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

Sep 2017

Project Reference Number

NIA_NGGT0113

Project Registration

Project Title

Induction Heating

Project Reference Number

NIA_NGGT0113

Project Licensee(s)

National Gas Transmission PLC

Project Start

July 2017

Project Duration

1 year and 9 months

Nominated Project Contact(s)

Kirsty McDermott, .box.GT.innovation@nationalgrid.com

Project Budget

£93,600.00

Summary

Gas flame heating with oxy-propane is the most commonly used methods of applying preheat during in-service welding. Propane by itself does not give a hot enough flame for heating of high pressure gas pipelines, but can be used on low pressure pipelines/pipework. Gas flame heating is relatively cheap in terms of equipment needed, and it is versatile for site use.The disadvantages are:

- The welder has to stop working whilst heat is being applied.& bull; There are increased safety considerations due to the naked flame being used in close proximity to other personnel (i.e. welders and inspectors).
- Possible overheating may occur which leads to the integrity of the pipe will be comprised and the pipe must be replaced.
- Replacing an overheated pipe can cost in the region of £500,000.

Third Party Collaborators

Rapid Heat Systems

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

National Grid uses an oxy propane gas torch to heat the pipeline to 250°C when hot tap welding is required on a transmission pipeline. The pipeline must be heated to that temperature to allow welding to commence, this heat must be maintained and when the temperature drops to 150°C welding is stopped and the pipe reheated back to 250°C. Prior to welding a heat decay trial is carried out to measure the time it takes for the temperature to drop from 250°C to 150 °C for welding to commence the decay time has to be a minimum of 40 seconds; however, as the gas runs through the pipe it takes the heat away which causes the pipe to cool. Pre-heating

is very time consuming and if welding a 42 inch pipe it can take approximately 31 hours for the pipe to be welded completely. There are instances where epoxy grout is used, however in an emergency it is not feasible to use this method as each epoxy tee needs to be designed and built, therefore any emergency work to be carried out on a pipeline must be welded.

Method(s)

The aim of this project will be to produce hand held heating system which will localise induction heating on in-service welding projects. The hand held coil will be a prototype unit configured to suit one pipe diameter (DN450).
Deliverables are:
a. Task 1 – Requirements Capture.
b. Task 2 – Product Development.
c. Task 3 – Product Demonstration.
d. Task 4 – Standards and Procedures.
e. Task 5 – Training.
Task 1 – Requirements Capture
A cross-functional team of technical, safety and project management personnel to define the key performance requirements for this equipment for use on in-service welding operations.
Established structured techniques of Fault Tree Analysis (FTA) and Process Failure Modes and Effects Analysis (PFMEA) will be used to identify possible failure modes – not just of the equipment but of the whole in-service welding working environment.
For each failure mode, a probability of occurrence (P), severity level (S) and ease of detection (D) will be assessed.
The output of this session will be used to direct the design of the equipment, and define the onsite conditions needed for successful implementation.
Task 2 – Product Development
The output of the PFMEA session will be used to direct the product development.
For onsite induction heating, the key items of equipment and features are as follows:
• Generator, induction heating unit, cables and connectors.
• Hand-held induction coil.
• Temperature measurement and recording equipment.
• Control of heat input/metal temperatures.
The generator, induction heating unit, cables and connectors are all standard, industrially proven items of equipment. So, apart from the specifics of site configuration, there is no technical development required for these items.
Hand-held induction coils are well established. However, the shape and dimensions of the coils, as well as the ergonomics need to be refined.
Temperature control can be achieved by direct measurement and/or indirectly by timed interval heating. The supplier uses contact thermocouples for heating of rotating pipes/vessels, so with some minor modifications this can be adapted for the hand-held coils.
Control of temperature by times interval heating is easily achieved with the existing equipment. It can be set to deliver power for a specific time duration after which the power automatically cuts out. This method is very simple and reliable, provided all other conditions – such as ambient temperature, product flow rate and heat sink – don't vary too much.
Task 3 – Product Demonstration
A product demonstration will be undertaken to bring all the elements of the equipment and procedural operation together and performed in workshop conditions on a split tee fitted onto a mind-range pipe size.
Task 4 – Standards and Procedures
The supplier will produce an operating procedure for use of induction heating on in-service welding projects, also offer technical advice on any changes that may or may not be required to T/SP/P/9 relating to induction heating.
Task 5 – Training
Two technicians will be trained and the core competencies will be defined by the supplier. of two technicians.

December 2017 Update
To fully explore the latest thermocouple arrangement, allow appropriate time for the manufacture of the prototype, complete additional testing and mitigate any further impact on task two (which was due to technical issues regarding the time in receiving the drawings for the thermocouple), the duration of the project must be extended.

Scope

Gas flame heating with oxy-propane is the most commonly used methods of applying preheat during in-service welding. Propane by itself does not give a hot enough flame for heating of high pressure gas pipelines, but can be used on low pressure pipelines/pipework. Gas flame heating is relatively cheap in terms of equipment needed, and it is versatile for site use.
The disadvantages are:

• The welder has to stop working whilst heat is being applied.
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Objective(s)

To evaluate induction heating techniques to assess the suitability to improve welding process within National Grid.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

To maintain preheat using induction heating for in-service hot tap welding and include it into business as usual.

Project Partners and External Funding

Rapid Heat Systems Ltd.

Potential for New Learning

To demonstrate that induction heating can be maintained when conducting in-service welding.

Scale of Project

Trial in a working environment

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

Ambergate Pipeline Maintenance Centre (PMC)

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£93,600

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 approximate annual savings would be £43,720 based on welding two (2) 42"(1050mm) x 42" (1050mm) pipes in 1 year. In the event of any emergency welding requirements the savings will be increased.
Welding pipes of this size currently require 31 hours (4 days) is total time to complete, inclusive of the gas torch pre-heat time.
Based on previous user experience, there is a potential saving between 20 and 30% on welding time by using induction heating.
Which would reduce the total welding time from 31 hours to between 21 and 25 hours?
Induction heating is a well-established method of applying preheats to a work-piece. It is a non-contact method of electrically heating conductive materials.
It is considered that induction heating techniques would become standard practice on in-service welding projects for National Grid.
It's difficult without any trials as it has not been confirmed. However, for the longitudinal welds its was ascertained that a 20% reduction in welding time; therefore, it has been estimated that a saving of at least this on the circ welds as the heat sink from the gas draws heat away from the weld which is not an issue for the long seams.

Please provide a calculation of the expected benefits the Solution

Base cost – Welding using oxy-propane
Welding - 42" x 42" pipes (31 hours = 4 days) the costs are as follows:
11 FTE's - £500 each per day = £5500 x 4 = £88,000
Gas Consumables £ 3,860
Total £ 91,860
Method cost – Welding with induction heating
11 FTE's - £500 each per day = £5500 x 3 = £66,000
Consumables = £ 2000
Total £68,000
Projected Weld Saving: £43,720/annum (based on above scenario)
The analysis is based purely on the physical welding process. In reality other network requirements also need to be considered such as necessary local gas flow constraints to enable the weld to be performed safely. These can place considerable impacts on customers and other distribution operators. These are very case by case specific but have high cost implications.
Induction heating methods offer considerable safety and workplace improvements in the local welding environment for all engineers and technicians. The benefits will be to improve weld quality, reduce the potential of pipeline damage due to overheating material in

the preheating stage (which could result in significant increases in project times as the pipe section will require replacement costing in excess of £500,000), auditable preheat temperatures and increase safety.

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

This technique has the potential to be used in distribution networks.

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

The successful demonstration of Induction heating will result in its specification for use on all appropriate pipe welding across the network.

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

The induction heating process will enable the gas pipeline to be welded safer, better, faster and the specification will be updated in line with the new method.

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

• Health and safety – Oxy propane is used to heat a gas pipeline (which is under pressure) in preparation for welding; if the pipe was overheated it will lose strength. Consequently the pipe will need to be replaced; furthermore an overheated pipe may cause the pipeline to burst.
The new method using induction heating guarantees that the desired temperature cannot be exceeded therefore no possibility of overheating the pipe.
• Environment – by using greenhouse gas to pre-heat the pipe reduces the CO2 emissions

☑ 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.

There is currently no work currently being carried out investigating the potential of induction heating.

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