Energy Networks Innovation Process

Project Closedown Report Document

The voice of the networks

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Project Closedown Report Document

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Project Title (*This cannot be changed once registered*)	Project Reference
Alternative Jointing Techniques	NIA_SSEN_0054
Funding Licensee(s)	**Project Start Date**
SSEN - Scottish Hydro Electric Power Distribution & Southern Electric Power Distribution	July 2021
Project Duration	**Year**
17 months	2022

Nominated Project Contact(s)

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1. Scope

Scope of the Project

Stage 1 - Proof of Concept

The Scope is to develop the putty material to a proof of concept/component validation in a laboratory, experimenting with the same scale of joints that are used currently.

The output of stage 1 is to prove the feasibility that using a resin-based putty can be used to encapsulate a LV joint and withstand the electrical voltages.

Output 1:

- Validate that it is feasible to create a mouldable putty solution that meets the mechanical and electrical requirements of an LV joint. There will also be potential additional benefits in the following areas: -
    - Cost reduction and efficiencies operational time and effort
    - SHE (Safety, Health and Environment) impact

2. Objective(s)

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The projects objectives are as follows.

Develop Requirements to describe the specific requirements of the technology in terms of material performance, process methodology needs, cost targets, process duration targets.

- Product specification

- Process specification / targets
- Cost targets

Investigate manufacture of a resin-based putty system with standard curative systems.

- Measure the ability to mould the joint between clam shells
- Measure the base dielectric strength or other electrical requirements

3. Success Criteria

- Be applicable to all LV Waveform and PILC cable types.
    - System passes accelerated ageing and electrical testing programme
- Competitive unit and operational cost compared to current method.
    - Cost modelling of resin and equipment as well as measured time savings
- Be able to work as a 1 man lift in harsh environment
    - Putty mass target to be < 10kg
- Be safe to use on site.
    - Written risk assessment
- Provide operational benefits e.g. number of trips required back and forth from van
    - Time-motion comparison of new versus existing techniques
- Be transportable within van weight limit and size.
    - Measure complete package mass
- Have an acceptable level of cable damage resistance.
    - Report comparing the cable damage resistance of the putty repair process against conventional repair techniques
- Practicable without requiring intensive/excessive operational training
    - Obtain operator feedback
- Be applicable to Consac cables.
    - Successful Laboratory and field trials

4. Performance compared to the original project aims, objectives and success criteria

The original project aims, objectives and success criteria focused on a resin-based putty but the initial stage of the project involved a wide assessment of existing jointing techniques and products as well as research into different potential materials: putties, fillers, foams, resins and curing mechanisms. The scope was altered early in the project to reflect difficulties in developing a hardening putty and the discovery of lightweight fillers and a silicone based gel which may better meet the projects aims and objectives.

After laboratory trials examined a range of alternative fillers and materials, the project split into two parts. One side of the project looked at replacing the sand as a filler with lightweight Fillite and the other side of the project focussed on developing an improved clamshell filled with a lightweight material such as foam or gel.
Compared to the original project aims a product specification has been produced and a time in motion study was completed to generate process targets. Cost targets were not supplied by SSEN however costs for alternative materials have been produced for comparison of the alternative techniques.
The project has met 15 of the 18 success criteria:

- The solutions proposed are applicable to all LV Waveform and PILC cable types.
- Time savings compared with the current resin and sand solution have been measured
- Case study event proved that our solutions can be used by a single person

- The foam and gel meets the original putty mass target of less than 10kg. A tub of resin and Fillite also meets this target
- The solutions provided are safe to use on site
- Safety data sheets for the materials have been reviewed for health and safety assessment purposes
- Operational benefits have been met for the gel and foam solutions
- Time-motion comparison of new versus existing techniques has been completed
- Solutions are transportable within van weight limit and size
- Measured complete package mass
- Solutions have an acceptable level of cable damage resistance
- Solutions are practicable without requiring intensive/excessive operational training
- Operator feedback has been obtained at the case study event
- Applicable to Consac cables
- Successful Laboratory and field trials

The project has not met the following criteria due to limitations and failures in mechanical and electrical testing proof of concept prototypes, and a lack of information on pricing per unit for completely designed products. These proof of concept joints may use further developed foam or gel systems for this specific application and therefore further testing at this stage would be premature.

- System passes accelerated ageing and electrical testing programme
- Report comparing the cable damage resistance of the putty repair process against conventional repair techniques
- Competitive unit and operational cost compared to current method.

Overall, the project has proved that there are alternative jointing techniques that may effectively meet the success criteria. These solutions are lighter, quicker and easier for the jointer to carry out.

A second phase to the project tested resin and sand, resin and Fillite and foam straight joints to an AC withstand test taken from BS 50393. All three joints passed the test, so the foam concept was tested further and therefore the same test was completed while submerged in a metre head of water. The foam filled straight joint failed this test as water was getting into the cable join and coming out the ends of the cable. This proves the need for a watertight design if the foam filled concept is to be designed and developed in a second project.

5. Required modifications to the planned approach during the course of the project

The Network Licensee should state any changes to its planned methodology and describe why the planned approach proved to be inappropriate. Please confirm if no changes were required

Once it was concluded that the semi-solid thermoset putty was not a viable option, the approach was changed to look at a lightweight filler to replace the sand used with the current liquid thermoset resin.
We tried the following products:

- Talc
- Glass Bubbles (hollow glass spheres)
- Q cell
- Fillite
- Foam

Glass bubbles, hollow glass spheres, were the least dense material trialled with a measured density of 81.3kgm-3, however, the filler was very difficult to combine with the resin because it dispersed into an airborne cloud upon mixing, causing a health and safety issue when mixed at site. After combining with the resin, the mixture had a density of 785kgm.

Hollow sodium silicate borate microspheres (trade name Q-cell) is another microsphere which is used as a volume extender and is also much lighter than sand, with a measured density of 126 kgm-3 . This also had the same problem as the glass bubbles when mixing with the resin at site. The powder dispersed over a large area and did not stay in the mixing container.

Talc has a measured density of 502 kgm-3 , 70% lower than the density of sand. This material was also difficult to use as it thickened the resin greatly, making it difficult to pour into the clamshell.

Alumino-silicate microspheres (trade name Fillite) is a microsphere which is extracted from pulverised ash taken from power stations. It has a measured density of 519 kgm-3 and was similar in mixing to sand. It did not disperse into an airborne cloud nor drastically thicken the resin. The resin and Fillite combination at a 1:1 ratio gives a density of 977 kgm-3 , 43% less dense than the current resin and sand combination. Fillite was deemed successful from the initial trial and was taken forwards for development.

An idea for an efficient and lightweight method to fill the clamshell was expanding foam. There are a range of foams with different properties on the market. Foam could be injected into the clamshell. Trials were performed with a one-part expanding polyurethane foam, dispensed from a can in layers and then left to expand. The foam filled the joint but cure was delayed. The process was easy but further resin development would be needed to match the foam to the joint.

6. Lessons learnt for future projects

Describe how the project (methodology, stakeholder engagement etc.) changed, or provided opportunities, from your expectation at the start of the project and therefore could be useful for a future project. In addition, please discuss the effectiveness of the research development or demonstration undertaken.

A successful case study event was held which provided opportunity to get hands on with the proposed solutions, as well as benchmark the new methods against the existing process. Foam shows promise as it is significantly lighter, quicker and easier to fill the clamshell with. Although Fillite is lighter, it takes longer to pour into the clamshell. This could be compensated for by adjusting the composition of the resin and hardener to reduce viscosity.

7. The outcomes of the project

When available, comprehensive details of the Project's outcomes are to be reported. Where quantitative data is available to describe these outcomes it should be included in the report. Wherever possible, the performance improvement attributable to the Project should be described. If the TRL of the Method has changed as a result of the Project this should be reported. The Network Licensee should highlight any opportunities for future Projects to develop learning further.

The key outcomes of the project are:

• Developed and successfully trialled a lightweight filler that could potentially replace the sand currently used. The filler is a by-product of the coal power industry and reduces weight by 69% compared with sand.
• Developed and successfully trialled a two-part polyurethane foam filling system. The foam was 5 times quicker to fill a breach joint and 35 times lighter compared with traditional joint materials. Less than 1kg of foam is needed to fill a breach joint compared with 33.75kg of resin and sand.
• Prototyped a hinged clamshell with cable gland connectors and clips to make assembly easier and quicker for jointers.
• Developed a proof of concept joint which included a pre-formed electrically insulating gel. This solution requires no mixing or filling of a clamshell on site and is the quickest solution. The clamshell can be assembled and secured onto the joint within 5 minutes. The gel material however is very expensive.
• Generated benchmark weight and times for the current method which were previously undocumented.
For further detail see section 4.

8. Data Access & Quality Details

A description of how any network or consumption data (anonymised where necessary) gathered in the course of the Project can be requested by interested parties. Please include a link to the publicly available data policy.

For information how to request data gathered in the course of this project, see Network Innovation Competition (NIC) and Network Innovation Allowance (NIA) Data Sharing Procedure at https://ssen-innovation.co.uk/innovation-strategy/.

9. Foreground IPR

A description of any foreground IPR that have been developed by the project and how this will be owned.

N/A

10. Planned implementation, recommendations or next steps

Please describe the next steps to implement this innovation project. What policies and standards need to be updated or created as part of this implementation.

The concepts prototyped using Fillite to reduce joint weight and to replace resin and filler with an expanding foam may form the basis of a follow on project which is currently being scoped. If it proceeds, it is likely that a third option using shrink wrap will also be explored.

11. Other comments

N/A

12. Standards Documents

Identify any industry standards that may require updating due to the outcomes or understanding developed from this innovation project. If no standards will need to be updated, please state - not applicable

N/A