National Grid/RITEC Tests at FGH Mannheim 15-17 Feb 2010

Summary report of the tests and results

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Introduction

Following successful tests on 400kV string insulators National Grid proposed to test insulators that are used in sub-stations. These post insulators are of a type not designed for salt-fog conditions but are intended for use in heavy-wet conditions. However they *are* used in locations prone to salt-fog conditions.

Improvement in performance, as result of the application of VoltShield, will lead to further use across the electricity supply system.

Testing Company

FGH Engineering and Test GmbH in Mannheim are accredited to ISO 9001 and 17025. They have the equipment and procedures to meet the requirements of the salt-fog tests to IEC 507 and ac and impulse tests to IEC 60060-1.

Test requirements

The tests were conducted in accordance with British Standard BS EN 60507:1993. IEC 507:1991. “Artificial pollution tests on high-voltage insulators to be used on ac systems.” The procedure involves a pre-conditioning series of high-voltage applications to induce flashovers on the insulators under test. After this series the insulators are tested for one hour to see if they pass the withstand test.

Procedure

Tests were conducted with reference to the appropriate clauses in *IEC507 section 3 Salt fog method*

Clause 7 Salt solution.
Salt is mixed in large tanks of distilled water and the salinity is constantly monitored to ensure that it is maintained at e.g. 80kg/m^3.

The following numbers refer to the clauses in the standard.

8. Spraying system

A nozzle system is used here where a flow of saline liquid from one port of the nozzle is blown out by compressed air at right angles onto the insulator under test.

The post insulators tested here had a number of nozzles mounted vertically some distance from it. This ensured an even distribution of simulated salt-fog over the test piece.

9. *Conditions before test*

Although it was a cold day outside the test building the temperature inside was within that prescribed in the standard (between 5ºC and 40ºC)

10. *Preconditioning Process*

The insulator under test was subjected to the salt-fog spray and high voltages.
The voltage was held at the reference level for up to 20 minutes.
If no flashover occurred then the voltage was raised in steps of 10% every 5 minutes until flashover did occur.
If a flashover occurred then the voltage was raised quickly to 90% of the reference level.
The voltage was then increased in 5% steps every 5 minutes until flashover occurred.
This process was repeated 8 times.

Detailed results show that the conditioning flashover level was up to ½million volts for the treated insulators. This is twice their operating voltage.
The fog was cleared and the insulator was washed-down with tap water in p reparation for the withstand test.

11. *Withstand test*

The object of the test was to confirm the specified withstand salinity of the insulator at the specified test voltage.

We have received test results. (see Table 1 overleaf)

The two salinities selected for the tests (80kg/m^3 and 160kg/m^3) are the most onerous.

Results

Results of the tests are given on Table 1 from FGH.

Table 1: Test Results

Test sample	Salinity		First test sequence		Second test sequence		Third test sequence	
			Salt fog	*Heavy wetting*	*Salt fog*	*Heavy wetting*	*Salt fog*	*Heavy wetting*
Untreated	160 kg/m³	*Test result,*	Passed	Passed	Failed	Passed	Failed	Passed
		Highest leakage current value	1860 mA	91 mA	Flashover after 32 min	172 mA	Flashover after 11 min	158 mA
		Remarks						
Treated 1	80 kg/m³	*Test result,*	Passed	Passed	Passed	Passed	Passed	Passed
		Highest leakage current value	146 mA	98 mA	253 mA	147 mA	372 mA	150 mA
		Remarks						
Treated 2	160 kg/m³	*Test result,*	Passed	Passed	Passed	Passed	Passed	Passed
		Highest leakage current value	300 mA	113 mA	556 mA	177 mA	750 mA	310 mA
		Remarks						

Comments on the results

No failures occurred with the untreated insulators at the higher salinity of 160kg/m^3.
The untreated insulators failed at both 80kg/m^3 and 160kg/m^3.

OTHER TESTS

The post insulators were subjected to the same lightning impulse, ac and switching impulse tests that were performed on the 400kV overhead-line insulator-strings at NaREC High Voltage laboratory.

Tests performed

Lightning impulse withstand voltage test to 1425kV
Power frequency withstand voltage dry test to 680kV
Power frequency wet withstand test to 630kV
Switching Impulse wet test to 1050kV

Results

The certified results show that the treated insulators passed all of these test requirements.

Conclusion

The salt-fog performance of 400kV post insulators to IEC 507 is enhanced after the application of VoltShield.

The performance under lighting impulse, alternating voltage and wet switching impulses of VoltShield-treated post insulators meet the requirements of IEC 60060-1.

APPENDIX

Insulators used on high voltage transmission and distribution systems are subjected to severe atmospheric conditions. Electrically conducting rain or salt-fog results in flashovers, short-circuits and power follow-through leading to blackouts. The cost is astronomical. Anything that can improve the performance of insulators to limit the damage must be tried. Various shapes have been devised to increase the “creepage” distance over the surface of insulators.

Fig. 1 shows the cross section of different attempts at improving insulators.

a. Equal sheds to lengthen the insulation path.

b. Unequal sheds to increase the path and also to improve performance in wet conditions where the upper shed “protects” the shorter shed and the underside may remain dry.

c. Equal but with more shallow fog-resistant sheds.

d. Equal but with deep protective sheds. These are used in salt-fog conditions.

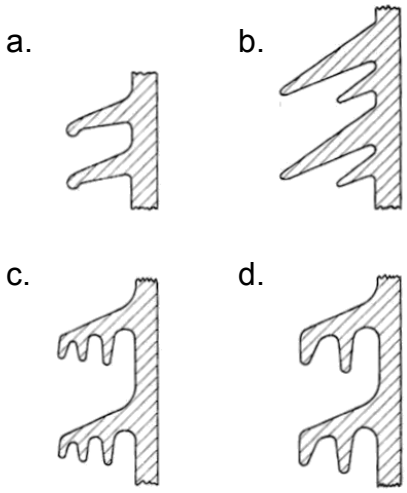

Fig .1: Common re-entrant profiles of insulators. None of these common shapes can be made by pressing or moulding, in porcelain. Sections must be made and stuck-up, or shapes must be turned

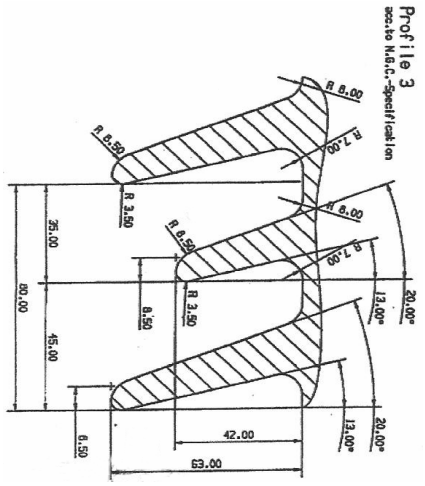

Fig. 2: Profile of the insulator tested

Fig. 3 shows the post insulator ready for test at FGH Mannheim. The total insulator height is 3.83m high and is mounted on a 2m plinth. The total creepage distance is 10.5m.

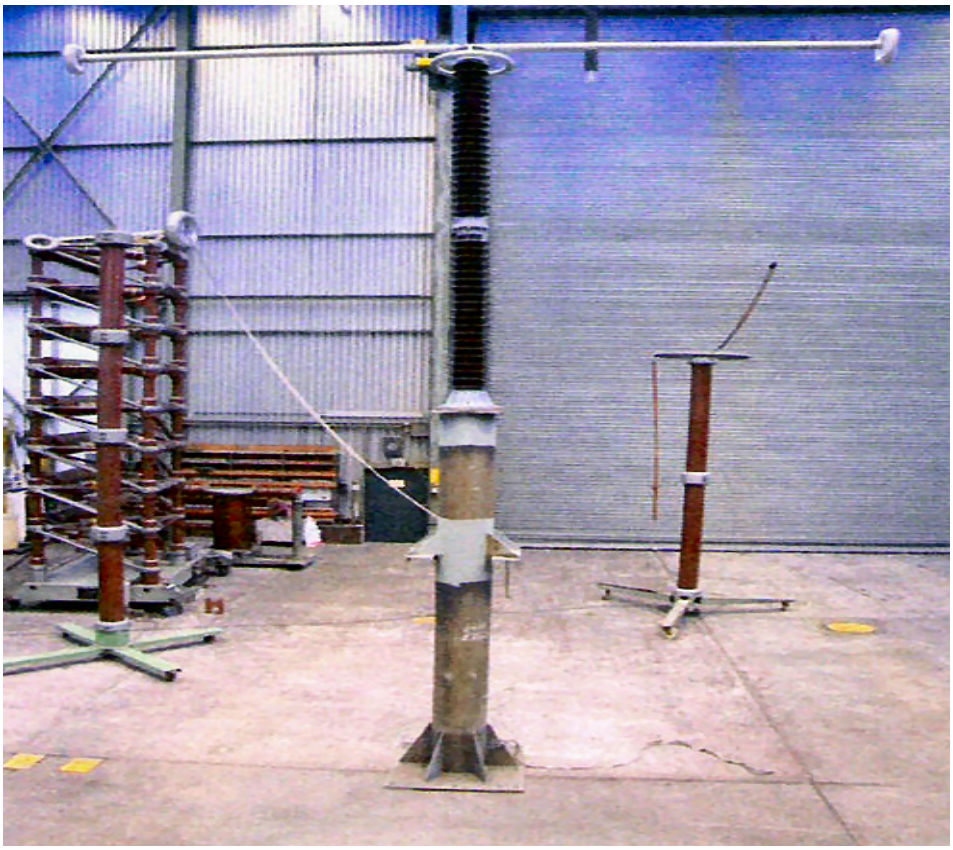

Fig. 3: Post insulator installed in FGH high-voltage laboratory, prepared for LI withstand test

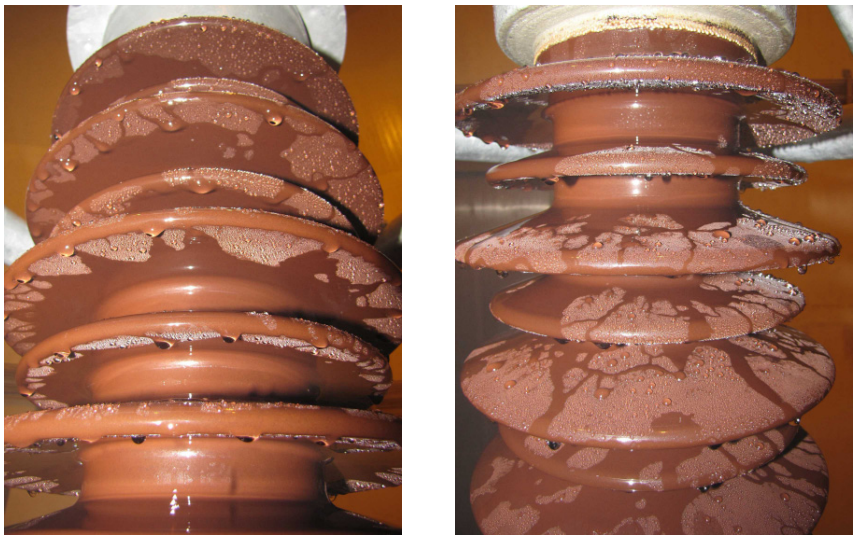

Fig. 4: Photographs showing the condition of the treated post insulators after tests at FGH Mannheim