

NIA Project Registration and PEA Document

Date of Submission

Jan 2015

Project Reference Number

NIA_NGGT0064

Project Registration

Project Title

High Altitude Aerial Surveillance (HAAS)

Project Reference Number

NIA_NGGT0064

Project Licensee(s)

National Gas Transmission PLC

Project Start

January 2015

Project Duration

3 years and 7 months

Nominated Project Contact(s)

Kevin Robertson , box.GT.innovation@nationalgrid.com

Project Budget

£1,924,500.00

Summary

Regular surveillance of transmission pipelines is required to comply with IGE/TD/1 and T/PR/MAINT/5, and forms a key protection measure within the National Grid Gas safety case. At present, surveillance comprises mainly of aerial patrols by helicopter (covering ~12,000 km every 2 weeks) plus some line walk and vantage point surveys. The latter are used where aerial surveys are not possible due to flight restrictions, flight cancellations and also for areas where third party damage poses a significant threat.

Helicopters have been the preferred method for performing the aerial patrols for many years. The helicopters operate at low altitude (generally around 500 feet) with an on-board observer looking out of the window and manually entering any potential threats into the SRP system.

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

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Problem Being Solved

One of the biggest threats to the UK high pressure gas pipeline network is damage by third party interference. To mitigate against this threat, National Grid perform regular aerial patrols (amongst other measures), covering the high pressure network every two weeks. However this project looks to transition from using the relatively low-flying helicopters to using fixed wing aircraft which fly higher and faster, driving cost efficiencies and reducing risk. During helicopter patrols, a human observer looks out of the window down at the ground, and manually records potential sightings/threats on the on-board SRP1 computer. A disadvantage of flying higher and faster is

that the observer will be unable to visually identify the threats with the same reliability, so there will also need to be a move to an automated solution for threat identification.

Method(s)

A long term semi-automated system is likely to involve a camera fitted to the aircraft which records high resolution imagery for the pipeline corridors and surrounding area. These images will be downloaded to a ground station for processing. They will then be aligned with previously captured imagery to enable change detection to occur and the automatic detection of features that could be a threat to the pipeline. There will be a priority based system notification to allow a human analyst to further investigate and action potential high risk sightings. The final solution will require some element of human intervention / decision making before highlighted features of interest are passed to National Grid as a potential threat to the pipeline's integrity. It is envisaged that this project will take several years to complete so will therefore be stage gated:

Stage 1 Proof of Concept

The aim of the first stage is to capture and evaluate the problems that future automation may entail and then identify appropriate solutions. The work in stage 1 will prove if a subset of threats can be automatically identified from the aerial imagery and therefore provide increased confidence that the full set of threats could potentially be identified in subsequent stages of the project.

Stage 2

This stage will build upon the algorithms developed using stock imagery during Stage 1. Imagery for this stage will be collected from a predefined representative area of the pipeline network, and will be repeatedly collected over a period of time. This will help create a library of 5 to 10 passes over a single area which will allow further development of the change detection and feature detection algorithms. The camera types used during these flights will be specified as part of the 1st stage and will include some above-cloud capture.

Stage 3

Further development of algorithms using larger collected representative data set and from alternate camera / sensor types. In this stage more extensive and representative aerial imagery will be collected, attempting to capture every type of threat.

Stage 4 – Full Scale Trial

This stage will require running the existing helicopter patrols alongside patrols at the higher altitude for an extended period (~ 6 to 9 months) so that all weather conditions are encountered. Also, the threats detected by the two systems (existing and new) will be compared to establish the performance and benefits of the new system over the existing process. The commercial viability of a full implementation project and as well as expected operational costs for a final solution will be considered. This will allow an informed decision to be made as to whether a fully integrated production system can be developed that would ultimately supersede the current approach of the helicopter patrols.

Scope

Regular surveillance of transmission pipelines is required to comply with IGE/TD/1 and T/PR/MAINT/5, and forms a key protection measure within the National Grid Gas safety case. At present, surveillance comprises mainly of aerial patrols by helicopter (covering ~12,000 km every 2 weeks) plus some line walk and vantage point surveys. The latter are used where aerial surveys are not possible due to flight restrictions, flight cancellations and also for areas where third party damage poses a significant threat.

Helicopters have been the preferred method for performing the aerial patrols for many years. The helicopters operate at low altitude (generally around 500 feet) with an on-board observer looking out of the window and manually entering any potential threats into the SRP system.

The use of a fixed wing aircraft, flying higher and faster is thought to have significant benefits as they would be able to patrol the entire network in much less time than the helicopters. This could result in cost savings or more frequent patrols. However, operating in this mode, often above cloud, an observer would not be able to directly monitor the ground so a special camera system would be required capable of penetrating cloud. Even if there was no cloud cover, the height and speed would not allow a human observer to reliably detect all threats. For an observer to be replaced in the future with a specialised camera system (housed on any aircraft type or satellite) then there will be a number of challenges to overcome. It is these challenges that are the focus of this multi-stage project:

- Determining the camera systems to use: Optical cameras can be used on cloudless days, but the use of other cloud penetrating technologies will need to be considered, including LIDAR and near-infrared as well as 3D image visualisation.

- Imagery Resolution: The ideal image resolution will need to be determined in order to provide the best compromise as well as take into account;
 - Identification of ground objects.
 - Maximising the area covered by the image (the larger area the image covers, the more accurately it can be geo-located).
 - Minimising the amount of unnecessary data that is captured and transferred.
- Image Capture: Images can be taken using inflight cameras that are angled to the side, ahead or straight down. An assessment will be required to determine the best angle that will allow the semi-automatic processing of images. In addition, the ideal amount of overlap between two images will also be considered.
- Data Processing: There will be a large amount of data collected during each patrol, which will need to be downloaded from the aircraft, processed and any potential threats disseminated to the pipeline engineers for investigation within a reasonable time frame.
- Change Detection: For each patrol there will be many thousands of images captured so an automated process will be required that will compare the current image with previous images and then highlight areas of significance that have changed. One particular challenge is that images could be taken in different lighting conditions and with different shadows present. An operator would still be required to examine these changes to determine whether such changes actually pose a threat to the pipeline. The challenge to be overcome would be to intelligently filter out changes that are obvious non-threats – for example traffic moving on a highway.

These challenges will be the same whether the camera is fitted to a helicopter, aircraft, HAPS or satellite. This proposal focuses on solving these key issues using conventional aircraft.

Objective(s)

To develop and prove a high altitude aerial surveillance system as a viable alternative to current helicopter patrols.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Key success criteria at the end of each stage are as follows:

Stage 1 Successful demonstration of the first iteration of algorithms and report

Stage 2 Successful demonstration of new / updated algorithms and report

Stage 3 Successful demonstration of new / updated algorithms and report

Stage 4 Report detailing the comparison between the current patrols and the new system.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

Initial work will be desk based, with field trials if initial stages of work prove successful.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will take place at National Grid and supplier offices with field trials at locations within the UK.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

NIA expenditure - £ 1,924,500

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:

n/a

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

n/a

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)

The key benefit of the project is safety related. Third party interference is the number one risk on the gas transmission and distribution networks and a high pressure gas pipeline incident could have serious human, economic and environmental consequences resulting in many millions of pounds worth of damage.

More frequent patrols of the network would reduce the risk of third party damage to the pipelines, but using the current method of helicopter patrols (£1.76 million annual cost) would increase costs in the region of £1.44 million if patrols were doubled in frequency to a total of £3.2 million. A high altitude surveillance solution would allow this increase in patrol frequency for £1.6 million, a significantly lower cost.

Please provide a calculation of the expected benefits the Solution

N/A- research project

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

It is anticipated that the methodology could be used on all above 7 bar pipelines on gas transmission and distribution systems, included pipelines that are not currently covered by helicopter patrol and have to be vantage point surveyed.

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

A high altitude aerial surveillance solution is expected to cost in the region of £1.6 million per annum (Excluding camera technology) if the pipelines are surveyed at a frequency of once a week.

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

A high altitude aerial surveillance system will be of benefit to all gas transmission and distribution operators for use of above 7 bar pipeline.

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

The project is aligned to our safety theme.

- Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

n/a

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

n/a

Additional Governance And Document Upload

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

n/a

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

Yes