

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

Mar 2013

### Project Reference Number

## Project Registration

### Project Title

MI HVDC Cable Load Cycling

### Project Reference Number

### Project Licensee(s)

National Grid Electricity Transmission

### Project Start

January 2009

### Project Duration

6 years and 10 months

### Nominated Project Contact(s)

National Grid TO Innovation Team

### Project Budget

£1,867,000.00

## Summary

High Voltage Direct Current (HVDC) Mineral Insulated (MI) Cables have complicated stress processes that are particularly vulnerable in the cooling stages immediately associated with power reductions or emergency shut downs, especially when occurring during the delivery of short term overloads, however the behaviour of MI cables under different load conditions is not clearly understood. This knowledge would be of great benefit to Utilities.

Mass impregnated HVDC subsea cable has for long been and still remains the state-of-the-art technology. The electrical insulation of such cables consists of paper impregnated with a high viscosity oil (the "mass"), enclosed by a lead sheath that prevents water ingress.

Recent installations operate at typically 400 - 450 kV and have a continuous power rating per cable of up to more than 500 MW. Two HVDC links are presently in operation between Norway and the European continent, and more are expected to come. In a future pan-European electrical power grid, subsea cables in the North Sea are expected to play a crucial role, both for exchanging power between the UK, Scandinavia and the European continent, and for transferring power generated in large off-shore wind farms.

It is generally accepted that the cooling period after a power reduction or turn-off is the most critical part of the operation of subsea mass impregnated HVDC cable. Consequently, the power rating of such cables, both with regard to short term overloads and on a continuous basis, is largely set by considering the risk of having a dielectric breakdown during a power reduction or turn-off. However, as will be described in some detail below, the behaviour of the cable insulation under different load conditions, and thereby the risk of having such breakdowns, is far from fully understood. Hence, it is reasonable to assume that the true capacity and operational flexibility this cable technology can offer, are not fully exploited.

### Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

## Problem Being Solved

## Method(s)

## Scope

## Objective(s)

To determine what load conditions (power ratings and load patterns) typical high voltage direct current (HVDC) mass impregnated paper insulated cables can be subjected to without risking cavity-induced dielectric breakdowns during a cooldown period after a power reduction or turn-off.

To establish an informal North Sea cable working group towards collaboration on HVDC link projects, potential sharing of spares holding and repair resources.

Project Deliverables:

- Obtain a detailed physical understanding of the processes that lead to cavity formation and the importance of various operational, environmental and cable design parameters to these processes
- Develop a numerical model that quantitatively describes the radial mass flow and cavity formation under load cycling
- Determine the operational constraints for one or more HVDC subsea cables presently in service.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

n/a

## Project Partners and External Funding

n/a

## Potential for New Learning

n/a

## Scale of Project

n/a

## Geographical Area

## Revenue Allowed for the RIIO Settlement

## Indicative Total NIA Project Expenditure

## 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)

n/a

#### Please provide a calculation of the expected benefits the Solution

n/a

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

n/a

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

n/a

### 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**

n/a

**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

**Please demonstrate how the learning from the project can be successfully disseminated to Network Licensees and other interested parties.**

**Please describe how many potential constraints or costs caused, or resulting from the imposed IPR arrangements.<**

**Please justify why the proposed IPR arrangements provide value for money for customers.**

## 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