Further research into the performance of cables after a flood

With around 5 million[1] properties in England and Wales at risk of flooding every year, Electrical Safety First has looked at how certain types of cable perform when flood water enters a property and whether, following a suitable drying-out period they can be re-used rather than be replaced after the flood water has subsided.

Issue 36 of Switched On magazine contained a summary of the preliminary research carried out by the British Approvals Service for Cables (BASEC) for Electrical Safety First. This article summarises the second stage of this research project.

The research

Samples of the following types of flat 'twin and earth' cable, having 2.5 mm^2 live conductors were used for this stage of the research:

- 6242Y with PVC insulated solid conductors (sample D)
- 6242Y with PVC insulated stranded conductors (sample E)
- 6242B with low smoke halogen free (LSHF) insulated with solid conductors (sample F).

In order to simulate a 'typical' termination, both ends of 5 m long samples of the above cables were prepared by having 100 mm of the outer sheathing removed to expose the insulation of the live conductors and the unsheathed protective conductors therein, and 12 mm of the insulation removed at the ends of the live conductors to expose the copper conductors.

Samples of each of the three cable types, prepared as described above were placed into separate tanks filled with clean water, silty water and salty water to simulate a range of water types likely to be encountered in flood conditions. In each instance the full length of the sample cable including both prepared ends was coiled and held at a depth of 1 m below the water and left for one week.

After the week had elapsed the samples were removed from the tanks and left to dry at ambient temperature. The prepared ends were dried manually using tissue paper prior to the first post-immersion insulation resistance (IR) test being carried out.

IR testing at 500 V dc was carried out between line and cpc and neutral and cpc using an IR test instrument at the following times after withdrawal:

- Prior to immersion
- Immediately after withdrawal (once ends were dried off as described above)
- 24, 48 and 72 hours

[1] Environment Agency figures. C. 2012.

- Weekly for three weeks
- Monthly thereafter for a further three months.

The findings

6242B LSHF cable with solid conductors (sample F)

With the exception of the IR test results obtained immediately post-immersion in salty water, all IR test results were 'off scale' (in excess of 100GΩ).

On internal examination, after the final test results were recorded, it could be seen that water had penetrated along the cpc inside the sheath and the cpc was observed to have discoloured with a blackish deposit on its surface where it had been exposed to salty or silty water. There was no evidence of water penetration between the insulation and the live conductors.

It was noted that this sample had significantly lower initial (pre-test) IR than the other PVC cable under test, the difference being put down to differences in the polymer used in the insulation and during manufacture.

6242Y cable with stranded conductors (sample E)

The IR test results obtained post-immersion were lower than the pre-immersion values and continued to drop for a few days after removal from the tank. This decrease in IR was more pronounced in the sample that had been immersed in salty water. Thereafter IR of the samples that had been immersed in clean or silty water continued to recover to, relatively speaking, close to pre-immersion values.

On internal examination, after the final test results were recorded, it could be seen that water had penetrated along the cpc inside the sheath. There was extensive water penetration between the stranded conductors and their insulation.

6242Y cable with solid conductors (sample D)

The IR test results obtained post-immersion were lower than the pre-immersion values. However, unlike the other cable types tested, IR continued to drop throughout the testing period after removal from the tank and was still falling at the final test.

On internal examination, after the final test results were recorded, it could be seen that water had penetrated along the cpc inside the sheath and to a length of around 300 mm between the solid conductors and their insulation.

Summary

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- In all samples tested, measured values of IR remained significantly in excess of minimum values for such contained in *BS 7671 Requirements for electrical installations.*
- Cables having stranded conductors appear to be significantly more prone to liquid penetration than those with solid conductors.
- Cables having LSHF insulation seemed to recover more quickly and more fully than those having PVC insulation.
- Within the constraints of the testing methodology and test period duration the research indicates that following a suitable drying out period, it would appear that cables would be suitable for re-use although no conclusions could be drawn with respect to the effect of such immersion on the overall projected life of the cables.

Conclusions

The report concludes with the following recommendations:

<u>For new installations or rewires of properties in flood-prone areas</u>

- Consider using LSHF type twin and earth cables rather than PVC cables.
- Use solid conductor rather than stranded.
- Consider the merits of not using a cable with an uninsulated CPC.

<u>Actions to be taken post-flood</u>

- Test and monitor the insulation resistance of flooded cables during the drying process, once isolated, comparing them where possible to tests on non-flooded cables (for example an isolated length of identical cable in an upstairs circuit).
- LSHF cables (solid conductor) may dry out and be re-usable within a few days.
- The drying out of PVC cables may take longer and may not recover fully.
- If the insulation resistance values continue to be significantly lower or are not improving after 1 week / 1 month, then consider replacement.

If it was not necessary to replace wiring after a flood this would result in the following benefits in relation to refurbishment activities:

- Significant cost savings
- Shorter work completion time
- Reduced time period before properties can be reoccupied.

The flooding of properties is occurring more frequently in some geographic areas and ever more properties are being built in locations where flooding might occur. We feel this research, and any which may follow, will be of interest to insurers, property developers and

renovators and the like. It may also be of interest to the owners of property in areas affected by flooding who currently experience difficulty getting the relevant insurance cover on their properties.

A full copy of the test report can be viewed or downloaded for free from www.electricalsafetyfirst.org.uk/productsafety.

Electrical Safety First would like to thank BASEC for their help and assistance on this research project.

General post-flood electrical safety advice can be found at:

http://www.electricalsafetyfirst.org.uk/guides-and-advice/around-the-home/flooding-advice/.