File Ref: CT235006EN | Effective April 2022 New Issue | **COOPER POWER** SERIES

UltraSIL™ Polymer-Housed VariSTAR™ Type UHS Class DH Distribution-Class Surge Arresters Certified Test Report

Powering Business Worldwide

UltraSIL™ Polymer-Housed VariSTAR™ Type UHS Class DH Distribution-Class Surge Arresters

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.

Manager of Product Engineering - Arresters

INTRODUCTION

This test report certifies that the UltraSIL VariSTAR arresters UHS Class Distribution – DH were successfully tested to IEC 60099-4 TM:2014 “Metal-Oxide surge arresters without gaps for a.c. systems”.

TEST PROGRAM

OBJECTIVE

To demonstrate that the UltraSIL VariSTAR Arresters Class Distribution - DH 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

	Test Description	Per IEC60099-4:2014 section
A.	Insulation Withstand test	10.8.2
B.	Residual Voltage test	10.8.3
C.	Test to verify long term stability under continuous operating voltage	10.8.4
D.	Repetitive charge transfer withstand	10.8.5
E.	Heat dissipation behavior of test sample	10.8.6
F.	Operating duty test	10.8.7
G.	Power-frequency voltage versus time test	10.8.8
H.	Arrester Disconnector	10.8.10 9
I.	Short-circuit Test (Design B)	10.8.10
J.	Test of the bending moment	10.8.11
K.	Weather ageing test	10.8.17

RESULTS

The UltraSIL VariSTAR arresters met all performance requirements of IEC 60099-4:2014.

TEST A:
INSULATION WITHSTAND

Test Report Number: B8000322
Certifying Laboratory: CESI

Objective: 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 applied voltage was 1.3 times the maximum residual voltage at the nominal discharge current. 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 with a peak value of 0.88 times the lightning impulse protection level for a period of one minute.

Results: The sample passed with no discharges during the one-minute period.

TEST B:
RESIDUAL VOLTAGE TESTS

Test Report Number: B87021541
Certifying Laboratory: CESI

Objective: 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.

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.

Table 1: Maximum Residual Voltage Characteristics

UltraSil HD Star		1/2 Wave	8/20 Wave Forms						30/60 Switching Surge	
Rating	MCOV	(kV, peak)	(kV, peak)	(kV, peak)	(kV, peak)	(kV, peak)	(kV, peak)	(kV, peak)	(kV, peak)	(kV, peak)
		10 kA	1.5 kA	3 kA	5 kA	10 kA	20 kA	40 kA	125 A	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:
Test to Verify Long Term Stability under Continuous Voltage

Test Report Number: B87020999
Certifying Laboratory: CESI

Objective: To demonstrate the ability of the metal-oxide resistors to remain thermally stable (decreasing power loss) throughout the expected lifetime of the arrester in the surrounding medium applicable for the design

Procedure: The sample were heated in an oven to 115°C and energized to a corrected voltage U_c' and further corrected by unbalancing factor due to voltage distribution for a duration of 1000 hours.

Results: During the aging test, all measurements of power loss including final measurements were not greater than 1.1 x the starting power loss and have satisfied the acceptance criteria showing a decreasing trend

TEST D:
Repetitive Charge Transfer Withstand

Test Report Number: B87022894
Certifying Laboratory: CESI

Objective: To demonstrate the ability of the arrester to transfer charge

Procedure: The 10 samples were subject to twenty lightning impulses 8/20 with an amplitude resulting in a current density of 0.5kA/cm^2, divided into ten groups of two 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 5% change in reference voltage and no mechanical damage after the final application of a current impulse of 8/20 as revealed by visual inspection.

TEST E:
Heat Dissipation Behavior Verification of Test Sample

Test Report Number: B87021751
Certifying Laboratory: CESI

Objective: To demonstrate the thermal equivalent section cools equal to or slower than the complete arrester

Procedure: The complete arrester equipped with fiber optic temperature probes was placed in the testing laboratory at still ambient air of 19.5°C and was heated to a temperature of approximately 140°C by applying a power frequency over-voltage above the reference voltage. After the goal temperature of 140°C was reached, the source was disconnected and the cooling curve was monitored for more than two hours. The thermal equivalent section was then placed in was placed in the testing laboratory at still ambient air of 20.2°C and was heated to a temperature of approximately 140°C (corrected for differences in ambient temperature) by applying a power frequency over-voltage above the reference voltage. After the goal temperature of 140°C was reached, the source was disconnected and the cooling curve was monitored for more than two hours

Results: The thermal equivalent section met the goal by cooling slower than the complete arrester throughout the cool curve time range of more than two hours.

TEST F:
OPERATING DUTY TEST

Test Report Number: B7021795
Certifying Laboratory: CESI

Objective: To demonstrate the ability to recover after transfer of the thermal charge Q_{th}

Procedure: After application of a high current impulse 4/10 µs at 100kA. The thermal equivalent section was then heated in an oven at the temperature of 61°C till thermal equilibrium was reached. The section was then injected with two lightning current impulses 8/20 µs at the thermal charge transfer of Q_{th} of 0.55 C per impulse. 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, no sign of breakdown as verified by the oscillograms, achieving thermal stability. After the samples had cooled to ambient temperature, two current impulses 8/20 µs one-minute apart at the nominal discharge current have been applied to check the integrity of the internal parts.

TEST G:
POWER FREQUENCY VOLTAGE VS. TIME

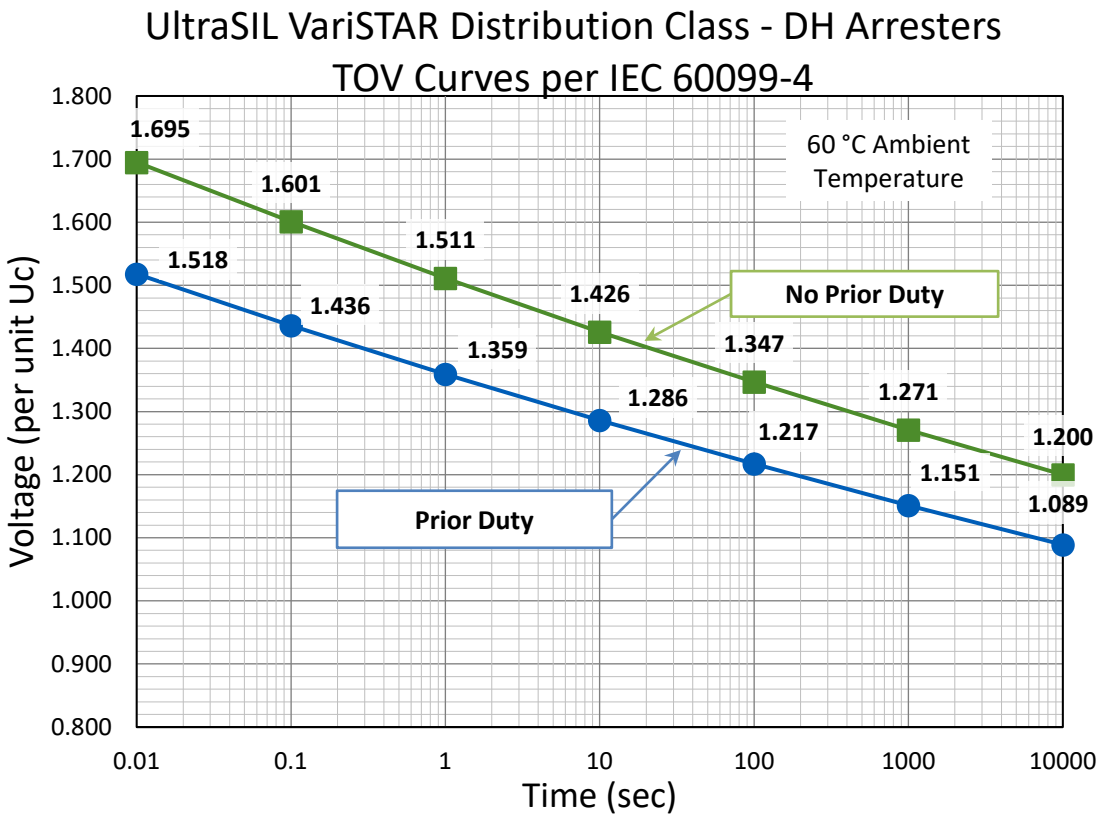
Test Report Number: B7022031
Certifying Laboratory: CESI

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

Procedure: Two samples were tested with no prior duty. Four samples were tested with prior duty. The samples were heated in an oven to 60 °C until thermal equilibrium was reached. The two samples with no prior duty were tested at:
1.211 x U_r' for 10 sec and 1.059 x U_r' for 1000 sec
The recovery voltage of U_C' was applied to the sample for thirty minutes.

The four samples were subject to two lightning current impulses 8/20 at the rated thermal charge transfer Q_{th} of 1.1 C then tested at:
1.133 x Ur' for 1 sec
1.072 x Ur' for 10 sec
1.014 x Ur' for 100 sec
0.959 x Ur' for 1000 sec
The recovery voltage of U_C' was applied to the sample for thirty minutes.

Results: The variation of lightning impulse residual voltage before and after the test was less than 5% The thermal stability was achieved.



TEST H: Arrester Disconnector

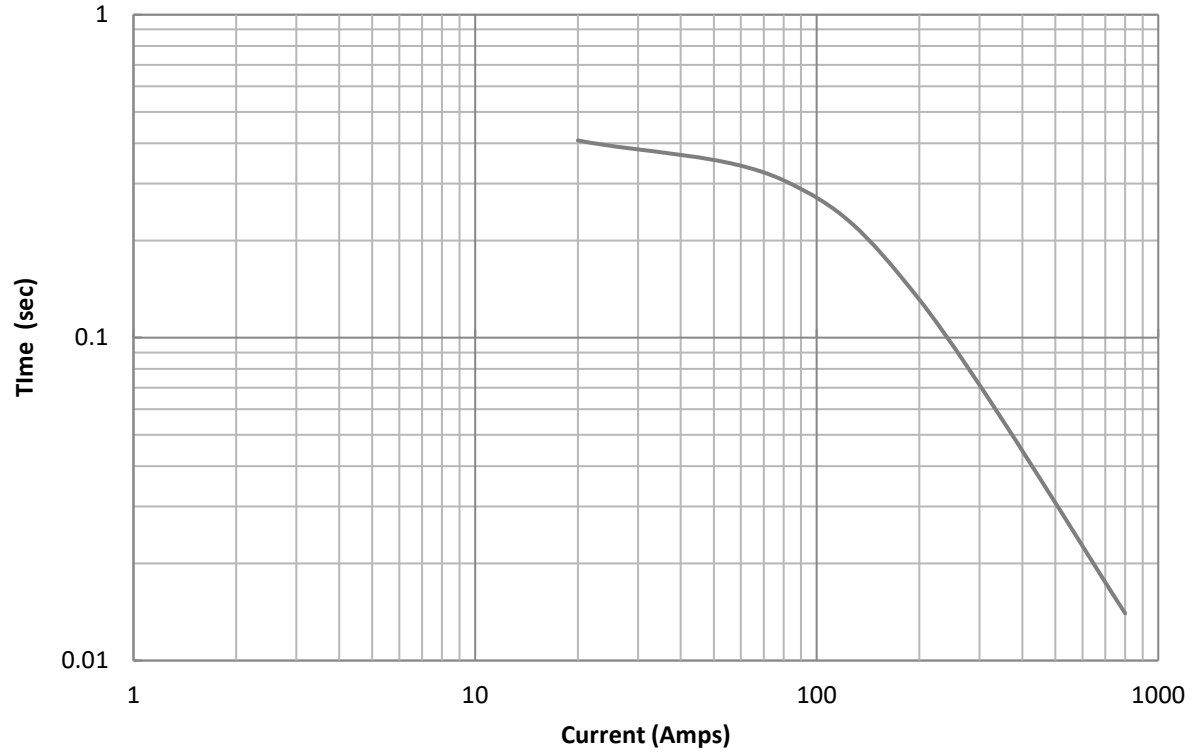
Test Report Number: A4-000660
Certifying Laboratory: CESI

Objective: 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.

Isolator Disconnect Curve



TEST I:
SHORT- CIRCUIT TEST

Test Report Number: B7001288
Certifying Laboratory: CESI

Objective: 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. The four 60kV arresters were tested at a reduced voltage.
-High current short-circuit test with 20.6 kA for 0.21 sec.
-High current short-circuit test with 12.4 kA for 0.21 sec.
-High current short-circuit test with 6.25 kA for 0.21 sec.
-Low Current short-circuit test with 630 A for 1.02 sec.

Results: 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.
The 60kV arresters tested at reduced voltage met all test requirements

TEST J: Bending Moment

Test Report Number: B7021096
Certifying Laboratory: CESI

Objective: This test demonstrates the ability of the arrester to withstand the declared values for bending loads. Specified long-term load (SLL) and Specified short-term load (SSL) for UHS – Distribution Class – DH.

Procedure: a) All three samples were subjected to 1000 cycles of bending moment, each cycle comprising loading from zero to SLL of 180 Nm in one direction, followed by loading to SLL in the opposite direction, then returning to zero load. The cyclic motion shall be approximately sinusoidal form at 0.1 Hz.

b) Two of the samples from procedure a) were subjected to a bending moment test. The bending load was increased smoothly to SSL of 225 Nm over 60 s. During this time the deflection was measured. then the load was released smoothly. The maximum deflection was recorded 10 min after the release of the load. The third sample from procedure a) was subjected to a terminal torque. A terminal torque of 27Nm was applied for 30 sec. This sample was then subjected to four 24 hours thermal cycles of heating and cooling as shown in fig. 11 of the reference standard while mechanically stressed at the specified load of 180Nm. The load direction was changed every 24 hours according to fig. 12 of the reference standard

c) Subject all three samples to water immersion test. The samples were kept for 52 hours at 80°C in a deionized water with 1kg/m3 of NaCl.

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 $1.05*U_c$, and the residual voltage at the same discharge current did not deviate by more than 5%. The change in reference voltage was less 2%.

TEST K:
WEATHER AGING TESTS

TEST SERIES A: 1000 HR

Test Report Number: T04-1374
Certifying Laboratory: STRI

Objective: 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 UV LIGHT

Test Report Number: B803644
Certifying Laboratory: CESI

Objective: To verify the material of the polymer housing is stable under UV Light

Procedure: Three samples of housing material 150 x 100 mm were subjected to 1000 hours of UV Light.

Results: All samples met the test requirements of no cracks or raised surfaces. The surface roughness was measured and met the requirement of < 0.1 mm.

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REVISION TABLE

REVISION NO.	DATE	WHAT WAS ADDED/CHANGED
0	04/2022	New Report

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Cooperpower.com

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