UHS 10kA Arrester

Certified Test Report

IEC 60099-4 2004

CERTIFICATION

Statements made and data shown are, to the best of our knowledge and belief, correct and within the usual limits of commercial testing practice.

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INTRODUCTION

This test report certifies that the UltraSIL VariSTAR arresters UHS Class 1 – 10kA were successfully tested to IEC 60099-4:2004 “Metal-Oxide surge arresters without gaps for a.c. systems”.

TEST PROGRAM

OBJECT

To demonstrate that the UltraSIL VariSTAR Arresters Class 1 –10kA meet all performance requirements.

PROCEDURE

The following design tests were performed on a sufficient number of samples to demonstrate all performance requirements are met.

TYPE TESTS

A. Insulation Withstand Test
   a) Lightning Impulse Voltage Test …… Per IEC 60099-4 Section 8.2.6
   b) Power Frequency Voltage Test…..……. Per IEC 60099-4 Section 8.2.8
B. Residual Voltage Test
   a) Steep Current Impulse Residual Voltage Test .. Per IEC 60099-4 Section 8.3.1
   b) Lightning Impulse Residual Voltage Test ……. Per IEC 60099-4 Section 8.3.2
   c) Switching Impulse Residual Voltage Test …… Per IEC 60099-4 Section 8.3.3
C. Long Duration Current Impulse
   Withstand Test …… Per IEC 60099-4 Section 8.4.2
D. High Current Impulse Operating Duty Test ……. Per IEC 60099-4 Section 8.5.4
E. Power Frequency Voltage vs. Time ……. Per IEC 60099-4 Section 6.10, Annex D
F. Characteristics of an Arrester Short Circuit Tests .. Per IEC 60099-4 Section 6.11
G. Internal Partial Discharge Tests …… Per IEC 60099-4 Section 8.8
H. Moisture Ingress Test
   a) Terminal Torque Pre-conditioning.…… Per IEC 60099-4 Section 10.8.13.2.1
   b) Thermo Mechanical Pre-conditioning..…….. Per IEC 60099-4 Section 10.8.13.2.2
   c) Water Immersion Test.…… Per IEC 60099-4 Section 10.8.13.3
   d) Verification Tests …… Per IEC 60099-4 Section 10.8.13.4
I. Weather Aging Tests
   a) Test Series A: 1000 hr ……. Per IEC 60099-4 Section 10.8.14.2.1
   b) Test Series B: 5000 hr ……. Per IEC 60099-4 Section 10.8.14.2.2
J. Mechanical Tests
   a) Test of the Bending Moment …….. Per IEC 60099-4 Section 8.9
   b) Sulphur Dioxide Test ……. Per IEC 60099-4 Section 8.10.3.2
   c) Salt Mist Test ……. Per IEC 60099-4 Section 8.10.3.3
K. Disconnector Operation ……. Per IEC 60099-4 Section 8.6.3

RESULTS

The UltraSIL VariSTAR arresters met all performance requirements of IEC 60099-4:2004.

TEST A:
INSULATION WITHSTAND

Test Report Number: SD-E232A/2005
Certifying Laboratory: LAPEM

Object: To demonstrate the voltage withstand capability of the external insulation of the arrester housing.

Lightning Impulse Voltage Test
Procedure: The sample was clean and dry. The sample was subject to fifteen positive and negative 1.2 X 50 μs impulses.

Results: The sample passed with less than two discharges at the positive and negative voltage values. No internal discharges occurred.

Power Frequency Voltage Test
Procedure: The sample was clean and tested under wet conditions. The sample was subject to a power frequency voltage of 1.06 times the switching impulse protection level for a period of sixty seconds.

Results: The sample passed with no discharges during the sixty-second period.

TEST B:
RESIDUAL VOLTAGE TESTS

Test Report Number: A6/021601
Certifying Laboratory: CESI

Object: To determine the maximum discharge voltage for each discharge current.

Lightning Impulse Residual Voltage Test
Procedure: A lightning current impulse was applied to each sample for approximately 0.5, 1, and 2 times the nominal discharge current. The current impulse had a front time between 7μs to 9μs and the virtual time to half-value on the tail was between 18μs to 22μs.

Switching Impulse Residual Voltage Test
Procedure: One switching current impulse was applied to each sample at 125 A and 500 A. The current impulse had a front time greater than 30μs and less than 100μs and a virtual time to half-value of approximately twice the virtual front time.

Steep Current Impulse Residual Voltage Test
Procedure: One steep current impulse was applied to each sample with a peak value equal to the nominal discharge current of the arrester. The current impulse had a front time between 0.9μs to 1.1μs and the virtual time to half-value on the tail was not longer than 20μs.

Results:

UltraSil HD Star		1/2 Wave	8/20 Wave Forms						30/60 Switching Surge	
Rating	MCOV	(kV, peak) 10 kA	(kV, peak) 1.5 kA	(kV, peak) 3 kA	(kV, peak) 5 kA	(kV, peak) 10 kA	(kV, peak) 20 kA	(kV, peak) 40 kA	(kV, peak) 125 A	(kV, peak) 500 A
3	2.55	10.8	8.2	8.7	9.1	9.9	10.9	12.3	7.1	7.6
6	5.1	21.5	16.3	17.4	18.2	19.8	21.9	24.7	14.1	15.1
9	7.65	32.4	24.6	26.1	27.3	29.8	33.0	37.1	21.3	22.7
10	8.4	34.4	26.0	27.7	29.0	31.6	34.9	39.4	22.6	24.1
12	10.2	43.2	32.7	34.8	36.4	39.7	43.9	49.5	28.3	30.3
15	12.7	52.2	39.6	42.1	44.0	48.0	53.1	59.8	34.3	36.6
18	15.3	64.8	49.1	52.3	54.7	59.6	65.9	74.2	42.6	45.5
21	17	68.8	52.1	55.4	58.0	63.2	69.9	78.7	45.1	48.2
24	19.5	79.5	60.2	64.1	67.0	73.1	80.8	91.1	52.2	55.8
27	22	92.4	70.0	74.5	77.9	84.9	93.9	106	60.6	64.8
30	24.4	100.5	76.1	81.0	84.7	92.4	102	115	66.0	70.5
33	27	114.2	86.5	92.1	96.3	105	116	131	75.0	80.1
36	29	120.8	91.5	97.3	102	111	123	138	79.3	84.7

TEST C:
LONG DURATION CURRENT IMPULSE WITHSTAND TEST

Test Report Number: A6/021602
Certifying Laboratory: CESI

Object: To demonstrate the ability of the arrester to meet the long duration current impulse withstand test requirements.

Procedure: The sample was subject to eighteen impulses, divided into six groups of three operations, with approximately 60 seconds between impulses. The samples cooled to ambient temperature between impulses.

Results: The samples met test requirements with less than 5% change in residual voltage and no physical damage.

TEST D:
HIGH CURRENT IMPULSE OPERATING DUTY TEST

Test Report Number: A6/021603
Certifying Laboratory: CESI

Object: To demonstrate the ability of the arrester to meet the high current impulse operating duty test requirements.

Procedure: The sample was subject to twenty 8/20 lighting current impulses with a peak value equal to the nominal discharge current of the arrester with the sample at U_C'. The impulses were divided into four groups of five impulses, with 50-60 s between impulses and 30 minutes between groups. The sample was then subject to two 100kA $\pm$ 10kA high current impulses. Within 100ms of the second impulse, the sample shall be energized at U_R' for 10 s and U_C' for 30 minutes.

Results: The samples met test requirements with less than 5% change in residual voltage, achieving thermal stability, and no physical damage.

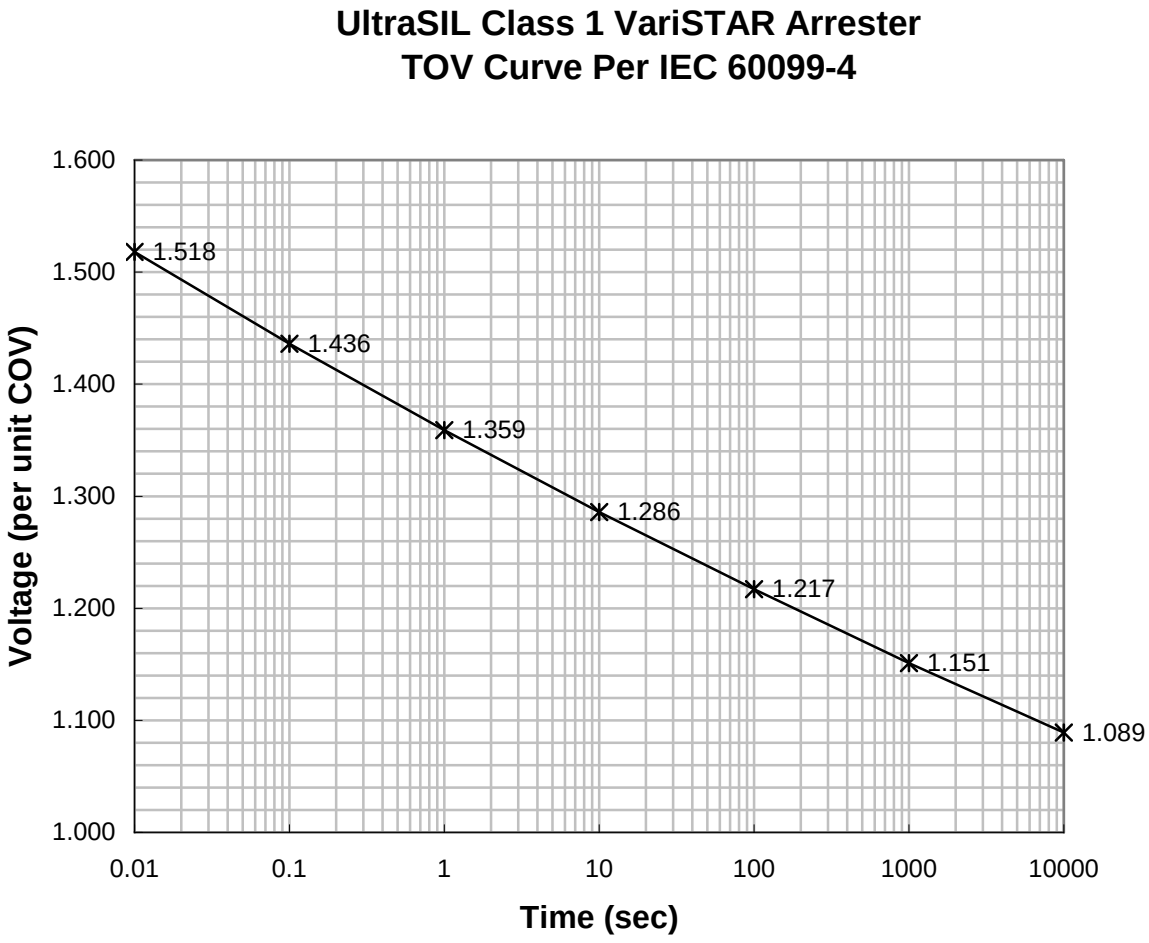
TEST E:
POWER FREQUENCY VOLTAGE VS. TIME

Test Report Number: A6/021605
Certifying Laboratory: CESI

Object: To determine the over voltage values and time durations for the arrester design.

Procedure: The sample was subject to one high current impulse. The sample was then subject to each over voltage at each specified time range. The recovery voltage of U_C' was applied to the sample for thirty minutes.

Results:



TEST F:
CHARACTERISTICS OF AN ARRESTER: SHORT CIRCUIT TEST

Test Report Number: S1-03165A
Certifying Laboratory: KEMA

Object: To verify arrester internal fault is not likely to create an explosive event.

Procedure: Samples were thermally pre-killed using an over voltage applied for 5±3 minutes. Two 21kV arresters were then tested at full voltage and four 60kV arresters were tested at a reduced voltage.

Results: The 21kV arresters tested at full voltage met high current test requirements of 20kA. The 60kV arresters tested at reduced voltage met high current test requirements of 20kA. The 60kV arresters tested at reduced voltage met low current test requirements of 600A.

TEST G:
INTERNAL PARTIAL DISCHARGE TESTS

Test Report Number: A4-003926
Certifying Laboratory: CESI

Object: To verify the arrester design does not generate excessive partial discharge.

Procedure: The sample was energized to the rated voltage for 2 seconds. The voltage was then lowered to 1.05 * U_C and the partial discharge level was recorded.

Results: The samples met test requirements with partial discharge ≤ 10pC.

TEST H:
MOISTURE INGRESS TEST

Test Report Number: A4-003914
Certifying Laboratory: CESI

Object: To verify the arrester design will not decrease in performance under thermo-mechanical and moisture conditions.

Procedure: The samples were subjected to a series of preconditioning tests including power loss, internal partial discharge, residual voltage, terminal torque, and thermo-mechanical preconditioning. The samples were then immersed in boiling de-ionized water with $1kg/m^3$ of NaCl for a period of 42 hours. The samples remained in the water until the temperature cooled to 50 ^oC. After the samples reached ambient temperature they were tested for changes in power loss, internal partial discharge and residual voltage.

Results: All samples showed no signs of physical damage, demonstrated less than a 20% change in power loss, the internal partial discharge did not exceed 10pC, and there was a less than 5% deviation in residual voltage with no signs of breakdown seen in the voltage and current oscillograms.

TEST I:
WEATHER AGING TESTS

TEST SERIES A: 1000 HR

Test Report Number: T04-1374
Certifying Laboratory: STRI

Object: To verify the ability of the arrester to withstand continuous salt fog conditions and endure surface arcing and heating.

Procedure: The samples were placed in an enclosure filled with a salt fog mist. The samples were energized at U_C for a period of 1000 hours. The samples underwent pre and post testing consisting of partial discharge and reference voltage.

Results: All samples met the test requirements of: no housing punctures or housing erosion, no internal breakdowns, no surface tracking was evidenced by physical examination, the arrester reference voltage did not decrease by more than 5%, and the partial discharge level did not exceed 10 pC.

TEST SERIES B: 5000 HR

Test Report Number: T04-1329
Certifying Laboratory: STRI

Object: To verify the ability of the arrester to withstand continuous salt fog conditions and endure surface arcing and heating.

Procedure: One 60kV surge arrester was placed under various environmental stresses in a cyclic manner while energized at U_C for a period of 5000 hours. These stresses included solar radiation simulation, artificial rain, dry heat, damp heat, high dampness at room temperature, and salt fog at low concentration. The sample underwent pre and post testing consisting of partial discharge and reference voltage.

Results: All samples met the test requirements of: no housing punctures or housing erosion, no internal breakdowns, no surface tracking was evidenced by physical examination, no over current trip out, the arrester reference voltage did not decrease by more than 5%, and the partial discharge level did not exceed 5 pC.

TEST J:
MECHANICAL TESTS

TEST OF THE BENDING MOMENT:

Test Report Number: A4-003923
Certifying Laboratory: CESI

Object: To verify the arrester could withstand cantilever and environmental stresses.

Procedure: The maximum permissible static load (180 Nm) was applied to the upright arrester for a period of 60 – 90 seconds. The sample was then immersed in a vessel, boiled in de-ionized water with 1 kg/m^3 of NaCl for 42 hours. At the end of the boiling, the sample remained in the vessel until the water cooled to 50 °C. The sample underwent pre and post testing consisting of power loss, partial discharge and residual voltage.

Results: The sample showed no physical damage, the power loss did not increase by more than 20 % of the initial measurement, the partial discharge did not exceed 10 pC at 1.05*Uc, and the residual voltage at the same discharge current did not deviate by more than 5%.

SULPHUR DIOXIDE AND SALT MIST TESTS:

Test Report Number: 13-7351-20-04-3A-rev2
Certifying Laboratory: Thomas A. Edison Technical Center

Object: To verify the arrester could withstand cantilever and environmental stresses.

Procedure: The arrester was placed in an airtight box with sulphur dioxide gas for a period of 21 days. The sample was then placed in a chamber with a salt mist atmosphere for a period of 96 hours. The sample underwent pre and post testing of partial discharge.

Results: The sample showed no physical damage and the partial discharge did not exceed 10 pC at 1.05*Uc.

TEST K:
DISCONNECTOR OPERATION

Test Report Number: A4-000660
Certifying Laboratory: CESI

Object: To verify the disconnector was effective and permanently disconnected from arrester.

Procedure: Five disconnectors were tested without the surge arrester at 20A, 200A, and 800 A. The applied voltage was approximately 2700 V.

Results: In each test, the samples disconnected and the separation was permanent.