nationalgrid

Date of Submission

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Network Innovation Allowance Progress Report

Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

Project Progress

Project Title

13kV Shunt Reactor Refurbishment

Project Reference

NIA_NGET0102

Project Licensee(s)

National Grid Electricity Transmission

Project Start Date

Dec 2013

Project Duration

15 Months

Nominated Project Contact(s)

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Scope

The scope of the project covers the relocation of a failed 13kV 2x30MVA shunt reactor (English Electric design) from Willesden substation, London to ABB, Drammen, Norway for inspection; technical teardown (to include recommendations on refurbishment options); redesign and if economically feasible, manufacture of the active part; refurbishment of reactor tank and cooler bank (with option to replace cooler bank with modern equivalent); factory acceptance test of refurbished unit to modern standards and installation and commissioning of the refurbished reactor in its original location at Willesden substation i.e. the reactor will reuse the existing plinth therefore negating the need for extensive civil works.

Objective(s)

To establish viability of refurbishment (including active part redesign) of a 13kV reactor.

Success Criteria

This project will be successful is we establise a methodology for refurbishment of 13kV Shunt Reactors suitable for modern standards. Further success for this project will be if the refurbishment is economically viable, and also if we can roll out the refurbishment option to the National Grid 13kV reactor fleet.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

NGET (“NG”) has endeavoured to prepare the published report (“Report”) in respect of 13kV Shunt Reactor Refurbishment (10303 NIA_NGET0102) (“Project”) in a manner which is, as far as possible, objective, using information collected and compiled by NG and its Project partners (“Publishers”). Any intellectual property rights or confidential information developed in the course of the Project and used in the Report shall be owned by the Publishers (as agreed between NG and the Project partners). This Report contains confidential information owned by the Publishers such information should not be shared by viewers of the Report with any third parties or used by viewers of the Report for any commercial purposes without the express written consent of the Publishers who may at its absolute discretion request the viewer of the Report enters into separate confidentiality provisions.

Overview

Shunt reactors are used on the transmission system to compensate for the high capacitance found in long conductor lengths and cable systems; without them, the Transmission system would be much more expensive to run. Asset replacement of reactors is costly and can involve a large amount of civils work which also has a large carbon footprint. Reactors cannot be refurbished using the old designs as the equipment wouldn't meet the specification required to enable it to be installed on the Transmission system. Therefore refurbishment must include a redesign of the active part of the reactor.

This project will determine the methodology and cost effectiveness of refurbishing a 13kV reactor to modern standards, as opposed to replacing the asset.

Plan

2013/14

The project began in December 2013 and during the first 3 months an NIA contract was agreed with ABB and the project plan developed.

2014/15

The project was more than 90% complete at the end of March 2015.

The following key milestones were achieved during 2014/15:

1. The removal of the reactor from site and its transportation by road and ship to ABB's Drammen refurbishment facility.

2. A post-mortem inspection of the active part (core and coils) was completed after they were removed from the tank. A post mortem report was delivered.

3. Following a series of technical design reviews, a new active part was manufactured to fit into the existing tank. The relative cost of transporting the cooler bank (radiators) in order to facilitate the completion of the required temperature rise (heat run) tests meant that it was economically more attractive to replace the cooler bank with a modern equivalent.

4. The new active part was assembled, placed in the original tank and subjected to a suite of tests, in line with National Grid's current technical specification. The majority of test results were compliant with the technical specification. Non-compliances are detailed later in the report.

Next Steps

The project will complete in 2015/16 and the final steps are preparation for shipment, transportation to Willesden Substation with subsequent site installation and pre-commissioning. Completion of the project was due in March 2015 but was briefly delayed following a problem with the test equipment during factory tests. Discussions are ongoing to agree the ex-works date that best aligns with other works at Willesden substation.

Required Modifications to the Planned Approach During the Course of the Project

Design Modifications

There were some items that had not been fully considered ahead of the project, namely:

1. Bursting disk. Rather than return the reactor to service with the relatively old technology of a bursting disk, the decision was taken to replace it with a modern equivalent and therefore a Pressure Relief Device (PRD) was fitted.

2. Core steel and losses. The active part design that was initially proposed met the basic requirements to replace the existing active part and fit it in the original tank. However, an opportunity to reduce losses over the anticipated asset life of the refurbished reactor was identified. To achieve this, funds were released from the contingency to secure the use of lower loss core steel – these costs will be recouped in-service.

Issues During Test
Aside from the difficulties (that were overcome) due to the failure of factory test equipment, there were two other issues that were not originally foreseen:

1. Vibration Test. The vibration measurements made were in excess of the 100µm permitted level specified.

2. Sound Power Level Test. The sound levels measured were also in excess of specified maximum levels.

As ABB reused the original tank, they couldn't reasonably guarantee either of these levels. The reactor at Willesden will be returned to an enclosure, meaning that these technical test failures are not insurmountable. However any future proposed refurbishment project where noise level sensitivity might be a cause for concern would need to be mindful of these issues.

Lessons Learnt for Future Projects

As noted above the reuse of the original tank meant that certain aspects of National Grid's Power Transformers and Reactors technical specification could not be fully satisfied. In this particular case these non-compliances can be managed but this is an aspect that needs careful consideration before future refurbishment projects can go ahead.

Before choosing the candidate for refurbishment a number of elements were considered, a number of problems anticipated and (where possible) avoided. These included aspects such as:

- Overall external condition of the reactor, specifically the tank and lid. If the tank had shown signs of significant ageing (e.g. corrosion or excessive leaks) then it would not have made a good candidate. Even though the 46 year old reactor tank and pipework appeared to be sound, following oil fill and before testing, an oil leak occurred and a minor repair had to be completed – this caused a short delay to the test programme.
- The cooler bank was inspected and found to be in reasonable condition, but the cost of transporting the coolers to Drammen so that the temperature rise test could be completed (normally a requirement on the first unit or 'type test') was not economic. If further reactors of the same design were to be refurbished by ABB at Drammen (i.e. with the same new active part design), then the temperature rise test would not be required and the in situ, existing cooler bank could be reused. This would achieve a further saving – notwithstanding any on site refurbishment of the coolers that might be required e.g. painting.
- Whilst a small reduction in core loss was proposed during design review, an opportunity to enhance the efficiency of the reactor was noted and better grade, more expensive, core steel was included in the design. This could have been anticipated; early calculations to enhance performance completed and a lower loss value specified. If National Grid pursues a strategy of reactor refurbishment this loss figure would be a consideration in the assessment of any commercial offers (as it is for any new equipment).
- Given the age of the asset, a more detailed consideration of fixtures and fittings could have been made. Whilst the addition of optical fibre to measure temperature in the winding was considered and included in the cost, the opportunity to replace the bursting disk with a more modern Pressure Relief Device was overlooked at contract placement.
- National Grid assigns family codes to its assets meaning that sister units (i.e. same design from same factory) can be quickly identified. For example, if a fault arises in a particular transformer or reactor, it can be helpful to understand whether a similar issue is likely to occur elsewhere or in multiple units. However, when selecting a reactor for refurbishment it would make sense to choose a family that might yield economies of scale in the long term. In this case, the family that was selected has a further 8 sisters in service on the National Grid system. Further economies will only be realized in the long term as National Grid does not advocate the mass replacement of sister assets based on age; assets are replaced on a condition and criticality basis.
- Procurement rules (competitive tender): the bespoke nature of reactors and the unique approach taken by suppliers to product design means that a future decision to refurbish even a sister unit may lead to a completely different solution.

If further work is put out to tender, the supplier involved in this NIA project might be seen as having a competitive advantage however it is not believed that the market would find this insurmountable.
Putting aside all of the points made above, unless the competitively tendered offering from the market can contend with new build (or at worst new build plus civil engineering costs associated with asset replacement), an asset replacement strategy built on refurbishment will not be feasible. In short, it would appear that a case by case consideration of projects is the most likely scenario.