

Gas Network Innovation Competition Screening Submission Pro-forma

Notes on completion

Before completing this form, please refer to the Gas Network Innovation Competition (NIC) Governance Document, which details all of the information that you are required to provide. Please use the default font (Verdana size 10) in your submission, the text entry areas are predetermined and should not be changed. The full-completed submission should not exceed 11 pages in total.

Ofgem will publish all the information contained within the Screening submission.

Funding Licensee

National Grid Gas Plc (Transmission)

Network Licence Project Partners

Funding Licensee area

National Grid Gas Transmission

Project title

In-Line Robotic Inspection of High Pressure Installations

Project Summary

The Licensee must provide an approximate Project start and end date.

Traditionally the onshore pipeline industry has only been able to inline inspect high pressure pipelines using PIGs (Pipeline Inspection Gauges). Inline inspection of pipelines provides the most accurate and reliable information on the condition of buried pipelines, other inspection methods external to the pipeline have a number of limitations. However, pipework on high pressure above ground installations (AGIs) cannot currently be inline inspected because of a number of engineering challenges associated with complex pipework geometries, lack of access and retrieval points and flow factors.

This industry leading innovation project looks to demonstrate a commercially viable, prototype inspection robot that can be inserted into high pressure AGIs for assessment of the asset condition, without the need for an outage or gas venting. The project has three key activities: development and demonstration of the high pressure installation inspection robotic tool (both the crawler and sensor elements), development and demonstration of an access system for launch and retrieval under live conditions and smart data analysis. The project will run from April 2015 to November 2019.

The key benefits of the project are the ability to accurately and reliably determine the condition of high pressure pipework, which will enable a risk based maintenance and replacement approach to be adopted. The environmental, safety and financial benefits to the customers are associated with avoiding disruption caused by excavations, premature asset replacement and unplanned events. If successful, the project will realise a minimum total saving of £20m over a 20 year period.

Estimated Project funding

The Licensee must provide an approximate figure of the total cost of the project and the NIC funding it is applying for.

Total cost of Project

£4.9m

NIC funding requested

£4.4m

Cross Sector Projects only: Requested funding from Electricity NIC, NIA or second tier LCN Fund?

If yes, please specify

N/A

Problem

The Licensee must provide a narrative which explains the Problem(s) which the Project is seeking to address.

National Grid Gas Transmission has an obligation to operate our network in a safe and reliable manner, to do this we must understand the condition of our assets. For pipelines we achieve this through, amongst other activities, inline inspection i.e. inserting a device within the pipeline. Currently we inline inspect over 7,000 kms (99.5%) of our National Transmission System (NTS) using Pipeline Inspection Gauges (PIGs). However, PIGs are not suitable for pipework on above ground installations (AGIs) and some other pipeline sections, for a number of reasons including:

- AGIs have complicated geometries associated with both above ground and buried pipework e.g. tight bends and changing pipe diameters which PIGs cannot negotiate
- PIGs are dependant on the flow speed of the gas for drive, and the gas flow through an AGI can be highly variable (either faster or slower than a PIG requires)
- There is a lack of appropriate launch and receive facilities

We have over 200 AGIs on the NTS, including terminals, compressor sites, multi-junctions and off-takes, which are critical to the operation of the network and the country's security of supply. Our asset management strategy on AGIs involves external visual inspection of above ground assets whereas for below ground pipework we rely upon the original design in terms of use of thick walled pipe, external coatings and cathodic protection combined with CIPS (close interval protection surveys), which are used to ensure the coatings are in good condition, and asset life modelling.

If issues are suspected on the below ground pipework, we currently excavate the relevant area to expose the pipework for more detailed inspection and then potentially undertake remedial action, both operations are performed at full or slightly reduced pressure. In some cases this may require full isolation and the vent and purge of the site pipework. Both options are costly, have an environmental impact and could be disruptive to customers and the operation of the network. They also may be unnecessary as CIPS data cannot identify the scale of corrosion present.

As the age of our assets continues to grow, we are beginning to reach the end of their original design life; therefore the ability to understand the asset condition is vitally important to enable us to develop risk based maintenance and asset replacement strategies. An inline inspection robot to provide the necessary information on below ground pipework at an AGI would be a very valuable innovation that could avoid the disruption to customers caused by unnecessary inspection excavations and premature asset replacement. In addition the consequences of not identifying a potential problem could be extremely serious and result in the high pressure release of natural gas which would have significant environmental, safety and financial impacts.

Method(s)

The Licensee should describe the Method(s) which are being demonstrated or developed. The Licensee must outline how the Method(s) could solve the Problem. The type of Method should be identified where possible eg technical, commercial etc.

The project comprises of five stages:

Stage 1: Solution Development

Review of different robotic systems, including development of the design for a live launch and retrieval system, and desktop 3D modelling to look at different layouts of AGI that could be inspected. An existing decommissioned AGI will then be used to trial different robotic drive units, assessing capability limits / restrictions. This stage will also establish the type of condition assessment that can be achieved, such as photographic, laser scan, wall thickness and geo-location.

Stage 2: Development Testing

Develop Class 600 (the appropriate pressure rating for pipes and fitting on high pressure installations) specifications for all key components, concept design for all key components, and subsequent manufacture of prototype parts. Complete a full series of pressure and dynamic testing, followed by review and development specification stage.

Stage 3: Field Trials

Method(s) continued

Prepare, submit and obtain network approvals. Complete a full series of "dead" field trials, followed by challenge and review. Update and verify working procedures, then complete a full series of live field trials.

Stage 4: Data Analysis

Collate trial data, including performance of all component parts. Analyse data from systems such as CCTV, laser scanning, ultrasonic wall thickness, geo-location. Complete challenge and review of data. Establish procedures for operational data capture and analysis.

Stage 5: Business Readiness

Complete challenge and review. Identify business units who will utilise the technology. Develop working procedures, training plans, method statements, risk assessments, and plans for support / maintenance.

At the end of each stage there will be a stage gate review and opportunity.

Funding commentary

The Licensee must provide a commentary on the accuracy of its funding estimate. If the Project has phases, the Licensee should identify the approximate cost of each phase. IGTs should indicate potential bid costs expenses.

An approximate costing has been developed, and is estimated to +/- 25%. Prices will be fixed in the final submission.

Stage 1: Solution Development	£900,000	9 months
Stage 2: Development Testing	£2,340,000	18 months
Stage 3: Field Trials	£880,000	6 months (during summer outage periods)
Stage 4: Data Analysis	£450,000	3 months
Stage 5: Business Readiness	£330,000	6 months

NIC bid preparation costs are likely to be in the region of £100,000 which will be funded through NIA bid preparation costs, and include bid preparation, legal and procurement activities.

Specific Requirements (please tick which of the specific requirements this project fulfils)

A specific piece of new (ie unproven in GB) equipment (including control and/or communications systems and/or software)	X
A specific novel arrangement or application of existing gas transmission or/and distribution equipment (including control and communications systems software)	
A specific novel operational practice directly related to the operation of the gas transportation system	X
A specific novel commercial arrangement	

Accelerates the development of a low carbon energy sector & has the potential to deliver net financial benefits to existing and/or future customers

The Licensee must demonstrate that the Solution has the potential to accelerate the development of the low carbon energy sector in GB and/or deliver wider environmental benefits to GB customers. The Licensee must demonstrate the potential to deliver net financial benefits to existing and/or future customers.

As stated in the Gas NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

- i. How the proposed Project will make a contribution to the Carbon Plan. In particular the Network Licensee should outline:
 - *What aspects of the carbon plan the Solution facilitates;*
 - *The contribution the roll-out of the Method across GB can have in facilitating these aspects of the Carbon Plan;*
 - *How the roll-out of the proposed Method across GB will deliver the Solution more quickly than the current most efficient Method in use in GB; and/or**
- ii. How the proposed Project could deliver environmental benefits to customers; and*
- iii. The expected financial benefits the Project could deliver to customers.*

ii. The project is expected to deliver environmental benefits to customers in three main areas:

- **Avoidance of excavations for inspection**

As discussed above, based on the limited information provided through CIPs surveys and asset modelling, a number of unnecessary excavations are undertaken each year. We anticipate ~30 excavations will be undertaken each year on AGIs. Excavation has a number of environmental impacts to customers from disruption of archaeological features, impacts on subsequent land use and stewardship and depending on the location significant transport carbon emissions. This project, if successful should eliminate all unnecessary excavations.

- **Avoidance of premature asset replacement**

Understanding the condition of below ground pipework on an AGI and optimising replacement and maintenance strategies to avoid early replacement of assets would result in significant environmental savings to customers. From a recent example, the cost of carbon associated with replacing key assets (pipework, fencing and one valve) on a small AGI was in the region of 700 tonnes.

- **Minimisation of potential asset failures leading to the release of high pressure gas**

The consequences of a high pressure release are significant. A large high pressure installation could consist of up to 21 km of pipework, pressurised up to 94 bar. This would equate to an inventory of over 200 tonnes of natural gas (3,400 tonnes CO₂ equivalent), which could be vented to atmosphere if there was an asset failure on the below ground pipework. Understanding the condition of this pipework and optimising the replacement and maintenance strategies based on this information should reduce the potential frequency of an incident.

Additional environmental benefits, in terms of identifying and targeting maintenance to avoid fugitive emissions should also be realisable.

iii. The expected financial benefits to customers of the project result from a reduction in the total expenditure associated with the replacement and maintenance of below ground pipework and minimising the potential for an asset failure. We anticipate if successful, the project will realise a minimum total saving of £20m over a 20 year period. This is based on £10m from improved intelligence associated with asset condition, consequently reducing unnecessary excavations and avoiding the need for a wide spread asset replacement programme on AGIs and £10m from avoiding one major network disruption in twenty years on a site of strategic importance. These savings relate to the gas transmission network only; roll out across the gas distribution networks would realise further benefits. Further detail is provided in the section "Delivers value for money to gas customers".

Delivers value for money for gas customers

The Licensee must demonstrate that the Method(s) being trialled can derive benefits and resulting learning that can be attributed to or are applicable to the gas transportation system.

As stated in the Gas NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

- i. What is the potential Direct Impact of the Project on a Network Licensee's gas network or on the operations of the GB System Operator;*
- ii. Justification that the scale/ cost of the Project is appropriate in relation to the learning that is expected to be captured;*
- iii. The processes that will be employed to ensure that the Project is delivered at a competitive cost;*
- iv. The expected proportion of the benefits which will accrue to the gas transportation system as opposed to other parts of the energy supply chain; and*
- v. How Project Participants have been identified and selected including details of the process that has been followed and the rationale for selecting Project participants and ideas for the Project.*

i. If the project is successful it will reduce the costs associated with maintaining and replacing below ground pipework on AGIs. The current assets are approaching the end of their design life requiring more surveys, excavations and ultimately replacement; activities which could be disruptive to customers. In the short term, the cost of excavations to allow for inspection is estimated to be £1m per year. This project, if successful should eliminate all unnecessary excavations.

As we begin to replace assets, without improved inspection techniques to determine asset condition, the replacement programme will be inefficient and largely reactive in nature. A replacement programme across the 200+ high pressure installations would be extremely costly and disruptive to customers. Over the long term a small saving on a large asset replacement programme would deliver significant benefits. In addition from a system operator perspective we will not need to constrain flows on the network to inspect the pipework, thus avoiding constraint costs and customer disruption.

The project should also minimise the potential for an asset failure. If an asset failure occurred on a high utilisation AGI such as Peterborough compressor station, we may be unable to meet our capacity obligations and therefore would need to buy back capacity, which could cost in excess of £1m per day, and be disruptive to customers.

ii. The £4.9m cost of the project is appropriate considering the potential benefits, described above, that the successful development of a robotic tool could bring. In terms of the scale required for the tool to be confidently used within National Grid it will need to be demonstrated in a live environment. Therefore we believe the scope of the project is appropriate to ensure the robotic tool is sufficiently proven in terms of technology and benefits.

iii. The project will be subject to robust project management practices, including a stage gate process throughout. National Grid will establish a Project Management Board with the other partners and appoint a dedicated project manager to ensure the project is delivered to time and budget. For all procurement activity, National Grid will wherever possible undertake competitive tendering.

iv. The benefits described above relate to the National Transmission System, we would expect to see similar, if not greater, benefits on the gas distribution networks. In addition the avoidance of outages either planned or unplanned, benefits the wider industry in terms of minimising disruption and costs.

v. Project partners have been selected through a process that started with ideas generation and identification of priority themes. A number of proposals were received from various potential partners, and compared and assessed against the NIC criteria and National Grid's innovation strategy. The joint proposal received from Premtech and Synthotech on inline inspection of high pressure installations, was chosen as the successful candidate. Both companies are British SMEs (small and medium enterprises) with a track record of delivering value with a high degree of specialised engineering knowledge. National Grid has experience of both suppliers, with Premtech already successfully delivering NIA projects for National Grid Gas Transmission.

Demonstrates the Project generates knowledge that can be shared amongst all Licensees

The Licensee must explain the learning which it expects the Method(s) it is trialling to deliver. The Licensee must demonstrate that it has a robust methodology in place to capture the learning from the Trial(s).

As stated in the Gas NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

- i. What new knowledge is intended to be generated from completing the Project;*
- ii. What methodology will be used to capture results from the Project and how the Project's results will be disseminated to other Network Licensees; and*
- iii. Whether the Network Licensee wishes to conform to the default IPR arrangements as set out in Chapter 9. If the Network Licensee wishes to deviate from the default IPR arrangements it must outline the proposed arrangements, justify why the arrangements are more suitable than the default arrangements and justify how the new arrangements will deliver value for money for customers.*

There are three main areas of learning intended to be delivered by this project:

1. Development and demonstration of a high pressure installation robotic inspection tool, consisting of both the crawler and sensor elements. Information captured through a range of modular sensors is expected to include visual images, laser profiling and information for material analysis.
2. Development and demonstration of an access system for launch and retrieval under live conditions with no release of gas to atmosphere.
3. Data analysis, including the smart use of data capture for modelling/ surveying below ground pipework as well as asset condition monitoring.

The project manager will prepare update reports identifying all relevant knowledge gained to the project steering committee at least twice a year. These will be published on the project web portal, details of which will be sent to all GB Network Licensees. Project progress will be reported through various media including video and interactive web based engagement. Results and project learning will also be reported at the annual LCNI conference, in National Grid Gas Transmission's annual Network Innovation report and on National Grid's innovation website www.nationalgrid.com/innovation.

The project will conform to the default IPR arrangements.

Please tick if the project conforms to the default IPR arrangements set out in the NIC Governance Document?	X
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If the Licensee wishes to deviate from the default requirement for IPR then it must demonstrate how the learning will be disseminated to other Licensees and how value for money will be ensured. The Licensee must also outline the proposed alternative arrangements and justify why the arrangements are more suitable than the default arrangements.

How is the project innovative and with an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness.

Demonstrate why the Licensee has not previously used this Solution (including where the Solution involves commercial arrangements) and why NIC funding is required to undertake it. This must include why the Licensee would not run the trial as part of its normal course of business and why the Solution is not Research.

As stated in the Gas NIC Governance Document, the Network Licensee must provide the following to demonstrate compliance with this criterion:

- i. Why the Project is innovative and has not been tried before;*
- ii. Why the Network Licensee will not fund such a Project as part of their business as usual activities;*
- iii. Why the Project can only be undertaken with the support of the NIC, including reference to the specific risks (e.g. commercial, technical, operational or regulatory) associated with the Project.*

- i. From the research undertaken to date, the relevant specialists have not identified any inline inspection tool that can undertake inspections of below ground pipework on AGIs that operate up to 94 bar pressure. The challenge that the tool is predominantly intended to overcome relates to inspecting aging assets. The market for this innovation/product is only now emerging in the UK gas industry, as many of the assets were built in the 1970s. In addition, recent advances in robotics and the introduction of robotics for inspection at lower pressures make the probability of success much greater. The specific areas of innovation that will need to be addressed are as follows:
 - Robotic systems and inspection tools that can operate safely and reliably within a high pressure (up to 94 barg) operational gas installation, considering gas pressures, gas temperatures and gas flow rates, plus the pipework system configurations and geometry.
 - Novel techniques to launch and retrieve in-line inspection robotic tools from a live operational gas installation, operating at pressures up to 94 barg.
 - High pressure glanding arrangements and alternative connection systems.
 - Techniques associated with tethered and wireless in-line inspection robot systems.
 - Technologies to improve geo-location and tracing capability of below ground inspection systems.

How is the project innovative and with an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness - continued.

- ii. The extent of the technical challenges associated with operating a complex robotic tool at such high pressures in a live gas environment mean that the project would not be undertaken as part of business as usual activities.
- iii. The NIC funding allows the technical risks of developing and proving the robotic tool to be overcome with an appropriate sharing of risks between UK consumers and National Grid Gas Transmission.

Project Partners and external resourcing/funding

The Licensee must provide evidence of how Project Partners have been identified and selected, including details of the process that has been followed and the rationale for selecting participants and ideas for the Project.

The Licensee should provide details of any Project Partners who will be actively involved in the Project and are prepared to devote time, resources and/or funding to the Project. If the Licensee has not identified any specific Project Partners, it should provide details of the type of Project Partners it wishes to attract to the Project.

National Grid Gas Transmission held a workshop with internal stakeholders to generate ideas and identify priority themes for the 2014/15 NIC. The workshop consisted of representatives from Asset Management, Safety and Sustainability, Market Operation, Capital Delivery and RIIO Delivery functions. The workshop identified four key themes which were then circulated to potential partners and suppliers and published on NationalGrid.com/ innovation. These themes were also shared with the other gas networks at the ENA Gas Innovation and Governance Group meeting. As a result of this activity, a number of proposals were received, compared and assessed against the NIC criteria and National Grid's innovation strategy. The joint proposal received from Premtech and Synthotech on inline inspection of high pressure installations, was chosen as the successful candidate.

At this stage the project has identified three partners; National Grid Gas Transmission, Premtech and Synthotech.

Premtech provide engineering, consultancy and design management services to companies involved in the development, construction and operation of high pressure gas transmission assets. It is proposed that Premtech take a joint role in this project, utilising their experience in design of class 600 high pressure gas systems to ensure that the correct design and operational standards are applied and safety standards are not compromised.

Synthotech have extensive experience of in-pipe camera technologies, and have developed the SynthoTrax™ robotic platform, that has successfully completed over 35 working projects on live gas mains throughout the UK.

Derogations or exemptions

The Licensee should outline if it considers that the Project will require any derogations, exemptions or changes to the regulatory arrangements.

No derogations, exemptions or changes to regulatory requirements are required.

Customer impact

The Licensee should outline any planned interaction with customers or customers' premises as part of the Project, and any other direct customer impact (such as amended contractual or charging arrangements, or supply interruptions).

Impact on customers will be minimal as any demonstration testing would initially take place on decommissioned assets and the Eakring training AGI. The method is intended to be less disruptive than other alternatives.

Details of cross sector aspects

The Licensee should complete this box only if this Project forms part of a larger cross sector Project that is seeking funding from multiple competitions (Gas NIC, Electricity NIC or LCN Fund). The Licensee should explain about the Project it will be collaborating with, how it all fits together, and must add a justification for the funding split.

N/A

Any further details the Licensee feels would add to the submission

N/A

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Job title

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