

Paper 017: A Round Robin Test of the Water Induced Corona Test

P. Sidenvall, I. Gutman
STRI
Box 707, 77180 Ludvika
Sweden

L. Carlshem, J. Bartsch
Svenska Kraftnät



STRI

Introduction

- Line composite insulators were first used in polluted areas (main driving force)
- At present are more and more used in light polluted and clean areas
- Deterioration in clean environments found
- More complicated insulation structures
- **Grading of electric field is needed**



STRI/EPRI: criteria established

- The limit of electric field on the grading ring 1,8 kV/mm
- The limit of average electric field along the housing surface 0,42 kV/mm for 10 mm along the insulator surface

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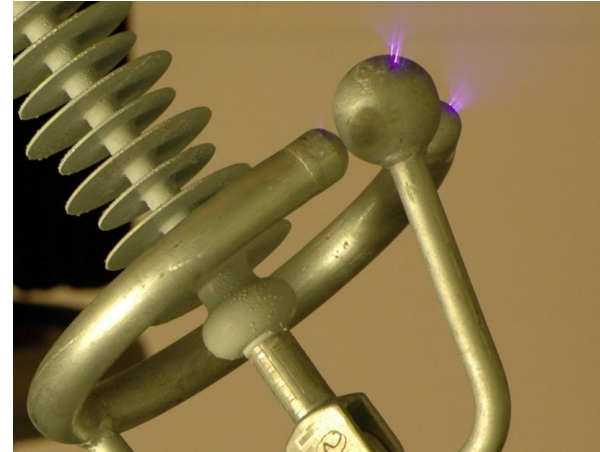
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Electric-Field Limits for the Design of Grading Rings for Composite Line Insulators

A. J. Phillips, *Member, IEEE*, A. J. Maxwell, *Member, IEEE*, C. S. Engelbrecht, *Member, IEEE*, and I. Gutman, *Senior Member, IEEE*

Development of test for verification of maximum E-field for water drop corona case

- Corona from metal 



- Corona from water drop 



Verification for full-scale insulators 400 kV

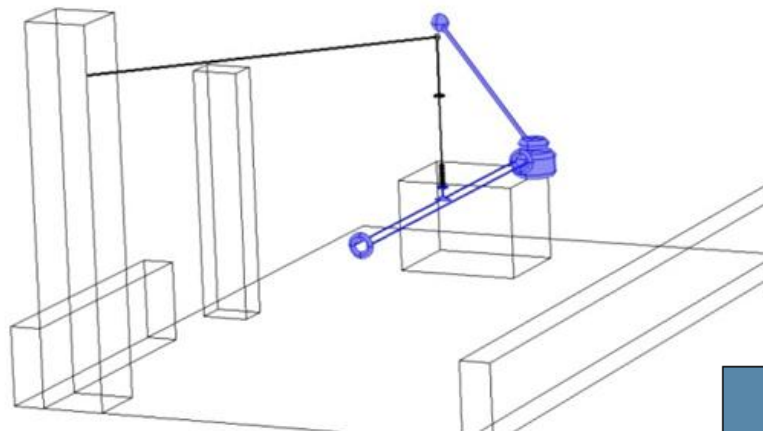
Insulator	Corona inception voltage	Maximum average E-field along 10 mm at corona inception voltage	Prediction of results from calculations at 267 kV	Corona on housing at 267 kV
	kV	kV/mm	kV/mm	Yes/No
Design-1.1	290	0.42	0.38	No
Design-1.2	300	0.43	0.38	No
Design-1.3	340	0.49	0.38	No
Design-2.1	290	0.44	0.41	No
Design-2.2	280	0.43	0.41	Yes
Design-2.3	300	0.46	0.41	No
Design-3.1	330	0.52	0.42	No
Design-3.2	300	0.47	0.42	No
Design-3.3	320	0.50	0.42	No

Verification for insulation structure 400 kV



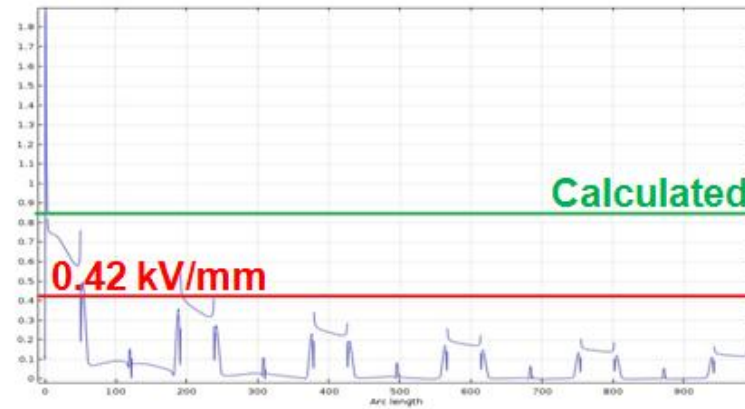
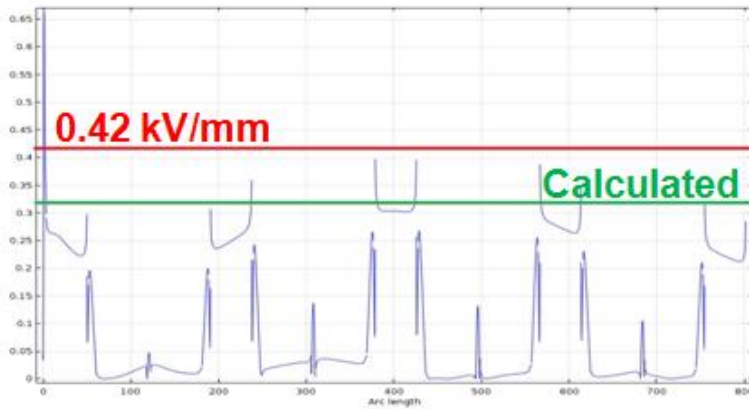
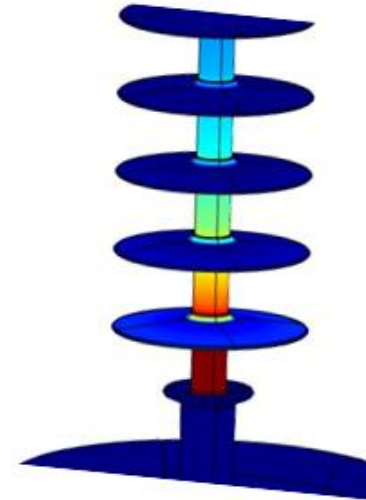
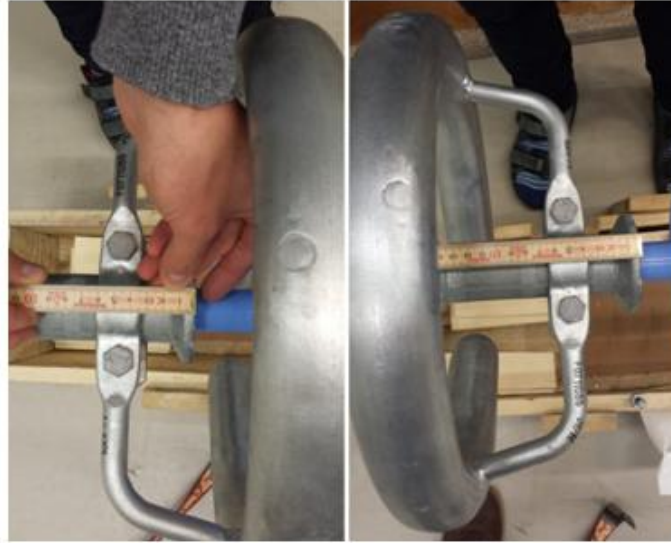
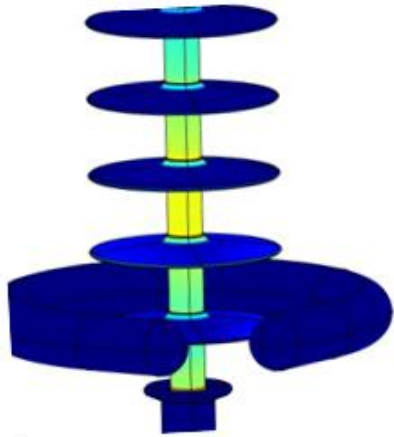
Tested	Voltage	Corona	Maximum average electric field along 10 mm of housing	Maximum electric field at triple point
	kV	Yes/No	kV/mm	kV/mm
Inclined in pivoting arrangement	292	No	0,41	0,22
Post in pivoting arrangement	292	No	0,28	0,08
Inclined in non-pivoting arrangement	292	No	0,37	0,19
Post in non-pivoting arrangement	292	No	0,35	0,13

Electric field calculations for Round Robin Test in 5 HV laboratories



Criterion	Maximum average electric field along 10 mm of the housing
	0,42 kV/mm
Correct positioned grading ring	0,32 kV/mm
Incorrect positioned grading ring	0,85 kV/mm

Round Robin Test (5 laboratories): test objects



Round Robin Test (5 laboratories): test set-up and method

- Set-up and environment as per standard RIV-test
- The wetting should be made by the spray bottle recommended for the wettability test according to the IEC 62073.
- The voltage should be applied similar to the RIV test, i.e. first should be increased to corona inception voltage and then reduced to a target voltage of 100% of maximum operating voltage.
- The observation of corona should be made by two standard photo cameras, installed in parallel at two height levels, with 30 seconds shutter time.
- The acceptance criterion is the absence of visible corona at 100% of maximum operating voltage.



Test results – test conditions

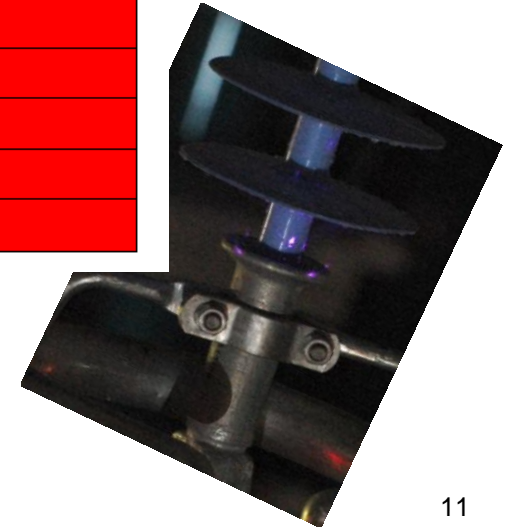
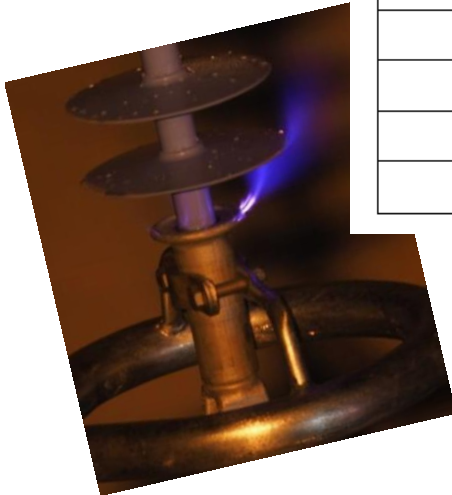
Laboratory	Ambient conditions		
	Relative humidity (%) Requirement 45-75	Temperature (°C) Requirement 10- 35	Air pressure (mm) Requirement 870-1070
1	50	19	993
2	42,3	18,6	977
3	71,8	11,3	985,3
4	NA	NA	NA
5	47,5	17,5	937,1

Round Robin Test: results

Czech Republic, France, Germany, Japan, Sweden



Laboratory	Correct grading ring position	Incorrect grading ring position
	Water drop corona on housing Yes/No	Water drop corona on housing Yes/No
1	No	Yes
2	No	Yes
3	No	Yes
4	No	Yes
5	No	Yes



Comparison with IEC requirements presented to CIGRE WG B2.57 in March-2017

IEC requirement	Fulfilled?	Comment
Representativeness	Yes	Yes, good correspondence with E-field calculations used to design insulators for the latest decades
Repeatability	Yes	The same levels of corona inception and extinction in three series of tests with three different manufacturers
Reproducibility	Yes	Five different laboratories have reproduced the test with similar results
Cost-effectiveness	Yes	It is very cost effective if combined with standard RIV-test using the same arrangement

Summary

- The criteria for the limiting of the E-field in sensitive parts of a composite insulator are established after comprehensive research performed separately by STRI and EPRI, but leading to the same results.
- The electric field calculations predict the outcome of the test correctly.
- The results of testing for water induced corona on housing are the same for all five participating laboratories.
- It is possible to verify the results of electric field calculations using the new-developed Water Drop Corona Induced (WDCI) test procedure. At this stage the WDCI test fulfils all four typical IEC requirements.
- The test method is very cost effective if performed in conjunction to the standard RIV and/or corona test. The test procedure can be considered as an additional type test in the user's specification for composite insulators.
- A combination of E-field calculations and their verification by laboratory testing creates a good basis for the optimal dimensioning of grading rings for composite insulators.

Thank You!

