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NIA Project Registration and PEA Document

Date of Submission

Jul 2017

Project Reference Number

NIA_NGET0212

Project Registration

Project Title

Positioning ballistic screening on substation sites

Project Reference Number

NIA_NGET0212

Project Licensee(s)

National Grid Electricity Transmission

Project Start

December 2018

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Roberto Fernandez

Project Budget

£100,000.00

Summary

The overall objective of this project, and all the related work previously carried out, is to reduce the operational impact of the risk management hazard zones on our substation sites that are currently used to mitigate risks to substation staff.

Nominated Contact Email Address(es)

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Problem Being Solved

Disruptive failures to hollow-core porcelain-clad equipment caused by the thermal shock energy generated by an internal electrical fault, can cause porcelain fragments to be projected over a wide area. This kind of failure has a low probability of occuring, but has potentially significant safety implications for staff on site at substations. For a number of years now National Grid has managed to associated safety risks by defining risk management hazard zones around equipment that can fail in this way, and access to these areas is carefully restricted.

- Whilst effective at managing the safety risk, this significantly affects our ability to carry out a number of routine inspection and maintenance activities, as well as resticting the opportunities for asset repair and replacement projects. We have been investigating the causes, effects and potential alterantive risk mitgation measures through a number of research projects over a number of years.
- Between 1999 and 2005 National Grid worked with Cranfield University to study and produce a computer model to simulate the likely dispersal pattern and fragement trajectories from an explosive failure of porcelain clad equipment. This delivered a computer model based on technology of the day, that runs mutiple simulations of how fragments could disperse following failure and is used to help inform the extent of risk management hazard zones.
- In 2008/9 research began into developing a modular, relatively easily installed and movable screen capable to blocking porcelain fragments of various sizes with energies in excess of the likely worst case event in a real substation. The screen was designed from non conductive materials and this phase of work culminated in testing the screen by firing 1kg fragments of porcelain from an air cannon at the screen at velocities greater than those modelled from previous studies and then detonating a ceramic insulator column at a distance of 10m from the screen. This project developed a prototype screen and proved that it was effective at stopping fragements at a distance of 10m.

- In 2015 a second set of tests were successfully carried out replicating the ceramic insulator column detonation, this time with the screen at a distance of 3m. In addition to proving the screen is effective at just 3m distance, the ability of the screen to withstand a shower of molten metal was also demonstrated.

Following the success of projects in the development and testing a suitable screen, 80 screens have been purchased by National Grid and are being deployed on site.

This project seeks to develop the following knowledge necessary to make the best use of the screen that has been developed to date, and to identify and assess potential alternatives that may be effective in circumstances where it is not practical to make use of the current screen design.

- for a given screen height and position, relative to an at risk piece of equipment, what is the expected probability of a fragment of porcelain sailing over the top of the screen?
- relative to the polycarbonate GRP screen developed to date, how effective are other barrier systems (hera fencing, ISO containers, plywood or polycarbonate attached to pallisade/heras close boarded scaffold) and what practical advantages do they offer.
- study other modes of porcelain asset failure (for example low pressure failure, where porcelain fragments might travel a shorter distance before coming to rest to the ground - as shown in several recent types of equipment failures (e.g. Reyrolle Hairpin CTs)), and extend the study to investigate the extent of fireball risk from mineral oil filled equipment.

Method(s)

This project will:

- examine the effect of adding screens of different heights and distance from a failing assets on the subsequent debris field by modifying the modelling software originally developed during the studies undertake in 2005,
- test other screening solutions and modify the model further to reflect the relative effectiveness of each solution that shows resaonable degrees of protection.
- study other asset failures including low pressure failures and use the data from those studies to further develop the computer simulation to add in different projectile/ballistic debris patterns and fireball behaviours.

The project is broken down into three work packages as described in the scope section below. The costs, timescales and TRL set out in this PEA relate to work package 1 only. A procurement process will shortly begin for work packages 2 and 3 and the PEA will be updated with further detail once this is completed. Work packages 2 and 3 may be carried out in parallel or sequentially depending on the results of the procurement exercise and the availability of resources such as test facilities.

Additional information about work packages 2 and 3 will be added prior to them commencing.

Scope

This project is divided into three distinct work packages.

Work package 1 will develop the original debris field modelling software to enable a number of variables to be introduced such that screens of different height and distance from a failing asset can be introduced and the resulting effect on debris pattern modelled. The updated modelling tool will have a simple graphical user interface and will be usable on any National Grid computer (this should ensure it is also usable by any other GB network). The aim is for the model to identify a location that represents the most exposed location.

Work package 2 will assess a range of alternative screening options and assess their relative effectiveness as a barrier and identify the probability of different fragment sizes and velocities penetrating the barrier. The computer model developed as part of work package 1 will be extended further to allow users to vary the type of barrier to be modelled, taking due account of the relative effectiveness of each barrier type in intercepting or altering the trajectory of different size and velocity fragments.

Work package 3 will investigate limitations of the model with lower pressure (eg 1-5 bar) failures. It will also investigate the behaviours of fireballs that may result from failure of mineral oil filled equipment. Depending on the success of these studies, the model will be updated further to enable a wider range of failure modes and impacts (such as a fireball) to be assessed when planning activies on sites affected by risk management hazard zones.

Work packages two and three will involve desk based research and depending on the outcomes of that, may include destructive testing of equipment to provide data for modelling.

Objective(s)

The specific research objectives for this project are to establish:

- for a given screen height and position relative to a known piece of equipment, what is the expected probability of a fragment of

porcelain sailing over the top of the screen?

- how effective other barrier systems (hera fencing, ISO containers, plywood or polycarbonate attached to pallisade/heras close boarded scaffold) are relative to the polycarbonate GRP screen developed to date, and what practical advantages do they offer.
- the effects on debris field from other modes of porcelain asset failure (for example low pressure failure), and study the extent of fireball risk from mineral oil filled equipment.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Each work package has its own set of success criteria.

Work package 1 - produce an enhanced version of the original simulation model to allow a number of variables to be easily modified by users and validate the new model against the orginal one.

Work package 2 - prepare a documented assessment of the relative effectiveness of different screening solutions, including testing where appropriate. If viable alternative are identified and suitably tested, then extend the simulation tool to allow users to easily model the effect of different types of screen when assessing risks to personnel on site.

Work package 3 - update the simulation tool further to take into account other factors that modify the risks from a porcelain asset failure, such as coatings and the effects of fireballs.

Project Partners and External Funding

n/a

Potential for New Learning

This project is designed to develop new learning about the effect of introducing barriers of different height, distance and effectiveness on the potentially harmful impacts from explosive failure of porcelain assets and to translate existing knowledge and the new information from the project into an easily used simulation tool that can be used on standard office computers by any networks licensee to better inform risk assessments and method statements for undertaking work in risk management hazard zones.

Scale of Project

Work package 1 will be desk based and involves updating and extending the simulation tool previously developed and validating the outputs.

Work packages 2 and 3 will both involve desk based studies as a minumum, but may also require destructive testing to be part of the scope to provide the data needed to achieve the desired outcomes.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

Work package 1 will be office based. This project is not expected to include any trials on any part of the transmission network. Work packages 2 and 3 may include destructive testing. The locations at which this would take place will be determined by the testing requirements, the suitability of available test facilities and a suitable procurement process.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

The indicative NGET NIA expenditure on work package 1 only is £100,000.

Further information about work packages 2 and 3 will be added once known.

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)

This project will help to provide alternatives to hazard zones in specific situations and as such will reduce the impact of hazard zones on system operability and increase access for maintenance.

Please provide a calculation of the expected benefits the Solution

Work package 1 of this project is a research project. Further information will be added prior to commening work package 2 and 3.

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

This output from this project is expected to be a new piece of software that will be easy to use for the assessment of how the risk of working in risk management hazard zones is modified by using ballistic screens. Nearly all tansmission substations in England and Wales have one or more risk mangement hazard zone.

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

The cost of roll out across England and Wales transmission network or other electricity networks, is likely to be limited to training operatives in the use of the software.

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

☐ 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

This project is designed to develop new learning about the effect of introducing barriers of different height, distance and effectiveness on the potentially harmful impacts from explosive failure of porcelain assets and to translate existing knowledge and the new information from the project into an easily used simulation tool that can be used on standard office computers by any networks licensee to better inform risk assessments and method statements for undertaking work in risk management hazard zones.

All electricity network licensees have assets of this kind and face similar challenges.

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

n/a

☑ 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.

This project is related to the ballistic screening projects already registered on the NIA portal.

Early stages of work are reported in the NGET IFI report for:

Rapid Deployment Ballistic Screen. http://www.smarternetworks.org/Project.aspx?ProjectID=650

- Ballistic Screening (IFI report 2009-10). http://www.smarternetworks.org/Project.aspx?ProjectID=893. and
- Rapid Deployment Ballistic Screen (IFI reports 2011-12 and 2012-13). http://www.smarternetworks.org/Project.aspx?ProjectID=650. This project continued under NIA and was registered as
- Rapid Deployment Ballistic Screens (NIA_NGET0079) http://www.smarternetworks.org/Project.aspx?ProjectID=1342

The previous work carried out was related to the development of a suitable screening solution. This project aims to take a computer model created in 2005 which simulates the trajectory of porcelain fragements after a failure and develop it to enable a 'virtual' screen to be inserted at different distances from the asset that fails to see how well different areas are protected by the screen.

Further work is being planned to continue to develop improvements in the ara of ballistic screening by identifying and quantiatively testing different screenng solutions that offer advantages in some respects and potentially disadvantages in others when compared to

the ballistic screening solution that has been developed to date. We plan to add models of any other screens that are tested in future phases to the computer similuation being developed in phase 1 of this project.

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

-

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

-

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

-

This project has been approved by a senior member of staff

☑ Yes