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

Feb 2020

Project Reference Number

NIA_NGTO051

Project Registration

Project Title

Long Term Stability Testing of Alternative Gases 2: C5F10O

Project Reference Number

NIA_NGTO051

Project Licensee(s)

National Grid Electricity Transmission

Project Start

April 2020

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Gordon Wilson (box.ngetinnovation@nationalgrid.com)

Project Budget

£200,000.00

Summary

Sulphur hexafluoride gas, SF6, is unique in its electrical and thermal performance. However, its Global Warming Potential, GWP, is very high at around 23900, compared with CO2 which has a GWP of one. Such negative impact on the environment led to the designation of the gas as a "Kyoto Gas". In the UK, it is estimated that SF6 contributes 0.2% of the annual greenhouse emissions. In recent years, new gas molecules and mixtures of gases have been considered and tested. A number of candidates have been particularly studied, these include dry air, N2 or CO2, polyfluorinated gases especially Trifluoroiodomethane (CF3I), Perfluorinated Ketones, Octafluorotetra-hydrofuran, Hydrofluoroolefins (HFOs), and Fluoronitriles.
This proposal is to extend the work being conducted on the stability of Novec™ 4710 and its mixtures under project NGTO002 to Novec™ 5110 (C5F10O) and its mixtures. Similar techniques, as developed for the Novec 4710™ gas mixtures project, will be adopted here.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

This project will focus on health and safety of the new gas mixtures based on the NOVEC™5110 gas. It will also give an initial indication of the gas mixtures stability and their interaction with the surrounding environment and materials. Breakdown gas by-products, due to varying levels of electrical discharge in the gas mixtures, will be analyzed by adopting a Cardiff in-house technique using a GCMS system developed for Novec™ 4710 gas mixtures. The interaction with surrounding materials will also be examined through surface analysis using SEM techniques.

Method(s)

The main work packages of the technical concept study are:
(i) A specialist stainless test rig will be used to conduct the tests. First, the effect of discharges and flashover in the gas mixtures will be measured in terms of by-products. Both short term and long-term tests will be explored. An in-house technique employing a GCMS system will be used to analyze the gas by-products following incremental periods of time of discharges and number flashover events. A list of by-products will be developed for each mixture tested in this programme and its correlation with severity of electrical discharge activity will be quantified. Furthermore, for the above tests, comparison of NOVEC™ 5110 with its various mixtures with CO2 and/or

N2 will be conducted (at 5, 10 and 20%). This will work will further help to indicate if any health and safety studies of the gas mixtures are required.
(ii) The second major axis of this work is to investigate the stability of the gas and its mixtures. Building on the previous work of breakdown gas by-products analysis, quantifying the impact of the gas and its mixtures on the surrounding materials will be necessary to determine the long-term stability of the gas and the GIS system. In this case, various materials used in GIS technologies will be sourced (through National Grid) and investigated. Existing methods analysis of dielectrics will be considered and adapted for the gas mixtures in the presence of various materials and under various diverging electric field conditions. This work will determine the overall stability of the gas mixtures and their reaction with the surrounding materials. Scanning electron microscopes (SEM) will be used to investigate the changes of surface properties of various materials used in GIS systems. This will form a solid platform for future detailed analysis of the gas long term stability.

Scope

This project will investigate the stability of the new gas mixture (Novec™ 5110 and other modified mixtures) in the presence of various materials and under different working pressures. Measurement of gaseous breakdown by-products when the gas mixture is subjected to electrical flashover and partial discharges will be carried out to understand their nature and their effect on the stability of the gas properties. An overview of the research into the health effects of the gas will also be conducted.

Objective(s)

The aim of this work is to gain a better understanding of the recently proposed alternative gases (C5F10O or Novec™ 5110) gas mixtures to replace SF6 gas. It will also enable obtaining a better understanding of the health and safety implications when using the newly proposed alternative gas mixtures, through by-products analysis. Moreover, it will allow the assessment of the stability of the new gas mixtures and their impact on surrounding equipment.
The objectives of this work are to:

- quantify the impact of electrical discharges and flashover on the dielectric properties of the gas mixtures
- measure the by-products of the gas mixtures following flashover
- determine the impact of the gas mixtures and their by-products on surrounding materials.
- develop an indicator of gas mixture degradation and estimate long term stability.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Obtain a better understanding of the health and safety implications when using the newly proposed alternative gas mixtures, through the by-products analysis. Moreover, assess stability of new gas mixtures and their impact on surrounding equipment.

Project Partners and External Funding

This project will be delivered by Cardiff University. There will be no external funding or partners

Potential for New Learning

By-products details following electrical discharge in Novec gas mixtures are not known / published. This project will deliver this new knowledge. Furthermore, indicators of long term stability of new gas mixtures and their impact on surrounding materials will be assessed.

Scale of Project

This project will last for 1 year involving extensive laboratory testing. It will benefit from the work already completed in NGTO002 thereby being shorter and lower cost than that project

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The work will be conducted at Cardiff University. The results are applicable to future projects involving technologies using alternatives to SF6 as insulation, these could be implemented anywhere on the National Grid network

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£200k

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)

If all the problems are solved a significant reduction in SF6 leak rate can be achieved and the impact electricity companies have on the environment reduced. This would provide a paradigm change in terms of the impact that electricity networks have on their scope 1 greenhouse gas emissions and result in the provision of more environmentally sustainable electricity to UK consumers.

Please provide a calculation of the expected benefits the Solution

It is not possible to quantify this yet as this is early research and we do not know the potential degree of environmental and cost advantage of a replacement gas until we find a mix that works.

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

The knowledge gained from the project is applicable anywhere in the UK. The outcomes of this project will enable UK license holders to make more informed decisions about the suitability of Novec™ 5110 as an alternative to SF6 to meet their environmental objectives.

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

The direct cost of making a policy or procedure change could range from as little as ten thousand to hundreds of thousands of pounds depending on the complexity of the change implications. The wider cost implications arising from such changes will be dependent on the specific outcomes generated from the project and typically will be subject to further stages of demonstration prior to roll out. Further information regarding roll out costs can be provided prior to demonstration stage.

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

All network licensees need to consider alternatives to SF6 insulation. This project will inform these considerations

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

Managing Assets and Corporate Responsibility
☑ 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.

A review of ongoing projects by other licencees on the ENA Smarter Networks suggests that no others are looking at this aspect of the suitability of Novec™ 5110. Cardiff University is engaged with other NIA projects on alternatives to SF6 requiring that they maintain awareness of other work in this area on an ongoing basis.

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

The project is innovative because it will investigate properties of Novec™5110 not previously investigated or published by the material supplier, equipment manufacturers or other users. This is a relatively new formulation to be available to utilities and considerations on health and safety, especially of breakdown products is not information that can be readily obtained.

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

The project is inherently a research project and carries a risk that the research may be unsuccessful or identify unforeseen barriers to implementation and therefore National Grid is unable to consider the research of this scale as business-as-usual. The NIA funding offers the most appropriate route for NGET to investigate the possibility that Novec™5110 can be a viable solution for reducing its environmental impact

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 uncertainties of the project are detailed above and the learning from the project will be directly relevant to all Network Licensees. For this reason, NGET believes this project is appropriately funded through NIA, and material from the project will be appropriately disseminated.

This project has been approved by a senior member of staff

☑ Yes