: Experiments and analysis of laboratory test data
The same method of data visualisation and detailed analysis used in Phase 1 is proposed for Phase 2. The laboratory test data

undergoes conversion into a series of graphs and a colour plot which show concentration across the detector array.

WP4: Define offsite test programme and adapt measurement test equipment
The expected programme of work for the offsite trials will aim to match the test cases from the NIA_346 project or gas releases close to the test cases. Previously the tests were to be aligned with large-scale gas releases planned for the LTS Futures project. This is now not possible and so an alternative test site is required. It has been noted that the NIA_346 tests cases do not have limiting orifices upstream of the vent pipe. The analysis will be revisited and compared to the known test sites to verify this and keep the tests relevant to actual AGI infrastructure. This could result in a change of the gas release rates from the vents. In the new programme this analysis has been brought forward to maximise the time available to specify and build the gas release system.

These revisited test cases will be used to specify the site requirements, with the site selected as part of WP5. The aim will be to keep the tests as close as possible to the test cases within any site constraints that may exist. The finalised test specifications derived from confirmed testing procedures will guide the design and manufacture of the gas release equipment for Phase 2b. Additionally, these specifications will facilitate the selection of a suitable off-site testing facility. Early discussions with Kiwa Energy indicate the Bishops Cleeve hydrogen production facility may be a suitable location for these tests. Other locations being considered are the HSE Science and Research centre in Buxton, Fire Service College and a bespoke Spadeadam test. This eventual offsite test programme will measure, log, and map out the concentration decay profile of hydrogen releases from a series of large vents similar to the test cases from NIA_346.

Phase 2b: Offsite testing

WP5: Select site, design and build large-scale gas release equipment
Building upon the specifications documented in WP4, this section outlines the approach for establishing the new location to conduct offsite testing, including hydrogen supply. The work scope in this work package will be heavily dependent on the site selection from the specification carried out in WP4. However, four key subtasks exist:

- Site Selection, including securing hydrogen supply
- Design and build of gas release equipment and representative vents
- Integration of measurement equipment
- Opportunities for cross-project collaboration

Site Selection, including securing hydrogen supply
As highlighted in WP4, early conversations with Kiwa Energy suggest that there is an opportunity to use their Steam Methane Reformation plant as a hydrogen store and supply for these tests. Alternative sites could be HSE Science and Research centre in Buxton, The Fire Service College or DNV Spadeadam. This selection process will include securing a hydrogen supply at the chosen location and consider factors like safety regulations, access to utilities, and proximity to existing infrastructure. The potential for using existing test facilities at these and other locations will be further investigated.

Design and build of gas release system
This involves fabricating a series of vent pipes as per the eventual specification of WP4. This will need to be fed with a suitable hydrogen supply. If the selected facility maintains an on-site hydrogen inventory, a direct connection to this source will be established with suitable control systems to manage controlled gas releases. For sites lacking an on-site inventory, the initial design will explore the feasibility of utilising manifolded multiple cylinder packs (MCPs). This approach offers a readily deployable solution, particularly for the lower flow rates defined in WP4. Higher flow rates may require another solution such as an intermediate, pressurised storage vessel. This vessel will then act as a buffer, enabling sufficient delivery at the required pressures and flow rates.

Integration of measurement equipment
The test design and construction will also integrate the measurement equipment specified for offsite tests as part of WP4.

Opportunities for cross-project collaboration
A final aim of this work pack will be to explore the potential for using the gas release equipment and knowledge gained from this project for other relevant testing initiatives. This would involve collaborative efforts aimed at maximising the utilisation and application of hydrogen across different projects.

Costing
A detailed cost breakdown will be provided as part of this work package, encompassing potential costs associated with:

- Daily rate usage of a chosen facility.
- Site preparation at a new location (if required).
- Rental fees for any additional equipment needed for the testing setup.

Selection of the most suitable site will be made following a comprehensive evaluation of potential offsite testing facilities against the criteria outlined above. Cost will be a factor, but not necessarily the overriding one.

Given the focus of this workshop on site selection, a starting budget of £13,000 is requested within this work package. This funding will enable us to begin exploring potential test locations. As part of this site selection process, we will develop and submit updated project cost estimates for approval by the funders. This update is likely to require a Variation Order.

Note that it is possible to carry out a high-level estimate of the costs for the large-scale trials. There are three main likely costs: daily rate of facility, equipment and tooling for the large-scale release, and hydrogen costs:

- Site Costs: Modest site costs are expected to be around £1,500 per day. The estimated work program is up to 3 weeks of site work, excluding any site preparation and demobilization.
- Gas Release Equipment: The equipment for the gas release could cost around £10,000 for vent pipes and control valves for simple vents. If an intermediate hydrogen buffer tank is required, it may need to be custom-made and pressure tested, leading to higher costs for the release equipment.
- Hydrogen Costs and Usage Estimates: The cost of hydrogen will vary depending on the final gas release rates required for the tests. As a reference point, a 15-cylinder Manifold Control Panel (MCP) currently costs around £1,600 and holds 108 cubic meters (m^3) of gas at standard temperature and pressure. In Phase 1 of the HAIM project, we used 5 x 20-second bursts of gas for measurements. Assuming similar conditions and a 2-minute test duration for each vent characterization in this project, we can estimate the hydrogen needed per test.

The overall cost will be very much dependent on the actual vents being measured. The costs are dominated by the two, higher pressure vents. The values will be revisited in WP4 at the start of the project, and it may be that these two very large vents are reduced. Value will certainly be achieved from testing the four smaller vent cases first.

WP6: Offsite experiments and analysis of results

Captured data will be analysed and the implications of the results interpreted. The same visualisation and analysis process used for the workshop test datasets will be used for the offsite data. This will result in graphed output and similar colour maps to those produced in the Phase 1 results.

The results will be compared with the calculated data from the IGEM/SR/25 hydrogen supplement, and this will contribute to major conclusions of the overall programme of work.

Note that costs for the design and build of the large-scale release equipment, the hire of the site and the hydrogen costs for the actual tests will be covered in the costs of WP5.

WP7: Comparison with modelled data

An outcome of the presentation of the Phase 1 results to the Network Safety and Impacts Board was that a comparison of modelled and measured data could be undertaken. One method of modelling the shape and magnitude of a vent from a gas release is the Hydrogen plus other alternative Risk Assessment Models (HyRAM+) software.

DNV is performing separate gas dispersion modelling for another project using ORDER and PHAST™ software. If they share the results, we can include them in this project's scope and review them.

WP8: Reporting and dissemination

The project will use a two-tiered communication approach for ongoing reporting. Fortnightly update meetings will be held to share results and discuss any potential adjustments to project scope or test cases. Additionally, monthly steering group meetings can be convened, as needed, to disseminate results to a broader audience. This work package will operate concurrently throughout Phases 2a and 2b.

Phase 2a will culminate in an interim report summarizing the workshop test results, outlining the design details for the gas release equipment, identifying a suitable off-site testing facility, and proposing a comprehensive large-scale test program.

A final report will be provided for discussion and dissemination to the project stakeholders and wider community at the end of Phase 2b. This report will be used to define the subsequent steps.

Upon completion of the Phase 2b analysis, stakeholder discussions will be held to determine the most effective path forward. This collaborative effort is anticipated to yield a roadmap for implementing any necessary modifications to the SR/25 hydrogen supplement. The project will prioritise the timely dissemination of findings as they become available, rather than waiting for the final report. This approach aims to maximize the value and impact of generated results before the September deadline for submitting evidence to the HSE evidence review groups (ERGs).

The outcomes of this WP will be:

- Fortnightly update meetings, combined with monthly steering group meetings.
- A final report of the results, including any additional further work required for investigation.
- A roadmap to adapt relevant standards as agreed by the steering group.
- Dissemination to relevant stakeholders.

Objective(s)

The aims and objectives of phase 2 of this project are to:

- Conduct comprehensive testing of gas plume envelopes from vent stacks and other releases in real-world conditions;
- Undertake larger scale tests using increased flow rates to cover a wider range of test cases from previous work;
- Incorporate alternative vent types including non-ideal angled vents and horizontal releases;
- Include consideration of wind and other external effects in the test programme;
- Compare measured results against those predicted for the test cases and draw conclusions from the results;
- Compare measured results against the outputs from other industry packages including ORDER and PHAST; and
- Develop a roadmap for updating industry standards pending results from testing and modelling.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register.

This project has been assessed as having a neutral impact on customers in vulnerable situations.

Success Criteria

The outcomes of the project will be considered successful if they can:

- Provide evidence to further assess the accuracy of the IGEM/SR/25 hydrogen supplement and calculator.
- Develop a better understanding of gas plume scenarios regarding 100% hydrogen operations.
- Develop a roadmap to deliver any required changes of the IGEM/SR/25 hydrogen supplement.

Project Partners and External Funding

Steer Energy and DNV will be the suppliers for this project with collaboration from all gas networks.

Potential for New Learning

This project attempts to better understand the discrepancies between the stated hazardous areas in IGEM/SR/25 and its hydrogen supplement, and the real-world scenarios. Appropriate comparisons from experimental data will help influence and amend the industry standard to better reflect reality.

Scale of Project

This stage of the project will be larger in scale than the previous phase 1. Larger, offsite testing will be conducted to give a more representative example of the possibilities when considering different verting and leak scenarios. This project will develop a roadmap to the update of the industry standard, providing an easier uptake of hydrogen across the network should policy decisions inform that.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The outputs of this project will be representative of the entire GB gas network.

Revenue Allowed for the RIIO Settlement

Not applicable.

Indicative Total NIA Project Expenditure

SGN – External £212,489 Internal £70,121

Cadent – External £124,978 Internal £39,700

NGN – External £31,244 Internal £14,711.80

NGT – External £31,244 Internal £7,811

WWU – External £31,244 Internal £10,415

Total – £573,959.13

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

The outputs of this project will provide a clearer understanding of the implications that 100% hydrogen gas will have on hazardous areas concerning above ground installations such as Pressure Reduction Stations (PRSs), and Pressure Reductions Installations (PRIs). The outcomes of the project will help to identify opportunities for updating the IGEM/SR/25 standard and allow networks to develop the low carbon gas network of the future safely and efficiently.

How the Project has potential to benefit consumer in vulnerable situations:

Not applicable.

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

Not applicable.

Please provide a calculation of the expected benefits the Solution

There is a lot of ongoing work to identify the most effective route to meet net zero in the UK and this project is one of many projects which will assist in this area. Repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save millions of pounds with minimal gas customer disruption versus alternative decarbonisation solutions.

Please provide an estimate of how replicable the Method is across GB

The outcome of this project is relevant to the entire GB gas network.

Please provide an outline of the costs of rolling out the Method across GB.

Not applicable.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☑ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

By identifying and confirming discrepancies in IGEM/SR/25, this project aims to provide network licensees across GB with an appropriate understanding of how hazardous areas might realistically be impacted in a switch to 100% hydrogen. This is to the benefit of the entire GB gas network and will reduce the need for unnecessary safety precautions across the gas network.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

Not applicable.

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

This project is a follow on from NIA2_SGN0041 HAIM Phase 1 which was a collaborative project across the GDNs. The results of this NIA project will be in the public domain as well as being disseminated to networks via the Network Safety and Impacts group.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

Not applicable.

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project will tackle a known issue within the gas industry by conducting testing with 100% hydrogen on vent configurations previously untested. This will help define a plan for reviewing existing operational procedures and develop new tools to assist in the transition to a low carbon gas network.

Relevant Foreground IPR

The test results and other outputs included in the report will form the foreground IP for this project.

Data Access Details

Information relating to the project will be published on the ENA Smarter Networks Portal at https://smarter.energynetworks.org/

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

The methodology undertaken in this project is deemed a beneficial part of the network conversion to 100% hydrogen. This is not yet a business-as-usual activity for the GDNs.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

The conversion of the GB gas network to 100% hydrogen is a key element on the road towards net zero. A reliable supply and the assurance of safe operations for workers and the public are crucial to support the viability of the hydrogen transition. The NIA framework can support works that ensure results that play an essential part in the roll-out of hydrogen.

This project has been approved by a senior member of staff

☑ Yes